

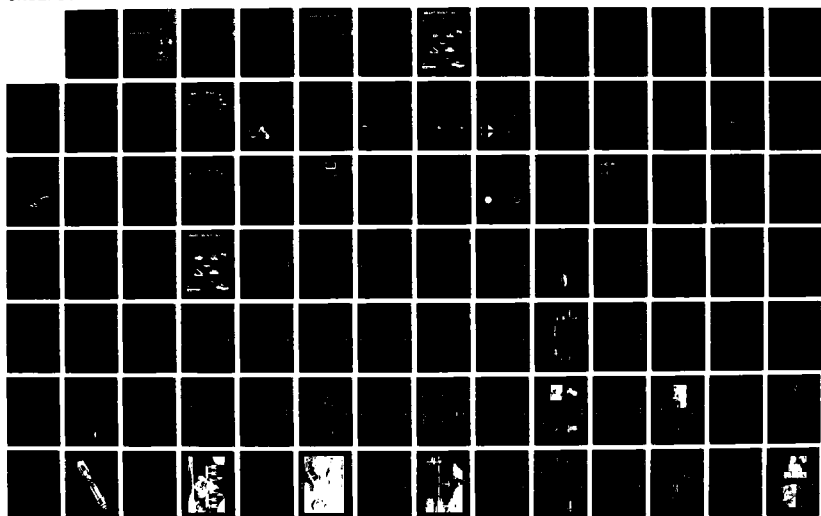
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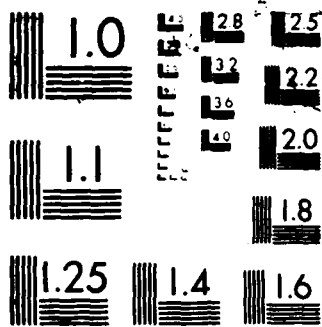
SMART MUNITIONS: AN INTRODUCTION TO THE CONCEPTS THE
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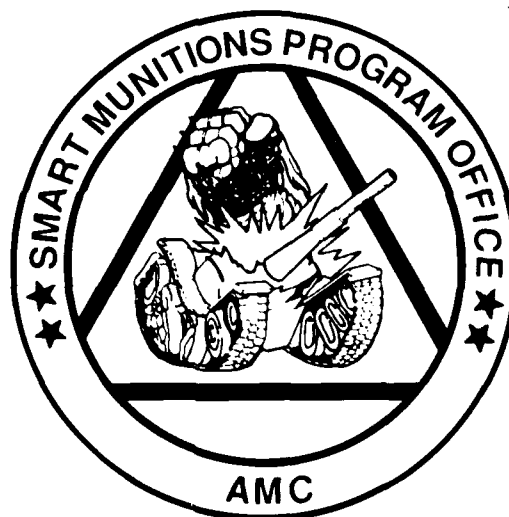
SMART MUNITIONS:

AN INTRODUCTION TO THE CONCEPTS,
THE TECHNOLOGIES, AND THE SYSTEMS
PRIMER AND BRIEFING MANUAL

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SMART MUNITIONS:

AN INTRODUCTION TO THE CONCEPTS, THE TECHNOLOGIES AND THE SYSTEMS PRIMER AND BRIEFING MANUAL

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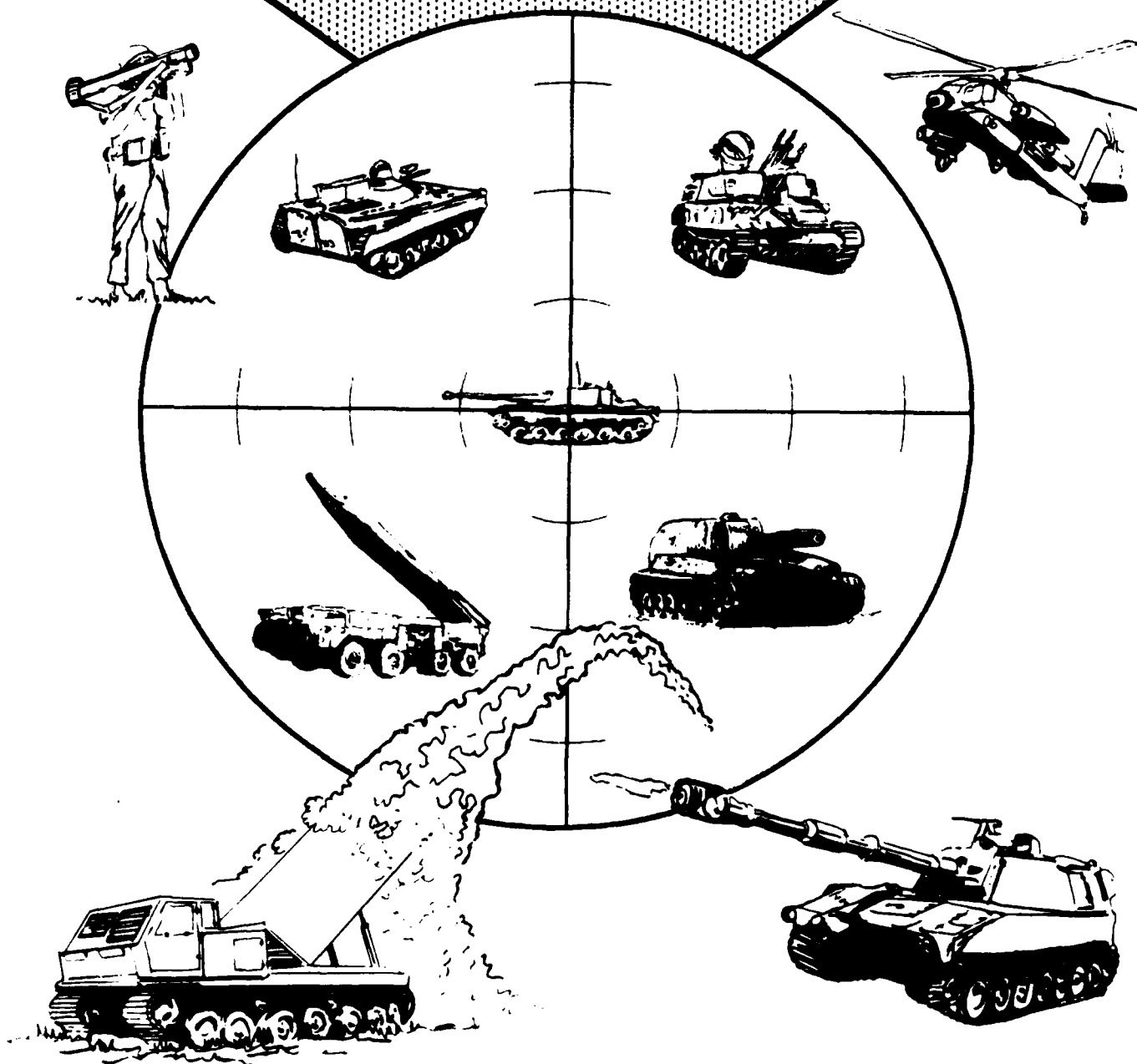
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**AN INTRODUCTION TO THE CONCEPTS
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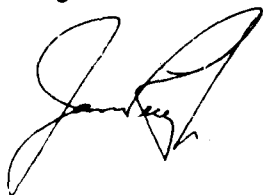
FOREWORD

To the reader:

Smart munition weapon systems will play a major role on the AirLand Battlefield of the future. They have the potential to dramatically improve weapon systems effectiveness by allowing autonomous engagement of targets, even in adverse battlefield environments, increasing target engagement rates, and lessening the combat attrition of our personnel and equipment. Smart munitions will provide the tactical commander with an enhanced capability of effectively engaging the enemy in the close, rear, and deep battles.

The United States Army has invested considerable resources in the research and development of smart munition technologies. Many of these concepts have matured to the point that we are now in the process of developing and fielding a modern family of smart munition weapon systems. As with any new technology, new terminology and nomenclature are involved.

This volume presents some of the basic concepts and techniques used in the design and operation of smart munitions weapon systems. It neither presents technical detail nor provides supporting mathematical or scientific analyses. Its sole purpose is to provide a simple primer by introducing smart munitions and describing the key technologies involved.



Colonel James D. Petty, Jr.
Director,
U.S. Army Smart Munitions Center
Redstone Arsenal, Alabama

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LIST OF ABBREVIATIONS

CLOS	command-to-line-of-sight
CM	countermeasure
EFP	explosively formed penetrator
IIR	imaging infrared
IR	infrared
LOAL	lock-on-after-launch
LOBL	lock-on-before-launch
LOS	line-of-sight
MMW	millimeter wave
P_{acq}	probability of acquisition
$P_{k/acq}$	probability of kill given a target acquisition
PGM	Precision Guided Munition
RPV	remotely piloted vehicle
SC	shaped charge
SFM	sensor fuzed munition
SM	Smart Munition
TGP	terminally guided projectile
TGM	terminally guided munition
TGSM	terminally guided missile

1. OVERVIEW

1.1 WHY SMART MUNITIONS?

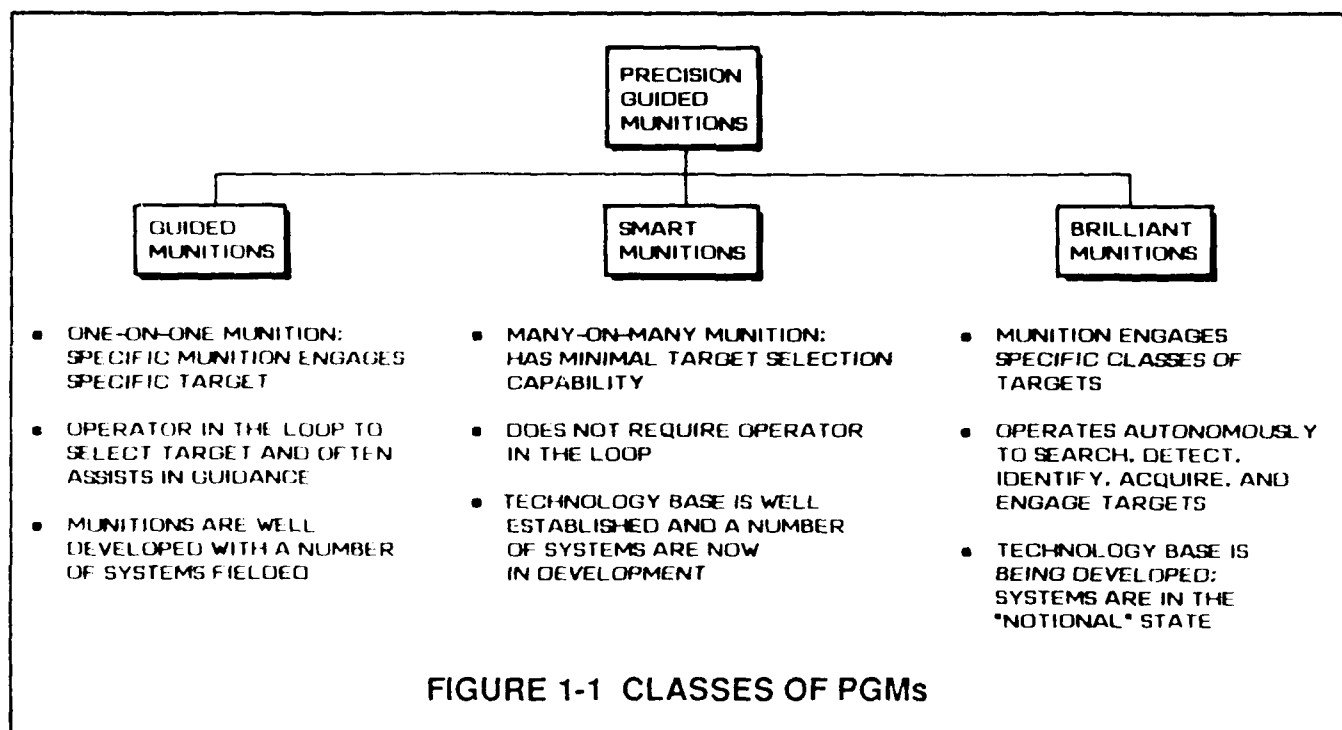
The United States Army is developing a family of weapon systems that will revolutionize land warfare. These weapon systems, which allow the Army to precisely attack deep targets and provide the capability of simultaneously engaging multiple targets, will greatly enhance our fighting capability and survivability. Smart Munitions (SMs) form the basis for these weapon systems.

SMs have the self-contained capability to search, detect, acquire, and engage targets. They are delivered to target areas by guns, rockets, or missiles, with these carriers delivering from one to a few dozen SMs. With this self-contained capability and the means to rapidly deliver large quantities of munitions, smart munition weapon

systems can perform new missions on the AirLand Battlefield. For example, large arrays of land-mobile targets can be effectively and efficiently engaged at longer ranges; thus, important segments of the enemy force can be countered before they can effectively fire on our forces.

1.2 SMART MUNITIONS - A CLASS OF PRECISION GUIDED MUNITIONS (PGMs)

SMs are one of three classes of PGMs, the other two being guided munitions and brilliant munitions (see Figure 1-1). Guided munitions are characterized as one-on-one munitions that require an operator in the loop to function. Each



munition is directed to a specific target by the operator or a gunner. This requires a direct line-of-sight (LOS) between the operator (or the sensor being used by the operator) and the target. Systems of this class are already fielded. SMs are in the development phase with weapon fielding scheduled for the 1990s. Brilliant munitions are in the notional state. It is conceived that such munitions would operate autonomously, as do SMs, but they would be capable of selectively identifying and engaging specific target sets. It will be a number of years before brilliant munitions are ready for development.

Smart munition weapons are viewed as an addition to, not a replacement for, guided munition weapons. Guided munition weapons have the distinct advantage of precisely engaging specific targets. In the close battle, where friendly and enemy forces are intermingled, the ability to engage specific targets is essential. Conversely, wherever they can be delivered, smart munition weapons are most effective against high target densities. Guided munition weapons and smart munition weapons are complementary.

Since guided munitions have been the precursor to SMs, a brief review of some currently fielded guided munitions should provide a better understanding of SMs. The operator is responsible for target selection and often is involved in the guidance process. Existing weapons in this class are TOW, DRAGON, HELLFIRE, and COPPERHEAD.

TOW and DRAGON are command-to-line-of-sight (CLOS) systems. The

operator, looking through a sight (telescope or infrared imaging device), searches, detects, and acquires targets. Upon acquiring a target, the operator aims the sight at the target and fires the missile. The operator continues to aim at the target during missile flight. Corrective missile guidance commands are automatically generated at the launcher by a process of comparing the operator's sight aimpoint to current missile location. The commands are then transmitted to the missile through a wire link between launcher and missile causing the missile to fly along the LOS between launcher and target.

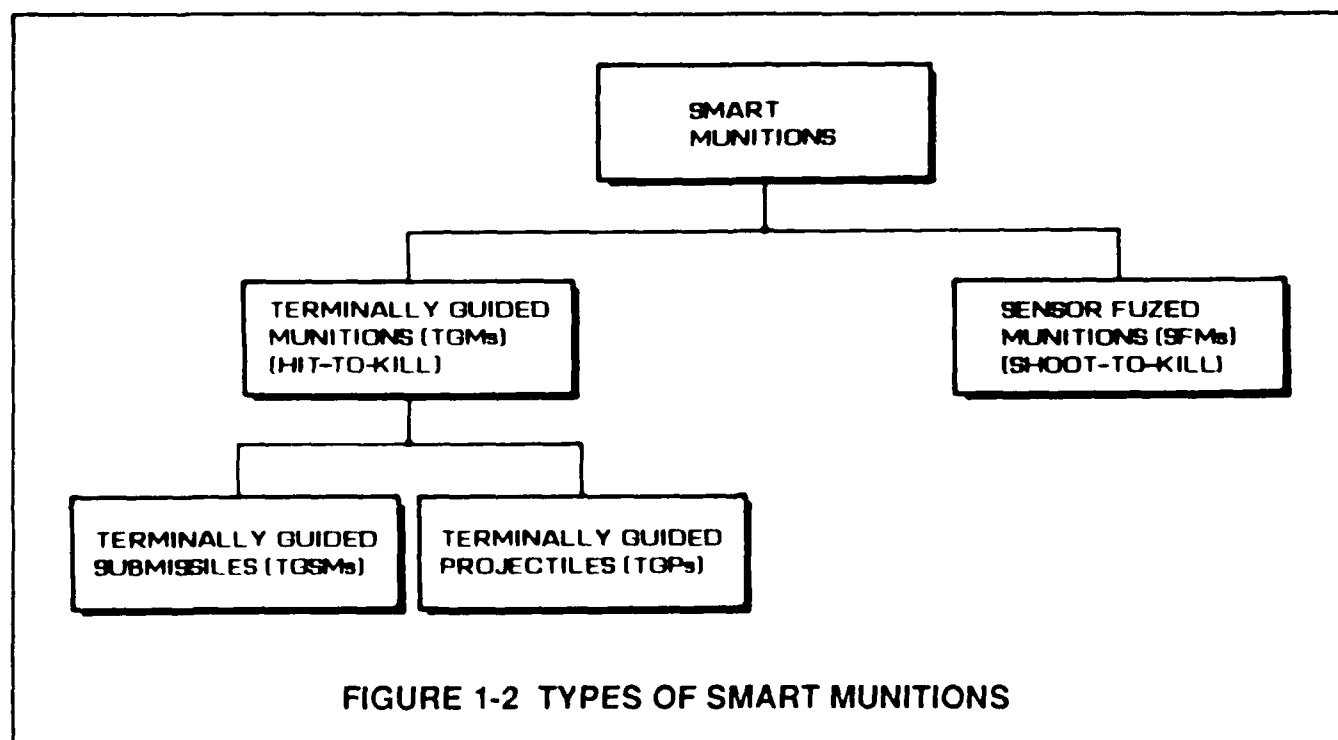
HELLFIRE and COPPERHEAD are terminal homing systems that use laser semiactive guidance during the terminal phase of flight, which ranges from the final several hundred meters to impact. To employ these weapons, an operator searches, detects, and acquires targets. Upon target acquisition, an operator aims a laser designator at the target. The laser radiation reflected from the target provides a unique signature on which the munition "homes." Both HELLFIRE and COPPERHEAD have seekers located forward which rely on the reflected laser radiation to guide the round to impact. COPPERHEAD is a lock-on-after-launch (LOAL) system, i.e., the munition's seeker locks onto the target after the munition is in flight. HELLFIRE can be operated either lock-on-before-launch (LOBL) or LOAL. In either case, the laser signature ensures a one-to-one correspondence between the munition and the target it is engaging.

1.3 TYPES OF SMART MUNITIONS

SMs, as noted above, operate autonomously. They have the self-contained capability to search for, detect, acquire, and engage targets but have minimal capability to discriminate among target classes or target types. They are designed for the many-on-many situation where many munitions are directed into an area known to contain many targets. The technology base for these munitions is well established, and several weapon systems are now in the early stages of development.

Figure 1-2 depicts the types of SMs. Terminally guided munitions (TGMs) are hit-to-kill weapons; they guide to the target and an onboard warhead is fuzed upon target impact. Sensor fuzed munitions (SFMs) are shoot-to-kill weapons; the warhead is fuzed some distance (tens of meters) from the target while the munition is aimed at the target.

In the past, there was little distinction between the two types of TGMs, terminally guided submissiles (TGSMs) and terminally guided projectiles (TGP). TGSMs were delivered by missiles or rockets while TGP were delivered by cannon. The difference being simply that TGP had to survive high cannon launch accelerations of thousands of g's, while TGSMs faced low launch accelerations of, at most, tens of g's. However, the Army is now pursuing the development of TGP with conventional geometry; i.e., a TGP having similar size and weight as that of a conventional artillery round. While this feature will greatly enhance tactical utility, TGP are becoming considerably different from TGSMs. Size and weight considerations normally preclude delivery of TGP from missiles or rockets. They are only delivered one at a time from cannons, and



the size/weight constraint is that dictated by ballistic requirements. However, several TGSMs may be delivered by a single missile or rocket. Though the requirements and designs of TGP's and TGSMs are rapidly diverging, they share a well-founded and common technology base.

2. SMART MUNITIONS ON THE BATTLEFIELD

Increases in firepower, mobility, and surveillance since World War II dictate that in the future major conflicts will be characterized by ill-defined front lines, dispersion of forces to prevent lucrative targets for nuclear weapons, and aggressive exploitation of tactical opportunities by all levels of command. Commanders at all echelons must be prepared to fight rear, close, and deep battles. The "fire-and-forget" nature of SMs provides a unique capability throughout the spectrum of combat.

An analysis of the threat shows that armored vehicles and artillery are the backbone of its combat power. While these targets are most appropriate for SM weapon systems, their nature and value vary with their distance from friendly forces. Company and battalion units normally acquire and engage individual armored vehicles or small groups of armored vehicles within 5 km of the forward line of own troops (FLOT). Brigade and division forces may detect and attack company/battalion-size maneuver units in assembly areas or moving toward the front, or artillery batteries in their firing position. The corps commander may detect and attack follow-on units, in assembly areas or on roads, as well as

high-value targets such as surface-to-surface missiles, command and control, and logistics complexes.

Regardless of target location, SM weapon systems are most effective in a "many-on-many" engagement. A number of SMs are delivered near the target array such as an artillery battery or a tank company. The sensor in each munition acquires and engages a suitable target. The more targets within the footprint of the delivery weapon, the more likely that each munition will select and attack a different target. For some weapons, this natural pairing of munitions and targets is enhanced with sensor acquisition algorithms that help distribute the munitions among the targets and improve the overall effectiveness of the total weapon system. Figure 2-1 shows a variety of smart munitions and targets on the battlefield.

3. SMART MUNITION WEAPON SYSTEM DESCRIPTION

3.1 INDIRECT FIRE SMART MUNITION WEAPON SYSTEMS

A smart munition weapon system includes not only the smart munition itself, but also those elements necessary to place the smart munition over the target vicinity. These other elements can include a carrier such as a missile, rocket, or projectile, and a launch platform such as an aircraft, vehicle, or rocket launcher. In general, the launch platform can transport and launch one to many carriers, each potentially carrying one to many SMs, as shown in Figure 3-1.

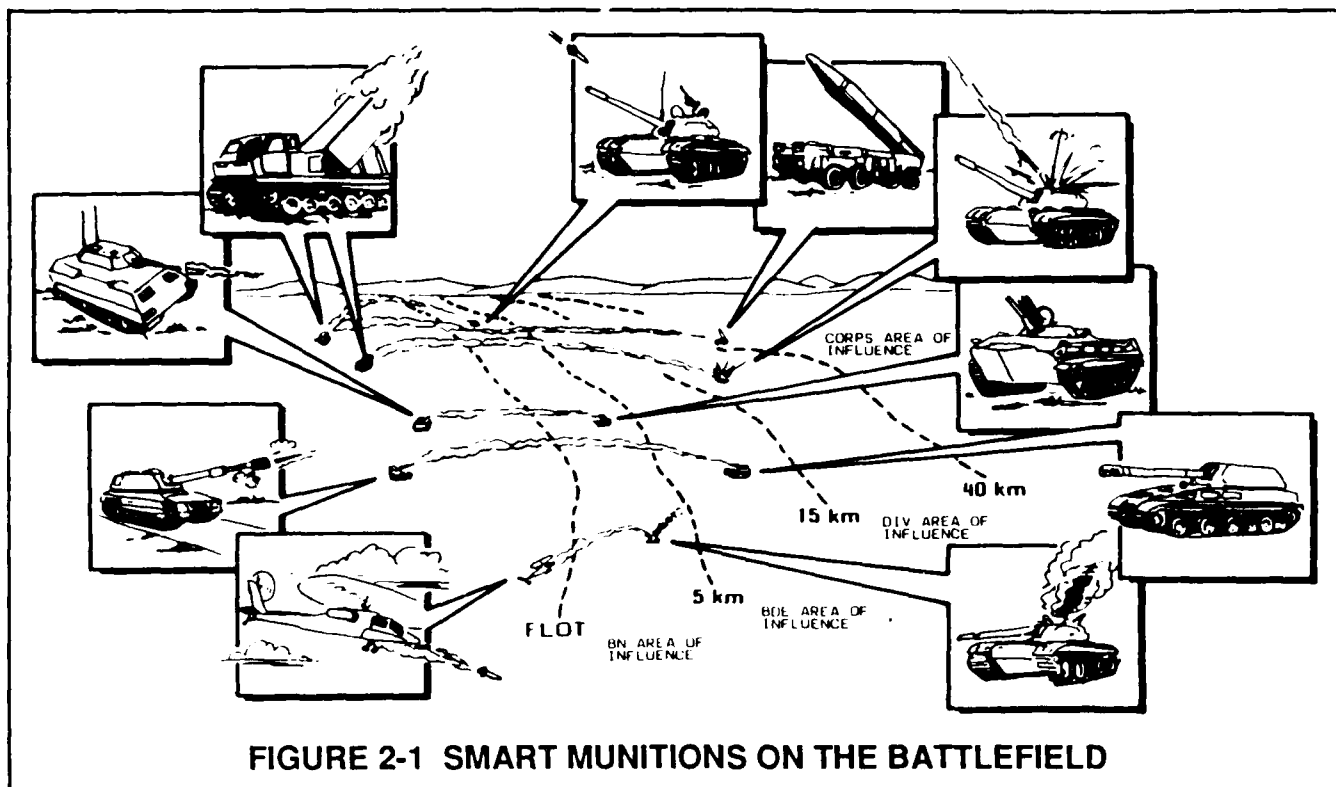


FIGURE 2-1 SMART MUNITIONS ON THE BATTLEFIELD

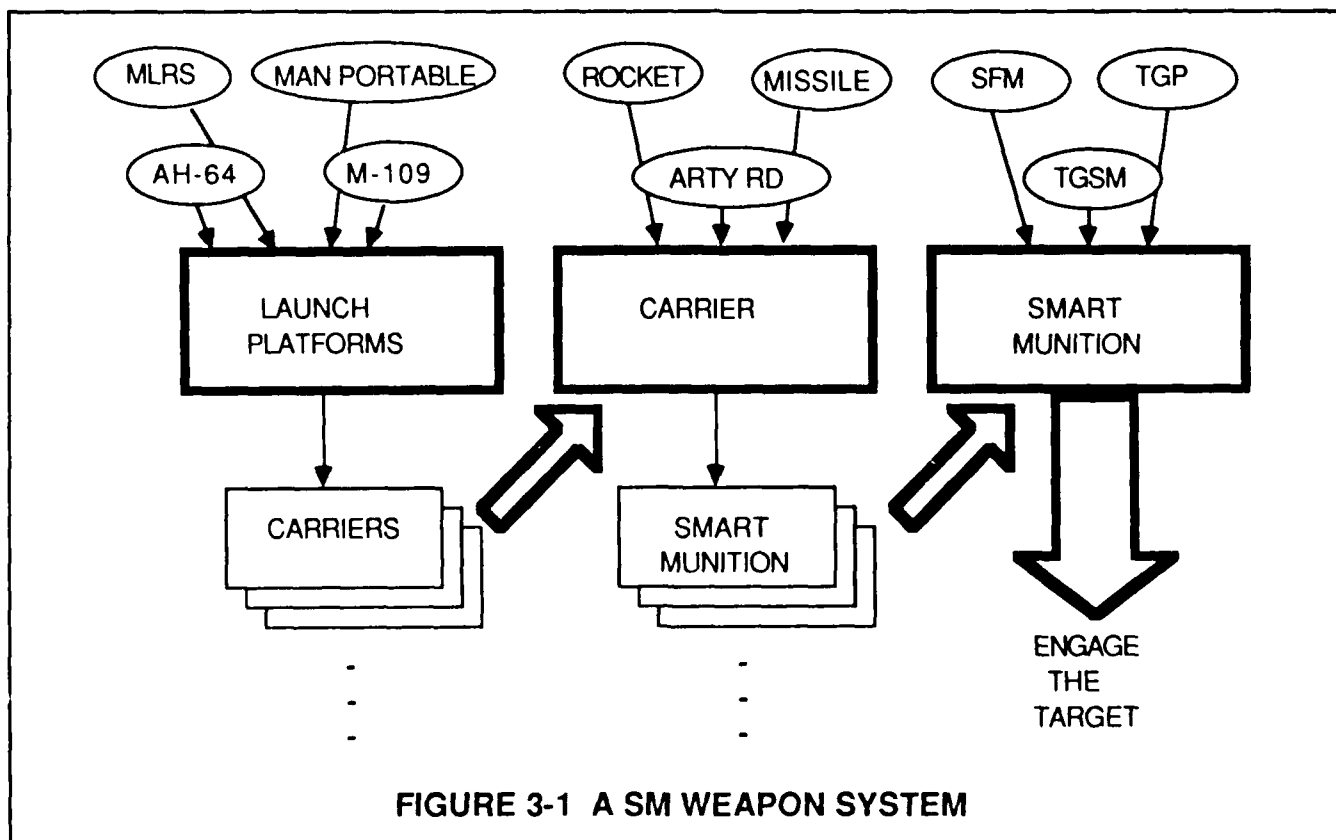
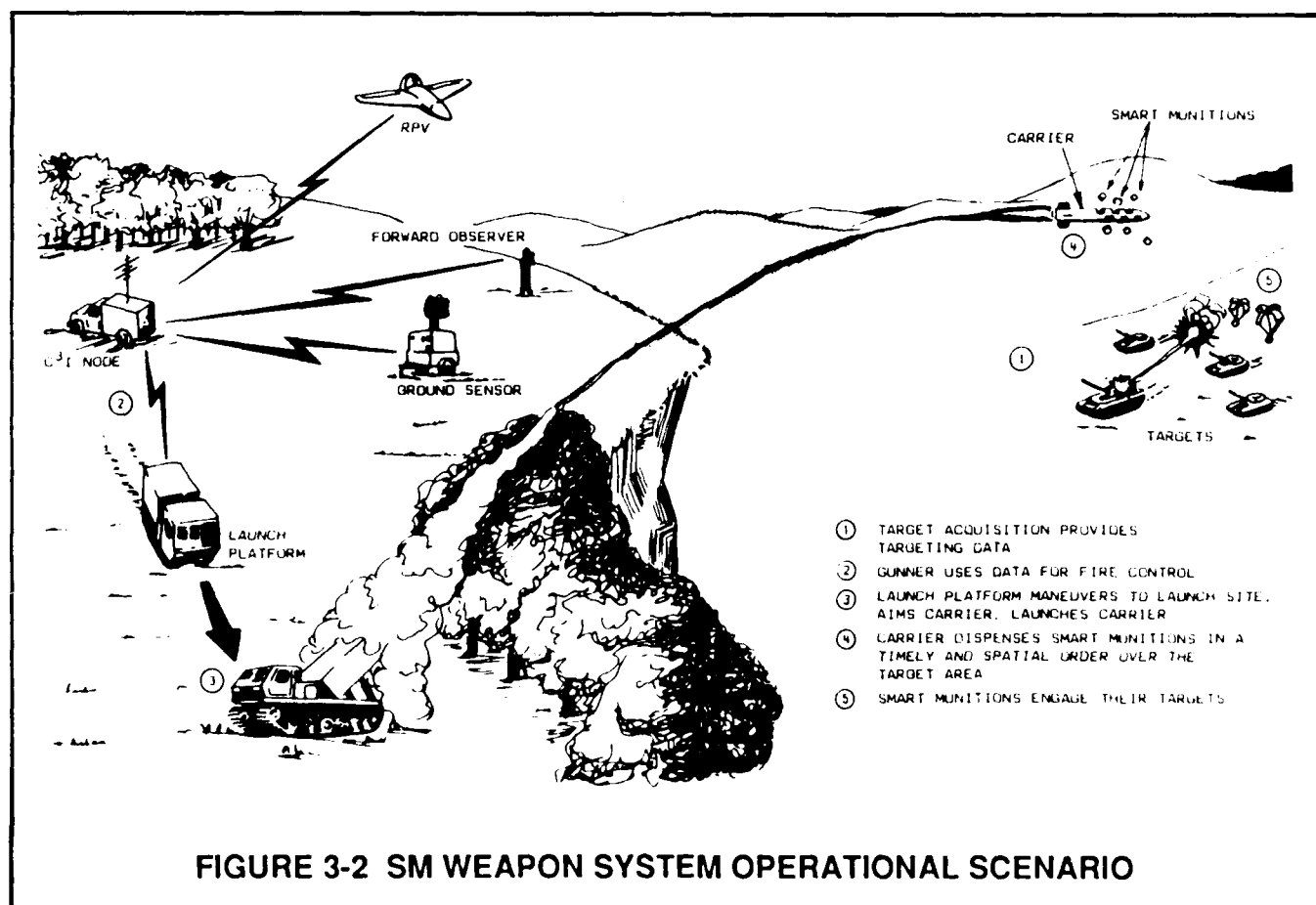


FIGURE 3-1 A SM WEAPON SYSTEM

In an operational scenario, a gunner obtains information regarding target location and the specific time of engagement. Target location can originate from any one or a combination of sources. These include aerial and ground sensors, forward observers, or target acquisition/fire-control equipment onboard the launch platform. The gunner then prepares to launch the smart munition carriers. The primary function of the launch platform is to transport, aim, and launch (fire, shoot, dispense, and drop) the carrier. It must then transport the SMs contained within its airframe from the launch location to the geographic point at which the SMs will be dispensed. The carrier must have the capability

to dispense the SMs in such a manner as to achieve a dispersal pattern that will result in the maximum number of engagement opportunities for that particular set of SMs. Once dispensed from the carrier, the smart munition must search for and engage targets. The way the SMs engage targets is dependent upon search pattern, trajectory, kill concepts (hit-to-kill or shoot-to-kill), etc. Figure 3-2 portrays a possible SM weapon system in an operational scenario.

Current efforts focus on indirect fire SM weapon system concepts. In this concept, the gunner does not have a direct LOS to the target, the range from the launch platform to the target is



normally in excess of 5 km, the SM's momentum is provided by the carrier, and one carrier delivers many SMs to engage many targets.

There are a variety of carriers and launch platforms from which SMs may be deployed. Furthermore, the configurations of the SMs themselves will be governed by the environment and the characteristics of the target arrays. The result is a number of possible SM weapon system configurations. The various combinations of these elements will yield weapon systems with varied degrees of effectiveness for given battlefield parameters. These parameters include the mission area in which the SM weapon system is deployed, the range from the launch platform to the target set, as well as the characteristics of the target.

These considerations, mission area, range, and target, drive the development of SM weapon systems, as well as their use on the battlefield. For example, SMs deployed among close combat forces would probably require some type of man-portable or vehicular launch platform. Launch platforms in the fire support mission area could include artillery and multiple rocket launchers, while the aviation mission area could include helicopters and remotely piloted vehicles (RPVs).

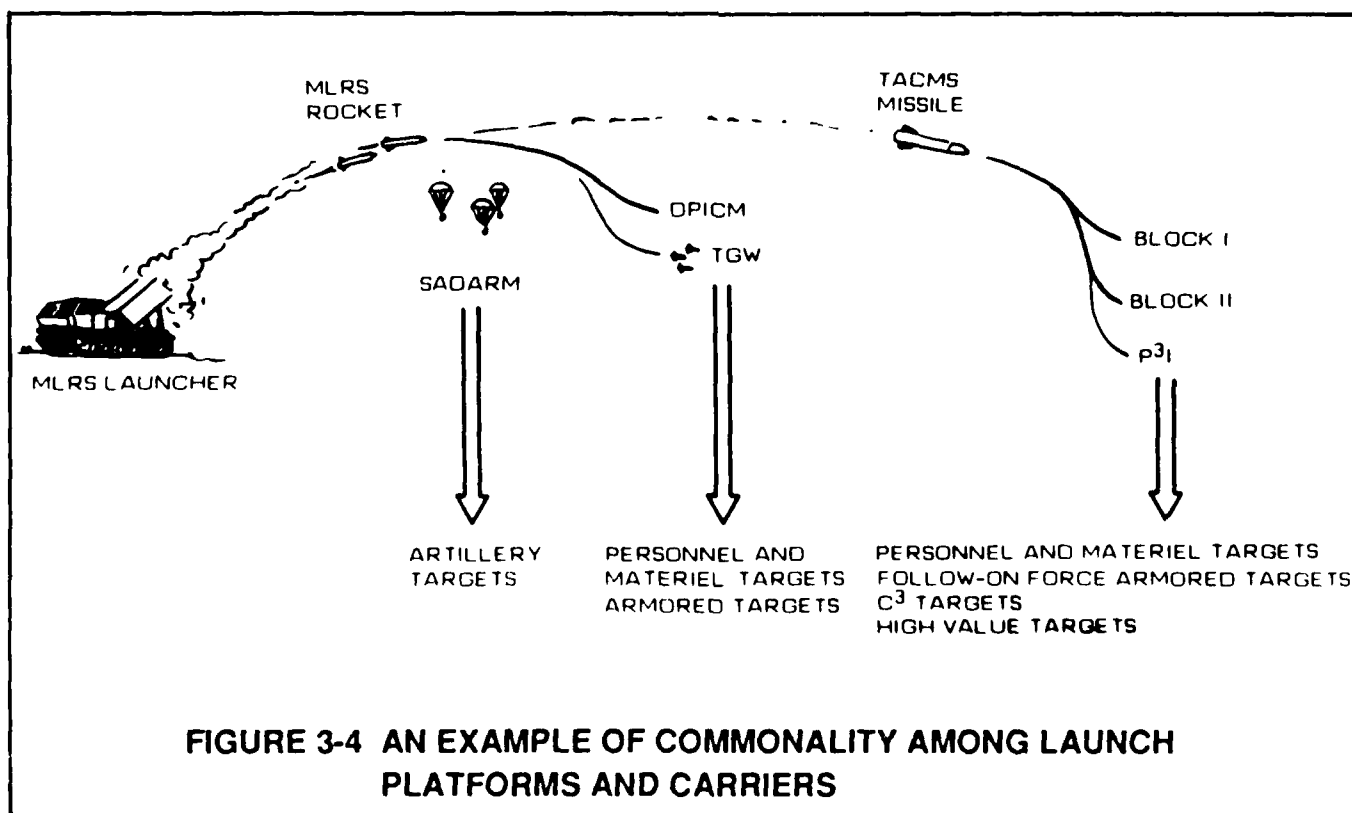
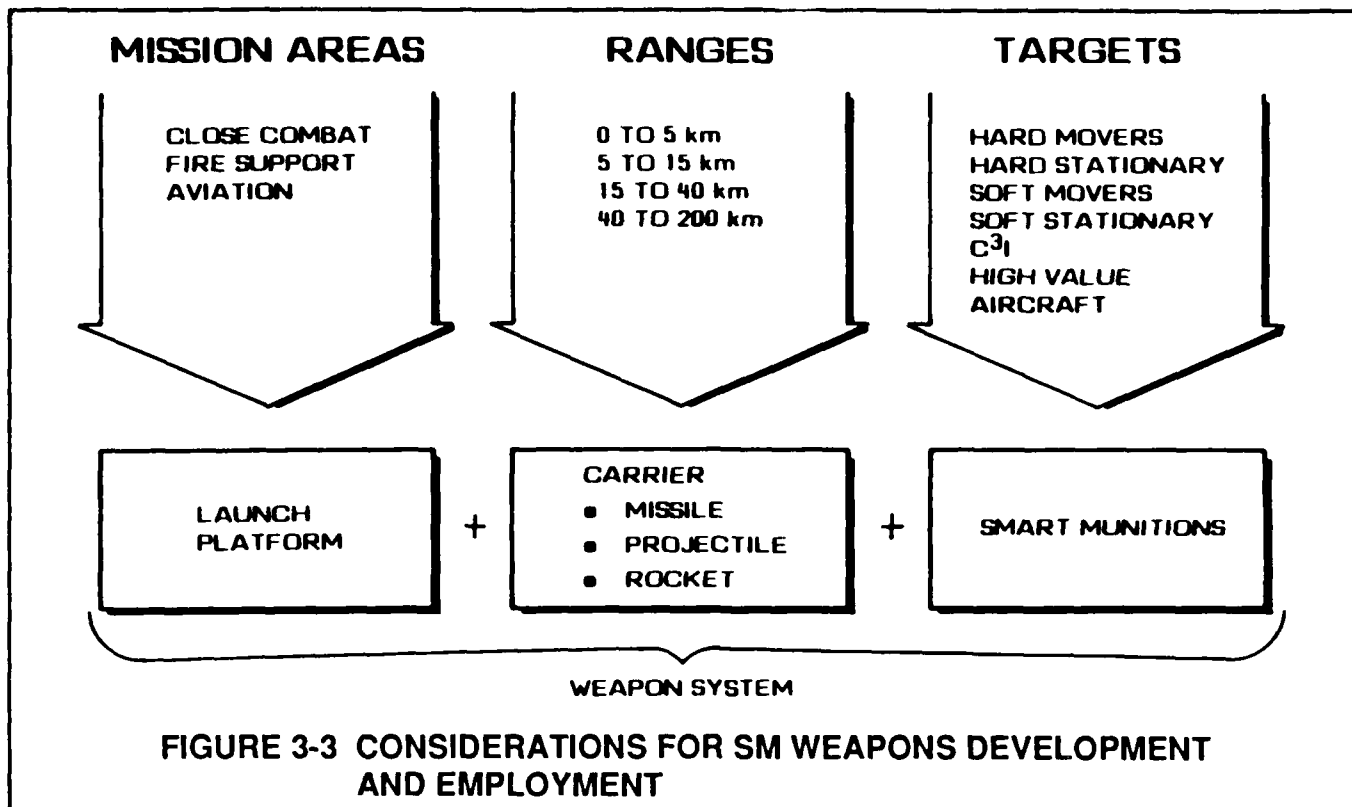
The choice of carrier will be based on the intended engagement range. The carrier must be designed to carry and dispense the desired number of SMs. The particular SM that will result in the highest weapon system effectiveness varies with the characteristics of the target or target set. These characteristics include armor thickness,

moving or stationary, target value (i.e., a jeep compared to a tank), target density, etc. For example, a parachute-suspended munition that employs a small search footprint and is not highly maneuverable would not be as effective against moving targets as a munition that guides to the target more rapidly and is highly maneuverable. The SM concepts and the way in which target characteristics drive the choice of the munition will be discussed later. Figure 3-3 emphasizes the way battlefield parameters effect the development and employment of SM weapon systems.

SM weapon systems may include the same launch platform and carrier and employ different SMs. As shown in Figure 3-4, the MLRS launcher and rocket system could be used to deliver SFMs or TGSMs. Since the SM itself must search for and engage armored targets, the choice of an SFM or TGSM significantly affects the weapon system effectiveness against various targets. Commanders on the battlefield must choose the weapon system that delivers the SM with the highest effectiveness and efficiency against the intended target. The following discussion of the two SM concepts will help the reader gain a better understanding of the technical features, performance, and factors driving the development of and decision to use an SFM or TGSM.

3.2 TWO SMART MUNITION CONCEPTS - TGSM AND SFM

Two clearly defined SM concepts currently under development are the Terminally Guided Submissile (TGSM) and the Sensor Fuzed

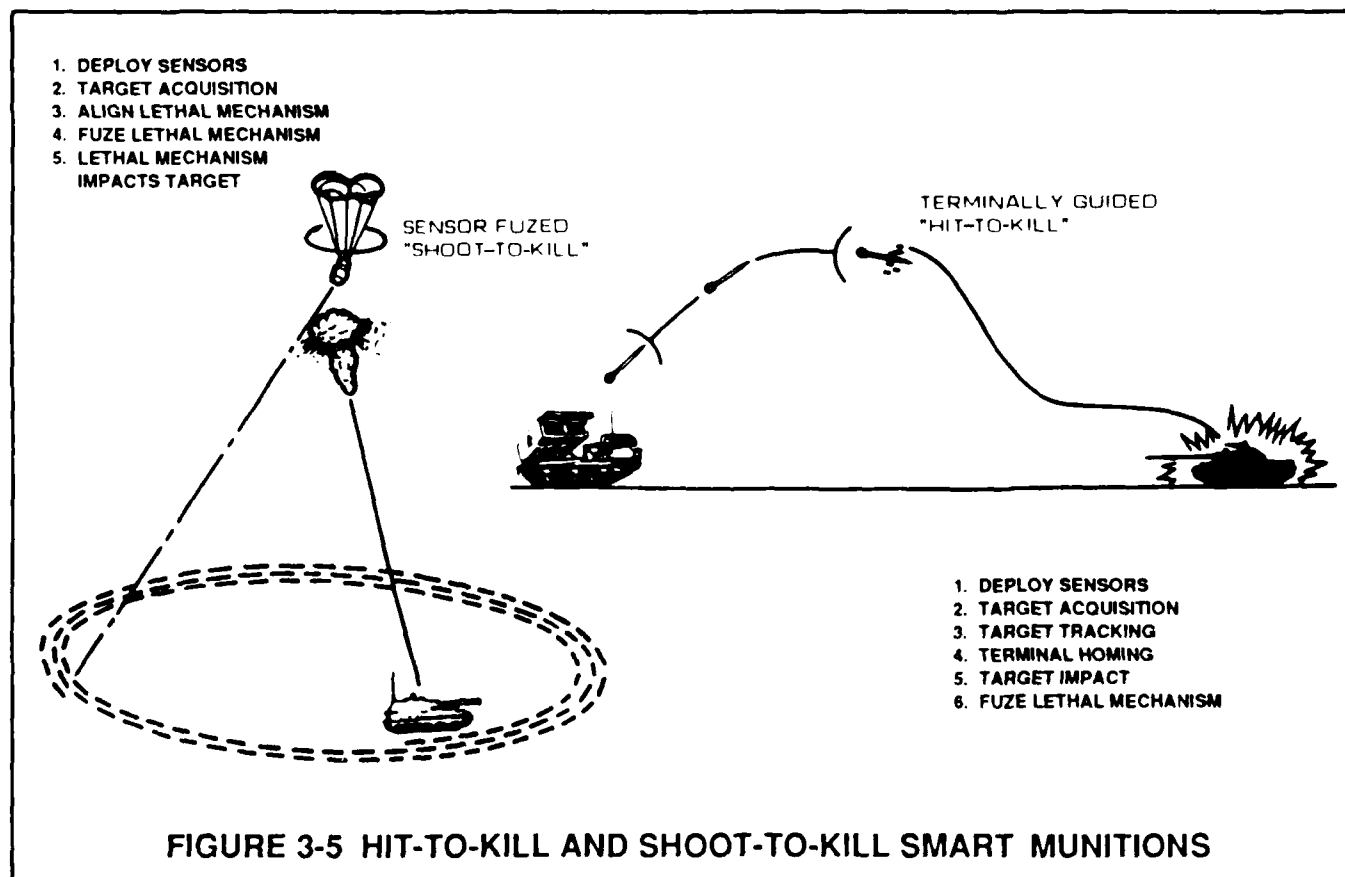


Munition (SFM). The subsystems that make these concepts unique include lethal mechanisms, sensors/seekers, airframes, etc. Various combinations of these subsystems result in SMs that either "hit-to-kill" or "shoot-to-kill" their target. A "hit-to-kill" SM must guide to target impact in order to defeat the target, while in the "shoot-to-kill" concept, a lethal mechanism is fired at the target while some distance away. As shown in Figure 3-5, TGSMs employ the "hit-to-kill" concept, while the SFMs employ the "shoot-to-kill" concept.

It is desirable to contrast these concepts in terms of their development and operational characteristics. From a development point of view, the SM designer is concerned with the

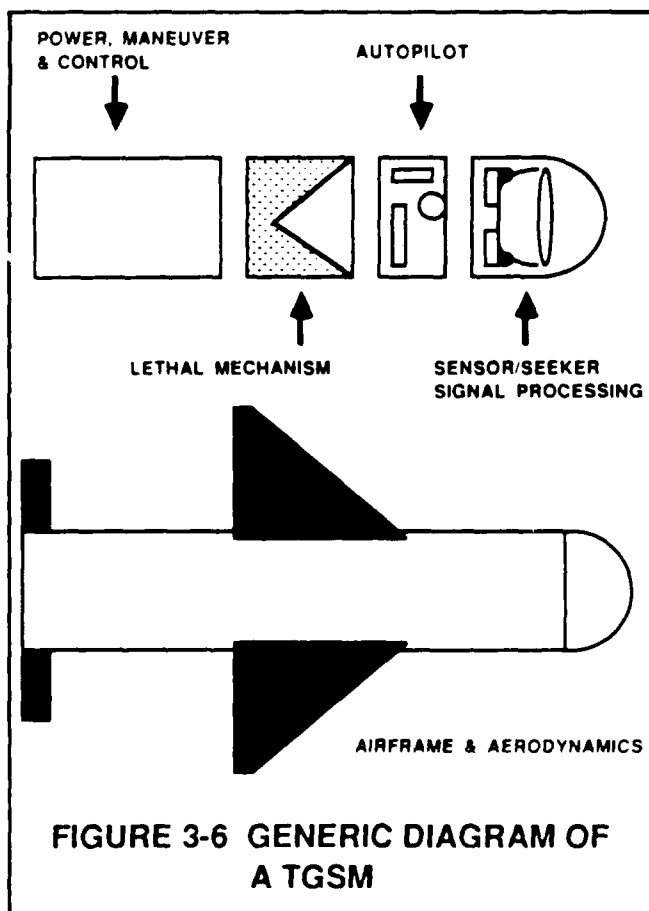
physical features that allow the TGSM to function as a "hit-to-kill" munition and the SFM to function as a "shoot-to-kill" munition and how these munitions function on the battlefield. The battlefield commander is concerned with the advantages/disadvantages he gains by choosing an SFM over a TGSM or vice versa.

The TGSM is the SM designed to "hit-to-kill" armored targets. The TGSM is delivered to the target area by the carrier, which dispenses a number of TGSMs and provides the momentum necessary for the unpowered, guided submissile to maneuver through the atmosphere. Once the TGSM is dispensed from the carrier and stabilized, it employs a large area search footprint. Upon target acquisition, the TGSM



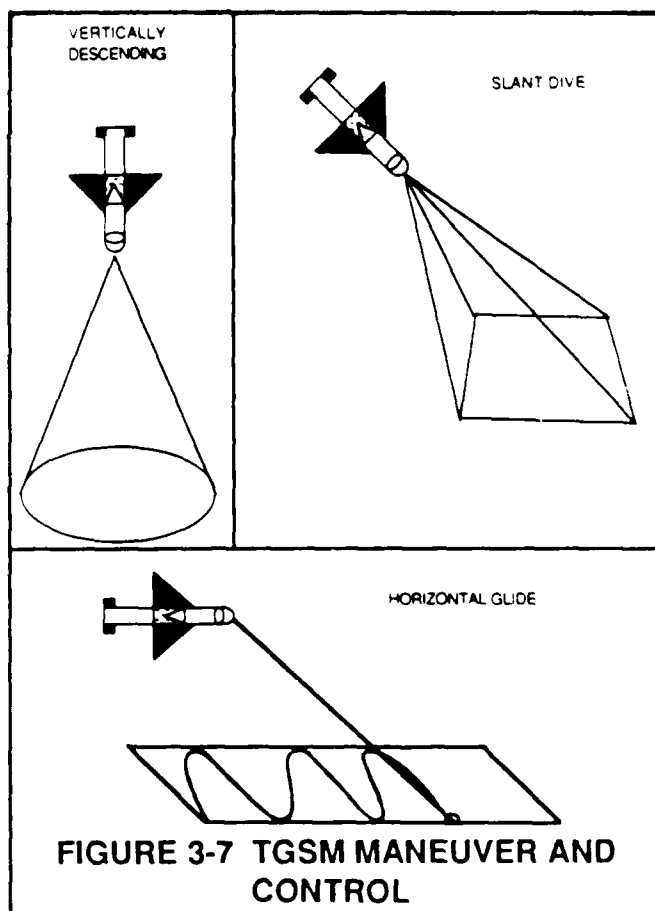
tracks the target and terminally homes to target impact. The lethal mechanism is detonated upon target impact.

The TGSM is comprised of a maneuver and control subsystem to govern the translation of the munition, an autopilot to generate steering commands, a sensor/seeker subsystem to receive radiation emitted or reflected from the target and process this data, a power subsystem to actuate the aerodynamic control surfaces, and an airframe to hold these subsystems and provide aerodynamic control surfaces, as well as a point contact fuzing mechanism and lethal mechanism to actually destroy the target. A generic diagram of a TGSM is presented in Figure 3-6.



The TGSM can be deployed to obtain this larger area search footprint, compared to SFMs, in either a vertically descending, slant dive, or horizontal glide mode as shown in Figure 3-7. The TGSM seeker must detect a target within this large area search footprint at much longer ranges than an SFM. It must then be able to track the target as it guides to target impact. The range at which the seeker must detect and track targets is a function of depression angle, altitude above target, and scanning angle. A TGSM generally has low depression angles and wide scan angles, resulting in longer slant ranges compared to SFMs.

The ability to generate large search area footprints and guide itself to target impact



requires additional subsystems. This requirement increases the cost of a TGSM. It is estimated that the relative cost of a TGSM versus an SFM lies between 4:1 and 10:1. As designs mature, the range of uncertainty in estimated cost should decrease.

To fully appreciate the concept, one must ask, "What capabilities will the TGSM provide on the battlefield?". First, the large area search footprint will help compensate for inaccuracies in pinpointing target location and in delivery. Furthermore, the TGSM can engage targets that are widely scattered and, even though they may be moving, can keep them within its search footprint. In addition, there is a significant probability that more potential targets will move into the larger search footprint. The ability to track targets, perform "high-g" maneuvers, and terminally home to the target will allow the TGSM to engage moving targets. Also, the lethal mechanisms employed by TGSMs have improved armor penetration capabilities when compared to the lethal mechanisms employed by SFMs. This feature will allow the engagement of heavily armored targets.

The SFM is the SM designed to "shoot-to-kill" armored targets. The SFM is delivered to and dispensed over the target area by a carrier. Once the SFM is dispensed and stabilized, its sensor begins to search for targets within a small search footprint. Upon target detection, the SFM immediately fuzes its lethal mechanism and directs it at the target.

Note that instead of guiding to target impact, the SFM fires its lethal mechanism from a

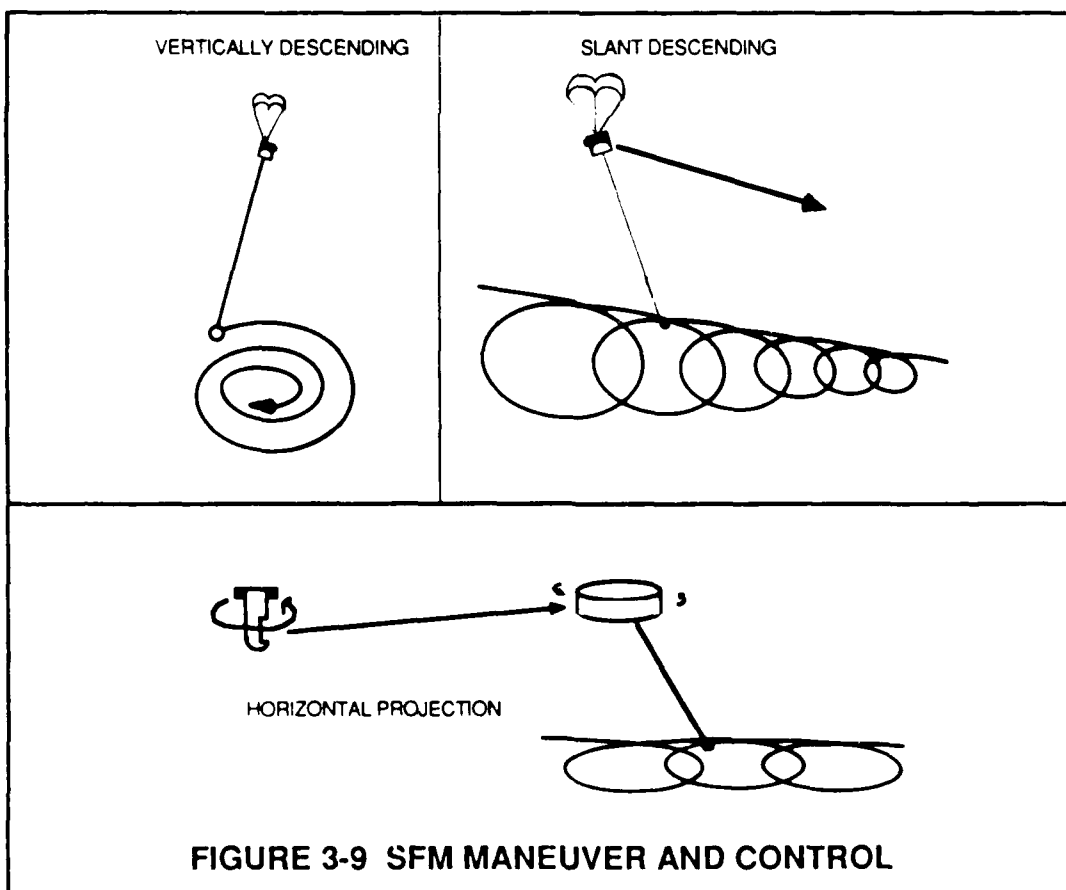
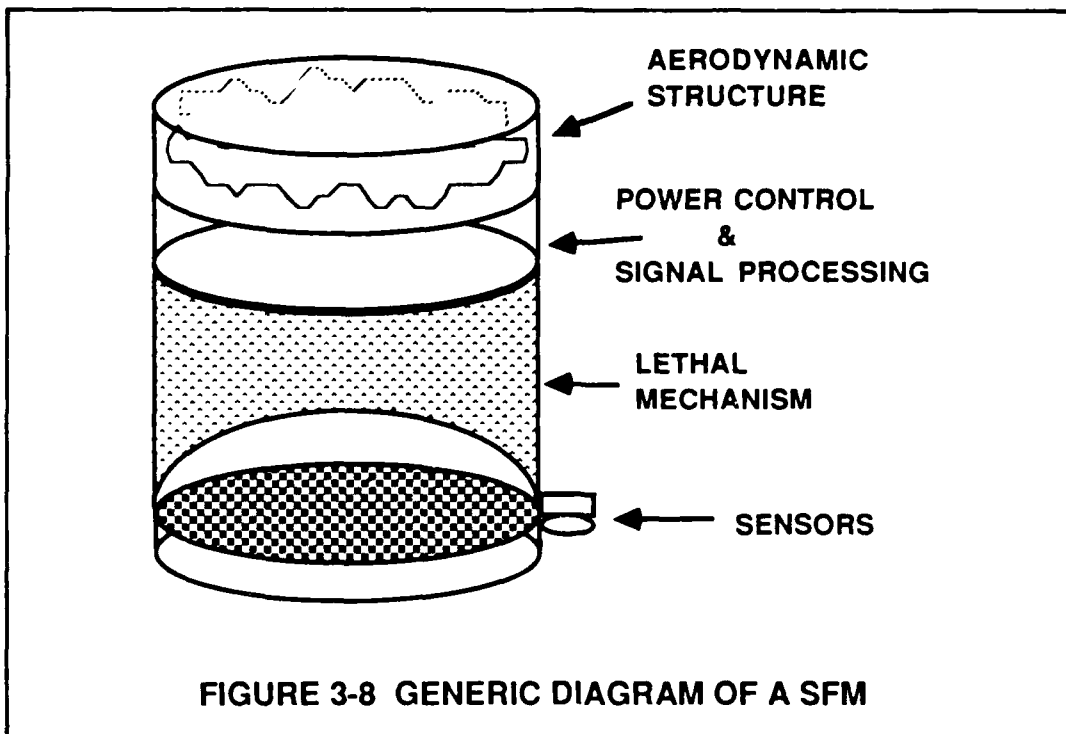
standoff position where detection takes place. The result is a much simpler munition configuration, i.e., fewer subsystems are needed than in the case of a TGSM. Thus, the SFM includes sensors, signal processing, a lethal mechanism, power and control subsystem, and possibly an autopilot depending on the SFM design, as well as an airframe to enclose all subsystems. A generic diagram of an SFM configuration is given in Figure 3-8.

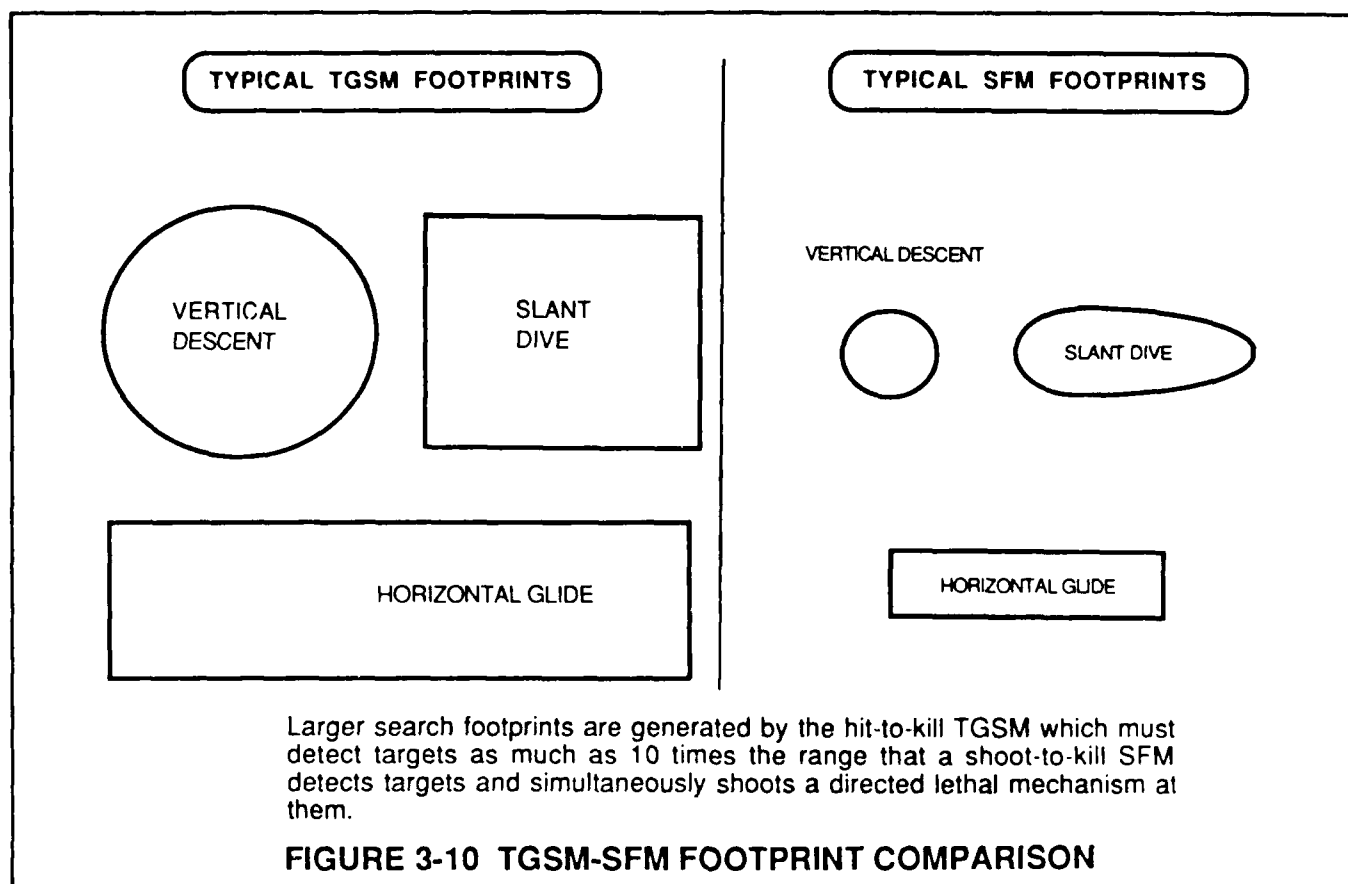
SFM's can be designed to search for targets in a number of ways as shown in Figure 3-9. The munition may be equipped with a parachute which both slows and stabilizes the descent and imparts spinning motion so that the sensors can sweep out a search area on the ground. A simple parachute results in a simple vertical descent, while mechanization of a steerable parachute can extend the footprint area.

The SFM searches for targets from lower altitudes and at steeper depression angles than a TGSM. This search geometry results in much shorter slant ranges and smaller search area footprints, both of which are necessary for effective "shoot-to-kill" munitions. For comparison purposes, the relative sizes and shapes of the search footprints of the TGSM and the SFM are given in Figure 3-10.

The simplicity of design of an SFM compared to the TGSM significantly reduces its cost. As mentioned previously, an SFM can be between 0.1 and 0.25 the cost of a TGSM.

Due to its smaller search footprints, the efficient use of SFMs requires better target location and smart munition placement.





Furthermore, the SFM will be more effective against slow-moving or stationary targets. The battlefield commander must also remember that due to differences in lethal mechanism design, the SFM may not penetrate as much armor as a TGSM. SFMs may be more appropriate for softer targets. Also, due to its lower cost, the SFM provides a cost-effective method of engaging self-propelled artillery, armored fighting vehicles, etc. Figure 3-11 summarizes the comparison between the SFM and TGSM.

3.3 OTHER TYPES OF SMART MUNITION WEAPON SYSTEMS

In some cases, the launch platform and delivery vehicle may be one entity. For example,

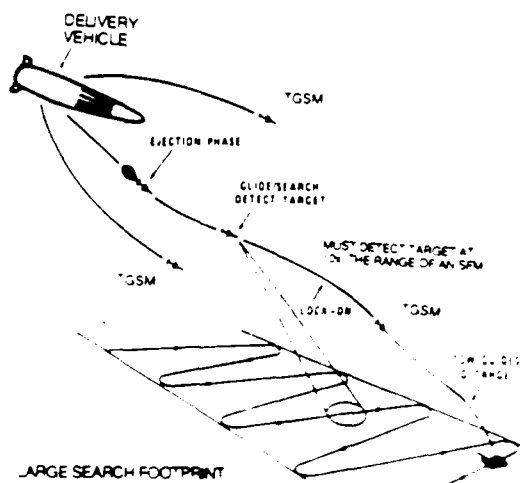
a jet aircraft or RPV may dispense or drop SMs directly over the target area. In this case, the launch platform also serves as a carrier. In such cases, the vehicles are referred to as "delivery vehicles." While an attack employing a delivery vehicle may still be a many-on-many scenario, this type of engagement may not be cost effective due to the attrition rate of the delivery vehicle (see Figure 3-12a).

In other cases, the smart munition may contain its own propulsion and therefore is a true smart missile with its inherent fire-and-forget capability. Thus, a carrier is no longer needed. The smart munition propels itself from the launch platform to the target area to search for and engage a target (see Figure 3-12b). These smart

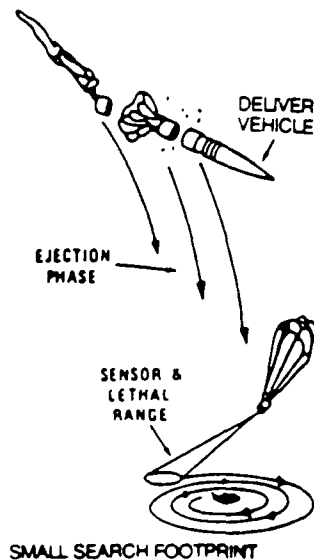
SMART MUNITION CONCEPT COMPARISON

SMART MUNITION DELIVERY SEQUENCES

TERMINALLY GUIDED SUBMISSILES

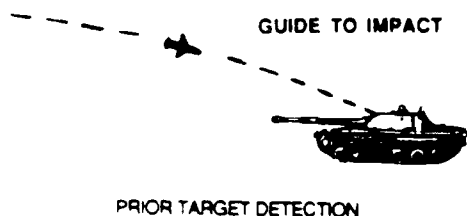


SENSOR FUZED MUNITIONS

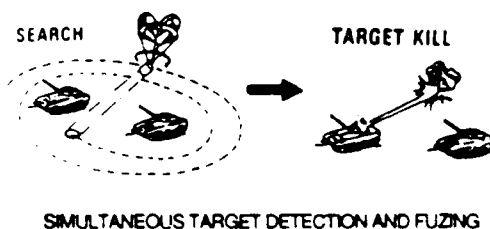


KILL CONCEPTS

HIT-TO-KILL (TGSMs)



SHOOT-TO-KILL (SFM)



EMPLOYMENT PRINCIPLES

TERMINALLY GUIDED MUNITIONS (EG. RLGS-TGM)

- BEST SUITED WHEN:
- LARGER TARGET LOCATION ERRORS (TLE)
 - LARGER DELIVERY ERRORS (DE)
 - MOVING AND STATIONARY TARGETS
 - ANTI-AIRBORNE AND DEEP BATTLE ROLES

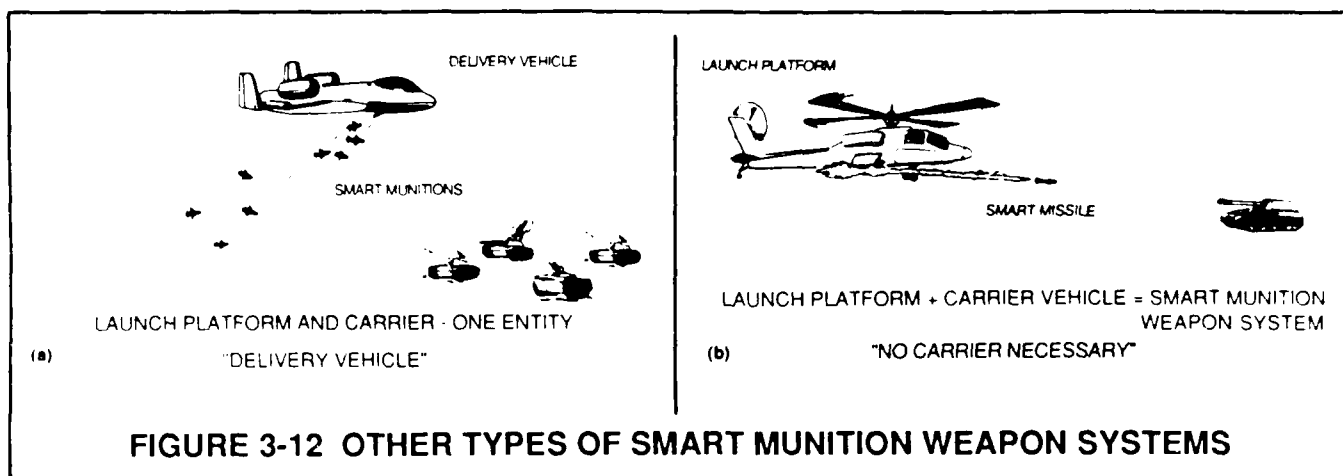
- ↓
- HIGHER COMPLEXITY
 - HIGHER UNIT COST
 - HARDER TARGETS

SENSOR FUZED MUNITIONS (EG. SABARM)

- BEST SUITED WHEN:
- SMALL TARGET LOCATION ERRORS (TLE)
 - SMALL DELIVERY ERRORS (DE)
 - STATIONARY TARGETS
 - COUNTERFIRE ROLE VS SPM

- ↓
- LOWER COMPLEXITY
 - LOWER UNIT COST
 - SOFTER TARGETS

FIGURE 3-11 TGSM-SFM MUNITION COMPARISON



munition weapon systems will be designed for one-on-one engagements and may offer improved performance over fielded one-on-one systems which are command guided.

4. SMART MUNITION SUBSYSTEM TECHNOLOGIES

As previously discussed, SMs consist of a number of rather complex components. Whether a TGSM or SFM, many similarities exist among these components. Sensors and lethal mechanisms are the most critical for SM performance and are presented in detail.

4.1 AUTOPILOT

The autopilot interprets the data provided by the internal sensors to produce commands that cause the SM to maneuver. The design of the autopilot depends primarily on the aerodynamics of the airframe. The vertically descending SFM does not require an autopilot.

4.2 MANEUVER/CONTROL

The munition's area of search is generated by a combination of a scanning process and the

translation of the munition. For example, both the vertically descending TGSM and SFM are rotated to generate an annular scan on the ground. The vertical descent of the munition causes ever-decreasing circles to be swept out, thus filling the pattern.

Subsequent to target detection, engagement of the target may require additional maneuvering. This is true for all TGSMs which must impact the target and may be true for the slant gliding SFM. Ideally, the munition should be able to maneuver to any target detected within the search footprint and achieve an approach angle and terminal aimpoint which maximize the efficiency of the lethal mechanism.

4.3 SENSORS

In order to detect targets, the SM must employ some type of sensor. Sensors are the components that link the SM to the outside world. They do this by receiving electromagnetic radiation emitted by targets and their surrounding environment and incident upon the sensor apertures. The sensor then produces internal electrical responses that change as the incident

radiation changes. These electrical signals are sent to a signal processor onboard the SM where they are analyzed to determine guidance commands for a TGSM or fuzing decisions for the SFM.

The various sources of radiation on the battlefield are shown in Figure 4-1. These sources can be grouped into three categories: 1) energy reflected by the target; 2) energy emitted by the target; or 3) energy reflected and emitted by the background (rocks, trees, sun, clouds, sky, etc.).

Sensor characteristics are difficult to generalize because of the various

techniques/technologies employed in their design. It will be useful to discuss two major sensor characteristics. These are the operating mode (which can be passive, active, or dual mode) and the operating waveband (which can include various regions of the electromagnetic spectrum).

A sensor that operates in a passive mode receives radiation emitted or reflected by objects on the battlefield. In a passive system, it is desirable that the emitting and/or reflecting characteristics of the target dominate those of the background. An operational block diagram of a passive sensor is shown in Figure 4-2. Radiation

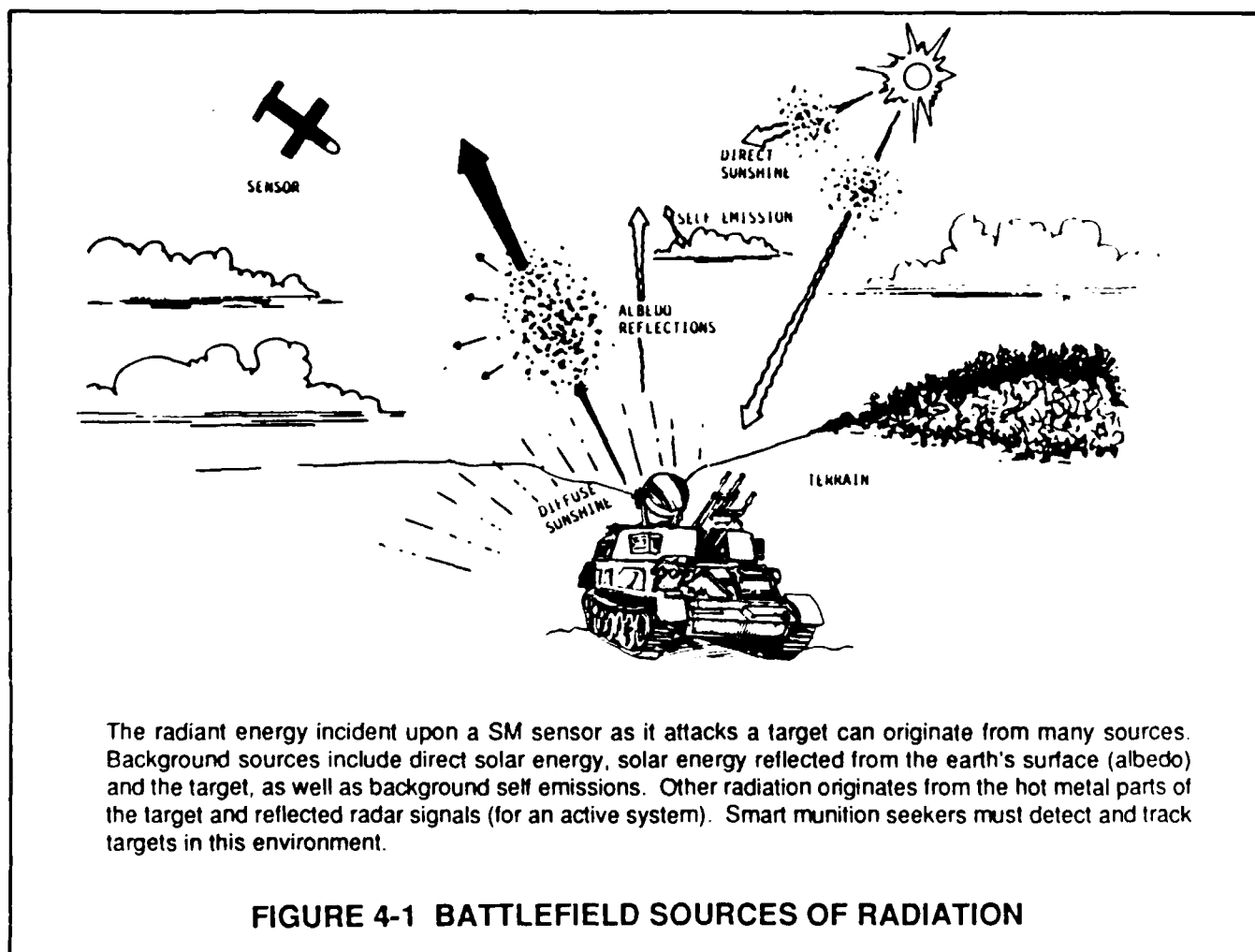
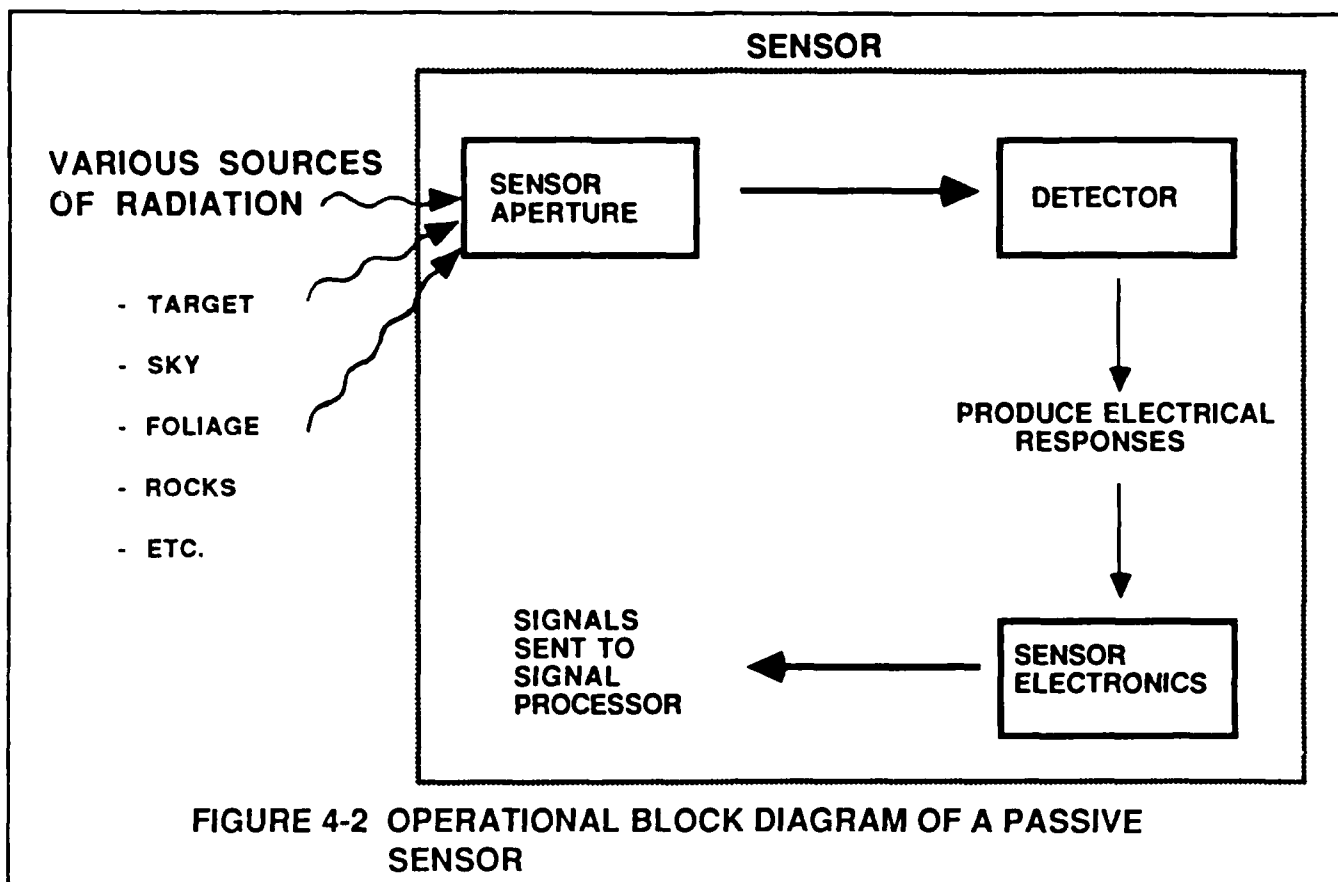


FIGURE 4-1 BATTLEFIELD SOURCES OF RADIATION



from various sources is incident upon the sensor aperture which collects and focuses the radiation upon a detector and is exploited by the signal processor. Note that all the radiation originated outside the sensor.

A sensor that operates in the active mode transmits radiation and receives the associated reflections, as well as radiation from other sources. An operation block diagram of an active sensor is shown in Figure 4-3. A transmitter onboard the SM transmits radiation and illuminates objects within its footprint. Part of the illuminating beam is reflected and that radiation, along with radiation from other sources, is incident upon the sensor aperture.

Electrical responses are produced and sent to the signal processor. The key difference in the active and passive system is the addition of a transmitter for an active system. Also, a major source of radiation reaching the sensor aperture is reflected radiation that originated within the sensor itself.

Sensors can also be designed to operate in a dual mode. This may include an active mode for target acquisition and tracking and a passive mode for the terminal phase of a TGSM or simultaneous active/passive sensing of an SFM. Dual-mode sensors offer the most promising technology for the next generation of SMs.

Sensors may be further characterized by

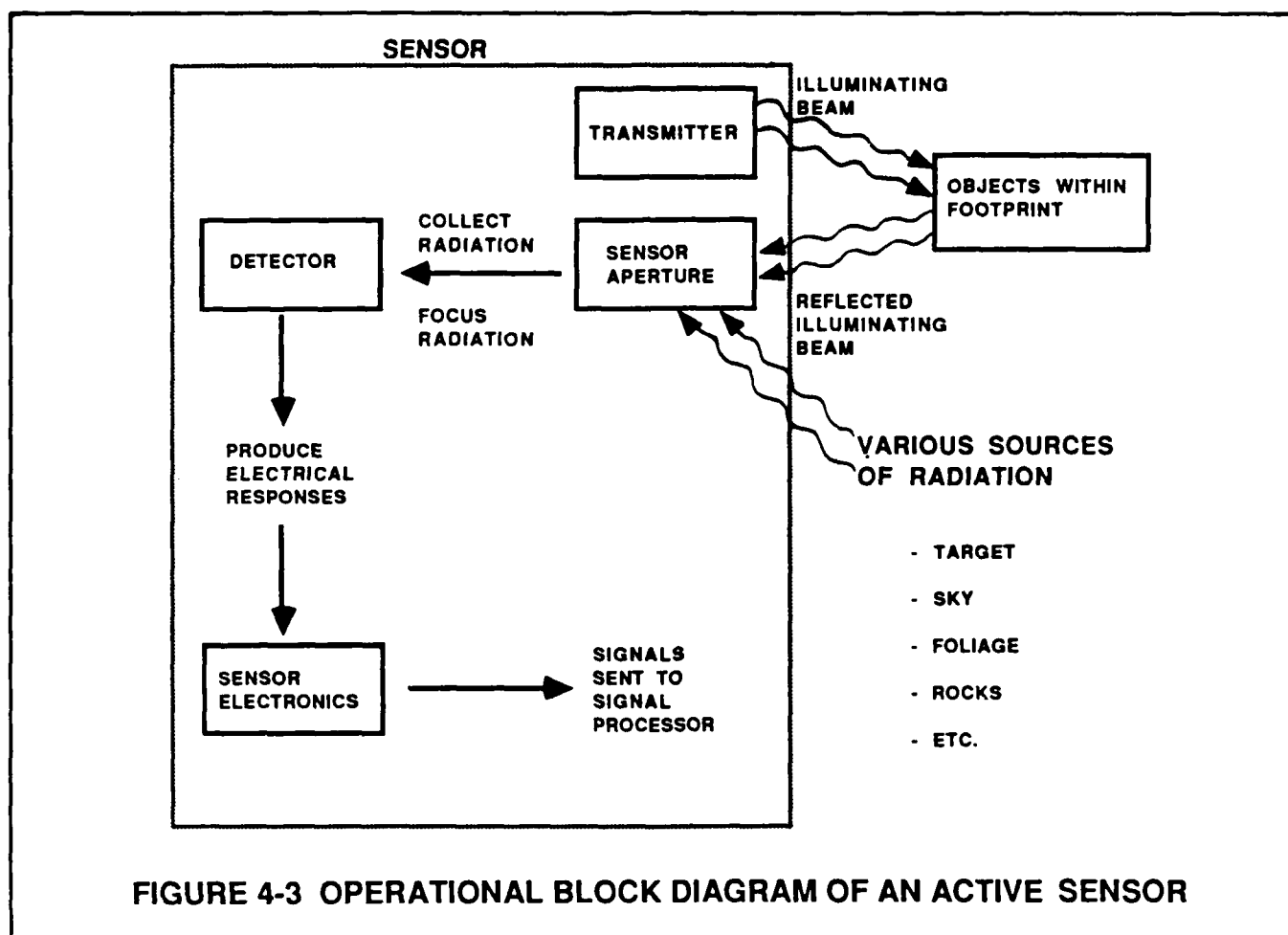


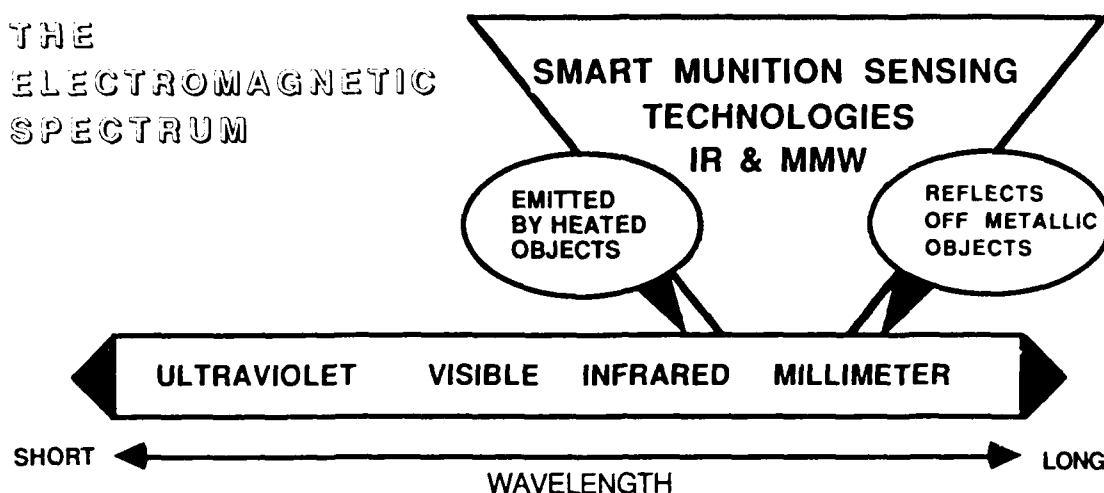
FIGURE 4-3 OPERATIONAL BLOCK DIAGRAM OF AN ACTIVE SENSOR

their operating wavebands. As shown in Figure 4-4, the leading candidates are passive sensors operating at infrared (IR) wavelengths, active sensors that operate at millimeter wavelengths, or a combination of the two. The IR and millimeter wave (MMW) sensors have been preferred because of their inherent day/night operating capability and their packaging compatibility within practical constraints typically imposed by both SFMs and TGSMs. Within the IR and MMW technologies there are many degrees of freedom potentially available to discriminate the target from background or from other interfering sources.

In addition to their search function, the sensor/seeker must also make a measurement of target location with respect to the munition so that the target can be engaged. The sensors may also be used to determine munition height above the terrain in order to improve the glide path. Thus, sensor selection and design are driven by many factors other than the autonomous target detection function. The TGSM with its large engagement footprint places the largest demand on its sensor.

There is no perfect choice of a sensor for use in an SM. The environment, target signature, and countermeasures (CMs), as well as size, cost,

THE ELECTROMAGNETIC SPECTRUM



The maximum amount of radiant energy emitted by heated objects lies within the Infrared portion of the electromagnetic spectrum. Metal objects are highly reflective to radiation characterized by millimeter wavelengths. These are just a few of the physical principles involved with the detection of armored vehicles in a battlefield environment.

FIGURE 4-4 SM SENSING TECHNOLOGIES

and complexity may lead to different tradeoffs. Ideally, the sensor must be able to operate in adverse environments (dirty battlefields), under less than ideal weather conditions, and in variable terrains. The sensor must also be capable of operating in the presence of battlefield obscurants and CMs including passive signature modifiers and suppressors and decoys, as well as active jammers and directed-energy radiation.

In general, the more degrees of freedom (i.e., independent measures of the sensed scene) that exist in the extracted signal, the better quality and reliability of the output decision. That is, a real target is more likely to be detected, and a false target is more likely to be rejected. There is no exact science to dictate just what must be sensed about a military target in a realistic

battlefield environment to correctly distinguish the desired target from clutter, system noise, and CMs. Thus, a variety of sensing techniques are under development. The following is a brief and simplistic discussion of the more common sensor types.

4.3.1 Single-Color Infrared

This is the simplest type of IR sensor. It operates in the passive mode by optically scanning the target area for the IR radiation emitted in a single waveband by all bodies. It has the advantage of high angular resolution, small size, and low cost. It has day/night capability, but can be severely limited by weather conditions. The purpose of an IR homing device is to receive IR radiation reflected or emitted from targets, such

as helicopters, armored vehicles, and artillery, and to autonomously generate signals for missile guidance.

4.3.2 Two-Color Infrared

This is an IR sensor that detects the target signature in two different wavebands, thus allowing better discrimination against backgrounds and decoys than that achieved by a single-color sensor (see Figure 4-5).

The comparison of the signals received in the two wavebands gives the capability to estimate target temperatures based upon the differences in signatures between two objects such as a tank and a flare. For example, a flare and an exhaust might radiate nearly equal energy in one waveband, while any temperature difference between the two sources would lead to different radiation levels in another IR band. Thus, using information in both bands allows a munition to distinguish between the two sources, thus permitting recognition of the real target. Two-color IR suffers most of the same disadvantages as single-color IR such as degradation in adverse weather.

4.3.3 Imaging Infrared (IIR)

The system designer may opt for high angular resolution for target detection and tracking rather than resolution of target temperature. The result is a signal that has image-like properties. The absolute resolution and total number of pixels (picture elements) can vary dramatically from one design to another. Thus, terms such as "quasi-imaging" are sometimes used to denote less than a TV-like

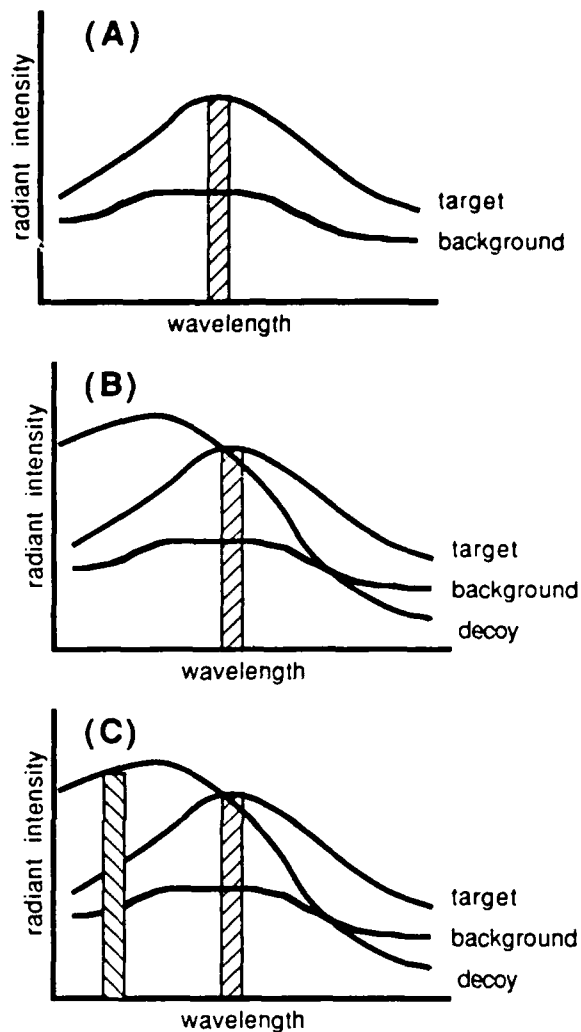
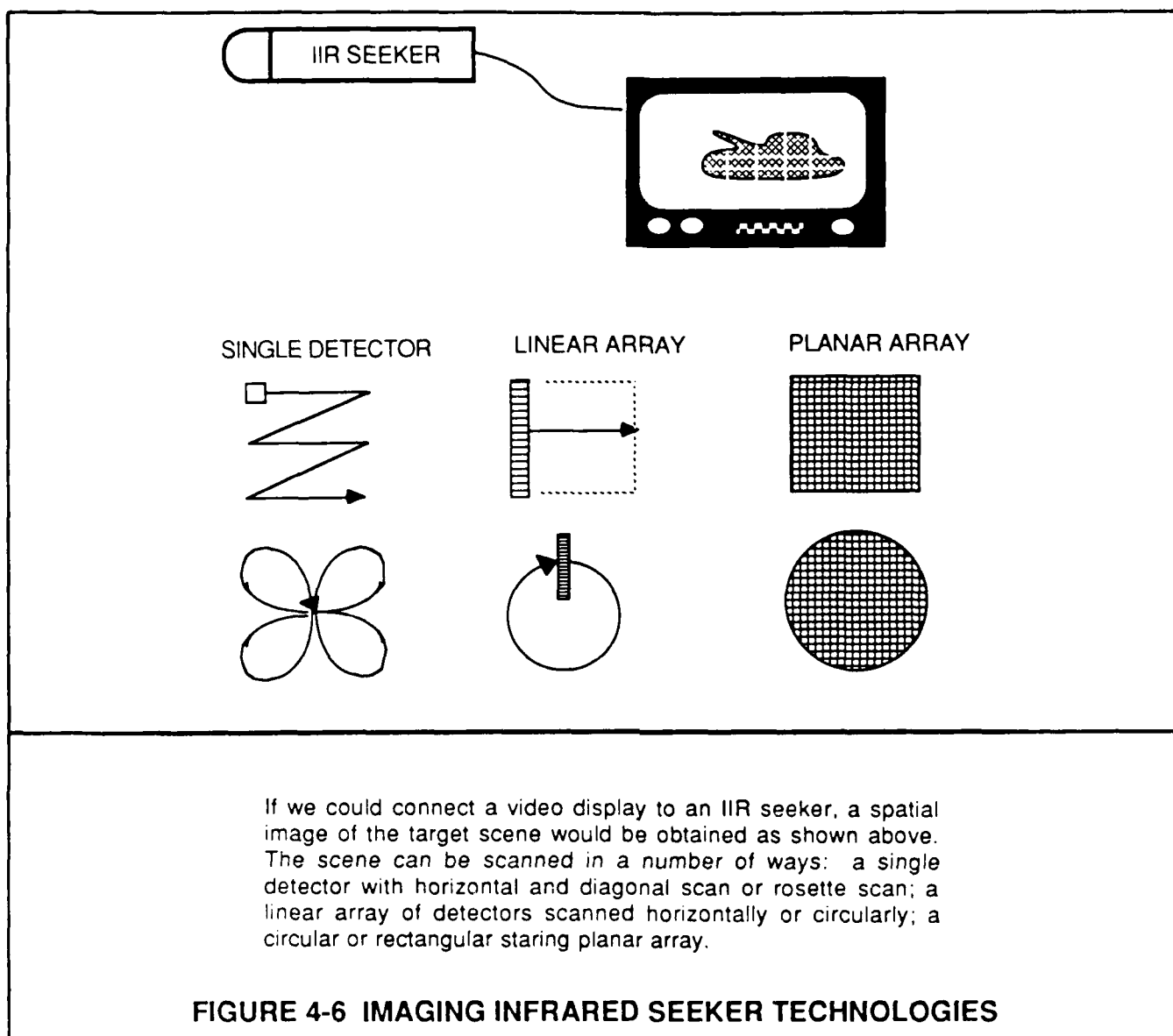


**FIGURE 4-5 TWO COLOR IR
OPERATING PRINCIPLES**

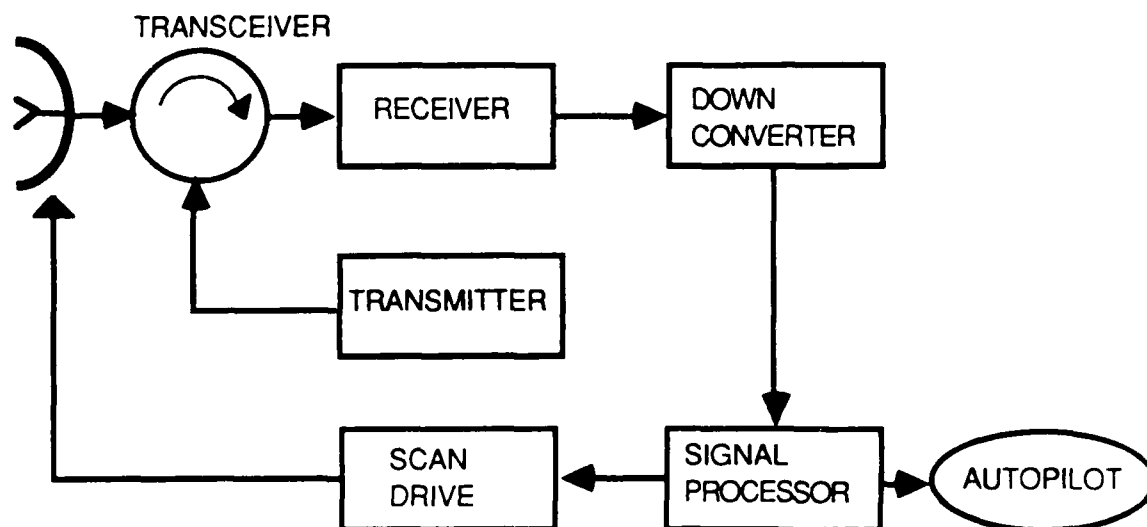
format and resolution. A number of techniques are used to form the image, which is the result of scanning one or more detectors in the image (or focal) plane of the seeker or, in the extreme, filling the image plane with detectors and performing no scanning at all. The various IIR scanning techniques are shown in Figure 4-6.



4.3.4 Millimeter Wave (MMW)

This type sensor can operate in two modes: active and passive. When operating in the active mode, a MMW sensor is similar to a microwave radar that transmits a signal of known characteristics and processes its return to determine target parameters. However, they differ in the frequency of the transmitted signal. A block diagram of an active MMW seeker is

shown in Figure 4-7. MMW technology is relatively new, therefore terminology to differentiate designs has not fully evolved. However, one will hear terms such as "polarametric" or "cross pole" applied to the sensor to imply that more than one sense of polarization is being used in either the transmit function, the receiving function, or both. Also, because range resolution is a distinguishing



A generic active MMW seeker consists of a transmitter to produce radiation, an antenna to direct and collect the radiation, a receiver (sensor), a transceiver to send radiation to the antenna and returns to the receiver, a down converter to manipulate the radar returns, and a signal processor to produce commands which drive the seeker scan and guide the munition.

FIGURE 4-7 ACTIVE MMW SEEKER BLOCK DIAGRAM

feature of active systems (which most but not all MMW sensors are), terms such as "fine range gated" and "range profile" are used.

MMW falls between the IR and microwave bands and has some of the characteristics of both; therefore, in addition to the active mode it can also operate in the passive mode similar to an IR optical system which is influenced by sky radiation reflected by the target and its environment. The advantage of MMW when compared to optical systems is good operational capability under adverse weather conditions and superior propagation characteristics through smoke, haze, dust, and fog.

For active MMW, the ability to measure additional parameters, such as range, increases the degrees of freedom for better discrimination and improved guidance. Compared to microwave systems of the same antenna size, MMW systems have a much narrower beamwidth which makes possible more accurate angular tracking, provides higher resistance to mainlobe jamming, and results in decreased clutter levels.

These characteristics indicate that MMW technology may have advantages over IR devices for weapons guidance. The disadvantages of MMW are: 1) the short radio frequency wavelengths are susceptible to rain attenuation; 2) the acquisition

range of MMW devices tends to be limited by atmospheric absorption, even on clear days with high visibility; and 3) many critical MMW components such as transmitters and low-noise, wide-bandwidth receivers are still in early development stages of maturity. In addition, they are sometimes bulky and certainly more expensive.

In summary, MMW sensors possess characteristics of both the microwave and electro-optical regions, which promotes attempts to blend the advantages of each. However, component technology developers have yet to prove that MMW seekers can be manufactured at a competitive cost when compared to IR seekers.

4.3.5 Multimode

By combining two or more guidance modes into a single munition, a multimode guidance system is obtained. These systems are intended to defeat enemy CMs, provide greater accuracy, reduce false alarms, or improve target detectability as compared to a single-mode system. This term is sometimes erroneously employed to denote systems that utilize more than one portion of the electromagnetic spectrum for their operation. For example, a system may use both multimode (active or passive) and multispectral (MMW and IR) systems. The onboard electronics and processing requirements increase in complexity and cost with multimode systems because of the additional sensor and signal processing requirements. On the positive side, the employment of a variety of sensors increases the burden of the sophistication and cost of the

enemy's CM devices and materials.

While the discussion above has touched on most of the common types of sensors and seekers under active consideration today, it is by no means complete. There are many possible variations on the concepts described. Furthermore, the designer of a sensor will typically give his concept a short title based on a distinguishing feature or combination of features. These short titles by no means encompass or capture the nature of the design, nor can they be used as the basis for comparing concepts, cost, performance, or operational utility.

4.4 SEEKERS

The seeker, which is employed in the TGSM, takes the sensor data and processes it for use by the SM. It orients the sensor to survey, acquire, and (finally) to lock-on and track the target. The major components of a seeker are:

1. Energy-gathering subsystem antenna for radio frequency or lens/mirror for optical spectrum;
2. Sensor to convert the received energy into a more usable signal processing format and, for an active system, a transceiver to transmit energy and convert received energy;
3. Stabilization subsystem to decouple the sensor from the airframe motions - this is typically accomplished with gimbals, torquers, and rate sensors; and

4. Signal processing subsystem to produce a signal to point the antenna/mirror at the target and/or to provide signals to ultimately control the missile's trajectory.

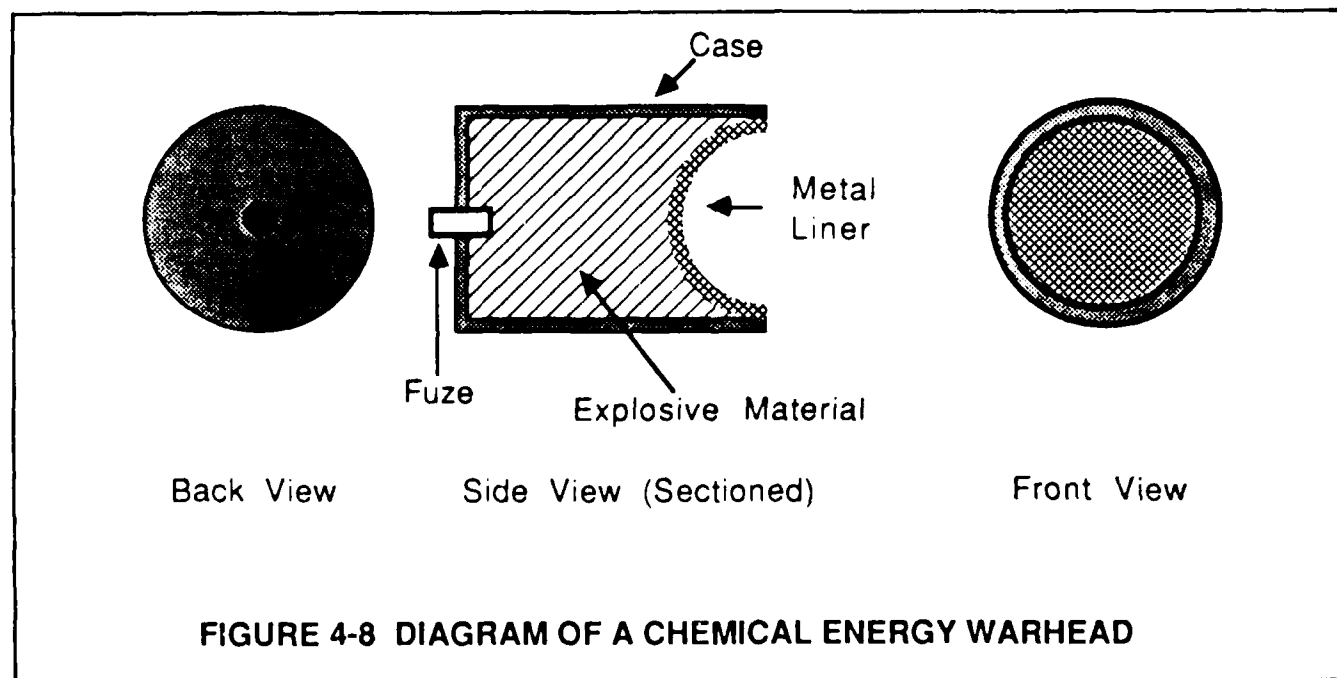
The additional complexity of the stabilization and signal processing subsystems is needed to achieve large search areas and implement the "hit-to-kill" concept. Equally significant is the requirement to employ sensors that have ten times the operating range as those used in the "shoot-to-kill" munitions.

4.5 WARHEADS

Chemical energy warheads are the lethal mechanisms used by SMs to defeat targets. In addition to the primary components shown in Figure 4-8, the chemical energy warhead may contain stand-off sensors and a safe and arming

device. In operation, the fuze ignites the explosive material; the case and liner shape (but they do not contain) the explosion; some of the explosive energy is transferred to the liner; and, depending on the design of the warhead, varying amounts of liner material is reformed and accelerated forward. Simply put, to defeat the target, this reformed liner material must penetrate the target's outer skin.

The outer skin of most SM targets is covered with armor. To defeat these targets, the warhead must penetrate different types of armor which often is quite thick and designed to reduce warhead effectiveness. Figure 4-9 is a diagram of a section of armor before and after warhead impact. Note that the warhead has made a hole in the armor and has caused secondary fragmentation debris generally referred to as "spall". It is the reformed material that penetrates the target and, very importantly, the spall that causes target



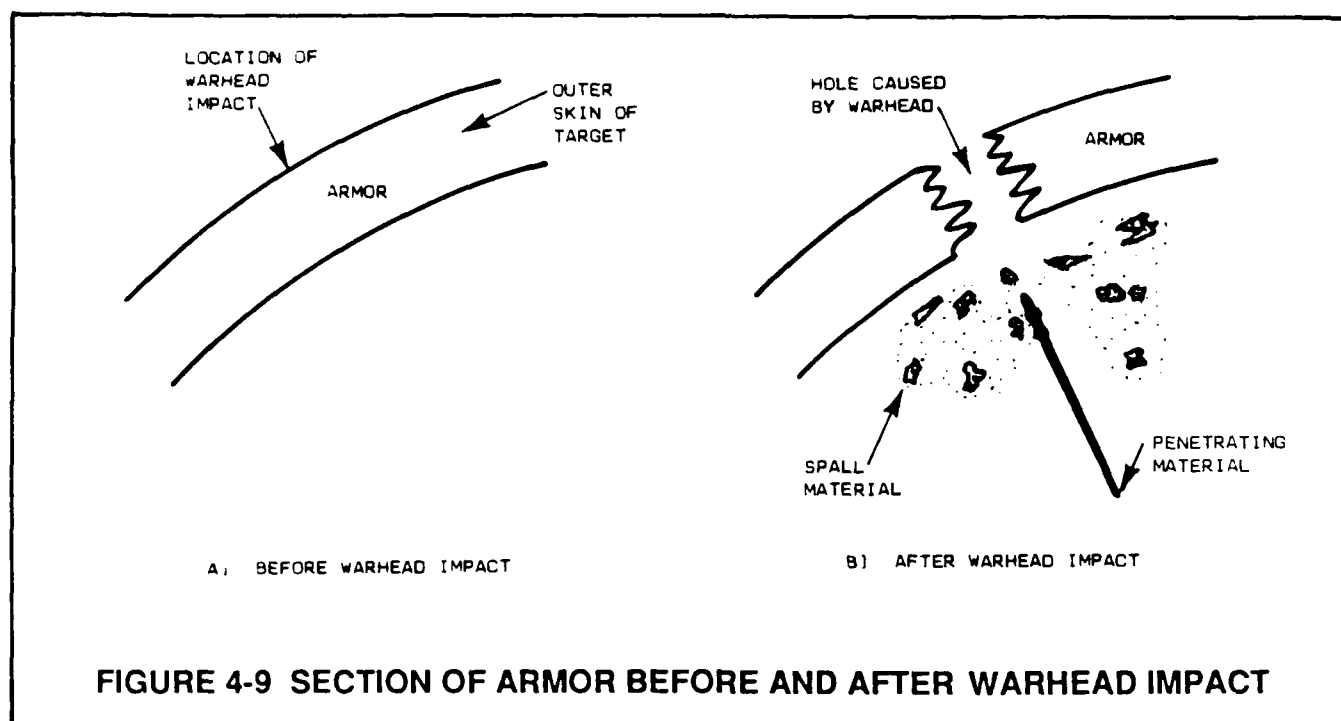


FIGURE 4-9 SECTION OF ARMOR BEFORE AND AFTER WARHEAD IMPACT

damage. Antiarmor warheads for SMs range in size from 10 to 15 cm in diameter and weigh approximately 3 to 6 kg.

There are two very different kinds of chemical energy warheads used against armored targets, namely, shaped charge (SC) warheads and explosively formed penetrators (EFPs). The two kinds of warheads are obtained by critical differences in shaping of the liner and case and fuzing of the explosive material. For SC warheads, the warhead explosion results in a portion of the liner being transformed into a long (dozens of centimeters) thin (millimeters in diameter) jet of ultra-high velocity metal; it is this jet that penetrates the target. For EFP warheads, the warhead explosion causes the liner to be folded upon itself to form a short rod (a few centimeters in diameter and several centimeters

long) or ball-like slug of metal that penetrates the target. The liners, after warhead detonation, are shown in Figure 4-10. One might also note in this figure that the liner for the SC is cone shaped, with the cone surrounded by explosive material, while the EFP liner is only slightly indented. The velocity of the jet from the SC is 1,000 to 10,000 m/s, and the velocity of the slug from the EFP is 2000 to 3000 m/s. The performances of these two warheads are distinctly different and both have application in different kinds of SMs.

The important performance differences between the two warheads are shown in Figure 4-11. SC warheads have tremendous capability to penetrate armor; however, to achieve this, the standoff distance (distance of warhead from armor at time of warhead) must be carefully controlled.

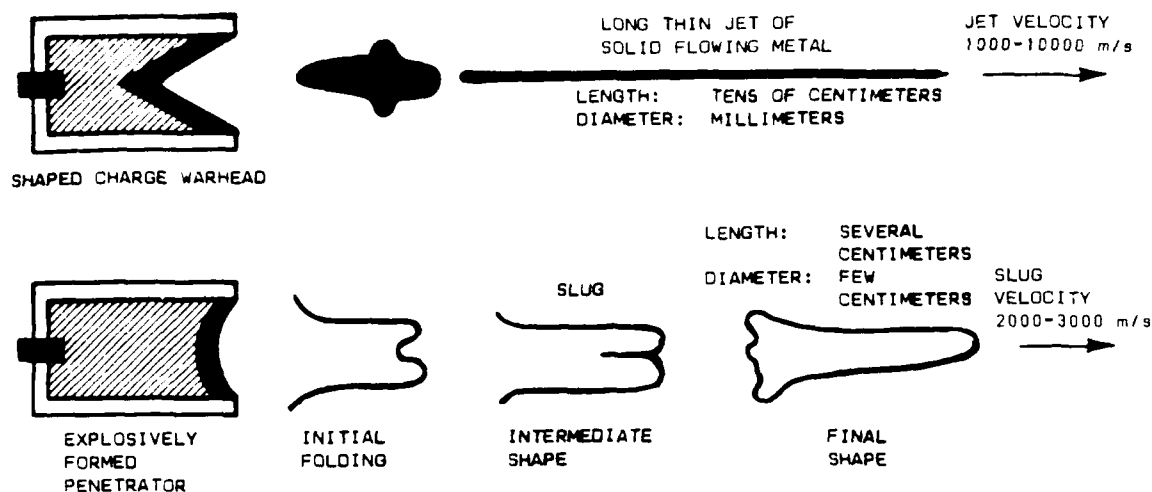


FIGURE 4-10 KILL MECHANISMS FROM SC AND EFP WARHEADS

The standoff detonation distance must be sufficiently great to allow room for the jet to form, but if the distance is too great, the jet breaks up into segments before reaching the target. In the latter case, jet penetrability decreases rapidly.

EFP warheads have significantly less penetrability than SC devices, but in many other respects they excel. For example, given a standoff distance sufficient for the slug to be shaped, the penetrability of the slug is quite insensitive to standoff distance. In fact, penetrability is almost constant for standoff distances between several meters and several tens of meters.

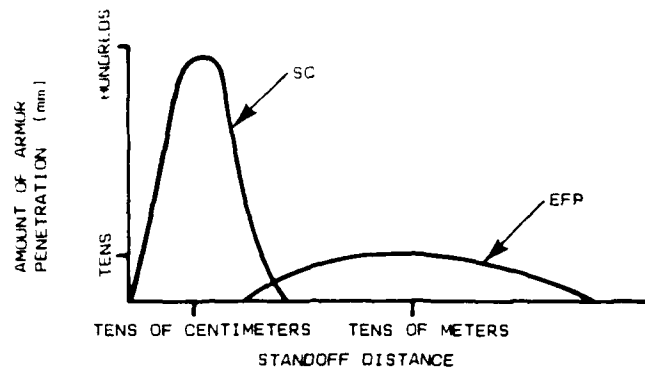
Given warhead penetration of the target, the diameter of the hole in the armor is proportional to the diameter and velocity of the penetrator; i.e., millimeters for SC warheads and a few to several centimeters for EFP warheads. Again, given penetration of the target, the EFP (mainly

because of the size of the hole) generally produces more spall fragments than the SC warhead.

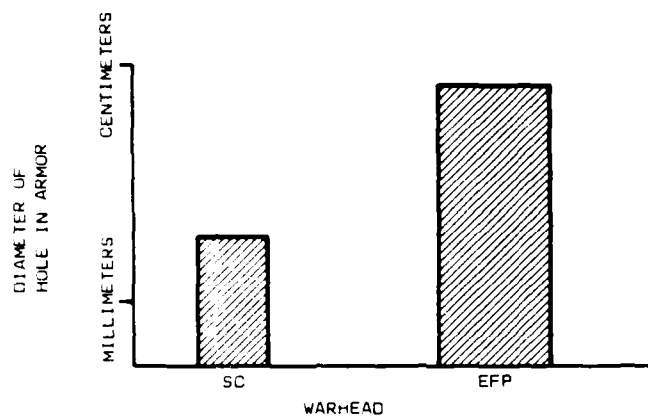
It is important to realize that both warheads are necessary. SC warheads are used in "hit-to-kill" TGMs as the higher penetrability of these warheads makes TGSMs effective against heavy armor. EFP warheads are used in "shoot-to-kill" SFMs and, as discussed previously, the munitions fuze (fire) the warhead while several meters from the target.

4.6 FUZE

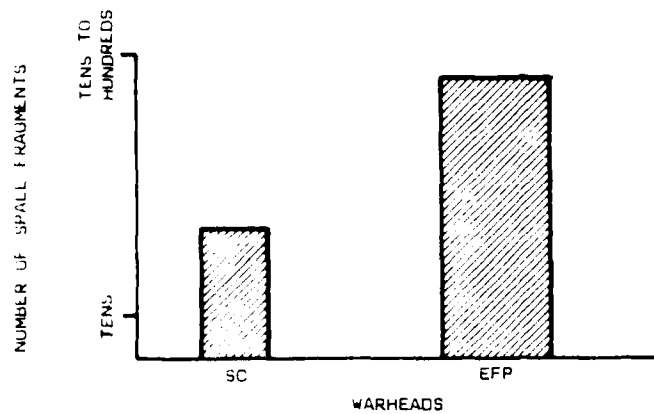
The function of the fuze is twofold: detonate the warhead at the proper time and provide safety during routine operations. The contact fuze of a TGSM ignites the warhead upon direct contact with the target. However, the SFM sensor remotely detects the presence of a target, determines the aimpoint, and fires an EFP. A safe and arming device provides safety during handling, storage,



a) Armor Penetration Versus Standoff Structure



b) Diameter of Hole in Armor



c) Number of Spall Fragments

FIGURE 4-11 PERFORMANCE OF SC AND EFP PENETRATORS

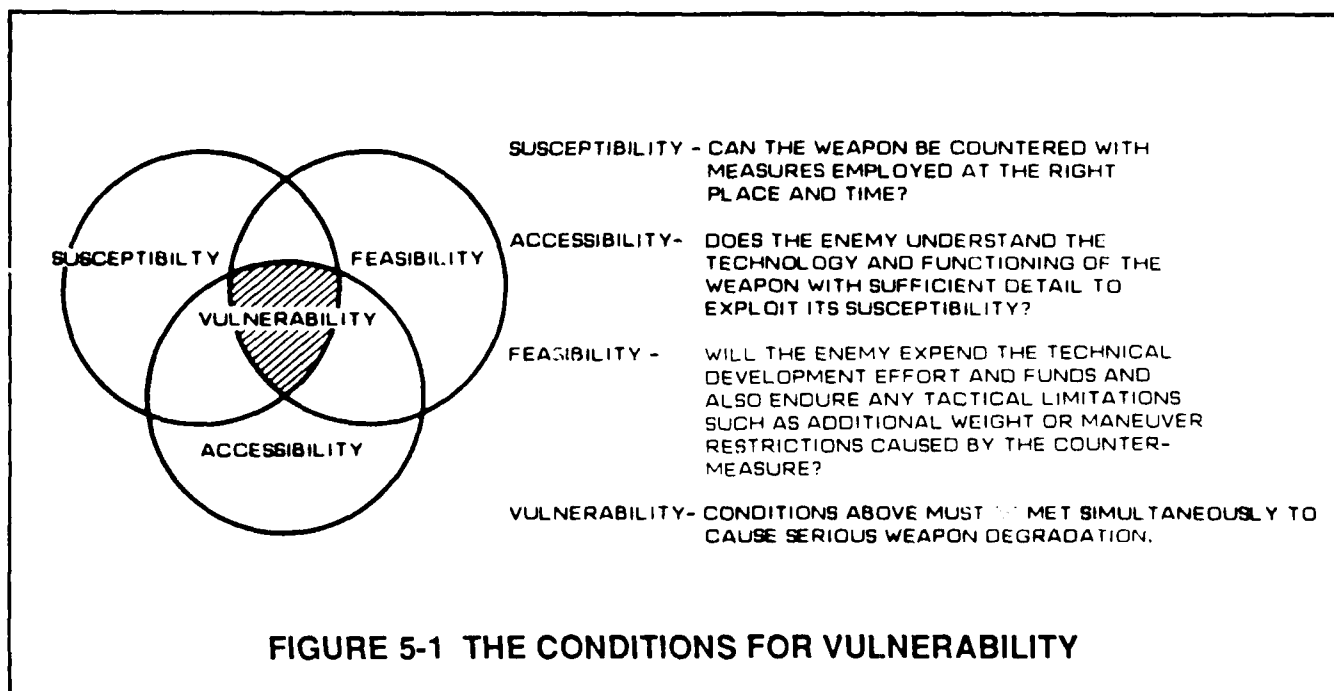
testing, and launch.

5. COUNTERMEASURES

A CM is a technique or device designed to degrade the performance of a weapon system. In the case of SMs, the enemy may deploy CMs which can reduce effectiveness by obstructing or confusing the SM sensor, reducing the armor penetration of the SM lethal mechanism, or destroying the SM before it engages the target. SM designers must be aware of the enemy's potential to develop and field effective CMs to SMs. If it is shown that the enemy will develop and employ CMs, the Army must determine if the expected CMs will cause serious weapon system degradation.

There are a number of conditions that must be simultaneously satisfied for a weapon system to be vulnerable to a CM or combination of CMs.

These are shown in Figure 5-1. and include susceptibility, accessibility, and feasibility. Only when all three conditions are met simultaneously is a weapon system vulnerable. If the weapon can be countered with measures employed at the right time and at the right place, it is susceptible. This factor does not depend upon the enemy's ability to develop and field the CM, only upon the technical characteristics of the weapon and the effects of the CM itself. Accessibility occurs when the enemy has access to the technical information that will allow design of a CM that exploits a particular susceptibility. However, even though a weapon may have a susceptibility to a CM and the enemy may have technical ability to access this susceptibility, the weapon may not be vulnerable. The enemy may not have nor be willing to commit the funds to develop and field the CM, or the employment of the CM may not be tactically



feasible. If a smart munition weapon system is susceptible to a CM, the enemy understands the technology sufficiently to exploit its susceptibility and has committed to develop, field, and employ the CM, then the SM weapon system is truly vulnerable.

A number of CMs to which SMs may be susceptible are shown in Figure 5-2. These CMs degrade SM performance by reducing: 1) the probability of acquisition, which is the statistical chance that a SM sensor/seeker can acquire a target; 2) the number of SMs available to engage targets; and 3) the probability that the SM will achieve a kill if it acquires a target.

The SM's probability of acquisition (P_{acq}) is decreased when its sensor does not receive a signature that it can detect. This can be accomplished by applying signature suppression

and modification to the target, deploying jammers that confuse the SM sensor, operating in the presence of obscurants (natural or man-made) that will attenuate target signatures, or using tactical and doctrinal techniques such as operation at night, "shoot and scoot," etc.

The enemy may reduce the number of SMs available to engage targets by employing decoys and jammers on which the SM may lock and engage, as well as directed-energy weapons which will destroy SM components.

Futhermore, CMs can also reduce the probability of kill given a target acquisition (P_{acq}). These include signature suppression and modifiers, as well as jammers (which can cause aimpoint error) and armor enhancements (which will reduce the penetration capabilities of the lethal mechanism).

COUNTERMEASURE CATEGORY	REDUCES SM P_{ACQ}	REDUCES NUMBER OF SUBMUNITIONS AVAILABLE TO ENGAGE TARGETS	REDUCES P_K/ACQ
SUPPRESSION	X		
DECOYS		X	
JAMMERS	X	X	X
DESTRUCTIVE DEVICES		X	
OBSCURANTS	X		
ARMOR ENHANCEMENTS			X
TACTICS	X		X

FIGURE 5-2 CMs AND INTENDED EFFECTS ON SMs

Computer modeling and analysis involving some early SM configurations (both SFM and TGSM) and their performance when tested against a variety of CMs have been performed for the many-on-many engagement scenario. Results of this analysis are illustrated in the curves in Figure 5-3. The right side of the top curve represents the number of target kills given a very high P_{acq} for the munition of interest. Movement to the left represents decreases in the P_{acq} . Movement downward represents decreases in the number of submunitions available to engage targets and/or decreases in the $P_{k/acq}$. Movements to the left and downward represent the employment of particular CMs. From the curves, the number of target kills remains generally

constant up to a certain point as the P_{acq} is decreased. The point where the number of kills begins to drop rapidly represents a very low P_{acq} . As shown, reducing the number of submunitions available or reducing the $P_{k/acq}$ lowers target kills more than reducing P_{acq} . Thus, for the many-on-many scenario, performance of SM weapon systems is generally insensitive to significant reductions in P_{acq} by a particular CM.

The Army must field a family of SM weapon systems that is robust against a variety of CMs. It can do this by minimizing susceptibilities of each SM and by fielding SM weapon systems that employ a variety of sensing techniques and lethal mechanisms.

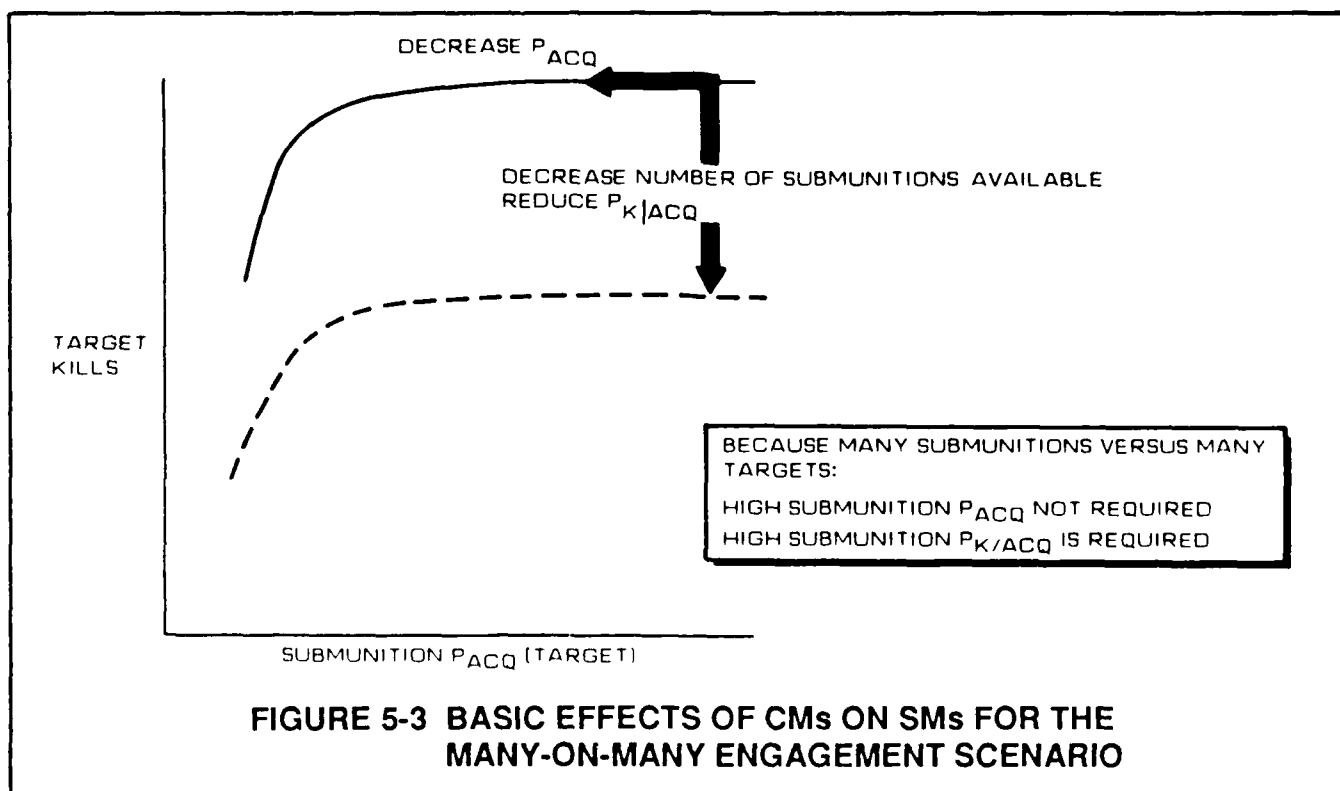


FIGURE 5-3 BASIC EFFECTS OF CMs ON SMs FOR THE MANY-ON-MANY ENGAGEMENT SCENARIO

6. CONCLUSIONS

The U.S. Army has invested extensive resources in the development of SM technologies. These technologies are maturing and the Army has begun funded development of SM weapon systems. These weapon systems will enhance our fighting capability by extending engagement ranges and allowing the Army to simultaneously fight the rear, close, and deep battles, while increasing engagement rates and survivability. These SM weapon systems will be employed at various levels of command. Various commanders, ranging from the battalion to the corps commander, may have SM weapon systems at their disposal that are designed to engage targets of interest. These targets will include artillery and armored vehicles, which make up the bulk of the Warsaw Pact threat to our ground forces.

While there are a few concepts that call for one-on-one engagements, the thrust of SMs development has focused on designing SM weapon systems for the indirect fire role. This implies many-on-many engagements. The SMs designed for this role can be divided into two categories: Sensor Fuzed Munitions and Terminally Guided Munitions. TGMs can be cannon launched, in which case they are referred to as Terminally

Guided Projectiles, or dispensed from rockets or missiles, in which case they are referred to as Terminally Guided Submissiles. While the design of TGP and TGSMs is diverging, their technology base is similar. SFMs can be dispensed by projectiles, rockets, and missiles as well as other carriers.

The two SM concepts, referred to as SFM and TGSM, will provide the tactical commander with complementary alternatives to engaging targets. The SFM is a "shoot-to-kill" munition that provides a cost-effective method of engaging slow-moving, closely packed, lightly armored targets (an artillery battery for example). The TGSM is a more complex and costly munition that employs the "hit-to-kill" concept. It has the capability to engage moving as well as heavily armored vehicles.

Early analysis has shown that in the many-on-many SM engagement scenarios, the SMs employing these technologies are relatively insensitive to CMs that degrade submunition P_{acq} .

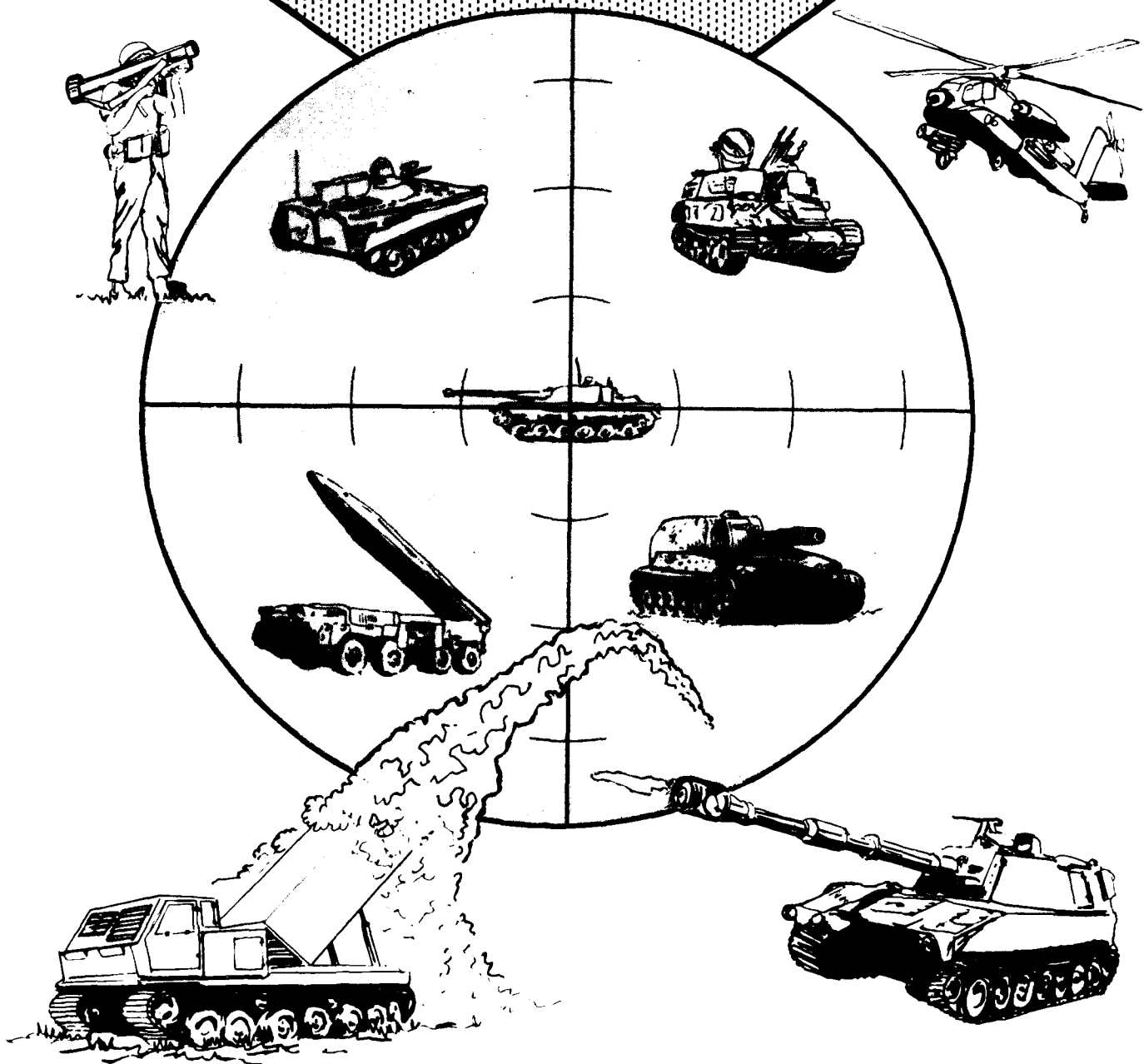
The Army has many SM weapon system candidates for the 1990s. Given the current cost constraints, it will select the systems that best meet future requirements.

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SMART MUNITIONS :

**AN INTRODUCTION TO THE CONCEPTS,
THE TECHNOLOGIES, AND THE SYSTEMS**

BRIEFING MANUAL



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THE PURPOSE OF THIS BRIEFING IS TO DESCRIBE THE U.S. ARMY'S APPROACH TO THE ACQUISITION OF SMART MUNITION WEAPON SYSTEMS. THIS APPROACH INCLUDES DEVELOPING NEW TECHNOLOGIES, ANALYZING THE THREAT FACING THE ARMY OF THE 1990s AND BEYOND, INTEGRATING SYSTEMS THAT SATISFY USER REQUIREMENTS AS STATED BY TRADOC, AND EXPLOITING THE COMMONALITIES THAT EXIST AMONG THE VARIOUS WEAPON SYSTEMS BEING DEVELOPED.

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(U) U.S. ARMY SMART MUNITIONS APPROACH

- **TECHNOLOGY**
- **THREAT**
- **REQUIREMENTS**
- **COMMONALITY**

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SMART MUNITIONS ARE A SUBSET OF PRECISION GUIDED MUNITIONS. THEY HAVE THE SELF-CONTAINED CAPABILITY TO SEARCH FOR, DETECT, ACQUIRE, AND ENGAGE TARGETS. THE GOAL OF SMART MUNITIONS IS TO ACHIEVE A COST-EFFECTIVE KILL WHEN THE USE OF GUIDED OR UNGUIDED MUNITIONS IS PRECLUDED BY COST PER KILL AND/OR PERFORMANCE.

EXCLUDED FROM THIS DEFINITION ARE PRECISION GUIDED MUNITIONS THAT REQUIRE A MAN-IN-THE-LOOP TO SELECT AND ENGAGE INDIVIDUAL TARGETS. ALSO EXCLUDED ARE HIGH- TO MEDIUM-ALTITUDE AIR DEFENSE SYSTEMS, WHICH OPERATE ABOVE THE ENVELOPE OF SMART MUNITIONS AND ENGAGE TARGETS THAT ARE NOT OF INTEREST.

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(U) ARMY'S DEFINITION OF SMART MUNITIONS

- MISSILES, PROJECTILES OR SUBMUNITIONS WHICH CAN:
 - SENSE TARGETS
 - GUIDE TO INTERCEPT OR AIM FROM STANDOFF
 - FUZE A LETHAL MECHANISM
 - EXCLUDED:
 - COMMAND-GUIDED SYSTEMS
 - HIMAD
- } TO ACHIEVE A
COST EFFECTIVE KILL

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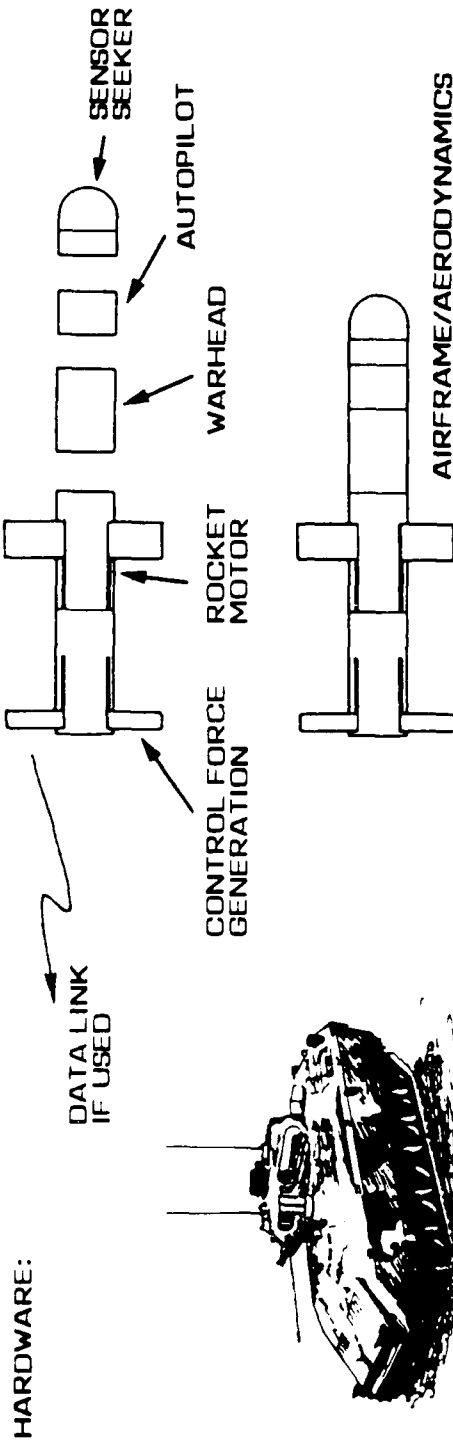
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THE MANY TECHNOLOGY CATEGORIES INVOLVED IN SMART MUNITIONS INCLUDE BOTH SUBSYSTEM TECHNOLOGIES AND RELATED FUNCTIONS AND ACTIVITIES WHICH MAKE THE FIELDING OF SMART MUNITION WEAPON SYSTEMS POSSIBLE. THE ARMY IS SEEKING TO EXPLOIT COMMONALITIES THAT MAY EXIST AMONG THE DIFFERENT SMART MUNITIONS. FOR EXAMPLE, THE SAME SENSOR/SEEKER SET OR THE SAME LAUNCH PLATFORM MAY BE USED FOR MORE THAN ONE SMART MUNITION; ALSO, IMPROVED PROCESSING ALGORITHMS AND UPDATED MODELS AND ANALYSIS TOOLS CAN BE APPLIED TO SMART MUNITIONS DEVELOPMENT.

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(U) SMART MUNITIONS TECHNOLOGY CATEGORIES



LAUNCH PLATFORM

RELATED HARDWARE/ SOFTWARE FUNCTIONS:

- TARGET ACQUISITION
- FIRE CONTROL
- PROCESSING ALGORITHMS
- C³I

RELATED ANALYTICAL AND EXPERIMENTAL ACTIVITIES:

- CONCEPT STUDIES
- CM/CCM
- MODELS AND ANALYSIS
- SIMULATION
- TARGET & BACKGROUND SIGNATURES
- THREAT STUDIES
- TEST AND EVALUATION

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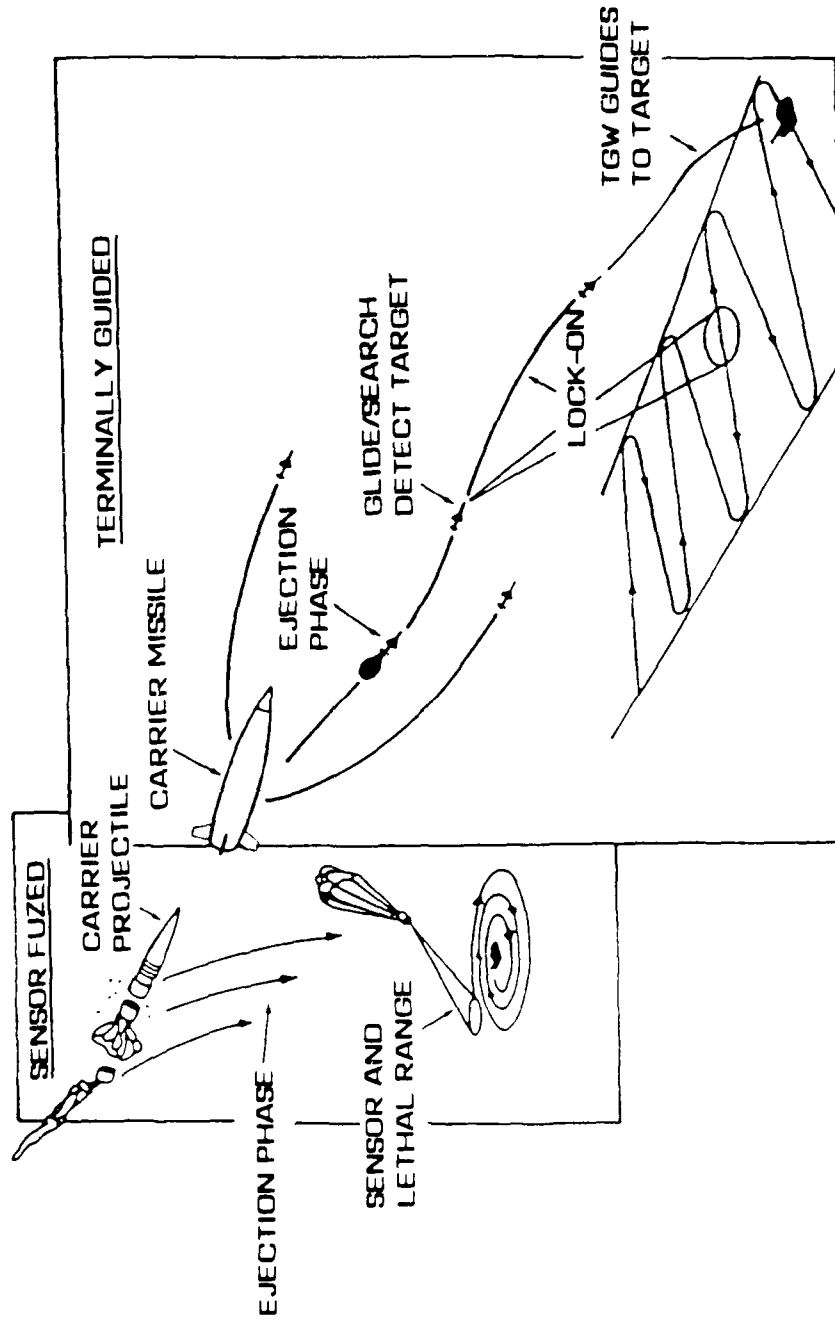
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TWO SMART MUNITION WEAPON SYSTEM CONCEPTS ARE THE SENSOR FUZED MUNITION (SFM) AND THE TERMINALLY GUIDED MUNITION (TGM). THE TGM SEARCHES LARGE AREAS AND GUIDES THE TARGET TO IMPACT. THE SFM, WHICH IS RELATIVELY SMALL IN SIZE, SEARCHES SMALLER FOOTPRINTS AND FIRES A DIRECTED LETHAL MECHANISM AT THE TARGET FROM SOME STANDOFF DISTANCE WHERE TARGET DETECTION OCCURRED.

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(U) SMART MUNITIONS SYSTEM COMPARISON



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THE SFM IS A LOW-COMPLEXITY, LOW-COST MUNITION WHICH IS MOST EFFECTIVE WHEN THERE ARE SMALL TARGET LOCATION AND DELIVERY ERRORS. THE TGM IS A COMPLEX, HIGH-COST MUNITION AND IS APPROPRIATELY USED WHEN THERE ARE LARGER TARGET LOCATION AND DELIVERY ERRORS. THE TGM IS MORE APPROPRIATE FOR ENGAGING HEAVILY ARMORED MOVING TARGETS WHILE THE SFM IS BEST SUITED FOR STATIONARY, SOFTER TARGETS.

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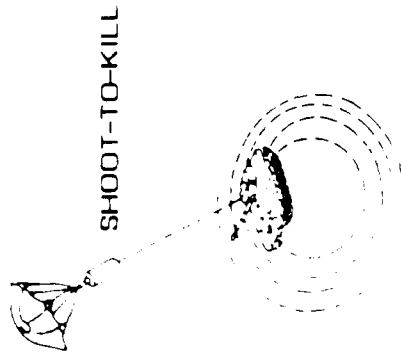
(U) SENSOR FUZED AND TERMINALLY GUIDED SMART MUNITIONS ARE COMPLEMENTARY

SENSOR FUZED MUNITIONS (E.G., SADARM)
BEST SUITED WHEN:

- SMALL TARGET LOCATION ERRORS (TLE)
- SMALL DELIVERY ERRORS (DE)
- STATIONARY TARGETS
- COUNTERFIRE ROLE VS SPH



- LOWER COMPLEXITY
- LOWER UNIT COST
- SOFTER TARGETS

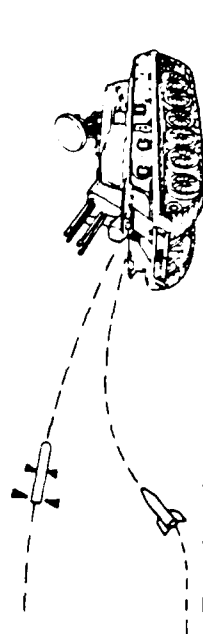
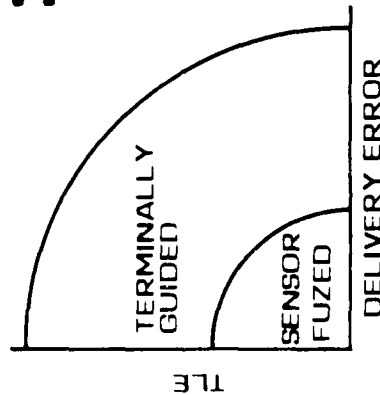


TERMINALLY GUIDED MUNITIONS (E.G., MLRS-TGW)
BEST SUITED WHEN:

- LARGER TARGET LOCATION ERRORS (TLE)
- LARGER DELIVERY ERRORS (DE)
- MOVING AND STATIONARY TARGETS
- ANTIARMOR AND DEEP BATTLE ROLES



- HIGHER COMPLEXITY
- HIGHER UNIT COST
- HARDER TARGETS



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SMART MUNITION DEVELOPERS MUST BE AWARE OF THE SPECIFIC TARGETS
THAT THE SMART MUNITION MUST DEFEAT AS WELL AS THE ENVIRONMENTAL
AND ENGAGEMENT FACTORS THAT CAN DEGRADE THEIR PERFORMANCE.

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(U) SMART MUNITIONS THREAT

TARGETS

TANKS

ARMORED COMBAT VEHICLES

ARTILLERY

AIR DEFENSE SYSTEMS

SSM SITES

HELICOPTERS

C³I SITES

ENVIRONMENT

- SIGNATURE VARIATIONS
 - MOVING VERSUS STATIONARY
 - VARIED GROUND CLUTTER
 - OPERATING VERSUS COLD
 - VARYING RANGES
- COUNTERMEASURES
 - SIGNATURE SUPPRESSION
 - DECOYS
 - OBSCURANTS
 - JAMMERS
 - DIRECTED ENERGY
 - SPECIAL ARMOR
- DIRTY BATTLEFIELD
- WEATHER

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WHILE THE U.S. ARMY IS DEVELOPING SMART MUNITION WEAPON SYSTEMS, IT IS ALSO CHANGING ITS DOCTRINE. TRADITIONALLY, THE ARMY WAS LIMITED BY THE RANGE OF ITS WEAPONS AND WAS MOST CAPABLE IN FIGHTING THE CLOSE BATTLE.

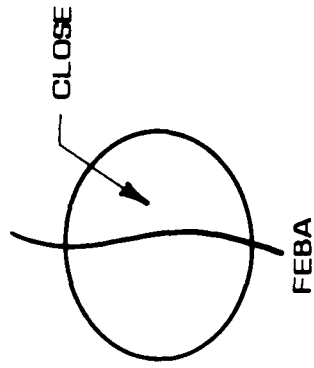
WITH THE ADVENT OF FASTER, MORE MOBILE SYSTEMS, SUCH AS HELICOPTERS AND ARMORED COMBAT VEHICLES, THE ARMY CAN RAPIDLY MOVE TROOPS AND WEAPONS TO COMBAT AREAS. THE DEVELOPMENT OF WEAPON SYSTEMS, SUCH AS MLRS AND THE ARMY TACTICAL MISSILE SYSTEM (ATACMS), HAS SIGNIFICANTLY INCREASED ENGAGEMENT RANGES. THE ARMY NOW POSSESSES THE CAPABILITY TO SIMULTANEOUSLY FIGHT THE REAR, CLOSE, AND DEEP BATTLE.

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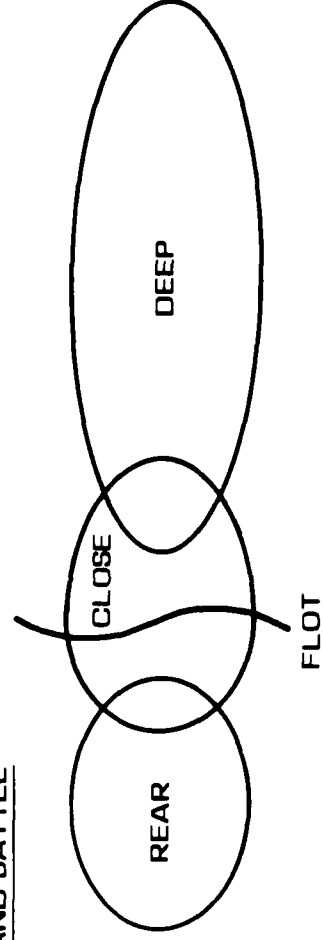
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(U) CHANGING DOCTRINE

TRADITIONAL BATTLE



AIRLAND BATTLE



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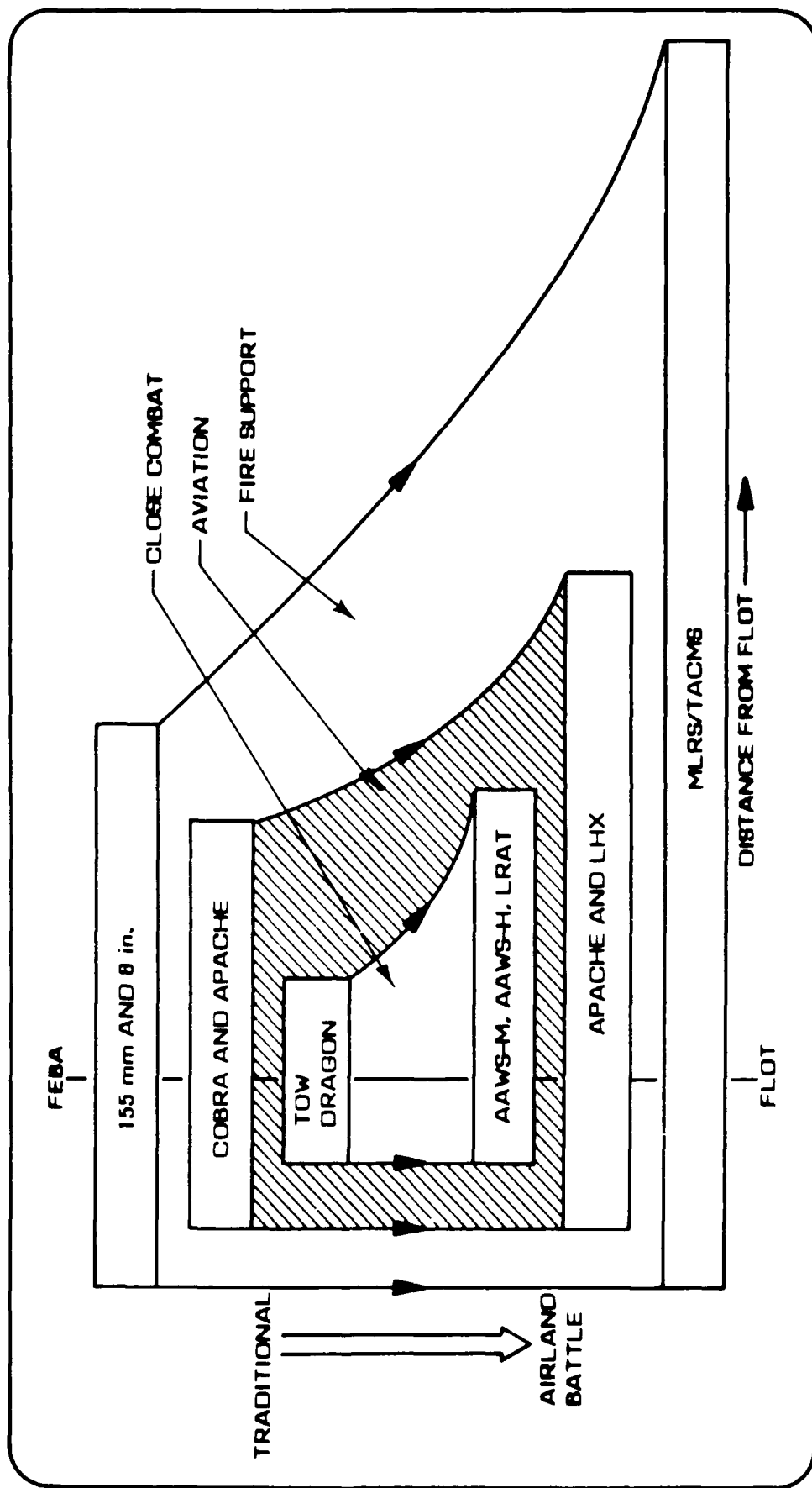
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THE FIRST-GENERATION SYSTEMS THAT MADE UP THE FIRE SUPPORT,
AVIATION, AND CLOSE COMBAT MISSION AREAS IN THE TRADITIONAL
BATTLE ARE SHOWN AT THE TOP OF EACH ANVIL. AS WE MOVE TOWARD THE
AIRLAND BATTLE, THE ADVENT OF SECOND-GENERATION SYSTEMS
SIGNIFICANTLY EXTENDS THE ENGAGEMENT RANGES IN ALL MISSION AREAS.
AS THE MISSION AREAS ARE EXTENDED, THE NUMBER OF POTENTIAL TARGETS
INCREASES. THE ARMY MUST DETERMINE WHAT TARGETS EACH MISSION
AREA IS RESPONSIBLE FOR, AS WELL AS HOW MANY SYSTEMS IT MUST FIELD
IN EACH MISSION AREA IN ORDER TO DEFEAT THE INTENDED TARGETS.

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(U) MISSION AREA EXTENSION



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THIS CHART LISTS THE ENGAGEMENT ELEMENTS OF THE U.S. ARMY, THE
RANGES AND MISSION AREAS IN WHICH THEY WILL OPERATE, AND THE
TARGETS FOR WHICH THEY ARE RESPONSIBLE.

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(U) U.S. ARMY ENGAGEMENT ELEMENTS

<u>ELEMENT</u>	<u>RANGE</u>	<u>TYPE OF TARGETS</u>
INFANTRY	REAR TO CLOSE. DEEP MANEUVER	TANKS PERSONNEL CARRIERS
ARMOR	REAR TO CLOSE. DEEP MANEUVER	AIRCRAFT
ARTILLERY	REAR TO DEEP	TANKS C3 NODES SUPPLY DEPOTS SAM SITES SSM SITES FARRPS STAGING AREAS BRIDGES
AIR DEFENSE	REAR TO CLOSE. SPT OF DEEP MANEUVER	FIXED WING ROTARY WING
AVIATION	REAR TO CLOSE. SPT OF DEEP MANEUVER	TANKS PERSONNEL TANKS ROTARY WING

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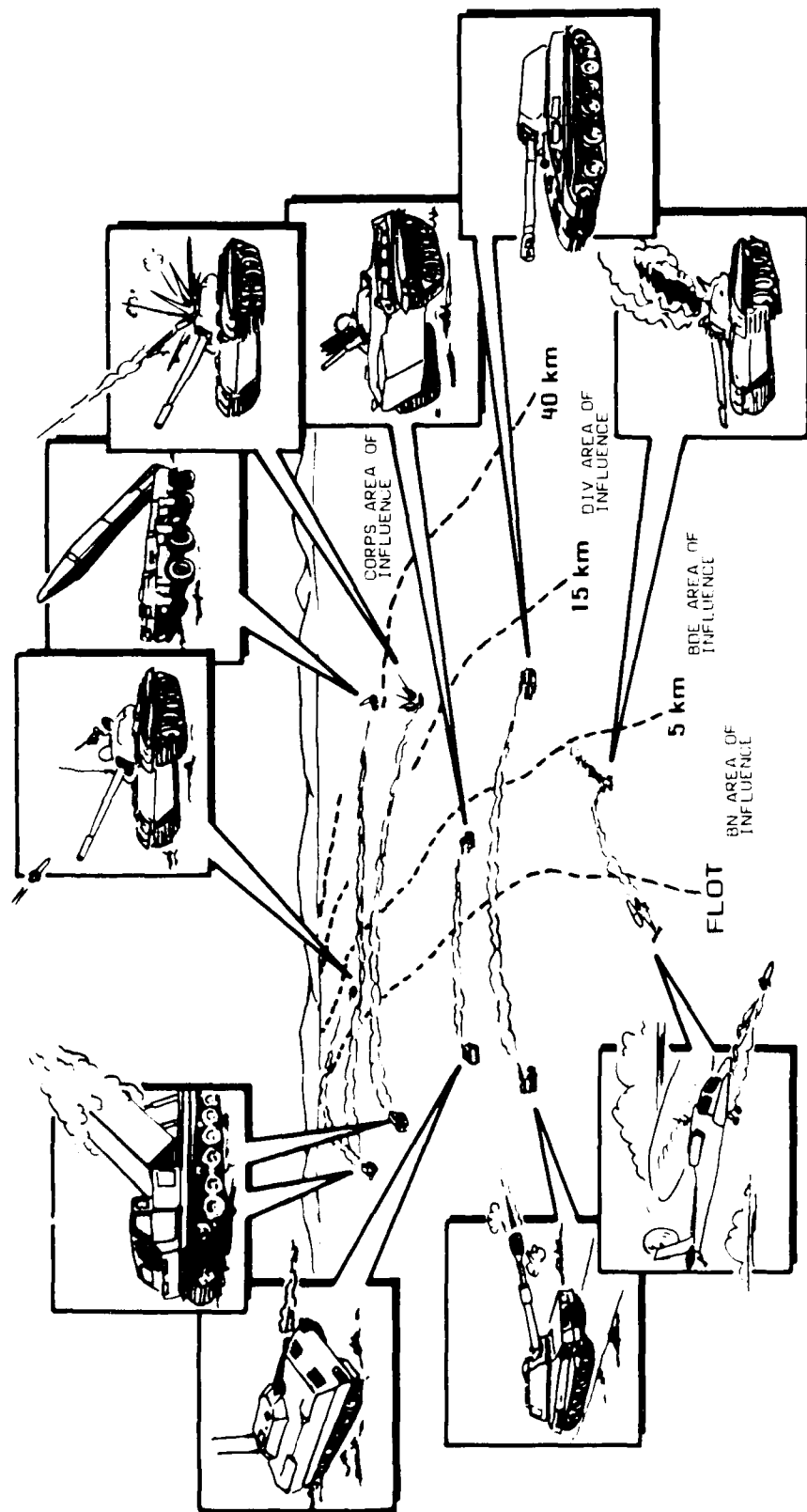
THE BATTLEFIELD IS NEITHER LINEAR NOR PERPENDICULAR. THIS GRAPHIC ILLUSTRATES THE TYPES OF SYSTEMS THAT WILL EMPLOY SMARI MUNITIONS, THE TARGETS THEY WILL ATTACK, AND THE AREA OF INFLUENCE IN WHICH THESE TARGETS WILL BE ENGAGED.

AS SHOWN, THE ARMY TACTICAL MISSILE SYSTEM (ATACMS) WILL ENGAGE HARD MOVERS AND SURFACE-TO-SURFACE MISSILE SYSTEMS IN THE DEEP BATTLE (BEYOND 40 km) OR CORPS AREA OF INFLUENCE, WHILE MLRS WILL ENGAGE THIS CLASS OF TARGETS IN THE DIVISION AREA OF INFLUENCE. THE BRADLEY FIGHTING VEHICLE WILL GO AGAINST ARMORED COMBAT VEHICLES IN THE CLOSE MANEUVER OR BATTALION AREA OF INFLUENCE. ARTILLERY SYSTEMS WILL ENGAGE ENEMY ARTILLERY IN THE BRIGADE AND DIVISION AREAS OF INFLUENCE, WHILE HELICOPTERS WILL LAUNCH WEAPONS THAT WILL DESTROY TANKS IN THE BATTALION AND BRIGADE AREAS OF INFLUENCE.

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(U) PARTITIONING OF BATTLEFIELD REQUIREMENTS



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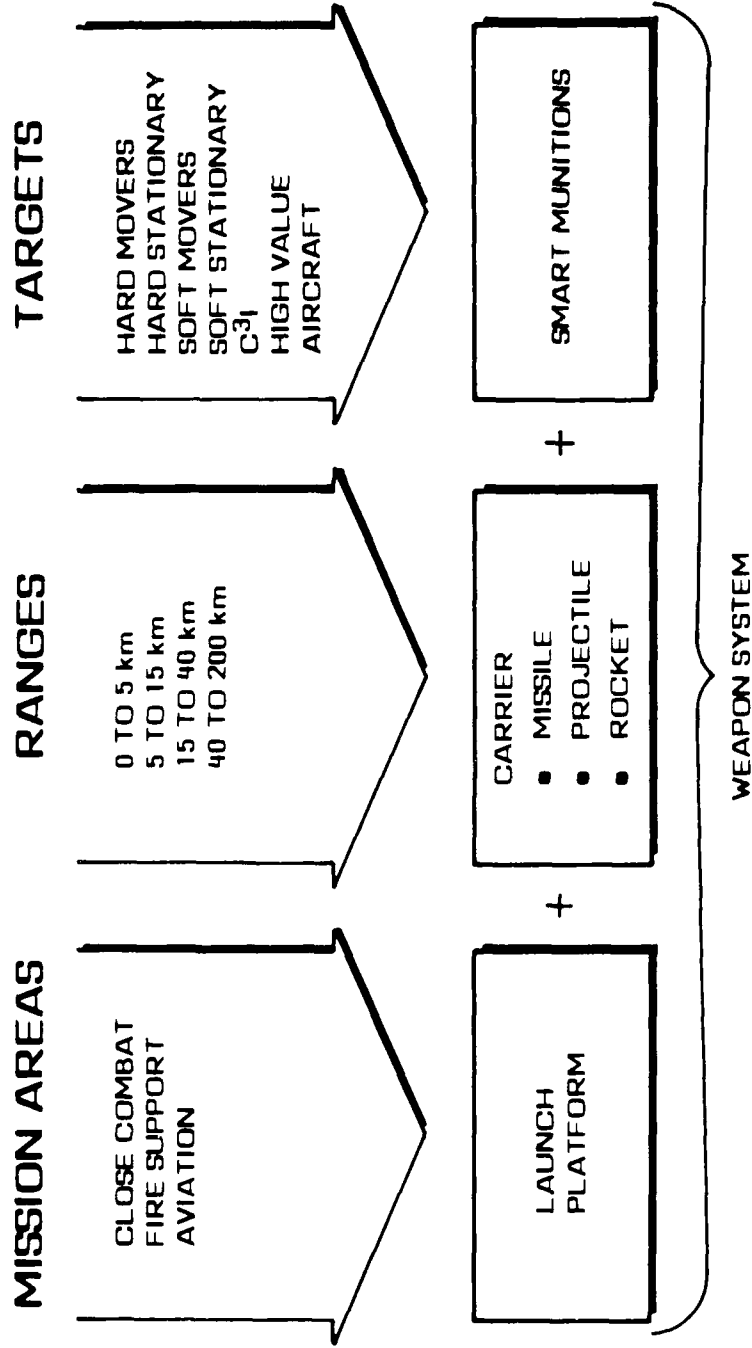
TRADITIONALLY, THE MISSION AREA APPROACH DETERMINED THE RANGES
AND THE TARGETS THAT COULD BE EFFECTIVELY ENGAGED.

WITH SMART MUNITIONS, THE MISSION AREA WILL TYPICALLY DETERMINE
THE LAUNCH PLATFORM TO BE USED. THE RANGE FROM THE LAUNCH
PLATFORM TO THE TARGET WILL DETERMINE THE NEED FOR A MISSILE,
ROCKET, OR PROJECTILE. CHARACTERISTICS OF THE TARGET BEING
ENGAGED WILL DETERMINE WHETHER OR NOT A SMART MUNITION IS NEEDED.

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(U) CONSIDERATIONS FOR SMART MUNITIONS WEAPONS DEVELOPMENT



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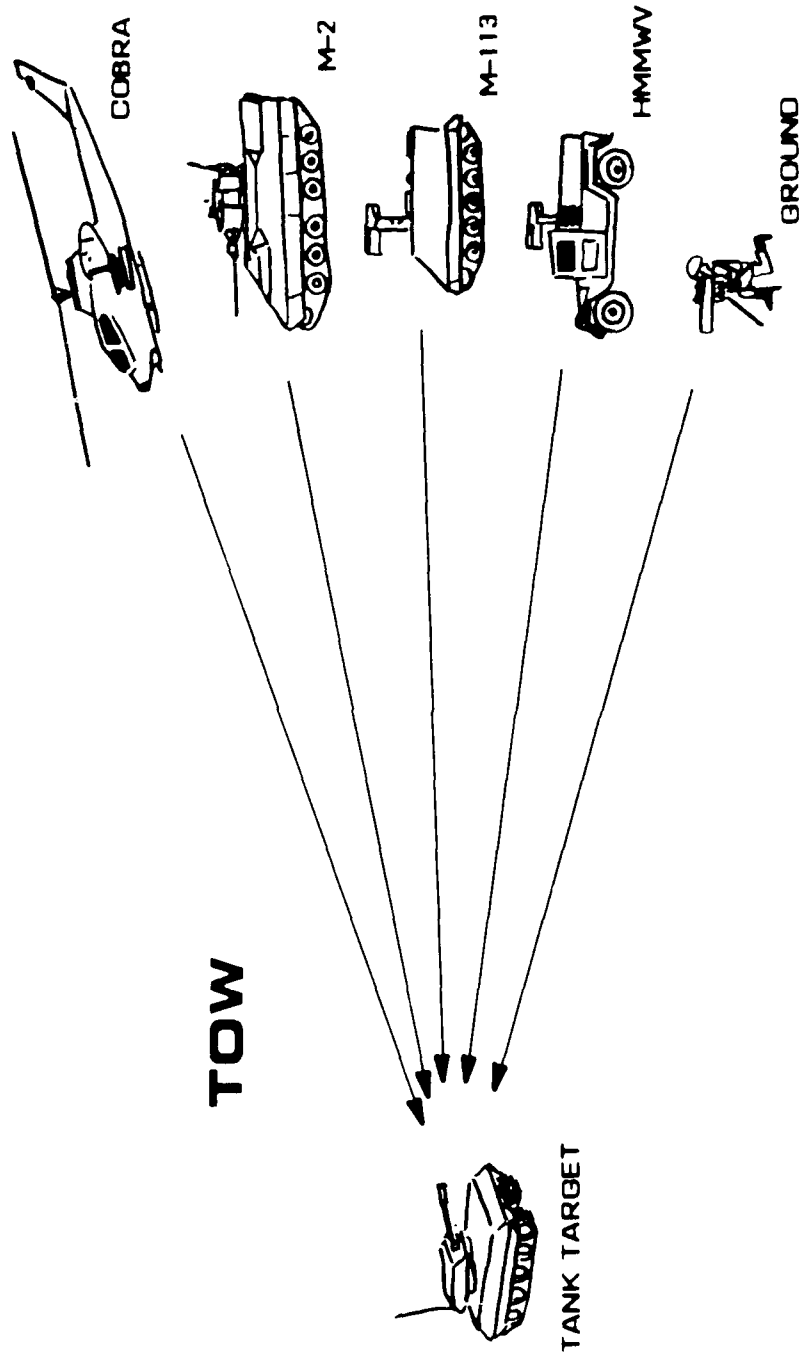
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THE TOW MISSILE SYSTEM IS THE MOST PROLIFIC EXAMPLE OF A COMMON WEAPON LAUNCHED FROM MANY PLATFORMS. BEING DEPLOYED ON MANY LAUNCH PLATFORMS GIVES AN ANTIARMOR SYSTEM A MORE ROBUST CAPABILITY TO ENGAGE ITS INTENDED TARGET ACROSS THE BATTLEFIELD.

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**(U) AN EXAMPLE OF A
COMMON WEAPON ON
MANY LAUNCH PLATFORMS**



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ANALOGOUS TO A COMMON WEAPON ON MANY LAUNCH PLATFORMS IS A LAUNCH PLATFORM AND CARRIER WHICH CAN DELIVER DIFFERENT WEAPONS. THIS WILL ENHANCE THE EFFECTIVENESS OF THE LAUNCH PLATFORM OR CARRIER SYSTEM BY ALLOWING IT TO ENGAGE A VARIETY OF TARGETS.

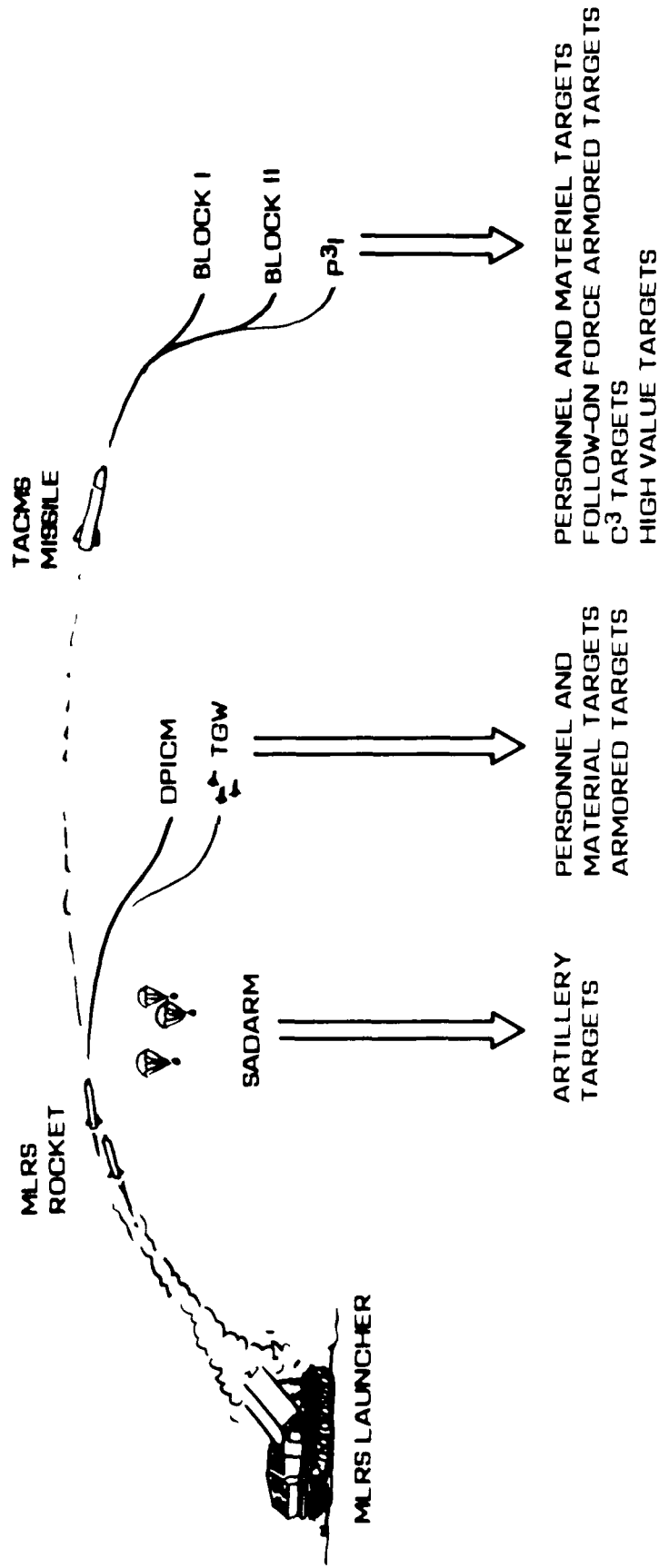
SHOWN BELOW IS THE MLRS LAUNCHER. IT CAN FIRE THE MLRS ROCKET THAT WILL BE CAPABLE OF DELIVERING A VARIETY OF MUNITIONS INCLUDING THE SADARM AND TGW SMART MUNITIONS. ALSO PICTURED IS THE MLRS/ATACMS MISSILE THAT WILL DELIVER THE BLOCK II AND P³I SMART MUNITIONS, AS WELL AS THE BLOCK I ANTIPERSONNEL-ANTIMATERIEL MUNITION.

THE TARGETS ENGAGED BY THE MLRS LAUNCHER WILL THEN RANGE FROM PERSONNEL AND MATERIEL, TO SOFT SITTERS, SOFT AND HARD ARMOR, AND HIGH-VALUE POINT TARGETS.

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(U) AN EXAMPLE OF COMMONALITY AMONG LAUNCH PLATFORMS AND CARRIERS



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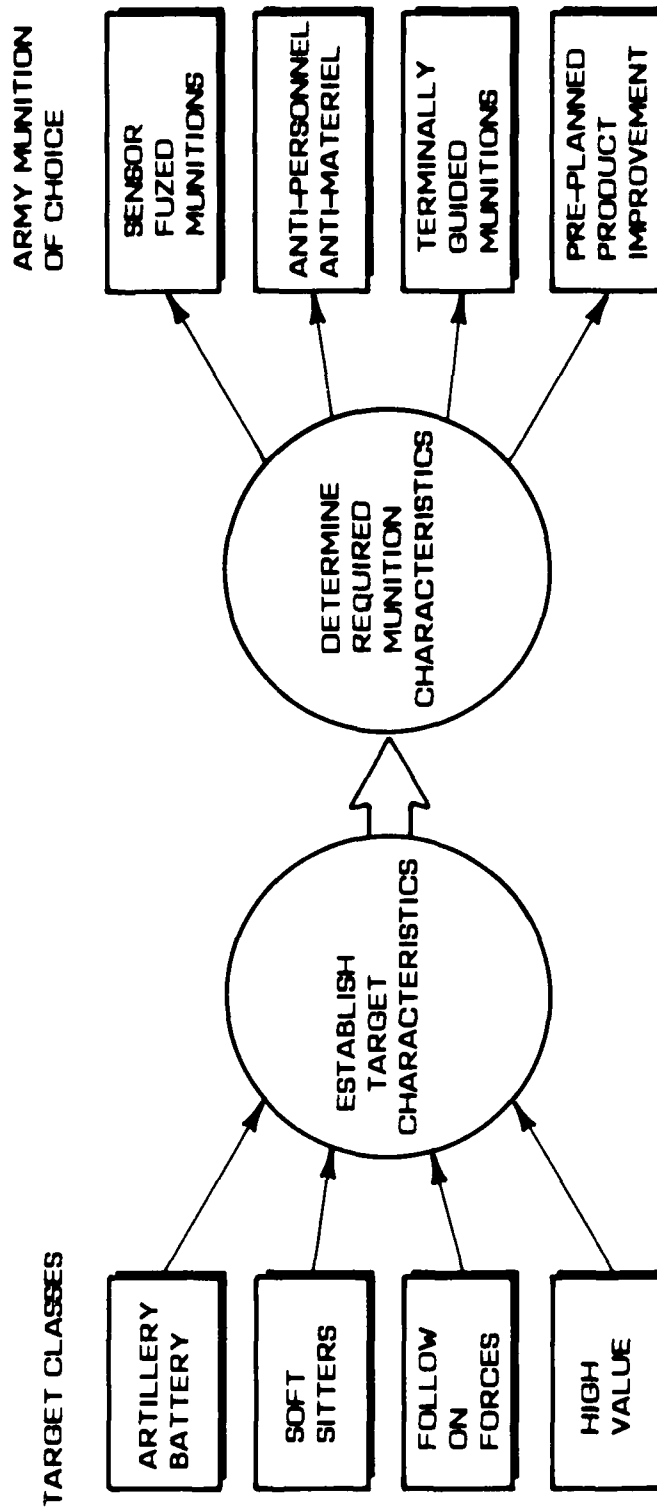
AS MENTIONED PREVIOUSLY, THE TARGETS DRIVE THE SELECTION OF THE MUNITION. MUNITION SELECTION IS ACCOMPLISHED BY CHOOSING A TARGET CLASS AND ESTABLISHING THE CHARACTERISTICS OF THAT TARGET CLASS. AS AN EXAMPLE, THE ARTILLERY BATTERY IS ONE OF THE TARGET CLASSES IN THE DEEP BATTLE. THE TARGETS IN THIS CLASS WILL BE STATIONARY AND LIGHTLY ARMORED. DUE TO THE USE OF COUNTERBATTERY RADAR, THE ASSOCIATED TARGET LOCATION ERROR IS SMALL. THEREFORE, A MUNITION LIKE THE SFM, WHICH HAS A SMALL SEARCH FOOTPRINT AND IS EFFECTIVE AGAINST SOFT TARGETS, COULD BE USED.

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(U) TARGETS DRIVE MUNITION SELECTION

DEEP BATTLE EXAMPLE



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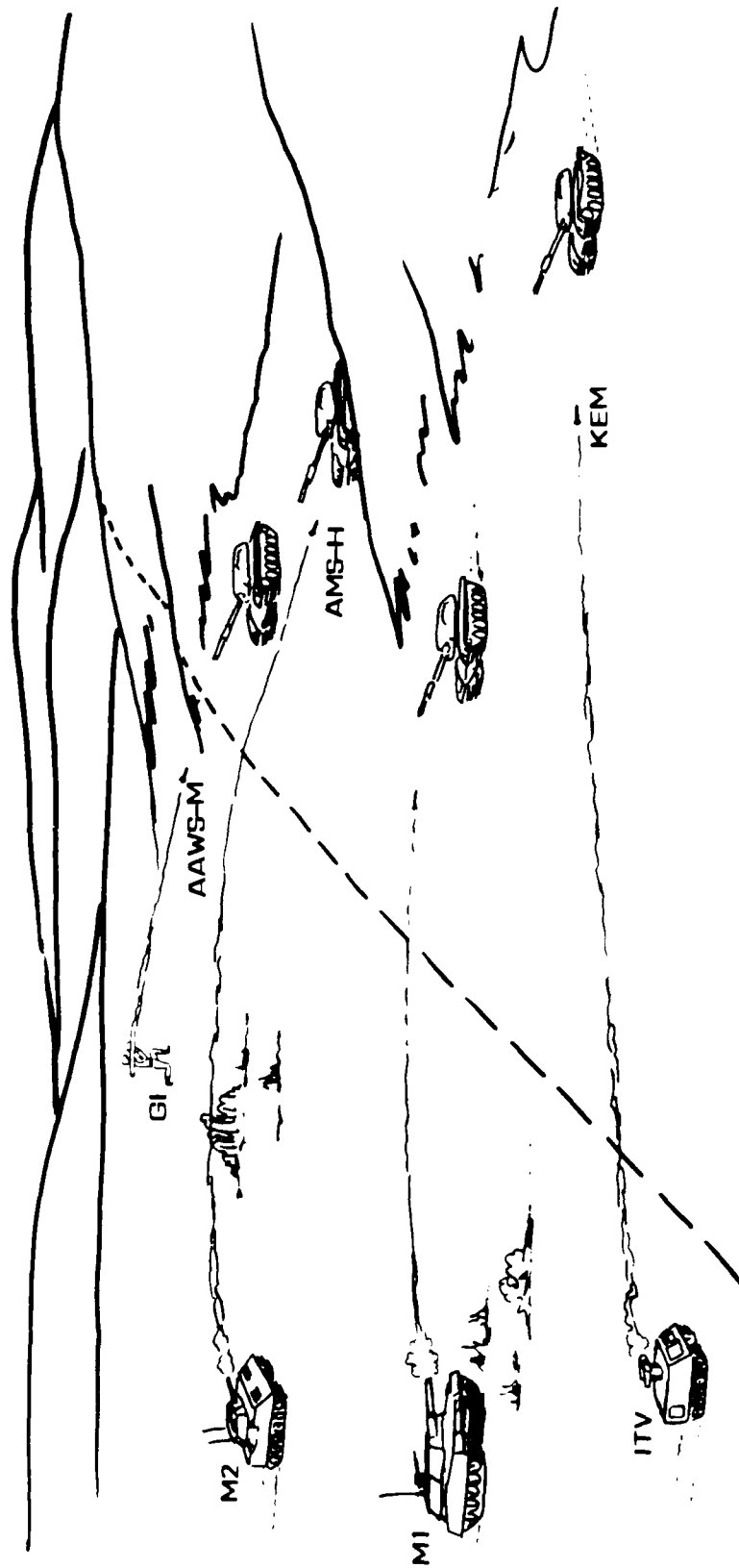
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THERE ARE FOUR SHORT-RANGE SMART MUNITION SYSTEM CONCEPTS. THESE INCLUDE THE SHOULDER-FIRED ANITARMOR WEAPON SYSTEM - MEDIUM (AAWS-M), A REPLACEMENT FOR DRAGON; THE ADVANCED MISSILE SYSTEM - HEAVY (AMS-H), WHICH WILL BE THE TOW REPLACEMENT; AND A KINETIC ENERGY MISSILE (KEM), WHICH IS A REPLACEMENT FOR THE IMPROVED TOW VEHICLE (ITV). OTHER CONCEPTS ARE ALSO BEING CONSIDERED FOR ARMORED VEHICLES AND TANKS.

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(U) SHORT-RANGE SYSTEMS



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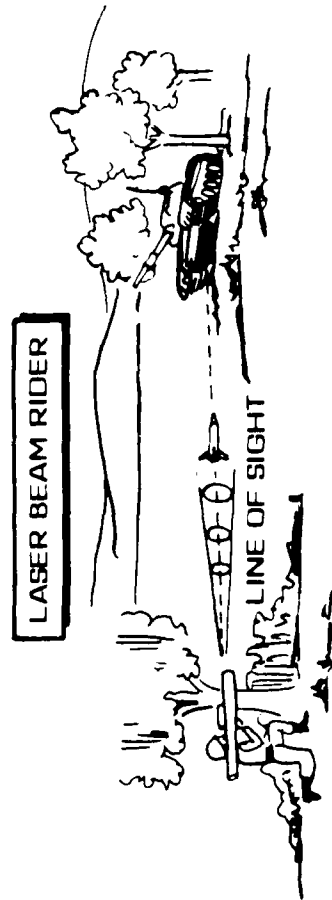
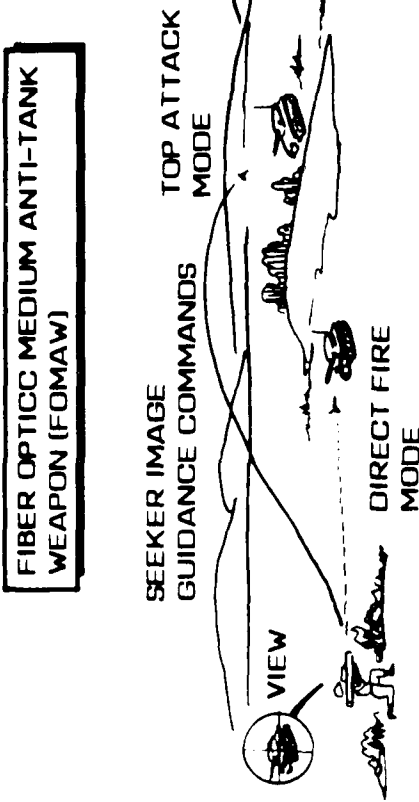
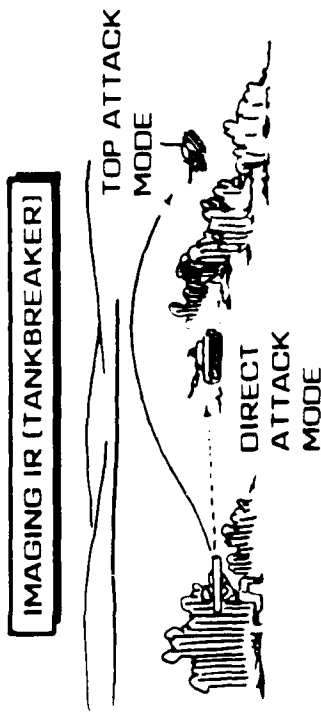
THIS GRAPHIC SHOWS THE THREE CANDIDATES UNDERGOING COMPETITIVE
PROOF-OF-PRINCIPLE FOR THE AAWS-M SYSTEM. THESE SYSTEMS INCLUDE A
FIRE-AND-FORGET MISSILE WHICH EMPLOYS IMAGING IR HOMING, A
FIBER-OPTIC GUIDED MISSILE, AND A LASER BEAM RIDER.

PAUSE

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**(U) ADVANCED ANTITANK WEAPON
SYSTEM-MEDIUM (AAWS-M)
3 CONCEPTS FOR PROOF-
OF-PRINCIPLE**



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THIS GRAPHIC SHOWS EARLY CONFIGURATIONS OF THE THREE CANDIDATES
BEING FIRED FROM DIFFERENT LAUNCH PROFILES. LISTED ARE SOME OF THE
OPERATIONAL CAPABILITIES THAT A FIELDED AAWS-M SYSTEM MUST
POSSESS.

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(U) THE AAWS-M WEAPON SYSTEM



THE CONCEPT

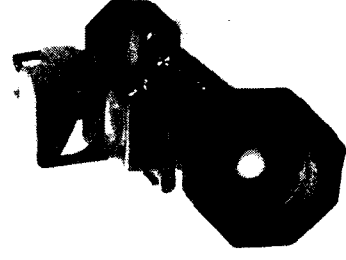


IMAGING IR

- DESIGNED TO EQUIP THE INFANTRYMAN
 - ▲ MAN-PORTABLE
 - ▲ EASY TO USE
 - ▲ MINIMUM TRAINING REQUIRED
 - ▲ FIRE FROM ENCLOSURES OR ANYWHERE AN INFANTRYMAN FIGHTS
- PROVIDES TOP OR DIRECT ATTACK CAPABILITY
- LETHAL AGAINST MODERN ARMOR
- RANGE GREATER THAN 2X DRAGON
- MINIMUM TRAINING REDUCES O&S COSTS
- GROWTH
 - ▲ MODULAR GUIDANCE AND WARHEAD FOR THREAT CHANGES
 - ▲ PROVIDES GROWTH WITH HIGH COMMONALITY TO AMS-H



FIBER-OPTIC GUIDED



LASER BEAM RIDER

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THE AMS-H WILL BE A HIGH-PERFORMANCE, FIRE-AND-FORGET MUNITION THAT MUST BE LETHAL AGAINST THE FUTURE SOVIET TANK AND BE HIGHLY SURVIVABLE. IT WILL RELY UPON A HIGH-PERFORMANCE MODULAR TARGET ACQUISITION SYSTEM.

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ADVANCED MISSILE SYSTEM HEAVY AMS-H



- **FIRE AND FORGET**
 - **LETHAL AGAINST ADVANCED ARMOR**
 - **HIGH SURVIVABILITY**
- **HIGH PERFORMANCE, MODULAR TARGET ACQUISITION SYSTEM**
 - **NEW, LIGHTWEIGHT, DIGITAL, INFRARED MODULES**
 - **AN IMPROVED CAPABILITY IN VEHICLE ANTITANK FIREPOWER**



**A NEW GENERATION ANTITANK WEAPON SYSTEM
FOR THE MODERN BATTLEFIELD**

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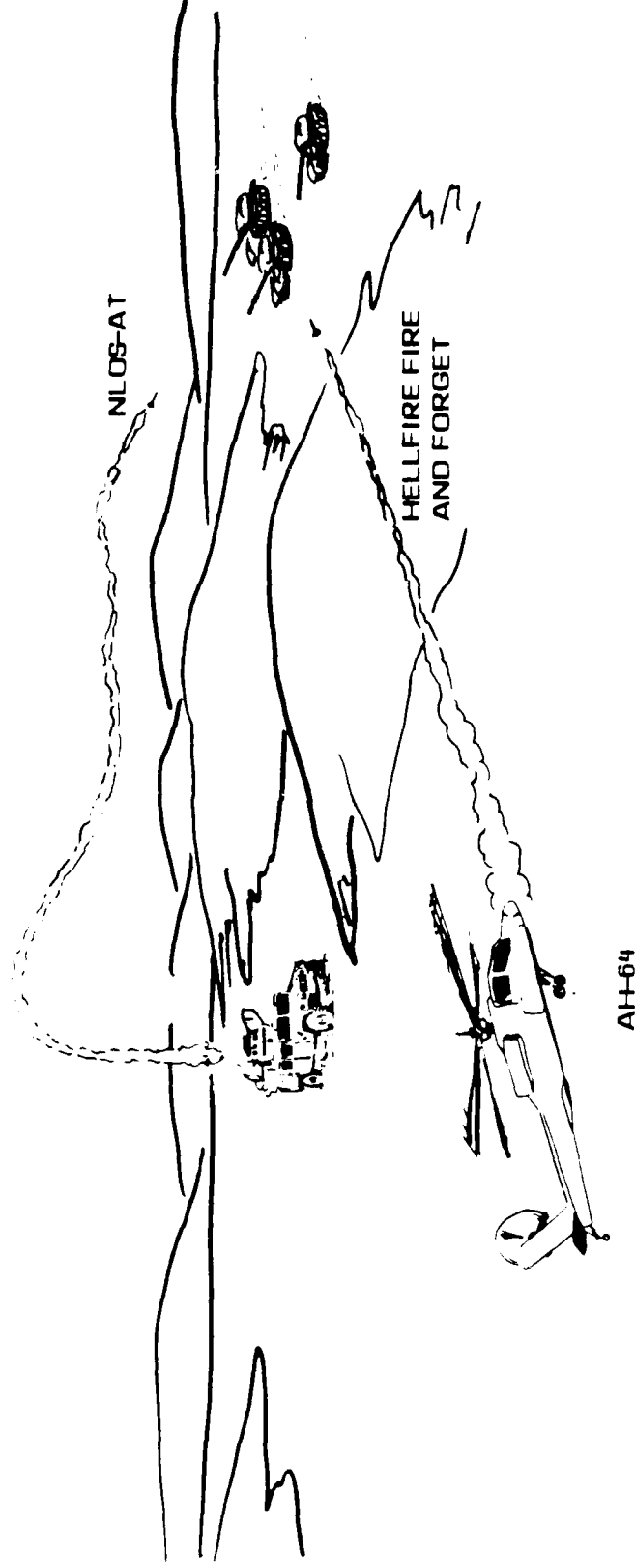
THIS GRAPHIC SHOWS TWO MEDIUM-RANGE SMART MUNITION SYSTEM CONCEPTS. THESE SYSTEMS WILL OPERATE PRIMARILY IN RANGES BETWEEN 5 AND 15 km.

THESE SYSTEMS INCLUDE THE NONLINE-OF-SIGHT ANTITANK (NLOS-AT) MISSILE, WHICH WILL EMPLOY FIBER-OPTIC GUIDANCE, AND A FIRE-AND-FORGET VERSION OF THE HELLFIRE MISSILE.

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(U) MEDIUM-RANGE SYSTEMS



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THIS IS A CUTAWAY VIEW OF THE CURRENT HELLFIRE MISSILE WHICH
EMPLOYS LASER SEMIACTIVE HOMING GUIDANCE. THE PHOTO ILLUSTRATES
THE MAJOR SUBSYSTEMS AND PHYSICAL PARAMETERS.

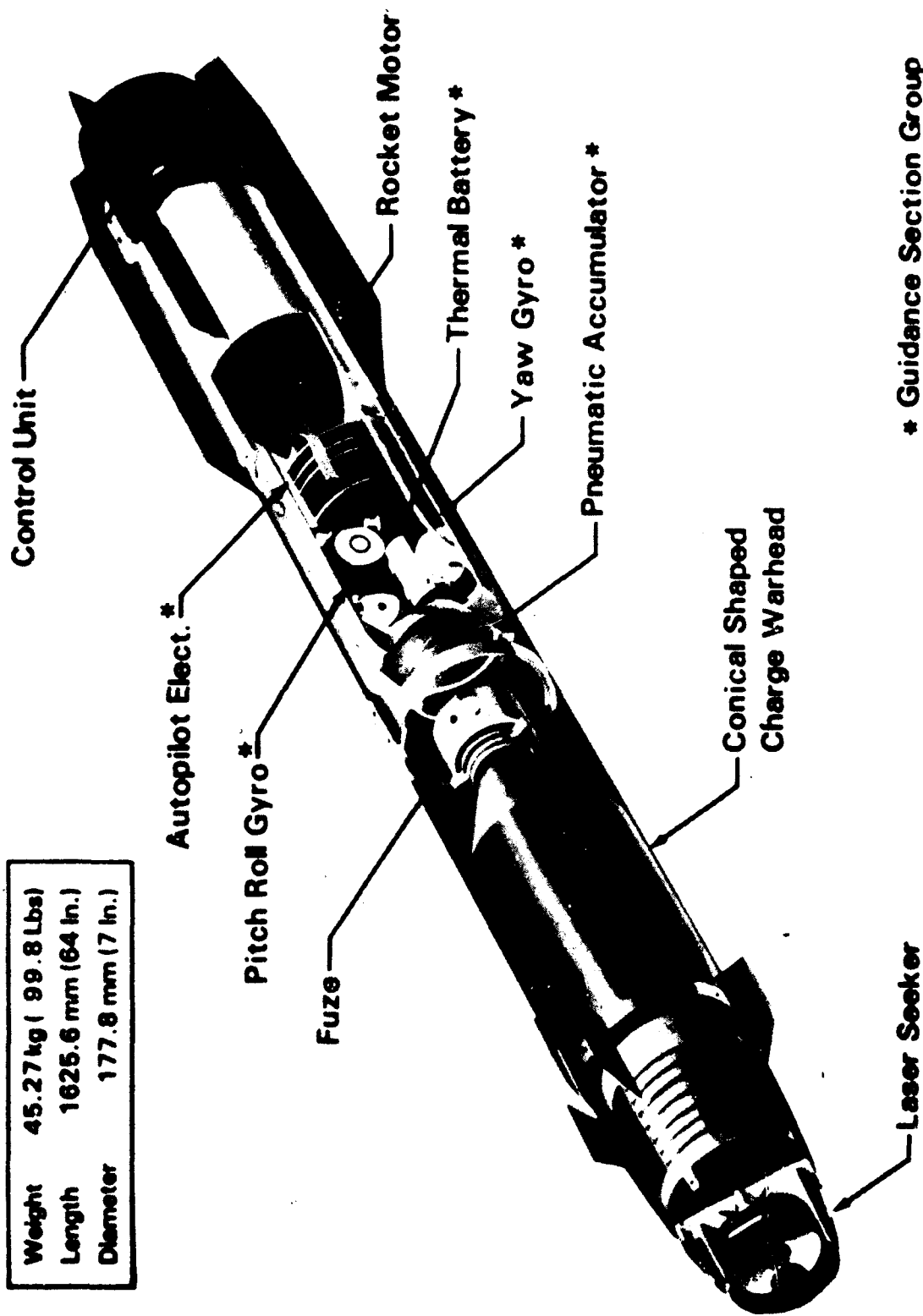
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HELLFIRE MISSILE

Weight	45.27 kg (99.8 Lbs)
Length	1625.6 mm (64 in.)
Diameter	177.8 mm (7 in.)



* Guidance Section Group

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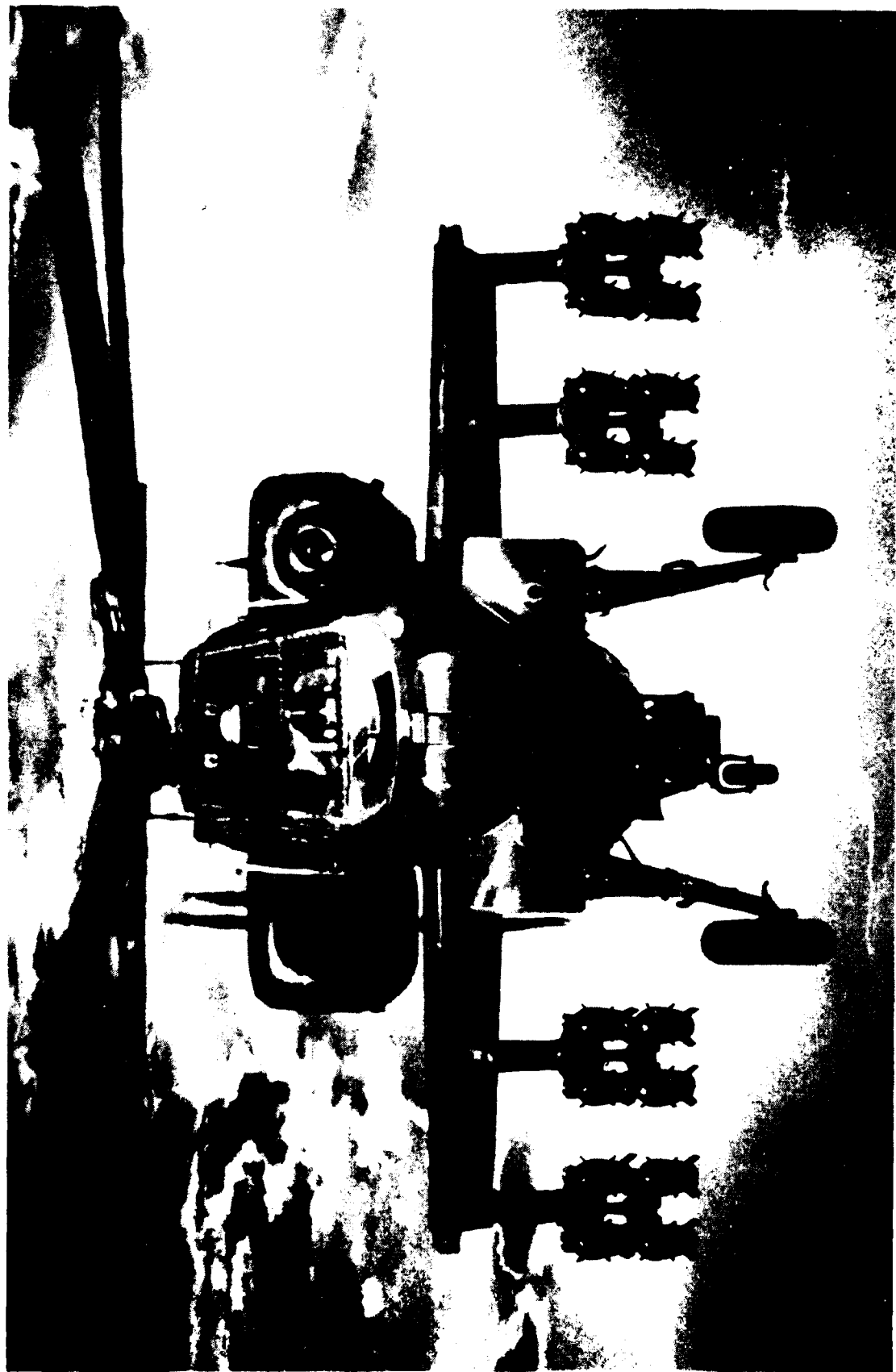
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THE AH-64 APACHE IS THE LAUNCH PLATFORM FOR THE HELLFIRE MISSILE.

BRIEF PAUSE

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THIS ILLUSTRATION SHOWS THE FIBER-OPTIC GUIDED MISSILE (FOG-M) WHICH EMPLOYS A TELEVISION SEEKER AND A FIBER-OPTIC DATA LINK. IN OPERATION, THE MISSILE IS LAUNCHED VERTICALLY AND THEN FLIES PARALLEL TO THE GROUND WHILE RELAYING THE VISUAL IMAGES WITHIN ITS FIELD-OF-VIEW TO THE GUNNER. ONCE THE GUNNER ACQUIRES A TARGET, HE DIRECTS FOG-M TOWARD THE TARGET, AT WHICH POINT THE SEEKER CAN LOCK-ON TO AND TERMINALLY GUIDE ITSELF TO THE TARGET.

FOG-M HAS THE CAPABILITY TO ENGAGE GROUND TARGETS OR SLOW-MOVING AERIAL TARGETS. IN THE SURFACE-TO-SURFACE ROLE, IT IS OFTEN REFERRED TO AS THE NONLINE-OF-SIGHT ANTITANK (NLOS-AT) WEAPON SYSTEM; IN THE SURFACE-TO-AIR ROLE, IT CAN BE REFERRED TO AS THE NONLINE-OF-SIGHT AIR DEFENSE (NLOS-AD) WEAPON SYSTEM.

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THE FOG-M IS ELEVATED FROM THE LAUNCH PLATFORM AND IS LAUNCHED VERTICALLY TO A CRUISING ALTITUDE WHERE IT WILL FLY PARALLEL TO THE GROUND. THIS ALLOWS THE GUNNER TO SEE MORE OF THE BATTLEFIELD WHEN HE BEGINS TO SEARCH FOR TARGETS. VERTICAL LAUNCH ALSO ALLOWS THE LAUNCH PLATFORM TO STANDOFF BEHIND TERRAIN FEATURES.

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THERE ARE A VARIETY OF LONG-RANGE SMART MUNITION SYSTEMS INCLUDING SMART MINES. THERE ARE PRIMARILY TWO LAUNCHING PLATFORMS.

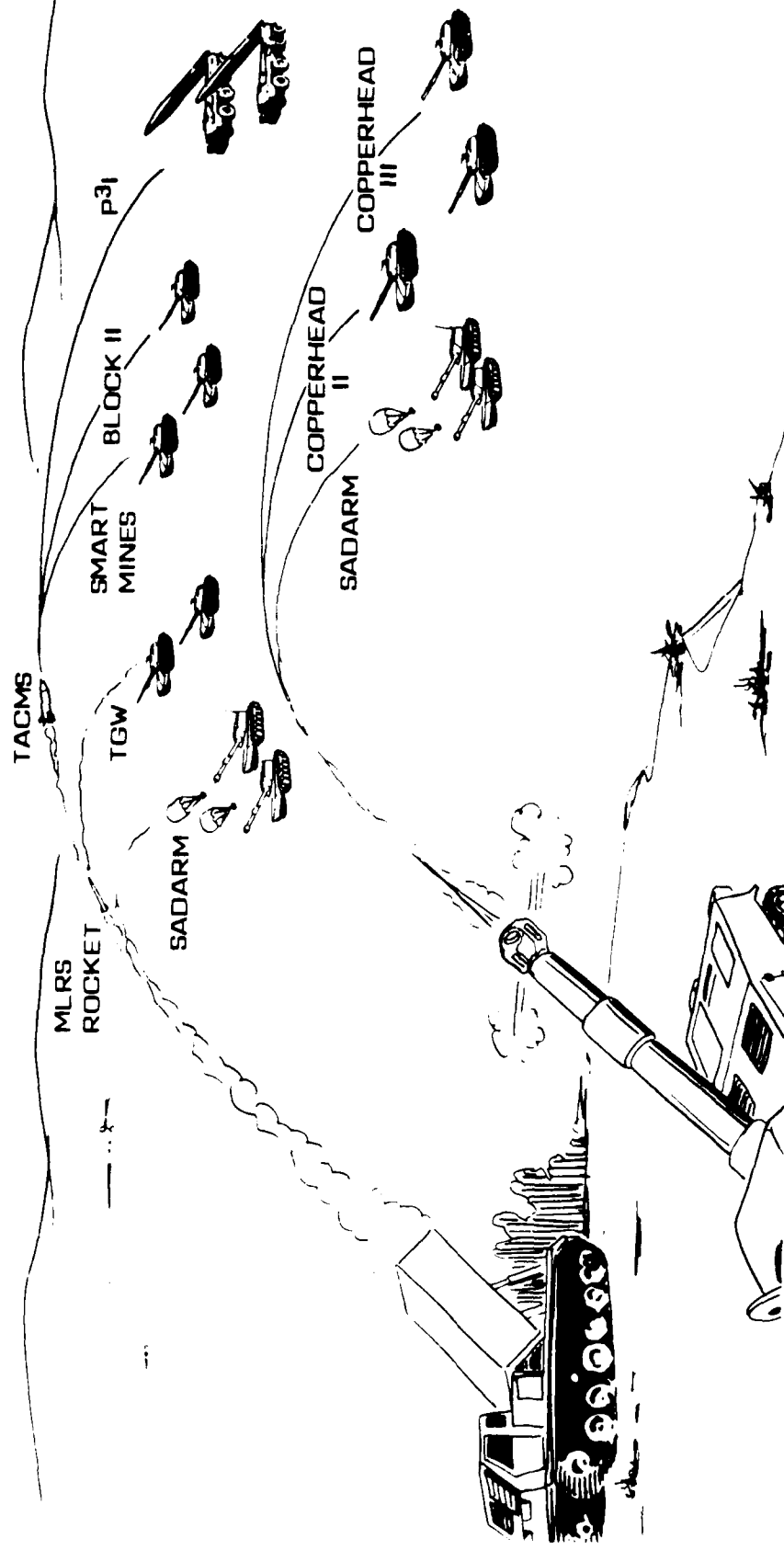
THE MLRS LAUNCHER WILL DELIVER SMART MUNITIONS CARRIED BY THE MLRS ROCKET AND THE ARMY TACTICAL MISSILE SYSTEM (ATACMS). THE ROCKET WILL DELIVER THE SENSE AND DESTROY ARMOR (SADARM) MUNITION AND THE TERMINAL GUIDANCE WARHEAD (TGW). THE ATACMS MISSILE WILL DELIVER BLOCK II AND P³I SMART MUNITIONS AS WELL AS SMART MINES.

THE 155-mm HOWITZER WILL DELIVER A VARIETY OF MUNITIONS INCLUDING SADARM AND COPPERHEAD II AND/OR COPPERHEAD III.

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(U) LONG RANGE SYSTEMS (Including Smart Mines)



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THE SADARM WEAPON SYSTEM UTILIZES THE 155-mm, SELF-PROPELLED HOWITZER AND THE MLRS AS LAUNCH PLATFORMS.

THE 155-mm PROJECTILE CARRIES TWO MUNITIONS WHICH ARE EJECTED FROM THE BACK. THE MLRS ROCKET CARRIES SIX MUNITIONS WHICH ARE EJECTED Laterally.

AFTER EJECTION, EACH MUNITION DEPLOYS A PARACHUTE WHICH CAUSES THE MUNITION TO SPIN AS IT DESCENDS. THE RESULT IS A SPIRAL SEARCH PATTERN.

UPON TARGET DETECTION, THE MUNITION FIRES AN EXPLOSIVELY FORMED PENETRATOR AT THE TARGET.

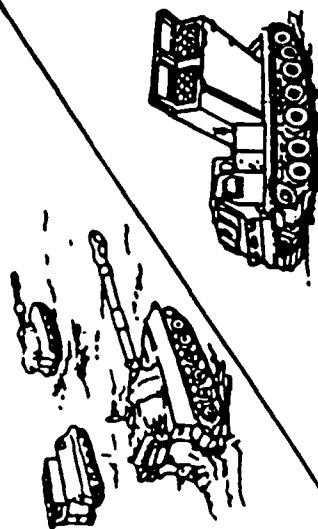
THE 8-INCH HOWITZER IS ALSO BEING CONSIDERED FOR DELIVERING SADARM.

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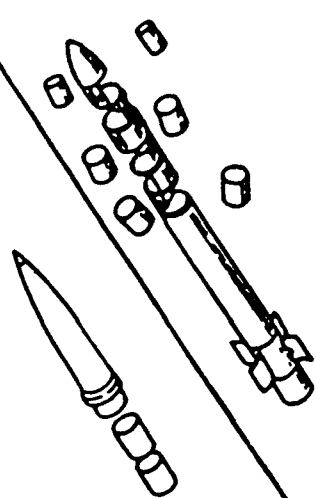
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(U) OPERATION CONCEPT OF THE SADARM SMART MUNITION

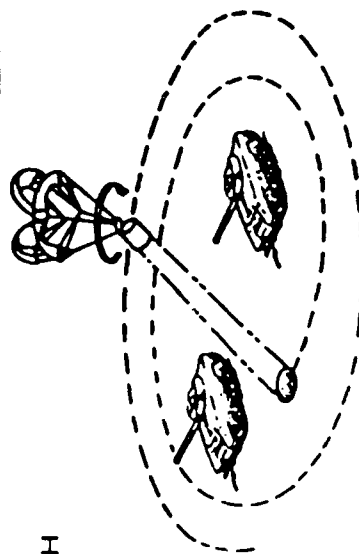
1. DELIVERY



2. EJECTION



3. SEARCH



4. TARGET KILL



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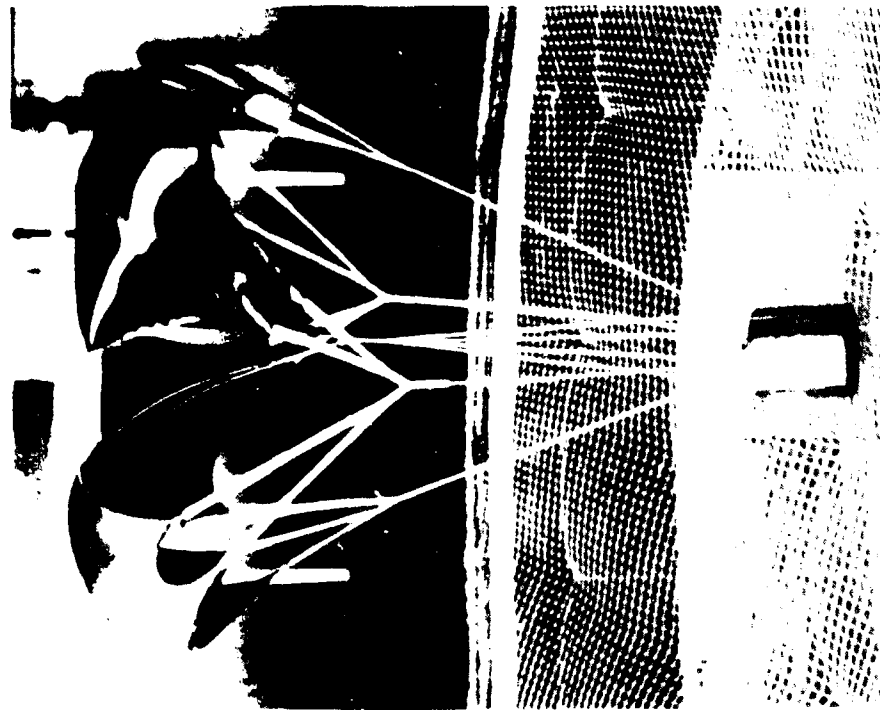
PICTURED (FIRST) IS AN ACTUAL EARLY CONFIGURATION OF THE SADARM
SUBMUNITION WITH ITS PARACHUTE DEPLOYED.

PICTURED (SECOND) ARE PHOTOS OF LIVE SUBMUNITION DROP TESTS. IN
THIS TEST CASE, THE MUNITION SCORED THREE HITS IN THREE DROPS.

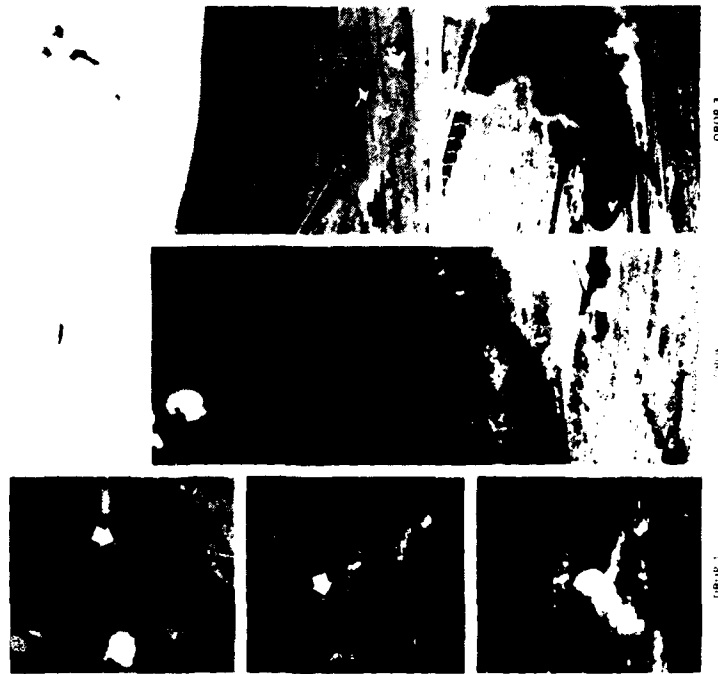
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(U) THE SADARM WEAPON SYSTEM



SADARM LIVE SUBMUNITION DROP
3 FOR 3



SANDIA CARBON COPY MAY 6 AND 8 1980

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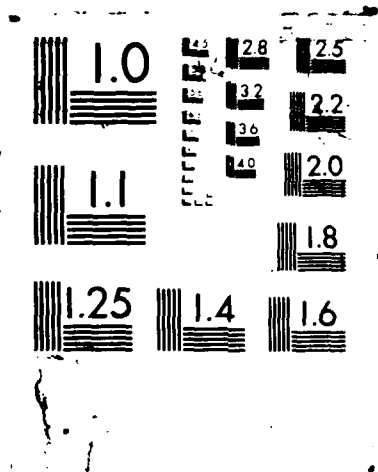
SMART MUNITIONS: AN INTRODUCTION TO THE CONCEPTS THE
TECHNOLOGIES AND THE (U) TACTICAL WEAPONS GUIDANCE AND
CONTROL INFORMATION ANALYSIS CE. N J MANGUS ET AL.

2/2

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15 NOV 87 GACIAC-SR-87-08 DAAH01-86-C-A050 F/G 1777.3 NL





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SHOWN IN THIS GRAPHIC IS THE PLANNED EVOLUTION OF COPPERHEAD FROM THE CURRENT GUIDED MUNITION TO A CONVENTIONAL GEOMETRY SMART MUNITION.

COPPERHEAD I IS CURRENTLY IN THE U.S. ARMY'S INVENTORY. IT EMPLOYS LASER SEMIACTIVE HOMING GUIDANCE AND IS AN UNCONVENTIONAL GEOMETRY PROJECTILE.

COPPERHEAD II WILL BE A FIRE-AND-FORGET UNCONVENTIONAL GEOMETRY PROJECTILE.

COPPERHEAD III WILL BE A FIRE-AND-FORGET CONVENTIONAL GEOMETRY PROJECTILE, WHICH WILL GREATLY DECREASE THE LOGISTICS BURDEN ASSOCIATED WITH COPPERHEAD I AND COPPERHEAD II PREDECESSORS.

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(U) COPPERHEAD



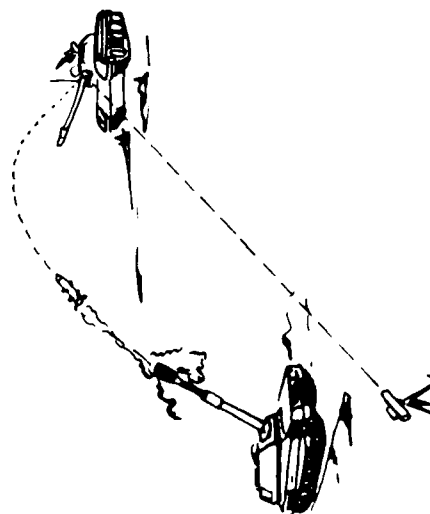
COPPERHEAD I



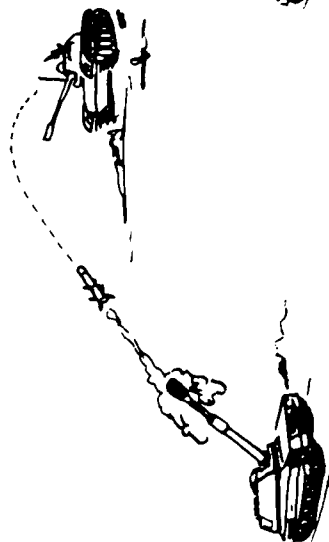
COPPERHEAD II



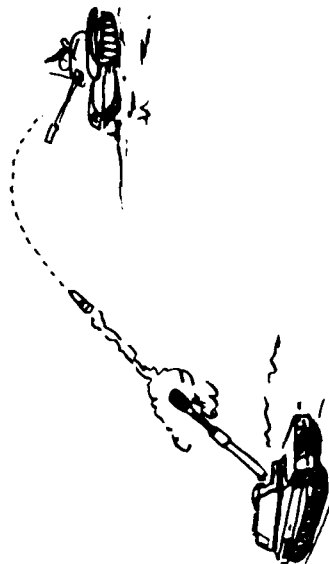
COPPERHEAD III



LASER SEMI-ACTIVE



FIRE-AND-FORGET



CONVENTIONAL
GEOMETRY

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THE COPPERHEAD PROJECTILES CAN BE FIRED FROM TOWED OR
SELF-PROPELLED ARTILLERY. THE UNCONVENTIONAL GEOMETRY
COPPERHEAD I IS PICTURED BESIDE THE M-198 TOWED 155-mm
HOWITZER.

BRIEF PAUSE

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M 198 / COPPERHEAD COMPATIBILITY



M 198

- MAXIMUM CHARGE USABLE: E201E2 Z7
- PEAK ACCELERATION: 7500g
- MUZZLE VELOCITY: 1928ft/s (588m/s)
- MAXIMUM RANGE: 19.6km FUFO
12.8km BALLISTIC

155H

COPPERHEAD

CALIBER: 155mm

LENGTH: 54in (137cm)

WEIGHT: 137lb (62kg)

DESIGN

ACCELERATION: 7200g

NO. 1

NO. 2

NO. 3



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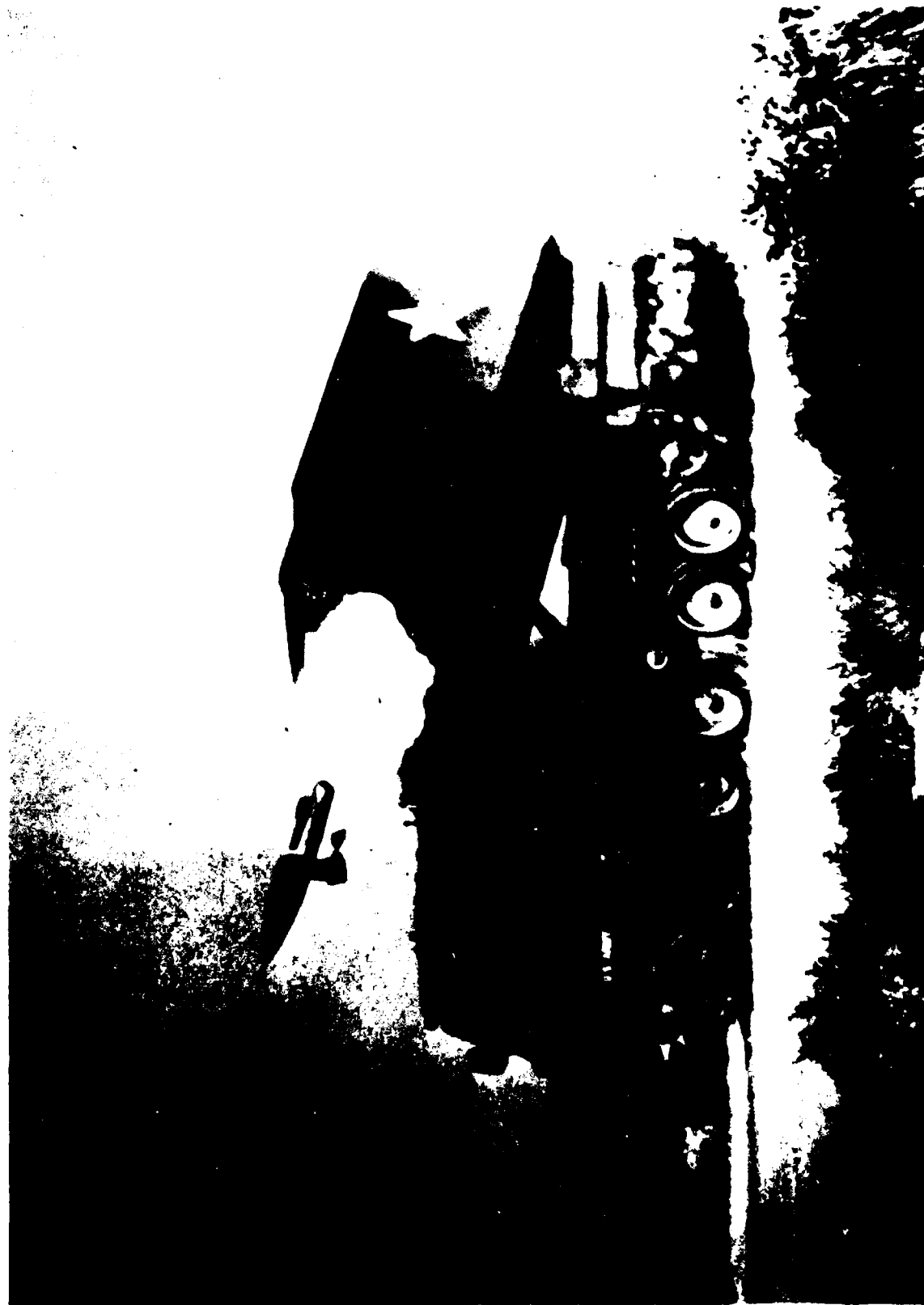
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THIS PHOTOGRAPH SHOWS FIRING OF AN MLRS ROCKET. THE ROCKET CAN
TRANSPORT AND DISPENSE SADARMS AND TERMINALLY GUIDED MUNITIONS
OVER THE TARGET AREA. THE MLRS CAN FIRE A VOLLEY OF 12 ROCKETS IN
LESS THAN ONE MINUTE.

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Very
little
information
is available
on the
subject of
the
subject's
activities
in the
United States
after the
subject's
return from
the Soviet
Union.



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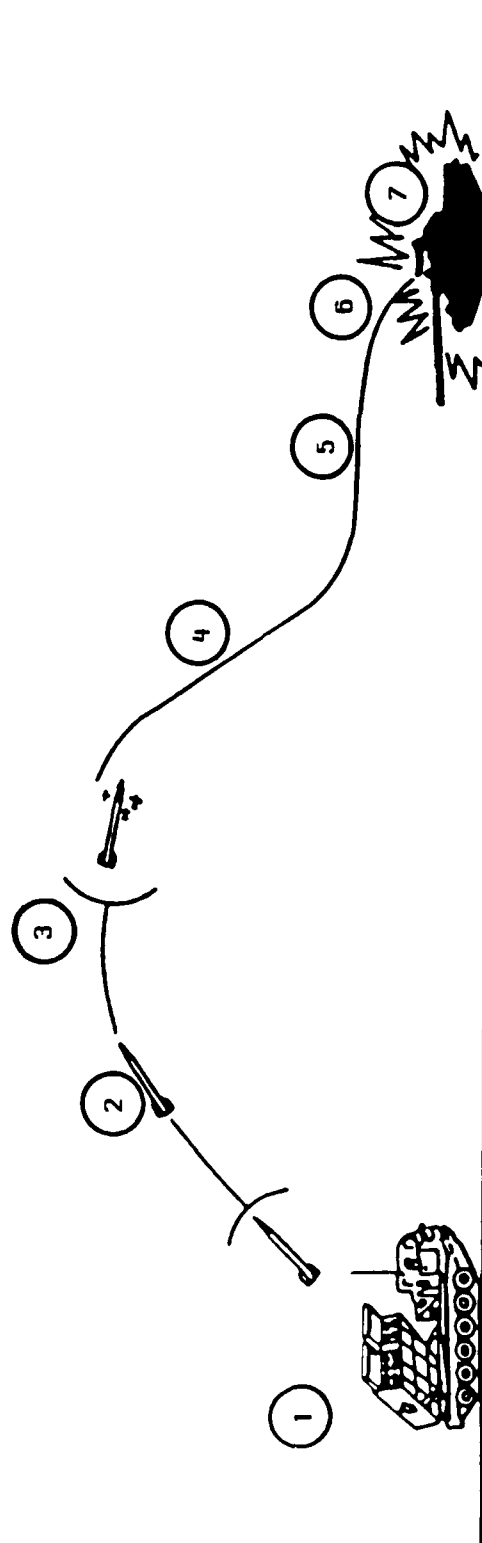
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THE OPERATIONAL SEQUENCE OF THE MLRS-TGW SMART MUNITION SYSTEM IS SHOWN IN THIS GRAPHIC. AN MLRS ROCKET CONTAINING THREE TERMINALLY GUIDED SUBMUNITIONS IS FIRED FROM THE LAUNCHER AND ASSUMES A BALLISTIC TRAJECTORY. AT THE PROPER TIME, THE ROCKET DISPENSES THE SUBMUNITIONS. EACH TGSM THEN MANEUVERS INTO THE PROPER GLIDE PATH AND BEGINS TO SEARCH FOR TARGETS. UPON TARGET ACQUISITION, THE TGSM WILL TERMINALLY HOME TO ITS TARGET AND FUSE A LETHAL MECHANISM UPON TARGET IMPACT.

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(U) OPERATIONAL SEQUENCE OF THE MLRS/TGW SMART MUNITIONS



PHASES

- | | |
|-------------------------------|-----------------------------|
| <u>1</u> LAUNCH | <u>5</u> TARGET ACQUISITION |
| <u>2</u> TGW BALLISTIC FLIGHT | <u>6</u> TERMINAL HOMING |
| <u>3</u> TGSM DISPENSE | <u>7</u> DESTROY TARGET |
| <u>4</u> TGSM FLIGHT PATH | |

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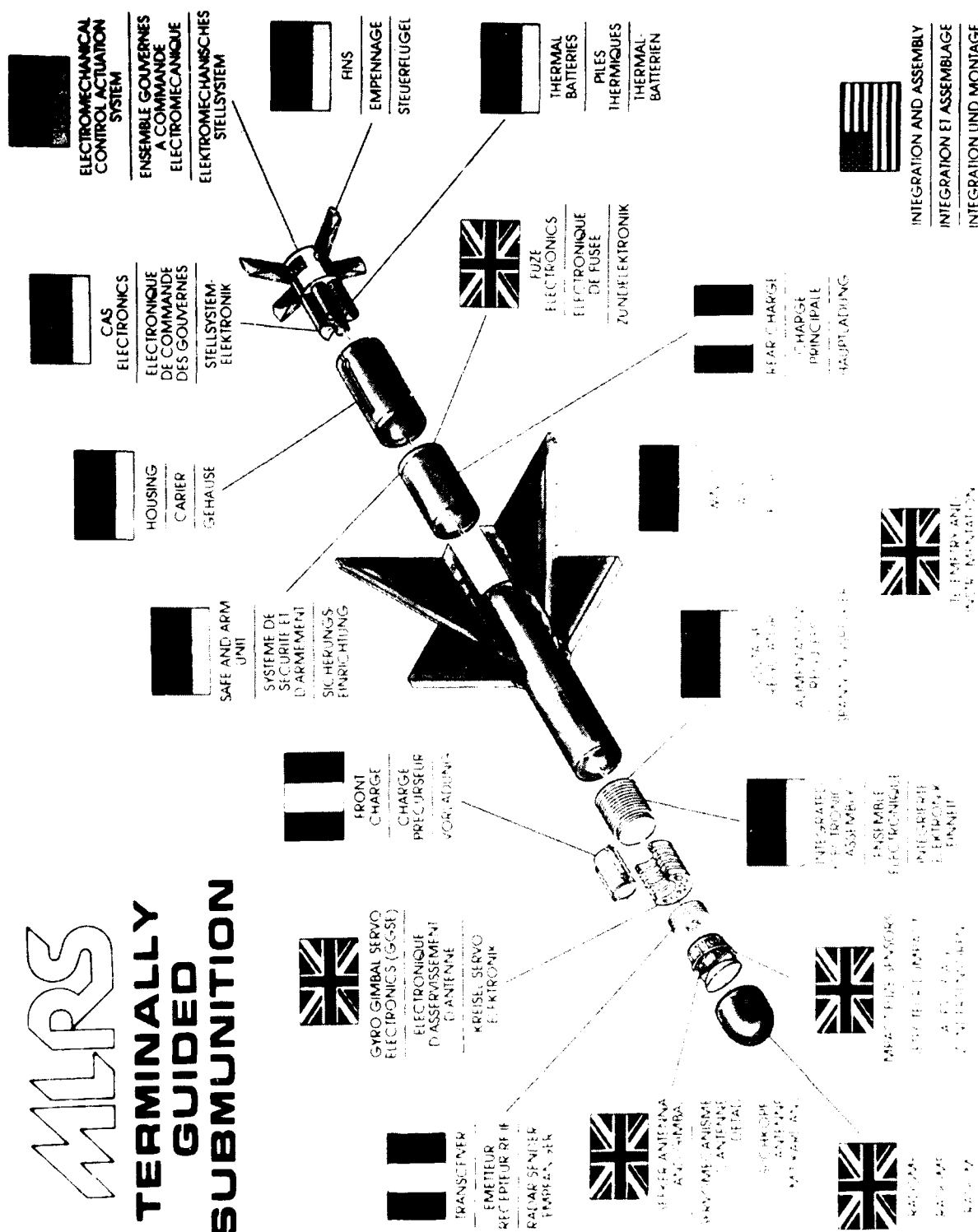
THE MLRS-TGW IS A MULTINATIONAL PROGRAM INCLUDING THE UNITED STATES, GREAT BRITAIN, WEST GERMANY, AND FRANCE.

PICTURED IS A DIAGRAM OF THE TGSM DENOTING THE COUNTRY RESPONSIBLE FOR THE DEVELOPMENT OF EACH OF ITS SUBSYSTEMS. THE U.S. IS PROVIDING APPROXIMATELY 40% OF THE FUNDING FOR THE PROGRAM AND IS RESPONSIBLE FOR THE TGSM INTEGRATION AND ASSEMBLY.

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ALRS TERMINALLY GUIDED SUBMUNITION



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THE ARMY TACTICAL MISSILE SYSTEM (ATACMS) EMPLOYS THE MLRS LAUNCHER AND CAN DELIVER THREE TYPES OF MUNITIONS.

THE BLOCK I MUNITION IS AN ANTIPERSONNEL-ANTIMATERIEL (APAM) ROUND BEING DESIGNED TO ENGAGE SOFT SITTERS. BLOCK I IS NOI A SMART MUNITION SINCE IT DOES NOT EMPLOY SENSORS OR SEEKERS AND IS UNGUIDED.

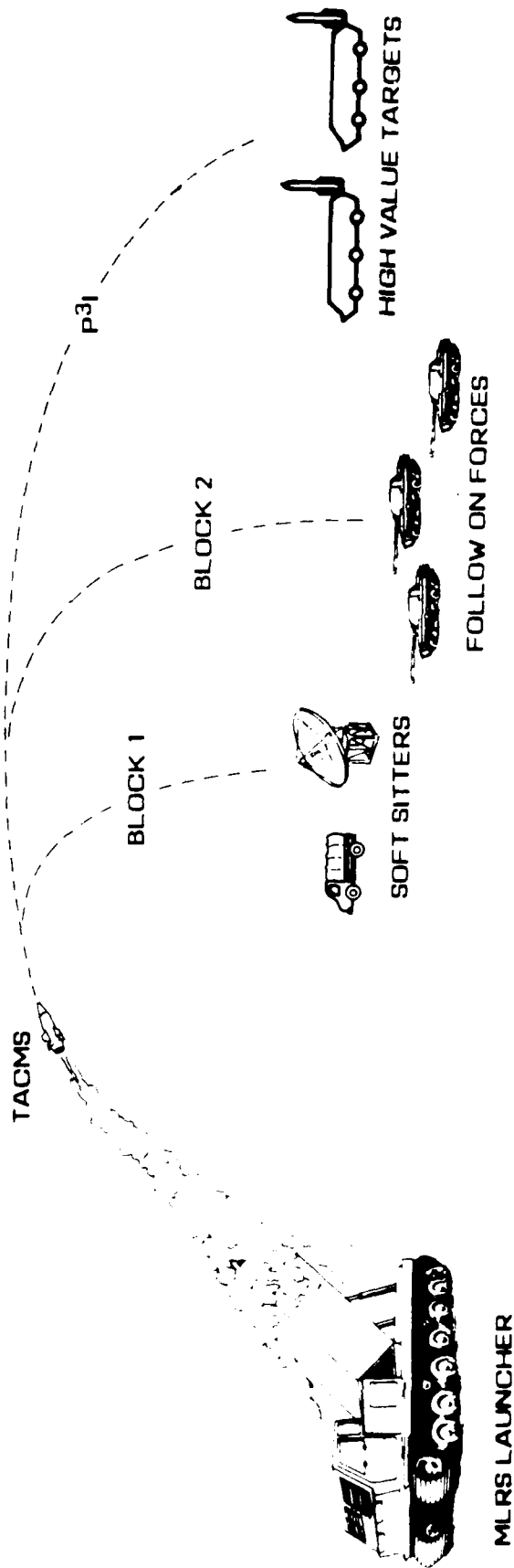
BLOCK II WILL BE A SMART TERMINALLY GUIDED SUBMUNITION DESIGNED TO ENGAGE ARMORED TARGETS AMONG FOLLOW-ON FORCES.

CURRENTLY, THERE ARE NO SYSTEMS THAT CAN AUTONOMOUSLY ENGAGE ENEMY SURFACE-TO-SURFACE MISSILE SYSTEMS (SSMS). THE ATACMS PREPLANNED PRODUCT IMPROVEMENT (P³I) MUNITION WILL BE DESIGNED FOR THIS MISSION.

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(U) U.S. ARMY TACTICAL MISSILE SYSTEM (TACMS)



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THE ARMY TACTICAL MISSILE SYSTEM (ATACMS) INCLUDES THE MLRS LAUNCHER AND A TACTICAL MISSILE CAPABLE OF ENGAGING DEEP TARGETS IN THE CORPS AREA OF RESPONSIBILITY.

FOR COMPARISON PURPOSES, THE ATACMS MISSILE IS PICTURED BESIDE SIX MLRS ROCKET PODS. THE ROCKET LAUNCHER CAN CONTAIN 12 MLRS ROCKETS OR TWO ATACMS MISSILES.

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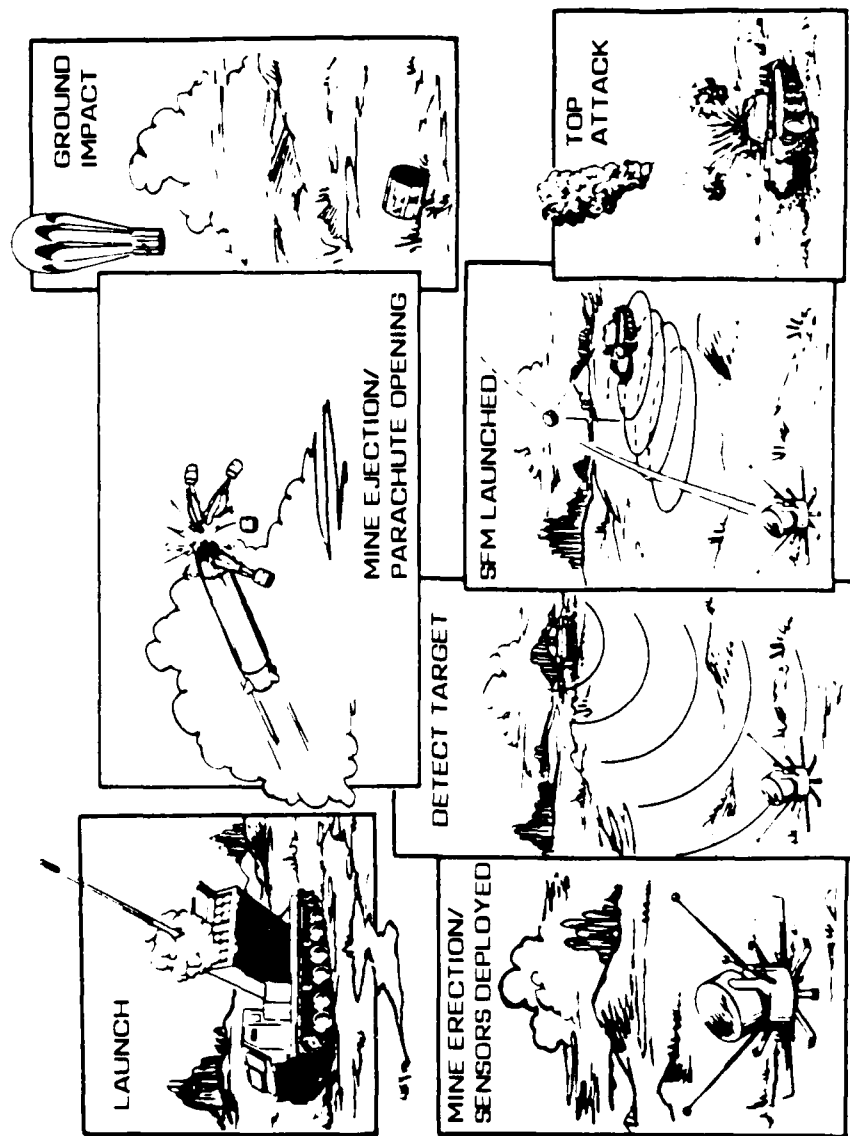
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THE SMART VERSION OF THE WIDE AREA MINE CAN BE DELIVERED TO THE TARGET AREA BY THE ATACMS MISSILE. AFTER EJECTION FROM THE CARRIER MISSILE, EACH SMART MINE WILL DEPLOY A PARACHUTE AND FLOAT TO THE GROUND. THE SMART MINE THEN ERECTS ITSELF AND DEPLOYS ITS SENSOR. UPON TARGET DETECTION, THE MINE WILL LAUNCH AN SFM AT THE TARGET AND THE SFM WILL FIRE AN EXPLOSIVELY FORMED PENETRATOR TO DESTROY THE TARGET.

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(U) OPERATIONAL SEQUENCE OF WIDE AREA MINE (WAM) (SMART VERSION)



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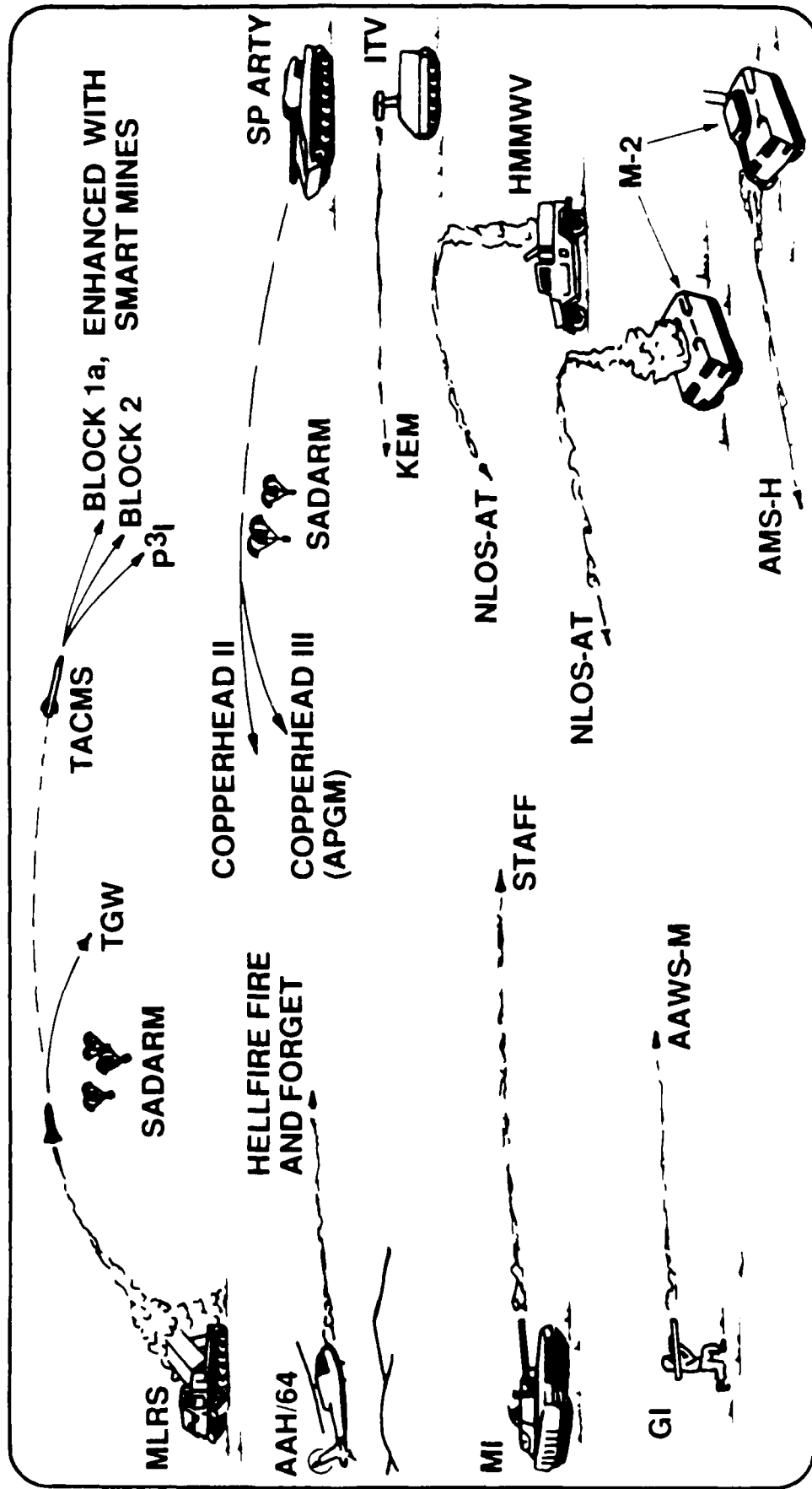
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THE ARMY HAS MANY SMART MUNITION WEAPON SYSTEM CANDIDATES FOR THE 1990s. SINCE THE ARMY DOES NOT HAVE SUFFICIENT FUNDS TO FIELD ALL THESE SYSTEMS, IT WILL SELECT SPECIFIC SYSTEMS OR COMBINATIONS OF SYSTEMS WHICH WILL BEST MEET THE ARMY'S FUTURE REQUIREMENTS.

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(U) THE SMART MUNITION WEAPON CANDIDATES FOR THE 1990s



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THE ARMY HAS ESTABLISHED A SINGLE PROGRAM OFFICE TO SERVE AS A FOCUS FOR THE OVERSIGHT OF ALL SMART MUNITION DEVELOPMENTS. THE OFFICE IS RESPONSIBLE FOR PREVENTING DUPLICATION OF EFFORTS, ENSURING A COST-EFFECTIVE MONEY MANAGEMENT AND INVESTMENT STRATEGY FOR THE ARMY, AND FACILITATING STABILITY WITHIN THE ACQUISITION PROCESS.

SMART MUNITION DEVELOPMENTS ARE BASED UPON THE THREAT AND THE ARMY'S INTEGRATED REQUIREMENTS.

CURRENTLY, THERE ARE NO SMART MUNITIONS IN THE INVENTORY, BUT A FEW SYSTEMS HAVE BEGUN FUNDED DEVELOPMENT. THE GOAL OF THE SMART MUNITIONS PROGRAM OFFICE IS TO DEVELOP A COST-EFFECTIVE ACQUISITION STRATEGY FOR THE ARMY SO THAT IT MAY FIELD AN EFFECTIVE FAMILY OF SMART MUNITION WEAPON SYSTEMS.

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(U) SUMMARY

- ARMY IS CONCENTRATING SMART MUNITION OVERSIGHT
- THREAT/TARGETS DRIVE ARMY SMART MUNITION DEVELOPMENTS
- SMART MUNITION DEVELOPMENTS ARE BASED ON INTEGRATED REQUIREMENTS
- ARMY HAS NO SMART MUNITION SYSTEMS IN CURRENT INVENTORY
- ARMY HAS LIMITED SMART MUNITION WEAPONS SYSTEMS IN FULLY FUNDED DEVELOPMENT

- GOALS:

DEVELOP THE ACQUISITION STRATEGY FOR A COST
EFFECTIVE FAMILY OF SMART MUNITIONS

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THE TACTICAL WEAPON GUIDANCE AND CONTROL INFORMATION ANALYSIS CENTER (GACIAC)

GACIAC is a DoD Information Analysis Center operated by IIT Research Institute under the technical sponsorship of the Joint Service Guidance and Control Committee with members for OUSDRE, Army, Navy, Air Force, and DARPA. The U.S. Army Missile Command provides the Contracting Officer's Technical Representative. Its mission is to assist the tactical weapon guidance and control community by encouraging and facilitating the exchange and dissemination of technical data and information for the purpose of effecting coordination of research, exploratory development, and advanced technology demonstrations. To accomplish this, GACIAC's functions are to:

- 1. Develop a machine-readable bibliographic data base - currently containing over 30,000 entries;*
- 2. Collect, review, and store pertinent documents in its field of interest - the library contains over 9,000 reports;*
- 3. Analyze, appraise and summarize information and data on selected subjects;*
- 4. Disseminate information through the GACIAC Bulletin, bibliographies, state-of-the-art summaries, technology assessments, handbooks, special reports, and conferences;*
- 5. Respond to technical inquiries related to tactical weapon guidance and control, and*
- 6. Provide technical and administrative support to the Joint Service Guidance and Control Committee (JSGCC).*

The products and services of GACIAC are available to qualified industrial users through a subscription plan or individual sales. Government personnel are eligible for products and services under block funding provided by the Army, Navy, Air Force and DARPA. A written request on government stationery is required to receive all the products as a government subscriber.

Further information regarding GACIAC services, products, participation plan, or additional copies of this Special Report may be obtained by writing or calling. GACIAC, IIT Research Institute, 10 West 35th Street, Chicago, Illinois 60616, Area Code 312, 567-4519 or 567-4544.

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