FM 5-106

EMPLOYMENT OF ATOMIC DEMOLITION MUNITIONS

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PREFACE

This manual establishes doctrine for the use of atomic demolition munitions (ADM) on the battlefield. It is a guide to commanders and their staffs during the planning and execution phases of tactical nuclear operations. It provides the user with the what, why, who, when, where, and how of atomic demolition munitions planning and employment on the battlefield.

FM 5-106 is an integral part of the series of operational level engineer how-to-fight manuals that implement the AirLand Battle doctrine. Employment of ADM is a critical asset in countermobility efforts to limit the maneuverability of the enemy's forces.

STANAG IMPLEMENTATION

The provisions of this publication are the subject of international agreements STANAG 2130 (Employment of Atomic Demolition Munitions) and STANAG 2139 (Atomic Demolition Munitions [ADM] Operations Order).

NEEDED PUBLICATIONS

For guidance on the employment of nuclear weapons, see Field Manual (FM) 101-31-1. The classified technical data for nuclear systems, including ADM, are in FM 101-31-2 (SRD).

This manual repeats information presented in other field manuals only as required for clarity, consistency, and continuity. Therefore, it must be used in conjunction with the following field manuals: 3-22, 100-50, 101-31-1, 101-31-2(SRD), and 101-31-3. Other references listed in appendix A should be available for occasional use.

USER INFORMATION

The proponent agency of this publication is the US Army Engineer School. Submit changes for improving this publication on DA Form 2028 (Recommended Changes to Publications and Blank Forms) and forward to US Army Engineer School, ATTN: ATZA-TD-P, Fort Belvoir, Virginia 22060.

THE ADM--OVERVIEW

This chapter defines ADM and provides an overview of obstacle employment, when and where ADM are used, who uses them, and who controls their use.

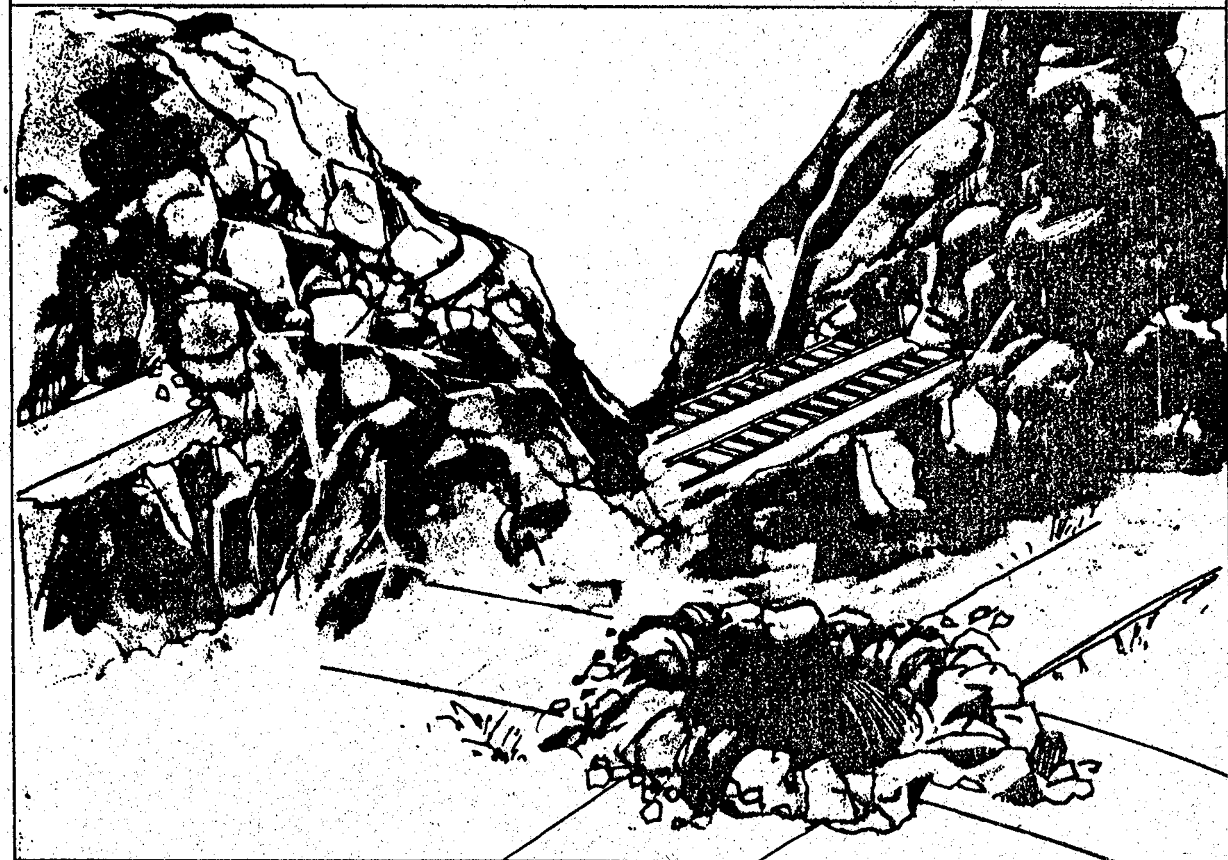
WHAT ADM ARE

Atomic demolition munitions (ADM) are nuclear devices designed to be detonated on or below the ground surface or underwater as a demolition munition against material-type targets to block, deny, and/or canalize the enemy. ADM are used primarily to create obstacles but may also be used to deny enemy use of facilities or supplies.

WHY OBSTACLES ARE USED

Obstacles are used to multiply the effectiveness of friendly combat forces. An obstacle is any obstruction that stops, delays, or restricts movement. Obstacles vary in size and are classified as existing or reinforcing. Existing obstacles are natural (drainage features, mountains, weather conditions like snow and fog, and forest) or cultural (man-made lakes, canals, embankments, cultivated farmlands, and built-up areas). Reinforcing obstacles are created on the battlefield. These include abatis or tree blowdown, antitank ditches, chemical or nuclear contamination, concrete and steel barricades, destroyed bridges, destroyed tunnels, landslides, minefields, road blocks and craters, and wire entanglements.

REINFORCING OBSTACLES



The objective of obstacle employment is battlefield terrain enhancement. The tactical commander analyzes the terrain to determine how existing obstacles can support tactical operations. Reinforcing obstacles are then created to block or restrict lanes in terrain, to strengthen weakly defended areas, and to extend existing obstacles. Obstacles are carefully integrated with friendly fires and the scheme of maneuver. The commander employs obstacles as combat multipliers to--

- Enhance effectiveness of friendly fires.
- Delay and disrupt enemy formations.
- Divert the enemy.
- Facilitate economy of force.
- Protect flanks.
- Deny the use of terrain.

USE OF ADM FOR OBSTACLES

ADM provide the tactical commander with a means to create massive obstacles with fewer soldiers and supplies and in less time than other demolitions or mechanical systems allow. Massive obstacles are large area obstacles or obstacles that significantly delay (for days to weeks) enemy ground forces. ADM can create craters from 15 to 175 meters in diameter with as little as 30 seconds' emplacement time on target.

ADM are typically used to destroy tunnels or major bridges, crater major highways, create landslides or craters to close mountain passes, or destroy dams and canals to create floods. In a tactical situation many of these obstacles cannot reasonably be created by any other means. ADM can also be used to destroy facilities such as sea or river ports, railroad marshaling yards, petroleum storage facilities, and underground storage or operations centers.

WHEN AND WHERE ADM ARE USED

The Army is organized and equipped to fight on nuclear battlefields and on nonnuclear battlefields under the threat of nuclear warfare. ADM are employed within the theater of operations in accordance with national and allied policy. ADM are used only in tactical nuclear conflicts. Employment of ADM rather than other obstacle-producing systems is usually dictated by requirements for massive obstacles and/or the inability of forces to reasonably create the desired obstacle by other means.

WHO USES ADM

Once the use of ADM has been authorized, responsibility for ADM employment is usually decentralized to the lowest tactical echelon capable of conducting ADM mission planning, coordination, and execution--normally, a division. The division executes ADM missions with the support of engineer ADM firing teams who assemble and emplace the munitions. See chapter 4 and appendix D.

WHO CONTROLS USE OF ADM

Both political and military authorities control the use of nuclear weapons. ADM are subject to the same command and control procedures as the other members of the tactical nuclear weapons family—that is, in mission planning, security, civilian and troop safety, collateral damage, target analysis, and authority to fire. See FM 100-50 and chapter 3 of this manual for employment control and planning techniques.

Chapter 2

EMPLOYMENT CONSIDERATIONS

This chapter discusses the what and why of ADM employment. To the commander who must decide if and when to use this system, it is the most important chapter in this manual. For that reason, plans and operation staffs from the corps to the brigade and the Engineer staff officer at those levels must know what is presented here.

The following sections discuss factors which must be considered in the decision to use ADM on the battlefield. Some characteristics of ADM are unique among the family of nuclear systems available to the commander, and, for that reason, ADM require special consideration by the commander who must decide which system(s) to use.

Section I—ADM SYSTEMS AND UNITS

ADM SYSTEMS

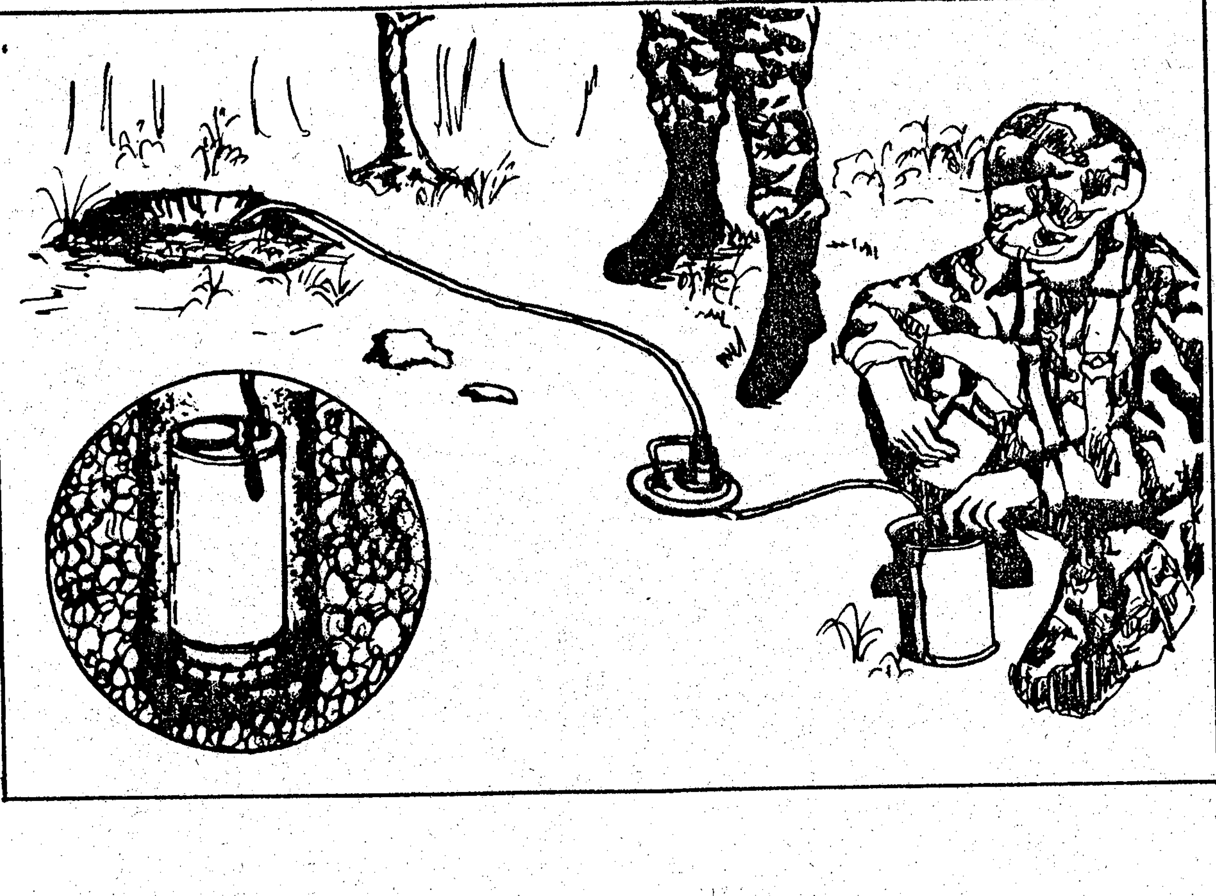
FIELDED SYSTEMS

The medium atomic demolition munition (MADM) and the special atomic demolition munition (SADM) are the two ADM systems currently in stockpiles. The MADM is a medium-yield ADM fired by a timer mechanism and portable by personnel. The SADM is a low-yield ADM also fired by a timer mechanism and portable by one person.

PLACEMENT

ADM missions are executed by maneuver forces supported with specially trained Engineer ADM firing teams. The ADM firing

MADM



team is a six-person team technically trained to assemble, emplace, and detonate the munition. ADM are hand-placed at the target site.

CHARACTERISTICS

In order to plan for the tactical employment of ADM, commanders and staffs must be familiar with their inherent design characteristics. Features which influence ADM employment and emplacement are: available yields, emplacement dimensions, transportation requirements, firing options, subsurface capabilities, and safe separation distances between ADM bursts. Because of security considerations, critical data pertinent to actual stockpiled ADM are

SADM BEING BACKPACKED

not presented in this manual but are set forth in FM 101-32-2(SRD). In this manual, a hypothetical family of ADM is introduced to facilitate unclassified discussion and instruction in ADM employment.

Physical data. The table below lists each ADM of the hypothetical family. The size and weight of either system permit air or ground transportation directly to the target.

Subsurface capability. ADM have both an underground and underwater capability. For an underground burst, the hypothetical backfill limitation is 10 meters. However, ADM may be placed much more deeply in a partially filled hole if the backfill limitation is not exceeded. For underwater placement, hypothetical depth limitation is also 10 meters. Special adaption cases are available to permit deeper emplacement both underground and underwater.

Greater destruction is achieved from the detonation if the ADM is placed inside the target structure, such as in a demolition chamber or an access tunnel. Underground emplacement also maximizes the cratering effect. From the cratering tables in appendix C, you will notice that a depth of burst of even 1 to 3 meters results in a crater nearly twice as large as a crater from the same yield detonated on the surface.

When surface emplacement is used, it is desirable to cover or tamp the munition with about 1.5 meters of fill material such as sand, soil, or filled sandbags. This tamping directs the energy to the target structure for just an instant which significantly improves the destructive results. Tamping also absorbs some of the electromagnetic pulse (EMP) generated from the detonation and protects the system against small arms and artillery fire. Tamping material must be relatively free of large rocks that could damage the munition.

There is no limit to the depth an ADM may be buried in a chamber if the hole or shaft is left open or if the amount of water or fill covering the munition does not exceed 10 meters for hypothetical depths. (See FM 101-31-2(SRD) for classified data.) If planners leave the hole

HYPOTHETICAL ADM FAMILY

Yield	Canister length		Minimum diameter of emplacement hole		Transportation weight	
kilotons	feet	meters	inches	meters	pounds	kilograms
0.01	3	0.91	15	0.38	100	45
0.05	3	0.91	15	0.38	100	45
0.10	3	0.91	15	0.38	100	45
0.50	5	1.52	30	0.76	500	227
1.00	5	1.52	30	0.76	500	227
5.00	5	1.52	30	0.76	500	227

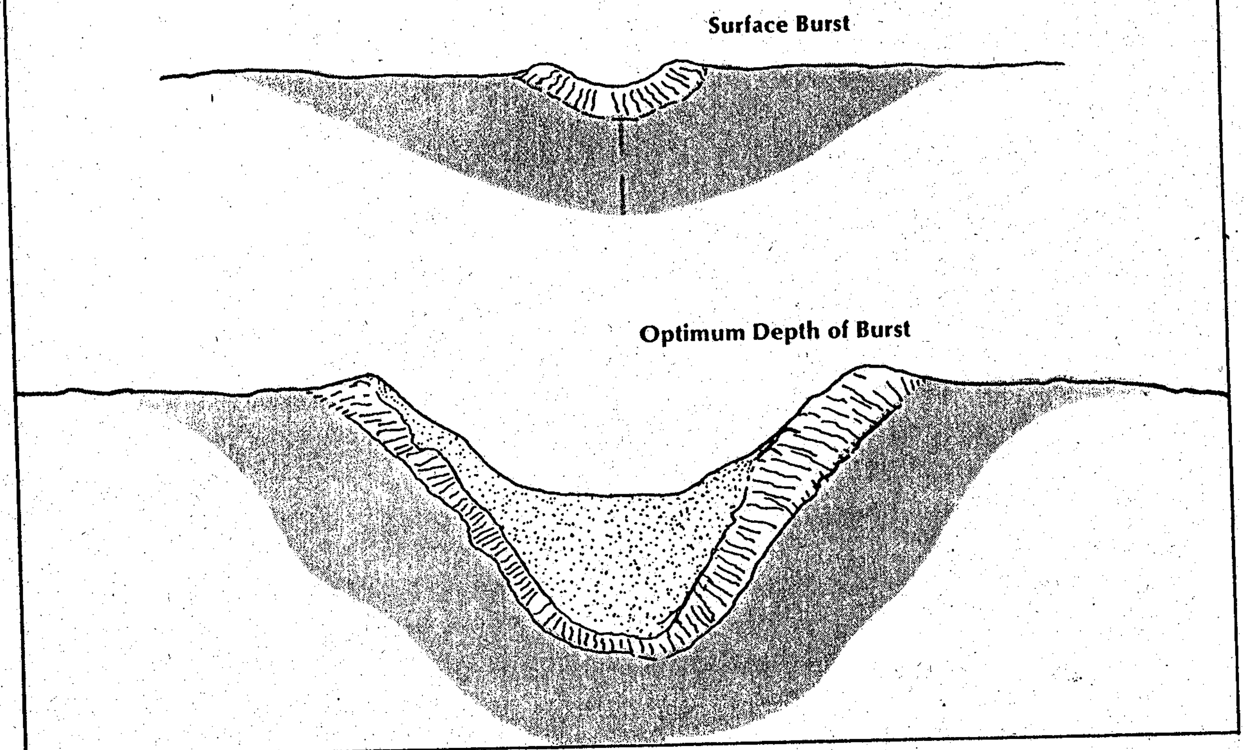
open or use no stemming or tamping material, crater dimensions will be 10 percent smaller than those listed in the crater dimensions tables. Water is the preferred tamping material. Backfilling with water provides for ease of removal if the mission is changed.

LIMITATIONS OF ADM SYSTEMS

Except in special clandestine missions, ADM are used to destroy targets near friendly forces. When friendly forces have lost control of the target structure, enemy access can no longer be prevented. High assurance of a successful mission may be lost unless the munition is well concealed. When planning to use an ADM against a target which may be lost to enemy control, a commander should direct the use of minimum timer settings so that the munition can be detonated rapidly.

During laboratory tests, some timer firing devices have demonstrated certain inaccuracies. For planning purposes, planners should assume the timer error to be plus or minus 2 minutes for each hour set. To the tactical planner, timer error means that if a munition is set by a timer to detonate 1 hour from now, it may actually detonate 2 minutes early or 2 minutes late. The use of minimum timer settings will negate the adverse effect of timer error on tactical planning. Procedures for computing timer error are in appendix B.

EFFECT OF DEPTH OF BURST ON CRATER SIZE



Since ADM emplaced on the surface and at shallow depths of burial will cause radioactive fallout, a fallout prediction must be made. Fallout can be avoided only when an ADM is detonated high enough above the ground or low enough below the surface so that the resulting firball does not interact directly with the ground surface. Height or depth of burst = $30.5W^{1/3}$ meters when W is the yield in kilotons. Examples might be detonation on a bridge spanning a gorge or river or a deep subsurface detonation that creates a subsidence crater.

ADM UNITS

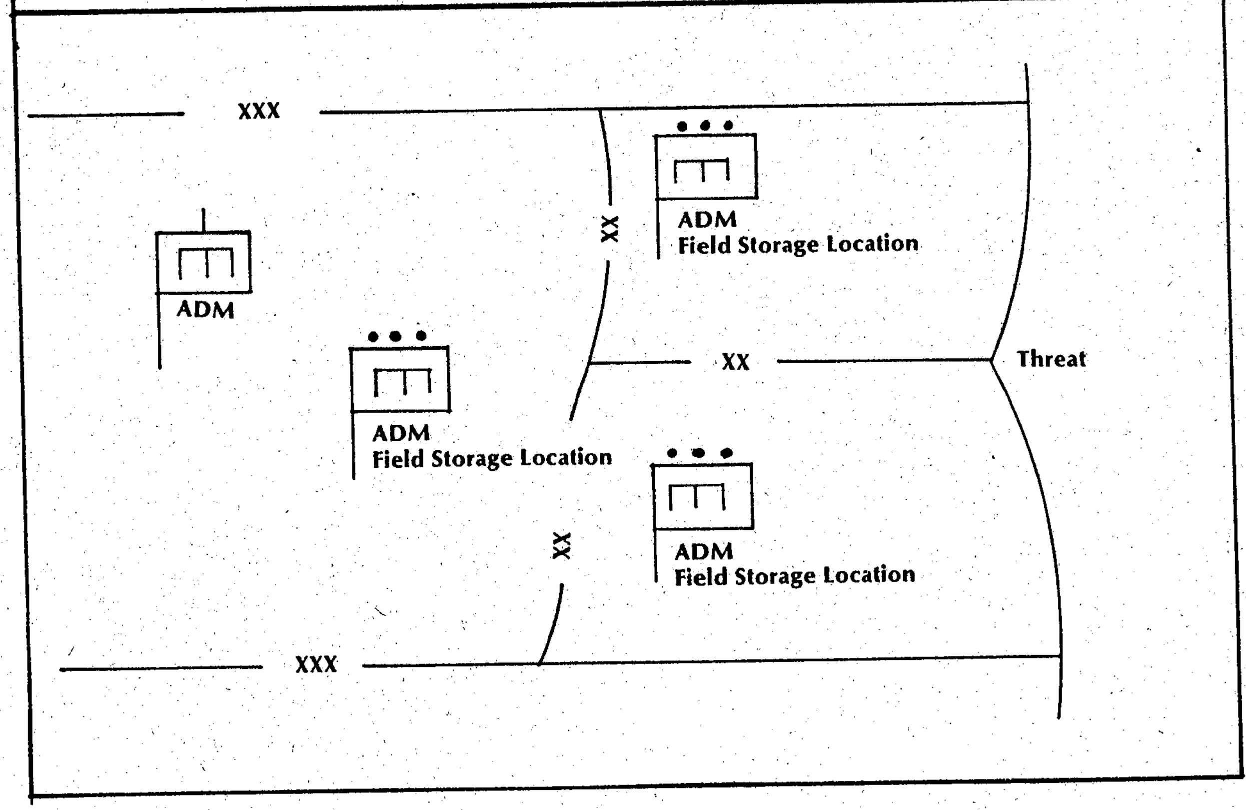
ADM units are combat engineer units specially organized, trained, and equipped for one mission--emplacing and detonating atomic demolition munitions. The basic unit capable of performing this mission is the squad or ADM firing team. The leader is a staff sergeant (E6), and the other four or five members range in grade from private first class (E3) to sergeant (E5).

The ADM team's organic transportation is a cargo truck with trailer.

ADM team's communication equipment is usually a backpack FM radio. Some squads may also be equipped with a backpack AM radio. Specific capabilities should be tailored to the mission.

ADM teams are organized into ADM platoons, and ADM platoons may be organized into ADM companies. The size of an ADM unit is determined by the mission and

ADM PLATOONS IN DIRECT SUPPORT OF DIVISIONS



the concept of operation of the supported unit. The usual relationship is either one ADM platoon per US division or one ADM company per US corps.

DEPLOYMENT

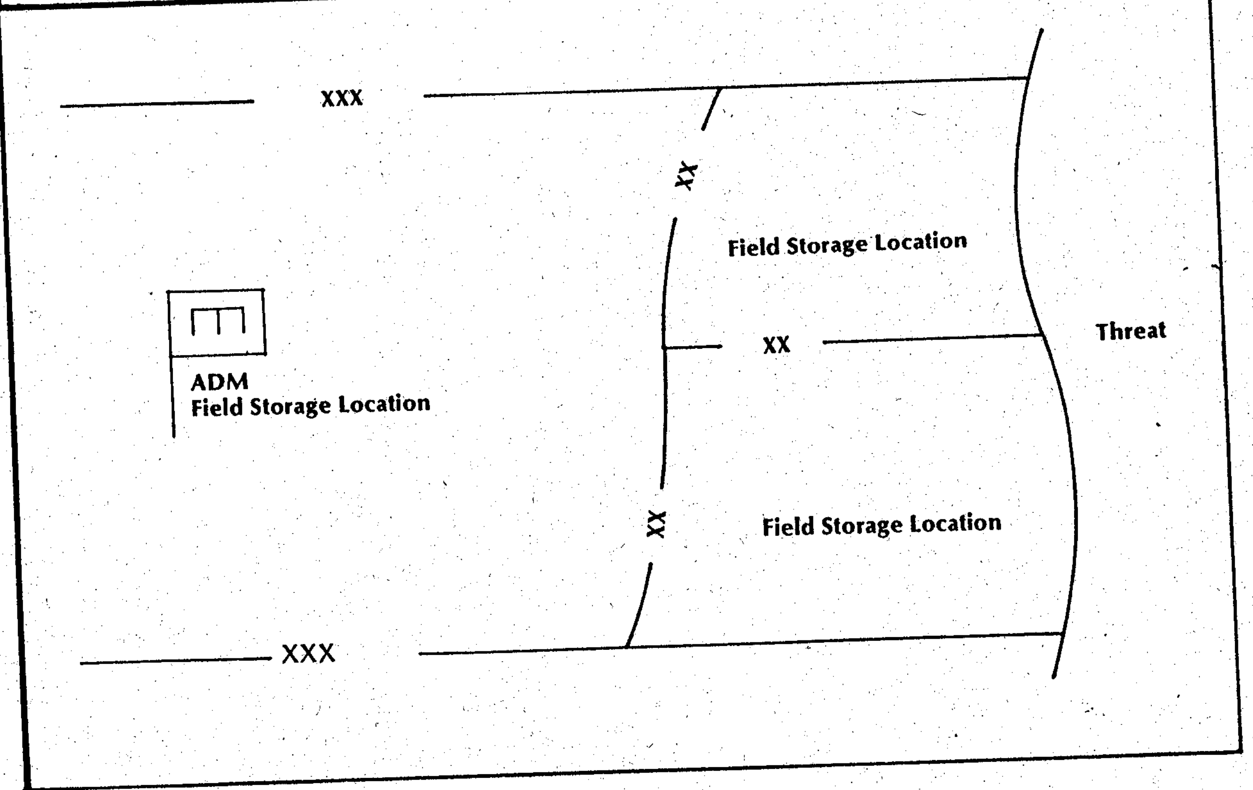
PLATOONS IN DIRECT SUPPORT OF DIVISIONS

When ADM platoons are organized as a corps company, support is usually provided to divisions by attachment of one or more platoons in a direct support role. The company headquarters is not capable of providing administrative or logistical support to platoons that are deployed to forward divisions. The ADM company headquarters provides support to uncommitted ADM platoons, trains replacement personnel, and forms advisory sections to provide technical advice to tactical commanders.

COMPANY IN GENERAL SUPPORT OF THE CORPS

Corps commanders may choose to support their divisions by allocating ADM firing teams to subordinate commanders on a mission-by-mission basis. A corps commander does this to retain maximum flexibility within the corps. However, when the commitment is made to provide firing teams to a subordinate commander, the command relationship must be attachment. No other support relationship is viable. A corps commander who wants to retain target execution authority, does so by written orders to subordinate commands, not by retaining command over the ADM team located in the division area.

ADM COMPANY IN GENERAL SUPPORT OF CORPS

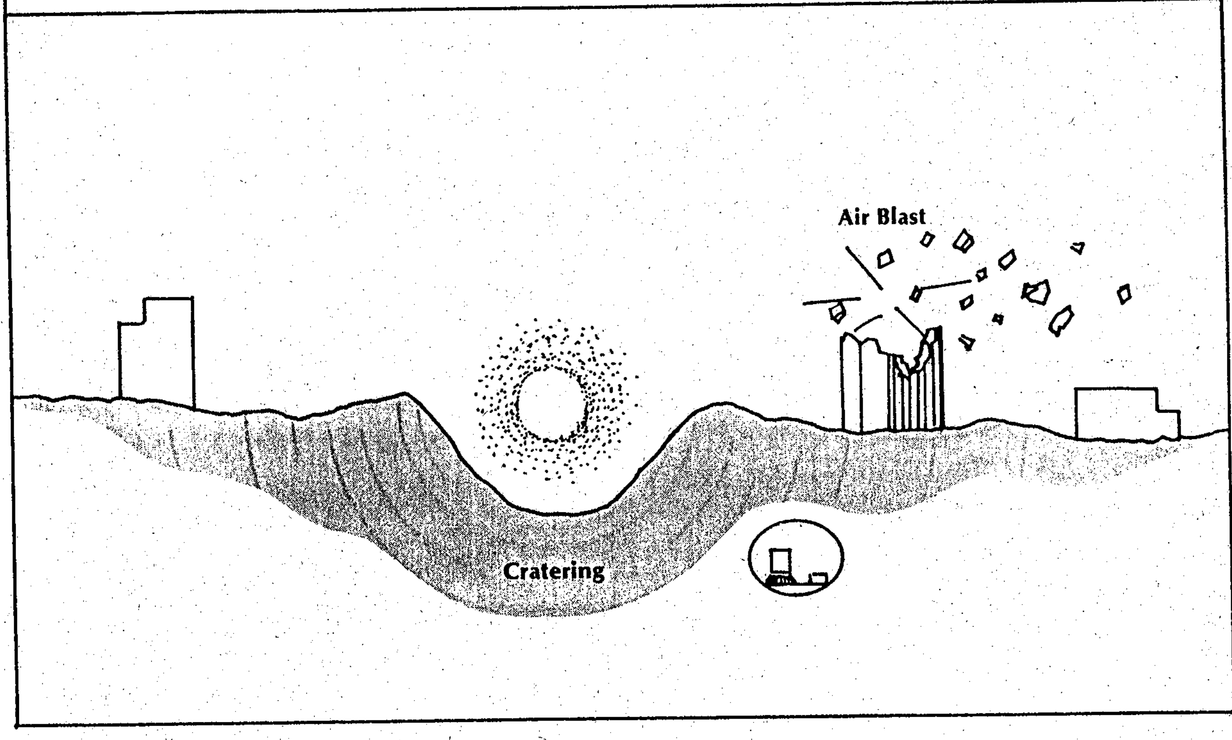


PRIMARY EFFECTS

In ADM targeting (the target selection, evaluation, and planning process), the primary damage-producing effects are air blast and cratering.

More than 50 percent of the energy from an ADM detonation results in blast. The tremendous energy from a surface or subsurface detonation scoops out great quantities of soil, rock, and water to create large craters which become obstacles to wheeled and tracked vehicles. When an ADM is placed against or inside concrete structures such as bridge piers, bridge abutments, tunnels, or dams, the air blast and cratering effects combine to destroy the target.

ADM PRIMARY EFFECTS



SECONDARY EFFECTS

Additional effects of ADM detonations are—

- Rock throw (missiling).
- Initial radiation.
- Residual radiation.
- Base surge.
- Tree blowdown and fires.
- Electromagnetic pulse (EMP).
- Electromagnetic radiation (EMR).
- Ground shock.

These effects may enhance obstacle effectiveness. Except in cases of deep underground bursts, residual radiation in the target area is sufficiently high to preclude obstacle-breaching efforts for a few days. These effects could also constrain friendly operations. In surface bursts, the air blast and thermal effects may cause significant wind and fire damage near the target area. For further information on nuclear effects, see chapter 6.

NEED FOR JUDGMENT

Many factors must be taken into account before use of ADM can be justified. Consideration of both advantages and disadvantages must precede a meaningful decision. In addition, the advantages of using ADM in a specific tactical situation must be weighed against the employment of high explosive demolitions or other members of the nuclear weapons family. Thus, the use of ADM is not justified if conventional demolitions can be used as quickly and effectively.

ADVANTAGES

NO DELIVERY ERROR

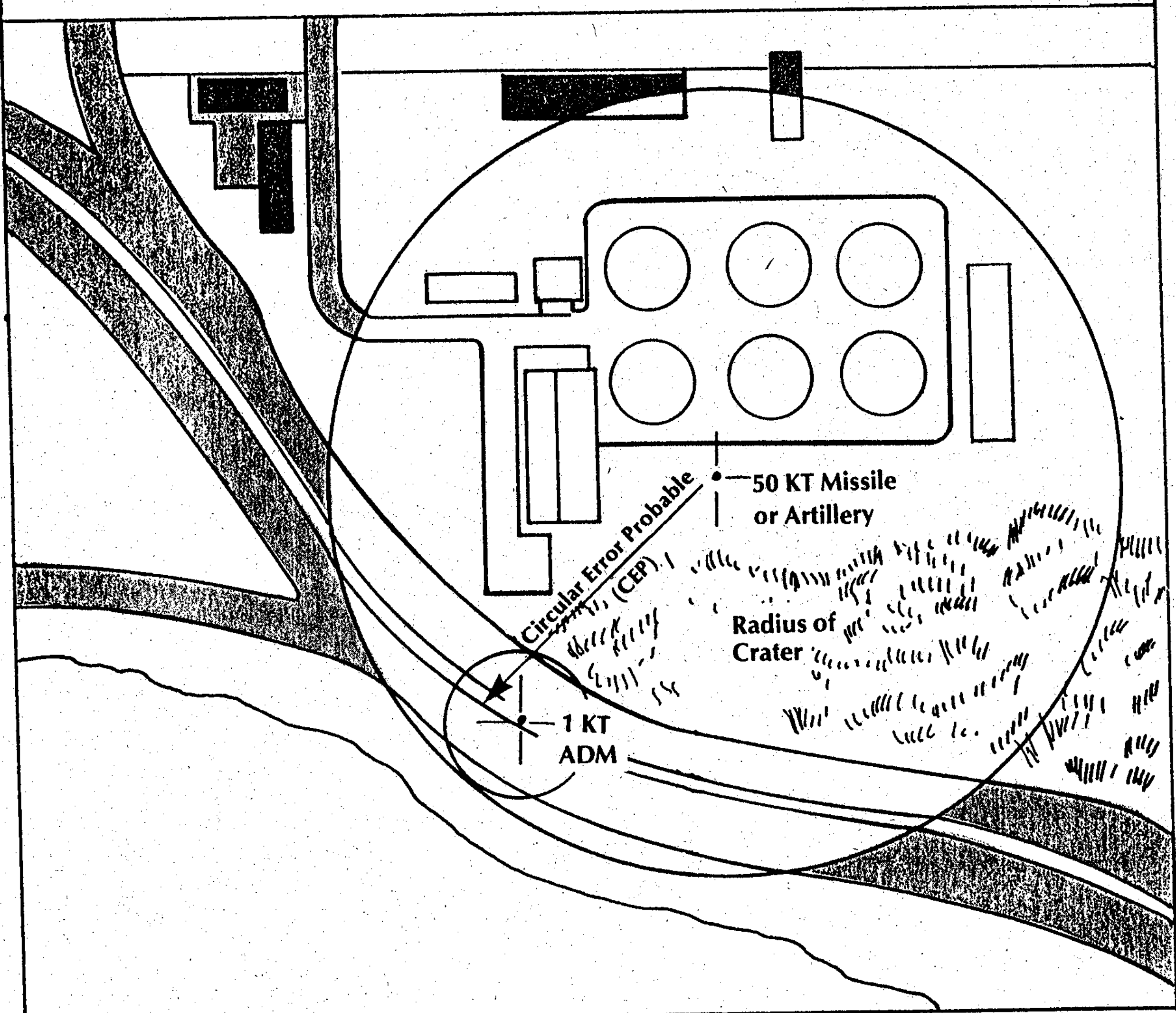
Like all other demolitions, ADM are emplaced in a predetermined position. This is the most important employment consideration—the one which separates ADM from the rest of the nuclear weapons family. ADM can be emplaced exactly where required to minimize nuclear yield and achieve desired destruction. In comparison of ADM with other nuclear weapons, it is necessary to take their fuzing characteristics and delivery error into consideration. To achieve the same degree of damage requires much larger yields than would be required using ADM.

For example, consider the destruction of a six-lane interstate-type highway by means of a crater. This kind of highway has a roadway width of about 30 meters including the shoulders and median strip. If an ADM were not used to form a crater, there would be no other tactical nuclear device which could reasonably produce the desired obstacle. To crater the roadway, it would be necessary to use at least a 50 kiloton (KT) nuclear missile or artillery weapon. This size, required to overcome delivery error, would produce a crater much larger than 30 meters and would significantly increase fallout and collateral damage. On the other hand, a surface detonation of a 1 KT ADM in the median strip of the roadway would reliably produce a 30-meter crater. Thus, by using ADM, we have reduced the required yield by at least a factor of 50 and have also controlled the degree of destruction, fallout, and damage.

UNDERGROUND CAPABILITY

Since ADM have no delivery error, they can be emplaced in any location above or below the ground, under water, or inside a structure. This capability is extremely significant for maximum utilization of nuclear energy. Therefore, ADM yields required to accomplish a cratering mission are further reduced when employed underground instead of on the surface. Thus, in the preceding example, the 30-meter crater produced by a surface detonation of a 1 KT ADM can be produced by

ADVANTAGE OF ADM DELIVERY ACCURACY

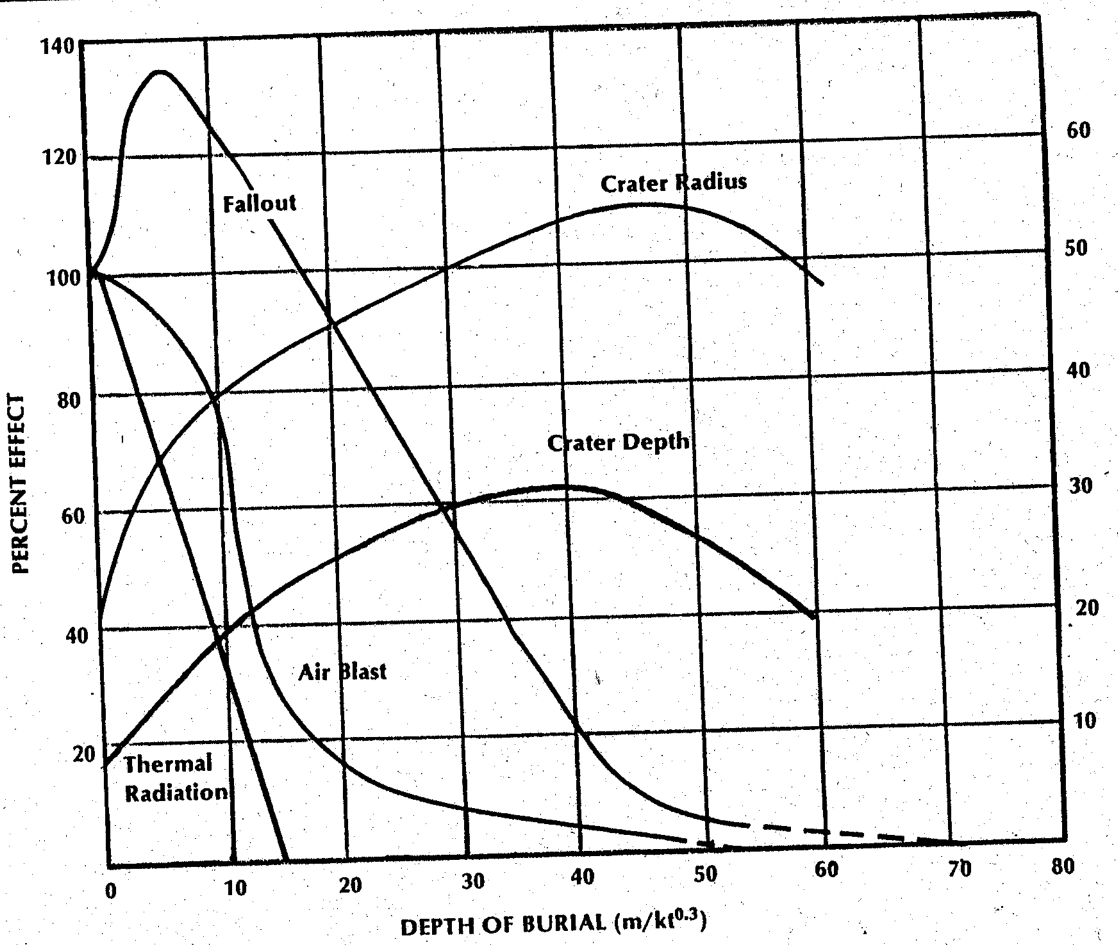


subsurface detonation of a 0.05 KT ADM buried at a depth of 17 meters. This is a reduction of yield by a factor of 20 compared to surface detonation. It is a reduction by more than 1,000 compared to the other nuclear system described.

CONTROL OF UNDESIRABLE EFFECTS

One of the greatest advantages of using ADM is the ability to control nuclear effects. This capability is especially important in ADM employment since ADM are normally used near friendly troops and therefore can create a troop safety hazard. The advantages of control of undesirable effects are apparent in two ways. First, the use of extremely small yields for target destruction reduces undesirable nuclear effects significantly compared to other nuclear methods of destruction. Second, while burial can reduce or eliminate most undesirable nuclear effects, the effectiveness of the cratering action is increased. See figure on page 2-5.

CONTROL OF ADM EFFECTS



Note in the graph on page 2-11 that while air blast, nuclear radiation, and thermal radiation are greatly reduced with increased depth of burst, the primary effect of cratering is maximized. Thus, as a result of the proper selection of depth of burst, the nuclear effects required for target destruction can be optimized while many of the undesirable effects can be reduced. Reduced troop safety distances result, allowing the use of ADM in areas which would otherwise be prohibited to nuclear weapons use. See figure on page 2-13.

ACCURATE TARGET ACQUISITION AND PREPLANNING

ADM are intended for employment against materiel-type targets. Therefore, most targets are stationary or permanent, such as tunnels, highways, bridges, airfields, or supply depots. Because of this specific mission, most ADM targets can be preplanned. The best ADM yield and emplacement position can be determined, and an emplacement hole or demolition chamber can be constructed long before anticipated enemy action. This preplanning capability combined with the selection of a depth of burst to control nuclear effects results in a versatile range of options. The existence of preplanned emplacement holes or demolition chambers also allows rapid and effective ADM emplacement.

DELIVERY MEANS

Unlike other members of the nuclear weapons family, ADM are not limited to specific methods of delivery as are cannon or rocket artillery with limited ranges. ADM can be transported by any of several methods including vehicle, helicopter, and, in the case of the SADM, backpack. In short, ADM may be delivered to any area accessible to foot troops. This advantage of requiring no special delivery equipment adds flexibility to the planning and use of ADM.

ACCOMPLISHMENT OF MISSIONS BEYOND THE CAPABILITY OF HIGH EXPLOSIVES

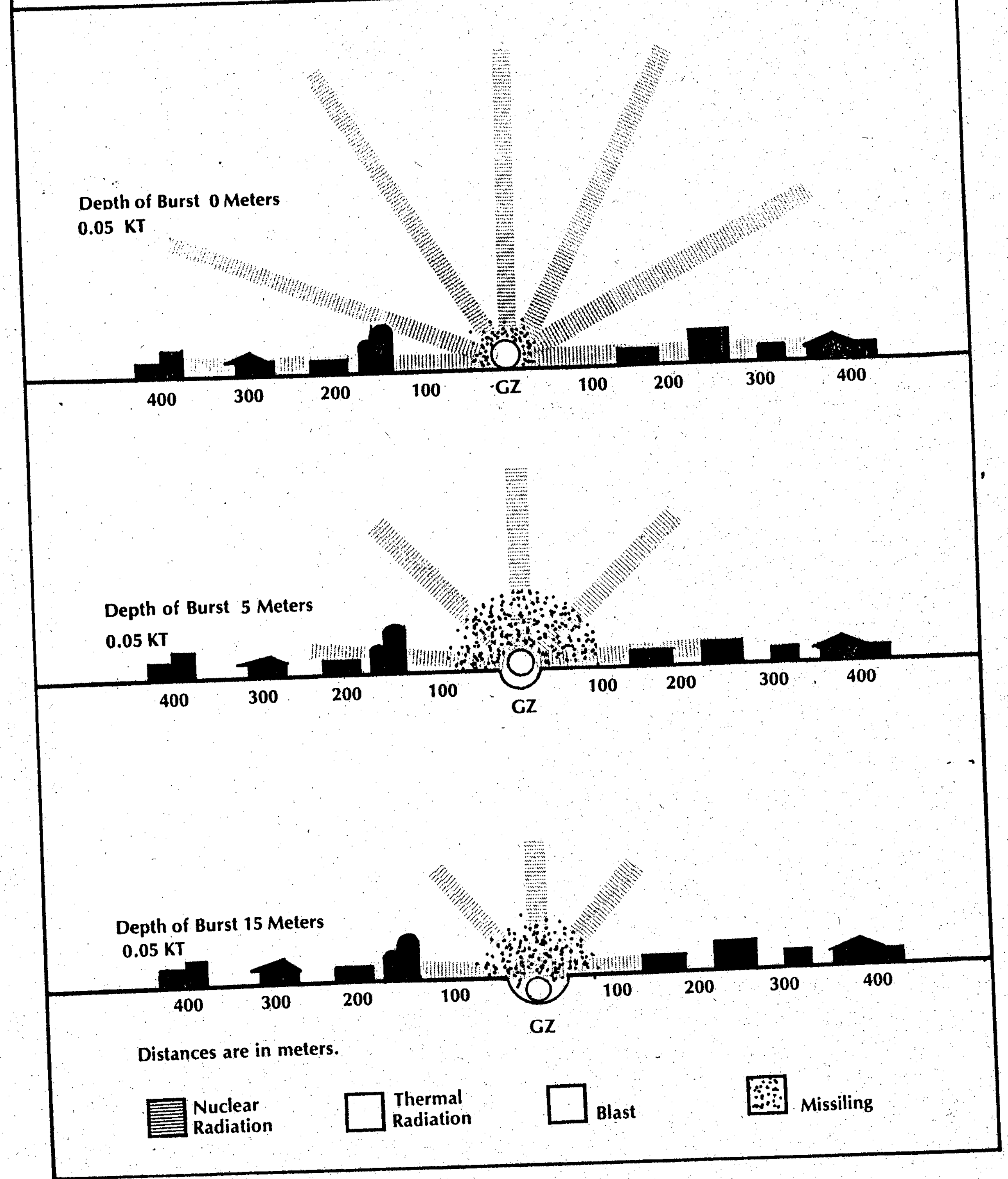
ADM are used in situations where the achievement of comparable damage with high explosives is prohibited by time, manpower, and material requirements. A comparison of ADM with high explosives is shown in the table below. The logistical advantages of even the minimum-yield ADM over high explosives are obvious. Logistical support for conventional explosives increases directly with yield while for ADM it is relatively unchanged.

LOGISTICAL COMPARISON OF ADM AND HIGH EXPLOSIVES

	ADM	TNT
Yield	0.01 KT	20,000 pounds
Weight	100 pounds	25,000 pounds
Volume	0.5 cubic meters	15 cubic meters
Transportation	2 persons	4 5-ton dump trucks
Emplacement time*	0.5 man-hour	440 man-hours

*Excludes security time

REDUCTION OF UNDESIRABLE EFFECTS BY DEPTH OF BURST



USE ON THE MOBILE BATTLEFIELD

Analysis for and employment of ADM should be an integral part of engineer support planning for the AirLand Battle. Prehostility planning is preferred, but ADM can and should be part of the obstacle plans developed as the battle progresses.

DISADVANTAGES

EMPLACEMENT REQUIREMENT

To control ADM effects through underground emplacement, it is often necessary to prepare the emplacement site before use. Necessary construction of an emplacement hole or demolition chamber can involve considerable time and personnel. Because of the preplanned nature of most ADM targets, proper preparations can overcome this disadvantage. Preparing an ADM emplacement takes but a fraction of the time and resources required to emplace an equivalent amount of high explosives. The need for an emplacement chamber must be fully realized and evaluated in the planning and execution of all ADM missions. Surface detonations usually require higher yields than subsurface detonations.

SECURITY

Security of the munition during tactical storage, transportation, and emplacement and continuing up to the time of firing is necessary in all ADM missions. Security is normally provided by the combat unit in whose sector the ADM mission is planned. In a clandestine operation, security is provided by secrecy and surprise.

RESIDUAL RADIATION

Residual radiation is comprised of induced radiation and fallout. Induced radiation is largely in or very near the crater. It is sufficiently intense to prohibit safe crossing of the crater for several days. Fallout may be a hazard to friendly forces and the civilian population as well as to the enemy. It is possible to control the amount of residual radiation while simultaneously optimizing obstacle size and munition yield. A thorough knowledge of the effects of underground emplacement is necessary to achieve this goal. As shown in the graph on page 2-11, there is a large increase in fallout at shallow depths as compared to surface burst. Fallout then decreases at deeper depths of burst.

ADVANTAGES AND DISADVANTAGES OF ADM EMPLOYMENT

ADVANTAGES	DISADVANTAGES
1—No delivery error; results in lower yield than other nuclear systems	1—Site preparation
2—Surface-subsurface control of effects	2—Security during delivery
3—Flexible delivery means	3—Residual radiation
4—Provides capability beyond that of conventional explosives	

Section IV—SAFETY CONSIDERATIONS

HAZARDS TO TROOPS AND CIVILIANS

Employment of ADM at specific targets includes an evaluation of the primary and secondary damage-producing effects which may result in hazards to friendly troops or collateral damage. Collateral damage is undesirable damage to civilian materiel and facilities or undesirable injuries to the civilian population produced by the effects of friendly nuclear weapons. ADM effects and associated troop safety and collateral damage considerations are discussed in the following text. Also see pages 6-38 through 6-40.

NUCLEAR RADIATION

The nuclear radiation emitted and the radioactive material produced by a surface or shallow subsurface nuclear detonation may be significant. Thus, troop safety from nuclear radiation is an important consideration. Adequate protective shielding is difficult to acquire. Moreover, it is reasonable to assume that personnel in the combat zone may receive repeated radiation doses. The amount and frequency of doses received in past operations and the urgency of the tactical situation must be considered in determining the degree of friendly troop exposure. Nuclear radiation is measured in centigrays (cGy). One centigray is equal to one rad.

RADIATION HAZARD

The radiation hazard from a surface or underground nuclear detonation consists of initial and residual radiation. Base surge and radiation in ADM craters are of particular concern and are separately discussed.

Initial radiation. Initial nuclear radiation is defined as that nuclear radiation emitted by a nuclear explosion within the first minute after the burst. Initial nuclear radiation often produces casualties among personnel protected from blast and thermal effects, and it is of considerable significance in assessing the radiation hazard. By subsurface emplacement of ADM, initial radiation is sharply reduced as the result of the absorption of radiation by the surrounding ground. See figure on page 2-13.

Residual radiation. In addition to initial radiation, a nuclear burst produces radioactive particles that may be a lingering radiation hazard of operational significance. Nuclear radiation that is emitted 1 minute or more after burst time is called residual radiation. Residual radiation is present in and near a radioactive cloud and in the nuclear crater and lip. The hazards on the ground are caused by—

- *Neutron-induced radiation* from radioactive materials produced within a relatively small circular area around ground zero.
- *Fallout* which is usually found in a large, elongated area stretching downwind from ground zero.
- *Fallback* which is ejected material that falls back into the crater.

Base surge. Base surge is the low-rolling radioactive dust or water cloud that travels outward along the ground from ground zero. The base surge radius can exceed the cloud radius. Base surge data is provided in appendix C. Cloud radius is estimated in accordance with procedures in FM 3-22.

Radiation in ADM craters. Estimates of nuclear radiation levels in ADM craters and lip areas are provided in appendix C. These estimates are provided for troop safety purposes so commanders can estimate when it is safe to cross over or work in or near nuclear craters.

TOTAL RADIATION DOSE

The total dose of radiation absorbed by an individual includes both the initial and residual radiation doses received. Although the human body recovers partially from nuclear radiation damage in time, the biological effects from repeated doses received during a few weeks are essentially cumulative.

In view of repeated exposure, lack of recovery in the first 30 days, and slow overall recovery, the commander must also consider the consequences to personnel previously exposed to significant but nonsymptomatic doses. To assist the commander, friendly units are divided into four categories based on previous exposure history. (See FM 3-12 for techniques in classifying units.) Military personnel operating in a nuclear environment may expect radiation exposure as a normal combat hazard. The table below may be used to relate a unit's current radiation state (based on

RADIATION EXPOSURE STATES

Previous exposure determines radiation exposure state category; minimum safe distance must be adjusted as shown.

Radiation Exposure State (RES)	Total past cumulative dose (cGy)	Commander's risk guidance in meters: Negligible	Moderate	Emergency
RES-0	0	Neg	Mod	Emer
RES-1	>0, ≤70	Neg + 100	Neg	Mod
RES-2	>70, ≤150	Neg + 200	Neg + 100	Neg
RES-3	>150	Neg + 300	Neg + 200	Neg + 100

Notes:

1. Radiation exposure state is based on previous exposure to radiation.
2. Reclassification of units from one radiation exposure state to a less serious one is done by the commander upon advice of the surgeon after ample observation of actual state of health of the exposed personnel.
3. All exposures to radiation are considered to be total body and simply additive. No allowance is made for body recovery from radiation injury.
4. Risk levels are graduated within each exposure state to provide more stringent criteria as the total radiation dose accumulated becomes more serious.
5. Minimum safe distance (MSD) is determined from the radii of troop safety table (table C-11) with distance adjustments noted in the commander's risk guidance.

total past cumulative dose) to troop safety for future operations. The table assumes no body recovery from radiation injury.

MILITARY SIGNIFICANCE OF THE INITIAL NUCLEAR RADIATION EXPOSURE HAZARD

Variation in intensity. A knowledge of the variation of initial radiation intensities is necessary in order to assess the immediate radiation hazard. At the present time, initial radiation data are available for air and surface detonations only (FM 101-31-2[SRD]). Shielding by dust and debris produced by a subsurface explosion, as well as absorption by the surrounding media, considerably reduces the exposure dose. The extent of this reduction, however, cannot now be quantitatively estimated.

Minimum safe distance. The ADM target analyst uses the minimum safe distance (MSD) to make troop safety calculations. The MSD is a measure of the distance beyond which critical nuclear effects do not extend. To determine MSD, the analyst needs to know degrees of risk and vulnerability.

Degrees of risk. There are three degrees of risk—*negligible, moderate, and emergency.* These are defined by the numbers of casualties or persons suffering a nuisance

nicht Friedensrisiko, sondern Kampffähigkeit steht im Vordergrund

effect within 4 weeks (see table below). A nuisance effect is an injury which may cause a significant decrease in a soldier's performance but which will not result in a casualty. Risk criteria are determined by the effect which governs (extends farthest from ground zero).

- At a *negligible risk* distance, troops are 1-2,5% completely safe with the possible exception of a temporary loss of night vision or dazzle. A negligible risk from exposure to nuclear radiation is possible only when an individual or unit has an insignificant radiation dose history which causes no decrease in combat effectiveness. An insignificant accumulated dose means that blood changes will probably not be detectable. A negligible risk is acceptable in any case where the use of nuclear bursts is desired. **A negligible risk is not exceeded unless significant advantages are to be gained.**

- At a *moderate risk* distance, the anticipated effect on troops from a single exposure to a nuclear burst is tolerable or, at worst, a minor nuisance. A moderate risk occurs in two ways: either an individual or unit has a significant radiation exposure history but has not yet shown

DEGREE OF RISK DEFINITIONS

	Incidence of	
Degree of risk	Casualties	Nuisance effect
Negligible	1%	2.5%
Moderate	2.5%	5%
Emergency	5%	no limit

symptoms of radiation sickness; or a planned single dose is sufficiently high that exposure of up to four or five repetitions, alone or in conjunction with previous exposure, would constitute a significant radiation exposure history. A moderate risk is considered acceptable in close support operations as, for example, to halt an enemy advance. **A moderate risk is not exceeded if troops are expected to operate at essentially full efficiency after a friendly burst.**

- At an *emergency risk* distance, the anticipated effect on troops from a single exposure to a nuclear burst may result in some temporary shock, mild burns, and a few casualties. However, casualties should never be extensive enough to neutralize a unit. An emergency risk from exposure to nuclear radiation occurs in two ways: either a unit has a radiation exposure history which is at the threshhold for onset of combat ineffectiveness from radiation sickness; or a planned single dose is sufficiently high that exposure of up to two or three repetitions, alone or in conjunction with previous exposures, would approach or exceed the threshhold for combat ineffectiveness from radiation sickness. An emergency risk should be accepted only when absolutely necessary and should be **exceeded only in extremely rare situations which might loosely be called "disaster" situations.** No attempt is made to define a "disaster" situation. The commander must determine these extremely rare situations and decide which criteria are appropriate to use in attempting to salvage such a situation.

Vulnerability. Closely associated with the degree of risk is the vulnerability of the individual soldier. The danger to an individual from a nuclear detonation depends principally upon how well the soldier is protected from nuclear effects. For example, an individual who is well protected can safely be much closer to ground zero than one in the open. A person has one of the following three conditions of personal vulnerability at the time of burst: *unwarned, exposed; warned, exposed;* and *warned, protected*. Note that there is no category for unwarned, protected. Although protection may be available, it is assumed that soldiers will not take advantage of it unless warned.

- *Unwarned, exposed* persons are assumed to be standing in the open at burst time but to have dropped to a prone position by the time the blast wave arrives. They are expected to have areas of bare skin exposed to direct thermal radiation, and some personnel may suffer temporary loss of vision (dazzle).

- *Warned, exposed* persons are assumed to be prone on open ground with all skin areas covered and with an overall thermal protection at least equal to that provided by a two-layer summer uniform. Such a condition may occur when a nuclear weapon is employed against a target of opportunity during an attack, and sufficient time exists to broadcast a warning. Troops have been warned but do not have time to dig foxholes.

- *Warned, protected* persons are assumed to have some protection against heat, blast, and radiation. Protection depends upon the shielding properties, the blast-wave modifying factors, and the vulnerability to blast of the vehicles or fortifications sheltering the personnel. Armored vehicles are assumed to be sealed since the personnel are warned. A warned, protected condition may occur when nuclear weapons are used during preparation for an attack. Protected places include tanks, armored personnel carriers, foxholes, weapons emplacements, and command posts and shelters.

DETERMINATION OF TROOP SAFETY

When examining troop safety, the target analyst must consult table C-11 to find out if radiation is the governing troop safety criteria. If radiation does not govern, the unit's radiation history does not have to be considered. If radiation does govern, the unit's radiation history must be considered, and table C-11 and the table on page 2-16 should be consulted and interpreted as follows:

Adjust troop safety distance only if radiation is the governing effect.

- For units with no past cumulative radiation dose (identified in the table on page 2-16 as RES-0 units), read direct from table C-11 for the appropriate risk and degree of vulnerability.

- For units with a past cumulative dose up to 70 cGy (RES-1 units), any further radiation exposure must be considered a moderate or an emergency risk. There can be no negligible risk for personnel in this category.

- For units with a past cumulative dose from 71 to 150 cGy (RES-2 units), any further radiation exposure must be considered an emergency risk. Even though a further exposure to nuclear radiation is an emergency risk, the effects to this unit would include some sickness, but rarely incapacitation.

- For units with a past cumulative dose of more than 150 cGy (RES-3 units), all further exposures must be considered an emergency risk. Any further exposure is dangerous. This unit should be exposed only if unavoidable because additional exposure will result in sickness, incapacitation, and probably some deaths.

FACTORS INFLUENCING FALLOUT/DISTRIBUTION

The distribution and intensity of gamma radiation resulting from radioactive fallout depend primarily on the following factors:

- The kinds and quantities of radioactive materials produced by the explosion.

- The fraction of the radioactive materials produced that escapes to the atmosphere.

- The dimensions of the main cloud.
- The wind speed and direction up to maximum cloud height.
- The dimensions of the base surge cloud. The base surge cloud radius is significant in troop safety because there can be a very high radiation dose rate within its confines. For an underwater burst, the base surge is transient, and its contribution to residual radiation is minor.

FALLOUT PREDICTION PROCEDURES

Numerous fallout prediction procedures have been developed. The procedures presented in chapters 3 and 4 of FM 3-22 are recommended for use by small units in tactical situations.

The procedures in chapter 3 of FM 3-22 are for simplified fallout predictions. These simplified methods enable small units to estimate immediately the location of a potential fallout hazard, thereby allowing greater unit self-sufficiency.

The procedures in chapter 4 of FM 3-22 are for atomic demolition munitions fallout predictions. These procedures, designed for the prediction of fallout from friendly bursts, also allow for possible subsurface emplacement and/or subkiloton yields. The table below, based on FM 3-22, illustrates typical downwind distances of Zones I and II for

ZONE I AND ZONE II DOWNWIND DISTANCES (IN KILOMETERS)

Yield (KT)	DOB=0 Surface Burst		DOB-15W$^{0.3}$m Shallow Burial		DOB-35W$^{0.3}$m Optimum Burial	
	Zone I	Zone II	Zone I	Zone II	Zone I	Zone II
0.01	< 0.2	< 0.4	< 0.2	< 0.3	< 0.1	< 0.2
0.05	0.3	0.6	0.31	0.61	0.2	0.41
0.1	0.63	1.26	0.66	1.8	0.44	0.88
0.5	2.5	5.0	2.6	5.3	1.75	3.5
1.0	3.6	7.2	3.8	7.6	2.5	5.0
5.0	9.5	19.0	10.0	20.0	6.5	13.1

NOTE:

An effective wind speed of 15 kilometers per hour is assumed. Downwind distances are based on fallout prediction using FM 3-22. The 0.01 KT downwind distances are conservative approximates.

ZONE I: A zone within which are areas where exposed, unprotected personnel may receive doses greater than 150 cGy in relatively short periods of time (less than 4 hours after arrival of fallout).

ZONE II: A zone within which the total dose to exposed, unprotected personnel is not expected to reach 150 cGy within a period of 4 hours after the actual arrival of fallout but within which personnel may receive a total dose of 50 cGy or greater within the first 24 hours after the actual arrival of fallout.

surface and subsurface bursts. Note that the downwind distance of Zone I initially increases as depth of burst is increased from surface to shallow and that there is a significant decrease for all zones as the depth of burst is increased to optimum. A worksheet that may be used in plotting a simplified ADM fallout prediction based upon yield and an effective downwind message may be found on pages 2-23 and 2-24.

BLAST

DIRECT EFFECTS

The direct effects of blast are an important troop safety consideration.

High overpressures estimated at 45 to 55 pounds per square inch (psi) for nuclear explosions cause immediate deaths while lower overpressures on the order of 20 to 35 psi may cause severe internal injuries especially to the lungs or abdominal organs. Eardrum rupture, which is painful but not necessarily disabling, may result from overpressures as low as 5 psi. Soldiers in field fortifications may become casualties at lower incident blast overpressures which multiple reflections within small inclosures may build up to casualty-producing levels.

Translation, the process in which persons and objects are picked up and thrown, is the basis for prediction of blast casualties to soldiers in the open.

SECONDARY EFFECTS

Secondary effects of blast also produce casualties.

The blast wave converts flying debris, stones, and sand to missiles, thereby causing casualties to unprotected personnel. Hot, dust-laden gases may cause burns. Airborne dust may cause irritation and possible suffocation as well as limiting visibility and movement within and adjacent to the target area. Buildings or fortifications may collapse on personnel.

DEGREE OF RISK AND DAMAGE CRITERIA

In tactical operations using ADM, the primary area of concern is the close-in region in which persons and structures of military significance are subjected to damaging overpressure levels from blast. The following criteria determine troop safety distances for warned, protected personnel (foxhole protection):

Degree of Risk	Blast Overpressure (psi)
Negligible	4.0
Moderate	7.5
Emergency	10.0

The above blast criteria, however, do not preclude all blast injuries to protected personnel. Personnel in tanks subjected to 10 psi overpressure will probably receive no significant injuries. Personnel in foxholes, however, may become indirect blast casualties as a result of foxhole collapse. An overpressure of 4 psi (negligible risk) does not cause sufficient damage to either tanks or foxholes to produce either direct or indirect casualties.

Damage criteria for structures and field fortifications of tactical significance are given in appendix C.

When preclusion of damage to nearby structures is desirable, potential blast damage must be evaluated. Normally, 1 psi overpressure is the criterion for preclusion of light damage due to blast.

Close-in blast overpressures resulting from subsurface detonations are considerably less than those generated by an air or surface burst. Table C-13 shows peak air overpressures on the surface as a function of depth of burst and surface range for yields in a dry soil medium. In a rock medium, blast is reduced much more. In a rock medium at depths greater than 50 $W^{0.3}$ feet (15 $W^{0.3}$ meters), reduce the distances in table C-13 by 50 percent. The depth of burst and the range to which a given peak overpressure extends are directly proportional to the cube root of the yield.

MISSILING

A hazard that accompanies the blast effect in cratering is the ejection of large particles of debris which travel along ballistic paths as missiles and are deposited at considerable distances from ground zero. These missiles can cause casualties and severe damage to structures and equipment. The missile hazard is not considered a limiting effect for ADM employment. However, you should caution personnel within the area and move or protect equipment which may be damaged.

THERMAL RADIATION

Thermal radiation results from the heat and light produced by a nuclear explosion. During a nuclear explosion, the immediate release of an enormous quantity of energy in a very small space creates an initial fireball temperature that ranges into millions of degrees. The temperature drops rapidly as the fireball expands and its energy release lessens.

If the fireball from subsurface burst does not penetrate the ground surface, practically all the thermal radiation is used in the vaporization and melting of the medium surrounding the device. Even when the fireball penetrates the ground surface, the intensity of thermal radiation is considerably less than that from a surface burst. Refer to the figure on page 2-13.

Thermal radiation intensities vary with distance from the detonation. This variation has been documented for air bursts and surface bursts. No data are available, however, to quantitatively estimate the thermal radiation intensities at varying distances from subsurface bursts. Below scaled depths of approximately 5 $W^{0.3}$ meters (W is yield in KT), the radius of the base surge cloud is greater than the distances to which militarily significant levels of thermal radiation are transmitted. To assess the thermal radiation hazard from subsurface burst, assume that—

- For scaled depths of burst of 5 $W^{0.3}$ meters or deeper, there is no militarily significant thermal radiation at distances beyond the base surge cloud.
- For scaled depths of burst of 50 $W^{0.3}$ meters or deeper, the fireball is contained underground, and there are no thermal radiation effects to consider.

GROUND SHOCK

Cratering with ADM transmits energy into the ground as well as into the air. Most of the energy transmitted is in the vicinity of ground zero and contributes to crater formation. Ground shock is not used in the design of ADM-created obstacles since the air blast and cratering effects dominate.

UNDERGROUND STRUCTURES

Within the regions of the rupture and plastic zones of a crater (see page 6-10), damage to underground structures ranges from complete collapse to damage that seriously impairs the use of the structure. The plastic zone, therefore, is the limit beyond which no militarily significant ground shock damage to underground structures occurs.

SURFACE STRUCTURES

Evaluation of ground shock damage to surface structures includes a range of structures from those specifically designed to resist ground shock to the usual residential-type buildings. The criteria for precluding ground shock damage are based on residential-type buildings so that use of these criteria precludes damage to stronger structures. The collateral damage tables in appendix C incorporate analysis of structural damage caused by ground shock.

FALLOUT PREDICTION WORKSHEET FOR ADM

(Figure numbers refer to FM 3-22)

a. Time of Burst (Date-Time Group) ____________ DELTA DDtttt (Local or Zulu)

b. GZ Coordinates ____________ FOXTROT yzzzzzz

c. Yield ____________ KT

d. Depth of Burst ____________ meters

e. Effective Downwind Direction ____________ degrees

f. Wind Speed ____________ kmph

g. Stabilized Cloud Radius (fig 30) ____________ (km, nearest tenth) For yields of less than 0.15 KT, use 400 meters as the radius around ground zero.

h. Downwind Distance (DWD) of Zone I (Enter fig 31 with f and c) ____________

i. Downwind Distance of Zone II (2 x Line h) ____________

For subsurface bursts, complete Lines j—n.

For surface bursts, continue at Line o.

j. Scaled Depth Factor (Enter fig 21 with c) ____________

k. Scaled Depth ________ x ________= (Line d x Line j) ____________ meters

worksheet continued on next page

FALLOUT PREDICTION WORKSHEET FOR ADM (continued)

l. Correction Factors for Zone I and Zone II (DWD) (Enter fig 22 with k) ________ Zone I ________ Zone II

m. Adjusted DWD Zone I ______ x ______ = ________ (km, nearest tenth)
(Line h x Line l)

n. Adjusted DWD Zone II ______ x ______ = ________ (km, nearest tenth)
(Line i x Line l)

o. Azimuth of Left Radial Line ________ (mils or degrees)

p. Azimuth of Right Radial Line ________ (mils or degrees)

q. Time of Arrival of Fallout at End of Zone II (Zone II downwind distance divided by effective wind speed times 60 min) ________ minutes

r. Complete the fallout prediction:

1. Draw left and right radial lines from ground zero (Line b) using angles from Lines o and p.
2. Draw two arcs between the radial lines, using GZ as center, with radii equal to the downwind distances from Lines m and n.
3. Draw a circle around GZ, using Line g.
4. Draw tangents to the GZ circle and the points of intersection of the two radial lines with the Zone I arc.
5. Plot the time-of-arrival arc, using the data from Line q.

NOTE:
To portray combined effects for troop safety, draw a minimum safe distance (MSD) circle around ground zero (GZ). See chapter 6.

Thorough peacetime planning is required to provide the tactical commander flexibility in ADM employment. ADM have application as a combat multiplier in all kinds of tactical operations. Upon receiving mission orders, the commander analyzes the mission and develops a concept of the operation. The plans and operations (G3) staff and Engineer then develop an ADM plan to support the commander's concept. Thorough peacetime planning facilitates nuclear release and control and thus provides the commander needed flexibility in ADM employment. During planning, all potential ADM targets in the corps are analyzed and placed in a corps atomic demolition munitions location (ADML) listing. The ADML listing facilitates ADM release request and controls the use of ADM. The corps area is divided into several preplanned employment option areas. When the tactical situation dictates, the corps or division commander requests a particular number of ADM to be used in any ADML-listed target in a particular option area during a specified time period. When the release is granted, the corps commander has the authority to execute the released number of ADM at any ADML in the option area. The yield of the ADM used must match the previously planned yield specified for the target. Normally the nuclear release authorization specifies a time limitation on execution to control and limit use of nuclear weapons.

Section I—ADM SUPPORT OF TACTICAL OP[illegible]

ADM ROLE IN THE OFFENSE

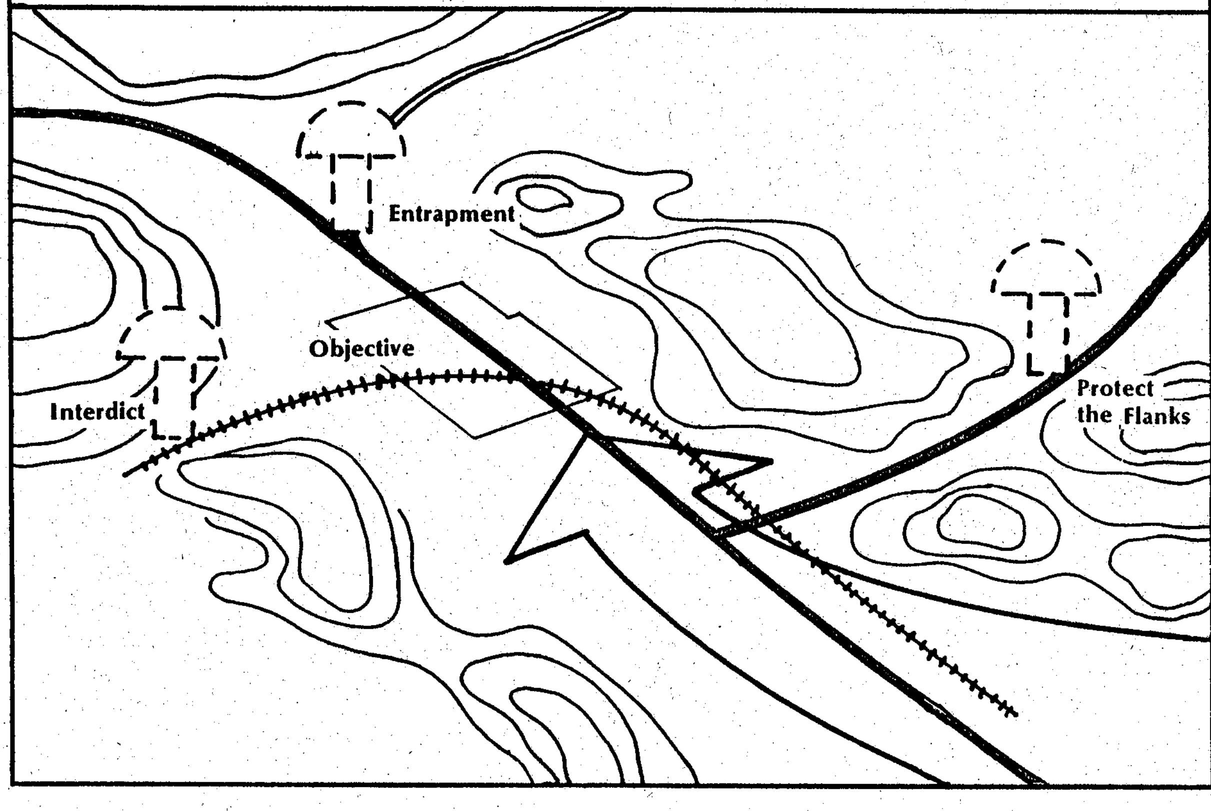
ADM are usually employed in areas under friendly control and are integrated with obstacle and fire support plans to support the commander's concept of the operation. One of the roles that ADM can play in the attack is to protect the flanks of an attacking formation, particularly in crosscompartmented terrain. ADM can be used to seal likely avenues of enemy counterattack.

A second role for ADM in the offense is to create obstacles behind the enemy to prevent escape from the attacking forces. Another role is interdiction—disruption of enemy forces by destroying major highway and rail bridges in enemy territory and disrupting the enemy's main supply routes.

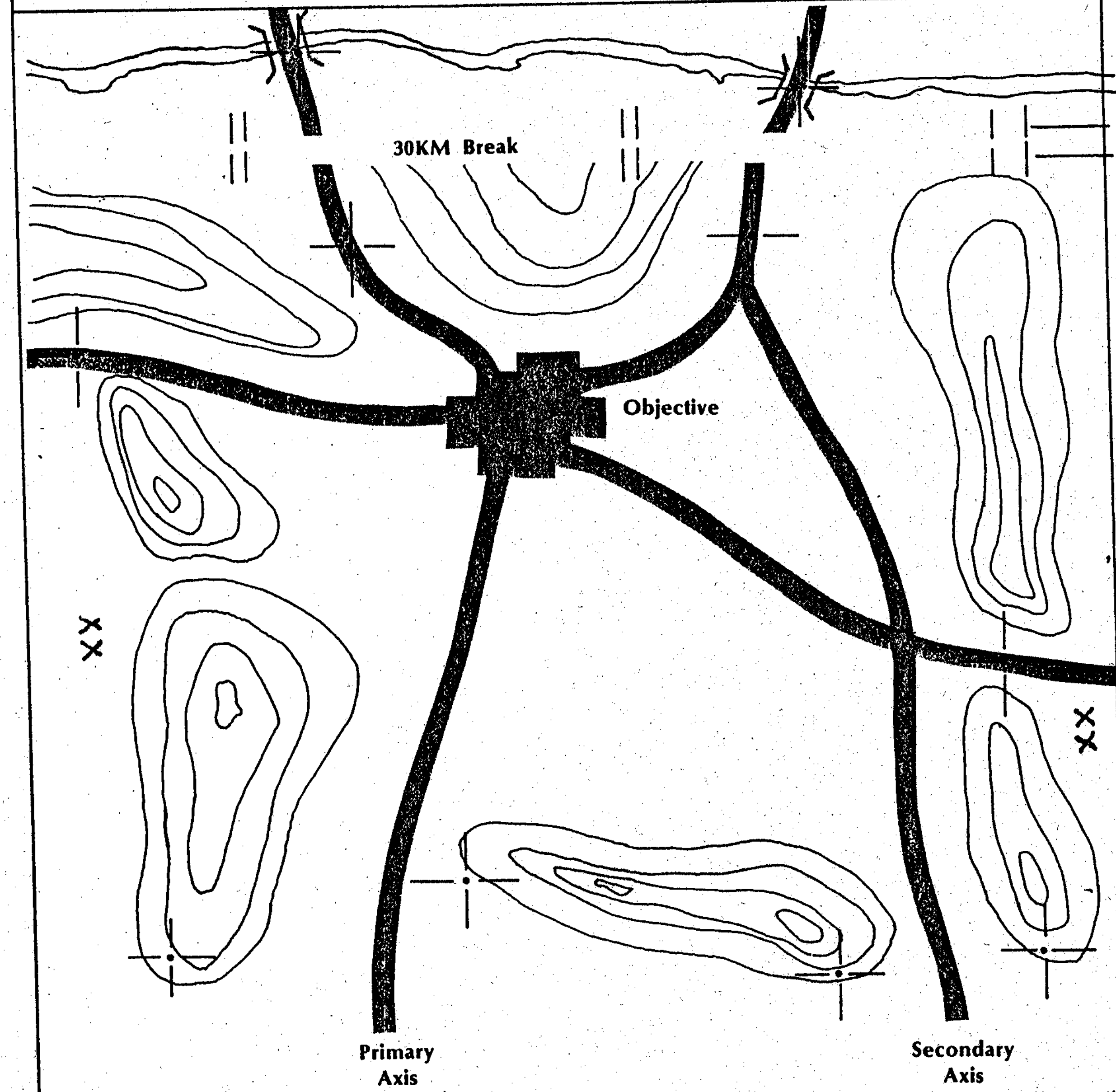
ADM employment teams can travel with a mechanized attacking force or be placed at target locations by aircraft. The use of specially trained stay-behind forces is another technique which can be used to attack enemy rear areas.

Not every position in the following discussion will be used for ADM obstacles, but every one is a good potential target that merits consideration. Note that ADM should not be used on targets that are easily bypassed unless friendly forces desire to divert enemy forces to the bypass.

ADM IN THE OFFENSE



ADM IN OFFENSIVE OPERATIONS



Targets 1 and 2 can cut off the enemy's withdrawal routes. They could be executed by airmobile forces inserted in the enemy rear area.

Targets 3 and 4 can cut off enemy counterattack routes. These targets would not be detonated unless the enemy actually counterattacked.

Targets 5 and 6 can provide flank security to the attacking elements. Coordination with adjacent friendly units is necessary since the ADM effects will extend there.

Targets 7, 8, 9, and 10 can provide economy-of-force support in holding the shoulders of the penetration. These targets would not be detonated unless the enemy attempted to seal off the base of the penetration.

ADM ROLE IN THE DEFENSE

The ADM has utility in all kinds of tactical operations, but its greatest utility is in the defense. ADM in the defensive role provide key obstacles in barriers, block dangerous avenues of approach, and counter enemy success with initial barriers. ADM are especially effective in creating massive obstacles that can shape the battlefield to facilitate economy of force operations.

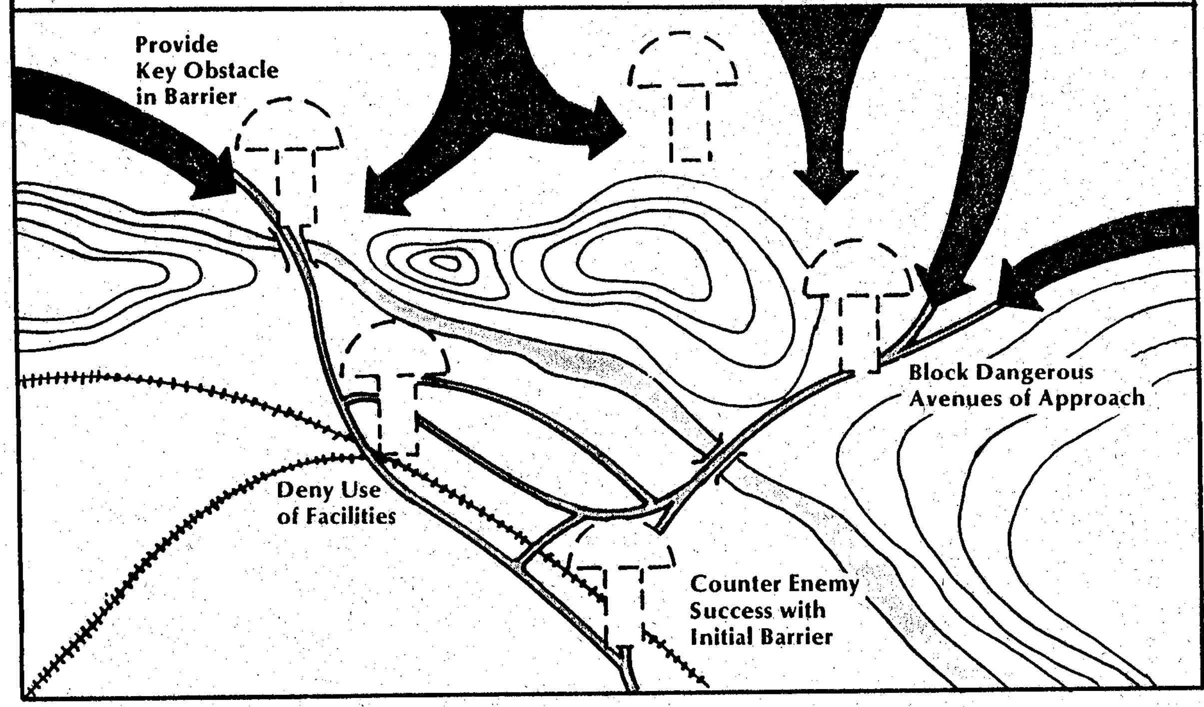
When enemy forces capture undamaged facilities such as airfields, transportation centers, and supply depots, they gain a very significant addition to their combat power by reducing dependence on follow-on logistical support. It is very difficult to evacuate large quantities of supplies because of the many other demands for transportation. Therefore, all commanders must have detailed plans for destroying supplies and installations that may offer a significant combat advantage to the enemy. The ADM is very suitable for cratering large airfields. Low-yield ADM may effectively deny the enemy use of large supply depots, POL products and equipment, rail centers, highways, and ports.

Although the ADM is usually used only as a demolition, its basic effects are the same as those from any other nuclear weapon. The nuclear effects of the ADM may provide additional benefits useful to the countermobility support of the battle plan.

EXAMPLE OF DEFENSIVE OPERATIONS

ADM targets are planned throughout the battle area. Targets should be planned well forward to delay enemy attacking forces and protect friendly counterattack force. Targets should also be planned deep to counter potential enemy penetration. In the figure on page 3-5, the river is the forward edge of the battle area (FEBA).

ADM IN THE DEFENSE



ADM IN DEFENSIVE OPERATIONS

Target 1 is designed to narrow an avenue of approach. It will force the enemy to follow the path shown by the dotted arrow. The enemy will be required to narrow the formation and will be vulnerable while moving through a kill zone to bypass the ADM crater.

Target 2 is designed to canalize. It will completely block the defile between the two hills and will force the enemy to seek another route (probably near target 1).

Target 3 is a dam. Its destruction will wash out the bridges at targets 4 and 5 and will flood low-lying areas along the river. Mud will make the lake and river bed impassable to vehicles for a considerable time. Target 3 must be coordinated with adjacent units and national authorities because its effects will be widespread.

Targets 4 and 5 are bridges. They will not be detonated until the covering force withdraws across the river.

DELAY DETERMINED BY TACTICAL SITUATION

REQUIRED DELAY

Targets are attacked in different ways according to the delay required.

Short-term delay (Category A): These obstacles will delay passage (breach) by the enemy for several hours to days.

Intermediate delay (Category B): These obstacles will delay passage by the enemy for days to weeks.

Long-term delay (Category C): These obstacles will delay passage by the enemy for weeks to months.

NOTE

Although unable to breach the obstacle in the given time, the enemy may be able to find or construct a bypass route in a much shorter time.

OPTIONS OF DELAY

Many ADM targets can be attacked in a variety of ways. Each way may produce a different length of delay. The tactical situation usually determines the length of delay required. For instance, if we expect soon to halt the enemy advance and to try to regain lost ground, we would not want to destroy key bridges to produce a long-term delay. On the other hand, if we desire to preclude enemy vehicular access to a portion of the battlefield, a long-term delay may be appropriate.

METHODS DETERMINED BY DELAY REQUIRED

CRATERS AND LANDSLIDES

ADM can produce craters wide enough to block all lanes of virtually any superhighway. If the smallest-yield ADM is emplaced in a culvert, the crater produced is wide enough that a vehicle-launch bridge or medium-length fixed tactical bridge cannot breach it.

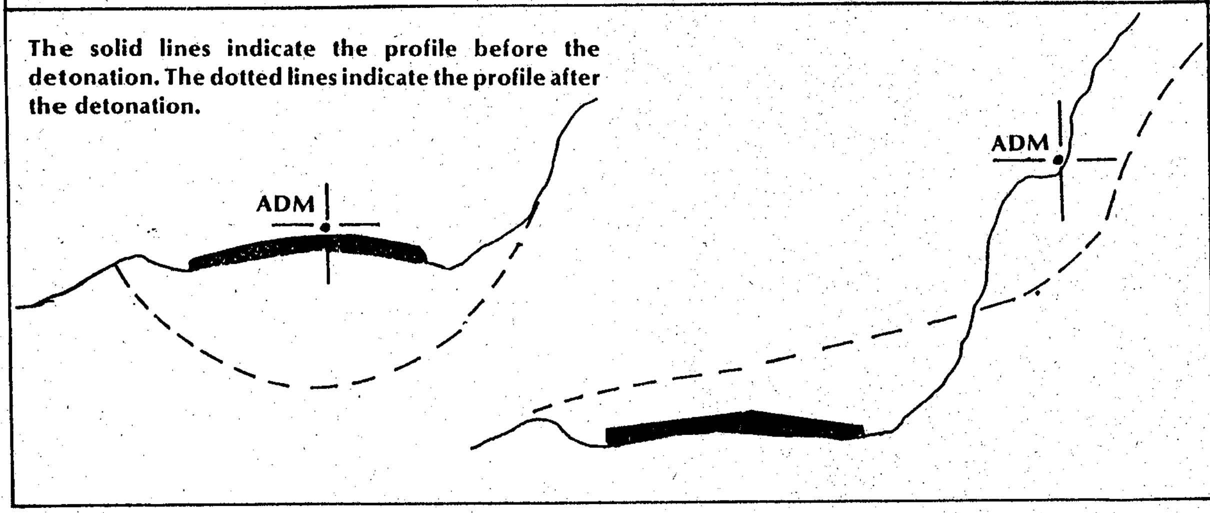
An ADM-produced crater is difficult to breach with tactical bridging because it has a very loose and contaminated lip. Its volume is so large that filling it is a lengthy process. It has steep slopes that are usually very loosely packed. Vehicles cannot get out of these craters unassisted. In addition, tanks cannot easily bypass these craters if the adjacent hillsides are steeper than 30 degrees.

Often a road that can be closed by a crater can also be blocked by a landslide. This method produces a large mound of loose rubble and makes bypass around either the uphill or downhill side virtually impossible. To block a road by landslide, the height of slope above must be at least equal to the road's width, and the slope should be at least 30 degrees.

Craters and landslides usually produce effective kill zones. For example, a crater or landslide on a mountain road may back up enemy traffic. If the road is narrow, some vehicles may be lost while trying to reverse direction. If a superhighway is blocked, possible bypasses become kill zones. A carefully sited ADM obstacle along an enemy avenue of approach can cause the enemy to back up near the obstacle site and create a dense target for attack.

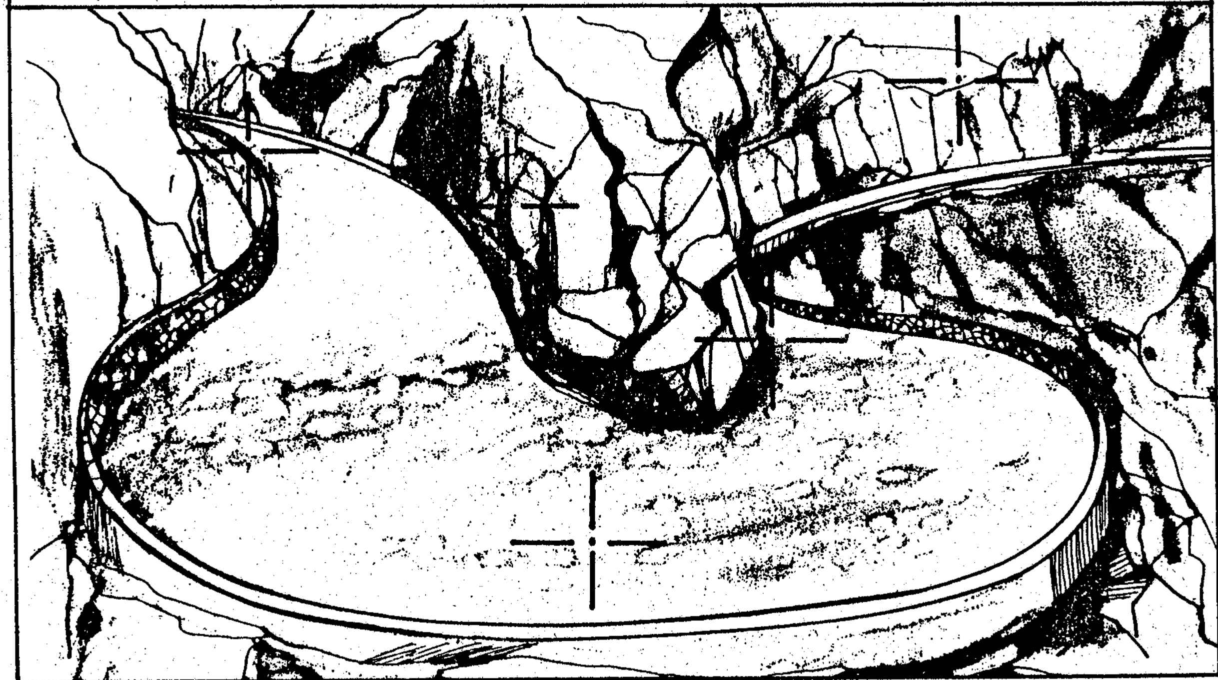
Integration with natural obstacles can further extend delay. Local bypasses or areas that can easily be upgraded into bypasses should be covered by fire or other deterrents (scatterable mines dropped **after** the ADM detonation, wire entanglements, or chemical contamination). These additional obstacles can keep the enemy in the kill zones created by the ADM obstacle longer and thus enhance the fire of friendly weapons. Sometimes ADM contingent effects (such as tree blowdown) enhance the crater or obstacle.

COMPARISON OF A CRATER AND A LANDSLIDE



The figure below shows a switchback that could be effectively blocked with an ADM. There are several choices for emplacement points: upper roadway, curve, lower roadway, rock outcrop, or the mountainside. Emplacement on the road will block the road with a crater causing a Category B delay. Emplacement in the rock outcrop or mountainside will block the road with a landslide to cause a Category A delay. It will be very difficult for the enemy to reverse direction or disperse when halted by the obstacle, and the enemy will be extremely vulnerable to artillery or tactical air strikes.

POTENTIAL ADM CRATER OR LANDSLIDE SITES



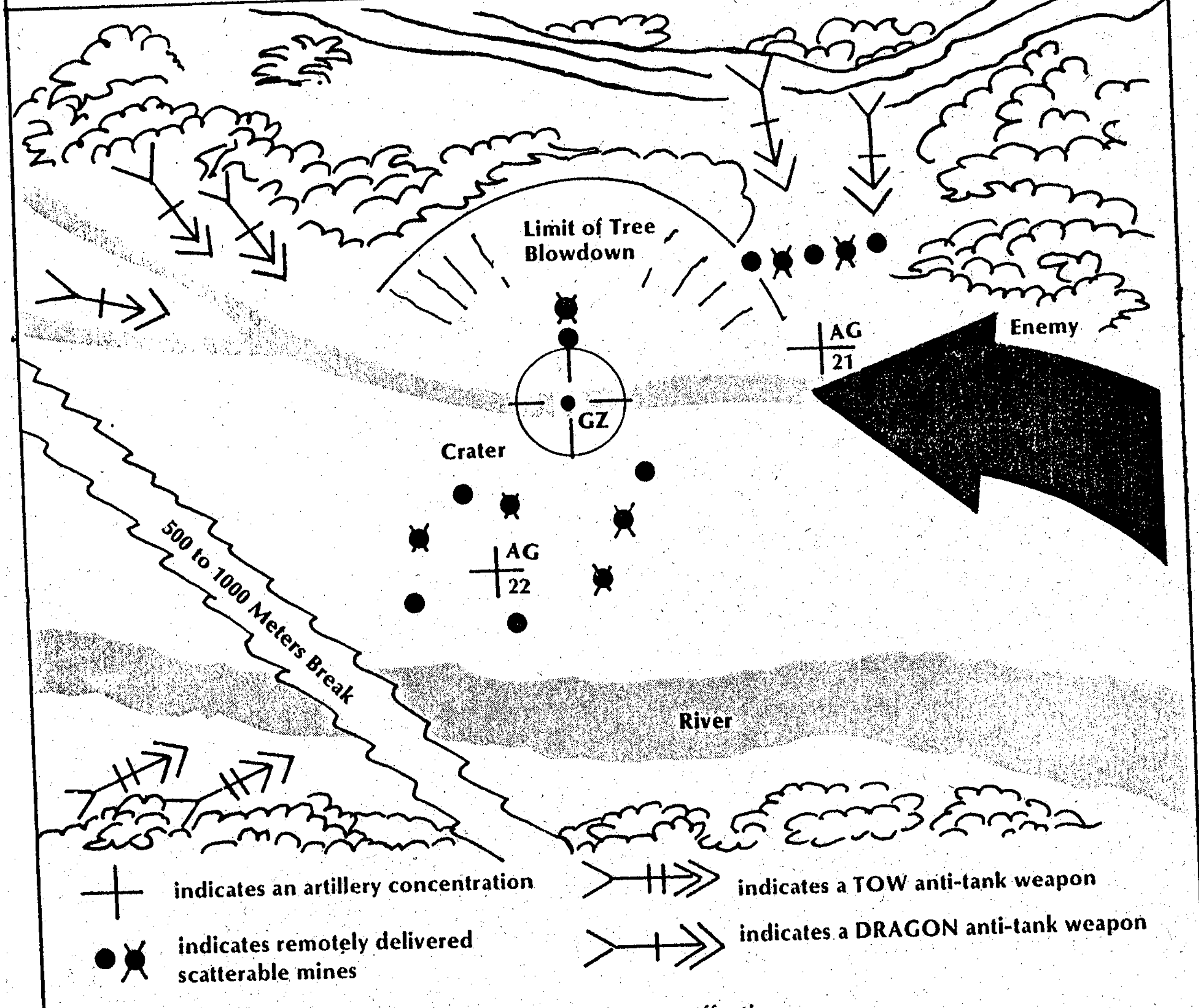
The figure below shows a road that runs along one side of a narrow, steep valley. Cratering the roadway produces two kill zones: one where enemy vehicles will stop on the road and one in the open field where the remotely delivered scatterable mines are shown.

BRIDGES

Bridges may be attacked in three ways to produce three different lengths of delay:

- The approach road network may be blocked to produce a short-term delay (Category A).
- The approach road network may be cratered or the approach ramp and short

HIGHWAY CRATER CAUSING ENEMY DELAY



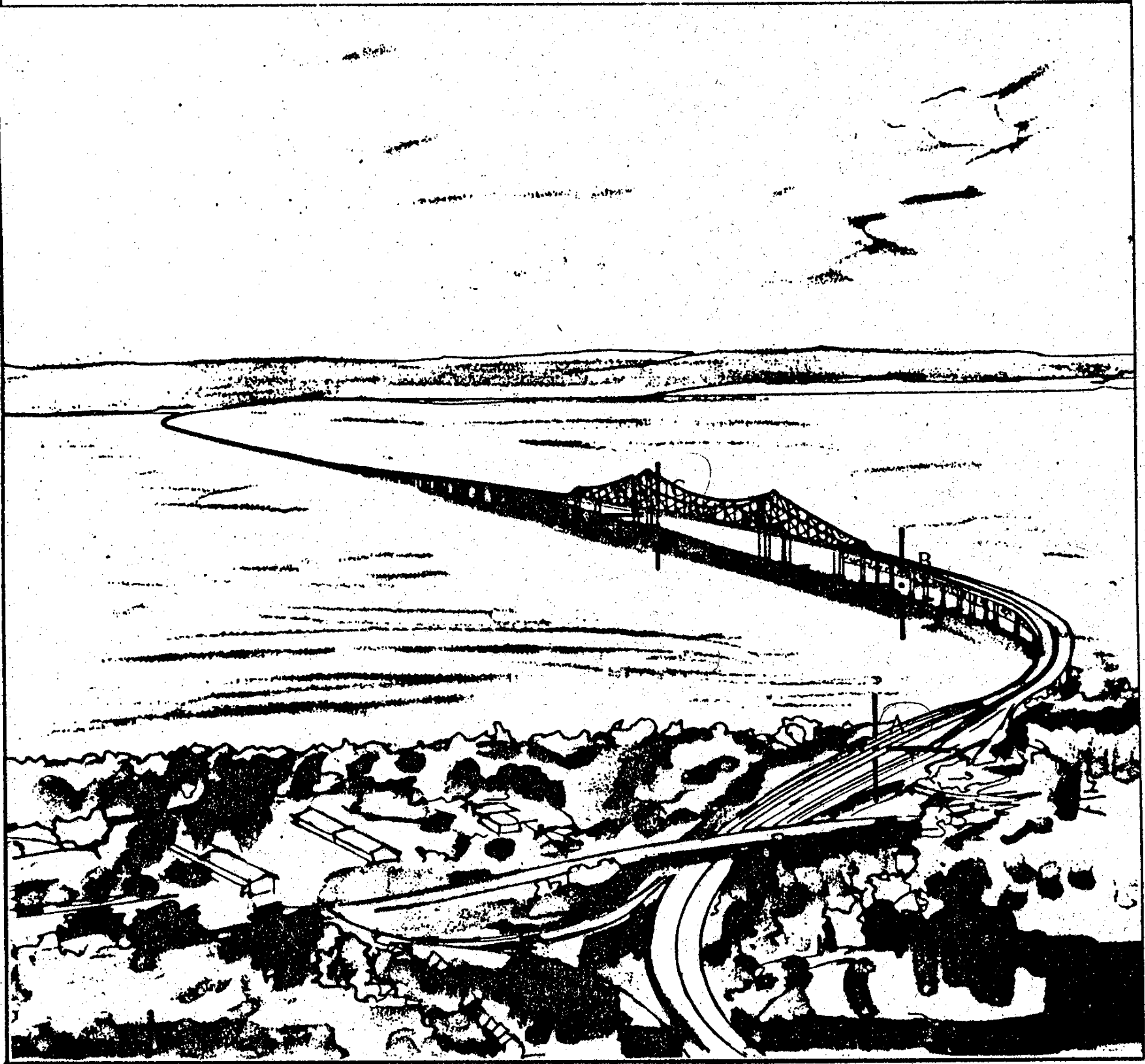
NOTE: If the open field is marshy, the operation is more effective.

spans can be destroyed to produce an intermediate delay (Category B).

- The large center spans or the entire bridge can be destroyed to produce a long-term delay (Category C).

In the figure below, point A is a possible emplacement for short- or intermediate-term delay dependent upon munition emplacement (intermediate-term if the entire roadway is cratered; short-term if the roadway is blocked but not destroyed). Emplacement at point B would cause intermediate delay. Emplacement at point C would cause damage that could take months to repair.

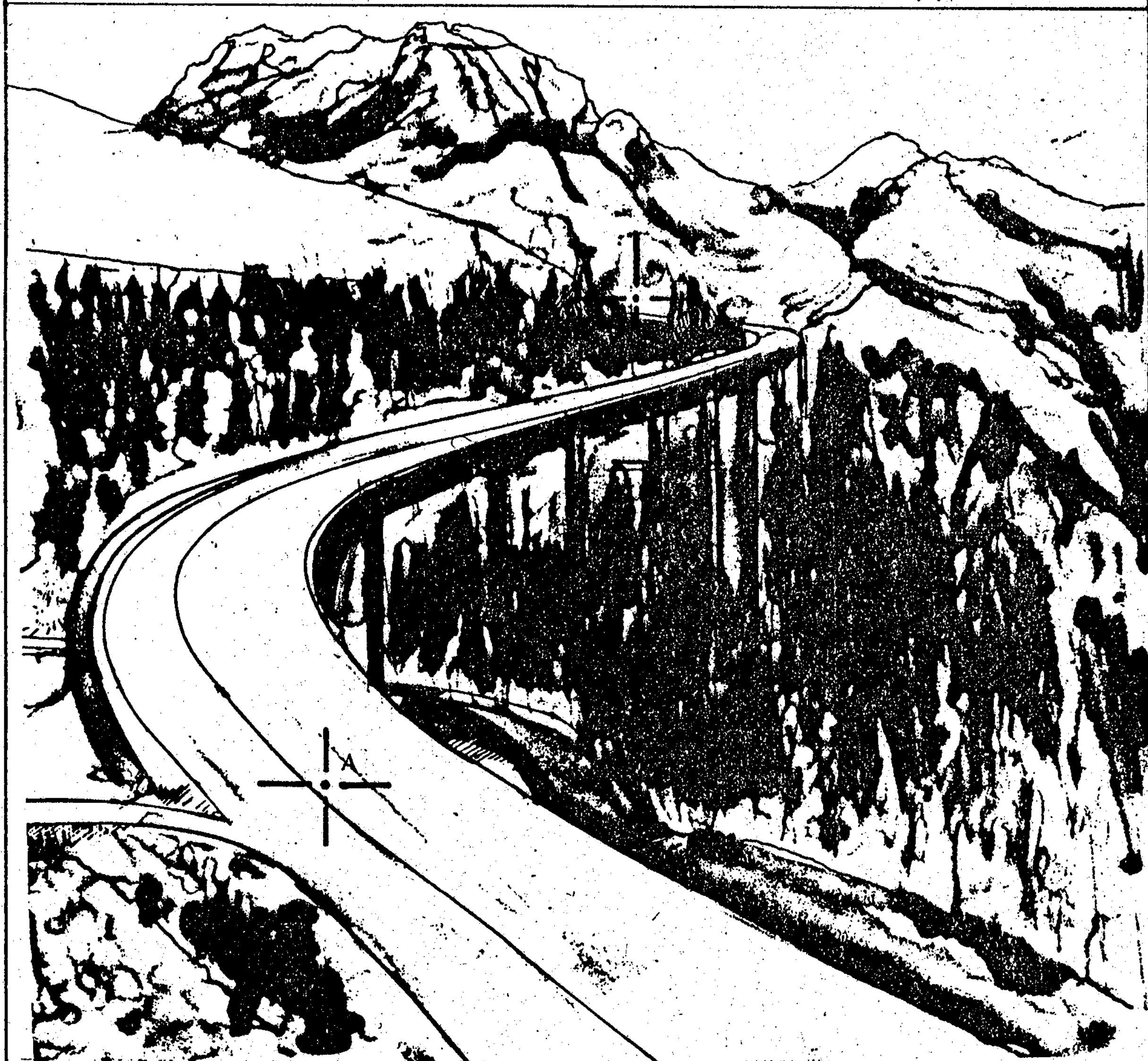
DELAY OPTIONS FOR DESTRUCTION OF BRIDGES (1)



In the figure below, points A at each end of the bridge would cause a tactical delay to the enemy. The munition could be placed to create either a Category A or a Category B delay. Emplacement at point C would cause damage that could take months to years to repair (Category C).

The bridge in the figure at right can be attacked to create a Category A, B, or C

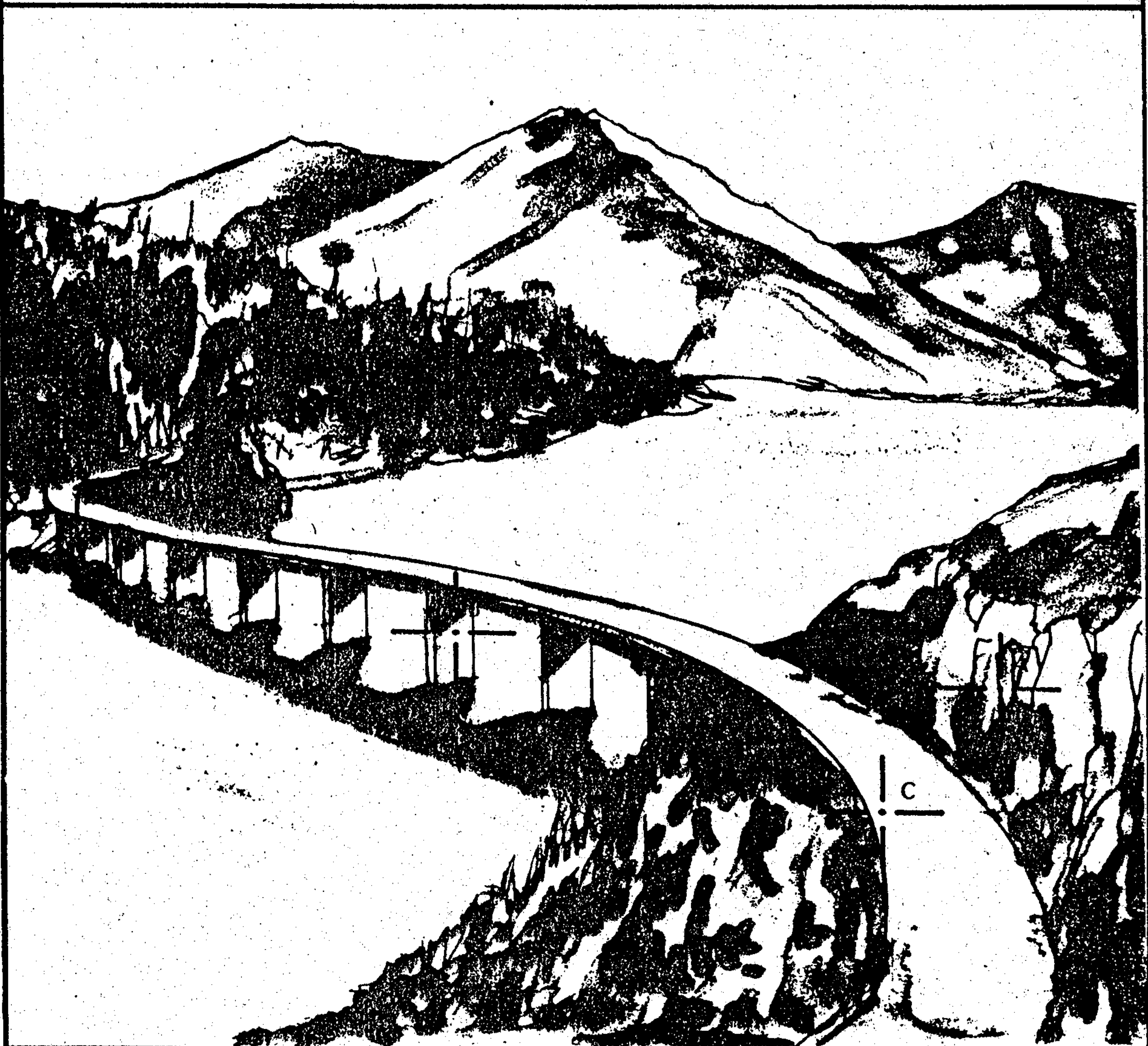
DELAY OPTIONS FOR DESTRUCTION OF BRIDGES (2)



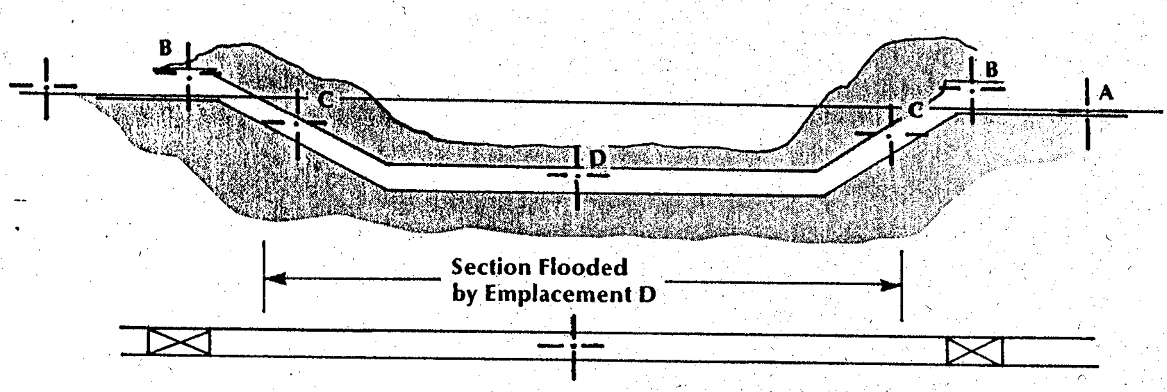
obstacle. Short-term delay can be achieved by creating a landslide at the bridge approach (point A); intermediate-delay by cratering the approach roadway (point B); and long-term delay by destroying several bridge spans (point C).

Because bridges destroyed by ADM usually do not need to be supplemented with conventional obstacles, detonation may be reserved until the tactical situation requires it. If the situation never requires the obstacle, the ADM is quite easy to recover.

DELAY OPTIONS FOR DESTRUCTION OF BRIDGES (3)



DELAY OPTIONS FOR DESTRUCTION OF TUNNELS



TUNNELS

Tunnels may be attacked in four ways. See figure above.

- A munition can be placed on the approach road network (positions A) to create either a Category A or a Category B delay. The approach road may be blocked to produce a short-term delay. This approach does not deny the use of the tunnel to foot troops. The approach road may be cratered to produce intermediate-term delay.

- The entrance or exit portals may be blocked by crater, landslide, or destruction of a short portion of a tunnel entrance (positions B). This method denies the tunnel to both vehicles and foot troops for an intermediate delay.

- The underground portion of a tunnel may be damaged or destroyed (positions C). Moderate damage could be repaired by clean-up crews removing rubble from the tunnel and would produce intermediate delay. Severe damage could be repaired only by techniques used in digging a new tunnel and would cause long-term delay. The degree of damage is dependent upon the ADM yield.

- The underwater portion of a tunnel may be destroyed (position D). This method would flood the tunnel, would be very difficult to repair, and would cause very long-term delay.

DAMS AND CANALS

Dams and canals are almost always very difficult to replace, and the release of stored water normally causes long-term delays.

Destruction of a dam or canal lock creates two zones of damage.

Downstream. The area downstream is flooded, bridges may be washed away, and structures may be destroyed. After the water drains away, the area is swampy. An example of the downstream result of destroying a dam is: In May 1943, British air strikes breached a dam on the Moehne River. In 12 hours, 83 percent of the reservoir (116 million cubic meters) drained. A flood wave 10 meters high moved down the river valley at an average speed of 5.8 kilometers per hour. This wave destroyed 25 hydroengineering complexes, 4 railroad and 16 highway bridges, 80 kilometers of railroad and highway, and several thousand buildings. All permanent bridges within 50 kilometers downstream of the dam were washed away.

Upstream. The reservoir behind the dam or the canal behind the lock drains and becomes a swamp or mud flat that is difficult to traverse.

Major roads often pass across dams. If the objective is to block the road and if the consequences of destroying the dam are undesirable, consider a different location.

COMPLEX TARGETS

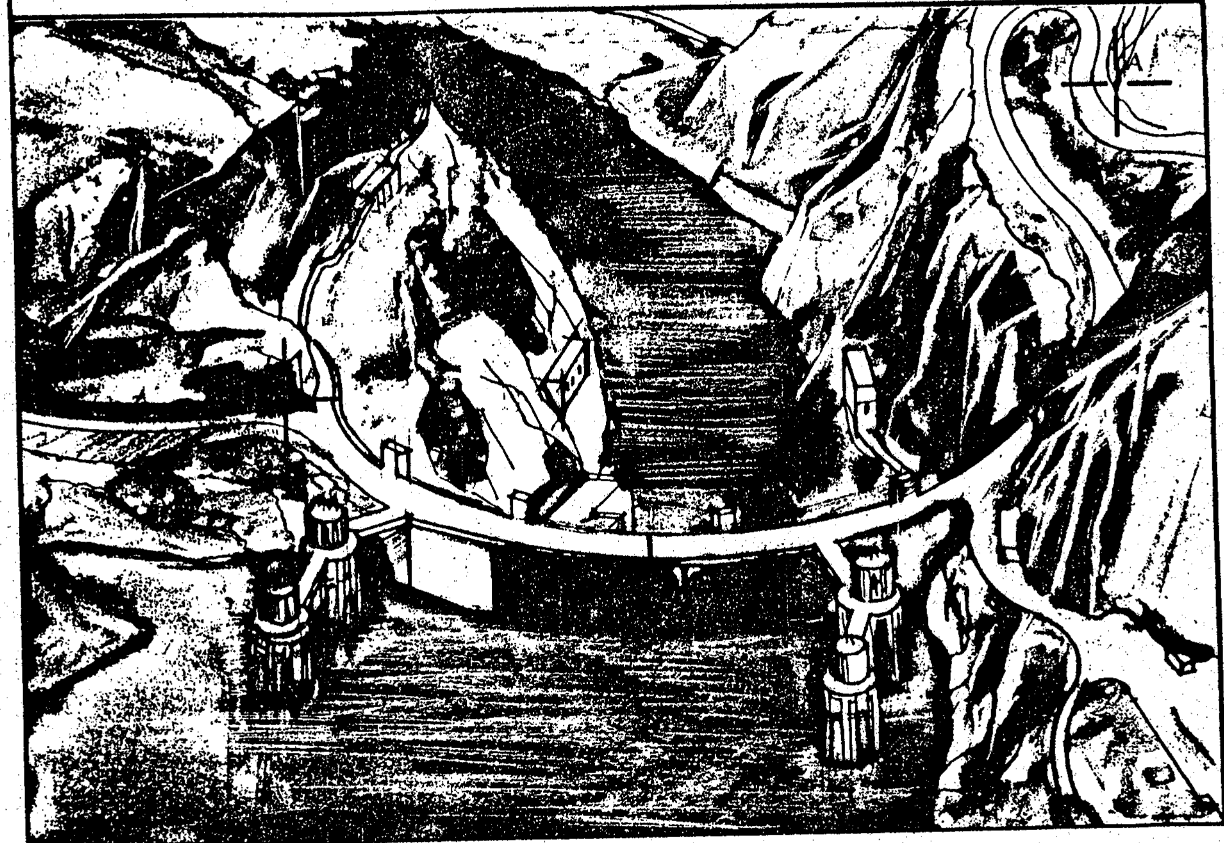
Some targets involve a combination of the preceding types of targets. Some examples are shown below and on pages 3-14 and 3-15.

The dam below restrains a huge lake more than 500 feet deep. For 250 miles downstream, there are only five points where the river is bridged. Destruction of the dam could possibly destroy all of them. It would assuredly destroy the first two (the third bridge is 130 miles downstream). Therefore, destruction of this dam may create a 300-mile-long barrier.

In addition, the road across the dam is a major route. Destruction of the dam (position C or a position within the dam) would cut this road.

Alternatives to destroying the dam are shown as two positions A. Landslides or craters at these points would close the road without harming the dam. There are numerous other possible sites for craters and landslides on this highway.

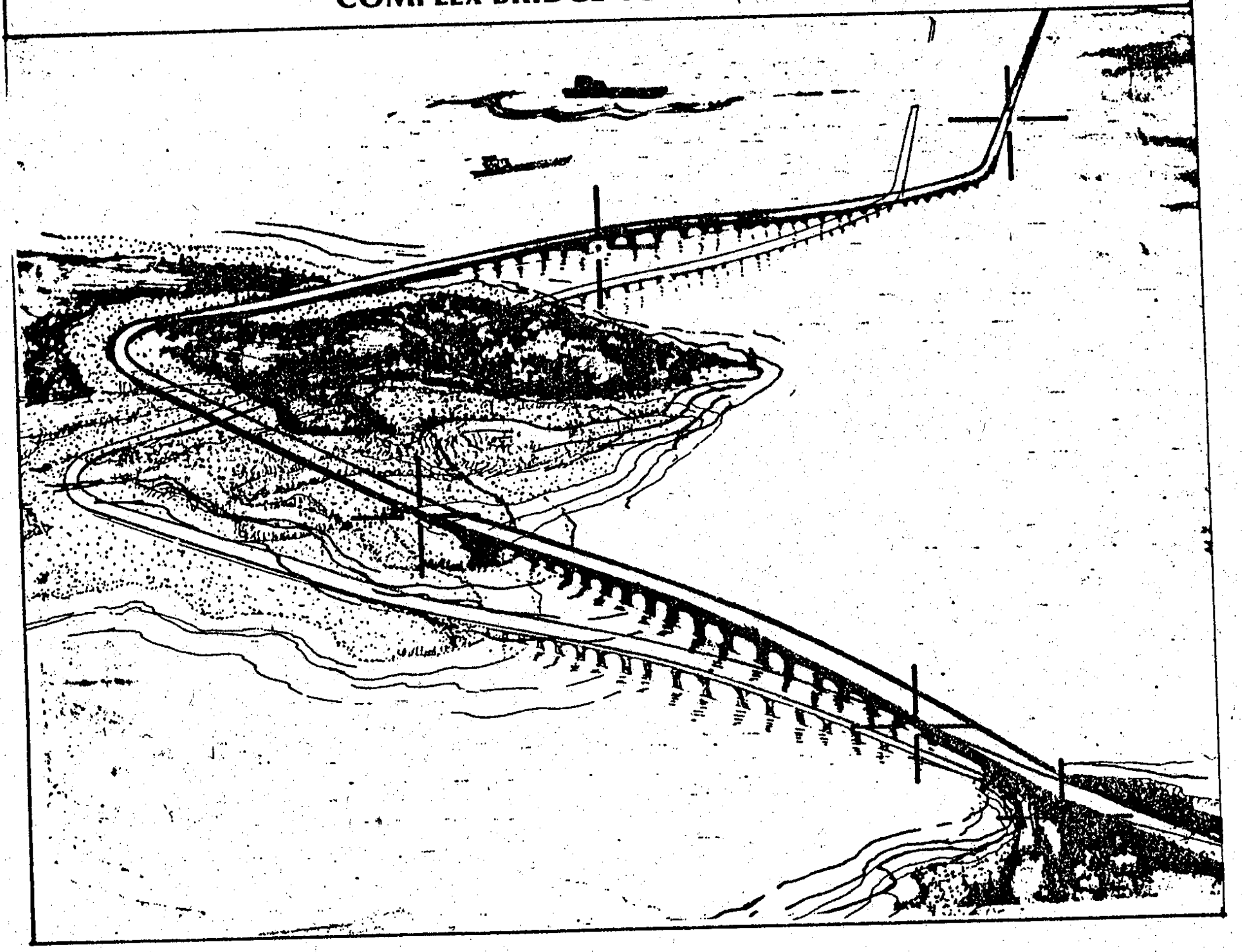
COMPLEX DAM TARGET



The bridge-tunnel complex in the figure below is the farthest downstream crossing of a large estuary. The next crossing point is 115 miles upstream. Destruction of this bridge-tunnel complex could trap an enemy on the peninsula between bridge and tunnel, or it could deny that peninsula to an enemy approaching from the near shore.

This complex could be damaged for long-term delay at points C or D. However, in this case, a crater at points A or destruction of short spans at point B suffices if the defender has air or naval superiority. The enemy would be very vulnerable while working to repair even minor damage at those exposed locations.

COMPLEX BRIDGE-TUNNEL TARGET

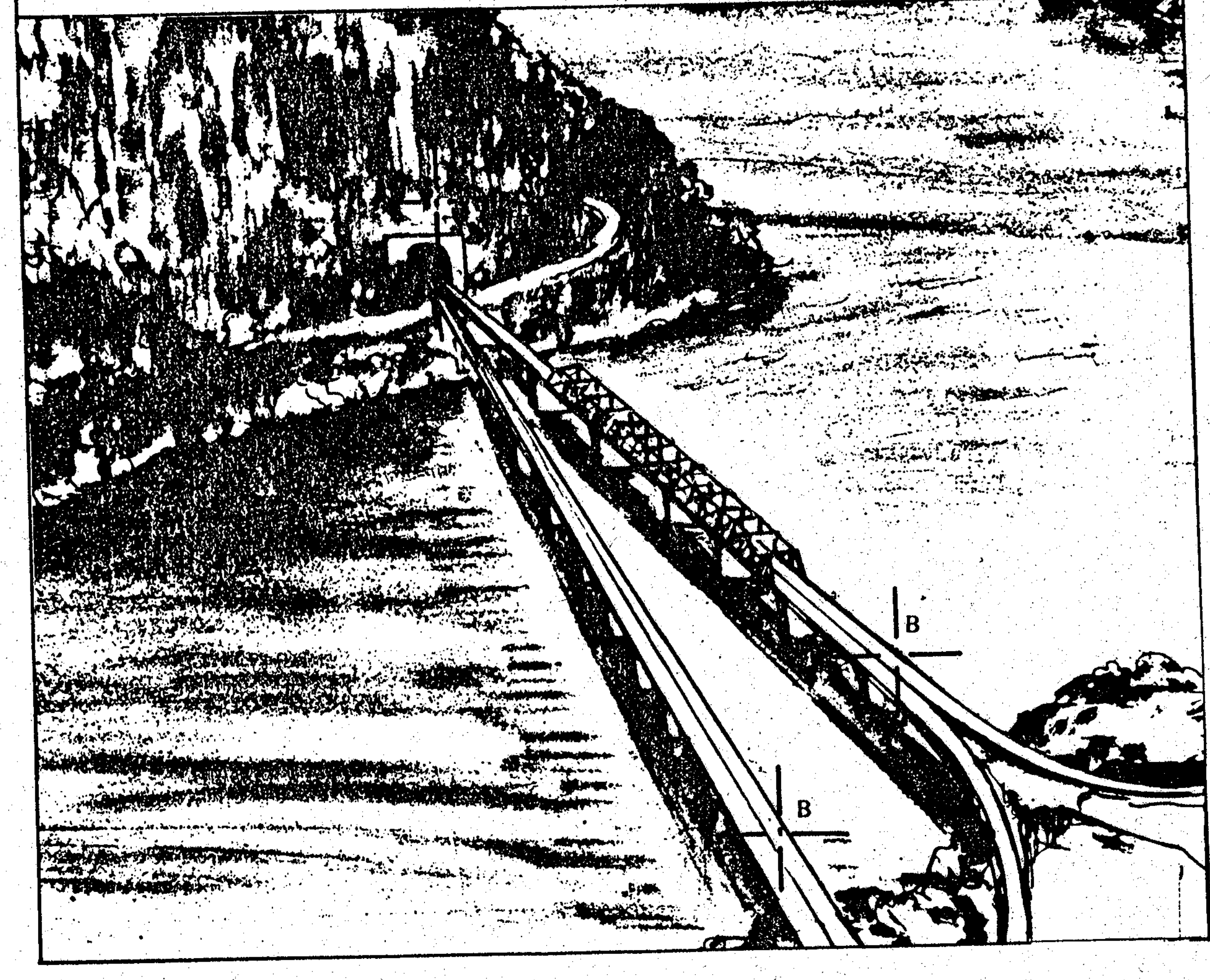


There are four military targets in the figure below: the two bridges, the tunnel, and the road around the mountain.

An ADM emplaced at point A to cause a landslide would create obstacles at all four targets.

Either of the two bridges could be selectively destroyed with a low-yield ADM emplaced at one of the two points B, or a higher-yield ADM could destroy both bridges. The tunnel could be selectively destroyed with an ADM emplaced inside it.

COMPLEX BRIDGE-TUNNEL-ROAD TARGET



Section II—COMMAND AND STAFF PLANNING RESPONSIBILITIES

NEED FOR COORDINATION

Command responsibilities and staff actions in the planning and employment of atomic demolitions generally follow established command and staff channels. Planning for the use of ADM is an integrated effort with many overlapping staff responsibilities that necessitate continuous coordination. The engineer is the key ADM actor on the coordinating staff. The engineer is the principal advisor to the G3 in the preparation of ADM plans to support the concept of operations through initial planning to the execution of the ADM mission operations order.

TASKS AND RESPONSIBILITIES FOR ADM PLANNING

Tasks and responsibilities for ADM planning are outlined on the following pages. Execution responsibilities which are discussed in chapter 4 are also outlined. This matrix provides an overview of ADM mission planning, command and control, pre-employment, and employment tasks and responsibilities. For detailed definitions of actors, see appendix D. The coordinating staff consists of the principal staff and Engineer, civil affairs, air liaison, fire support, nuclear, biological, chemical (NBC), and combat electronics warfare intelligence elements. Additional guidance on operations involving tactical nuclear systems is in Field Manuals 6-20, 100-5, and 100-50.

COMMAND GUIDANCE

The magnitude and nature of nuclear effects have a profound influence on ground operations. Guidance of commanders to their staffs is vital to successful operations on the integrated battlefield. Guidance must be timely

TASKS AND RESPONSIBILITIES FOR ADM PLANNING AND EXECUTION

	Corps—Releasing Commander	Division—Executing Commander	Maneuver Unit	Special Unit	Military Police	Aviation	Engineer	ADM Unit	Coordinating Staff	Mission Officer	EOD	Signal
PLANNING Develop Concept of Operation												
Target Selection												
Target Reconnaissance												
Target Analysis												
Target Folder Preparation												
ADML Listing Preparation												
Group Employment Plan (GEP) Preparation												
ADML Listing and GEP Approval												
Advise Corps/Div. Cdr. on ADM												
Incorporate ADM on OPLAN												
Request ADM Release												
Prepare ADM OPORD												
COMMAND AND CONTROL—FINAL PLANNING Receive ADM Release Approval												
Designate Number, Option, Area and Time Frame												
Relay Nuclear Release Message												
Designate Executive Commander												
Issue ADM OPORD												
Designate Mission Officer(s)												
Designate Mission Task Force												
PRE-EMPLOYMENT Operate as Field Storage Location												
Secure Ground Convoy*												
Secure Field Storage Unit*												

Provided as directed by Executing Commander and designated in the mission task force organization in the ADM OPORD. Normally from maneuver unit but may be selected from any assets available to Executing Commander.

TASKS AND RESPONSIBILITIES FOR ADM PLANNING AND EXECUTION (continued)

	Corps—Releasing Commander	Division—Executing Commander	Maneuver Unit	Special Ammo Unit	Military Police	Aviation	Engineer	ADM Unit	Coordinating Staff	Mission Officer	EOD	Signal
Conduct Traffic Control												
Provide Air Transport of ADM												
Prepare Emplacement/Firing Sites												
Provide ADM Mission Officer*												
Provide ADM Target Team Leaders*												
Provide ADM Security Force(s)												
Evacuation of Civilians												
Prefire Checks and Preparations												
EMPLOYMENT												
Conduct Mission IAW ADM OPORD												
Coordinate Mission Execution												
Command Mission Task Force												
Secure Ground Convoy FSL to Target*												
Secure Emplacement Site*												
Provide Area Security												
Install Field Wire Command Link*												
Conduct Traffic Control												
Transport ADM Firing Team with Munition												
Provide Engineer Support												
Provide Communication Support												
Perform Emergency Nuclear Weapons Support												
Emplace, Assemble, Detonate Munition IAW OPORD												
Conduct Emergency Destruction												
Report Mission Results												

***Note:** Provided as directed by Executing Commander and designated in the mission task force organization in the ADM OPORD. Normally from maneuver unit but may be selected from any assets available to Executing Commander.

and as complete as possible. In developing their initial staff planning guidance, commanders must consider the requirements of all their general and special staff. As much of their guidance as possible should be standing operating procedures (SOP). As a minimum, the commander's guidance should address—

- Results desired from the employment of ADM such as stop a penetration, delay for four days, divert penetration, protect flanks, interdict or destroy fixed targets, and so forth.
- Desired degree of target destruction, for example, severe or moderate.
- Acceptable risk to our troops from our weapons.
- Preclusion of damage. Collateral damage constraints.
- Target priorities.
- Security of ADM systems.
- Nuclear accident or incident control.
- Command and control of ADM missions.
- Communications for ADM operations.

STAFF AREAS REQUIRING COMMAND GUIDANCE

Replacement of individuals and units
Radiation exposure records
Mass casualties and graves registration
Medical treatment priorities

Target acquisition
Target priorities
Essential elements of information (EEI)

Risk and vulnerability criteria
Collateral damage criteria
Command and control of nuclear missions
Preclusion of damage criteria
Target priorities
Psychological operations
Allocation and assignment of special ammunition
Mission-oriented protective posture (MOPP)

G4

Prescribed nuclear load (PNL)
Resupply
Nuclear accident incident control (NAIC)

G5

Civil affairs
Host nation support

Chemical Officer

NBC reports
Decontamination
NBC defense

Engineer

ADM employment
Engineer work priorities

Fire Support Coordinator

Allocation and assignment of special weapons
Target priorities

Section III—PLANNING ADM MISSIONS

STEPS IN PLANNING

Planning for ADM missions requires the following steps:

1. Analyzing the mission, concept of operations, and terrain.

2. Selecting possible ADM target locations to support the concept of operations and making mission statements.

3. Obtaining target information on all selected possible targets.

4. Performing target analysis to select—within any command constraints—the yield of munition required to produce the desired obstacle.

5. Obtaining target approval.

6. Developing employment option areas and group employment plans.

7. Requesting release or authority to execute one or more ADM.

8. Writing the ADM operations order for the execution of missions.

MISSION STATEMENT

COLLABORATION ON MISSION STATEMENT

After analyzing the unit mission and the terrain, the commander decides on a concept of the operation. Knowing the concept of the operation and the terrain, the Engineer staff officer tentatively selects from a map those potential obstacle or denial target sites which may be suitable in size and importance. The plans officer or the plans and operations staffs and the Engineer staff officer then collaborate on a mission statement for each ADM target.

Examples of mission statements are—

"The destruction of the bridge at HB487380 must delay the enemy forces for 5 days."

"The road crater at HB94107295 must cause the attacking enemy forces to change direction to follow Highway 202."

"The road crater at HL10248130 will block any possible enemy counterattack from the right flank."

NEED FOR PRECISION IN MISSION STATEMENTS

The mission statement should state the **purpose** and the **what** and **where** as precisely as possible. **Who** and **when** will be covered in other portions of the plan. The mission statement provides the basis for all subsequent planning. For example, it will influence the type of information required during the target and mission area reconnaissance and the quantity and yield of ADM needed to do the job. It may very well influence the releasing commander's decision to approve or disapprove the target.

RECONNAISSANCE

RESPONSIBILITIES

The combat Engineer battalion is responsible for ADM target reconnaissance in its area of operation. The divisional combat Engineer battalion is responsible for reconnaissance in the division's area of operation. Nondivisional Engineer battalions are assigned responsibility for ADM target reconnaissance in the corps rear area by the corps Engineer in conjunction with the corps rear area tactical commander. The ADM company/platoon can provide technical advice and assistance to reconnaissance parties. A reconnaissance party should coordinate its actions with the target analyst.

INITIATION

Once the tentative targets are selected and mission statements written, the Engineer staff officer requests the Engineer unit to conduct a ground reconnaissance of each site and the surrounding mission area. The reconnaissance of the target plays a key role in selecting the minimum yield to do the job. The reconnaissance must be done by a ground party because of the large amount of information required.

MISSION AREA RECONNAISSANCE

Because the ADM is a nuclear demolition, the planner must consider hazardous as well as desired effects. As a result, the planner needs information about the area surrounding the target as well as technical data on the target itself. When planning for employment in friendly territory, the planner should coordinate with host nation authorities.

CONDUCT OF RECONNAISSANCE

Complete instructions for conducting an ADM target reconnaissance and a mission area reconnaissance can be found in chapter 5.

TARGET ANALYSIS

DEFINITION

ADM target analysis is an examination of potential targets and surrounding areas to determine munitions required to produce desired obstacles and to limit undesirable effects.

RESPONSIBILITIES

The analysis of ADM reconnaissance data and selection of munition and placement position are the responsibility of the target analyst. Any staff officer position authorized to be qualified with Additional Skill Identifier (ASI) 5H must, by virtue of this qualification, be able to perform ADM target analysis. The analysis must be verified by both the operations and engineer staff elements. Staff sections which have qualified target analysts are operations, fire support, engineer, and chemical. The Engineer prepares the target folder. The ADM company/platoon can provide technical assistance.

DATA FOR ADM TARGET ANALYSIS

Tables in appendix C of this manual and in FM 101-31-3 present technical data for the hypothetical ADM family. Where conflicts exist, the most current field manual shall be used. For stockpile weapons, see tables in FM 101-31-2 (SRD). The ADM damage tables in this manual provide hypothetical data for most demolition targets. Hypothetical troop safety tables and collateral damage tables are also included.

The troop safety tables (appendix C) simultaneously consider initial nuclear effects and the degree of risk to friendly troops in each condition of vulnerability. The tables give the minimum distances that friendly troops in various conditions of risk and vulnerability must be separated from ground zero to preclude casualties.

The damage tables (appendix C) show the extent of effects based on surface and/or subsurface ADM bursts. For each ADM, damage dimensions to various target types are shown.

The contingent effects tables consider the distance to which tree blowdown, hazard to aircraft in flight, fire areas, and collateral damage extend.

The tables in FM 101-31-2 (SRD) have been computed for ADM in the United States stockpile, whereas those in appendix C have been computed for the hypothetical family of ADM. The formats, however, are similar. One who understands how to use the unclassified tables can readily make the transition to the classified tables.

PROCEDURES

Chapter 6, appendix D, and FM 101-31-2 (SRD) present specific technical procedures for target analysis.

OBTAINING TARGET APPROVAL

The corps commander must approve all ADM targets.

The corps commander must approve all ADM targets. Since military operations are conducted within political and military constraints, the corps commander considers constraints such as geographical or political boundaries, yield limitations, minimization of fallout, collateral damage limitations, preclusion of damage, and restrictions on attacking specific kinds of targets. Thorough prehostility planning can result in prewar approval of most if not all potential ADM targets. Normally the corps commander must submit target data to the echelon above corps (EAC) which coordinates with political authorities and obtains their approval to add specific targets to the approved ADM location listing.

ATOMIC DEMOLITION MUNITIONS LOCATION (ADML) LISTING

ADM target location. The corps maintains an ADML listing which is a compilation of all approved ADM targets within the corps. Divisions and brigades maintain the portions of the corps ADML listing for their respective areas of operation. The ADML listing includes, as a minimum, target number, target location, target description, and munition/yield to execute target (or munition options; that is, SADM/0.5 KT at 10-meter depth of burst or MADM/1.O KT surface burst). The

ADML listing may also include pertinent effects data and a purpose statement for each target.

TARGET APPROVAL

The division and corps rear area commanders select potential targets, prepare target folders in accordance with appendix D, and submit the folders to corps for approval. The corps Engineer and operations elements review the target folders to insure that the planning satisfies political and military constraints and provide their recommendations to the corps commander. The corps commander then approves or disapproves the target. A request to add the target to the corps' ADML listing is then forwarded to echelons above corps. Maneuver commanders should strive to have all potential ADM targets approved (namely, posted on the corps ADML listing) before fighting starts. Prewar approval streamlines ADM request procedures.

The corp commander approves or disapproves all targets.

SAMPLE ADML (ATOMIC DEMOLITION MUNITION LOCATION) LISTING

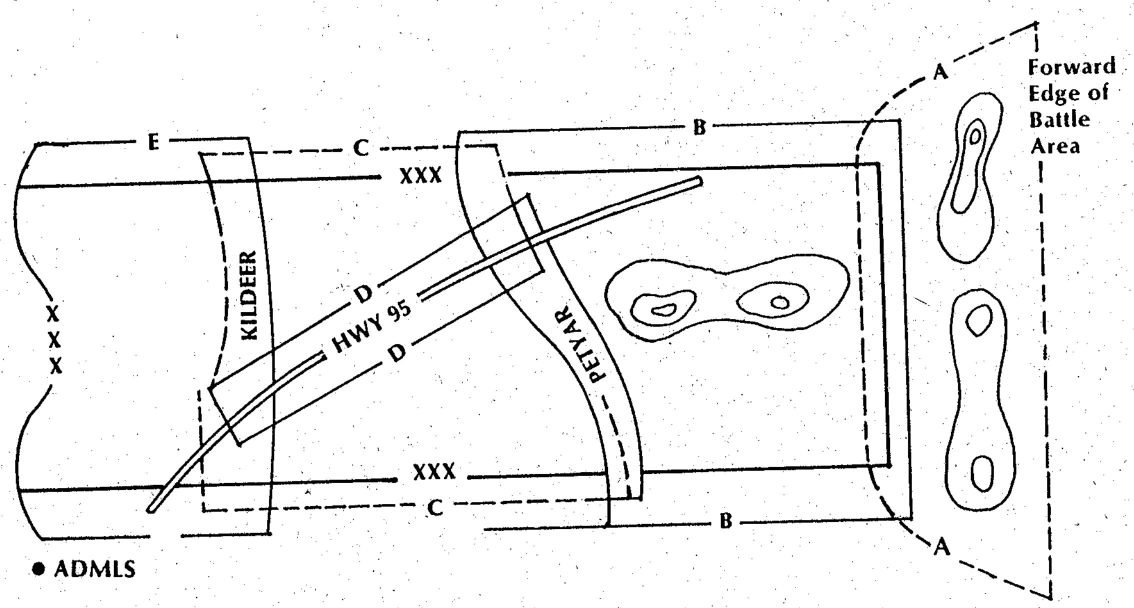
Target No.	Location	Description	Munition	Purpose
A27	HB 487380	HWY Bridge	0.10 KT	Delay enemy force for 5 days.
B09	HB 10248130	Crater HWY 95	0.5 KT @ 10m DOB or 1.0 KT surface	Block possible enemy counter-attack.
B10	HC 94107295	Crater HWY 10	5 KT	Cause enemy to change direction of attack to follow highway 202.
B12	HC 74198920	Tunnel HWY 10	1 KT	Block avenue of approach for 10 days.
C31	HC 250158	Earthen Dam	1 KT	Flood the Hart River valley to delay the enemy for 2 weeks
C39	HC 210050	Railroad Marshaling yard	0.01 KT	Deny enemy use of railroad facilities.

DEVELOPING GROUP EMPLOYMENT PLANS

To control and limit the use of nuclear munitions, corps and higher echelon commanders limit execution to a specific number of munitions within a specific time frame and within a specified geographical area. To simplify nuclear release request and to control munition execution, corps or higher headquarters should define and approve employment option areas during planning. These areas may be defined along military or key terrain boundaries. These option areas, combined with the ADML listing to form group employment plans, streamline ADM release requests and help the corps commander control nuclear munition employment. Some overlap should be provided at option area boundaries for flexibility in a rapidly moving battle.

GROUP EMPLOYMENT PLAN

Option Areas Based Upon Terrain Features

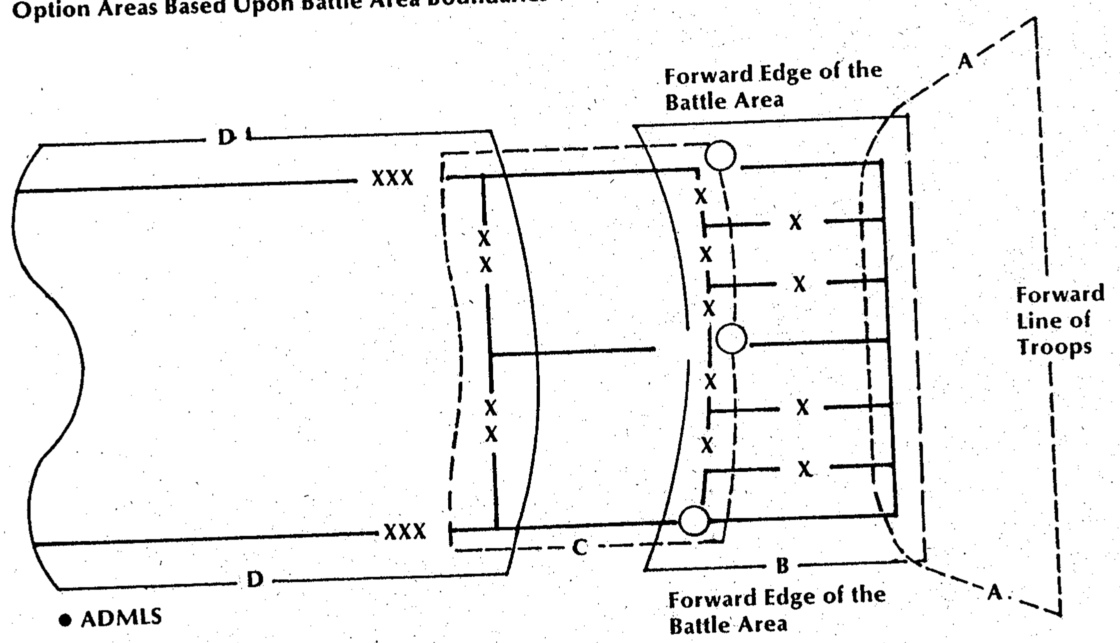


RELEASE OF ADM FOR EMPLOYMENT

Because nuclear weapons including ADM represent combat power of tremendous magnitude, the first use of nuclear weapons significantly changes the nature of any conflict. While the corps usually orients tactical nuclear planning to achieve tactical goals, any employment of nuclear weapons has a political aspect of which planners at all echelons must be aware. Whether nuclear weapons should be used during a conflict and how much they should be used are strategic decisions that political authorities will make. To dampen the escalatory effects of using nuclear weapons, release normally will be granted only for limited numbers of weapons to be fired within a specified time frame and within specified areas.

GROUP EMPLOYMENT PLAN

Option Areas Based Upon Battle Area Boundaries



WHO REQUESTS RELEASE

Requests for release of ADM are usually prepared by division and submitted to corps. Corps considers subordinate requests and, if appropriate, forwards a formal request to echelons above corps.

FORMAT FOR RELEASE REQUEST

Release request is in a format specified by major commands (MACOMS). The request for ADM release should contain the following:

- Specific number of ADM requested.
- Specific option area of planned employment.
- Specific time frame for employment.
- Justification of the need to employ ADM.

Note that corps and echelons above corps have the corps' group employment plan (ADML listing of approved targets and a definition of the corps preplanned option areas). If the request is approved, the corps commander has authority to execute the specific number of munitions, during the specified time frame, within the specified employment area. Only targets on the corps ADML listing may be executed, and the yield of the munition used must match the target yield specified in the ADML listing.

PREPLANNED NUCLEAR WEAPONS PACKAGES

ADM release is usually managed as described in the preceding paragraph, i.e., separately from preplanned nuclear weapons (artillery and missile) packages, but ADM may be included in these packages. See FM 6-20. Planners must recognize that obstacles such as those produced by ADM are often needed to force the enemy into a disposition that makes him a profitable nuclear weapon target. Therefore, the obstacle must be created; the situation must develop; then the preplanned nuclear weapon package may be fired. The specified time frame for a mixed package (namely, joint ADM and artillery) execution may not be enough for the above process. If so, ADM should be requested as outlined in the preceding paragraph for execution before an artillery nuclear weapon package. ADM employment plans must not conflict with other planned nuclear strikes.

THE OPLAN

The final stage in pre-employment planning is the preparation of the operation plan (OPLAN). ADM planning and employment must be addressed in division and corps rear OPLANs. This can be done by using a separate ADM annex, the engineer annex, the obstacle annex, the fire support annex, or any combination of these as long as each is cross-referenced. A sample format for an ADM annex is at appendix E.

THE ADM OPERATIONS ORDER

The final stage in employment planning is preparation of the ADM mission execution order. This order must be prepared by the headquarters executing the ADM mission, normally the division. The ADM operations order is standardized. Most of this order can be prepared well before the need to execute ADM with the remainder prepared by filling in the blanks just before the mission begins. The specific contents of the ADM operations order are detailed in appendix D.

ADM MISSIONS

This chapter discusses the **who** and **how** of ADM employment. It defines key personnel, their execution duties and responsibilities, and security and safety procedures for the conduct of ADM missions. This chapter should be used in conjunction with appendix D which is the Standard NATO ADM Operations Order Agreement and FM 100-50. The key actors in the conduct of ADM missions are the releasing commander, executing commander, ADM mission officer, ADM platoon leader, ADM target team leader, ADM firing team leader, ADM security force commander, and engineer support commander.

Section I—LEADERS' RESPONSIBILITIES

RELEASING COMMANDER

The releasing commander usually is the commander of a corps. The releasing commander is appointed by higher headquarters and is empowered to authorize ADM expenditure subject to restraints imposed by higher authority. This officer has overall responsibility for the mission. Given National Command Authority and theater commander release, the releasing commander authorizes employment of ADM from the corps' nuclear allocation or requests additional allocation from higher command echelons. The releasing commander orders or delegates target execution. The releasing commander also—

- Exercises approval authority over all subordinate ADM plans and targets, including the ADML listing.

- Designates the executing headquarters for ADM target execution. The releasing commander's headquarters or those of a subordinate unit may become the executing headquarters.

- Insures that the executing unit has resources to support and execute the ADM mission.

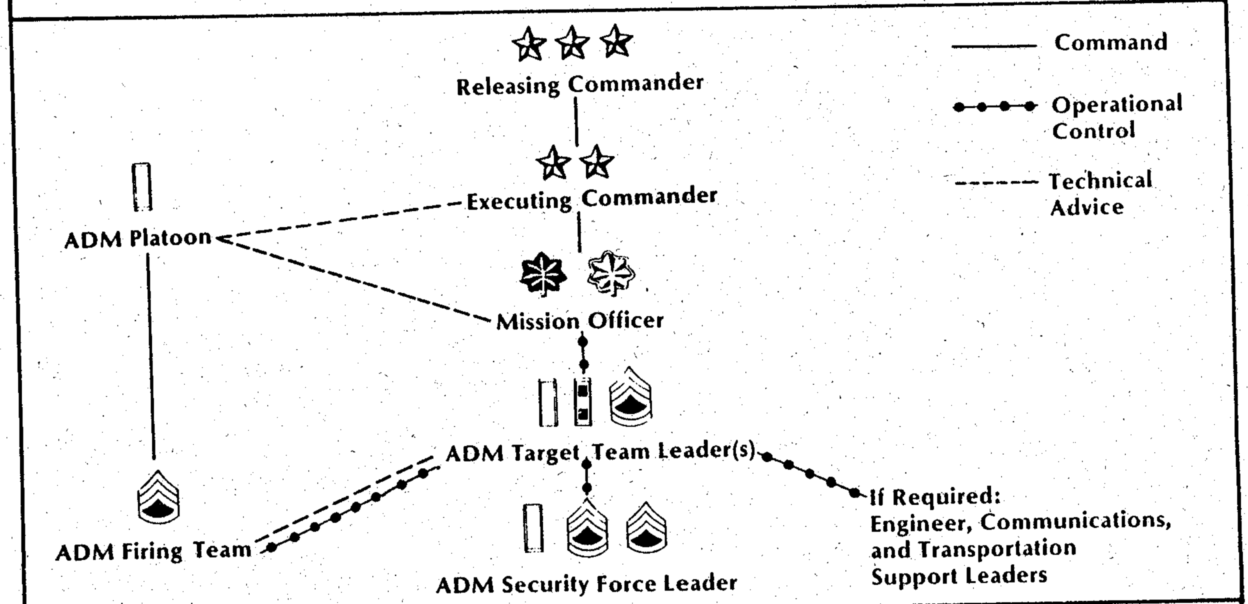
- Provides instructions, as required, to coordinate all elements engaged in the mission and insures adequate control.

- If retaining authority to detonate the ADM, also establishes reliable channels of communication to transmit the detonation order quickly and securely.

EXECUTING COMMANDER

Executing commanders are those to whom nuclear weapons are released for delivery in accordance with approved plans. Executing commanders are responsible for execution of

COMMAND AND CONTROL OF ADM MISSIONS



ADM targets within their operational area in accordance with instructions issued or approved by the releasing commander. An executing commander is normally a division commander. The executing commander—

- Issues the ADM operations order (appendix D). This order may be completed, with the exception of filling in some blanks, during peacetime.
- Appoints a mission officer and an alternate for the conduct of the ADM mission. A mission officer may be assigned multiple targets if provided with the necessary target teams or a single mission officer may be designated for each target. The mission officer's grade should be appropriate for control of the forces assigned. A second lieutenant could be assigned as mission officer for a single target. An officer more senior in grade would be required for execution of multiple targets that normally require extensive coordination. For example, a maneuver task force commander or that person's executive or operations officer could be designated mission officer to execute several ADM that create obstacles critical to the task force's mission.
- Determines the strength of and designates the formation of units to provide the ADM target teams [ADM security force, ADM firing team(s), and any required Engineer, Signal, and transport support]. Insures that the mission officer has the assets to accomplish the mission.
- Prepares target folders and plans the use of ADM for the assigned area of operations.
- Warns friendly units and civilians near a detonation. This responsibility includes control of traffic and refugee flow, and, if warranted, military and civilian evacuation of danger areas.
- Provides the releasing commander munition expenditure and tactical damage reports.
- Establishes primary and positive alternate channels of communication to transmit orders to fire the ADM or to transmit changes in mission to the ADM mission officer.
- Establishes and maintains procedures for passage of emergency action messages (EAM) and permissive action link (PAL) data to the ADM platoon and firing teams.

ADM MISSION OFFICER

The ADM mission officer is the executing commander's representative and the leader of the ADM mission task force. The ADM mission officer is in operational control of the ADM target team(s). This officer is responsible to the executing commander. The mission officer—

- Directs and controls the mission in accordance with the executing commander's orders.
- Operationally controls the mission task force and the organization of the target teams.
- Insures completion of the mission in accordance with the executing commander's orders.
- Indicates command site forward location and firing site(s) if these are not specified in the operations order. This decision must include consideration of the technical requirements specified by the ADM platoon or firing team leaders.
- Insures familiarization with command relationships and responsibilities for emergency firing and emergency destruction.

- Nominates and briefs the most suitable available officer as an alternate if this has not been done by the executing commander. The ADM mission officer should also detail and brief further alternates on their relative seniority and duties. The ADM mission officer should inform the ADM firing team leader(s) and leaders of other subordinate mission elements of such appointments.

- Passes on orders regarding changes in state of readiness and firing of ADM to the ADM target team leader(s) and ADM firing team leader(s) immediately on receipt and records such in the ADM OPORD in the appropriate place. See appendix D.

- Insures that the ADM target team leaders are immediately informed of any changes to plans which may affect the mission or nuclear munition custodial procedures.

- Keeps the executing commander informed on the tactical situation at the target site(s) and the state of readiness of the ADM in accordance with the Orders, Reports, and Code Words appendix to the Operations Order. See appendix D.

- Provides a tactical damage evaluation of the ADM firing(s) to the executing commander by the quickest means.

- Establishes positive signal communication links with the ADM target teams.

- Assumes the duties and responsibilities of ADM target team leader and security force commander when assigned.

ADM PLATOON LEADER

ADM platoon leaders or in their absence the ADM platoon sergeants are responsible for command of the ADM platoon. They release operational control of ADM firing team(s) to the mission officer for the execution of missions. ADM platoon leaders are directly responsible to the commander of the unit to which the platoon is assigned or attached. An ADM platoon leader—

- Operates a field storage location (FSL) for munitions if the platoon leader has appropriate security forces. A platoon leader's responsibility includes not only physical possession of the munitions but also total responsibility for their combat movement, storage, security, safety, maintenance, and related accident and incident control.

- Is responsible to the custodian of nuclear weapons, usually the commander of the special ammunition supply point (SASP), for maintaining custody of nuclear munitions issued to and in the charge of the platoon leaders. Custody is recorded on DD Form 1150 which is used to transfer custody, certify expenditure, and certify destruction or transfer of nuclear munitions or components. An ADM platoon leader shall use DD Form 1150 to transfer munitions to ADM firing team leaders before they depart with a duly appointed mission officer or target team leader from the SASP or FSL to execute a target. See FM 100-50.

- Decodes and authenticates nuclear control orders and relays them to deployed ADM firing teams when appropriate.

- Provides permissive action link (PAL) information to ADM firing team leaders.

- Informs the ADM mission officer and ADM firing team leader(s) immediately of any changes which affect the mission and national custodial procedures.

- Is also responsible for the emergency destruction of munitions as a last resort if it appears that a munition will fall into enemy hands and orders are in force which do not permit firing it.

- Serves as advisor or liaison officer to higher headquarters on the conduct of ADM missions.

ADM TARGET TEAM LEADER

The ADM target team leader is a commissioned or warrant officer or noncommissioned officer in the grade E7 or above who is in charge of an ADM target team. The ADM target team leader is the mission officer's representative at a particular ADM target location (ADML). For a single ADM target execution, an ADM target team leader is not required. In this case, the mission officer will always be at the ADML. When a mission officer executes multiple targets, ADM target team leaders are appointed for each target. See appendix D. The ADM target team leader is responsible to the mission officer. The ADM target team leader—

- Operationally controls the ADM target team (security, ADM firing team, and any required transportation, engineer, or communications support elements).
- Becomes acquainted with the ADM operations order and executes the assigned target in accordance with that operations order.
- Knows command relationship and responsibilities on emergency firing and emergency destruction.
- Keeps the ADM mission officer informed of the tactical situation at the target site and the state of readiness of the ADM as outlined in the Orders, Reports, and Code Words appendix to the OPORD. See appendix D.
- Holds the target folder for the ADML.
- Reports the result of the ADM firing to the ADM mission officer by the quickest means.

ADM FIRING TEAM LEADER

ADM firing team leaders, usually staff sergeants, are the senior individuals in charge of an ADM firing team. They are responsible for assembly, emplacement, detonation, and, if necessary, emergency destruction of munitions in their charge in accordance with the ADM OPORD. ADM firing team leaders are Engineer ADM squad leaders. When deployed from their platoons for target execution, they are directly responsible to the ADM platoon leader for custody of munition(s) in their charge; decoding and authentication of nuclear control orders and PAL information; completion of appropriate expenditure, destruction, or transfer reports; and tactical nuclear accident and incident control. They are responsible to the ADM target leader or, if absent, the ADM mission officer. The ADM firing team leader—

- Carries out all necessary prefire checks and orders.
- Emplaces the ADM and prepares firing options.
- Fires the ADM as specified in the ADM OPORD.
- Carries out any orders for changes in states of readiness and firing received from the ADM mission officer/ADM target leader.
- Advises the target team leader/mission officer on factors that affect the reliability of the munition and technical requirements for the emplacement and firing sites.
- Carries and maintains an equipment organizational maintenance allowance in accordance with munition system technical manuals.

ADM SECURITY FORCE COMMANDER

The ADM security force commander is responsible to the ADM mission officer for attaching a security element to each ADM target team. The security element serves under the operational control of the ADM target team leader. In the case of single ADML execution, the mission officer may assume the duties of the security element commander. An ADM security force commander—

- Is responsible for physical security of the ADM firing team and munition during transportation and emplacement, and the local protection of ADML(s) and firing site(s) from enemy attack and sabotage.

- Is responsible for control of traffic and refugees near the target to prevent interference with operations.

ENGINEER SUPPORT COMMANDER

The Engineer support commander is responsible to the ADM mission officer/ADM target leader for providing any Engineer support required. If necessary, an Engineer support commander—

- Prepares a demolition chamber.

- Assists the ADM team with tamping during munition emplacement.

- Undertakes engineer work at the emplacement site to protect the ADM prior to detonation and at firing sites to create obstacles, camouflage, and protective shelters if required.

Section II—SUPPORT REQUIREMENTS

SECURITY

REQUIREMENT

The critical mission of ADM firing teams makes them a prime target for enemy attack. These teams are so small and so armed that they are capable only of self-defense and limited protection of the munition and associated material. Tactical commanders must be prepared to augment these teams with well-trained security forces to safeguard pickup, delivery, emplacement, and target execution.

ACTIVE SECURITY MEASURES

Security is the safeguarding of classified defense information and material from unauthorized disclosure as well as protection of the ADM and ADM firing team from enemy interference. Three kinds of active security measures may be needed for an ADM mission—**physical, local, and tactical.**

Physical security of the ADM and related defense information and material is denial of physical and visual access to ADM and associated equipment by unauthorized personnel. Only authorized personnel (normally only ADM firing team members and ordnance personnel) are permitted physical access to ADM. For the tactical commander, responsibility begins with ADM pickup and continues until detonation. Typical precautionary measures are transporting the munition in closed containers and erecting camouflage nets over emplacements sites. At the time of pickup, an **exclusion area** in the immediate vicinity of the munition is established and maintained throughout transportation and emplacement and until detonation. Only authorized ADM personnel are permitted within the exclusion area. Security forces may be called upon to assist in security enforcement immediately outside the exclusion area. Exclusion areas are normally designated within the confines of a covered vehicle or structure or within several meters of the munition. These areas are not normally marked. Stereotype patterns of activity must not evolve at locations where nuclear weapon movements originate and terminate. Such signature could identify activities as nuclear-related and alert an enemy. See FM 19-30 for recommended physical security techniques.

Local security provides immediate protection of the ADM and ADM firing team from enemy interference or sabotage during transport and emplacement. This security is provided by the ADM target team's security element. A **restricted area** outside the exclusion area is established. Its size varies in accordance with the tactical situation and the size of the assigned security element. During transport, it is the area in which security forces are located or will deploy in the event of a halt. At the emplacement site, the restricted area may be reinforced by protective minefields, warning devices, and obstacles. Such protective devices are carefully noted, however, in the event that return to the emplacement site becomes necessary. Personnel other than those designated by the security element commander are not allowed access into the restricted area.

Tactical security includes those measures which are beyond the capability of the local security element. This kind of security is generally provided by the tactical disposition of the executing unit. It may be provided by offensive and delaying action, as well as defensive operations. The executing unit also maintains open routes of withdrawal for the security element and firing party. Although the requirement for tactical security may be less severe in rear than in forward areas, the executing unit must make adequate provisions to counter an attack by enemy guerrillas and infiltrators.

PASSIVE SECURITY MEASURES

Passive measures such as cover, concealment, camouflage, decoy emplacements, and communications security contribute to the security of ADM missions.

SECURITY AFTER EMPLACEMENT SITE EVACUATION

Once the ADM has been armed and the security force and ADM firing team have withdrawn, security of the site until detonation is still maintained by the executing unit. Ground and aerial surveillance, sensors, long-range direct and indirect fire, and ground control of entry into the area are possible methods of maintaining security after evacuation.

ADM DENIAL

OBJECTIVE OF DENIAL

The objective of denial of ADM is to prevent enemy possession of munition design features and nuclear materials.

MEANS OF DENIAL

The primary means of ADM denial is the maintenance of adequate security measures. When these measures do not provide adequate denial and capture of the munition is threatened, the senior individual in possession of the munition must take alternative steps to deny it. The method of denial chosen—physical removal, emergency destruction, or emergency firing—depends on the nature of the threat, the time available, the environment in which the munition is stored or emplaced, and the resources available.

Physical removal. The most desirable form of denial is physical removal from the area of the threat; that is, local repositioning or evacuation.

Emergency destruction. Under emergency conditions where ADM relocation or mission execution is not practical, destructive denial is necessary. Emergency destruction methods

Emergency destruction. Under emergency conditions where ADM relocation or mission execution is not practical, destructive denial is necessary. Emergency destruction methods for each ADM system are described in the appropriate technical manual and TM 39-50-8(U). In general, violent means of destruction by initiation of warhead high explosive should be elected if the situation permits. If destruction by violent means is unacceptable, disablement of selected key components provides a simple and rapid, though less effective method. If the tactical situation permits, disablement may be followed by violent destruction to complete denial of ADM design information and acquisition of active material.

COMMANDER'S RESPONSIBILITIES

ADM emergency destruction is sufficiently important and sensitive to warrant the personal concern of and decision by the commanders who establish procedures. Unit SOP instructions for emergency destruction should cover all details necessary for the individual who executes them, including—

- Origin of the decision to carry out emergency denial. The commander may delegate authority to execute munition relocation or emergency destruction.
- Step-by-step procedures including differences in procedures as may be required in movement or emplacement at a storage site.
- Instructions for the location of necessary emergency destruction equipment to be readily accessible under all circumstances of storage, movement, position of readiness, and firing configuration.
- Instructions for the disposition of classified documents such as technical manuals, operations orders, and unit ADM SOP.

SAFETY

SAFETY RULES

Safety is a continuing function of command. ADM, like other demolition materials, involve potential danger. The safety of troops and civilians is of primary importance. Safety rules are promulgated by Department of the Army regulations and letters. They are disseminated through appropriate command directives. Their purpose is to create the maximum safety consistent with operational requirements.

ACTIONS IN CASE OF ACCIDENT

If there is an accident involving ADM, the commander in possession of the munition at that time is responsible for notifying emergency teams to assist in rescue, recovery, and damage assessment. Explosive ordnance disposal (EOD) units should be called upon to render safe, recover, and dispose of unexploded munitions or, in the event of a low-order detonation, to recover and dispose of classified components and radioactive materials. FM 3-15 provides guidance for nuclear accident and incident control. ADM team safety activities are stated in the technical manuals for each munition, in associated safety publications, and in the unit SOP.

SAFETY DURING TEMPORARY STORAGE

Safe distance criteria for temporary storage are in general the same as those which govern temporary storage of high explosive and nuclear materials. Particular storage requirements are covered in the organizational maintenance manual for each munition.

COMMUNICATIONS

Direct communications must be maintained between the executing commander and the mission officer and between the mission officer and all target teams during the conduct of the mission.

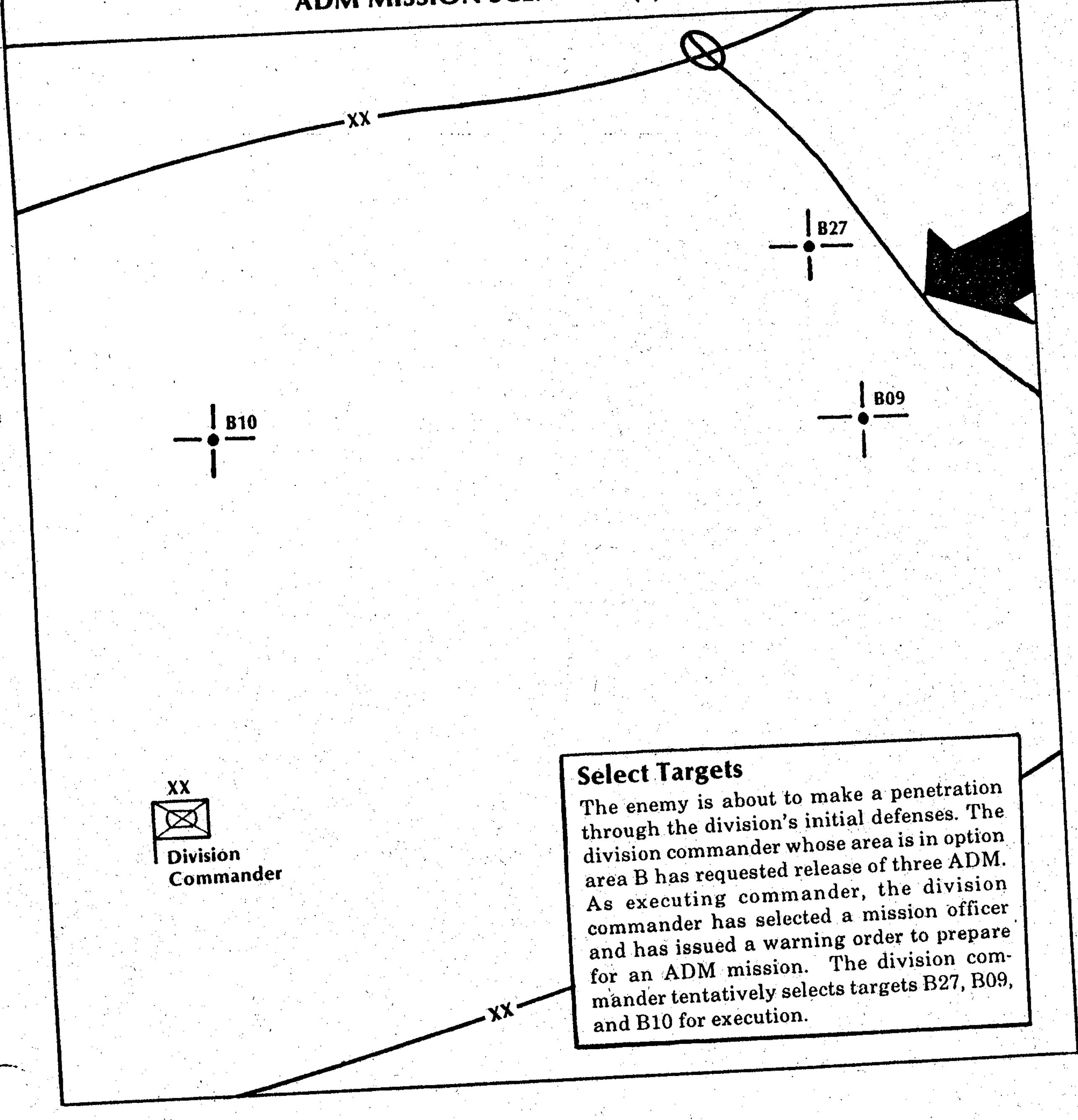
SOP FOR ADM EMPLOYMENT

Standing operating procedures for ADM employment are included as an appendix to the ADM operations order. See appendix D.

ADM OPERATIONS ORDER

The format for the ADM mission execution order is standardized. This format and instructions for use are at appendix D.

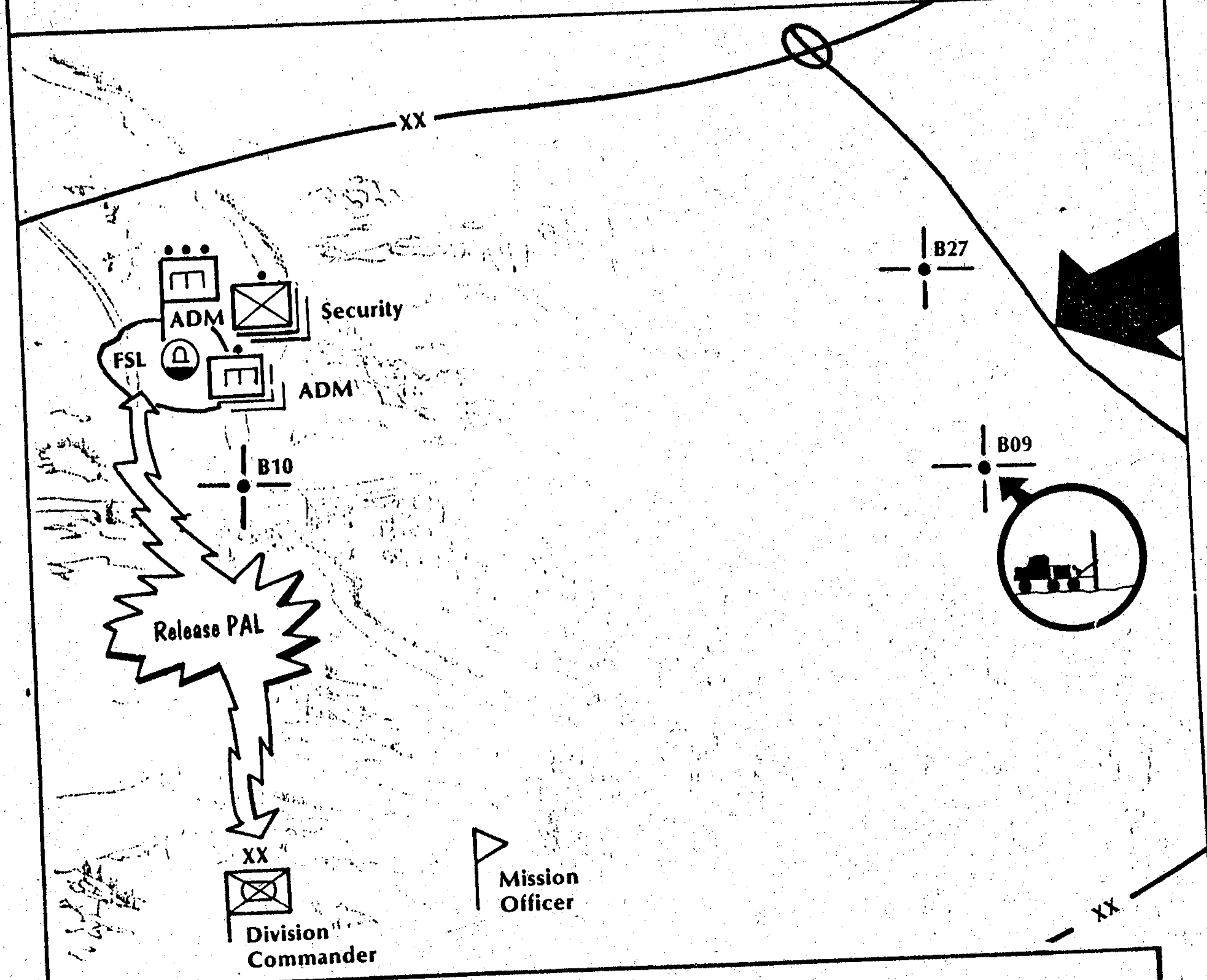
ADM MISSION SCENARIO (1)



Select Targets

The enemy is about to make a penetration through the division's initial defenses. The division commander whose area is in option area B has requested release of three ADM. As executing commander, the division commander has selected a mission officer and has issued a warning order to prepare for an ADM mission. The division commander tentatively selects targets B27, B09, and B10 for execution.

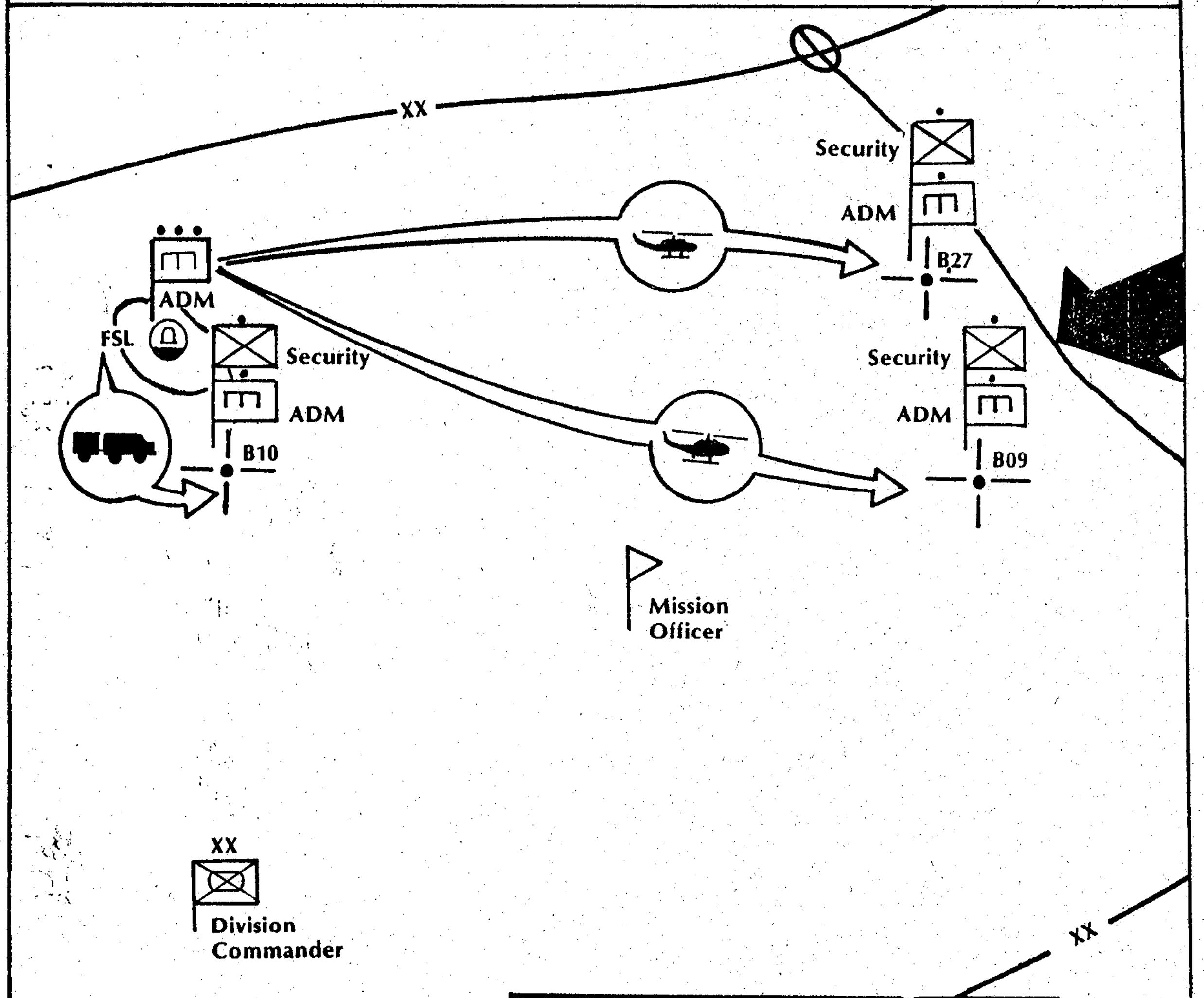
ADM MISSION SCENARIO (2)



Issue OPORD and Prepare to Execute

The division commander tasks 1st Brigade to provide the mission officer with three target team leaders and three local security forces (squad-sized with organic vehicles and communications since target sites are in friendly-controlled territory). The mission officer reports to division headquarters for briefing. The signal battalion is tasked with establishing direct communications between the division commander and the mission officer and between the mission officer and each target team leader. The engineer battalion is tasked to prepare a chamber for target B09. The executing commander's staff makes final preparation of the ADM operations order. The order is then issued and execution begins. The mission officer directs that the target teams assemble at the FSL. The ADM firing team for target B10, a MADM target, is directed to begin prefire operations. Simultaneously, the executing commander and the ADM firing teams receive a nuclear control order releasing three ADM for employment in option area B. The firing teams also receive permissive action link (PAL) unlock values.

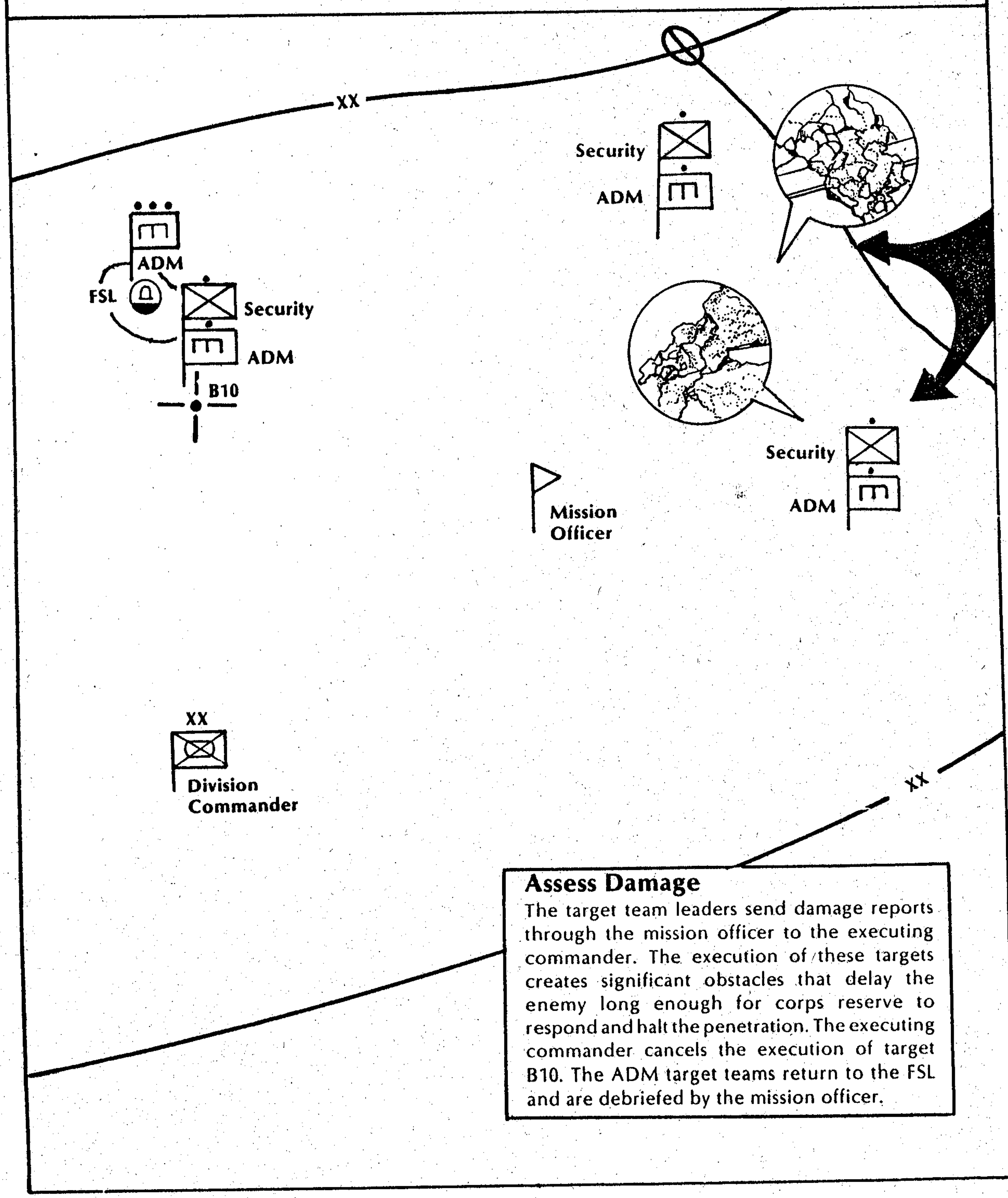
ADM MISSION SCENARIO (3)



Brief and Deploy Teams

The ADM platoon leader designates three firing teams and releases operational control of these teams to the mission officer. The mission officer arrives at the FSL and briefs target team leaders and other mission personnel. The aviation battalion provides support for target teams B09 and B27. The ADM target teams deploy from the FSL to the emplacement sites and prepare the targets for destruction. The mission officer deploys to the command site.

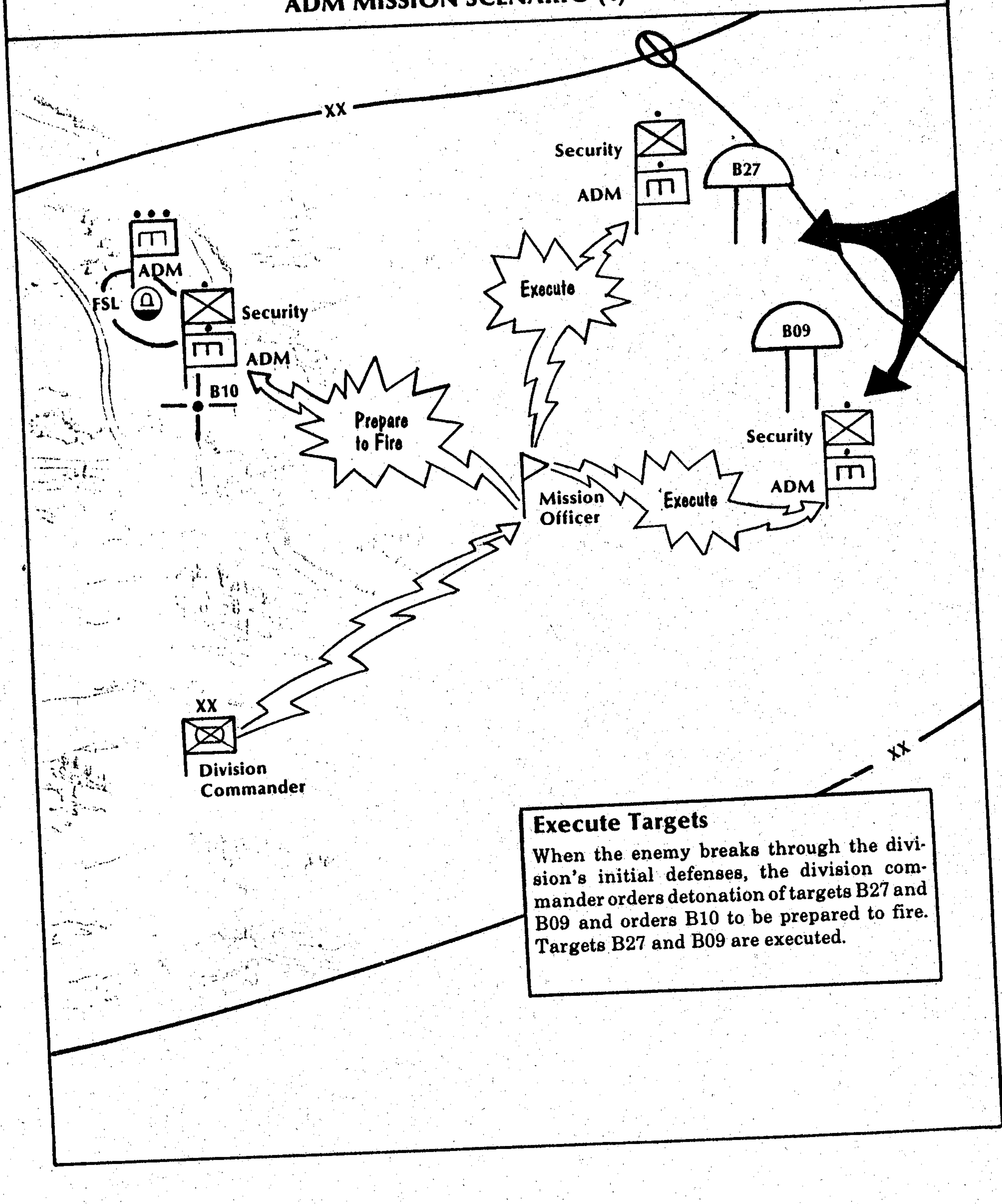
ADM MISSION SCENARIO (5)



Assess Damage

The target team leaders send damage reports through the mission officer to the executing commander. The execution of these targets creates significant obstacles that delay the enemy long enough for corps reserve to respond and halt the penetration. The executing commander cancels the execution of target B10. The ADM target teams return to the FSL and are debriefed by the mission officer.

ADM MISSION SCENARIO (4)



Execute Targets

When the enemy breaks through the division's initial defenses, the division commander orders detonation of targets B27 and B09 and orders B10 to be prepared to fire. Targets B27 and B09 are executed.

Chapter 5

TARGET RECONNAISSANCE

ADM target reconnaissance is an Engineer responsibility. The ground reconnaissance of potential ADM targets is normally conducted by direct support engineer battalion reconnaissance teams with the ADM unit providing technical advice. Members of reconnaissance teams must have a general knowledge of ADM effects and how these effects achieve target damage. Information collected by these teams is used by the mission planner in determining suitability of the target for nuclear destruction and by the target analyst in determining munition yield, placement, and effects data.

Section I—RECONNAISSANCE PREPARATION

CONSIDERATIONS

The target reconnaissance team collects information on the target and the area surrounding the target. In addition to target data, the mission planner needs the location or proposed location of friendly troops and the type of protection afforded to them near ground zero. Considerations such as the location of population settlements or nearby forests are important. In cratering, soil type is significant. In all obstacle targets, the proximity of bypasses which may reduce an obstacle's effectiveness must be defined.

The reconnaissance team selects potential firing sites and alternate firing sites. Concealed routes of withdrawal to areas of protection against nuclear effects are also reconnoitered and the withdrawal time noted.

If emplacement holes or other emplacement methods beyond the capabilities of ADM teams are considered, the mission planner needs such information together with an estimate of the number and kind of engineers and equipment needed and an estimate of the time necessary to prepare the target. When aerial delivery of ADM is contemplated, the reconnaissance party reconnoiters and reports suitable landing areas.

RECONNAISSANCE PARTY

The reconnaissance (recon) party is normally constituted by the Engineer battalion that supports a maneuver unit in its area of operations. In the following list of recon party personnel and equipment, note that one soldier could perform more than one task:

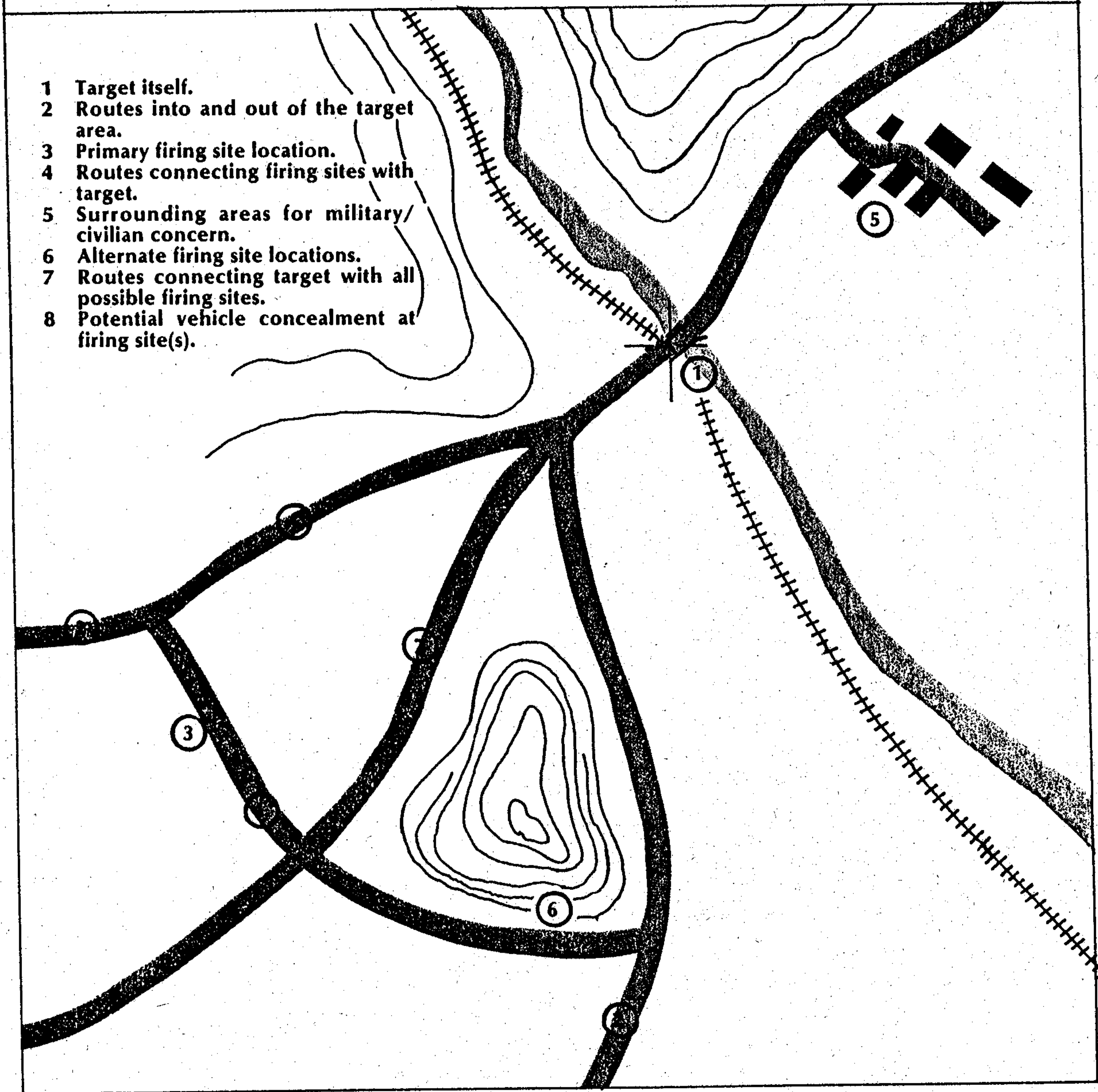
- **Party chief** to organize the party and prepare the recon report.
- **Security personnel** as needed by the tactical situation.
- **Vehicle driver(s)** as required for transportation.
- **Radio operator(s)** as required for communications with the Engineer battalion and maneuver unit.
- **Data recorder(s)/photographer** with camera, sketching equipment, overlay acetate, mapsheets, and measuring devices.
- **Optional representative(s)** from the proposed ADM mission task force security team or for the proposed ADM mission officer.
- **Optional representative(s)** from the support ADM unit.

INFORMATION COLLECTION PRIORITIES

Priorities for information collection are shown in the figure at the right.

RECONNAISSANCE PRIORITIES

1. Target itself.
2. Routes into and out of the target area.
3. Primary firing site location.
4. Routes connecting firing sites with target.
5. Surrounding areas for military/civilian concern.
6. Alternate firing site locations.
7. Routes connecting target with all possible firing sites.
8. Potential vehicle concealment at firing site(s).



Section II — CONDUCTING THE RECONNAISSANCE

COLLECTING INFORMATION

The operations officer assigns the target number and name and states the mission. When conducting the reconnaissance, the team collects information based upon this mission statement following the guidelines given in this section. A reconnaissance report checklist such as the one provided at the end of this section may be given to the team to insure a complete and accurate report.

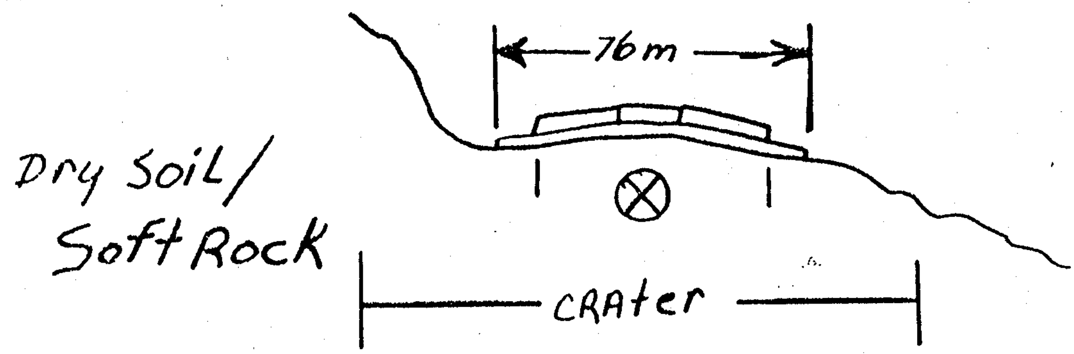
TARGET DATA

Targets are grouped according to size into point targets and area targets. A point target is considered as a single element. An area target is an extensive area or facilities.

POINT TARGETS

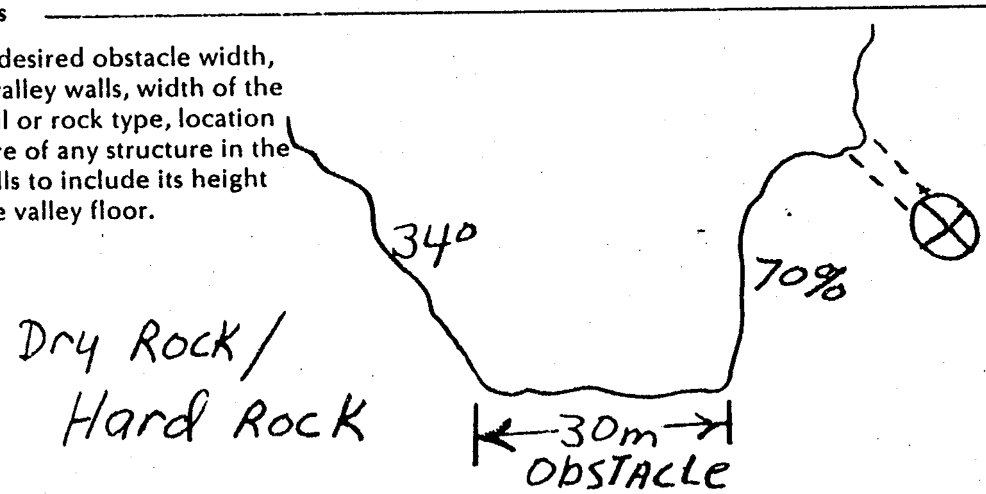
High speed avenues of approach

State the desired obstacle width and surface material.



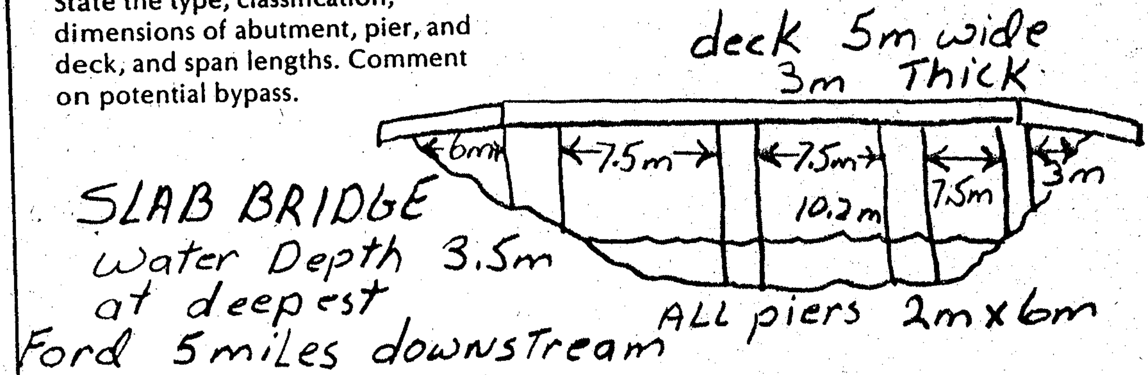
Landslides

State the desired obstacle width, slope of valley walls, width of the valley, soil or rock type, location and nature of any structure in the valley walls to include its height above the valley floor.



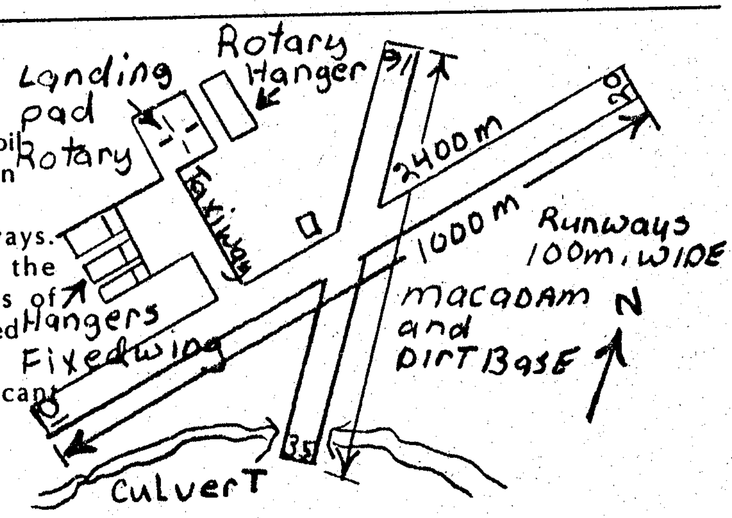
Bridges

State the type, classification, dimensions of abutment, pier, and deck, and span lengths. Comment on potential bypass.



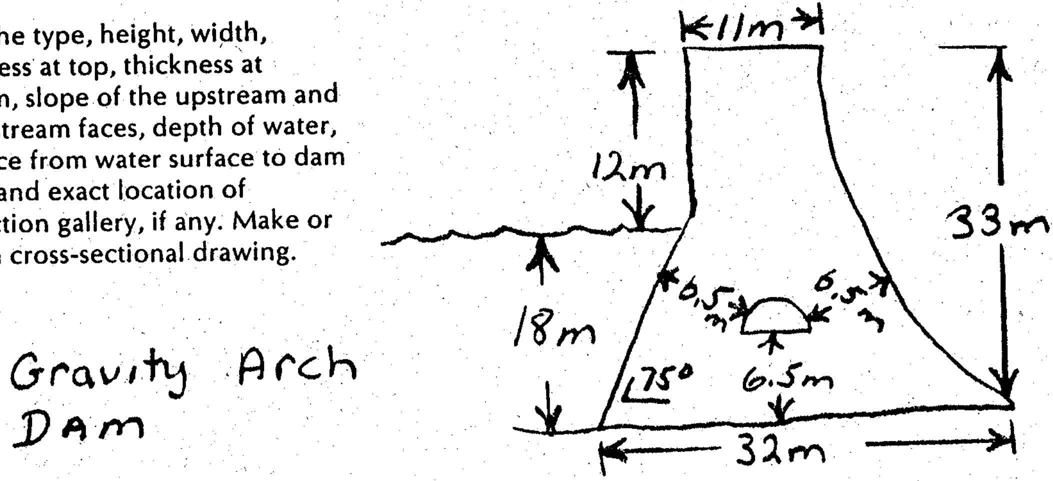
Airfields

State the length and width of all runways and taxiways, type and thickness of runway surfacing, soil type under runways, and location and size of any culverts or other structures under the runways. Provide a sketch showing the orientation and dimensions of runways. Comment on associated facilities such as radar, hangars, petroleum, oils, and lubricant storage.



Dams

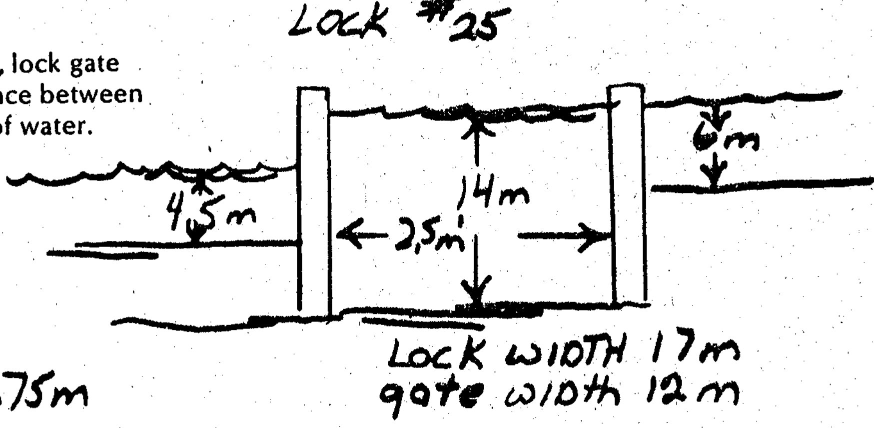
State the type, height, width, thickness at top, thickness at bottom, slope of the upstream and downstream faces, depth of water, distance from water surface to dam crest, and exact location of inspection gallery, if any. Make or obtain cross-sectional drawing.



POINT TARGETS (Continued)

Canals

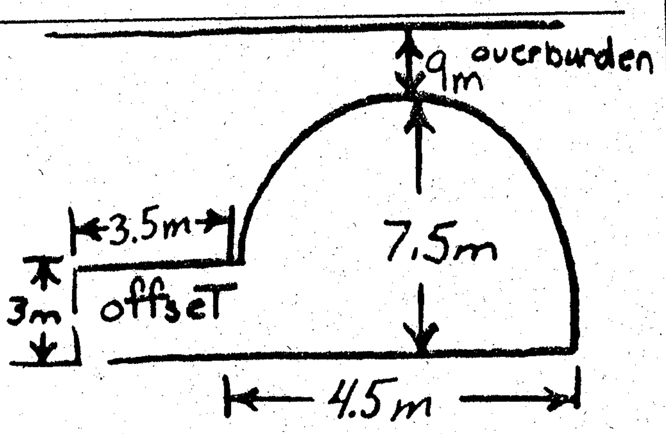
State the lock location, lock gate dimensions, and distance between lock gates and depth of water.



Reinforced
Concrete
14" Thick
drop 2.75m

Underground tunnels

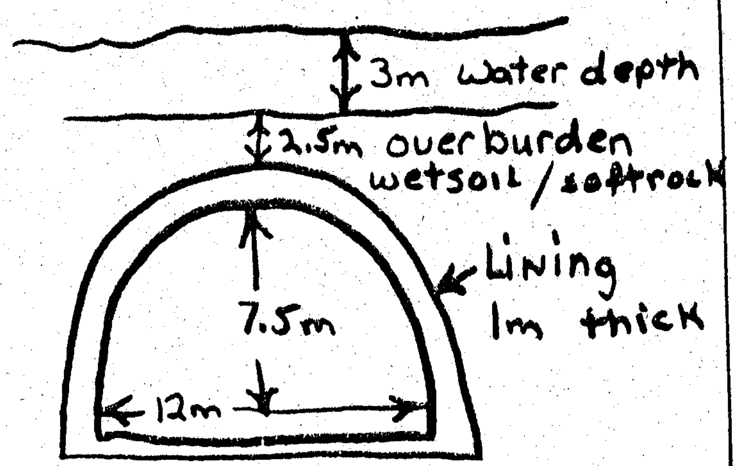
State the height, width, length, type and depth of overburden, location and size of any access shafts or passageways, and location and size of any underground structures above or near the tunnel.



dryrock/hardrock

Underwater tunnels

State the height, width, length, thickness of tunnel lining, type and thickness of tunnel overburden, and, if known, depth of water over tunnel.



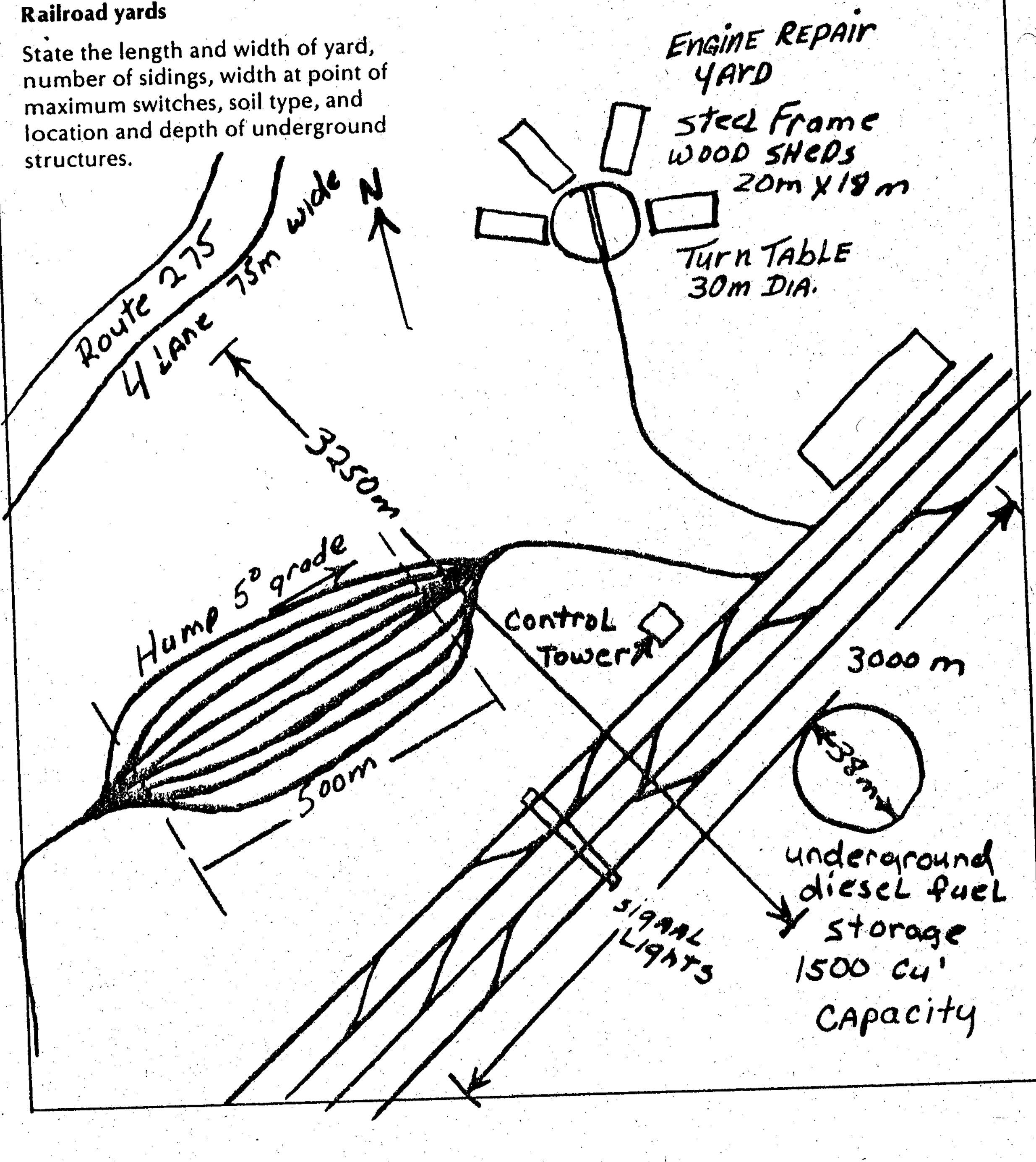
725m Long

AREA TARGETS

State the size by giving a radius for circular targets or outline the target boundaries by giving grid coordinates and approximate dimensions. For area targets not shown, describe as well as possible. Use FM 30-10 as a guide for required information.

Railroad yards

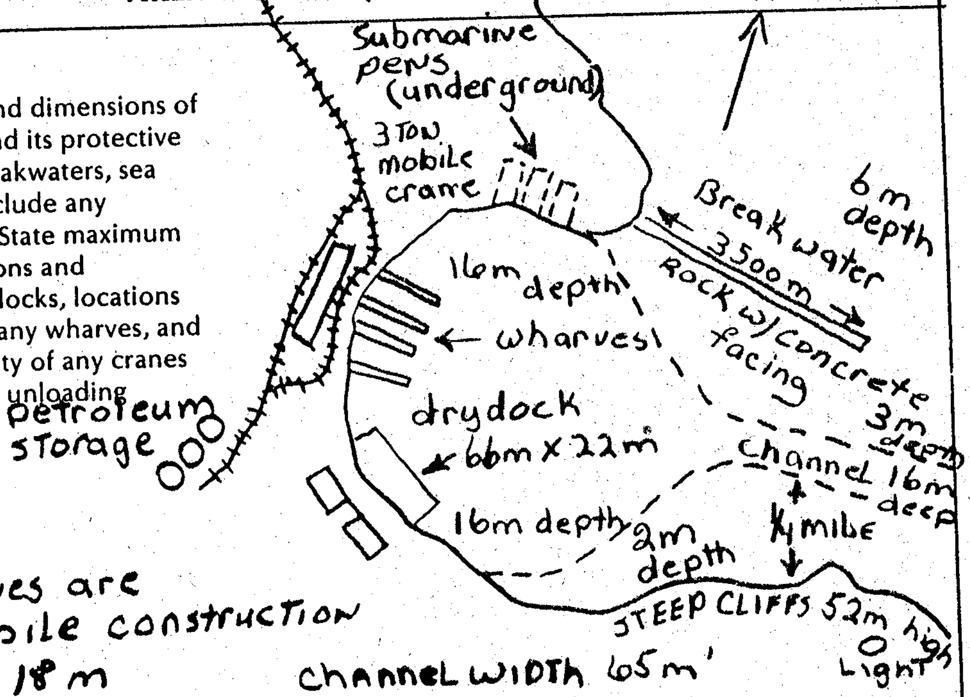
State the length and width of yard, number of sidings, width at point of maximum switches, soil type, and location and depth of underground structures.



AREA TARGETS (Continued)

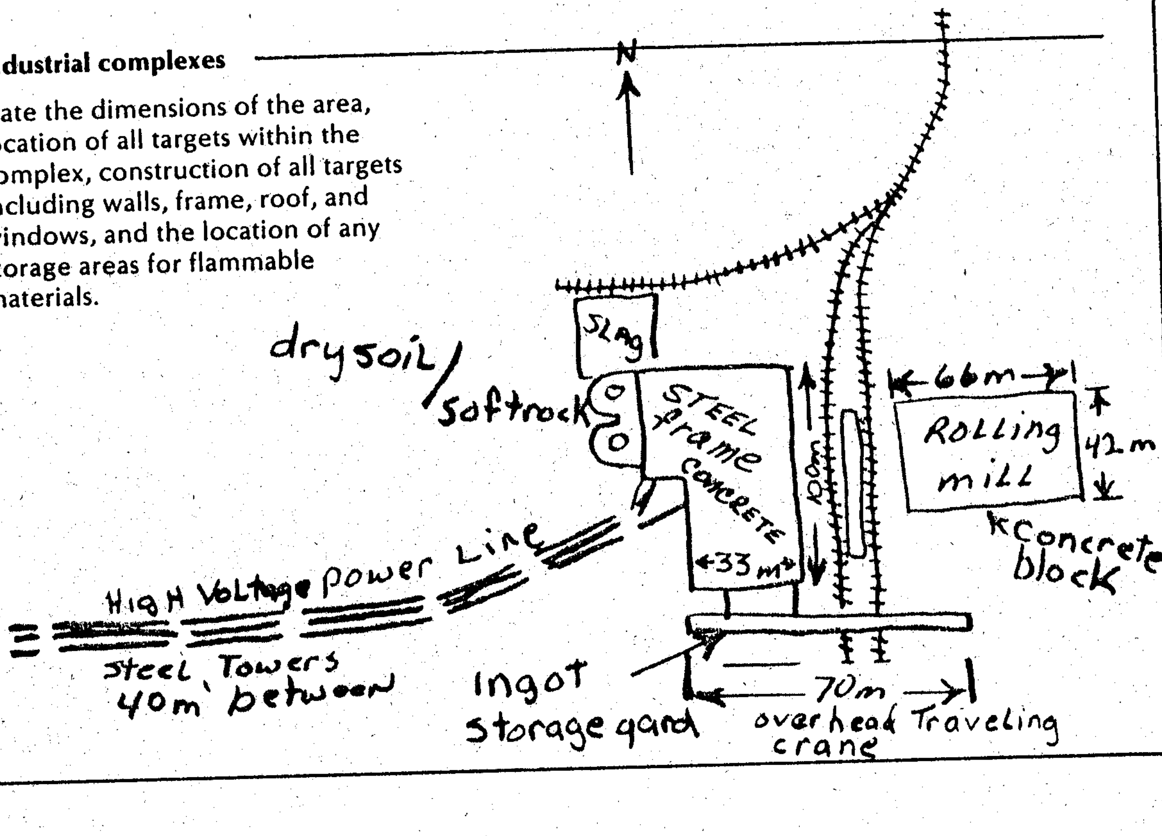
Port facilities

State the location and dimensions of the major harbor and its protective features such as breakwaters, sea walls, and dikes. Include any internal structures. State maximum water depth, locations and dimensions of dry docks, locations and dimensions of any wharves, and location and capacity of any cranes or other loading or unloading devices.



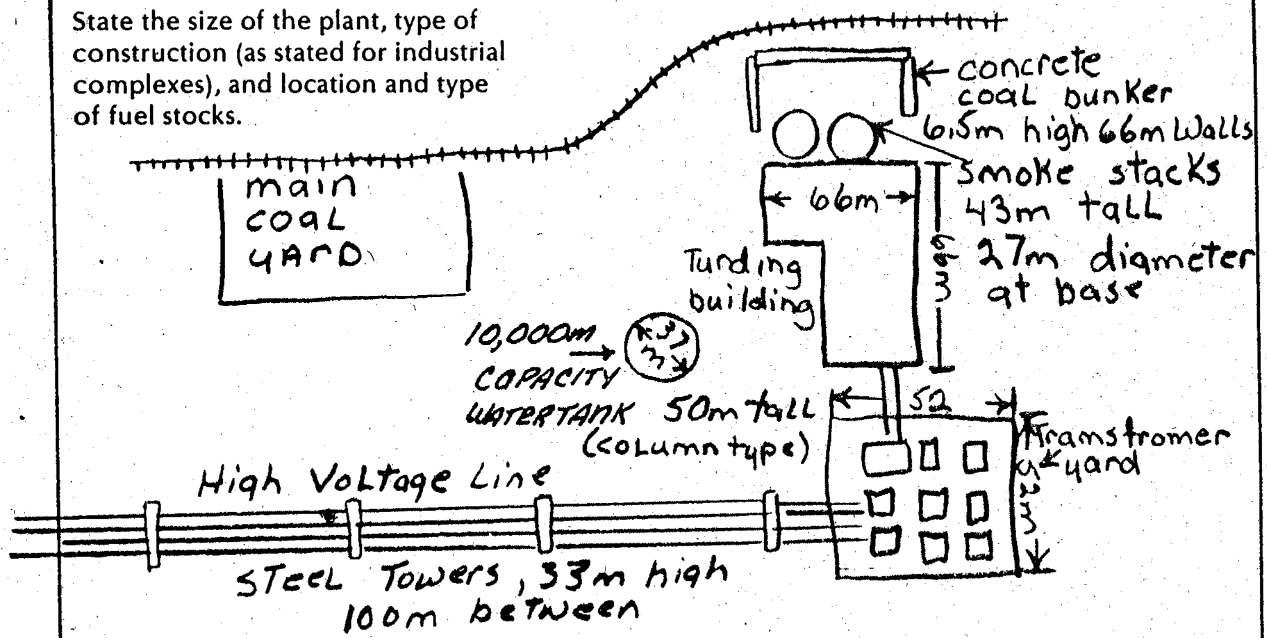
Industrial complexes

State the dimensions of the area, location of all targets within the complex, construction of all targets including walls, frame, roof, and windows, and the location of any storage areas for flammable materials.



Power/utility plants

State the size of the plant, type of construction (as stated for industrial complexes), and location and type of fuel stocks.



FIRING SITES

The recon team should evaluate at least two sites. In recommending a primary and an alternate site, the team should use the following criteria. The site should—

- Be located at least 45 degrees from the prevailing downwind direction. In addition, the alternate firing site should be at least 45 degrees from the primary site.
- Be located outside the minimum safe distance for mission personnel. Consult with the target analyst or the ADM unit for technical advice.
- Have a line of sight to target, if possible.
- Have withdrawal routes from the target. Primary and secondary withdrawal routes to each firing site should be reconned for withdrawal time and afforded cover.
- Allow exit without going near the target or through the downwind area.
- Offer protection and concealment with a minimum of construction.
- Be easily defendable by small arms, if necessary.

LOCAL SECURITY

The recon team should evaluate the terrain to suggest locations for the ADM security force and identify avenues of approach to the emplacement site.

The recon team should also determine areas for protection of the ADM security forces after evacuation of the emplacement site just before detonation.

SURROUNDING AREA

The blast and thermal effects of an ADM detonation may produce bonus effects or collateral damage. Therefore, an investigation of the surrounding area should extend to a radius of approximately 3 kilometers from the center of the primary target. State the location, direction, and distance from target center, type, and size in as much detail as time permits for each of the following items:

- **Bridges and roads.** These should be reported using the standards on pages 5-4 through 5-6.
- **Facilities.** These are power lines, electric generating stations, water supplies, medical services, and other similar facilities.
- **Structures.** These are any commercial, industrial, or residential structures.
- **Civilian communities.** The investigation for civilian population centers should extend to 10 kilometers in the prevailing downwind direction.
- **Points of special interest.** These are anything that might have cultural, historic, religious, or social value.
- **Vegetation.** State if it is evergreen or broadleaf type. Comment on the amount of leaf litter, and estimate the moisture content of the litter as dry, moist, or wet. State whether deciduous trees have living leaves, dead (dry) leaves, or no leaves.

SUPPLEMENTARY INFORMATION

Include as much as possible within time and material constraints.

SCALED SKETCHES AND OVERLAYS

A detailed sketch of the primary target should show potential ADM placement positions. An overlay (to a military map) should show the target, firing sites, withdrawal routes, and significant surrounding features. Include distance, dimensions, and proper orientations. Use a map scale of 1:50,000. Include anything that in your professional judgment would assist the commander or target analyst, such as nearby bridges and towns.

PHOTOGRAPHS

Ground photographs should cover the target in detail. If aerial photographs are possible, they show the overall target area, firing sites, and other important features.

LOCATION OF FRIENDLY TROOPS

Give their grid coordinates or distance and direction from target. If troops are in fortifications, indicate the orientation and type. This kind of data is useful only for immediate employment when it is unlikely that troop location will soon change. For long-range planning, indicate probable locations of friendly troops. Consult with the S3 of the appropriate maneuver unit.

ROUTES

Determine the primary and secondary routes to and from the emplacement and firing sites.

SUBSURFACE STRUCTURES

ADM are frequently employed subsurface. To save time and effort, existing subsurface structures such as sewers, subways, and culverts should be sought out, and their type, size, depth, and length should be reported.

ENGINEER SUPPORT

Make a rough estimate of the soldiers and equipment required for emplacement. Also list the tasks that must be performed. (If numerous emplacement sites are possible, evaluate each of these.)

CAMOUFLAGE

Determine camouflage required for soldiers near the potential emplacement site and for the ADML after its emplacement.

SUGGESTED RECON REPORT

Commanders may adapt the checklist shown for local unit use.

ADM TARGET RECONNAISSANCE CHECKLIST

TARGET NO. ____________________

NAME ____________________

MISSION OF TARGET ____________________

____

____

TYPE/DESCRIPTION ____________________

____

____

____

____

____

LOCATION (8 DIGITS) ____________________

MAP SHEET NUMBER & SCALE ____________________

1. TARGET/EMPLACEMENT SITE

☐ Locate and identify target.

☐ If area target, locate target center.

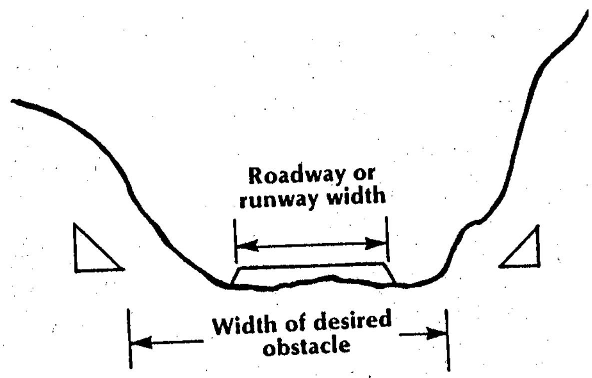
☐ Obtain photographs and sketches. Make detail drawings, including a cross section view.

☐ Locate key elements on map or overlay.

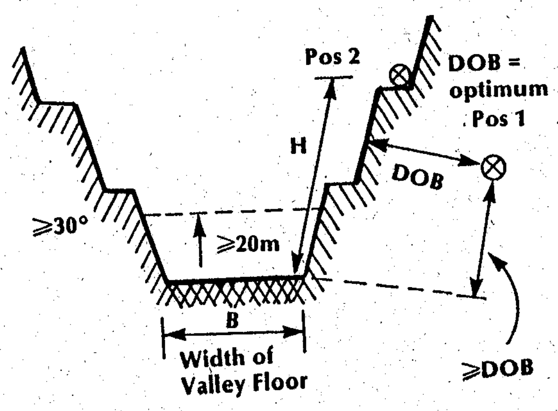
☐ Provide map key and map scale.

☐ Identify potential emplacement positions (sewers, subways, and culverts).

☐ Provide additional information as indicated for each kind of target.



An effective obstacle must be tied in properly on the left and right with either artificial or natural obstacles



Depth of burst into the hillside (DOB) (perpendicular to the valley wall)

CRATERS

Type:

☐ Road crater

☐ Airfield (runway)

☐ Landslide

☐ Other ______

Medium:

☐ Dry soil/soft rock < 10 percent moisture

☐ Wet soil/soft rock ≥ 10 percent moisture

☐ Dry rock/hard rock < 3 percent moisture

☐ Wet rock/hard rock ≥ 3 percent moisture

Provide information on all taxiways and additional runways.

Width of target: ______

Obstacle width: ______

Length of runway: ______

Type of surfacing material: ______

Thickness of surfacing: ______

Width of valley floor (B): ______

Degree of slope of valley sides: ______

______

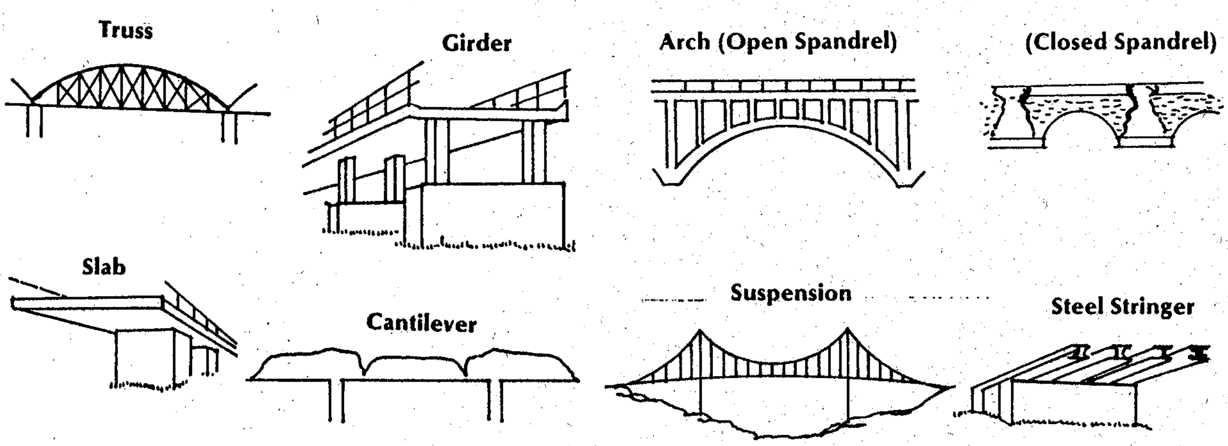
BRIDGES

Type:

☐ Railroad ☐ Truss ☐ Slap ☐ Open spandrel

☐ Highway ☐ Suspension ☐ Arch ☐ Closed spandrel

☐ Other: ____________________



Classification (MLC): ____________

Construction material: ____________

Abutment:

Width: ____________

Height: ____________

Thickness (base): ____________

Thickness (1/2 H): ____________

Length of spans: ____________

Type of spans: ____________
(simple or continuous)

Number of spans: ____________

Diameter of cables: ____________
(record dimensions in meters)

Pier:

Width: ____________

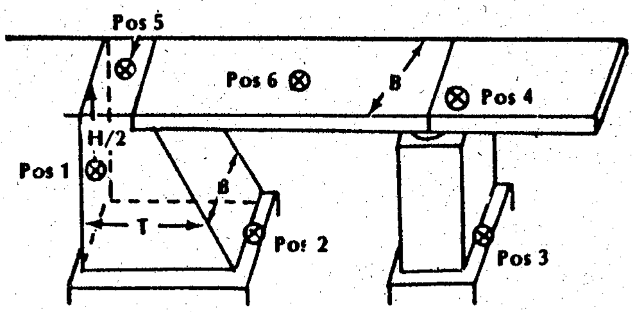
Height: ____________

Thickness: ____________

Traveled Way:

Width: ____________

Thickness: ____________



Pos 2 DOB is 15 meters
or 2 times r, whichever is smaller

DAMS

Types:

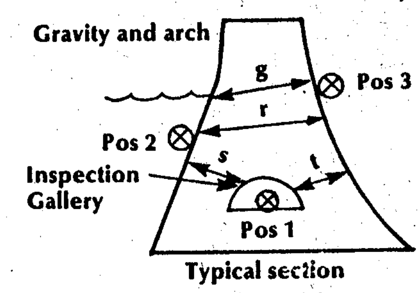
☐ Gravity

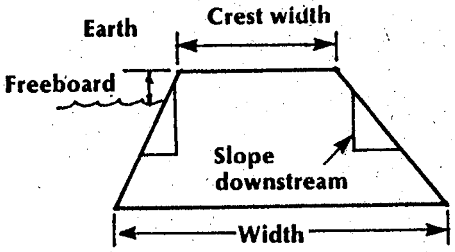
☐ Arch

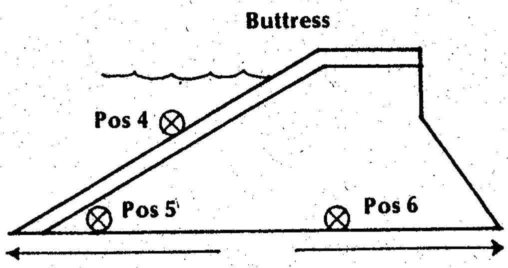
☐ Earth

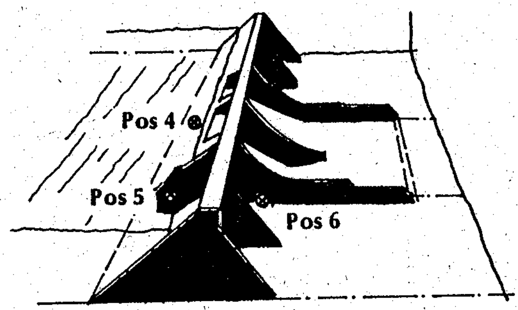
☐ Buttress

☐ Other: ______________________









Dimensions:

Width: ______________________

Height: ______________________

Thickness at bottom: ______________________

Earth:

Thickness at top (crest): ______________________

Slope ratio upstream: ______________________

Slope ratio downstream: ______________________

Freeboard: ______________________

Freeboard = Distance between water and top of dam.

Type of material: ______________________

Width of buttress: ______________________

Distance between buttresses: ______________________

Thickness of upstream slab: ______________________

Show location of sluice gates, chambers, or other subsurface placement position.

OIL TANK FARM

Height of tanks: ______________________

Diameter of tanks: ______________________

Number of tanks: ______________________

Average distance between tanks: ______________________

Dimensions of farm: ______________________

Type of fuel in tanks: ______________________

Level of fuel in tanks: ______________________
(Empty, 0.5, 0.9, full,)

Tanks open: ______________________

Tank covered: ______________________

TUNNELS

Type:

☐ Underground ☐ Underwater

Dimensions:

Length: ____________

Width (w): ____________

Height: ____________

Shaft offset (BTD): ____________

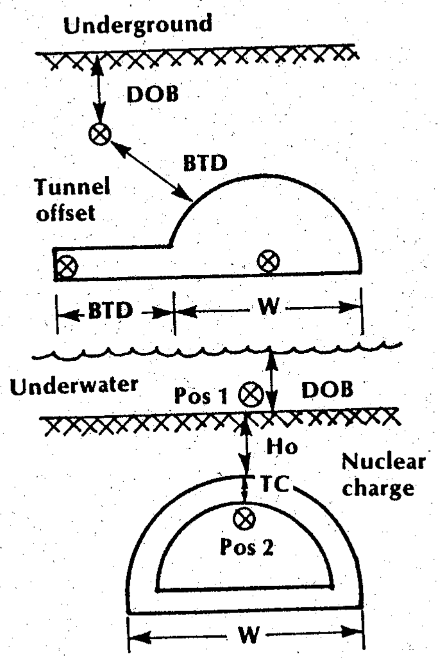
Thickness (wall) (TC): ____________

Depth of overburden (H_O): ____________

Depth of water (D): ____________

Type of overburden: ____________

Type of construction: ____________



Locate/identify any shafts or offsets that may serve as an emplacement position.

Damage distance for rock overburden = H_O + TC

Damage distance for other-than-rock overburden = ½ H_O + TC

CANALS

Type:

☐ Single level ☐ Dams ☐ Lifts ☐ Aqueducts

☐ Variable level ☐ Locks ☐ Pumps

Lock gate dimensions: ____________

Width: ____________

Height: ____________

Thickness: ____________

Type of material: ____________

Depth of water: ____________

Distance between lock gates: ____________

Number of lock gates: ____________

2. FIRING SITE

☐ Select two firing sites — primary and alternate.

Primary ____________________

Alternate ____________________

☐ Firing sites should be 45 degrees apart.

☐ Locate outside MSD (to be verified by target analyst).

☐ Make target observation possible.

☐ Locate at least 45 degrees from the prevailing downwind direction.

☐ Provide cover and concealment.

☐ Locate away from enemy.

☐ Select alternate and primary routes to each firing site.

☐ Select easy withdrawal route.

3. VEHICLE HIDE

☐ Provide cover and concealment for vehicles.

☐ Make accessible from firing site.

☐ Select one near target and at each firing site.

Emplacement site: ____________________

Primary firing site: ____________________

Alternate firing site: ____________________

Other: ____________________

4. TRAFFIC CONTROL POINTS

☐ Locate on all routes coming into target area.

☐ Locate outside MSD.

A. ____________________

B. ____________________

C. ____________________

5. OPs/LPs

☐ Locate on enemy side of the target.

☐ Select number needed according to terrain and enemy situation.

☐ Find easy withdrawal routes.

☐ May be selected by security elements.

OP/LP ____________________

OP/LP ____________________

OP/LP ____________________

6. SECURITY ELEMENTS

☐ Provide for local close-in security around potential target.

☐ Locate on enemy side of target, concentrating on the avenues of approach.

☐ Provide for good observation and fields of fire.

☐ Locate easy withdrawal routes.

☐ Identify areas that meet requirements:

______

______

______

7. FRIENDLY FORCES

☐ State location of command post or liaison.

______

______

☐ State type and size of unit.

______

______

☐ State degree of protection/risk.

______

______

8. STRUCTURES, FACILITIES, VEGETATION, AND POPULATION

☐ Locate and identify all structures and facilities within a 3,000-meter radius of the target.

______

______

______

______

______

☐ Describe wooded areas. (Coniferous or deciduous, dry or green, dimensions.)

______

☐ Locate populated areas. Determine population and city limits. (Check up to meters in prevailing downwind direction.)

______

______

9. RESOURCES

☐ Estimate engineer support needed.

☐ Identify any special skills required (scuba diving, rappeling, etc.).

☐ Identify any equipment needed.

☐ Prepare a mission task list.

REMARKS:

REPORT COMPLETED BY: ______________________________
(Print name and rank)

UNIT DESIGNATION: ______________________________

DATE COMPLETED: ______________________________

SIGNATURE: ______________________________

ADM target analysis is an examination of potential targets and surrounding areas to determine military importance, priority of demolition, and munitions required to obtain a desired level of damage. The purposes of analysis are to compare the respective advantages of conventional and nuclear demolitions in achieving desired target damage, to select the most suitable munition available, to predict the effects of the detonation, to select the desired ground zero (DGZ) and depth of burst (DOB), and to compare the actual with predicted results for further application.

ADM are normally employed in areas under friendly control. The smallest yield consistent with military necessity should be employed to prevent overdestruction of artificial and natural features and civilian casualties and to minimize radiation hazards.

Section I—PREPARATION

CLASSIFICATION BY SIZE

Nuclear targets are classified according to size, into point targets and area targets. The analyst uses this distinction to determine acceptable degrees of damage.

POINT TARGETS

A point target is a single element such as a bridge or dam. ADM normally destroy point targets by the cratering effect. Bridges and other above-ground targets sensitive to blast may be damaged by the blast effect.

AREA TARGETS

Targets which occupy a sizable portion of terrain are termed area targets. Examples are POL storage facilities, railroad yards, and port facilities. Generally, 30 percent coverage of an area target is the minimum acceptable for destruction of the target. Blast is the principal effect.

ASSUMPTIONS

Analysis is based on the following assumptions:

RELIABILITY

It is assumed that the ADM will be successfully detonated.

UNIFORM DISTRIBUTION

Employment of ADM usually takes place after detailed ground, air, and map reconnaissance of the target area. However, if detailed information is not available, the analyst assumes that elements of area targets are uniformly distributed.

ATMOSPHERIC CONDITIONS

The target analyst usually does not consider the influence of atmospheric conditions on initial nuclear effects.

TERRAIN

If a nuclear detonation occurs within a narrow defile, initial nuclear effects may be increased within the defile and reduced outside of it because of shielding by the terrain. Analysis makes no assumption of these variables.

SUBSURFACE EMPLACEMENT

In many instances, damage is predicted upon adequate ADM subsurface emplacement. Target analysts must be familiar with the subsurface emplacement capabilities of executing units and base analysis on their limitations. The analyst does not assume an impractical construction ability.

DATA FOR ADM TARGET ANALYSIS

The tables in appendix C present technical data to be used in target and troop safety analysis for the hypothetical ADM family. See FM 101-31-2 (SRD) for tables used with stockpiled weapons. A troop safety table and contingent effects tables are also included. The unclassified tables in this manual are similiar to the classified tables in FM 101-31-2 (SRD). One who understands how to use the unclassified tables can readily make the transition to the classified tables.

ADM TARGET ANALYSIS DA FORM ______

A standard target analysis work sheet must be completed by the analyst (see page 6-7). The analyst uses this work sheet, which ultimately becomes part of the target folder, to select the proper munition and to predict its effects. For availability, see appendix D.

Section II—ANALYSIS PROCEDURES

STEPS TO FOLLOW

The target analyst uses the following procedural steps. The experienced target analyst may omit or change some steps. These procedural steps closely parallel techniques outlined in FM 101-31-1, but, since ADM are hand-emplaced, the circular error probable (CEP) and the probable error in height of burst (PEH) are not considered.

STEP 1—IDENTIFY PERTINENT INFORMATION

The target analyst identifies the pertinent portions of the SOP and becomes familiar with the commander's guidance. From the target reconnaissance report, the analyst collects information concerning the target location, nature, shape, and size, its distance from friendly troops or civilians, and its distance from key surrounding structures.

STEP 2—DETERMINE DATA

ESTIMATION OF DAMAGE TO THE TARGET

There are three ways to estimate damage by ADM: the cratering method, the visual method, and the numerical method. The method used depends on the nature of the target and the governing primary effect. The figure on page 6-5 shows how the method of analysis can be determined.

TARGETS DESTROYED BY CRATERING

The target analyst uses cratering methods for specific point targets which are damaged by the cratering effect. These are targets such as bridges, dams, tunnels, and road craters. (See pages 6-6 through 6-31.)

TARGETS DESTROYED BY AIR BLAST

Visual method. This method is used to estimate damage to irregular area targets—those whose length (l) is greater than or equal to twice the width (w)—such as port facilities. The analyst locates radii of damage for various target categories in the damage tables. Radius of damage is the distance from ground zero at which the probability of achieving the specified degree of damage is 50 percent. The analyst superimposes the appropriate radius of damage (RD) on the target and visually estimates the fraction of the target area covered. This fraction (f) is expressed as a percentage of the total target area. (See page 6-32.)

Numerical method. This method is used to estimate damage to approximately circular area targets—those whose length is less than twice the width. The target analyst uses the radius of target (RT) and the displacement distance (d), if any, with nomographs and an area target coverage graph to estimate coverage. Displacement distance (d) is the distance between ground zero and the center of the target. The numerical method is also used with a point target graph extension to estimate the probability of damaging a point target. Normally a probability of 90 percent is desired to achieve destruction. (See page 6-34.)

CONSIDERATION OF LIMITING REQUIREMENTS

Restrictions on the employment of ADM are called "limiting requirements" and are considered in three distinct areas—troop safety, collateral damage, and preclusion of damage.

Troop safety. The target analyst determines the distance that friendly troops must be from ground zero to meet the commander's risk guidance.

Collateral damage. The target analyst makes sure that undesirable civilian personnel injuries and material damage are minimized and that anticipated damage is well defined in the target analysis.

Preclusion of damage. The target analyst precludes damage to heavily populated areas, vital supply installations, and other facilities as defined in the commander's guidance.

SELECTION OF THE DESIRED GROUND ZERO

To obtain the maximum effectiveness of an ADM, the first choice for desired ground zero is the target center, or the center of mass of a target. However, limiting requirements or the engagement of multiple targets with a single device may require displacement of the desired ground zero.

STEP 3—MAKE RECOMMENDATION

After the target analysis has been completed, a recommendation is presented to the commander in the form of completed target analysis sheets (page 6-7). The recommendation should include the following information.

ADM

The ADM to be used is shown by yield; for example, "0.1 KT ADM."

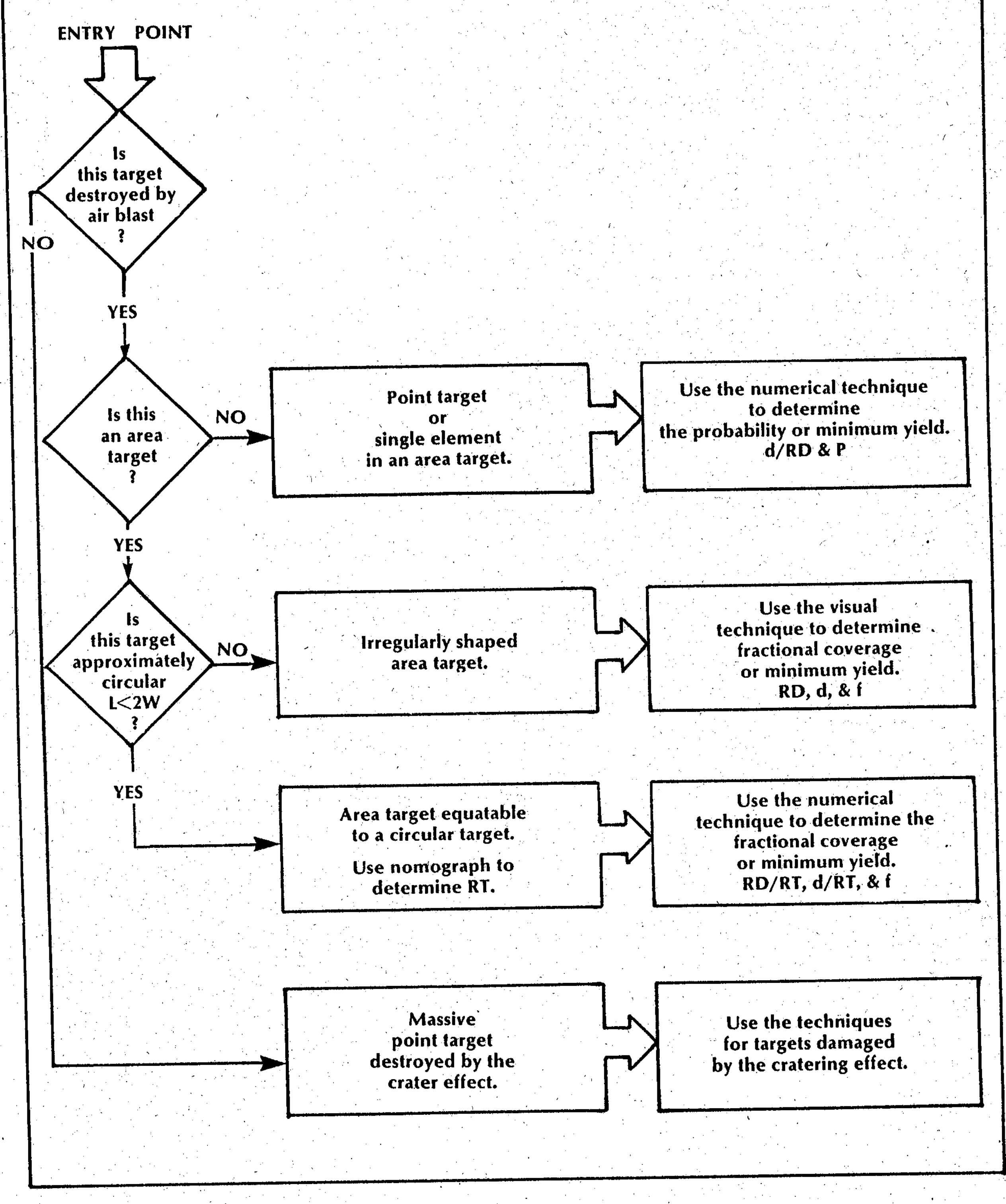
DEPTH OF BURST

Give the exact depth of burst (DOB) in meters where applicable. In addition, when an emplacement hole must be constructed, an estimate of the time and resources required for construction must be included.

DESIRED GROUND ZERO

The desired ground zero (DGZ) is the point on the earth's surface at or below which the

CHOOSING ADM TARGET ANALYSIS TECHNIQUE



detonation will occur. DGZ is generally designated by universal transverse mercator (UTM) map coordinates.

EMPLACEMENT POSITION

When a structure is involved, the emplacement position (burst point) is also specified as, for example, "base of center pier." When a demolition chamber must be constructed, an estimate of the time and resources required must be included.

FIRING OPTION

The timer firing option is applied to the fast-moving battlefield by the use of minimum timer settings. Settings can be used to allow the firing team to leave the target site and to detonate the munition immediately thereafter.

TROOP SAFETY

A graphic portrayal shows the commander the distance beyond which the risk to unwarned, exposed personnel is negligible. If friendly troops are located within this distance, a graphic presentation shows the resultant risk and/or protection required. Troop safety may influence the selection of yield, ground zero, time of burst, and scheme of maneuver. When the SOP or commander's guidance concerning troop safety cannot be met, take one or more of the following corrective actions:

- Move the location of ground zero.
- Change the depth of burst.
- Use a lower-yield ADM.
- Withdraw troops to safe distances.
- Accept a higher degree of risk to friendly troops.
- Increase the protection of friendly troops.
- Use conventional demolitions.
- Cancel the mission.

Section III—TARGETS DAMAGED BY THE CRATERING EFFECT

CRATERS

Unlike other nuclear systems, ADM are employed to destroy hard targets and create obstacles rather than to cause personnel casualties. Nuclear cratering, therefore, is usually the principal effect desired from ADM employment. Other nuclear effects are considered bonus effects or limiting effects, depending on the mission. The unique lack of delivery error considerably simplifies ADM target analysis techniques. This section, therefore, presents modifications to the general target analysis methods outlined in FM 101-31-1. It shows how to use ADM to displace large masses of soil, rock, or concrete.

CRATER SIZE

A nuclear detonation in soil or rock forms a crater by crushing, compacting, fracturing, and displacing the medium. Material adjacent to the explosion is vaporized and melted. Large quantities of soil or rock are thrown out of the ground. Three factors generally determine crater size: yield, depth of burst, and the surrounding medium.

Yield. Crater dimensions increase with increased yield. A tenfold increase in yield will generally double crater dimensions.

Depth of burst. Depth of burst is the most

ADM TARGET ANALYSIS

1. TARGET INFORMATION: ADML NO. A17 GEP SCORCH

Mission crater highway

Description of ADML 4 lane highway ~~Target Radius (RT)~~

Location: UTM Grid VA 906420 Map Sheet No. 7661, Series U822

Name Oaksten Scale 1:50,000

Soil Type dry rock Fuel Condition: (Green) ~~Dry~~

Forest Type: (Deciduous) ~~Coniferous~~

2. DESIRED EFFECTS: Crater Radius 20 meters

~~Degree of Damage: moderate/severe, Fractional Coverage or Probability of Destruction ___%~~

Other

3. TROOP SAFETY:

Risk (neg) ~~mod/emer~~ Vulnerability: (unw exp) ~~war exp/war prot~~

RES: (0) ~~1/2/3~~ Distance from GZ: 1580 meters

4. COLLATERAL DAMAGE:

Personnel		Material	Distance from GZ
Vulnerability	Distance from GZ	Single story frame building	920 meters
Urban	2630 meters	Single story masonry building	920 meters
Rural	920 meters	Light steel frame industrial building	2630 meters
Open	920 meters	Fixed bridges	3210 meters
		Railroad equipment	4240 meters

Constraints preclude damage to urban population and facilities

5. PRECLUSION REQUIREMENTS None

Obstacles

Damage

Other

6. TARGET ANALYSIS: See reverse.

7. RECOMMENDATION: ADM-Type 0.5 KT MK-Y 0.5 KT

DOB: 3 m meters; Position: in culvert

8. VERIFICATION: Engineer Branch James Wright

JAMES WRIGHT, CPT, CE

Operations Branch Willy Korec

WILLY KOREC, MAJ, FA

9. REMARKS:

ADM TARGET ANALYSIS (continued)

DTG of Selection 23 1200Z Sep 83 Analyst MAJ Barry Wull Unit HHC, V Corps

1.	ADM-TYPE YIELD, KT	.05 KT			
2.	TARGET TYPE (1)	highway			
3.	DAMAGE EFFECTS (2)	crater			
4.	ADM POSITION ON TARGET OR DISPLACEMENT DISTANCE D (3)	in culvert			
5.	DESIRED CRATER OR DAMAGE RADIUS (4)	20m			
6.	DOB, METERS	3m			
7.	PREDICTED CRATER OR DAMAGE RADIUS (5)	20m			
8.	ADM SUITABLE/UNSUITABLE	suitable			
9.	TROOP SAFETY: NEG risk, RES 0				
	MSD 1 - War. prot.	1150			
	MSD 2 - War. exp.	1150			
	MSD 3 - Unw exp.	1150			
	Troop Distance from GZ	1580			
	Safe/Unsafe	safe			
10.	COLLATERAL PERSONNEL INJURY				
	Safety Distance (degree of risk 5% inc.) (7)	680			
	Personnel Distance from GZ	2630			
	Safe/Unsafe	safe			
11.	COLLATERAL MATERIAL DAMAGE CDD (6)	357			
	Distance from GZ	2630			
	Safe/Unsafe	safe			
12.	PRECLUSION OF OBSTACLES, DAMAGE LSD				
	Distance from GZ				
	Safe/Unsafe				
13.	BONUS/HAZARD EFFECTS				
	Forest Blowdown, Radius, meters	398			
	Fires, Radius, meters	335			
	Landmine, Vulnerability Radius, meters AT/AP	206 /1699	/	/	/
	Suitable/Unsuitable	suitable			
14.	FALLOUT PREDICTION DATA EWS kph/DWD	15 /190	/	/	/
	Cloud Radius/Base Surge Radius (8)	650/410	/	/	/
	Zone I, meters	3750			
	Zone II, meters	6000			
	Suitable/Unsuitable	suitable			

NOTES:(1) Enter type of target.
(2) Enter primary damage producing effect; i.e., air blast, cratering.
(3) Enter code number indicating placement position (FM 5-26).
(4) Enter critical target dimensions; i.e., for a crater, enter the desired crater radius and/or depth.
(5) Enter predicted damage radius from appropriate effects table or graph.
(6) Chapter 12 of FM 101-31-2
(7) FM 101-31-1, FM 101-31-2.

(8) Cloud Radius FM 3-22; Base Surge table to be developed.

important factor in determining crater size. An increase in the depth of burst increases crater size until a point at which crater dimensions are maximum. At depths greater than that, crater size decreases until a subsidence crater is formed.

Medium. For the same yield and depth of burst, craters in rock are smaller than in soil, and craters in a wet medium are larger than in a dry one.

CRATER NOMENCLATURE AND DIMENSIONS

See the figure below for a cross section of a typical crater in rock and the significant dimensions and zones associated with cratering.

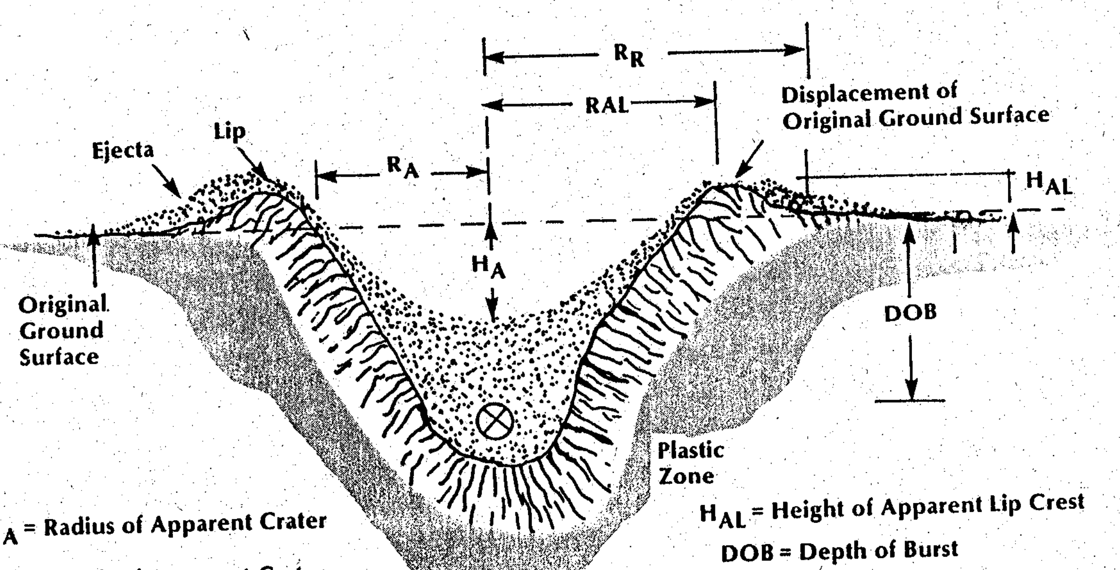
Fallback. Fallback is material which has been thrown into the air and which has then fallen back into the crater. Fallback fills up a portion of the true crater, producing the final (apparent) crater shape.

Ejecta. Ejecta are material thrown out of the crater. Ejecta assist in lip formation and produce a missile hazard and a base surge dust cloud. Continuous ejecta form a portion of the lip to a distance of about one apparent crater diameter from the crater edge.

Rupture zone. The rupture zone consists of material which has been severely fractured and crushed, but which has not undergone significant displacement. It is adjacent to the true crater. The radius of the rupture zone (R_R) is about one and one-half times the radius of the apparent crater, (R_A). See figure on page 6-10. This radius can be determined from the cratering tables in appendix C.

Plastic zone. The plastic zone is an area beyond the rupture zone in which stresses have caused permanent deformation of the medium, but not significant crushing or fracturing. Structures in the plastic zone are vulnerable to damage. The plastic zone

CRATER DIMENSIONS AND NOMENCLATURE



R_A = Radius of Apparent Crater

H_A = Depth of Apparent Crater

R_R = Radius of Rupture Zone

H_{AL} = Height of Apparent Lip Crest

DOB = Depth of Burst

RAL = Radius of Apparent Lip Crest (Obstacle Radius) extends to a distance of about two crater radii from ground zero.

Elastic zone. The elastic zone is beyond the plastic zone. The properties of the material in this zone are not significantly affected by the detonation although strong ground pressures have been transmitted.

Apparent crater. The apparent crater is that portion of the visible crater below the original ground surface. The apparent crater radius (R_A) and depth (H_A) are the dimensions of primary interest in the creation of crater obstacles. These dimensions are determined from the cratering tables in appendix C.

True crater. The true crater is the crater actually formed by the detonation. The true crater is the boundary between the fallback material and the rupture zone. Fallback material fills up a portion of the true crater to form the apparent crater.

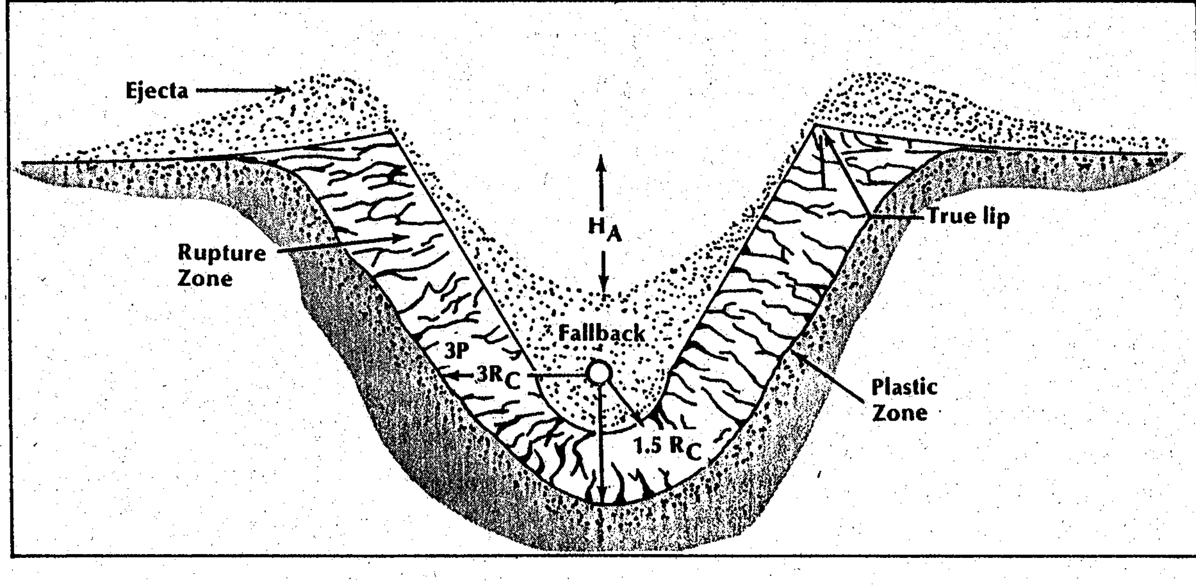
Apparent lip. The apparent lip of a crater is composed of the true lip and the ejecta lip. The true lip is formed by the upward displacement of the ground surface above the rupture zone. The ejecta lip is formed by the material thrown out of the crater onto the true lip. The apparent lip defines the limits of the visible crater above the preshot ground elevation. The radius of the apparent lip crest (RAL) constitutes the radius of the obstacle. It is about 15 percent larger than the apparent crater radius. The radius of the apparent lip crest (RAL) equals 1.15 R_A. The height of the apparent lip crest (HAL) equals 0.25 H_A. The characteristics of the apparent crater lip depend on the yield, depth of burst, and the media. An ADM creates its greatest lip height and diameter in rock media.

Volume. The volume of the apparent crater (Vc) is equal to

$$\frac{\pi}{2} H_A(R_A)^2$$

This formula helps calculate the amount of backfill required to breach the crater obstacle.

CRATER CROSS SECTION SHOWING SHAPE AND EXTENT OF RUPTURE ZONE



Depth of burst. See figure below. Shallow depth of burst is defined as approximately $15W^{0.3}$ meters. The yield W is expressed in kilotons. Optimum DOB varies with the surrounding medium from approximately $34W^{0.3}$ meters for dry rock to $49W^{0.3}$ meters for dry soil.

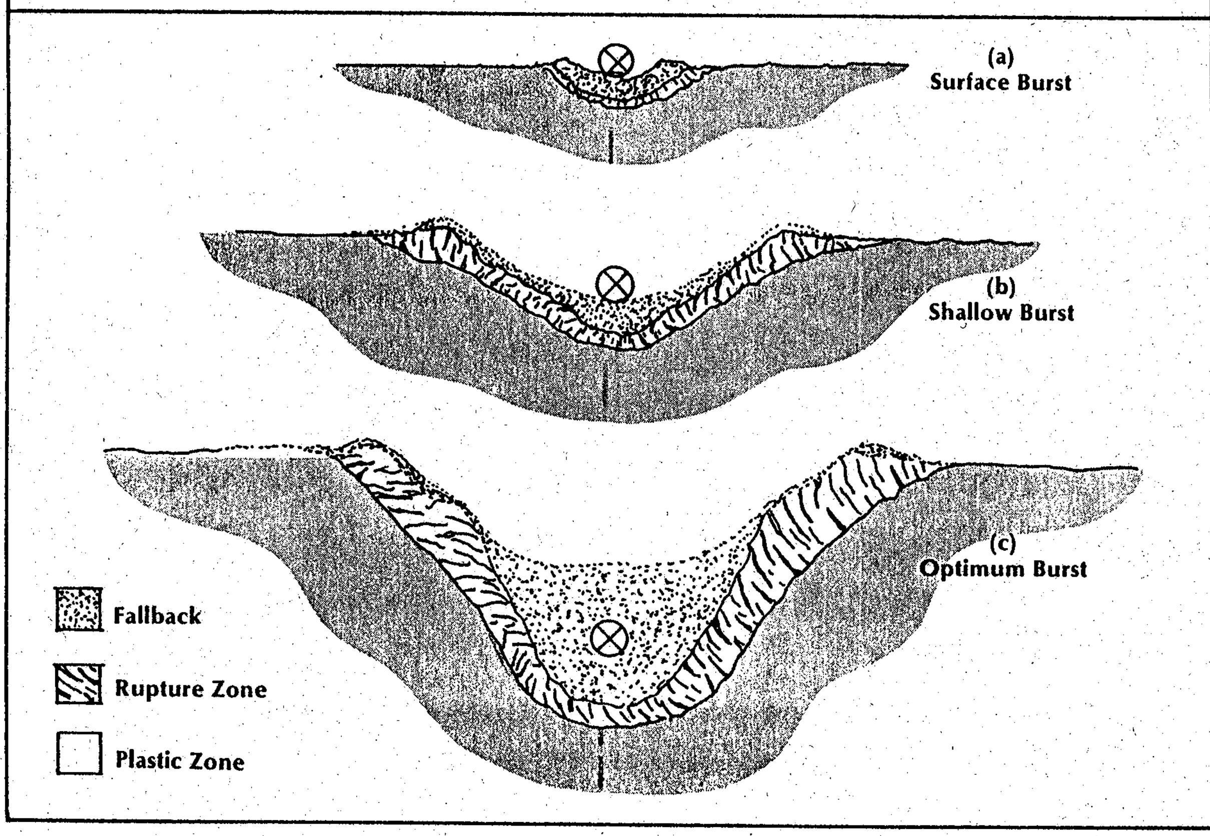
True crater shape. The true crater shape is a circle that best describes the intersection of the preshot ground surface with the walls of the true crater. For depths of burst less than optimum, the true crater radius and the apparent crater radius are approximately equal. The depth of the true crater is equal to the depth of burst of the ADM plus the radius of the cavity created by the detonation. The cavity radius (Rc) is approximately equal to $14W^{1/3}$ meters (see appendix C, table C-25). The true crater depth H_T may be determined from this equation:

$$H_T = DOB + Rc \text{ or}$$
$$H_T = DOB + 14W^{1/3}$$

Apparent crater shape. The shape of the apparent crater varies with the depth of burst of the ADM. Craters resulting from surface detonations have gentle slopes and are relatively shallow in depth. Detonations near optimum depth of burst produce craters with relatively steep slopes. Although the shape of the apparent crater varies with depth of burst, the crater cross section remains approximately parabolic.

The effectiveness of a crater obstacle depends primarily on the slope of the crater sides and

CRATER PROFILES RELATED TO DEPTH OF BURST

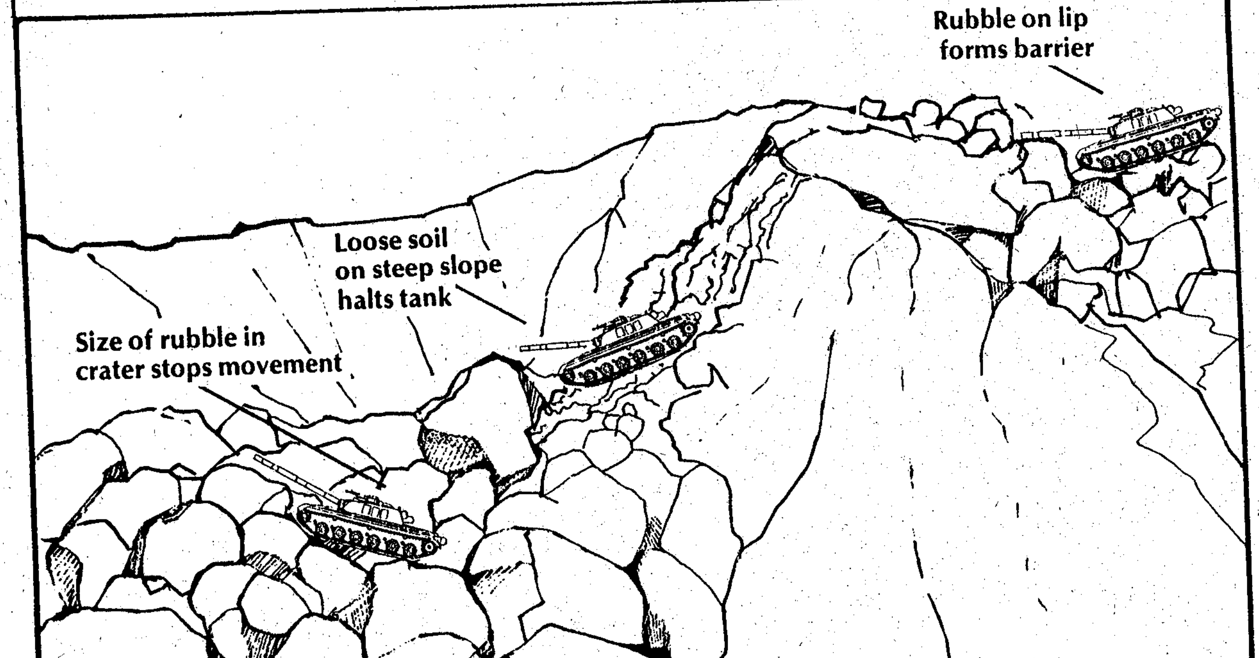


the properties of the medium cratered. The depth of loose material on the crater sides and the moisture content of the soil become important factors at near critical slopes. Test results indicate that a slope of approximately 30 degrees is critical for tracked vehicles in dry soil (desert alluvium). More gentle slopes may be negotiated by such vehicles without assistance, whereas greater slopes require some type of assistance. Craters produced at the same scaled depth of burst in the same media generally will have the same cross section shape regardless of the yield. In dry soil, the critical slope for tracked vehicles occurs at depths of burst of 0 meters and greater. In hard rock, such as basalt or granite, the size of the rubble in the crater may be expected to preclude vehicle passage without regard to the steepness of the slope. The rubble near the lip of a crater formed in rock may also provide an effective barrier to vehicular movement and should be considered a bonus effect. The obstacle width of a crater is considered to be the apparent lip diameter (D_{AL}). It is that width that has to be bridged or reduced by bulldozing or by some other means.

As part of a test (Project TANK TRAP) to determine the obstacle value of craters, an M-60 tank was lowered into a crater in rock (see figure below). The tank could not descend into the crater without assistance and could not get out of the crater without help from a tank retriever. Note the relative size of the rocks.

Optimum depth of burst. Optimum depth of burst is the depth at which the maximum-size crater is produced for a specific yield and medium. In addition to producing the maximum crater radius, optimum subsurface em-

TANKS IMMOBILIZED BY ADM CRATER



placement produces other advantageous effects such as the following:

- Maximum uplift of the rupture zone producing higher lips.
- Maximum ejecta contributing to lip height and obstacle value.
- Steepest crater slopes, reducing trafficability.
- Maximum crater volume, increasing breaching time.
- Large reduction of thermal and initial nuclear radiation effects.
- Large reduction of blast effects.
- Underground containment of most residual radiation (fallout and induced).
- Higher concentration of induced radiation in the crater.

EFFECTS OF TAMPING AND STEMMING

Tamping. The crater dimensions table, table C-6, is based on the assumption that there is no tamping for surface bursts. Tamping of surface shots has some beneficial effect on energy coupling and absorption of electromagnetic pulse (EMP) although these effects cannot be stated quantitatively. To protect the surface-placed system from battlefield damage, placement of 1.5 meters of earth or sandbags around and over the munition is recommended.

Stemming. Table C-6 is based on the assumption that buried ADM are fully stemmed. In the tests on which these tables are based, the emplacement holes were filled with material that varied from sand and gravel to concrete plugs. Under these circumstances, using the tables to predict crater size is valid. However, in a tactical situation, a fully-stemmed emplacement hole is usually not desirable for the following reasons:

- If the mission is changed, recovery of the ADM would be difficult or even impossible.
- Additional engineer support and materials would be required on all subsurface ADM missions.
- Emplacement of an ADM would take a considerably longer time.
- Deep emplacement might not be possible if the height of the stemming material exceeds the backfill limitations of the ADM.

MODIFICATIONS TO FULL STEMMING

When full stemming is not used, general guidelines, followed with the proper degree of engineering judgment, will allow ADM employment.

Water stemming. The height of the ground water table in many areas of the world will cause water-filled emplacement holes. The difference in crater size between a solid-filled hole and a water-filled hole is not militarily significant. Thus, table C-6 can be used without change for full water stemming. Two obvious requirements are that the ADM has negative buoyancy and that the water pressure does not exceed the allowable hydrostatic pressure on the ADM. Water stemming is preferred to soil stemming.

Partial stemming. The use of at least 1.5 meters of stemming material over the munition will produce a crater almost as large as a fully stemmed detonation. Stemming materials can be loose sand or gravel or water. Thus, table C-6 can be used without change for 1.5 meters of stemming or more. The figure on page 6-14 illustrates a typical stem design for subsurface emplacement.

Unstemmed holes. The quickest method of underground ADM employment is emplacement in an unstemmed hole. This eliminates all the disadvantages associated with buried ADM and provides for rapid emplacement and recovery. Reduce crater dimensions given in table C-6 by 10 percent for unstemmed holes.

EXAMPLE

Given

A 5 KT ADM will be detonated in wet soil at a depth of burst of 50 meters. The ground water table is 45 meters below the surface; therefore, the ADM will be covered by about 5 meters of water.

Required

Find the apparent radius (R_A), the apparent depth (H_A), and obstacle radius (RAL) of the resulting crater.

Solution

Use table C-6. Find the columns headed "Yield 5.000 KT."

R_A = 139 meters (Crater Radius, Wet Soil, at 50 meters DOB)

H_A = 73 meters (Crater Depth, Wet Soil, at 50 meters DOB)

RAL = 1.15 x R_A

= 1.15 x 139

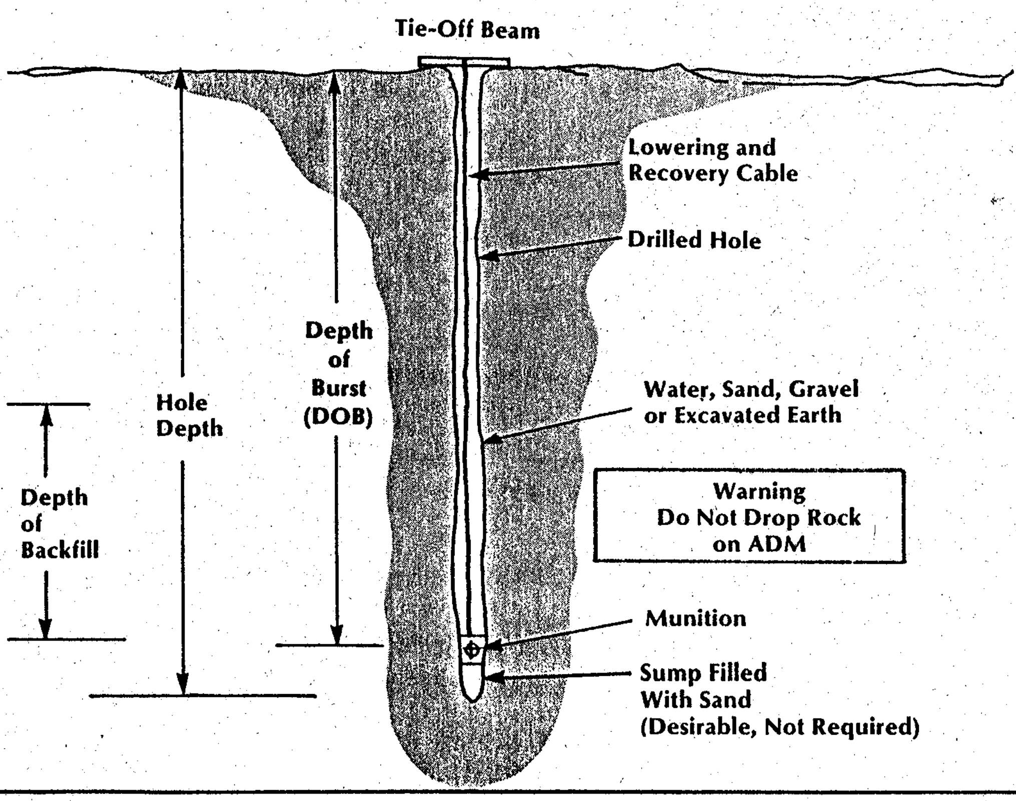
= 160 meters

CRATERING YIELD DETERMINATION

The target analyst determines the required yield using the following procedure:

- Determine the desired obstacle width. This

TYPICAL STEM DESIGN FOR SUBSURFACE EMPLACEMENT



should be greater than the enemy's assault bridging capability. The obstacle width is taken to be the diameter of the apparent lip crest (D_{AL}).

- Divide this value by 2.3. This gives the apparent crater radius (R_A).
- Determine the required yield from the appropriate cratering table (table C-6).
- Select a depth of burst based on practical considerations (for example, capability to construct chamber, yields of munitions available, or existing chambers).

EXAMPLE:

Given

You are directed to crater a divided highway consisting of two 12-meter traveled ways separated by a 4-meter turfed median strip. The shoulders are 4 meters wide. The enemy's assault bridging capability is 32 meters. The subgrade in the target area is dry soil. The water table is 20 meters below the surface. Your unit has a capability to drill emplacement holes as deep as 15 meters. Allocated ADM include 0.01, 0.05, and 0.10 kilotons.

Required

Find the lowest-yield ADM to produce an effective obstacle.

Solution

Determine obstacle width. You decide to crater the road from the outside edge to the outside edge of the shoulders (36 meters). This crater width exceeds the enemy's bridging capability and precludes use of the shoulders as a bypass.

Determine the required apparent crater radius:

$$\frac{D_{AL}}{2.3} = R_A$$

$\frac{36}{2.3}$ = 15.65, say 16 meters, the required apparent crater radius.

Use table C-6 to determine the required yield.

Start with the smallest yield, 0.01 KT ADM. From table C-6, in a medium of dry soil and at a depth of 15 meters,

R_A =8

With R_A = 8, the requirements are not met for the crater is too small.

Try 0.05 KT ADM. From table C-6, find the following value:

R_A = 15

With R_A = 15, the requirements are not met for the crater is too small.

Try 0.10 KT ADM. From table C-6, find the following value:

At a depth of 3 meters, R_A = 16.

Answer

Since a DOB of 3 meters is within our unit's capability, a 0.10 KT ADM is suitable.

SITE SELECTION

Defiles. Obviously, the best place for a crater is in a defile with steep sides. Cratering a defile effectively eliminates it as an avenue of approach. If all or most of the defiles in a corridor are so blocked, the enemy's mobility and flexibility are seriously hindered.

Multilane highways. Even where no defiles exist, craters are effective in destroying multilane highways. A crater should compel the enemy to construct a wide detour. Such an obstacle every few miles renders the highway virtually useless as a high-volume, high-speed avenue of approach. Whenever possible, crater highways at locations where construction of a bypass is impossible or difficult.

LANDSLIDES

One of the best locations for a landslide to produce a barrier is in a defile. A blocked defile can stop an enemy advance and cause them to mass in an area where they can be destroyed. ADM emplacement positions and yield requirements for blocking defiles depend primarily on the steepness of side slopes and width of the defile. An ADM emplaced in a side of the defile can deny access through steep-sided cuts by blocking the cut with a landslide produced by the ejecta. Good results can be expected if the side slopes of the defile are at least 30 degrees. At flatter slopes, a significant landslide may not occur, and vehicles may be able to detour around it.

YIELD SELECTION AND EMPLACEMENT

The creation of a landslide across a defile can be assured if the slopes of the defile are steep and if the analyst estimates conservatively the amount of material to be ejected. Therefore, the analyst makes several conservative assumptions.

Table C-7 provides a way to select ADM yield. The table is based on the width of the defile to be blocked and emplacement of the ADM at optimum DOB. Emplacement must be at an elevation such that the true crater produced by the detonation will not intersect the bottom of the defile. Therefore, the ADM must be emplaced at a height above the bottom of the defile at least equal to the DOB, as shown in the sketch in table C-7. The landslide volume is the volume of material from the true crater produced by the detonation. No consideration has been given to the additional volume of material that would normally be expected to fall from the slope above the crater. This addition is a considerable amount of bonus material. Table C-7 is based on a height of landslide of at least 20 meters, with a 30-degree angle of repose of the material, the approximate angle of repose for soil.

If the landslide is composed of hard rock, passage for vehicles is extremely difficult and is possible only after significant engineer effort. However, if the material is soil, the landslide may be traversed by tracked vehicles after minor engineer effort.

The commander desires to block a roadway in a defile between two large mountains. At one point, the road passes through a gap 85 meters wide where the slopes are 35 degrees. At this point, the medium is dry soil.

Find the ADM required to block the road and its emplacement position.

The width of the gap is 85 meters. From table C-7, a yield of 5 KT emplaced at 10 meters below the surface will block a gap of 90 meters. Minimum height is 46 meters.

5 KT ADM, emplaced at a depth of 10 meters at least 46 meters up the slope.

BRIDGES

Often bridges may be quickly and efficiently destroyed with ADM. Bridge demolition begins with an examination of bridge construction. To effectively destroy a bridge with minimum yield, personnel, time, and equipment, the target analyst must be familiar with the various types of bridges, their construction, and the location of vulnerable points.

PROCEDURE

To determine how ADM may be best used, the analyst selects the most suitable effect of a nuclear detonation, establishes damage criteria, and chooses the most suitable emplacement location. Cratering action is the principal means of bridge demolition. In some cases, defined in the section of this chapter beginning on page 6-32, air blast may be the governing effect.

OPTIONS FOR DESIRED DAMAGE

According to degree of damage desired and preparation time, there are three demolition options.

Pier or abutment base option. Destruction by ADM at or near the base of a pier or abutment provides the best use of the cratering action of a nuclear detonation. Destruction of the friendly shore abutment is preferred. This choice makes enemy reconstruction more difficult and facilitates friendly reconstruction.

Pier destruction. This placement achieves maximum damage in that it collapses two spans, removes a pier, and craters the river bottom at the point where a replacement pier might be built.

Abutment destruction. This placement achieves bridge destruction with the lowest yield and greatest control of effects. If the bridge has a single span or if pier demolition is not desired, destruction of an abutment is recommended.

Pier or abutment top option. When circumstances such as lack of equipment, personnel, or time do not permit placement of the ADM for pier or abutment base destruction, the pier or abutment top option is also a means of exploiting cratering effects.

Traveled way option. With limited time available, the damage criterion recommended is complete breach of the traveled way. Place the ADM directly on the traveled way and, if time permits, tamp it with at least 1.5 meters of sandbags.

DETERMINATION OF YIELD FOR ABUTMENT AND PIER BASE DESTRUCTION

To achieve major bridge damage by cratering, the analyst relates crater dimensions to the dimensions of critical bridge components. The analyst measures widths of traveled ways, piers, and abutments and ascertains which yields produce crater dimensions that are approximately equal. Of course, any plan for using ADM must include an evaluation of the bonus or limiting effects such as blast, ground shock, and thermal and nuclear radiation.

Demolition of bridge abutments.

Emplacement behind abutment. The best ADM position for the demolition of a bridge abutment is emplacement behind the abutment at a depth equal to or greater than one half of the height of the abutment as shown in table C-8, position 1. Detonation at this depth insures that a significant portion of the abutment is destroyed.

The yield requirement for ADM emplacement behind the abutment is determined by the width (B) of the abutment. If the yield used produces a crater with a diameter of rupture zone equal to the width of the abutment, the thickness of the abutment is always breached. Table C-8 gives ADM yields needed to destroy bridge abutments by the detonation of ADM emplaced behind the abutment. The tables are based on the yield required to produce a diameter of rupture zone in hard rock equal to the abutment width (B) using the thickness of the abutment (T) as the effective depth of burst. If the thickness is not listed in the table, use the thickness which is closest to but less than the actual abutment thickness. Table C-8 indicates that smaller yields are required as the abutment thickness increases. The reason is that cratering effects are enhanced as the depth of burst (thickness of abutment) increases. If the width of the abutment is not listed, go to the next higher listed width.

Emplacement on face of abutment. If the characteristics of the ADM, the tactical situation, or the lack of emplacement construction equipment preclude placing the ADM behind the abutment, the nuclear munition may be placed on the abutment face (table C-8, position 2). Detonation on the abutment face above water level produces a crater similar to the crater resulting from a surface burst in hard rock. If the ADM is placed under water, crater dimensions increase somewhat because of the tamping effect of the water. This manual does not attempt to evaluate the increase numerically.

The ADM yield requirements for destruction of an abutment by detonation on its face are determined by both the width (B) and the thickness (T) of the abutment. The analyst selects a yield which produces a diameter of rupture zone equal to the abutment width (B) and a depth of rupture zone equal to its thickness (T). Table C-8 determines required yields. The higher yield determined from the table for an abutment of given dimensions (B and T) governs. If the abutment dimensions are not listed, go to the next higher listed dimensions.

If an abutment has a demolition chamber (a chamber specifically incorporated by design to facilitate bridge denial), the ADM is detonated in the chamber. Use table C-8 to select the required yield. For T (the thickness of the abutment), use the horizontal distance from the center of the ADM emplaced inside the chamber to the face of the wall adjacent to the backfill.

Demolition of bridge pier.

Emplacement. The best ADM emplacement position for pier demolition is at the base of the pier (table C-8, position 3). If this placement is not possible, place it as close to the base as is practicable.

Yield. Selection of a yield to destroy a pier depends on the width (B) of the pier. The combined effects of spall, vaporization, crushing, and plastic deformation will breach the pier thickness (T) if the ADM used produces a diameter of rupture zone in rock equal to the width (B) of the pier. Therefore, the pier width is the controlling dimension for selecting the yield.

DETERMINATION OF YIELD FOR ABUTMENT TOP OR PIER TOP DESTRUCTION

When destruction of the abutment or pier face cannot be accomplished, use the abutment or pier top option (table C-8, position 4). Placement is under the traveled way on top of a pier or abutment or, on an arch bridge, at the base of the arch rings on either the top of the pier or on the abutment shelf. For any of these situations, yield determination depends on the width of the pier top or abutment top. To determine yield, enter table C-8 with the pier or abutment top width (B), read width and up to the yield.

DETERMINATION OF YIELD FOR TRAVELED WAY DESTRUCTION

There are three placement positions on a roadway. These are directly over a pier (table C-8, position 4), directly over an abutment (table C-8, position 5), or at the midpoint of a span (table C-8, position 6). In all cases, the traveled way width (B) is the dimension of primary concern. Enter table C-8 with the traveled way width (B) and read up to obtain the yield.

EXAMPLE

Given

A bridge similar to the sketch in table C-8 is scheduled for destruction. Dimensions are as follows:

Abutment	
Width (B)	35 meters
Thickness (T) at 1/2 H	8 meters
Thickness (T) at base	12 meters
Pier	
Width (B)	30 meters
Traveled Way	
Width (B)	25 meters

Required

Find the ADM yield required at each of the emplacement positions (1 through 6).

Solution

1 Behind the abutment emplaced ½ H: B = 35 meters. T = 8 meters. There is no T = 8 meters. Therefore, read T = 5 meters (next lower thickness). Maximum width B = 37 for 0.05 KT ADM at T = 5 meters. Use 0.05 KT ADM.

2 Face of abutment: B = 35. T = 12 meters. B of 35 meters requires a yield of 0.5 KT; T of 12 meters requires a yield of 5.0 KT. The higher yield governs. Use 5 KT ADM.

3 Face of pier: B = 30 meters. Use 0.5 KT ADM.

4 Top of pier: B = 30 meters. Use 0.5 KT ADM.

5 Top of abutment: B = 35 meters. Use 0.5 KT ADM.

6 Traveled way: B = 25 meters. Use 0.5 KT ADM.

Answer

Position (1) 0.05 KT ADM

(2) 5.0 KT ADM

(3) 0.5 KT ADM

(4) 0.5 KT ADM

(5) 0.5 KT ADM

(6) 0.5 KT ADM

DAMS

ADM provide a capability for readily destroying large dams. One nuclear detonation can accomplish what could not have been done previously by hundreds of tons of TNT. In addition, the destruction potential is enhanced by the sudden release of large quantities of water below the dam.

Damage to power production equipment, turbines, and similar facilities is usually best accomplished by conventional explosives and, therefore, is not discussed in this manual. If ADM is considered appropriate for destruction of these facilities, use the blast criteria for industrial buildings. (See table C-1 and FM 101-31-2 [SRD].)

There are four types of dams: gravity, arch, buttress, and earth. The characteristics of each type require different methods of demolition. It is essential, therefore, for the target analyst to recognize basic dam types to obtain the best results from ADM employment.

GRAVITY AND ARCH DAMS

Gravity dams. Gravity dams are constructed of concrete or masonry and have massive cross sections. They often rise to heights of 150 meters or more. Because of the volume of material to be shattered, gravity dams are best breached by placement of the ADM in an inspection gallery. If more than one gallery exists, select the one which is lowest and nearest to the upstream face.

Arch dams. Arch dams are usually thin, relatively short in width, and comparatively high. They are constructed of masonry or concrete, usually in V-shaped gorges. The thinness of the cross section allows use of a smaller yield ADM than is required for the more massive gravity dams. Furthermore, the stability of an arch dam depends upon the arch abutments. For this reason, the dam is vulnerable to collapse from demolition of its abutments. The procedure for selection of ADM yields for demolition of arch dams is exactly the same as for gravity dams.

Emplacement positions. Table C-9 shows how to select an ADM yield to destroy a concrete gravity dam with emplacement at three locations.

Placement in an inspection gallery (position 1). The yields required to breach the distance (s) to the upstream face and the distance (t) to the downstream face are determined separately by using the appropriate width in table C-9. The larger of the two widths governs.

Placement on the upstream face of the dam (position 2). The water depth should be at least twice the distance to be breached or 15 meters (50 feet), whichever is smaller. The criterion of destruction is breaching the distance (r) to the downstream face of the dam.

Placement on the downstream face of the dam below the upstream water level (position 3). The destruction criterion is breaching the distance (q) to the upstream side of the dam.

EXAMPLE

Given

Destruction of a gravity arch dam similar to the one shown in table C-9 is being considered. Possible emplacement positions are the following:

- Placement in an inspection gallery that is 15 meters from the upstream face and 17 meters from the downstream face.
- Placement on the upstream face 15 meters below water level where the distance to the downstream face is 18 meters.
- Placement below the upstream water level on the downstream face, 30 meters below the crest of the dam, where the distance to the upstream face is 20 meters.

Required

Find the ADM required at each position.

Solution

- For position 1: from table C-9, for thickness s and t; the greater, t = 17, governs. Use 5 KT ADM.
- For position 2: from table C-9, for thickness r; r = 18. Use 0.1 KT ADM.
- For position 3: from table C-9, for thickness q; q = 20. Use 5 KT ADM.

BUTTRESS DAMS

Description. Hollow buttressed dams (table C-9) usually are a series of parallel, equidistant, concrete buttresses that support a watertight face, sloping upstream. All the structural elements of a buttress dam are constructed of reinforced concrete and generally are thinner than the structural components of either arch or gravity dams. If a buttress is destroyed, at least two spans of the dam will collapse. The emplacement positions shown in table C-9 are placement below the water level on the upstream face of the dam (position 4), placement below the water level on the downstream face of the dam (position 5), and placement in contact with the buttress itself (position 6).

If a buttress is destroyed, at least two spans of the dam will collapse.

Yield and emplacement. Since most of the structural components of a buttress dam are comparatively thin and therefore easily breached, the extent of the damage desired usually determines yield. If the intent is solely to release the impounded water, the upstream slab supported by the buttresses is easily breached. Refer to table C-9 to find the required ADM yield for emplacement on the upstream face of the slab (position 4) or on its downstream face (position 5). The same considerations used in analyzing gravity and arch dams are applicable. Since the buttress itself functions much like a bridge pier, yield determination for its destruction (position 6) follows the same procedure described for bridge piers beginning on page 6-17. Refer to table C-9 for determination of yield.

EARTH DAMS

Description. An earth dam is similar to an earthfill except that it contains an impervious core such as clay or it has a watertight blanket on the upstream face. The width of the crest of most earth dams is less than 40 feet (12 meters). The upstream and downstream slopes are seldom steeper than a horizontal-to-vertical ratio of 3 to 1 or 33 percent.

Yield and emplacement. Earth dams may be effectively destroyed by detonating an ADM beneath the crest or on its center. Detonation below the crest requires a smaller yield because of enhancement of cratering effects.

The objective is to produce a true crater large enough that an initial breach is at least 10 feet (3 meters) below the water level. This breach will allow a sufficient outflow of water so that erosion will complete destruction.

A method of yield determination. Use a drawing similar to the figure below to quickly determine the required yield for a surface burst, shallow depth of burst (DOB = 15 $W^{0.3}$ meters), and optimum depth of burst (DOB = 49 $W^{0.3}$ meters). This method may be used for crest widths up to and including 12 meters and for the slope ratios shown. ADM emplacement must be on or beneath the center of the crest.

Yield and depth of burst. To determine the yield and depth of burst to destroy any earth dam, draw a cross section of the dam to scale. Considering the ADM available and the emplacement capabilities, choose an ADM that will produce a crater which meets the criterion for destruction (breach 10 feet or 3 meters below water level). The choice is arrived at by trial and error starting with the lowest of the available yields. Plot the resultant crater to scale on the cross section drawing. Then draw a line from the true depth (H_T) to the radius R_A. At the point where this line intersects the upstream face of the dam, measure the distance to the water surface. This distance must be at least 3 meters. If it is less, make a second trial using either a higher yield or an increased depth of burst. Continue this process until the resultant crater is satisfactory. This method is valid only for ADM employment on or beneath the center of the crest.

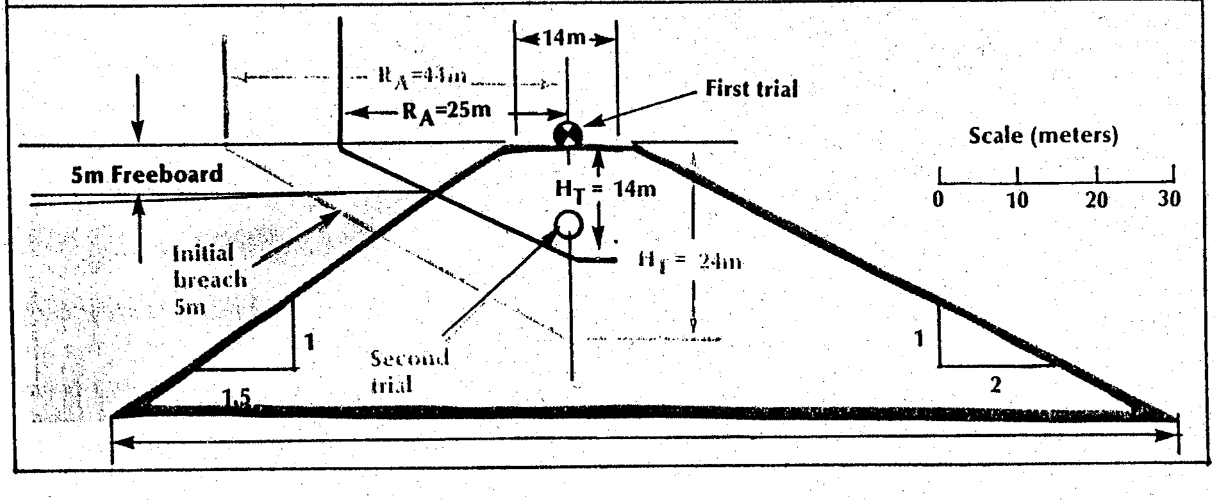
EXAMPLE

The following example illustrates the procedure outlined in the preceding paragraph.

Given

An earth dam is scheduled for demolition. Its cross section, plotted to scale, is shown below. Two ADM have been allocated, a 1 KT and a 5 KT. Fallout is not a limiting factor. Emplacement capabilities permit emplacement to a depth of 10 meters. The medium is wet soil.

GRAPHICAL SOLUTION TO EARTH DAM PROBLEM



Required

Find the yield and emplacement position required to destroy the dam.

Solution

The lower yield (1 KT) and the least difficult emplacement position (on the surface at the center of the crest) are considered first.

From table C-6, R_A for a 1 KT surface burst is 25 meters. H_T = DOB + 14 $W^{1/3}$ meters = 0 + 14(1) = 14 meters.

These values are plotted to scale on the dam cross section, and a line connecting them is drawn. The intersection of this line and the upstream face of the dam is just at the water level. Hence, this yield and emplacement position are inadequate.

In view of the known burst capability, a trial at a DOB of 10 meters is analyzed before going to a higher yield. From table C-6, a 1 KT burst at a DOB of 10 meters gives an R_A of 44 meters. H_T = 10 + 14 = 24 meters. Plotting these values shows that the initial breach will be 5 meters below water level. This breach meets the criterion for destruction of earth dams.

Answer

Use a 1 KT ADM emplaced 10 meters below the center of the crest.

EMPLACEMENT UPSTREAM FROM DAM

The breaches achieved with ADM placed at the previously discussed locations are produced primarily by the cratering effect of the blast. An upstream nuclear detonation with a crater radius that does not reach the dam can still cause its failure by hydrostatic pressure and shock waves. These effects may result in the overturning, sliding, or cracking of the structure. See DNA EM-1(S) for the effect of blast and shock on dams.

GATE BLOWOUT

Kinds of gates. An important function in the operation of any dam is the regulation of flow over or through the structure. In most cases, this is accomplished by spillway (flood) gates which regulate flow over the top of the structure and sluice gates which control the flow in tunnels through the dam. Some dams have only one type of outlet while others have both.

Spillway gates. Depending upon the design of the dam, spillway gates may extend along the entire dam or only along a small portion of its length. Spillway gates are usually the most vulnerable part of a dam. Although accessible taintor gates (common spillway gates) are usually more vulnerable to conventional demolition charges applied to the lower radial strut, they may also be blown out by a hydrostatic shock wave from an underwater nuclear detonation upstream. This gate blowout may be achieved without severe damage to the dam itself. The emplacement distance, of course, depends upon the size of the munition and the installation and strength of the gates. Other types of spillway gates may be affected similarly.

Sluice gates. Any nuclear detonation large enough and close enough to blow out sluice gates also causes cracking and probable failure of the dam itself.

DOWNSTREAM FLOOD

In any plan for destruction of a dam, one of the important considerations is the magnitude of the resulting flood. Many factors combine to determine the size and destructiveness of such a flood. A detailed system of analysis for flood prediction is beyond the scope of this manual. To obtain an accurate estimate of the extent of such a flood, a military hydrologist should analyze the actual conditions at and below the dam.

CANALS

Canals vary considerably in complexity. At one extreme is the single-level canal that is only slightly above sea level and requires no locks or lifts. At the other extreme is the multilevel canal which must raise ships over a terrain barrier. These canals have locks and gates, storage reservoirs, and pumps.

As a rule, the more complicated the system, the easier it is to put it out of operation, and the more difficult it is to repair. Because of the differences in canal size and construction, however, no specific directions for demolition are applicable to all. You must analyze each target individually to determine its vulnerable points.

Inland waterways and their auxiliary facilities are subject primarily to the effects of blast, cratering, hydrostatic pressure, and ground shock. In the selection and placement of an ADM to disrupt an inland navigation system, determine the principal effect and select an ADM of appropriate yield.

SINGLE-LEVEL CANALS

The single-level canal is the most difficult to put out of operation. Its relative invulnerability lies in its simplicity. It is a ditch connecting two natural bodies of water. Its water supply is inexhaustible, and no mechanism is required to regulate the water flow. The only practicable way to put a single-level canal out of service is to block it. Blocking may be done with varying degrees of success by earthslides or ships.

Blocking with earthslide. Blocking a canal with an earthslide is possible only in rare circumstances. The optimum conditions demand a soil with low cohesive strength and a relatively steep bank that is high enough to form a canal-blocking slide. Because cuts for canals are usually designed purposely to prevent slides, these conditions occur infrequently. However, when they do occur, see page 6-16 for the creation of landslides.

Blocking with sunken ships. Sinking of ships is an effective, expedient means to block a canal. Conventional explosives or other means of scuttling usually are used.

VARIABLE-LEVEL CANALS

Interdependence of functions. As a rule, the variable-level canal cannot be considered separately from its surroundings. It is probably part of a system which exploits one or more watersheds. In addition to navigable waterways, such a system may also provide power generation, water conservation, flood control, irrigation, and a channel for fish migration. Disruption of the facilities which permit navigation probably affects all the other functions as well.

Limiting damage to specific targets. If you want to damage only the navigational facilities and leave the remainder of the system intact, you must use extreme care.

Dams. In planning denial of a navigational system, remember the basic mission. To achieve the greatest possible damage, destruction of the dam which impounds the water for the system may be more profitable than an attack on the lock facilities. Destruction of the dam not only prevents navigation—even with all its other facilities intact—but also ends power generation, irrigation, and flood control. Additional damage may be done by the release of the impounded water. If the dam is the target, the data and methods presented on page 6-19 are used.

Locks. A lock is the most common system for raising or lowering vessels. To pass a vessel headed downstream, the lower gate is closed, and, by means of a system of valves and ducts, the lock chamber is filled with water. The vessel enters the chamber, and the upper gate is closed behind it. Through additional valves and ducts, the water is drained out of the chamber until the level is the same as the lower level of the canal. The lower gate is then opened, and the vessel can proceed. The lower gate must be the full height of the lock chamber. The upper gate need be only as high as the highest water level plus a safe margin for the deepest-draft vessel handled. Essential elements are the gates, lock chamber, operating machinery, and valves.

Machinery. When valves and machinery are the targets and limiting effects preclude the use of ADM, use conventional explosives. However, when the gates and chambers are targeted, no specific attention to valves and machinery is required. A nuclear explosion which damages the gates and chamber probably will damage this equipment as well.

Lock chambers. Lock chambers are generally constructed of concrete or masonry. To render a chamber unusable, select cratering as the governing effect. An ADM placed on the face of the end wall near the gate achieves the best results. Ground shock damage is considered a bonus.

Gates. Lock gates may be hinged at the side or bottom. They may slide vertically below the channel bottom or be raised above the channel. They may slide horizontally into the side walls or move on rails against the side walls. Gates are vulnerable to hydrostatic shock and dynamic pressures. Although they are designed to withstand static pressure, a large detonation exceeds the safety factor. The downstream gate is particularly vulnerable because its larger surface presents a greater area on which pressure can act. When the lock is full, the gate is loaded on the chamber side with the static pressure for which it was designed whereas the other side is virtually unsupported.

For maximum destruction, place an ADM underwater in the upstream end of the chamber near the upper gate or against the upstream chamber wall. Thereby the ADM destroys both gates and craters the chamber. For best results, the lock is full with all gates and valves closed at the time of detonation. If placed as recommended, any yield ADM will destroy the upper gate. Time or limited access may preclude optimum placement of the ADM. If so, considerable damage can be done to locks and gates by detonating an ADM near the facility.

A lock chamber may be equipped with more than one set of gates so that the length of the lock may be adjusted to the length of the vessel. Another feature frequently found is a gate upstream of the main gate so that the entire lock system may be drained for inspection and maintenance. For maximum effect, all gates and valves should be closed and the lock chamber filled during detonation.

Multiple locks. Locks frequently are built side by side to pass upstream and downstream traffic at the same time. To save water, adjacent chambers of double locks are usually connected so that the water drained from one can be run into the other until the levels are equal. The ducts connecting the chambers are good locations for placing a munition underground, thus destroying both chambers at once.

Parallel locks are not always adjacent; they are sometimes separated by water conservation basins. This separation may require a separate demolition in each lock chamber.

Lifts. A lift is a form of elevator which raises or lowers a large trough of water in which a ship is floating. Lifts may accomplish extreme changes in elevation. The ship moves into and out of the trough in much the same manner as it enters and leaves a lock. The lifting mechanism may be hydraulic or mechanical or a combination of both. The weight of the trough may be counterbalanced by using the same size of trough in a double lift. Both troughs are supported on hydraulic columns running in chambers interconnected by a system of floats or by counterweights.

Double hydraulic counterpoise lift. The double hydraulic counterpoise lift can be destroyed by an ADM placed so that the resultant crater breaches both cylinders.

Float counterpoise lift. The cratering action of an ADM placed on the surface at the foot of one of the towers will breach two of the float chambers and destroy the tower, thereby severely damaging the trough. The most critical components of the whole lift system are its elevating screws. Placement against a screw destroys at least one of them. The upstream tower is the preferred location. It may cause bonus damage to the upper canal and loss of water that results in flooding.

Pumps. Water generally flows through a lock system by gravity. Pumps are not essential to this operation. Where water is scarce, water may be pumped to a storage reservoir or to another lock rather than released to flow downstream. Destruction of these pumps prevents the conservation of water but does not completely prevent use of the locks.

When there is no natural water supply and the entire canal system is artificial, the pumps are vital. An ADM of any size temporarily disrupts the operation of a pumping station by destroying the building, controls, power lines, and other facilities. However, the items most difficult to replace are the pumps themselves. In a large pumping station, the pumps may be distributed so widely that one munition of reasonable yield will not sufficiently damage all of them. If so, conventional demolition charges applied to each pump are more efficient and practical.

Channels. When a canal is above the ground surface, it may be drained by blowing out one of the embankments. Use the same methods you use to breach an earthfill dam.

Aqueducts. Canals are particularly vulnerable where they cross roads, valleys, or other waterways on aqueducts. An aqueduct is nothing more than a bridge which carries water. Thus, destruction of an aqueduct is performed in the same manner as that of any bridge of similar construction.

TUNNELS

ADM can destroy or damage underground and underwater tunnels.

DAMAGE CRITERIA, UNDERGROUND TUNNELS

Blocking a tunnel with rock and debris for 30 meters is usually adequate for denial. There are two degrees of damage to a tunnel: severe and moderate.

Severe damage. A tunnel that requires standard tunneling procedures to repair is severely damaged. The volume of broken material varies from 80 to 100 percent of the volume of the original tunnel. Dislodged material completely fills the tunnel opening. The tunnel may sometimes be completely closed with solid rock. In absence of other guidance, 30 meters of severe damage is considered tunnel destruction.

Moderate damage. A tunnel that requires significant rehabilitation effort is moderately damaged. However, standard tunneling procedures may not be required. The tunnel is partially filled, and large amounts of broken material have to be removed. Floor heave may be extensive. The tunnel floor probably requires releveling before normal use by wheeled vehicles. A moderately damaged tunnel may be passable on foot without recovery work.

EMPLACEMENT POSITIONS FOR UNDERGROUND TUNNELS

Surface. An ADM may be placed on the surface of the ground above the tunnel. It is not necessary to place it directly over the tunnel, but it should be placed as close to the tunnel as possible. The distance from the ADM to the nearest tunnel wall (burst-to-tunnel distance) determines the required yield.

Underground. For purposes of tunnel destruction, an underground burst means one that occurs at a point below the ground surface but not within the tunnel. As an ADM is emplaced more deeply, more energy is transmitted to the earth, and the resultant ground shock increases. The required yield is a function of the burst-to-tunnel distance (BTD) and the depth of burst.

Burst offset from tunnel. ADM may be emplaced in shafts (adits) that lead off from the tunnel. To estimate damage, find in table C-6 the dimensions of an apparent crater in rock, using the offset distance as DOB. The estimated extent of damage to the tunnel floor is equal to the radius of the rupture zone (1.5 times the apparent crater radius). Completely stem the emplacement shaft with at least 1 meter of sandbags or similar material.

Burst on tunnel floor. To estimate the damage caused by a nuclear explosion in an open tunnel, follow the same procedure as for a burst offset from tunnel except that the offset distance is zero. The ADM should be placed at the tunnel wall to transmit energy to the medium more effectively.

YIELD DETERMINATION FOR UNDERGROUND TUNNELS

The first step is selection of the point at which the ADM is to be placed. Where possible, place an ADM far enough from the tunnel portals so that the desired damage is contained within the tunnel. If the tunnel length is too short, place an ADM at its midpoint. If the tunnel passes through a fault zone or similar nonstable geological conditions, additional damage may result.

Severe damage. Use table C-10 to find the yield required to produce 30 meters of severe damage from surface and underground bursts only. Enter the chart with the predetermined BTD, read across to the column with the proper DOB, and find the required yield.

Moderate damage. Use table C-10 also to find the yield required to produce 30 meters of moderate damage from surface and underground bursts and from bursts offset from the tunnel.

For surface and underground bursts, follow the same procedure as for severe damage with the correct columns.

For bursts offset from the tunnel, observe table C-10 notes to find the minimum yield.

EXAMPLE
(Surface emplacement.)

Given

Burst-to-tunnel distance (BTD) is 40 meters.

Required

Find the minimum ADM required to produce 30 meters of severe damage.

Solution

Use table C-10. Enter chart with BTD of 40 meters, read across to surface DOB (0), and extract a yield of 5.0 KT.

Answer

5.0 KT ADM.

EXAMPLE
(Underground emplacement.)

Given

Depth of burst is 10 meters. Burst-to-tunnel distance is 45 meters.

Required

Find the minimum ADM required to produce 30 meters of moderate damage.

Solution

Use table C-10. Enter chart with a BTD of 45 meters, read across to the 10-meter DOB column, and extract a yield of 0.5 KT.

Answer

0.5 KT ADM.

EXAMPLE
(Offset burst.)

Given

Offset distance of emplacement is 5 meters.

Required

Find the minimum ADM required to produce 30 meters of moderate damage.

Solution

Use table C-10. Enter with a BTD (offset distance) of 5 meters, read offset = 5 meters or larger, and extract a yield of 0.05 KT.

Answer

0.05 KT ADM.

DAMAGE CRITERION FOR UNDERWATER TUNNELS

Flooding is the damage desired to destroy an underwater tunnel. To achieve flooding, you must breach the tunnel casing and the overburden to allow water to force itself into the tunnel.

Rock overburden. If the tunnel is under rock, then the tunnel casing, which usually is reinforced concrete, and the overburden can be considered as the same material.

Other-than-rock overburden. This terminology is used for overburden of all kinds of soils that might be encountered on river or harbor bottoms: sand, clay, silt, muck, or any combination of these. Crater dimensions for a given yield in rock or concrete are about one half those in saturated soils. Therefore, when using table C-10, use one half the height of overburden (½ H_O).

EMPLACEMENT POSITIONS FOR UNDERWATER TUNNELS

Two emplacement positions are possible. Usually, the ADM is placed in the tunnel against the roof. However, lacking access to the tunnel, you may emplace an ADM on the river or harbor bottom directly over the tunnel.

YIELD DETERMINATION FOR UNDERWATER TUNNELS

Placement inside the tunnel. Placing an ADM in an underwater tunnel against the roof breaches the tunnel casing and the overburden in the same manner as an ADM emplaced on the face of a reinforced concrete abutment breaches the abutment. When using this method, use only the thickness (T) dimension on table C-8, position 2. $T = H_O + TC$ when overburden is rock. $T = ½H_O + TC$ when overburden is other than rock.

Placement on river or harbor bottom. This emplacement floods the tunnel by cratering action in the overburden. As the amount of overburden increases, rupture of the tunnel casing may be accomplished by spalling. To determine yield, first find the burst-to-tunnel distance. For underwater tunnels, this burst-to-tunnel distance is equal to the height of overburden (H_O) plus the thickness of the tunnel casing (TC). Determining the yield also takes into account the depth of burst or, in this case, depth of water. These computations are accomplished in table C-10 which gives burst-to-tunnel distances for varying depths of crater as a function of yield for rock overburden. Use the moderate damage table (table C-10) to find an ADM which in this case creates severe tunnel damage to underwater tunnels.

EXAMPLE

(Placement on river bottom with rock overburden.)

Given

Depth of water = 6 meters. Depth of rock overburden = 14 meters. Thickness of tunnel casing = 1 meter.

Required

Find the required yield.

Solution

Burst-to-tunnel distance = $H_O + T = 14 + 1 = 15$ meters. Enter table C-10 (moderate damage table) with BTD of 15 meters. Read across to DOB of 6 meters for a yield of 0.05 KT to produce severe damage.

EXAMPLE

(Placement on river bottom with other than rock overburden.)

Given

Depth of water = 6 meters. Depth of overburden = 15 meters. Thickness of tunnel casing = 1 meter.

Required

Find the required yield.

Solution

Burst-to-tunnel distance = $15/2 + 1 = 8.5$. Enter table C-10 with burst-to-tunnel distance of 8.5 meters. From table C-10, for a BTD < 15 meters, the minimum yield of 0.05 KT may be used.

AIRFIELDS

The most effective way to destroy the operational capabilities of an airfield is to demolish the runway complex. It is the single indispensable element of any field. Supporting facilities such as hangars, shops, warehouses, and communication equipment are not absolutely essential for emergency operations.

Since runway characteristics vary, the ADM emplacement locations to destroy a specific runway complex depend on the airfield size, layout, and importance.

EMPLACEMENT CRITERIA

Separation distances between ADM. The destruction of an airfield runway complex generally requires multiple-charge detonations. One of the most important factors to consider is the minimum separation distance between atomic demolition munitions required to prevent a detonation from damaging an adjacent munition. The safe separation distance of ADM in the hypothetical family for separately detonated surface bursts is 1,000 meters (3,300 feet). Occasionally, you can overcome the need for separation distances by detonating one device and returning at a later time to emplace and detonate the other. However, the level of radioactivity released to the atmosphere by the detonation of the first ADM would probably significantly limit return to emplace and detonate subsequent ADM.

Short- and long-term denial. The desired degree of destruction to supporting facilities and the runway complex is also important. Any ADM explosion on the runway denies immediate use of the airfield to nearly all aircraft because of local radioactivity levels and debris. For long-term denial, however, the analyst must find the most effective placement of ADM so that the maximum continuous length of undamaged runway is less than the length required for takeoff and landing of a given aircraft.

YIELD SELECTION

The yield required to crater a runway depends on the depth of burst of the ADM, the width of the runway, and the runway's subgrade material. The yield and depth of burst are selected so that the diameter of the rupture zone at the surface is at least equal to the runway width.

Surface emplacement. If the ADM cannot be emplaced beneath the runway or in drainage culverts or utility ducts under the runway, it must be detonated on the runway surface. For surface or near-surface detonations, concrete is the medium that determines crater dimensions. Use table C-6 determines crater dimensions. Use table C-6 to find the radius of rupture zone in dry rock for varying yields.

Subsurface emplacement. For subsurface detonations other than near-surface bursts, the concrete runway slab has little effect on the dimensions of the crater. The medium that determines yield for subsurface detonations, therefore, is the subgrade material. For analysis, assume it is similar to dry soil. Use table C-6 to find yields for shallow and optimum depth of burst in dry soil.

EXAMPLE

The following example illustrates the recommended procedure for determining yield requirements, depth of burst, and emplacement locations to demolish a runway.

Given

The figure on page 6-31 shows the layout of an airfield designed to handle heavy jet bombers. The objective of a demolition mission is to deny the use of the runway facilities to jet bombers and fighters. The maximum continuous length of undamaged runway which can remain after the accomplishment of the demolition mission is 4900 feet (1500 meters).

Required

Find the ADM yields and emplacement positions for detonation at the surface and at shallow and optimum depths of burst. For the subsurface detonations, determine the depth of burst. Assume a minimum separation distance of 3300 feet (1000 meters) for multiple ADM surface detonations.

Solution

Emplacement positions.

The location of the ADM on the runway complex is the same for surface and subsurface detonation. Analysis of the runway layout indicates that at least three ADM (shown at positions 1, 2, and 3 in the figure on page 6-31) are required to deny all runways. Detonations of ADM at positions 1 and 2 reduce the undamaged lengths of the main east-west runway and the north-south runway to less than 4900 feet. A detonation at position 3, together with the detonation at position 1, reduces the undamaged length of the southwest-northeast runway to less than 4900 feet.

Yield selection—surface detonations.

Positions 1 and 2: Width of east-west runway = 100 meters (governing width). Referring to table C-6 for a surface burst and a required radius of rupture zone of 50 (½ a crater diameter of 100 meters), find the yield required.

Answer: Use 5.0 KT.

Position 3: Width of southwest-northeast runway = 40 meters. Referring to table C-6 for surface burst and a required radius of rupture zone of 20 meters, find the yield required.

Answer: Use 1.0 KT.

Yield selection—subsurface detonations (10-meter DOB).

Positions 1 and 2: Width of east-west runway = 100 meters (governing width). Referring to table C-6 for a 10-meter DOB, and a required radius of rupture zone of 50, find the yield required.

Answer: Use 1.0 KT.

Position 3: Width of southwest-northeast runway = 40 meters. Referring to table C-6 for a 10-meter DOB and a required radius of rupture zone of 20, find the yield required.

Answer: Use 0.1 KT.

Yield selection—subsurface detonations (optimum DOB).

Positions 1 and 2: Width of east-west runway = 100 meters (governing width). Referring to table C-6 for optimum DOB and a required radius of rupture zone of 50 meters, find the yield required.

Answer: Use 0.1 KT.

Position 3: Width of southwest-northeast runway = 40 meters. Referring to table C-6 for optimum DOB and a required radius of rupture zone of 20 meters, find the yield required.

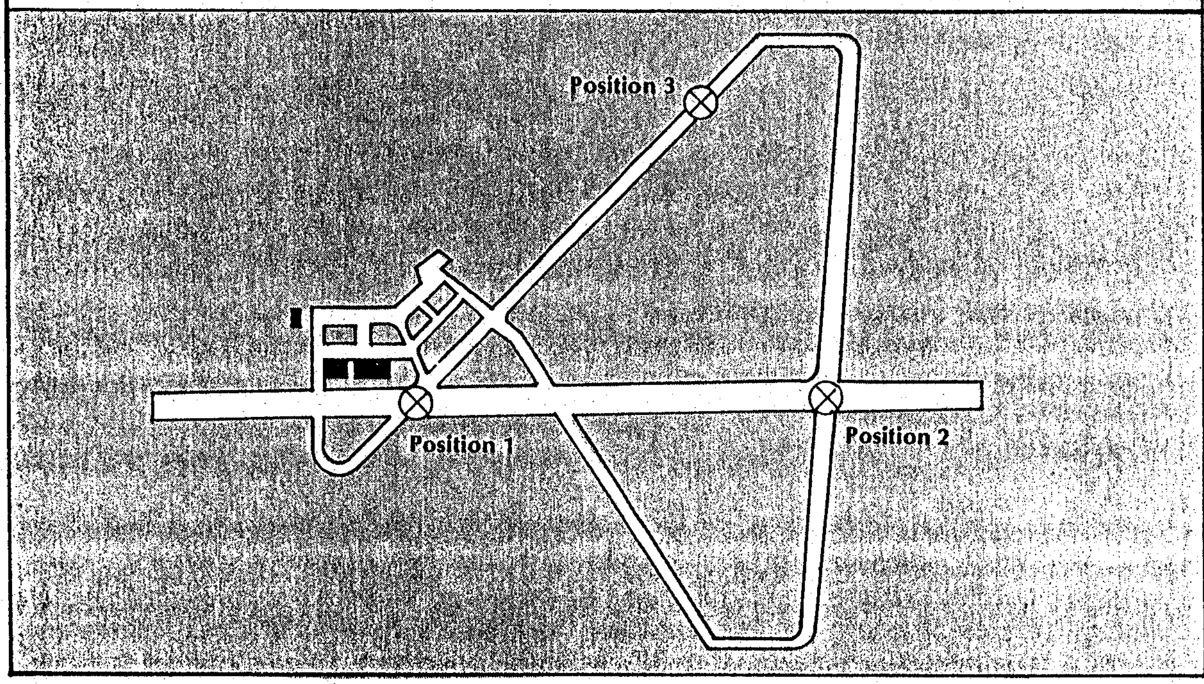
Answer: Use 0.1 KT.

Summary of yield requirements

This summary of yield requirements shows the advantage of subsurface emplacement. Furthermore, the radioactivity released from deep subsurface detonations is much less than from surface bursts. The radioactivity released to the atmosphere by subsurface detonation at optimum depth of burst is less than 15 percent of that released by a surface detonation of the same yield.

Position	1	2	3
Surface	5.0 KT	1.0 KT	1.0 KT
Subsurface			
10 meters DOB	1.0 KT	1.0 KT	0.1 KT
Optimum DOB	.05 KT	0.1 KT	0.1 KT

EXAMPLE OF ADM EMPLACEMENT POSITIONS ON AN AIRFIELD



Section IV—TARGETS DAMAGED BY THE AIR BLAST EFFECT

EFFECTS OTHER THAN CRATERING

Cratering for point targets is the main effect in the analysis techniques discussed in the preceding section. This section discusses other targets also appropriate for ADM attack in which cratering may not be the main effect. ADM have an extensive destruction capability. Moreover, target analysis is not complete until the target area is analyzed for contingent effects. To analyze target areas for the air blast effect, use either the visual or numerical method with the appropriate damage tables and contingent effects tables in appendix C.

ANALYSIS METHODS FOR AIR BLAST TARGETS

DETERMINATION OF RADIUS OF DAMAGE

Radius of damage. Before you can visually estimate the fractional coverage (f) of a target, you must determine the radius of damage (RD). To do this, use the air blast damage radii tables (tables C-1 through C-4). These tables contain the RD for buildings, bridges, field fortifications, and military field equipment. Enter the table with the appropriate target description, ADM yield, and degree of damage (moderate or severe) specified, and extract the RD.

Correction for subsurface bursts. Subsurface bursts require correction of the RD. To do this, enter the air blast radii reduction distance table (table C-5) with the DOB and ADM yield. Extract the air blast radii reduction distance. Add the reduction factor to or subtract it from the RD as shown in the following discussion and examples. The result will be the corrected RD for the subsurface burst. If the reduction distance is greater than the air blast damage radii or if it is shown as a blank, consider the RD to be zero.

AREA TARGETS

Visual method.

Damage estimation. The visual method of damage estimation may be used for any shape of target. It is the only damage estimation method for area targets that cannot be equated to a circle (length ≧ twice width). With the visual method, find f by using a transparent circular map scale inscribed with circles and arcs at 100- or 200-meter intervals or by using a compass. First, extract the RD from the air blast damage radii tables (tables C-1 through C-4). Reduce the RD for subsurface emplacement. With a compass, draw the RD on the scaled target with the center at ground zero. Visually estimate the fraction of the target area covered.

A communications complex. The commander desires severe damage to the open grid radar antennas. The target is 1600 by 600 meters.

Determine the fractional coverage (f) produced by a 1.0 KT ADM detonated on the surface.

Enter table C-4 and extract an RD of 508 meters. Draw this RD on the scaled target over GZ. Estimate the percent of the target area covered. (See figure on page 6-33.)

f = 60 percent

Yield selection. Use the visual method of yield selection when the commander gives the fractional coverage of the target area and

Yield selection. The numerical technique i
also used to determine the minimum yie
required. First, enter the area target gra
with the d/RT ratio at the bottom and m
up the graph to the required percent cover
line. Then move across to the left side o
graph and extract an RD/RT ratio. The
step is to calculate the required RD nece
to achieve the desired results. Multip
RD/RT ratio by the target radius (RT
RD/RT x RT) Enter the appropriate a
damage table (C-1—C-4) with RD to s
minimum yield. Correct the RD fo
surface burst by adding the reducti
from table C-5. Recheck the air bla
radii table for minimum yield.

EXAMPLE

(Numerical method)

Given

The objective is moderate
percent of the railroad car
railway marshaling yard.
the target is 260 meters.

For tactical reasons, the clo
position is located 40 m
center.

Assume a worst case of

Requ

Find the minimum yi
above requirements.

So

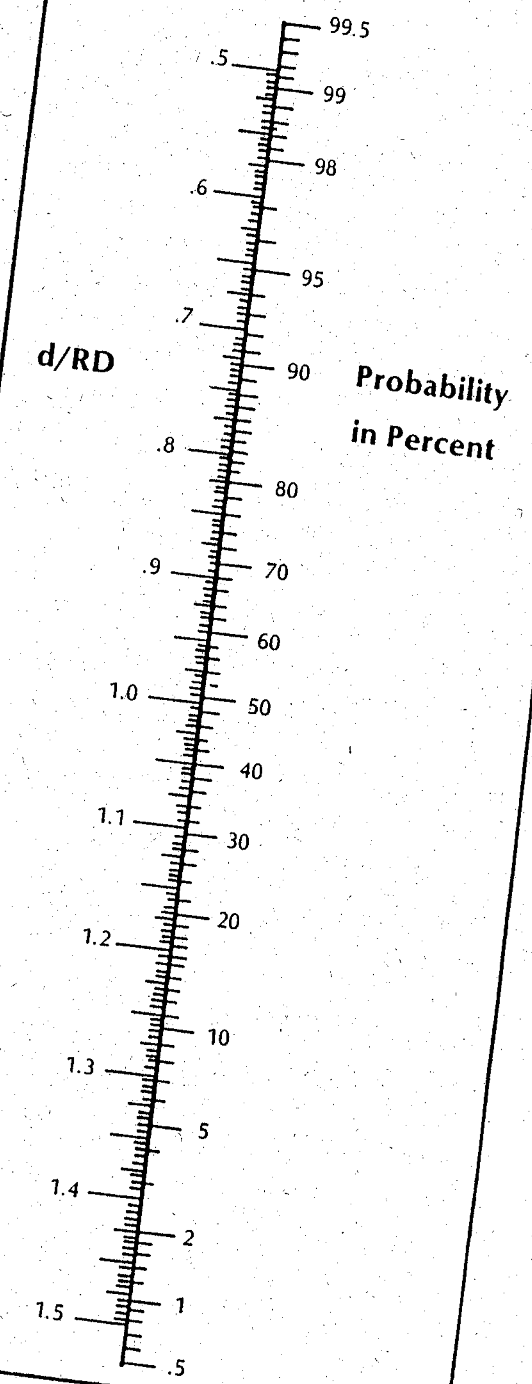
RT = 260/2 = 130 m

From the area ta
d/RT = 40/130 =
0.62

RD = 0.62 (RT) =

From table C-4,
meters.

Point Target Graph Extension



Required

Determine the final probability of severely damaging the bridge with a 5.0 KT ADM.

Solution

RD = 442, d = 100 meters, d/RD = 100/442 = 0.23. Enter point target graph extension with d/RD = 0.23 on the left scale to extract the probability on the right scale. Since the d/RD ratio is less than any value shown, the probability is greater than 0.995 (99.5 percent) of severely damaging the bridge.

Answer

P = 99.5 percent.

Yield selection. Enter the point target graph extension with the desired probability (P), and extract a d/RD ratio. Next, calculate the RD needed to achieve the desired damage. Obtain this by dividing the displacement distance (d) by the d/RD ratio (RD = d: d/RD) After you have calculated the required RD, enter the air blast damage radii tables, and extract the minimum yield that has an RD equal to or greater than the required RD. If a subsurface burst is desired, use table C-5 to find the reduction factor and add it to the RD. Recheck the air blast damage radii table for minimum yield.

EXAMPLE

(Yield selection for point targets)

Given

The commander desires a 90 percent probability of causing severe damage to oil storage tanks (supply dump). The storage tanks are located 100 meters from ground zero.

Required

Determine the minimum surface-burst ADM yield which meets the commander's guidance.

Solution

Enter point target graph extension with P = 90.

Extract a d/RD ratio of 0.73.

Displacement distance is 100 meters.

Calculate the required RD using the equation

$$RD = \frac{d}{d/RD}$$

RD = d/0.73 = 100/0.73 = 137 meters.

Enter table C-4 with the required RD to determine the yield. Moving across from supply dumps (severe damage), you find that a 5 KT is the minimum yield that will meet the commander's guidance.

Answer

5 KT.

RAILROAD MARSHALING YARDS

A railroad marshaling yard is an area target susceptible to blast as well as cratering effects. Repair facilities, roundhouses, engine sheds, and rolling stock are damaged primarily by blast while turntables and switching facilities are most effectively damaged by cratering. Depth of crater in a railroad yard is less important than width since any significant disruption of the rails requires major rehabilitation. Blast damage criteria for various yields are shown in the air blast damage radii tables (tables C-1 through C-5). Cratering data may be obtained from the crater dimensions table (table C-6).

PORTS

There are two methods by which port facilities when the length is greater than or equal to twice the width. The first step is to center a circular map scale over the desired ground zero (DGZ) of the target sketch. Next, visually estimate the radius of damage (RD) required to achieve the desired fractional coverage (f). Finally, select from tables C-1—C-4 the minimum yield which has an RD equal to or greater than the required RD. For subsurface bursts, correct the RD by adding the reduction factor from table C-5. Recheck the air blast damage radii table for minimum yield.

Numerical method.

Damage estimation. On area targets of approximately circular shape (length < twice width), use the numerical method to determine fractional coverage. The numerical method is more accurate than the visual

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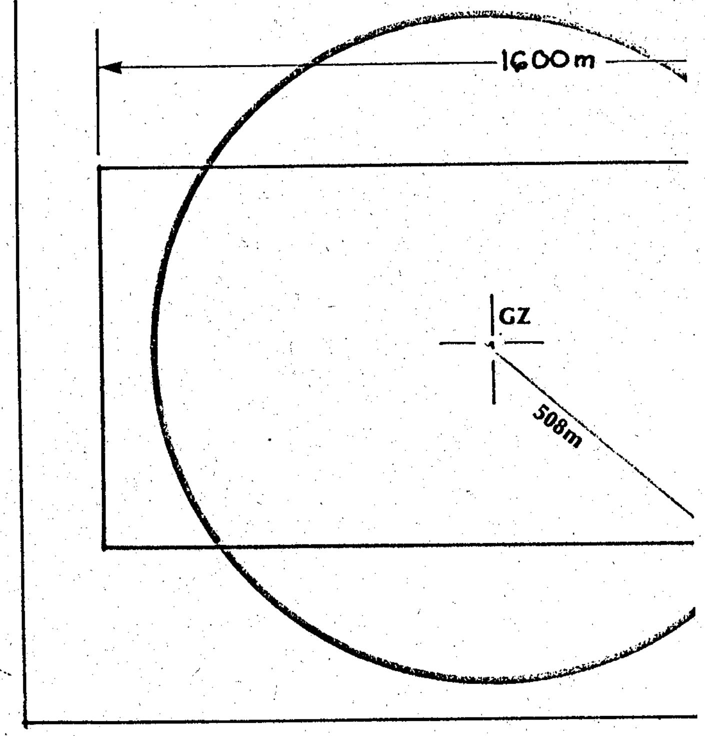
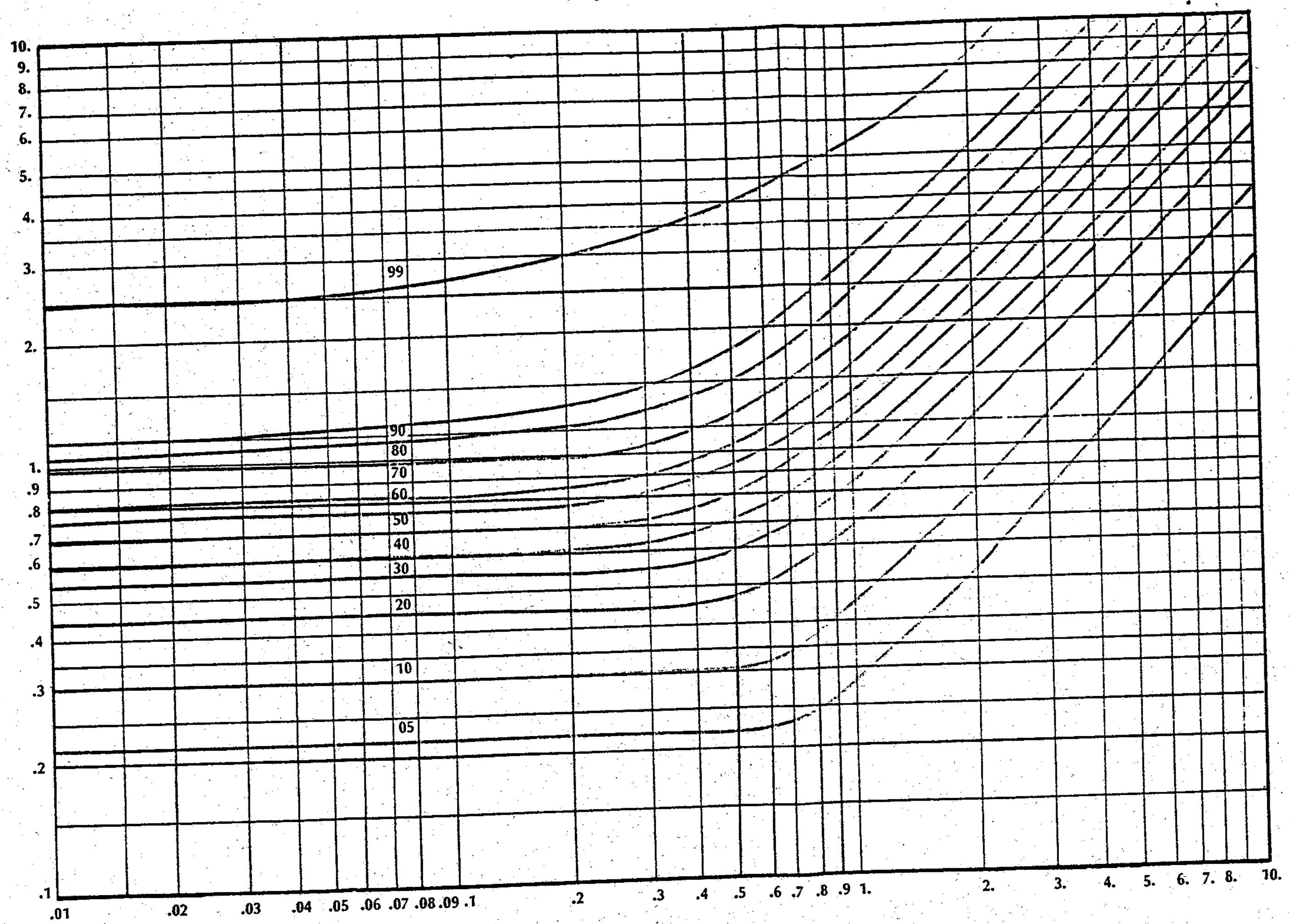
EXAMPLE OF VISUAL METHOD OF



AREA TARGET GRAPH
(expected coverage)



- For subsurface emplacement, subtract the reduction factor from the RD.
- Calculate RD/RT and d/RT ratios. If DGZ is at target center, d/RT = 0.
- Enter the area target coverage graph with the ratios found above. Read fractional coverage (f) using the curved lines. Visually interpolate if necessary. If d/RT = 0, use left axis of the graph (d/RT = .01).

EXAMPLE
(Numerical method)

Given

A group of oil storage tanks (supply dump) in an area 500 meters in diameter is scheduled for destruction with ADM. The only available yield is a 5.0 KT ADM. Severe damage is required. Analyze the target with DGZ at target center and with DGZ located 125 meters from target center.

Required

Find the fractional coverage of the target.

Solution

RT = 250 meters

From table C-4, RD (severe) = 243 meters

When DGZ is at target center:
RD/RT = 243/250 = 0.97; d/RT = 0

When DGZ is displaced 125 meters:
RD/RT = 0.97; d/RT = 125/250 = 0.5

From the area target coverage graph, f = 87 percent (d = 0) and f = 62 percent (d = 125 meters)

Answer

Fractional coverage is 87 percent with DGZ at target center. Fractional coverage is 62 percent with DGZ displaced 125 meters.

may be denied. The first is to use one or more large-yield ADM to demolish the entire port as an area target. The second method is to employ a number of small-yield ADM to destroy key port installations. The method of employment depends, of course, on the layout and size of the port and the number and type of ADM available.

SINGLE-TARGET METHOD

If you use one or more large-yield ADM to attack the entire port as an area target, many of the most essential facilities, such as wharves and tidal locks, will remain largely undamaged. Above-ground structures and equipment susceptible to blast and thermal effects will be damaged in accordance with the yield and their distance from ground zero. Fires, mostly of secondary origin, will contribute to destruction. Since this method of attack destroys only those facilities near ground zero, it will hinder but not completely deny the use of a large port. The principal advantages of this method are the economy of ADM employed and the short time and little effort required for preparation.

MULTIPLE-TARGET METHOD.

If you choose the second method, you can demolish key harbor installations with a number of relatively small-yield ADM consistent with separation distances and selectively emplaced. Some of these key facilities, such as the road and rail network serving the port, have already been discussed. The following text concerns only those facilities peculiar to port operations.

Wharves are essential. Destruction of all the wharfage completely denies the use of the port for an extended period. However, total destruction requires the use of numerous ADM and extensive emplacement effort. There are two general types of wharf construction: deck docks supported by piles, which are susceptible to blast and thermal effects; and quay walls made from concrete or masonry, which are best attacked by cratering in the ways prescribed for concrete dams or bridges.

In some ports, tidal locks are necessary to maintain an adequate depth of water in the harbor. Such facilities are attacked in a fashion similar to that prescribed for canal locks.

Breakwaters are frequently necessary to protect wharf areas from waves. Creating a large gap in a breakwater will hinder operations at the wharves but will rarely deny use of any of them. If you desire to breach breakwaters, however, use techniques similar to those prescribed for breaching gravity dams.

Ship repair facilities are destroyed in the same ways as are industrial plants. Methods of destroying drydocks, however, are comparable to the techniques prescribed for canal locks.

RADIATION HAZARD

Only destruction of the wharves can deny a port for an extended period of time. However, wharf demolition generally requires a large number of ADM and may result in overdestruction in the port area and a radiation hazard to the surrounding population.

INDUSTRIAL PLANTS AND POWER FACILITIES

The use of ADM permits rapid and long-term denial of industrial and power installations. However, such plants are usually located in or near heavily populated areas. As a consequence, it may be necessary to limit destruction and confine radiation. Analyze each industrial facility separately to determine the best method of denial. You may select one relatively large-yield ADM to destroy the entire facility or smaller ADM, consistent with safe separation distances, to destroy critical portions of it. In either event, the primary nuclear effect is generally blast overpressure.

AREA TARGET TECHNIQUE

The area target technique requires the selection of a yield which insures moderate to severe damage for the entire installation area. You can reduce residual radiation in the surrounding area by placing the ADM on a tall structure with little mass, such as a smokestack.

SELECTIVE DESTRUCTION TECHNIQUES

With selective destruction techniques, the most important elements or areas of the plant are chosen for destruction. If the installation has its own power plant and if substitute power is not readily available, destruction of the power plant denies use of the entire facility. Other elements that may be crucial are the blast furnaces in a steel mill or the cracking plant in a petroleum refinery. However, before employing ADM against targets of this type, consider the use of conventional demolitions.

BRIDGES

Steel truss and floating bridges are particularly vulnerable to destruction by the blast effects of ADM. To use the blast effect, position the ADM so that the blast wave impacts side-on to the bridge. Radii of damage by blast to steel truss and floating bridges are given in table C-2.

Section V—LIMITING REQUIREMENTS

TROOP SAFETY

DEFINITIONS

The detonation of an ADM has injury-producing effects which must be considered for the safety of friendly personnel. These are nuclear radiation, thermal radiation, blast, ground shock, base surge, and missiling. A minimum safe distance (MSD), also called radii of safety, is the minimum distance from GZ at which there is 99 percent assurance a specific degree of risk and vulnerability will not be exceeded. The MSD is a measure of the distance to which certain nuclear effects extend. The target analyst uses the MSD to make troop safety calculations. The following terms (defined in chapter 2, beginning on page 2-15) are used in determining the appropriate MSD:

Three degrees of risk considered in troop safety are negligible, moderate, and emergency. The degree of risk is based upon the commander's guidance.

Three categories of vulnerability of the individual soldier are unwarned and exposed, warned and exposed, and warned and protected.

MSD DETERMINATION

The distance to which troops will evacuate depends upon the yield, depth of burst, degree of risk, and vulnerability category. To extract MSD, enter table C-11 with the appropriate yield and DOB. In table C-11, find the correct column for troop vulnerability and risk criteria. Project horizontally from the DOB to extract the MSD in meters. If depth of burst falls between two listed depths of burst, find the MSD for both and use the larger.

COLLATERAL DAMAGE

Collateral damage is undesirable damage to civilian material and facilities or undesirable injuries to the civilian population produced by the effects of friendly nuclear weapons. While the overall goal is to limit collateral damage, a balance between collateral damage constraints and military effectiveness is necessary for successful operations. Determination of collateral damage constraints is a command responsibility. If not determined by national or theater commands, collateral damage constraint levels will normally be the responsibility of the corps commander. Often the need for target coverage or probability can be met while still avoiding collateral damage. Some ways to reduce collateral damage are to—

- Invoke civil defense measures.
- Adjust depth of burst.
- Move ground zero.

Should the target analyst move the location of ground zero or adjust the depth of burst, the analyst must reanalyze the target to meet the commander's guidance for target destruction (that is, fractional coverage, probability, and obstacle size).

PRECLUSION OF DAMAGE

GUIDELINES

Not causing damage to nearby civilian personnel, structures, facilities, or property is a concern of the target analyst. The commander normally wishes to prevent as much collateral damage as possible. Usually a 5 percent incidence of casualties and of moderate structural damage at the edge of populated areas is acceptable. Since it would be unrealistic to tabulate every possible personnel protective posture and structure type, representative personnel categories and structure types are used. Table C-18 of this manual and the appropriate table in FM 101-31-2 show collateral damage avoidance distances for representative population categories and structures. Blocks 10 and 11 of the ADM Target Analysis sheet on page 6-8 refer to collateral damage. A determination of safe or unsafe must be made in each case based on the actual distance that civilian personnel and facilities are from ground zero compared to the respective distances recommended in the tables.

COLLATERAL PERSONNEL INJURY DETERMINATION

Block 10 of the ADM Target Analysis sheet refers to collateral personnel injury. To determine a safety distance, a degree of risk must be found. The degree of risk is recorded as a 1, 2½, or 5 percent (negligible, moderate, or emergency risk, respectively) incidence of casualties. For peacetime planning, use the degree of risk specified in the SOP or the ADM annex of the Corps operations plan. Table C-18, Radii of Safety for Collateral Damage, shows personnel injury distances for 5 percent casualties. To use this table, find the yield of the munition and then select the column for the appropriate personnel category (i.e., personnel in urban, rural, or open areas). Enter the DOB column, and read across until you reach the column selected. Extract the distance given in meters. If the actual DOB falls between two listed DOBs, extract the safety distances for both and use the larger. In the event that a commander selects a lesser incidence of injury to civilian personnel (namely, 1 or 2½ percent) determine the safety distance using Table C-11, Radii of Safety. In this case, civilians in open, rural, or urban areas are equated to the unwarned exposed, warned exposed, and warned protected categories of troop vulnerability respectively. Enter Table C-11 with the yield, vulnerability category, and degree of risk at the top and the DOB in the left-hand column. Extract the safety distance.

EXAMPLE

Given

The commander wishes to preclude greater than 5 percent incidence of injury to civilian personnel in the open. You are using a .05 KT system and have a 12-meter DOB.

Required

What is the collateral personnel injury distance?

Solution

Use table C-18 for a 0.05 KT yield. Find the column headed "Personnel Categories, Open." Enter DOB column for both the 10-meter and 15-meter DOB. Select the larger radii.

Answer

Collateral personnel injury distance is 708 meters.

EXAMPLE

Given

The commander wishes to preclude greater than 1 percent incidence of injury to civilian personnel in the open. You are using a 0.01 KT system and have a 1-meter DOB.

Required

What is the collateral personnel injury distance?

Solution

Use table C-11 for a 0.01 KT yield. Equate civilian personnel in the open to the unwarned exposed vulnerability category. Find the columns headed "Unwarned, Exposed" and, under that heading, "NEG RISK" (negligible risk). Enter the DOB column for 1-meter DOB. Extract the safety distance.

Answer

Collateral personnel injury distance is 230 meters.

COLLATERAL MATERIAL DAMAGE DETERMINATION

Table C-18, is used to determine collateral material damage distances. To determine this distance, enter the table with the yield and type of facility at the top and the DOB in the left-hand column. Extract the collateral material damage distance (CDD). If the actual DOB falls between two listed DOBs, extract the CDD for both and use the larger.

EXAMPLE

Given

The commander wishes to preclude collateral damage to light steel frame industrial buildings. You are using a 0.1 KT system at a 3-meter DOB.

Required

What is the collateral material damage distance?

Solution

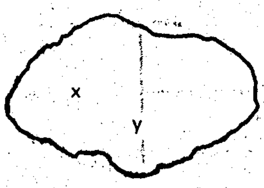
Use table C-18 for a 0.1 KT yield. Find the column for light steel frame industrial buildings (Lt Steel Indus Bldg). Enter DOB column at 3-meters. Extract the CDD.

Answer

Collateral material damage distance is 180 meters.

Conversion of Elliptical Targets to Circles of Equivalent Area

1. For determination of radius (RT) of circle of area equivalent to area of ellipse of longer axis (x) and shorter axis (y).



2. Use only when x ÷ y is less than 2.

EXAMPLE

1. Given: Elliptical target with x=2500 meters and y=1600 meters.

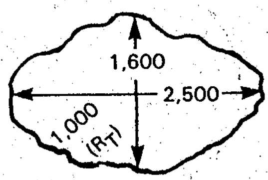
2. Find: RT for circle of equivalent area.

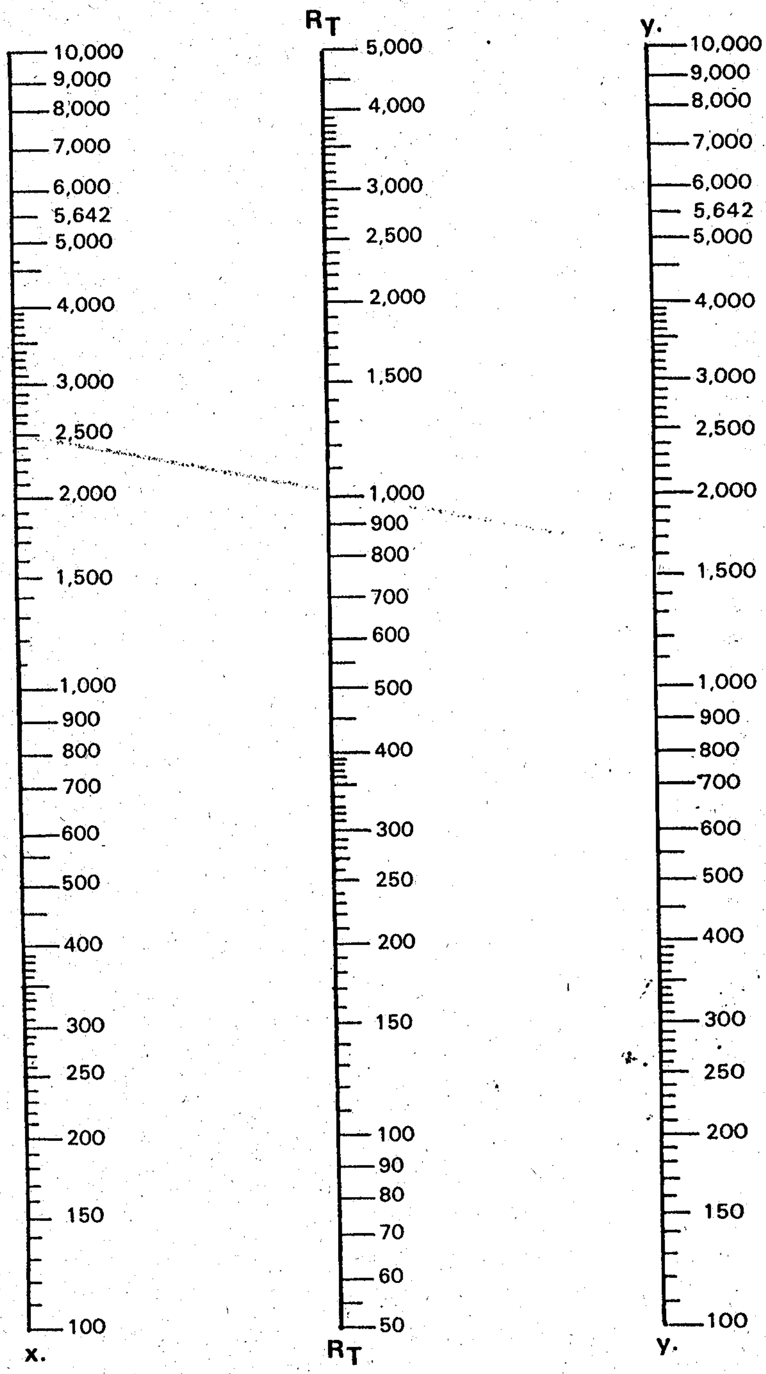
3. Method:

   a. x ÷ y is less than 2. Therefore, the conversion nomogram may be used.

   b. Placing a straight edge to intersect 2500 on the x scale and 1600 on the scale, determine the point of intersection with RT scale.

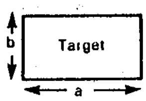
   c. At the intersection with the RT scale read RT=1000 meters.





CONVERSION OF RECTANGULAR TARGETS TO CIRCLES OF EQUIVALENT AREA

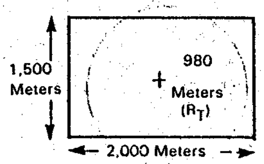
1. For determination of radius (RT) of circle of area equivalent to area of rectangle of larger side (a) and smaller side (b).

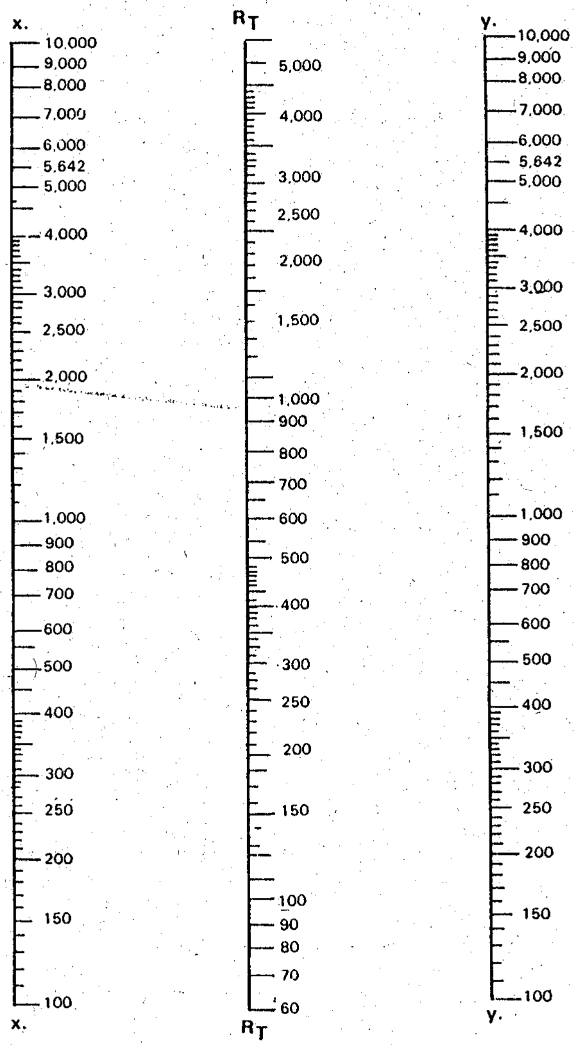


2. Use only when a ÷ b is less than 2.

EXAMPLE

1. Given: Rectangular target with a=2000 meters and b=1500 meters.
2. Find: RT for circle of equivalent area.
3. Method:
   a. a ÷ b is less than 2. Therefore, the conversion nomogram may be used.
   b. Placing a straight edge to intersect 2000 on the a scale and 1500 on the b scale, determine the point of intersection with RT scale.
   c. At the intersection with the RT scale read RT=980 meters.





APPENDIX A

REFERENCES

REQUIRED REFERENCES
Field Manuals

FM 3-22	Fallout Prediction
FM 5-100(HTF)	Engineer Combat Operations (How to Fight)
FM 100-50	Operations for Nuclear-Capable Units
FM 101-31-1	Staff Officers' Field Manual: Nuclear Weapons Employment Doctrine and Procedures
FM 101-31-2	(SRD) Staff Officers' Field Manual: Nuclear Weapons Employment Effects Data (U)
FM 101-31-3	Staff Officers' Field Manual: Nuclear Weapons Employment Effects Data

RELATED REFERENCES
Army Regulations

AR 50-5	Nuclear Surety
AR 50-106	(C) Safety Rules for Operations with the Medium Atomic Demolition Munition (MADM)
AR 50-107	(O) Safety Rules for Operations with the Special Atomic Demolition Munition (SADM)
AR 55-203	Movement of Nuclear Weapons, Nuclear Components and Related Classified Nonnuclear Materiel
AR 70-60	Army Nuclear Survivability
AR 380-5	Department of the Army Information Security Program
(C) AR 380-10	Department of the Army Policy for Disclosure of Military Information to Foreign Governments (U)
AR 380-150	Access To and Dissemination of Restricted Data
AR 604-5	Clearance of Personnel for Access to Classified Defense Information and Material

AR 700-65	Nuclear Weapons and Nuclear Weapons Materiel

RELATED REFERENCES
Field Manuals

FM 3-12	Operational Aspects of Radiological Defense
FM 3-15	Nuclear Accident Contamination Control
FM 3-22	Fallout Prediction
FM 3-87 (HTF)	Nuclear, Biological, and Chemical (NBC) Reconnaissance and Decontamination Operations
FM 5-25	Explosives and Demolitions
FM 5-30	Engineer Intelligence
FM 5-36	Route Reconnaissance and Classification
FM 6-20 (HTF)	Fire Support in Combined Arms Operations
FM 19-30	Physical Security
FM 21-30	Military Symbols
FM 21-40	NBC (Nuclear, Biological and Chemical) Defense
FM 24-18	Field Radio Techniques
FM 27-10	The Law of Land Warfare
FM 30-10	Military Geographic Intelligence (Terrain)
FM 55-205	Air Transport Procedures: Transport of XM129 and XM159 Atomic Demolition Charges by US Army Helicopters
FM 55-226	Air Transport Procedures: Transport of the W45-3 Warhead in Container, H-815, for Medium Atomic Demolition Munition (MADM) by US Army Helicopters
FM 71-100 (HTF)	Armored and Mechanized Division Operations
FM 100-5 (HTF)	Operations (How to Fight)

FM 105-5	Maneuver Control

RELATED REFERENCES
Technical Manuals

TM 3-220	Chemical, Biological and Radiological (CBR) Decontamination
TM 9-1100-205-10	(CRD) Operator's Manual: XM129 and XM159 Atomic Demolition Charges (U)
TM 9-1100-205-20	(CRD) Organizational Maintenance Manual: XM129 and XM159 Atomic Demolition Charge: XM130 Training Atomic Demolition Charge (U)
TM 9-1100-205-20P	Organizational Maintenance Repair Parts and Special Tools List (Illustrated Parts Breakdown): XM129E1, XM129E2, XM159E1, and XM159E2 Atomic Demolition Charge: XM130E1 Training Atomic Demolition Charge
TM 9-1100-226-10	Operator's Manual for M172 and M175 Atomic Demolition Charges: XM3 and M4 Coder-Transmitters
TM 9-1100-226-20	(CFRD) Organizational Maintenance Manual: M172 and M175 Atomic Demolition Charge: XM3 and M4 Coder-Transmitter (U)
TM 9-1100-226-20P	(C) Organizational Maintenance Repair Parts and Special Tool Lists (Illustrated Parts Breakdown): M167, M172 and M175 Atomic Demolition Charge: XM3 and M4 Coder-Transmitters (U)
TM 9-1100-227-12	Operator's and Organizational Maintenance (Prefire Procedures for Employment) for XM-15 Atomic Demolition Charge Training Equipment
TM 9-1100-227-20P	Organizational Maintenance Repair Parts and Special Tool Lists (Illustrated Parts Breakdown): XM15 Atomic Demolition Charge Training Equipment
TM 9-1300-206	Ammunition and Explosives Standards
TM 39-50-8	(CRD) Emergency Destruction of Nuclear Weapons

RELATED REFERENCES
Other Publications

DOD Reg 5200.1-R	Information Security Program Regulation
JCS Pub 13, Vol 1	(S) Policies and Procedures Governing the Authentication and Safeguarding of Nuclear Control Orders (U)
JCS Pub 13, Vol 2	(SFRD) Policy and Procedures Governing the Permissive Action Link/Coded Switch Cipher System (U)
(S) DNA EM-1	Capabilities of Nuclear Weapons (This publication is available from Defense Technical Information Center, Cameron Station, Alexandria, VA 22314, with a letter giving justification for the request or a completed DTIC Form 55.)
DA Pam 50-3	The Effects of Nuclear Weapons
TB 9-1100-803-15	Army Nuclear Weapons Equipment Records and Reporting Procedures
TB 385-2	Nuclear Weapons Firefighting Procedures
ARTEP 5-57	Engineer Atomic Demolition Munition (ADM) Units
TOE 5-57H5	Engineer Atomic Demolition Munitions Company (Corps)
TOE 5-57OH2	Engineer Combat Support Teams

To obtain the following publications, write the Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA, 19120.

STANAG 2130	Employment of Atomic Demolition Munitions
STANAG 2139	Atomic Demolition Munitions (ADM) Operations Order

To obtain DA Forms 3065, 3065-1, and 3065-2, write ATZA-PAA-A, Fort Belvoir, Virginia, 22060. They are not stocked at The AG Publications Center in Baltimore, Maryland, and are available only at the above address.

Appendix B

TIMER CALCULATIONS

NEED FOR ACCURACY

Accurate timer calculations are essential to insure control and safety during an ADM mission which uses a timer option. Moreover, it is important to precisely determine and record the time of detonation for the protection of recovery or disarming personnel. Timers may be the primary means of detonation. When timers are used, it is **not** possible to state that an ADM will fire at a specific time. There is always a time span or **span of detonation.**

DEFINITIONS OF TERMS

Span of detonation is that total time period between the earliest possible time of detonation and the latest possible time of detonation. This time span is caused by the integral timer error.

Early time hour is the earliest possible time that the munition can detonate with inclusion of timer error.

Late time hour, similarly, is the latest possible time that the munition can detonate.

Fire time hour is that time when the munition would detonate if the timer functions with no error. In other words, fire time hour is the date-time group resulting from the addition of the time period set on the timer to the time of day the timer is started. Fire time hour falls between early time hour and late time hour.

Starting time hour is the point in time (date-time group) that the timer is started.

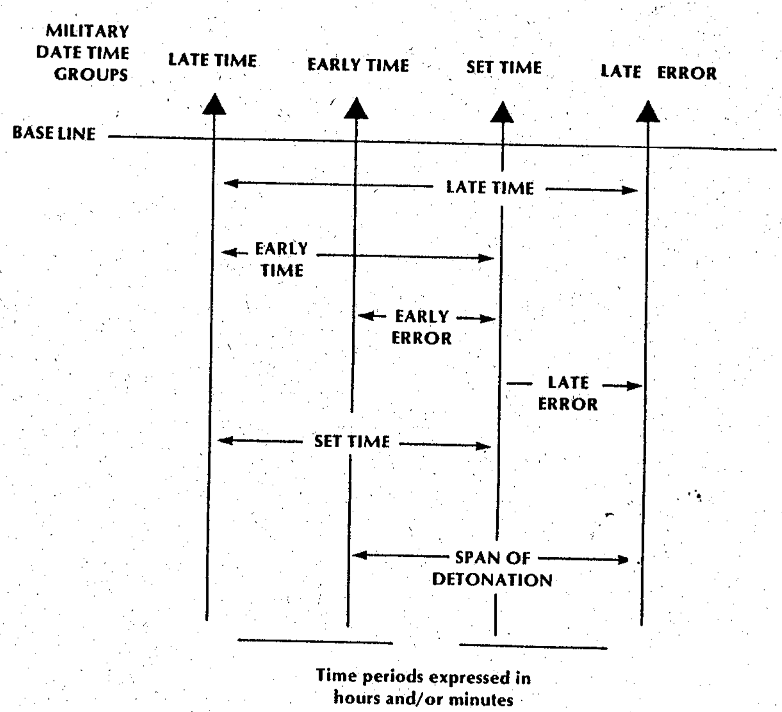
Set time is the time period that is actually set on the timer. It encompasses the entire period from starting time hour to fire time hour. This term is used interchangeably with **fire time.**

Early error is the time period between early time hour and fire time hour.

Late error is the time period between late time hour and fire time hour.

See the figure below for these time relationships and the tables that follow for early and late error times for the MADM and SADM at various timer settings.

TIMER CALCULATION PROBLEM-SOLVING FORMAT



MADM Timer Table

TIMER SETTING min = minute(s), hr = hour(s) TIMER ERROR

Set (Fire) Time	Early Error Set time minus	Late Error Set time plus	Span
00 hr 07 min thru 00 hr 29 m (000007 thru 000029)	1 min	1 min	2 min
00 hr 30 min thru 00 hr 59 min (000030 thru 000059)	2 min	2 min	4 min
01 hr 00 min thru 01 hr 59 min (000100 thru 000159)	4 min	4 min	8 min
02 hr 00 min thru 02 hr 59 min (000200 thru 000259)	6 min	6 min	12 min
03 hr 00 min thru 03 hr 59 min (000300 thru 000359)	7 min	7 min	14 min
04 hr 00 min thru 04 hr 59 min (000400 thru 000459)	9 min	9 min	18 min
05 hr 00 min thru 05 hr 59 min (000500 thru 000559)	11 min	11 min	22 min
06 hr 00 min thru 06 hr 59 min (000600 thru 000659)	13 min	13 min	26 min
07 hr 00 min thru 07 hr 59 min (000700 thru 000759)	15 min	15 min	30 min
08 hr 00 min thru 08 hr 59 min (000800 thru 000859)	16 min	16 min	32 min
09 hr 00 min thru 09 hr 59 min (000900 thru 000959)	18 min	18 min	36 min
10 hr 00 min thru 10 hr 59 min (001000 thru 001059)	20 min	20 min	40 min
11 hr 00 min thru 11 hr 59 min (001100 thru 001159)	22 min	22 min	44 min
12 hr 00 min thru 12 hr 59 min (001200 thru 001259)	24 min	24 min	48 min

MADM Timer Table (continued)

TIMER SETTING	TIMER ERROR		
Set (Fire) Time	Early Error Set time minus	Late Error Set time plus	Span
13 hr 00 min thru 13 hr 59 min (001300 thru 001359)	25 min	25 min	50 min
14 hr 00 min thru 14 hr 59 min (001400 thru 001459)	27 min	27 min	54 min
15 hr 00 min thru 15 hr 59 min (001500 thru 001559)	29 min	29 min	58 min
16 hr 00 min thru 16 hr 59 min (001600 thru 001659)	31 min	31 min	1 hr 02 min
17 hr 00 min thru 17 hr 59 min (001700 thru 001759)	33 min	33 min	1 hr 06 min
18 hr 00 min thru 18 hr 59 min (001800 thru 001859)	34 min	34 min	1 hr 08 min
19 hr 00 min thru 19 hr 59 min (001900 thru 001959)	36 min	36 min	1 hr 12 min
20 hr 00 min thru 20 hr 59 min (002000 thru 002059)	38 min	38 min	1 hr 16 min
21 hr 00 min thru 21 hr 59 min (002100 thru 002159)	40 min	40 min	1 hr 20 min
22 hr 00 min thru 22 hr 59 min (002200 thru 002259)	42 min	42 min	1 hr 24 min
23 hr 00 min thru 23 hr 59 min (002300 thru 002359)	43 min	43 min	1 hr 26 min
24 hr 00 min thru 24 hr 59 min (010000 thru 010059)	45 min	45 min	1 hr 30 min
25 hr 00 min thru 25 hr 59 min (010100 thru 010159)	47 min	47 min	1 hr 34 min
26 hr 00 min thru 26 hr 59 min (010200 thru 010259)	49 min	49 min	1 hr 38 min

MADM Timer Table (continued)

TIMER SETTING Set (Fire) Time	TIMER ERROR Early Error Set time minus	Late Error Set time plus	Span
27 hr 00 min thru 27 hr 59 min (010300 thru 010359)	51 min	51 min	1 hr 42 min
28 hr 00 min thru 28 hr 59 min (010400 thru 010459)	52 min	52 min	1 hr 44 min
29 hr 00 min thru 29 hr 59 min (010500 thru 010559)	54 min	54 min	1 hr 48 min
30 hr 00 min thru 30 hr 59 min (010600 thru 010659)	56 min	56 min	1 hr 52 min
31 hr 00 min thru 31 hr 59 min (010700 thru 010759)	58 min	58 min	1 hr 56 min
32 hr 00 min thru 32 hr 59 min (010800 thru 010859)	1 hr 00 min	1 hr 00 min	2 hr 00 min
33 hr 00 min thru 33 hr 59 min (010900 thru 010959)	1 hr 01 min	1 hr 01 min	2 hr 02 min
34 hr 00 min thru 34 hr 59 min (011000 thru 011059)	1 hr 03 min	1 hr 03 min	2 hr 06 min
35 hr 00 min thru 35 hr 59 min (011100 thru 011159)	1 hr 05 min	1 hr 05 min	2 hr 10 min
36 hr 00 min thru 36 hr 59 min (011200 thru 011259)	1 hr 07 min	1 hr 07 min	2 hr 14 min
37 hr 00 min thru 37 hr 59 min (011300 thru 011359)	1 hr 09 min	1 hr 09 min	2 hr 18 min
38 hr 00 min thru 38 hr 59 min (011400 thru 011459)	1 hr 10 min	1 hr 10 min	2 hr 20 min
39 hr 00 min thru 39 hr 59 min (011500 thru 011559)	1 hr 12 min	1 hr 12 min	2 hr 24 min
40 hr 00 min thru 40 hr 59 min (011600 thru 011659)	1 hr 14 min	1 hr 14 min	2 hr 28 min

MADM Timer Table (continued)

TIMER SETTING Set (Fire) Time	TIMER ERROR Early Error Set time minus	 Late Error Set time plus	 Span
41 hr 00 min thru 41 hr 59 min (011700 thru 011759)	1 hr 16 min	1 hr 16 min	2 hr 32 in
42 hr 00 min thru 42 hr 59 min (011800 thru 011859)	1 hr 18 min	1 hr 18 min	2 hr 36 min
43 hr 00 min thru 43 hr 59 min (011900 thru 011959)	1 hr 19 min	1 hr 19 min	2 hr 38 min
44 hr 00 min thru 44 hr 59 min (01200 thru7 012059)	1 hr 21 min	1 hr 21 min	2 hr 42 min
45 hr 00 min thru 45 hr 59 min (012100 thru 012159)	1 hr 23 min	1 hr 23 min	2 hr 46 min
46 hr 00 min thru 46 hr 59 min (012200 thru 012259)	1 hr 25 min	1 hr 25 min	2 hr 50 min
47 hr 00 min thru 48 hr 00 min (012300 thru 020000)	1 hr 27 min	1 hr 27 min	2 hr 54 min

FOUR KINDS OF TIMER CALCULATIONS

The prefire team may be required to make the following four basic kinds of timer calculations:

Fire at (Detonate the munition at a stated time): Given the starting time hour and the fire time hour, find the early time hour, the late time hour, and the set time.

Span (Detonate the munition no earlier than a stated time and no later than another stated time): Given the early time hour and the late time hour, find the starting time hour, the fire time hour, and the set time.

NET (Detonate the munition no earlier than a stated time): Given the starting time hour and the early time hour, find the late time hour, the fire time hour, and the set time.

NLT (Detonate the munition no later than a stated time): Given the starting time hour and late time hour, find the early time hour, the fire time hour, and the set time.

MADM Timer Table (continued)

TIMER SETTING	TIMER ERROR		
Set (Fire) Time	**Early Error Set time minus**	**Late Error Set time plus**	**Span**
41 hr 00 min thru 41 hr 59 min (011700 thru 011759)	1 hr 16 min	1 hr 16 min	2 hr 32 in
42 hr 00 min thru 42 hr 59 min (011800 thru 011859)	1 hr 18 min	1 hr 18 min	2 hr 36 min
43 hr 00 min thru 43 hr 59 min (011900 thru 011959)	1 hr 19 min	1 hr 19 min	2 hr 38 min
44 hr 00 min thru 44 hr 59 min (01200 thru7 012059)	1 hr 21 min	1 hr 21 min	2 hr 42 min
45 hr 00 min thru 45 hr 59 min (012100 thru 012159)	1 hr 23 min	1 hr 23 min	2 hr 46 min
46 hr 00 min thru 46 hr 59 min (012200 thru 012259)	1 hr 25 min	1 hr 25 min	2 hr 50 min
47 hr 00 min thru 48 hr 00 min (012300 thru 020000)	1 hr 27 min	1 hr 27 min	2 hr 54 min

FOUR KINDS OF TIMER CALCULATIONS

The prefire team may be required to make the following four basic kinds of timer calculations:

Fire at (Detonate the munition at a stated time): Given the starting time hour and the fire time hour, find the early time hour, the late time hour, and the set time.

Span (Detonate the munition no earlier than a stated time and no later than another stated time): Given the early time hour and the late time hour, find the starting time hour, the fire time hour, and the set time.

NET (Detonate the munition no earlier than a stated time): Given the starting time hour and the early time hour, find the late time hour, the fire time hour, and the set time.

NLT (Detonate the munition no later than a stated time): Given the starting time hour and late time hour, find the early time hour, the fire time hour, and the set time.

SADM Timer Table

TIMER SETTING	TIMER ERROR		
Set (Fire) Time	Early Error Set time minus	Late Error Set time plus	Span
00 hr 05 min thru 02 hr 55 min	1 min	6 min	7 min
03 hr 00 min thru 05 hr 55 min	2 min	7 min	9 min
06 hr 00 min thru 09 hr 55 min	3 min	8 min	11 min
10 hr 00 min thru 12 hr 55 min	4 min	9 min	13 min
13 hr 00 min thru 15 hr 55 min	5 min	10 min	15 min
16 hr 00 min thru 19 hr 55 min	6 min	11 min	17 min
20 hr 00 min thru 22 hr 55 min	7 min	12 min	19 min
23 hr 00 min thru 24 hr 00 min	8 min	13 min	21 min

REMOTE OPTION PROBLEM

When a timer is used to back up the remote option, a special problem arises. This problem is to calculate the set time for the timer so that it will positively run down and detonate the ADM no earlier than the time prescribed to detonate it with the remote option, but as close to that time as possible. In this case, the calculation for the timer option is made by using the time prescribed for the remote option as *early time hour* in a NET calculation.

SAMPLE PROBLEM

Given: You are ordered to use the timer option to detonate a MADM at 1500 (fire time hour) and to start the timer at 1200 (starting time hour).

Find:

1 Set time. 2 Early time hour. 3 Late time hour.

Solution:

1 Set time equals fire time hour minus starting time hour. 1500 - 1200 = 3 hours. Answer: 3 hours.

2 Early time hour equals fire time hour minus timer error (MADM Timer Table) of 7 minutes. 1500 - 0007 = 1453. Answer: 1453.

3 Late time hour equals fire time hour plus timer error. 1500 + 0007 = 1507. Answer: 1507.

Appendix C

ADM TARGET ANALYSIS TABLES

Table C-1 Air Blast Damage Radii Buildings and Structures

Surface Burst Only*

(Distances in Meters)

Target Description	Degree of Damage	Yield (KT) .01	Yield (KT) .05	Yield (KT) .1	Yield (KT) .5	Yield (KT) 1	Yield (KT) 5
Multistory blast resistant reinforced concrete building with reinforced concrete walls. No windows.	MOD SEV	30 23	58 45	81 63	151 117	201 155	479 369
Multistory reinforced concrete building with concrete walls, small window area, three to eight stories.	MOD SEV	44 30	86 58	126 85	247 165	352 235	813 570
Multistory wall-bearing building, brick apartment house type, up to three stories.	MOD SEV	69 54	140 108	207 160	398 307	557 429	1284 988
Multistory wall-bearing building, monumental type, up to four stories.	MOD SEV	43 33	99 76	142 109	276 212	357 298	829 691
Wood frame building, house type, one or two stories.	MOD SEV	92 62	193 129	286 191	555 371	723 517	1643 1238
Light steel frame industrial building. Single story, up to 5-ton crane capacity.	MOD SEV	45 21	91 42	127 59	263 133	339 200	859 553
Heavy steel frame industrial building. Single story, with 25- to 50-ton crane capacity.	MOD SEV	30 18	59 35	83 50	201 124	295 185	765 502
Heavy steel frame industrial building. Single story, with 60- to 100-ton crane capacity.	MOD SEV	26 18	49 33	70 47	172 116	258 173	647 454
Multistory steel frame office type building, 3 to 10 stories, earthquake resistant construction.	MOD SEV	27 18	51 34	72 48	133 90	185 124	436 291
Multistory steel frame office type building, 3 to 10 stories, nonearthquake resistant construction.	MOD SEV	33 21	67 42	93 59	174 110	241 151	576 361
Multistory reinforced concrete frame office type building, 3 to 10 stories, earthquake resistant.	MOD SEV	28 20	56 40	78 56	144 103	194 139	466 334
Multistory reinforced concrete, frame office type building, 3 to 10 stories, nonearthquake resistant.	MOD SEV	34 23	65 44	91 61	168 113	231 154	595 417

*See table C-5 for subsurface burst radii reduction.

MOD - moderate SEV - severe

Table C-2 Air Blast Damage Radii for Bridges

Surface Burst Only*

(Distances in Meters)

Target Description	Degree of Damage	Yield (KT) .01	Yield (KT) .05	Yield (KT) .1	Yield (KT) .5	Yield (KT) 1	Yield (KT) 5
Highway and railroad truss bridges; spans 60-120 meters. Two-lane hwy, dbl trk, open floor and sgl trk ballast floor. Railroad: spans 60-120 meters, sgl trk, open floor, RR: spans 120 meters.	MOD SEV	22 19	46 38	69 58	140 117	200 167	529 442
Highway and railroad girder bridges; spans 23 meters. Two-lane deck and through and four-lane deck, highway. Dbl trk deck, open or ballast floor, or sgl or dbl trk, through, ballast floor, railroad.	MOD SEV	16 15	34 31	49 45	98 89	139 127	354 322
Highway and railroad girder bridges; spans 60 meters. Two-lane through and four-lane deck or through, hwy. Dbl trk deck or through, ballast floor, railroad.	MOD SEV	20 16	42 33	63 49	124 96	176 136	452 348
Highway and railroad girder bridges; spans 60 meters. Two-lane highway. Sgl trk deck or through, ballast floor and dbl trk deck or through, open floor, railroad.	MOD SEV	26 20	56 43	82 63	170 138	230 209	630 573
Floating bridges. U.S. Army standard M2 and M4, random orientation.	MOD SEV	22 17	47 36	69 54	141 109	200 154	521 402

MOD - moderate SEV - severe

Table C-3 Air Blast Damage Radii for Field Fortifications

Surface Burst Only*

(Distances in Meters)

Target Description	Degree of Damage	Yield (KT) .01	Yield (KT) .05	Yield (KT) .1	Yield (KT) .5	Yield (KT) 1	Yield (KT) 5
Command post and personnel shelter, modular sections 6 feet by 8 feet with top 3 feet to 5 feet below ground surface, earth covered, and covered trench entrance.	MOD SEV	18 17	36 34	49 46	93 88	122 115	286 269
Machine gun emplacement, 7 feet by 7 feet, framework extends 2 feet above original ground surface, has open firing ports and open trench entrance, 3 foot to 5 foot mound of earth covers framework and extends down to the ground surface except at openings.							
Firing port facing towards ground zero.	MOD SEV	26 24	53 47	71 64	137 123	179 160	420 377
Firing port facing away from ground zero.	MOD SEV	21 20	42 40	57 54	109 103	142 135	334 316
Unrevetted trenches and foxholes with or without cover.	MOD SEV	42 32	84 65	114 88	218 169	285 221	672 521
Wire entanglements.							
Double apron barbed wire	SEV	24	54	76	161	221	579
Concertina wire	SEV	35	78	111	237	325	852

MOD - moderate SEV - severe

*See table C-5 for subsurface burst radii reduction.

Table C-4 Air Blast Damage Radii for Military Field Equipment

Surface Burst Only*

(Distances in Meters)

Target Description	Degree of Damage	Yield (KT) .01	Yield (KT) .05	Yield (KT) .1	Yield (KT) .5	Yield (KT) 1	Yield (KT) 5
Tracked vehicles	MOD	17	38	54	115	157	411
	SEV	11	24	34	72	98	255
Artillery	MOD	18	39	55	117	160	419
	SEV	16	34	48	102	139	363
Wheeled military vehicles	MOD	23	52	74	157	215	563
	SEV	16	35	50	106	145	379
Supply dumps	SEV	11	23	33	68	93	243
Radios and elec fire control equip	SEV	22	49	70	148	203	531
Open grid radar antennas	SEV	54	122	173	370	508	1332
Railroad rolling stock							
End-on orientation	MOD	33	67	91	174	228	535
	SEV	31	62	84	161	211	496
45 degree orientation	MOD	28	62	87	186	255	667
	SEV	19	42	59	125	171	447
Side-on orientation	MOD	32	72	102	217	298	779
	SEV	26	58	82	175	240	627
Railroad locomotives							
End-on orientation	MOD	24	48	65	125	164	384
	SEV	15	30	41	77	101	237
45 degree orientation	MOD	22	48	68	144	197	515
	SEV	11	25	35	73	100	259
Side-on orientation	MOD	22	49	69	146	200	528
	SEV	13	28	39	82	112	291
Engineer heavy equipment							
Open	MOD	31	69	99	210	289	755
	SEV	20	43	62	130	179	467
Shielded	MOD	18	40	56	119	164	427
	SEV	16	35	49	104	142	371
Parked combat aircraft (random orientation)							
Jet fighter aircraft	MOD	26	53	71	137	179	420
	SEV	21	42	57	109	142	334
Jet bomber aircraft	MOD	50	100	136	262	343	808
	SEV	45	90	122	234	307	722
Prop transport aircraft	MOD	55	112	152	292	383	902
	SEV	50	100	136	262	343	806
Helicopter aircraft	MOD	66	134	182	350	459	1082
	SEV	58	118	161	308	404	952

MOD - moderate SEV - severe

*See table C-5 for subsurface burst radii reduction.

Table C-10 Tunnel Demolition Tables (continued)

30	5.00	0.50	0.50	0.50	0.50	0.10	0.10	0.10	0.10	0.05	0.05
35	5.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.10	0.10	0.10
40	5.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.10
45		5.00	1.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50
50		5.00	5.00	5.00	1.00	1.00	1.00	0.50	0.50	0.50	0.50
55		5.00	5.00	5.00	5.00	1.00	1.00	1.00	1.00	0.50	0.50
60		5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	1.00	0.50

Moderate Damage

Minimum yield (KT) ADM required to extend moderate damage for 30 meters within a tunnel through a hard rock medium

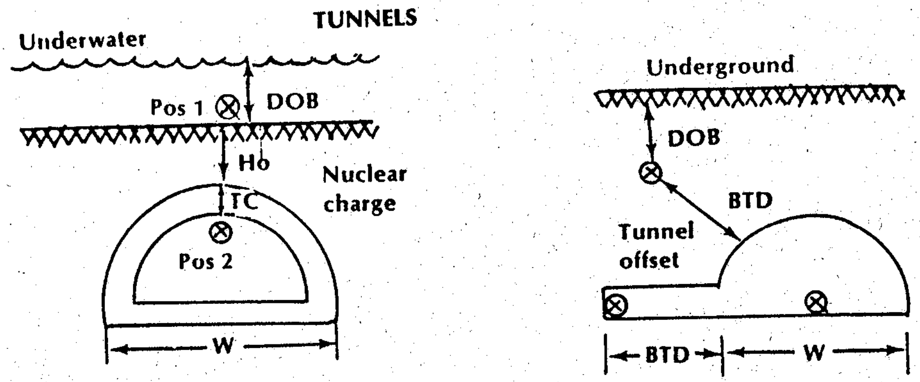
(Significant rehabilitation required to repair. Tunnel may be passable on foot without recovery work.)

BTD (meters)	Depth of Burst (Meters) 0	1	2	3	4	5	6	7	8	10	15
15	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
25	0.50	0.05	0.10	0.10	0.05	0.05	0.05	0.05	0.05	0.05	0.05
30	0.50	0.05	0.50	0.50	0.10	0.10	0.10	0.10	0.05	0.05	0.05
35	1.00	0.05	0.50	0.50	0.50	0.50	0.50	0.10	0.10	0.10	0.05
40	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.10	0.10
45	5.00	1.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50	0.50	0.10
50	5.00	5.00	5.00	1.00	1.00	1.00	0.50	0.50	0.50	0.50	0.50
55	5.00	5.00	5.00	5.00	1.00	1.00	1.00	1.00	0.50	0.50	0.50
60	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	1.00	0.50	0.50

Note - If tunnel is accessible, the following yields can be used to obtain 30 meters of moderate damage.

Offset (meters)	Yield (KT)
0	0.5
1	0.1
5	0.05

TUNNELS



Damage distance for rock overburden = Ho + TC = T
Damage distance other than rock overburden = ½ Ho + TC
POS 1. Use table D-10
POS 2. Use T dimension in table C-8, pos 2

TC = tunnel casing

BTD = Burst to tunnel distance

DOB = Depth of burial

Table C-11 Radii of Safety Tables

ADM with a 0.01 KT warhead.
(Distance in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	350 R	320 R	270 R	350 R	320 R	270 R	250 R	230 R	190 R
1	230 M	170 M	140 M	230 M	170 M	140 M	230 M	170 M	140 M
3	200 S	200 S	200 S	200 S	200 S	200 S	200 S	200 S	200 S
5	310 S	310 S	310 S	310 S	310 S	310 S	310 S	310 S	310 S
7	360 S	360 S	360 S	360 S	360 S	360 S	360 S	360 S	360 S
10	290 S	290 S	290 S	290 S	290 S	290 S	290 S	290 S	290 S
15	160 R	130 R	80 S	160 R	130 R	80 S	100 M	80 M	80 S

ADM with a 0.05 KT warhead.
(Distance in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	570 R	530 R	450 R	570 R	530 R	450 R	430 R	400 R	330 R
1	450 M	350 R	260 R	450 M	350 R	260 R	440 M	330 M	260 M
3	450 M	350 M	280 M	450 M	350 M	280 M	450 M	350 M	280 M
5	420 S	420 S	420 S	420 S	420 S	420 S	420 S	420 S	420 S
7	570 S	570 S	570 S	570 S	570 S	570 S	570 S	570 S	570 S
10	710 S	710 S	710 S	710 S	710 S	710 S	710 S	710 S	710 S
15	650 R	650 S	650 S	650 S	650 S	650 S	650 S	650 S	650 S

ADM with a 0.01 KT warhead.
(Distances in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	690 R	650 R	560 R	690 R	650 R	560 R	530 S	490 R	410 R
1	550 M	450 R	360 R	550 M	450 R	360 R	550 M	410 M	330 M
3	610 M	450 M	360 M	610 M	450 M	360 M	610 M	450 M	360 M
5	600 M	470 M	430 S	600 M	470 M	430 S	600 M	470 M	430 S
7	650 S	650 S	650 S	650 S	650 S	650 S	650 S	650 S	650 S
10	880 S	880 S	880 S	880 S	880 S	880 S	880 S	880 S	880 S
15	1000 S	1000 S	1000 S	1000 S	1000 S	1000 S	1000 S	1000 S	1000 S
25	490 R	440 R	440 S	490 R	440 R	440 S	440 S	440 S	440 S

Governing Effects: B - Blast; M - Missiling; T - Thermal; R - Radiation; S - Base Surge

If radiation governs, see table on page 2-16.

NEG - negligible MOD - moderate EMER - emergency

Table C-11 Radii of Safety Tables (continued)

ADM with a 0.5 KT warhead.
(Distances in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	1340 T	1220 T	850 R	1020 R	970 R	850 R	810 R	760 R	660 R
1	1230 T	1120 T	660 R	850 M	780 R	660 R	850 M	660 M	540 M
3	1150 M	920 T	680 M	1150 M	850 M	680 R	1150 M	850 M	680 M
5	1210 M	890 M	710 M	890 M	890 M	710 M	1210 M	890 M	710 M
7	1210 M	900 M	790 S	1210 M	900 M	790 S	1210 M	900 M	790 S
10	1190 M	1150 S	1150 S	1190 M	1150 S	1150 S	1190 M	1150 S	1150 S
15	1650 S	1650 S	1650 S	1650 S	1650 S	1650 S	1650 S	1650 S	1650 S
25	1950 S	1950 S	1950 S	1950 S	1950 S	1950 S	1950 S	1950 S	1950 S
30	1630 S	1630 S	1630 S	1630 S	1630 S	1630 S	1630 S	1630 S	1630 S

ADM with a 1.0 KT warhead.
(Distances in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	1920 T	1770 T	1000 R	1190 R	1130 R	1000 R	1050 B	920 B	780 R
1	1790 T	1650 T	930 T	1040 M	950 R	820 R	1040 M	890 B	680 M
3	1540 T	1420 T	810 M	1320 M	1000 M	810 M	1320 M	1000 M	810 M
5	1600 M	1190 T	940 M	1600 M	1180 M	940 M	1600 M	1180 M	940 M
7	1610 M	1190 M	950 M	1610 M	1190 M	950 M	1610 M	1190 M	950 M
10	1610 M	1200 M	1020 S	1610 M	1200 M	1020 S	1610 M	1200 M	1020 S
15	1580 M	1230 S	1230 S	1580 M	1230 S	1230 S	1230 S	1230 S	1230 S
20	1510 S	1510 S	1510 S	1510 S	1510 S	1510 S	1510 S	1510 S	1510 S
30	2150 S	2150 S	2150 S	2150 S	2150 S	2150 S	2150 S	2150 S	2150 S

ADM with a 5.0 KT warhead.
(Distances in meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK	NEG RISK	MOD RISK	EMER RISK
0	5180 T	4840 T	3110 T	3080 T	2830 T	2170 T	2400 B	2100 B	1330 R
1	4960 T	4630 T	2980 T	2950 T	2710 T	2070 T	2340 B	2040 B	1350 M
3	4530 T	4230 T	2720 T	3690 T	2470 T	1890 T	2347 M	1940 B	1490 M
5	4100 T	3830 T	2450 T	2640 M	2230 T	1700 T	2640 M	2010 M	1640 M
7	3670 T	3430 T	2190 T	2940 M	2210 M	1780 M	2940 M	2210 M	1780 M
10	3380 M	2820 T	1990 M	3380 M	2500 M	1990 M	2280 M	2500 M	1990 M
15	3810 M	2800 M	2290 S	3810 M	2792 M	2290 S	3810 M	2800 M	2280 S
20	3810 M	2870 S	2870 S	3810 M	2870 S	2870 M	3810 M	2870 S	2870 S
30	3810 M	3640 S	3640 S	3810 M	3810 S	3640 S	3810 M	3640 S	3640 S

Governing Effects: B - Blast; M - Missiling; T - Thermal; R - Radiation; S - Base Surge

If radiation governs, see table on page 2-16.

NEG - negligible MOD - moderate EMER - emergency

Table C-12 Dose Distance Tables

(Distances in Meters)

Exposed Personnel

Dose (cGy)	Yield (KT) .01	.05	.1	.5	1.0	5.0
5	1279	1288	1300	1391	1620	2680
10	1248	1257	1269	1360	1550	2520
15	1217	1227	1238	1329	1410	2400
20	1187	1196	1207	1299	1360	2320
25	1156	1165	1176	1268	1310	2260
30	1125	1134	1146	1237	1280	2210
35	1094	1103	1115	1206	1250	2170
40	1063	1073	1084	1175	1220	2130
45	1033	1042	1053	1145	1200	2100
50	1002	1011	1022	1114	1180	2070
60	940	949	961	1052	1150	2020
70	879	888	899	991	1120	1980
80	817	826	838	929	1100	1940
90	755	765	776	867	1080	1910
100	694	703	714	806	1060	1890

Personnel in Foxholes

Dose (cGy)	Yield (KT) .01	.05	.1	.5	1.0	5.0
5	1046	1054	1064	1142	1350	2290
10	1018	1026	1035	1113	1220	2110
15	989	997	1007	1084	1150	2010
20	961	968	978	1056	1100	1920
25	932	940	949	1027	1060	1860
30	903	911	921	998	1030	1820
35	875	882	892	970	1010	1780
40	846	854	864	941	990	1750
45	817	825	835	912	960	1710
50	789	797	806	884	940	1680
60	732	739	749	827	910	1640
70	674	682	692	769	890	1600
80	617	625	634	712	860	1570
90	560	568	577	655	850	1540
100	502	510	520	598	830	1510

Table C-20 Radii of Safety for Thermal Radiation (continued)

ADM with a 1.0 KT Warhead.

(Distances in Meters)

DOB	Personnel Categories Urban	Personnel Categories Rural	Personnel Categories Open	Sgl Story Frame Bldg	Sgl Story Masonry Bldg	Lt Steel Indus Bldg	Fixed Bridge	RR Equip	Thermal Ignition Wood Shingles	Thermal Ignition Drapes	Thermal Ignition Newspaper
0	780 R	1000 R	1000 R	1092 B	747 B	483 B	403 B	367 B	593 T	845 T	892 T
1	680 M	820 R	930 T	1047 B	716 B	463 B	385 B	351 B	553 T	788 T	832 T
3	810 M	810 M	810 M	964 S	658 B	483 G	353 B	322 B	472 T	675 T	713 T
5	940 M	940 M	940 M	887 B	605 B	523 G	324 B	294 B	391 T	562 T	593 T
7	950 M	950 M	950 M	816 B	557 G	557 G	296 B	269 B	310 T	448 T	474 T
10	1020 S	1020 S	1020 S	719 B	602 G	602 G	259 B	235 B	189 T	278 T	294 T
15	1230 S	1230 S	1230 S	662 G	662 G	662 G	206 B	187 B	0 T	0 T	0 T
20	1510 S	1510 S	1510 S	709 G	709 G	709 G	195 M	195 M	0 T	0 T	0 T
30	2150 S	2150 S	2150 S	779 G	779 G	779 G	221 M	221 M	0 T	0 T	0 T

ADM with a 5.0 KT Warhead.

(Distances in Meters)

DOB	Personnel Categories Urban	Personnel Categories Rural	Personnel Categories Open	Sgl Story Frame Bldg	Sgl Story Masonry Bldg	Lt Steel Indus Bldg	Fixed Bridge	RR Equip	Thermal Ignition Wood Shingles	Thermal Ignition Drapes	Thermal Ignition Newspaper
0	1330 R	2170 T	3110 T	2379 B	1849 B	1111 B	938 B	962 B	1907 T	2369 T	2442 T
1	1350 M	2070 T	2980 T	2320 B	1803 B	1081 B	913 B	936 B	1824 T	2268 T	2338 T
3	1490 M	1890 T	2720 T	2206 B	1713 B	1106 G	864 B	886 B	1658 T	2064 T	2128 T
5	1640 M	1700 T	2450 T	2098 B	1627 B	1173 G	817 B	838 B	1492 T	1861 T	1919 T
7	1780 M	1780 M	2190 T	1994 B	1545 B	1235 G	773 B	793 B	1326 T	1657 T	1710 T
10	1990 M	1990 M	1990 M	1848 B	1429 B	1319 G	709 B	728 B	1076 T	1352 T	1396 T
15	2280 S	2290 S	2290 S	1625 B	1439 G	1439 G	614 B	630 B	661 T	843 T	872 T
20	2870 S	2870 S	2870 S	1541 G	1541 G	1541 G	529 B	543 B	246 T	335 T	349 T
30	3640 S	3640 S	3640 S	1705 G	1705 G	1705 G	386 B	398 B	0 T	0 T	0 T

Sgl - single   Lt - light

Governing Effects: B - Blast; M - Missiling; G - Ground Shock; T - Thermal; R - Radiation; S - Base Surge

Table C-19 Radii of Safety for Missiling

ADM with a 0.01 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	156	127	108	156	127	108	156	127	108
1	222	169	137	222	169	137	222	169	137
3	131	111	98	131	111	98	131	111	98
5	93	79	69	93	79	69	93	79	69
7	93	79	69	93	79	69	93	79	69
10	93	79	69	93	79	69	93	79	69
15	93	79	69	93	79	69	93	79	69

ADM with a 0.05 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	290	233	198	290	233	198	290	233	198
1	440	324	257	440	324	257	440	324	257
3	447	341	278	447	341	278	447	341	278
5	394	318	271	394	318	271	394	318	271
7	240	205	181	240	205	181	240	205	181
10	196	163	142	196	163	142	196	163	142
15	161	135	118	161	135	118	161	135	118

ADM with a 0.1 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	379	303	256	379	303	256	379	303	256
1	549	409	327	549	409	327	549	409	327
3	607	448	355	607	448	355	607	448	355
5	598	461	378	598	461	378	598	461	378
7	553	443	374	553	443	374	553	443	374
10	334	281	246	334	281	246	334	281	246
15	250	207	179	250	207	179	250	207	179
25	203	169	147	203	169	147	203	169	147

ADM with a 0.5 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	694	557	471	694	557	471	694	557	471
1	844	654	539	844	654	539	844	654	539
3	1145	849	675	1145	849	675	1145	849	675
5	1201	886	703	1201	886	703	1201	886	703
7	1204	891	708	1204	891	708	1204	891	708
10	1184	889	715	1184	889	715	1184	889	715
15	1113	874	728	1113	874	728	1113	874	728
25	627	523	457	627	523	457	627	523	457
30	480	398	345	480	398	345	480	398	345

Neg - negligible Mod - moderate Emer - emergency

Table C-19 Radii of Safety for Missiling (continued)

ADM with a 1.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	896	722	612	896	722	612	896	722	612
1	1036	813	677	1036	813	677	1036	813	677
3	1317	996	807	1317	996	807	1317	996	807
5	1597	1180	936	1597	1180	936	1597	1180	936
7	1604	1186	942	1604	1186	942	1604	1186	942
10	1607	1191	948	1607	1191	948	1607	1191	948
15	1571	1182	952	1571	1182	952	1571	1182	952
20	1490	1154	951	1490	1154	951	1490	1154	951
30	1169	946	806	1169	946	806	1169	946	806
65	504	421	367	504	421	367	504	421	367

ADM with a 5.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1907	1520	1276	1907	1520	1276	1907	1520	1276
1	2054	1618	1347	2054	1618	1347	2054	1618	1347
3	2347	1814	1489	2347	1814	1489	2347	1814	1489
5	2640	2010	1632	2640	2010	1632	2640	2010	1632
7	2933	2206	1774	2933	2206	1774	2933	2206	1774
10	3373	2500	1988	3373	2500	1988	3373	2500	1988
15	3806	2792	2201	3806	2792	2201	3806	2792	2201
20	3806	2796	2207	3806	2796	2207	3806	2796	2207
30	3805	2804	2218	3805	2804	2218	3805	2804	2218
65	3062	2433	2041	3062	2433	2041	3062	2433	2041
100	1477	1232	1072	1477	1232	1072	1477	1232	1072

Neg - negligible   Mod - moderate   Emer - emergency

Table C-20 Radii of Safety for Thermal Radiation

ADM with a 0.01 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	133	123	66	83	75	59	18	17	13
1	100	92	50	62	56	44	14	12	10
3	33	30	16	21	19	14	5	4	3
5	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0

Neg - negligible   Mod - moderate   Emer - emergency

Table C-20 Radii of Safety for Thermal Radiation (continued)

ADM with a 0.05 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	339	309	162	194	174	132	34	30	21
1	284	259	135	162	145	109	27	24	16
3	175	159	81	98	88	65	13	11	6
5	66	59	27	34	30	21	0	0	0
7	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0

ADM with a 0.1 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	525	473	242	283	253	189	44	38	25
1	455	410	208	244	218	162	36	31	19
3	316	285	142	167	149	109	20	16	8
5	177	159	75	90	79	56	3	1	0
7	38	33	8	12	9	2	0	0	0
10	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0

ADM with a 0.5 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	1332	1218	651	710	638	463	118	104	72
1	1224	1119	597	651	585	424	106	93	64
3	1007	920	488	533	479	346	82	72	48
5	791	722	380	416	372	267	59	51	32
7	574	524	272	298	266	189	36	29	15
10	249	226	110	122	107	71	0	0	0
15	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0

ADM with a 1.0 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	1911	1761	991	1048	945	698	181	162	116
1	1785	1645	925	978	882	651	168	149	106
3	1533	1413	793	838	755	557	140	124	87
5	1282	1181	660	698	629	462	113	100	68
7	1030	948	528	559	503	368	85	75	50
10	653	600	329	349	313	226	44	37	21
15	24	20	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0

Neg - negligible Mod - moderate Emer - emergency

Table C-21 Radii of Safety for Base Surge (continued)

ADM with a 0.5 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	365	365	365	365	365	365	365	365	365
1	365	365	365	365	365	365	365	365	365
3	410	410	410	410	410	410	410	410	410
5	545	545	545	545	545	545	545	545	545
7	790	790	790	790	790	790	790	790	790
10	1148	1148	1148	1148	1148	1148	1148	1148	1148
15	1644	1644	1644	1644	1644	1644	1644	1644	1644
25	1944	1944	1944	1944	1944	1944	1944	1944	1944
35	1309	1309	1309	1309	1309	1309	1309	1309	1309

ADM with a 1.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	450	450	450	450	450	450	450	450	450
1	450	450	450	450	450	450	450	450	450
3	450	450	450	450	450	450	450	450	450
5	660	660	660	660	660	660	660	660	660
7	832	832	832	832	832	832	832	832	832
10	1016	1016	1016	1016	1016	1016	1016	1016	1016
15	1225	1225	1225	1225	1225	1225	1225	1225	1225
20	1510	1510	1510	1510	1510	1510	1510	1510	1510
30	2145	2145	2145	2145	2145	2145	2145	2145	2145

ADM with a 5.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	940	940	940	940	940	940	940	940	940
1	940	940	940	940	940	940	940	940	940
3	940	940	940	940	940	940	940	940	940
5	940	940	940	940	940	940	940	940	940
7	975	975	975	975	975	975	975	975	975
10	1483	1483	1483	1483	1483	1483	1483	1483	1483
15	2281	2281	2281	2281	2281	2281	2281	2281	2281
20	2868	2868	2868	2868	2868	2868	2868	2868	2868
30	3632	3632	3632	3632	3632	3632	3632	3632	3632

Table C-22 Radii of Safety for Blast

ADM with a 0.01 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	75	68	33	75	68	33	153	135	56
1	62	56	28	62	56	28	127	112	46
3	43	39	19	43	39	19	87	77	32
5	29	27	13	29	27	13	60	53	22
7	20	18	9	20	18	9	41	36	15
10	12	10	5	12	10	5	24	21	9
15	5	4	2	5	4	2	9	8	3

Neg - negligible Mod - moderate Emer - emergency

Table C-21 Radii of Safety for Base Surge (continued)

ADM with a 0.5 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	365	365	365	365	365	365	365	365	365
1	365	365	365	365	365	365	365	365	365
3	410	410	410	410	410	410	410	410	410
5	545	545	545	545	545	545	545	545	545
7	790	790	790	790	790	790	790	790	790
10	1148	1148	1148	1148	1148	1148	1148	1148	1148
15	1644	1644	1644	1644	1644	1644	1644	1644	1644
25	1944	1944	1944	1944	1944	1944	1944	1944	1944
35	1309	1309	1309	1309	1309	1309	1309	1309	1309

ADM with a 1.0 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	450	450	450	450	450	450	450	450	450
1	450	450	450	450	450	450	450	450	450
3	450	450	450	450	450	450	450	450	450
5	660	660	660	660	660	660	660	660	660
7	832	832	832	832	832	832	832	832	832
10	1016	1016	1016	1016	1016	1016	1016	1016	1016
15	1225	1225	1225	1225	1225	1225	1225	1225	1225
20	1510	1510	1510	1510	1510	1510	1510	1510	1510
30	2145	2145	2145	2145	2145	2145	2145	2145	2145

ADM with a 5.0 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	940	940	940	940	940	940	940	940	940
1	940	940	940	940	940	940	940	940	940
3	940	940	940	940	940	940	940	940	940
5	940	940	940	940	940	940	940	940	940
7	975	975	975	975	975	975	975	975	975
10	1483	1483	1483	1483	1483	1483	1483	1483	1483
15	2281	2281	2281	2281	2281	2281	2281	2281	2281
20	2868	2868	2868	2868	2868	2868	2868	2868	2868
30	3632	3632	3632	3632	3632	3632	3632	3632	3632

Table C-22 Radii of Safety for Blast

ADM with a 0.01 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	75	68	33	75	68	33	153	135	56
1	62	56	28	62	56	28	127	112	46
3	43	39	19	43	39	19	87	77	32
5	29	27	13	29	27	13	60	53	22
7	20	18	9	20	18	9	41	36	15
10	12	10	5	12	10	5	24	21	9
15	5	4	2	5	4	2	9	8	3

Neg - negligible   Mod - moderate   Emer - emergency

Table C-22 Radii of Safety for Blast (continued)

ADM with a 0.05 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	143	128	61	143	128	61	302	266	113
1	127	114	54	127	114	54	270	237	100
3	100	89	41	100	89	41	215	188	78
5	79	70	31	79	70	31	171	149	61
7	61	54	23	61	54	23	135	118	47
10	41	36	14	41	36	14	94	82	31
15	20	17	4	20	17	4	50	43	14

ADM with a 0.1 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	189	168	85	189	168	85	405	355	147
1	171	152	76	171	152	76	370	324	133
3	141	125	61	141	125	61	308	269	109
5	115	102	48	115	102	48	255	223	88
7	93	82	37	93	82	37	211	184	71
10	67	59	24	67	59	24	158	137	50
15	37	31	9	37	31	9	95	82	25
25	4	1	0	4	1	0	28	23	0

ADM with a 0.5 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	372	332	221	372	332	221	790	694	295
1	352	314	209	352	314	209	749	658	279
3	315	281	186	315	281	186	674	591	249
5	282	251	165	282	251	165	606	531	222
7	252	224	146	252	224	146	544	477	198
10	212	188	121	212	188	121	463	405	165
15	158	139	87	158	139	87	352	307	122
25	83	72	40	83	72	40	200	173	61
30	38	31	12	38	31	12	108	92	25

ADM with a 1 KT Warhead.
(Distances in Meters)

DOB	Unwarned Exposed Neg Risk	Unwarned Exposed Mod Risk	Unwarned Exposed Emer Risk	Warned Exposed Neg Risk	Warned Exposed Mod Risk	Warned Exposed Emer Risk	Warned Protected Neg Risk	Warned Protected Mod Risk	Warned Protected Emer Risk
0	498	446	337	498	446	337	1047	920	397
1	477	427	322	477	427	322	1004	883	380
3	438	391	295	438	391	295	924	812	348
5	402	359	270	402	359	270	850	747	319
7	368	328	247	368	328	247	782	687	292
10	323	288	215	323	288	215	689	605	255
15	258	230	170	258	230	170	558	489	203
20	206	182	134	206	182	134	450	394	160
30	127	112	79	127	112	79	291	253	97
65	8	5	0	8	5	0	48	39	1

Neg - negligible Mod - moderate Emer - emergency

Table C-20 Radii of Safety for Thermal Radiation (continued)

ADM with a 5 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1096	972	888	1096	972	888	2391	2092	867
1	1067	946	864	1067	946	864	2331	2040	843
3	1011	895	817	1011	895	817	2217	1939	798
5	957	847	773	957	847	773	2108	1843	754
7	906	801	730	906	801	730	2004	1751	712
10	834	736	670	834	736	670	1856	1621	653
15	724	637	579	724	637	579	1633	1424	564
20	627	550	498	627	550	498	1435	1249	484
30	464	403	361	464	403	361	1101	955	351

Table C-23 Radii of Safety for Nuclear Radiation

ADM with a 0.01 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	343	316	261	343	316	261	247	226	181
1	178	149	83	178	149	83	58	45	27
3	159	125	35	159	125	35	6	4	1
5	159	124	35	159	124	35	5	2	0
7	159	124	35	159	124	35	3	0	0
10	159	124	34	159	124	34	0	0	0
15	159	124	34	159	124	34	0	0	0

ADM with a 0.05 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	562	526	447	562	526	447	423	393	326
1	381	342	259	381	342	259	208	173	96
3	368	329	243	368	329	243	180	138	33
5	368	329	243	368	329	243	180	138	32
7	368	329	242	368	329	242	180	138	32
10	368	329	242	368	329	242	180	138	32
15	368	329	242	368	329	242	179	138	31

ADM with a 0.01 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	684	642	551	684	642	551	523	487	409
1	491	448	353	491	448	353	296	257	170
3	480	435	339	480	435	339	276	233	131
5	480	435	339	480	435	339	276	233	131
5	480	435	339	480	435	339	276	233	131
10	480	435	338	480	435	338	276	233	131
15	480	435	338	480	435	338	276	232	130
25	480	435	338	480	435	338	275	232	129

Neg - negligible Mod - moderate Emer - emergency

Table C-23 Radii of Safety for Nuclear Radiation (continued)

ADM with a 0.5 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1017	963	845	1017	963	845	801	754	651
1	833	775	651	833	775	651	574	524	415
3	822	765	640	822	765	640	561	511	400
5	822	765	640	822	765	640	561	511	400
7	822	765	640	822	765	640	561	511	400
10	822	765	640	822	765	640	561	511	400
15	822	765	640	822	765	640	561	511	400
25	822	765	640	822	765	640	561	511	400
30	821	764	639	821	764	639	560	510	399

ADM with a 1.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1187	1128	999	1187	1128	999	946	893	779
1	1015	950	811	1015	950	811	725	670	549
3	1006	941	802	1006	941	802	714	658	536
5	1006	941	802	1006	941	802	714	658	536
7	1006	941	802	1006	941	802	714	658	536
10	1006	941	802	1006	941	802	714	658	536
15	1006	941	801	1006	941	801	714	658	536
20	1005	941	801	1005	941	801	713	658	536
30	1005	941	801	1005	941	801	713	657	536

ADM with a 5.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1983	1893	1693	1983	1893	1693	1593	1509	1330
1	1818	1722	1505	1818	1722	1505	1366	1276	1078
3	1810	1713	1496	1810	1713	1496	1355	1265	1067
5	1810	1713	1496	1810	1713	1496	1355	1265	1067
7	1810	1713	1496	1810	1713	1496	1355	1265	1067
10	1809	1713	1496	1809	1713	1496	1355	1265	1067
15	1809	1713	1496	1809	1713	1496	1355	1265	1067
20	1809	1713	1496	1809	1713	1496	1355	1265	1067
30	1809	1713	1495	1809	1713	1495	1355	1265	1066

Neg - negligible   Mod - moderate   Emer - emergency

Table C-23 Radii of Safety for Nuclear Radiation (continued)

ADM with a 0.5 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1017	963	845	1017	963	845	801	754	651
1	833	775	651	833	775	651	574	524	415
3	822	765	640	822	765	640	561	511	400
5	822	765	640	822	765	640	561	511	400
7	822	765	640	822	765	640	561	511	400
10	822	765	640	822	765	640	561	511	400
15	822	765	640	822	765	640	561	511	400
25	822	765	640	822	765	640	561	511	400
30	821	764	639	821	764	639	560	510	399

ADM with a 1.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1187	1128	999	1187	1128	999	946	893	779
1	1015	950	811	1015	950	811	725	670	549
3	1006	941	802	1006	941	802	714	658	536
5	1006	941	802	1006	941	802	714	658	536
7	1006	941	802	1006	941	802	714	658	536
10	1006	941	802	1006	941	802	714	658	536
15	1006	941	801	1006	941	801	714	658	536
20	1005	941	801	1005	941	801	713	658	536
30	1005	941	801	1005	941	801	713	657	536

ADM with a 5.0 KT Warhead.
(Distances in Meters)

	Unwarned Exposed			Warned Exposed			Warned Protected		
DOB	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk	Neg Risk	Mod Risk	Emer Risk
0	1983	1893	1693	1983	1893	1693	1593	1509	1330
1	1818	1722	1505	1818	1722	1505	1366	1276	1078
3	1810	1713	1496	1810	1713	1496	1355	1265	1067
5	1810	1713	1496	1810	1713	1496	1355	1265	1067
7	1810	1713	1496	1810	1713	1496	1355	1265	1067
10	1809	1713	1496	1809	1713	1496	1355	1265	1067
15	1809	1713	1496	1809	1713	1496	1355	1265	1067
20	1809	1713	1496	1809	1713	1496	1355	1265	1067
30	1809	1713	1495	1809	1713	1495	1355	1265	1066

Neg - negligible   Mod - moderate   Emer - emergency

Table C-24 Nuclear Radiation in Crater and Lip (continued)

Predicted Rate in cGy/hr

.1KT

DRY SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	41300	2750	860	375	128	85	74
5	4310	280	89	42	13	9	1
10	2650	170	54	23	8	6	*
15	2240	159	48	20	7	5	*
20	2130	152	46	19	7	5	*
25	2370	162	51	23	7	5	*

WET SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	18300	960	450	158	58	38	5
5	2740	173	58	25	8	6	*
10	1830	136	40	17	6	4	*
15	1320	86	27	13	4	3	*
20	1210	79	25	12	4	2	*
25	1310	86	27	13	4	3	*

DRY ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	42700	2800	910	395	132	86	15
5	4390	290	89	42	13	10	1
10	2670	170	54	23	8	6	*
15	2480	170	54	23	8	6	*
20	2440	169	54	23	8	6	*
25	2520	170	54	23	8	6	

WET ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	28200	1800	610	240	92	58	9
5	2860	173	58	25	8	6	*
10	2090	156	46	19	7	5	*
15	1610	119	35	14	5	3	*
20	1510	107	34	14	5	3	*
25	1600	119	35	14	5	3	*

.5KT

DRY SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	43200	2800	910	400	132	90	16
5	7330	520	126	68	23	16	2
10	4550	290	93	43	13	9	1
15	3860	200	79	35	10	8	*
20	2970	179	63	27	8	6	*
25	2750	173	58	25	8	6	*
30	2620	171	56	23	8	6	*

WET SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	20400	1020	520	190	64	42	7
5	4440	285	92	43	13	9	1
10	2690	172	57	24	8	6	*
15	2430	169	54	23	8	6	*
20	2120	156	46	19	7	5	*
25	1930	145	42	18	6	4	*
30	1760	129	37	16	6	3	*

* rate is less than 1 cGy/hr.

Table C-24 Nuclear Radiation in Crater and Lip (continued)

Predicted Rate in cGy/hr

.5KT

DRY ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	45200	2850	920	410	138	94	17
5	7440	530	127	68	23	16	2
10	4650	295	94	44	14	10	1
15	3900	210	81	36	11	8	*
20	3440	189	69	31	10	8	*
25	3380	189	69	31	10	8	*
30	3380	189	69	31	10	8	*

WET ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	33200	2170	710	310	102	67	12
5	4540	290	93	43	13	9	1
10	3120	185	63	27	8	7	*
15	2630	171	56	23	8	6	*
20	2290	163	49	22	7	5	*
25	2010	150	43	18	7	5	*
30	1890	144	40	17	6	4	*

1KT

DRY SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	46000	3100	9600	420	141	96	17
5	7700	560	132	173	24	17	2
10	5200	325	101	49	16	11	1
15	4420	285	92	43	13	9	1
20	3640	192	73	33	9	7	*
25	2990	179	63	27	8	6	*
30	2760	173	58	25	8	6	*

WET SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	27000	1600	600	220	88	57	9
5	5330	325	102	51	17	12	1
10	3460	189	74	32	9	3	*
15	2940	178	63	27	8	6	*
20	2510	170	54	23	8	6	*
25	2250	158	46	19	7	4	*
30	1970	150	42	18	6	4	*

DRY ROCK

	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	47700	3150	970	420	142	98	17
5	7830	570	133	74	24	17	2
10	5340	325	102	51	17	12	1
15	4540	290	93	43	13	9	1
20	3870	200	79	35	10	8	*
25	3640	192	73	33	9	7	*
30	3490	190	70	31	10	8	*

WET ROCK

	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	36000	2300	770	330	112	74	13
5	5510	375	105	53	17	12	1
10	3610	192	73	33	9	7	*
15	3100	185	63	27	8	7	*
20	2780	173	58	25	8	6	*
25	2550	170	54	23	8	6	*
30	2290	159	48	21	7	5	*

* rate is less than 1 cGy/hr.

Table C-24 Nuclear Radiation in Crater and Lip (continued)

Predicted Rate in cGy/hr

5KT

DRY SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	60200	4500	2800	560	380	126	21
5	12300	825	290	106	36	24	3
10	8440	620	141	78	26	18	2
15	6170	420	112	58	19	13	2
20	5260	325	102	50	17	12	1
25	4460	285	92	43	13	9	1
30	3970	220	82	36	11	8	1

WET SOIL

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	43000	2800	910	400	132	90	16
5	8230	600	137	76	26	17	2
10	6110	420	111	58	20	13	2
15	4290	280	90	42	12	9	1
20	3640	192	73	33	9	7	*
25	3120	185	63	27	8	7	*
30	2860	173	58	25	8	6	*

DRY ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	62600	4600	2900	570	400	127	21
5	12710	920	295	107	37	25	3
10	8730	635	145	81	27	18	2
15	6330	430	114	61	19	13	2
20	5320	325	102	51	17	12	1
25	4630	295	94	44	14	10	1
30	4600	290	94	44	14	10	1

WET ROCK

DOB	H+1	H+10	H+24	D+2	D+5	D+7	D+30
0	54000	4000	1800	510	180	112	19
5	8990	650	148	83	28	18	2
10	6370	430	114	61	20	13	2
15	4340	280	89	42	13	9	1
20	4010	225	83	38	12	8	1
25	3860	210	81	36	11	8	*
30	3750	196	77	33	10	8	*

Table C-25
1/3 and 0.3 Powers of Various Numbers

Number	(No.) 1/3	(No.) 0.3	Number	(No.) 1/3	(No.) 0.3
.01	.22	.25	.40	.74	.76
.02	.27	.31	.50	.79	.81
.03	.31	.35	.60	.84	.86
.04	.34	.38	.70	.89	.90
.05	.37	.41	.80	.93	.94
.06	.39	.43	.90	.97	.97
.07	.41	.45	1	1.00	1.00
.08	.43	.47	2	1.26	1.23
.09	.45	.49	3	1.44	1.39
.10	.46	.50	4	1.59	1.52
.20	.59	.62	5	1.71	1.62
.30	.67	.70			

SAMPLE ADM OPERATIONS ORDER

Purpose. This appendix, which promulgates STANAG 2139 (Atomic Demolition Munitions [ADM] Operations Order), standardizes the procedures to be used for the issuance of ADM Operations Orders (OPORD).

The ADM Operations Order. The standard format for the ADM operations order is provided on the following pages. This ADM mission execution order is structured as follows:

BASIC ORDER

References

ADM Mission Task Force Organization

Situation

Mission

Execution

Service Support

Command and Signal

Demolition Report

ORDER OF APPENDIXES

1. 1:50,000 Overlay

2. Munition Employment and Firing Data

3. Subgroupings of ADM Mission Task Force

4. Orders, Reports, and Code Words

5. Standing Operating Procedures (SOP) for ADM Employment

6. ADM Target Folder(s)

The basic order and appendixes 1 through 4 are prepared on DA Form 3065, (ADM Operations Order). The ADM standing operating procedures are to be attached in their entirety as appendix 5 to the OPORD at the time it is issued. DA Form 3065-1 is the format for the ADM target folder and DA Form 3065-2 is the format used to record the ADM target analysis. The ADM target analysis is included in the ADM target folder at appendix 6 to the OPORD.

Forms. The ADM operations order shall be prepared on the forms outlined below. Samples are provided in this appendix. The layout, contents, and paragraph numbers will conform exactly to the DA Forms. Completed forms will bear the appropriate security classification in accordance with AR 380-5.

DA Form 3065 (ADM Operations Order). This form is to be completed when an ADM mission is to be performed. Note that an ADM mission may consist of one or more ADM targets. The OPORD will be signed by the executing commander or by an individual specifically authorized in writing to do so by the executing commander.

DA Form 3065-1 (ADM Target Folder). This form is to be completed for each ADML. It should be prepared in advance for preplanned ADMLs and issued as appendix 6 to the ADM OPORD if and when the target is selected for execution.

DA Form 3065-2 (ADM Target Analysis). This form is to be completed and included in the ADM target folder. For preplanned ADMLs this form should also be completed in advance, thereby providing a critical savings in time when needed for the execution of the ADM mission.

(Security Classification)

Copy No. 1 of 5 copies

52d Mech Div
(Issuing Headquarters)

Phoenix (VA 9712)
(Place of Issue) (may be in code)

25 0900Z SEP 1983
(Date-time Group of Signature)

XB 14
(Message Reference No.)

ADM OPERATIONS ORDER NO. 3 **FOR THE EXECUTION OF:**

SUPPLAN: ______ **(OR ADML(s):** A17 and A38 **)**

REFERENCES: a. SUPPLAN: SPARK Dated: 7 Oct 81

b. Map: Series U822 1:50,000 Scale, Sheet: 7661 (Oakston)

c. ADM Target Folders: A17 and A38

Time Zone used throughout the order: ZULU

EXECUTING COMMANDER: William P. Smith (Name) MG (Rank) Div Cdr (Position)

ADM MISSION TASK FORCE ORGANIZATION:

a. ADM Mission Officer: John Coleman (Name) MAJ (Rank) HHC, 52d Mech Div (Organization)

(1) Alternate: Allan Grady (Name) CPT (Rank) HHC, 52d Mech Div (Organization)

(2) Alternate: ______ (Name) ______ (Rank) ______ (Organization)
(If required)

b. Engineer Support Commander(s) and Unit(s): LTC David Thomas, 52d Engr Bn

c. Security Force Commander(s) and Unit(s): CPT Matthew Dillon, B Co., 1-45th Inf.

d. ADM Platoon Leader(s) and Unit(s): 1LT Frank Kovak, 3d Plt, 465th Engr Co. (ADM)

(Security Classification)

DA Form 3065 Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

e. **ADM Target Teams:**

(1) ADM Target Team A: 3d Bde provide team leader and local security
(Organization)

(2) ADM Target Team B: 3d Bde provide team leader and local security
(Organization)

(3) ~~ADM Target Team C:~~ ______
(Organization)

(4) ~~ADM Target Team D:~~ ______
(Organization)

(5) ~~Others as required:~~ ______
(Organization)

f. **Signal Element Commander(s) and Unit(s):** LTC David Harper, 52d Sig Bn

g. **Other Forces Unit:** ______

SITUATION (to be completed as necessary)

a. **Enemy Forces** 8th GTA of the Southern Front is expected to penetrate the Division's initial defenses along Highway 7 by 25 1600 Z Sep 83. Small bands of enemy airborne elements are attempting to secure key terrain in 2d and 3d Bde sectors.

b. **Friendly Forces**

Division OPORD 20

c. **Attachments and Detachments**

MISSION

Execution of SUPPLAN/ADML NO. A17 + A38 as modified by competent authority and as directed herein and after release notification.

EXECUTION

a. **Concept of Operations:** After receipt of final instructions from the Executing Commander and the authenticated Nuclear Control Order, the ADMLs shown on the 1:50,000 overlay at Appendix 1 are to be executed in accordance with this order. Target details (ADM Firing Options(s), Employment Data, etc.) are in individual target folders and are summarized at Appendix 2 to this order.

b. **ADM Target Teams:** See Appendix 3.

(Security Classification)

(Security Classification)

c. **Coordinating Instructions**

(1) ADM Mission Task Force rendezvous at Assembly Area: VA 863220 (grid reference) on order of Executing Commander. (NLT 251200Z Sep 83)

(2) ADM Mission Task Force move from Assembly Area to Employment Area on: order of mission officer (specific orders).

(3) Regroup at VA 863220 (grid reference) after mission completion.

(4) **State of Readiness:**

(a) If the state of readiness SITUATION III has not already been achieved, the ADM Mission Officer will order it independently and as he deems necessary.

(b) The ADM Mission Officer will order that the state of readiness SITUATION II be established immediately upon arrival at the employment area.

(c) State of readiness SITUATION I will be established by procedure selected and checked or filled in below:

	A17 A	A38 B	C	D
Will be ordered by the Executing Commander and passed on through ADM Mission Officer to the ADM Target Team Leader.			X	X
To be established by	1515 Z	1515 Z		
	DTG	DTG	DTG	DTG
Will be ordered independently by ADM Mission Officer after receipt of proper authority from the Executing Commander.	X	X	X	X

Remark: If firing to be by timer only, the state of readiness SITUATION I can be established only after the time of detonation has been ordered.

(5) **Firing Order Instructions:** ADM will be fired (Check the one desired below).

	A	B	C	D
In accordance with supplementary orders of the Executing Commander through ADM Mission Officer			X	X
In accordance with Appendix 2, Column m, of this OPORD	X	X	X	X

(Security Classification)

(Security Classification)

(6) **Return to prior condition**

The Executing Commander may, in unusual circumstances, require change of firing time after state of readiness SITUATION I has been established. In this case a change back to state of readiness SITUATION II is accomplished until a new date-time group (DTG) or order for change to state of readiness SITUATION I is ordered. (For timer only option a change from state of readiness SITUATION I to state of readiness SITUATION II is only possible up to 30 minutes prior to Time of Detonation (TOD).)

(7) **Emergency firing** (check desired procedure):

	ADML			
	A	B	C	D
(a) The ADM Mission Officer/ADM Target Team Leader is not authorized to order emergency firing of the ADM on his own initiative.				
(b) The ADM Mission Officer, or in his absence the ADM Target Team Leader, is authorized to order emergency firing only if all of the following conditions are met: • a valid nuclear release has been received; (This includes authority to change the state of readiness as required.) • the ADM is emplaced at the designated target; • emergency evacuation is not possible; • the enemy is in the act of capturing the ADM.	X	X		
(c) In accordance with Appendix 2, Column k., of this OPORD				

(8) **Emergency destruction:**
The ADM Platoon Leader (US) or in his absence the ADM Firing Team Leader (US) is responsible for having the ADM destroyed if it appears the ADM will fall into enemy hands and orders are in force which do not permit the firing of the munition and emergency evacuation is not possible.

(Security Classification)

(Security Classification)

SERVICE SUPPORT

To be issued separately by the ADM Mission Officer.

COMMAND AND SIGNAL

a. **Locations:**

(1) **Forward Location** (Forward Field Storage Site (FFSS)/Field Storage Site (FSS)/Assembly Area): See Appendixes 1 and 2.

(2) **Command/Assembly Sites:** See Appendixes 1 and 2 (or to be determined by the ADM Mission Officer).

(3) **Firing Sites:** See Appendixes 1 and 2 (or to be determined by the ADM Mission Officer/ADM Target Team Leader).

b. **Passwords:** To be issued by ADM Mission Officer, changing daily at 1200Z.

c. **Reporting:** See Appendix 4.

d. **Communication between Executing Commander and ADM Mission Officer:**

(1) Primary means of communication.

(a) Radio communications, including necessary relays will be provided between Executing Commander and ADM Mission Officer by:

HHC, 52d Mech Div
(enter responsible unit)

between ADM Mission Officer and ADM Target Team Leaders by:

3d Bde
(enter responsible unit)

(b) Pertinent signal communication data:

Division command channel frequency(s) will be used

(2) Alternate means of communication (at least one communication link is required). Possible alternatives are:

(a) Liaison Officer, ADM Mission Task Force

Paul Hunt	1LT	HHC, 52d Mech Div
(Name)	(Rank)	(Organization)

(b) Exisiting military and/or civil telecommunications networks:

G-3 Opns tele. no.: 641-9388
(pertinent data; e.g., telephone number, network entry point)

(Security Classification)

(Security Classification)

(c) courier
(other)

(3) Special instructions (for instance, radio silence, cryptographic material, loss of communication).

minimize radio air time in passing traffic

e. **Code Words:** See Appendix 4

f. **Liaison:** To be established as soon as possible with:

Oakton Police Dept. / VA 974110 / Tele. 641-9999
(Organization/Location)

g.(1) After execution of the mission all copies of this order will be returned to the Executing Commander.

(2) The ADM Mission Officer will complete para 6 below of Copy No. 2.

RANK: MG

SIGNATURE: William P. Smith

TIME OF ISSUE: 0900 Z

APPOINTMENT: CG 52d Mech Div

DATE: 25 Sep 83

DEMOLITION REPORT

a. **Mission Completed:** DTG ____________ CODE WORD: ________
(when last weapon is fired) (See Appendix 4)

b. **Remarks:** ____________

c. **Signature:** ADM Mission Officer ____________

6 Appendixes (Delete those not applicable)

1. 1:50,000 Overlay
2. Munition Employment and Firing Data
3. Subgroupings of ADM Mission Task Force
4. Orders, Reports, and Code Words
5. ADM Standing Operating Procedures
6. ADM Target Folders

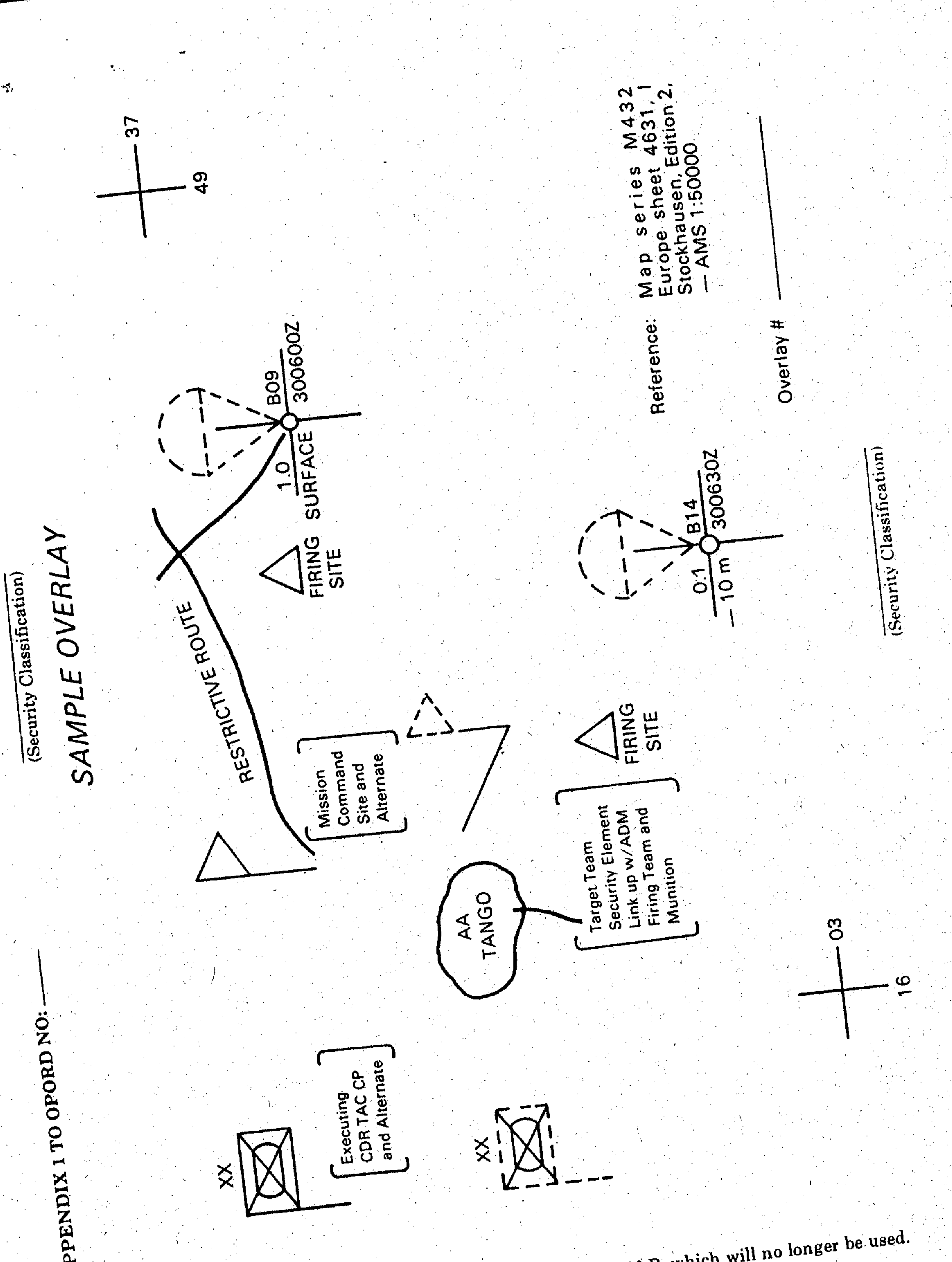
(Security Classification)

(Security Classification)

DISTRIBUTION:

Copy 1 without Appendix 6:	Executing Commander
Copy 2 with all Appendices:	ADM Mission Officer
Copy 3 with all Appendices:	ADM Platoon Leader (US) (ADM Firing Team Leaders)
Copy(s) 4 through 5 with Appendixes 1-5 and applicable Appendix 6:	ADM Target Team Leaders

(Security Classification)



DA Form 3065 Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

APPENDIX 1 to OPORD No. ____

1:50,000 OVERLAY

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(Security Classification)

(Security Classification)

APPENDIX 2 TO OPORD NO: 3 SUPPLAN TITLE: SPARK
(number, nickname, groupings)

MUNITION EMPLOYMENT AND FIRING DATA

ADML No.	Grid Reference	Target Description	Munition Yield	Firing Site Location (Grid ref)	Command Site Location (Grid ref)	Firing Options	Emplacement Detail
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
A17	VA 906420	HWY CRATER	0.5 KT	VA 895200	VA 892220 (VA 881122)	TIMER	IN CULVERT
A38	VA 914388	HWY BRIDGE	0.01 KT	VA 892220	VA 892220 (VA 881122)	TIMER	IN DEMO SHAFT

NOTES:
1. Column (a): Enter ADML numbers for employment area in priority of preparation for execution.
2. Column (c): Enter brief description (e.g., bridge, road in defile, runway).
3. Column (d): Enter both yields when optional surface/subsurface.
4. Column (f): Enter also alternate command site if applicable.
5. Column (h): Enter notes such as "in culvert under road" or "conventional demolition shaft."

DA Form 3065 Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

DA Form 3065 (Jul 84) Replaces DA Forms 3064-R, 3065-R, 3065-3-R, and 3066-R, which will no longer be used.

(Security Classification)

APPENDIX 2 (continued) TO OPORD NO: 3 SUPPLAN TITLE: SPARK
(number, nickname, groupings)

MUNITION EMPLOYMENT AND FIRING DATA

ADML No.	Depth of Burst (meters)	ADM Target Team	Emergency Firing Authorized (Enter YES or NO)	DTG of Receipt of Firing Order	Desired DTG of Execution	Remarks
(a)	(i)	(j)	(k)	(l)	(m)	(n)
A17	3 m	A	YES	25 0900Z Sep	25 1530Z Sep	
A38	9 m	B	YES	25 0900Z Sep	25 1530Z Sep	

NOTE: Column (j): Enter ADM Target Team responsible for each ADML from Appendix 3 of OPORD.

(Security Classification)

(Security Classification)

APPENDIX 3 TO OPORD NO: 3

SUBGROUPINGS OF ADM MISSION TASK FORCE

ADM Mission Task Force Headquarters

a. ADM Mission Officer: John Coleman (Name) MAJ (Rank) HHC, 52d Mech Div (Organization)

b. ADM Platoon Leader (US): Frank Kovak (Name) 1LT (Rank) 3d Plt, 465th Engr Co. (Organization)

c. ADM Security Force Commander: Matthew Dillon (Name) CPT (Rank) B Co, 1-45th Inf. (Organization)

d. ADM Engineer Support Commander: David Thomas (Name) LTC (Rank) 52d Engr Bn (Organization)

ADM Target Teams

a. ADM Target Team Alpha*

ADM Target Team Leader: John Holmes (Name) 2LT (Rank) A Co, 52d Engr Bn (Organization)

ADM Firing Team Leader (US): Richard Dix (Name) SSG (Rank) Team 1, 3d Plt, 465 Engr Co (Organization)

b. ADM Target Team Bravo

ADM Target Team Leader: Carl Porter (Name) 2LT (Rank) A Co., 52d Engr Bn. (Organization)

ADM Firing Team Leader (US): Mark Rice (Name) SSG (Rank) Team 3, 3d Plt, 465 Engr Co (Organization)

~~c. ADM Target Team Charlie~~

~~ADM Target Team Leader~~: ______ (Name) (Rank) (Organization)

~~ADM Firing Team Leader (US)~~: ______ (Name) (Rank) (Organization)

d.

**Similar information must be provided for each additional ADM Target Team.*

NOTE: This appendix is to be completed by the ADM Mission Officer.

(Security Classification)

DA Form 3065 (Jul 84) Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

APPENDIX 4 TO OPORD NO: 3 SUPPLAN TITLE: SPARK
(number, nickname, groupings)

ORDERS, REPORTS, AND CODE WORDS

1. ORDERS AND REPORTS REQUIRED DURING ADM MISSION BY EXECUTING COMMANDER, ADM MISSION OFFICER AND ADM TARGET TEAM LEADER (Apply this Appendix either to each ADML in the mission or to the entire group of ADMLs).

(Add ADML No. to all Orders/Reports) OBSERVE RADIO SILENCE as ordered by Executing Commander

	Check x if applicable to missions	Order (O)/Reports (R) Responsibility	Contents	TIMETABLE Planning before Mission	Planning Correction	Actual Execution	Remarks
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
a.		ADM Target Team Leader ADM Mission Officer (R)	State of Readiness SITUATION III completed				Transmit over wire if possible
b.	X All	ADM Target Team Leader ADM Mission Officer (R)	Departure from FSS /FFSS				Transmit over wire if possible
c.	X All	ADM Target Team Leader ADM Mission Officer (R)	Arrival at ADML or employment area				Reports c, d, e, f, g are transmitted in one message
d.	X All	ADM Target Team Leader ADM Mission Officer (R)	State of Readiness SITUATION II will be completed by ______ DTG				
e.	X All	ADM Target Team Leader ADM Mission Officer (R)	Minimum time required for changeover from State of Readiness SITUATION II to SITUATION I				
f.	X All	ADM Target Team Leader ADM Mission Officer (R)	Minimum time required between State of Readiness SITUATION I and firing				
g.	X All	ADM Target Team Leader ADM Mission Officer (R)	Timer Early/Timer Late times (at minimum time reported under f.)				Only applicable if timer option is used

DA Form ______ Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

DA Form 3065 Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

(Security Classification)

APPENDIX 4 (continued) TO OPORD NO: 3 SUPPLAN TITLE: SPARK
(number, nickname, groupings)

ORDERS, REPORTS, AND CODE WORDS

(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
h.		Executing Commander (O)	State of readiness SITUATION I has to be established by ______ DTG				Using timer option: Orders h. and j. are to be transmitted in one message. Using remote option only: Order j. is not yet necessary.
j.		Executing Commander (O)	Firing at (TOD) ______ DTG				
k.	X All	ADM Target Team Leader ADM Mission Officer (R)	Timer Early Timer Late times ______ DTG	1520 Z/ 1535 Z			Only applicable if timer option is used and different from Report g.
l.		ADM Target Team Leader ADM Mission Officer (R)	State of readiness SITUATION II has been established				
m.	X All	ADM Target Team Leader ADM Mission Officer (R)	State of readiness SITUATION I has been established	1515 Z			
n.		Executing Commander (O)	Earliest TOD/ Latest TOD ______ DTG				Not necessary if only remote option is used.
o.	X All	ADM Target Team Leader ADM Mission Officer (R)	Actual TOD ______ DTG Results				

(Security Classification)

(Security Classification)

APPENDIX 4 (continued) TO OPORD NO: 3 SUPPLAN TITLE: SPARK
(number, nickname, groupings)

ORDERS, REPORTS, AND CODE WORDS

2. CODE WORDS

ACTIONS TO BE TAKEN REPORTS	CODE WORD
a. State of readiness SITUATION III	Apple
b. State of readiness SITUATION II	Plum
c. State of readiness SITUATION I	Pear
d. Timer Early time Timer Late time	Banana
e. Change of state of readiness from SITUATION I to SITUATION II	Orange
f. Time of Detonation (TOD)	Grape
g. Earliest TOD	Tomato
h. Latest TOD	Lettuce
j. Actual TOD	Radish
k. Mission completed (Last Weapon Fired)	Onion
l. Mission cancelled	Bean
m. Go to Reduced Firing Options	Potato
n. Emergency Firing authorized Yes to No	Strowberry
o. Emergency Firing authorized No to Yes	Prune
p. ADML A17 (UTM Co-ordinates) VA 906420	Raisin
q. ADML A38 (UTM Co-ordinates) VA 914338	Peach
r.*	
s.*	
t.*	
u.*	
*Authorized additional code words may be used as required	

(Security Classification)

Appendix 5 to OPORD NO. 3

STANDING OPERATING PROCEDURES (SOP) FOR ADM EMPLOYMENT

GENERAL

1. The ADM Target Analysis is to be completed and included in the ADM Target Folder. For preplanned Atomic Demolition Munitions Locations (ADMLs), the Target Analysis form may be essentially completed in advance, providing a critical savings in time when needed for execution of an ADM mission.

2. The ADM Target Folder is to be completed for each ADML. It also should be prepared in advance for preplanned ADMLs.

3. The ADM Operations Order (ADM OPORD) is to be completed when an ADM Mission is to be performed. The OPORD will normally be prepared by the staff of the Executing Commander. The OPORD will be signed by the Executing Commander or by an individual specifically authorized in writing to do so by the Executing Commander.

SECTION I - DEFINITIONS

4. The following definitions are taken from AAP-6(P) and are repeated here for convenience:

a. **Releasing Commander**

A commander who has been delegated authority to approve the use of nuclear weapons within prescribed limits.

b. **Executing Commander**

A commander to whom nuclear weapons are released for delivery against specific targets or in accordance with approved plans.

c. **Emergency Destruction of Nuclear Weapons**

The destruction of nuclear munitions, components and associated classified material, without significant nuclear yield, to render the weapon tactically useless, to prevent the disclosure of classified design information, and to prevent salvage of the weapon for reprocessing.

5. The following terms and definitions are used for the purpose of this agreement: (see para 16 for diagram showing command relationships):

a. **ADM Mission Task Force**

A force employed for the execution of ADM missions under operational control of an ADM Mission Officer. It contains one or more ADM Target Team(s).

DA Form 3065 (Jul 84) Replaces DA Forms 3064-R, 3065-3-R, 3065-R, and 3066-R, which will no longer be used.

b. ADM Target Team

A subordinate element of the ADM Mission Task Force employed for the execution of an ADM mission under operational control of an ADM Target Team Leader. It consists of an ADM Firing Team (US), communications, transportation, security, and engineer support elements.

c. ADM Mission Officer

The Executing Commander's representative and the leader of the ADM Mission Task Force. He is in operational control of the ADM target teams. The ADM Mission Officer is responsible for coordinating all activities necessary for the completion of the mission.

d. ADM Target Team Leader

An officer or higher ranking noncommissioned officer (NCO) in charge of an ADM Target Team. He is the ADM Mission Officer's representative at a particular ADML when the ADM Mission Officer is not physically present. He is **not** automatically the alternate ADM Mission Officer unless so designated in the OPORD.

e. ADM Security Force

The element responsible for the physical security of the ADM Mission Task Force and especially of the ADM. It is under operational control of the ADM Mission Officer.

f. ADM Security Force Commander

The officer or NCO in command of the ADM Security Force.

g. ADM Platoon (US)

A custodial unit consisting of a platoon headquarters (MA team (US)) and one or more ADM firing teams (MC teams (US)).

h. ADM Platoon Leader (US)

The officer who exercises command less operational control of the ADM Platoon (US).

j. ADML

Atomic demolition munition location.

k. MA Team (US)

The term used to identify the platoon headquarters of the ADM Platoon.

l. MC Team (US)

A specialist team responsible, with the assistance of the Engineer Support Detachment, for the preparation, emplacement, and firing of ADMs. This team is also known as an ADM Team or an ADM Firing Team (US).

m. ADM Firing Team Leader (US)

The senior individual in charge of an ADM Firing Team (US).

n. Engineer Support Element

The element responsible for assisting the ADM Firing Team(s) (US) with emplacement of the munition and for undertaking engineering work such as camouflage, construction of protective structures, defences, etc., for accomplishment of the mission.

o. Engineer Support Commander

The senior individual in charge of the Engineer Support Element.

p. Signal Element

The element which provides necessary communication support to the ADM Mission Task Force.

q. Custodian

The commander of the detachment (US) or other organization assigned accountability and responsibility for weapons at a location supporting NATO delivery units. Custodial forces are those personnel who maintain custody of nuclear weapons, and include custodial storage detachments, support units, and depot units. Ownership and accountability of nuclear weapons remain with the custodial nation under all circumstances.

r. Nuclear Control Order

An appropriately authenticated Emergency Action Message (EAM) authorizing employment of ADM.

s. Permissive Action Link (PAL)

The Permissive Action Link is a lock which may be opened with a specific combination. It must be opened before final arming of the ADM can be achieved.

t. Early Time/Late Time

These are two time limits within which the timer may vary from expected time of detonation. The ADM Platoon/Firing Team Leader (US) will be able to determine and report Early Time/Late Time as soon as he knows the desired time of starting the timer and time of detonation.

u. **Emergency Firing**

The premature execution of the ADM mission by its firing on target to preclude the munition's capture by the enemy.

v. **Command Site**

The location of mission headquarters. It may be separate or colocated with a firing site and/or the forward location.

w. **Firing Site**

The location from which a munition is detonated if remote firing options are in use.

x. **Forward Location**

Location of Forward Field Storage Site (FFSS)/Field Storage Site (FSS) and appropriate administrative areas. May be colocated with command site.

SECTION II - READINESS SITUATIONS

6. The states of readiness relevant to this operations order are as follows:

1a. SITUATION III: The prefire checks have been executed, and all rear area preparations have been completed. Installation of the Field Wire Command Link (FWCL) has been initiated if applicable.

b. SITUATION II: All applicable preparatory measures for execution of Situation I and final arming of the ADM have been completed, such as:

- checks on the weapon and additional devices;

- preparation of emplacement;

- provision of camouflaging material;

- FWCL installation;

- setting up of forward location;

- setting up of firing site(s)

- setting up of command site.

c. SITUATION I: After receipt of the Nuclear Control Order by the Executing Commander, final arming is to be completed. The ADM is then emplaced, camouflaged and is ready for firing. Timers, if applicable, are started.

SECTION III - DUTIES

7. The **Executing Commander** is responsible for:

a. Executing the mission in accordance with the instructions issued or approved by the Releasing Commander.

b. Determining the strength of and designating the formation or unit to provide the ADM Security Force, the ADM Firing Teams(S)(US), the Engineer Support Element, the Signal Support Element and required communications equipment, and transport.

c. Normally, appointing the ADM Mission Officer and his alternate(s).

d. Establishing a clear channel of communications whereby the order to fire the ADM is transmitted from himself to the ADM Mission Officer.

e. Ensuring that this channel of communication is known and understood by all concerned.

f. Ensuring a positive alternate means of transmitting the order to fire, postpone, or cancel the mission.

g. Specifying whether or not (and under what conditions) the ADM Mission Officer is authorized to order the firing of the ADM on his own initiative.

h. Ensuring the tactical security of the mission.

j. Warning friendly forces in the area(s) of detonation.

k. Warning the responsible local national authorities in time to ensure the evacuation and control of affected civilians.

l. Ensuring that the ADM Mission Officer is immediately informed of any changes to current plans which could affect the mission or national custodial procedures.

m. Writing the ADM OPORD.

8. The **ADM Mission Officer** is responsible to the Executing Commander for:

a. Organizing the ADM Target Teams.

b. Operationally controlling the ADM Mission Task Force.

c. Ensuring the completion of the ADM Mission in accordance with the Executing Commander's orders.

d. Assisting him in completing the ADM OPORD and checking for its completeness, including the Target Folders.

e. Indicating the command site forward location and firing site(s) if these are not specified. He must give due consideration to technical requirements.

f. Familiarizing himself with the command relationship and responsibilities on emergency firing and emergency destruction.

g. Nominating and briefing the most suitable available officer as his alternate if this has not been done by the Executing Commander. In case the ADM Mission Officer and his nominated alternate are not available, further alternates should be detailed and briefed regarding their seniority and duties. Such appointments must be made known to the ADM Platoon/Firing Team Leader(s) (US) and leaders of other subordinate mission elements.

h. Passing on orders regarding changes in states of readiness and firing of the ADM to the ADM Target Team Leader(s) and to the ADM Firing Team Leader (US) immediately on receipt and recording such in the ADM OPORD in the appropriate place.

j. Ensuring that the ADM Security Force Commander and the ADM Target Team Leaders and the ADM Firing Team Leader (US) are immediately informed of any changes to current plans which may affect the mission or national custodial procedures.

k. Keeping the Executing Commander informed of the tactical situation at the target site(s) and the state(s) of readiness of the ADM.

l. Reporting the result of the ADM firing(s) to the Executing Commander by the quickest means.

m. Establishing signal communication links with the ADM Target Teams.

9. The ADM Platoon Leader (US) is responsible for:

a. Maintaining custody of the ADM in his charge.

b. Decoding and authenticating the Nuclear Control Order.

c. Providing PAL information to the ADM Firing Team Leader(s) (US).

d. Exercising command (without operational control) of the ADM Platoon (US).

e. Ensuring that the ADM Mission Officer and the ADM Firing Team Leader(s) (US) are immediately informed of any changes as a result of current plans which affect the mission or national custodial procedures.

f. Emergency destruction of the ADM as a last resort measure if it appears that the ADM will fall into enemy hands and orders are in force which do not permit the firing of the munition.

10. The **ADM Target Team Leader** is responsible to the ADM Mission Officer for:

a. Operationally controling the ADM Target Team.

b. Acquainting himself with the orders of the ADM Mission Officer and checking for their completeness, including the target folders.

c. Familiarizing himself with command relationship and responsibilities on emergency firing and emergency destruction.

d. Keeping the ADM Mission Officer informed of the tactical situation at the target site and the state of the readiness of the ADM.

e. Holding the target folder for the ADML.

f. Reporting the result of the ADM firing to the ADM Mission Officer by the quickest means.

11. The **ADM Firing Team Leader (US)** is responsible for execution of the ADM PlatoonLeader's (US) duties when the ADM Platoon Leader (US) is absent. He is responsible to the ADM Target Team Leader or in his absence to the ADM Mission Officer for:

a. Carrying out all necessary prefire checks and orders.

b. Emplacing the ADM with the assistance of any other engineer support provided and preparing firing options.

c. Firing of the ADM as specified in the ADM OPORD.

d. Carrying out orders for changes in states of readiness and firing, received from ADM Mission Officer/ADM Target Team Leader. He will know the name(s) and relative seniority of the alternate(s) and he will know the name of the current ADM Mission Officer/ADM Target Team Leader.

12. The **ADM Security Force Commander** is responsible to the ADM Mission Officer for attaching an ADM security element to each ADM Target Team.

13. The **ADM Security Element** is responsible for:

a. Ensuring the physical security of the ADM and the local protection of ADML and firing site(s) from enemy attack or sabotage.

b. Controlling traffic and refugees in the immediate vicinity to prevent their interfering with the operations.

14. The **Engineer Support Commander** is responsible to the ADM Mission Officers for attaching an engineer support element (if required) to each ADM Target Team.

15. The **Engineer Support Element** is responsible for:

a. Assisting the ADM Firing Team (US) with emplacement of the ADM.

b. Camouflaging the ADM and associated equipment at the ADML. (may also be done by the security force)

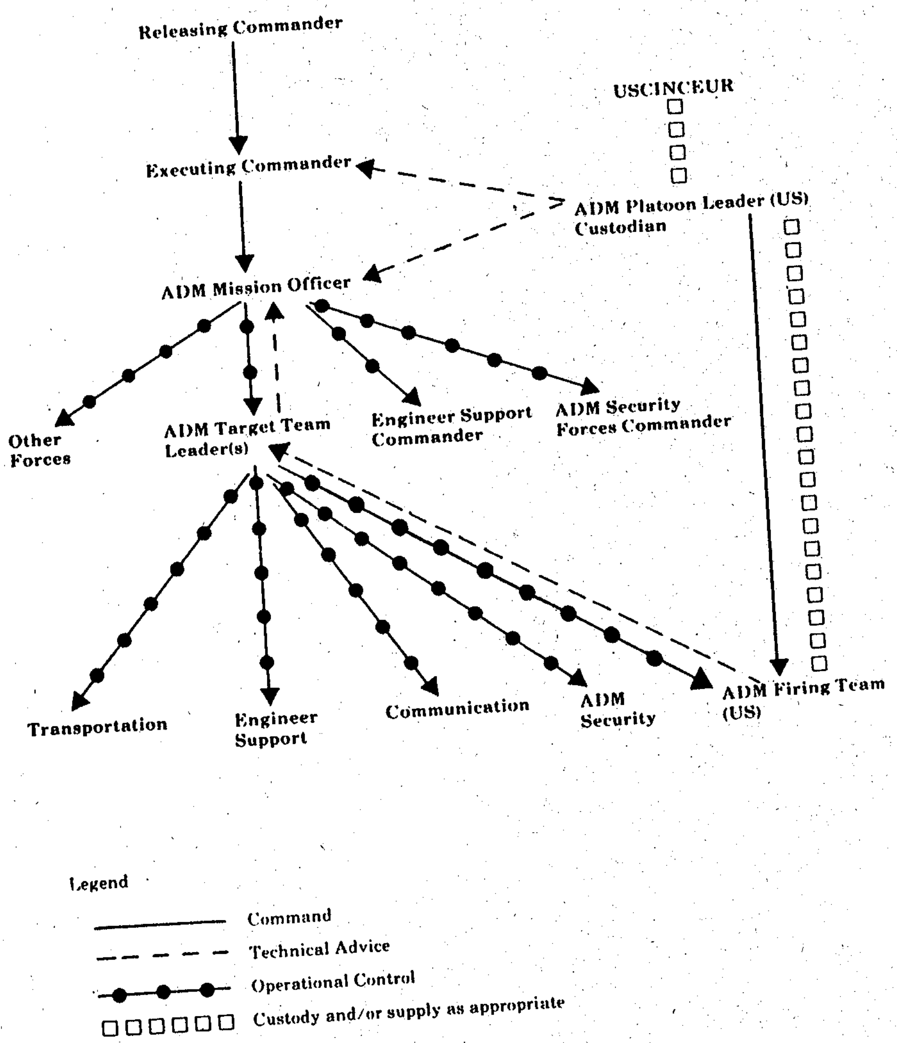
c. Undertaking engineer work in the area of the ADML which will be practicable afterwards or which is required to protect the ADM prior to its detonation.

d. Undertaking engineer work at the firing site such as defences, camouflage, and protective structures.

e. Laying the field wire for FWCL option, if required (may also be done by the security force).

16. The **Command Relationship Diagram** (see following page).

COMMAND RELATIONSHIP DIAGRAM



SECTION IV - PRELIMINARY ACTIONS

17. The **ADM Mission Task Force Assembly:** The ADM Mission Task Force will rendezvous as detailed in the OPORD and accomplish the following:

a. Ensure the munitions for the mission are in the correct state of readiness for the move to the employment area.

b. Ascertain which of the ADM Mission Task Force members, if any, have done a ground reconnaissance of the employment area.

c. Nominate alternate ADM Mission Officers if this has not already been done by the Executing Commander and ensure subordinate elements know of those nominations.

d. Issue signal instructions including passwords to all elements and establish communications for the ADM Mission Task Force and to the Executing Commander.

e. Issue instructions on administration and logistics for the duration of the mission.

f. Ensure that the custodial requirements for the munitions, if these still apply, can be met in the move to and at the employment area.

g. Issue movement instructions for the move from the rendezvous to the employment area.

h. See that the target folders for every ADML in the OPORD are with the ADM Mission Task Force.

18. On satisfactory completion of the above checks notify the Executing Commander when the ADM Mission Task Force is complete and ready to move to the employment area (if required by Appendix 4 of OPORD).

SECTION V - DEPLOYMENT OF ADM MISSION TASK FORCE

19. On arrival in the employment area, the following actions will be taken:

a. **Forward Location.** The Forward Field Storage Site/Field Storage Site and appropriate administrative areas may be established at the location shown in Appendix 1 to the OPORD.

b. **ADM Target Team(s).** The team(s) will deploy to their initial ADML(s) and prepare whatever firing options are specified in accordance with the OPORD.

c. **ADM Security Force.** The security force will deploy as part of the ADM Target Teams and prepare defensive positions covering the ADML(s) and the firing sites.

d. **The Engineer Support Elements.** When deployed as part of the ADM Target Teams, they will assist in preparing the firing options and give whatever engineering assistance is required to the ADM Security Force to improve local protection.

e. **The Signal Element.** It will establish communications between the Executing Commander, the ADM Mission Officer, and the units or formation HQs detailed in the OPORD.

f. **Liaison.** It will be established and kept throughout the mission with responsible local national authority and information will be recieved from it on the situation of the civilian population in the area of the firing site.

20. The ADM Mission Officer will ensure that routes among the firing sites, the Forward Location, and the Command Site are known by all concerned in order that the firing orders can physically be given as fast as possible to the firing teams after the Nuclear Control Order has been decoded by the ADM Platoon Leader (US) and the Firing Order has been received from the Executing Commander. When the ADM Mission Officer is satisfied that all above actions have been taken, he will inform the Executing Commander accordingly.

21. On receipt of the proper authority from the Executing Commander, the ADM Mission Officer will order the emplacement of munitions (sequentially one or more per firing team depending on the circumstances) and state of readiness Situation I. After this has been achieved, the ADM Mission Officer will inform the Executing Commander (if required by Appendix 4 of the OPORD).

SECTION VI - ORDERS FOR FIRING THE ADM

22. The order for firing the ADM will be passed to the ADM Mission Officer by the Executing Commander or the authorized individual signing the OPORD.

23. On receipt of this order, the ADM Mission Officer will immediately pass it to the ADM Firing Team Leader (US), through the ADM Target Team Leader, indicated in the Mission OPORD. The ADM Mission Officer will inform the responsible local national authority as soon as possible.

24. In event of a misfire, the ADM Mission Officer will report the circumstances to the Executing Commander at once. He will, if possible, provide the opportunity for the ADM Firing Team (US) to complete the operations specified in the appropriate technical manual. He will additionally request such services of Explosives Ordnance Disposal personnel as may be required to supplement procedures detailed in the appropriate technical manual.

SECTION VII - EMERGENCY FIRING ORDER

25. Appendix 2 to the OPORD lists the emergency firing order to the ADM Mission Officer for each ADML according to the instructions detailed by the Executing Commander. It will be one of the following:

a. He will order the firing of this munition on his own initiative provided that nuclear release has been granted, the ADM is on target, evacuation is not possible, and the enemy is in the act of capturing the ADM. (This includes the authority to change the state of readiness as required.)

b. He will not order the firing of the munition on his own initiative.

26. In the case of an emergency firing, the responsible local national authority should be informed prior to firing, if possible.

SECTION VIII - EMERGENCY DESTRUCTION

27. Emergency destruction is the responsibility of the ADM Platoon Leader (US) or in his absence the ADM Firing Team Leader (US).

(Security Classification)

ADM TARGET ANALYSIS

1. TARGET INFORMATION: ADML NO. A17 GEP SCORCH

Mission crater highway

Description of ADML 4 lane highway ~~Target Radius (RT)~~

Location: UTM Grid VA 906420 Map Sheet No. 7661, Series U822

Name Oakston Scale 1:50,000

Soil Type dry rock Fuel Condition: (Green)/~~Dry~~

Forest Type: (Deciduous)/~~Coniferous~~

2. DESIRED EFFECTS: Crater Radius 20 meters

~~Degree of Damage: moderate/severe; Fractional Coverage or Probability of Destruction ___%~~

Other

3. TROOP SAFETY:

Risk (neg)/~~mod/emer~~ Vulnerability: (unw exp)/~~war exp/war prot~~

RES: (0)/~~1/2/3~~ Distance from GZ: 1580 meters

4. COLLATERAL DAMAGE:

Personnel

Vulnerability	Distance from GZ
Urban	2630 meters
Rural	920 meters
Open	920 meters

Material	Distance from GZ
Single story frame building	920 meters
Single story masonry building	920 meters
Light steel frame industrial building	2630 meters
Fixed bridges	3210 meters
Railroad equipment	4240 meters

Constraints preclude damage to urban population and facilities

5. PRECLUSION REQUIREMENTS None

Obstacles

Damage

Other

6. TARGET ANALYSIS: See reverse.

7. RECOMMENDATION: ADM-Type 0.5 KT MK-Y 0.5 KT

DOB: 3 m meters; Position: in culvert

8. VERIFICATION: Engineer Branch James Wright

JAMES WRIGHT, CPT, CE

Operations Branch Willy Korec

WILLY KOREC, MAJ, FA

9. REMARKS:

(Security Classification)

DA Form 3065-2 Replaces DA Form 3065-2-R, which will no longer be used.

(Security Classification)

Atomal No. ________

ADM TARGET FOLDER

ADML No. A17

Coordinates: VA 906420

Description: crater in 4 lane highway

Planned MK and Yield: 0.5 KT

ATTENTION
Do not allow to fall into enemy hands

Copy No. 1 of 5 copies

(Security Classification)

DA Form 3065-1 (Jul 84) Replaces DA Form 3065-1-R, which will no longer be used.

(Security Classification)

Atomal No. ______

ADM TARGET FOLDER

ADML No. A17

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Do not allow to fall into enemy hands

Copy No. 1 of 5 copies

(Security Classification)

DA Form 3065-1 (Jul 84) Replaces DA Form 3065-1-R, which will no longer be used.

(Security Classification)

4. Sketch(s)

   a. Precise points of employment.

   b. Siting of any plannned supplementary work.

   c. Recommended positions of security forces and planned obstacles.

5. This folder and contents will become an appendix to an ADM Operations Order in accordance with STANAG 2139.

6. ADM target analysis.

7. Optional data.

   a. Additional maps.

   b. Materials list.

   c. Fallout predictor.

Target Folder completed by:

Name	Rank	Function
Barry Wull	MAJ	Corps Engr
Signature		Date
Barry Wull		23 Sep 83
Name	Rank	Function
Signature		Date

(Security Classification)

(Security Classification)

4. Sketch(s)

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Target Folder completed by:

Name	Rank	Function
Barry Wull	MAJ	Corps Engr
Signature		Date
Barry Wull		23 Sep 83
Name	Rank	Function
Signature		Date

(Security Classification)

____
(Security Classification)

Contents

1. ADM Target Analysis Sheet	________________	☒
2. Scale of map 1:250,000	________________	☒
1:50,000	________________	☒
3. Photos and quantity	________________	4
4. Sketch(s) and quantity	________________	3
5. Fallout Predictor (optional)	________________	☒
		☐

Insert a cross (x) or quantity where applicable.

X

____
(Security Classification)

(Classification)

c. Attachments and detachments.

Define ADM unit task organization within the corps (for example, ADM company in general support [GS] to the corps or ADM company headquarters and one platoon GS to corps with ADM platoons attached in direct support to divisions).

2. MISSION

State clearly and concisely the ADM employment task. Example: The corps emplaces ADM when authorized to create major obstacles to deny, impede, and canalize enemy vehicular movement.

3. EXECUTION

a. Concept of operation.

(1) Briefly outline potential uses of ADM within the corps.

(2) Describe in general how ADM operations are to be conducted. Outline ADM employment task organization.

b. Nuclear operations. Define arrangements for initiating ADM operations and controlling authority to expend ADM. Refer to ADML listing and employment option area appendixes.

c. Deployment. Define the deployment of the ADM company/platoons.

d. Restrictions/constraints. Define restrictions and constraints such as preclusion of collateral damage, preparation of emplacement chambers, criteria for minimizing fallout, time restrictions on operations, restrictions, if any, on prefire operations and deployment of munitions, etc.

e. Nuclear strike warnings. SOP.

f. Reference to engineer, obstacle, and fire support annexes.

g. Coordinating instructions.

(1) Operation exposure guide.

(Classification)

(Classification)

(2) Exceptions to SOP mission-oriented protective posture (MOPP).

(3) Troop safety.

4. SERVICE SUPPORT

a. Reference to service support annex or administrative/logistics orders.

b. Location of ADM field storage sites.

c. Allocation. Define ADM prescribed nuclear load for corps and subordinate elements.

5. COMMAND AND SIGNAL

a. Signal. Refer to OPLAN (OPORD) ______.

b. Command.

(1) Locations of ADM unit(s) headquarters.

(2) Refer to OPLAN (OPORD) ______.

(3) Define individuals by position who may be designated ADM executing commanders.

Acknowledgement instructions.

Last name of commander
Rank

Authentication.

Appendixes: 1. ADML Listing

2. ADM Employment Option Areas

Distribution:

(Classification)

GLOSSARY

ABBREVIATIONS AND ACRONYMS

ADM atomic demolition munition(s) (singular and plural)

ADML atomic demolition munition location

AP antipersonnel mine

AT antitank mine

ASI additional skill identifier

BTD burst-to-tunnel distance

CDD collateral damage distance

CEP circular error probable

cGy centigray

DAL apparent lip diameter

DGZ desired ground zero

DLIC detachment left in contact

DOB depth of burst

DS direct support

DTG date-time group

DWD downwind distance

EAC echelon above corps

EAM emergency action message

EEI essential elements of information

EMP electromagnetic pulse

EMR electromagnetic radiation

EOD explosive ordnance disposal

ET early time

EWS effective wind speed

FEBA forward edge of the battle area

FSL field storage location

G1 personnel staff

G2 intelligence staff

G3 operations staff

G4 logistics staff

G5 civil affairs staff

GS general support

GZ ground zero

H_A depth of apparent crater

HAL height of apparent lip crest

H_O height of overburden

H_T true crater depth

KM kilometer

KT kiloton

LSD limited safe distance

LT late time

M meter(s)

MACOM major Army command

MADM medium atomic demolition munition

MOPP mission-oriented protective posture

MSD minimum safe distance

NAIRA nuclear accident and incident response

NATO North Atlantic Treaty Organization

NBC nuclear, biological, chemical

NET detonate no earlier than a stated time

NLT detonate no later than a stated time

NMS new manning system

OPLAN operation plan

OPORD operations order

PAL	permissive action link
PEH	probable error in height of burst
PNL	prescribed nuclear load
psi	pounds per square inch
R_A	apparent crater radius
RAL	radius of apparent lip crest (obstacle radius)
Rc	cavity radius
RD	radius of damage
RES	radiation exposure state
R_R	radius of rupture zone
RT	radius of target
SADM	special atomic demolition munition
SASP	special ammunition supply point
SET	set time
SOP	standing operating procedures
SRD	secret restricted data
TC	tunnel casing
TNT	trinitrotoluene
UTM	universal transverse mercator
Vc	volume of apparent crater

SYMBOLS

a	long side of rectangle
b	short side of rectangle
B	width of abutment, pier, traveled way, or valley floor
d	displacement distance
f	fraction of damage to the target area expressed as a percentage
l	length
P	probability of damaging target to the desired degree
q	distance to upstream side of dam from a position on downstream face
r	distance to downstream face of dam from a position on upstream face
s	distance to upstream face of dam from inspection gallery
t	distance to downstream face of dam from inspection gallery
T	thickness of abutment
w	width
W	yield in kilotons
x	longer axis of elliptical target
y	shorter axis of elliptical target

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