United States General Accounting Office

GAO

Report to the Honorable Lane Evans, House of Representatives

September 2002

MILITARY OPERATIONS

Information on U.S. Use of Land Mines in the Persian Gulf War

GAO-02-1003

Contents

Letter 1

Results in Brief 2
Background 4
Effect of the Use of Self-Destruct U.S. Land Mines in the Gulf War Is Unknown 6
Extent of U.S. Casualties from Land Mines and Unexploded Ordnance 11
DOD Reports Express Fratricide and Mobility Concerns Relating to the Safety of, and Lack of Knowledge about, Land Mines and Dudfields 20
Agency Comments and Our Evaluation 36

Appendix I **Current U.S. Land Mine Inventory** 39

Appendix II **U.S. Land Mines Available for Use in the Gulf War** 44

Appendix III **U.S. Gulf War Casualties by Service** 51

Appendix IV **DOD-Reported Actions That Relate to Land Mine and UXO Concerns** 52

Developing Antipersonnel Land-Mine Alternatives and More Capable and Safer Self-Destruct Land Mines 52
Revising Doctrine and Procedures to Better Address Hazardous Submunition Dudfields 57
Increasing Ammunition Reliability and Reducing Dud Rates 60

Appendix V **Scope and Methodology** 63

Appendix VI **Comments from the Department of Defense** 67

Tables

Table 1: U.S. Land Mines Reportedly Used in the Gulf War 9
Table 2: Total U.S. Gulf War Casualties 12
Table 3: Descriptions of Casualty Categories 14
Table 4: U.S. Gulf War Casualties from Explosions and All Other Causes 15
Table 5: U.S. Gulf War Explosion Casualties by Category 16
Table 6: U.S. Scatterable Mines and UXO Reported by CMS, Inc., as Found on One Kuwaiti Battlefield Sector 27
Table 7: DOD Land Mine Stockpile Totals as of 2002 39
Table 8: Land Mines in Mixed Dispensers as of 2002 40
Table 9: Total U.S. Worldwide Inventory of Land Mines as of 2002 41
Table 10: Types and Numbers of Certain U.S. Land Mines Stockpiled Worldwide in 1990, Available in the Southwest Asian Theater, and Used during the Gulf War 49

Figures

Figure 1: Causes of U.S. Casualties during the Gulf War 13
Figure 2: Types of Munitions Causing 177 Explosion Casualties 17
Figure 3: Circumstances Causing 177 U.S. Casualties from Land Mines, Cluster Munition UXO, and Other UXO 18
Figure 4: Map of Kuwait Showing the CMS Explosive Ordnance Disposal Sector Surrounding Al Jaber Airbase 25
Figure 5: U.S. Land Mines Available and Used in the Gulf War 44
Figure 6: U.S. Land Mines Available but Not Used in the Gulf War 46
Figure 7: M-18 Claymore Nonself-Destruct Command-Detonated Antipersonnel Land Mine 48

Abbreviations

ADAM	Area Denial Artillery Munition
AP	antipersonnel
APL	antipersonnel land mine
ASD/SOLIC	Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict)
AT	antitank
ATACMS	Army Tactical Missile System
CBU	cluster bomb unit
CINC	commander-in-chief
CMS	Conventional Munitions Systems, Inc.
DAM	Demolition Attack Munition
DOD	Department of Defense
DPICM	dual-purpose improved conventional munition
FASCAM	family of scatterable mines
EOD	explosive ordnance disposal
GEMSS	Ground-Emplaced Mine Scattering System
JCS	Joint Chiefs of Staff
LM	land mine
MLRS	Multiple Launch Rocket System
MOPMS	Modular Pack Mine System
NSD-A	Non-Self-Destruct Alternative
ODS	Operation Desert Storm
OSD	Office of the Secretary of Defense
PDD	Presidential Decision Directive
PDM	Pursuit Denial Munition
RAAM	Remote Anti-Armor Mine
RADAM	Remote Area Denial Artillery Munition
SCATMINE	scatterable mine
SD	self-destruct
SLAM	Selectable Lightweight Attack Munition
SWA	Southwest Asia
UXO	unexploded ordnance
WAM	Wide Area Munition

G A O
Accountability * Integrity * Reliability

United States General Accounting Office
Washington, DC 20548

September 30, 2002

The Honorable Lane Evans
House of Representatives

Dear Mr. Evans:

The utility of land mines on the modern battlefield has come into question in recent years, largely because of their potential for causing unintended casualties and affecting U.S. forces' maneuverability.[1] These concerns were raised during the Persian Gulf War (August 1990 to April 1991). In the Gulf War, the Department of Defense (DOD) deployed over 580,000 military personnel and a wide array of conventional weapons and munitions that it had designed and acquired primarily to fight the Soviet Union. The munitions used by these forces included several types of land mines and represented the largest U.S. combat use of its newer aircraft- and artillery-delivered scatterable self-destructing land mines. Since the United States was attacked on September 11, 2001, DOD has been reviewing war plans to ensure that the military services are ready to meet future U.S. national security needs. This effort includes plans for the use of land mines. U.S. Gulf War experience documented in DOD after-action and lessons-learned reports provides insights concerning land mines.

As you requested, this report focuses on U.S. land mine use during the Gulf War. Our objective was to answer the following questions: (1) To what extent were U.S. land mines available, planned for use, and used in the Gulf War; and what enemy losses resulted from U.S. land mine use? (2) To what extent did land mines cause U.S. casualties? (3) What concerns and related actions were identified in lessons-learned and other reports about the use of land mines? In addition, you asked us to provide information on the quantity of land mines in the current U.S. stockpile and the planned U.S. use of land mines for the defense of the Republic of South Korea. We are providing information on the current U.S. land mine stockpile in appendix I. We will later provide information on the U.S. use of land mines for the defense of South Korea. Because land mine issues

[1] Department of the Army, *Field Manual 20-32*, *Mine/Countermine Operations*, (Washington, D.C.: May 29, 1998 [includes "Change 2," Aug. 22, 2001]) states, "Mines are explosive devices that are emplaced to kill, destroy, or incapacitate enemy personnel and/or equipment. . . . A mine is detonated by the action of its target, the passage of time, or controlled means. . . . "

are in some ways related to issues regarding unexploded ordnance (UXO) on the battlefield, we also discuss unexploded ordnance as it relates to U.S. casualties and troop mobility. This report does not assess the military utility or effectiveness of land mine warfare, the use of land mines by U.S. allies or the enemy in the Gulf War, the utility of nonland-mine "submunition"[2] weapons, the services' casualty-reporting systems, post-conflict humanitarian issues, or DOD's current actions to address land mine and unexploded ordnance issues. (See app. IV.)

Because many records on the use of land mines and U.S. casualties during the Gulf War had been destroyed or lost, were incomplete or contradictory, or were archived and not easily accessible, we compiled records and documents from various sources and different DOD locations and interviewed a wide range of cognizant officials. Military service officials believe that service-provided data regarding U.S. land-mine, casualty, and unexploded ordnance issues are as accurate as available DOD records permit and that our coverage of U.S. casualties is based on the most complete analysis by service casualty officials to date. (See app. V for a detailed discussion of this report's scope and methodology.)

Results in Brief

U.S. land mines of all types—nonself-destructing and self-destructing, antipersonnel and antitank—were available for use if needed in the Gulf War from U.S. land mine stockpiles, which contained about 19 million land mines. U.S. forces sent to the Gulf War theater of operations took with them for potential use over 2.2 million land mines. U.S. war plans included plans for the use of land mines if required by the tactical situation. According to DOD documents, no nonself-destructing, or "dumb," land mines were used; and the reported number of self-destructing, or "smart," land mines used by the services totaled approximately 118,000. DOD did not provide us information on the effect of U.S. land mine use against the enemy. Consequently, we are unable to report this effect. Although U.S. surface-laid scatterable land mines were employed by Marine Corps artillery to supplement a defensive position and by Air Force, Navy, and Marine aircraft to attack suspected Iraqi Scud missile transporters and other locations, no military service report attributed enemy losses to the U.S. use of land mines. Similarly, neither DOD, the Joint Chiefs of Staff, nor the U.S. Central Command provided us

[2] A submunition is any munition that separates from the parent munition to perform its task.

with any reports or other evidence clearly indicating that U.S. land mines used during the Gulf War had been the direct or indirect cause of enemy casualties, equipment losses, or maneuver limitations.

According to U.S. service records, of the 1,364 total U.S. casualties in the Gulf War, 81, or 6 percent, were killed or injured by land mines. Of these casualties, none was attributed to U.S. land mines, but rather, they were attributed to Iraqi or unknown types of land mines. Some portion of the 142 casualties caused by an unknown type of land mine or unknown or misidentified type of unexploded ordnance might have been caused by U.S. or other land mines, but there is no way of knowing. Similarly, it is possible that some U.S. casualties in the "unknown causes" and "other causes" categories might have resulted from land mines or unexploded ordnance. Because of service data limitations, it is not possible to determine the exact cause of all these casualties.

Concerns about land mines raised in DOD lessons-learned and other reports included the fear of fratricide and loss of battlefield mobility. These concerns led to the reluctance of some U.S. commanders to use land mines in areas that U.S. and allied forces might have to traverse. According to DOD reports, commanders gave two basic reasons for these concerns: The first entailed the obsolescence of conventional, nonself-destructing U.S. land mines as well as safety issues involving the use of land mines in general and other scatterable munitions. The safety issues during the Gulf War were heightened by malfunctioning, or dud, rates for land mines and other submunitions that were higher than anticipated. Furthermore, malfunctioning submunitions, when present on the battlefield in large numbers, can result in de facto minefields, or "dudfields," thus creating fratricide hazards and mobility limitations similar to minefields. The second reason for the concerns was that reporting, recording, and when appropriate, marking[3] the location of minefields or hazardous dudfields were not always accomplished when needed. According to DOD reports, even when self-destructing land mines are appropriately reported and marked, malfunctioning self-destruct mechanisms can still cause concerns about potential hazards similar to nonland-mine dudfields. DOD and service reports resulting from the Gulf

[3] Minefield reporting involves an oral, electronic, or written communication concerning mining activities, friendly or enemy, submitted in a standard format. Minefield recording involves a complete written record of all pertinent information concerning a minefield, submitted on a standard form. Minefield marking involves the visible marking of all points required in emplacing a minefield and the minefield's extent.

War recognized that concerns about land mines and other unexploded submunitions on the battlefield needed to be addressed. In various after-action reports, DOD identified a variety of corrective actions to address fratricide and mobility concerns and to improve the effectiveness and utility of land mine and nonland-mine submunitions. These actions included that DOD (1) replace older model nonself-destruct land mines with modern, safer ones or alternative systems; (2) emphasize procedures to reduce fratricide and battlefield mobility concerns associated with dudfields; and (3) include self-destruct mechanisms in nonland-mine submunitions. (Appendix IV identifies DOD-reported actions related to these concerns. However, because it was outside the scope of this report, we did not evaluate DOD's progress in these areas.)

In commenting on a draft of this report, DOD stated that the report is flawed because it makes assertions that are not based on fact and uses unreliable data (see app. VI for DOD's comments in their entirety). Though we have made some changes to clarify issues DOD raises, we do not agree that our report is flawed or contains unsupported facts or unreliable data. Almost all data in this report for U.S. land mine use, U.S. casualties, and DOD lessons learned were provided to us by service officials or were taken from DOD documents. The data's accuracy was not challenged by DOD, and DOD provided no alternative data. Much of DOD's concern about "unreliable data" stems from our use of the report by an Army contractor on unexploded ordnance cleanup of the battlefield. While DOD claims that the contractor's report contained inaccuracies, DOD did not provide any data to challenge the main message of the contractor's report, which was that a very large number of U.S. land mine and cluster munition duds were found on the Kuwaiti battlefield. See the "Agency Comments and Our Evaluation" section for our detailed response to DOD's comments.

Background

Land mines in the U.S. inventory are of two distinct types: The first consists of conventional land mines that are hand-emplaced and are termed nonself-destruct, or sometimes "dumb," because they remain active for years unless disarmed or detonated. They can therefore cause unintended post-conflict and civilian casualties. The second type consists of land mines that are generally, but not always, surface-laid "scatterable" land mines that are dropped by aircraft, fired by artillery, or dispersed by another dispenser system. They are conversely called "smart" because they remain active for preset periods of time after which they are designed to self-destruct or deactivate, rendering themselves nonhazardous.

According to DOD, smart land mines have a 99.99-percent self-destruct reliability rate. Most self-destruct land mine systems are set at one of three self-destruct periods: 4 hours, 48 hours, or 15 days. In addition, should the self-destruct mechanism fail, self-destruct land mines are designed to self-deactivate, meaning that they are to be rendered inoperable by means of the "irreversible exhaustion of their batteries" within 120 days after employment. This feature, according to DOD, operates with a reliability rate of 99.999(+) percent.[4] At the time of the Gulf War, U.S. forces were armed with both nonself-destruct and self-destruct land mines, and U.S. policy allowed them to use both types. Today, however, U.S. presidential policy limits the U.S. forces' use of nonself-destruct M-14 and M-16 antipersonnel land mines (see fig. 6 in app. II) to Korea.

Antitank mines, as the name implies, are designed to immobilize or destroy tracked and wheeled vehicles and the vehicles' crews and passengers. The fuzes that activate antitank mines are of various types. For example, they can be activated by pressure, which requires contact with the wheels or tracks of a vehicle, or by acoustics, magnetic influence, radio frequencies, infrared-sensor, command, disturbance, or vibration, which do not require contact. Antitank mines have three types of warheads. Blast mines derive their effectiveness from the force generated by high-explosive detonation. Shaped-charged mines use a directed-energy warhead. Explosive-formed penetrating mines have an explosive charge with a metal plate in front, which forms into an inverted disk, a slug, or a long rod.

Antipersonnel land mines are designed to kill or wound soldiers. Their fuzes can be activated, for example, by pressure, trip wires, disturbance, antihandling mechanisms, or command detonation. Antipersonnel land mine warhead types include blast, directed fragmentation, and bounding fragmentation. The blast mine is designed to injure the lower extremities of the individual who steps on it. The directed fragmentation mine propels fragments in the general direction it is pointed, and the bounding fragmentation mine throws a canister into the air, which bursts and scatters shrapnel throughout the immediate area to kill or wound the enemy.

[4] DOD reports that these reliability rates are based on proving ground tests, conducted over the past 14 years, involving nearly 67,000 self-destruct antitank and antipersonnel mines.

Antitank and antipersonnel land mines are often employed together, as "mixed" systems. In a mixed system, the antipersonnel land mines are intermingled with antitank land mines to discourage enemy personnel from attempting to disarm them. Antitank land mines may also be equipped with explosive antidisturbance devices designed to protect them from being moved by enemy personnel, thus increasing the difficulty and challenge of breaching a minefield.[5]

Effect of the Use of Self-Destruct U.S. Land Mines in the Gulf War Is Unknown

According to DOD, all the types of land mines in DOD's arsenal were available and included in U.S. war plans for use if needed in the Gulf War. DOD reported that during the war, U.S. forces used no nonself-destruct land mines. The services reported using a total of about 118,000 artillery-delivered or aircraft-delivered surface-laid scatterable self-destruct land mines. DOD provided few records showing why land mines were used and no evidence of specific military effects on the enemy—such as enemy killed or equipment destroyed—from the U.S. use of land mines during the Gulf War. We therefore could not determine the effect of U.S. land-mine use during the Gulf War. See appendix II for pictures, types, and numbers of land mines available for use and numbers used in the Gulf War.

U.S. Nonself-Destruct and Self-Destruct Land Mines Were Available in Theater

U.S. forces deployed to the Gulf War with over 2.2 million of the DOD-estimated 19 million land mines available in U.S. worldwide stockpiles in 1990.[6] These consisted of both the conventional nonself-destruct land mines and scatterable surface-laid, self-destruct land mines. Nonself-destruct, hand-emplaced land mines available but not used included the M-14 ("Toe Popper") and the M-16 ("Bouncing Betty") antipersonnel land mines and the M-15, M-19, and M-21 antitank land mines.[7] Self-destruct,

[5] *Field Manual 20-32* states, "AHD [antihandling devices] perform the function of a mine fuse if someone attempts to tamper with the mine. . . . AHDs are added to a minefield to discourage manual removal and reuse of mines by the enemy and to demoralize the enemy who is attempting to reduce the minefield."

[6] Types of U.S. land mines available to U.S. forces during the Gulf War include those shown in appendix II. According to service records, as of 2002, the DOD land mine stockpile contains about 18 million land mines of the types and quantities shown in appendix I.

[7] The U.S. land mine stockpile in 1990 included over 3.9 million M-14 and 2.3 million M-16 nonself-destruct antipersonnel land mines, with over 200,000 of these taken by U.S. forces to the Gulf War theater area. Over 2 million M-15/19/21 nonself-destruct antitank land mines were available in the U.S. stockpile and over 40,000 were taken to the Gulf War theater. See appendix II, table 10.

scatterable land mines included air-delivered cluster bomb unit (CBU) 78/89 Gator, which dispensed mixed scatterable antipersonnel and antitank land mines, and artillery-fired M-692/731 Area Denial Artillery Munition (ADAM) antipersonnel land mines and M-718/741 Remote Anti-Armor Mine (RAAM) antitank land mines.[8] (See app. II, figs. 5, 6, and 7 and table 10.)

The services reported that all standard types of U.S. land mines in their inventories were available from unit and theater supplies or U.S. stockpiles.

Planned Use of U.S. Land Mines

During the Gulf War, U.S. forces were permitted by doctrine, war plans, and command authority to employ both nonself-destruct and self-destruct land mines whenever an appropriate commander determined that U.S. use of land mines would provide a tactical advantage. U.S. land mines of all types were available and planned for use by U.S. forces.

U.S. land mine warfare[9] doctrine for the services during the Gulf War indicated that land mines could be used both offensively, for example, to deny the enemy use of key terrain, and defensively, for instance, to protect U.S. forces from attack. U.S. doctrine states that the primary uses of land mines are to provide force protection, shape the battlefield, and reduce the number of forces needed.

At the time of the Gulf War, U.S. land mine doctrine included the following four types of minefields:

1. protective minefields, whose purpose is to add temporary strength to weapons, positions, or other obstacles;

[8] The U.S. land mine stockpile in 1990 included over 4.4 million Area Denial Artillery Munition (ADAM) antipersonnel and over 2.5 million Remote Anti-Armor Mine (RAAM) antitank artillery-fired self-destruct land mines. In addition, U.S. forces had a number of other types of land mines and land mine dispenser systems, including over 2 million land mines for the M-128 Ground-Emplaced Mine Scattering System (GEMSS) (see app. II, fig. 6) and nearly 700,000 land mines contained in Gator CBU89/78 aircraft-delivered cluster bombs (see fig. 5). The United States took to the Gulf War theater for potential use about 2 million of these self-destruct land mines. See appendix II, table 10.

[9] "Mine warfare," the use of mines and mine countermeasures, is divided into two basic concepts with regard to land theaters—(1) the laying of mines to degrade the enemy's capabilities to wage land warfare and (2) the countering of enemy-laid mines to permit friendly maneuver or use of selected land areas.

2. tactical minefields, which are emplaced as part of an overall obstacle plan to stop, delay, and disrupt enemy attacks; reduce enemy mobility; channelize enemy formations; block enemy penetrations; and protect friendly flanks;

3. point minefields, which are emplaced in friendly or uncontested areas and are intended to disorganize enemy forces or block an enemy counterattack; and

4. interdiction minefields, which are emplaced in enemy-held areas to disrupt lines of communication and separate enemy forces.[10]

U.S. plans for the execution of the Gulf War included the use of hand-emplaced antipersonnel and antitank land mines (e.g., M-14/16/21), artillery-delivered land mines (ADAM/RAAM), air-delivered land mines (Gator), and others for these purposes when U.S. commanders determined their use was needed. Military units' on-hand ammunition supplies, as well as ammunition resupply stockpiles located within the combat theater, included millions of U.S. land mines. Ammunition resupply plans included planned rates for the daily resupply of land mines consumed in combat.

Services Reported that the United States Used about 118,000 Land Mines

The services reported that during the Gulf War, they used about 118,000 land mines from the approximately 2.2 million U.S. land mines that were taken to the Gulf War theater of operations and the millions of land mines available for use from U.S. worldwide stockpiles, which in total contained about 19 million land mines. All of the land mines used were the self-destructing, scatterable, surface-laid types. However, the services also indicated that, because Gulf War records related to land mines might be incomplete, information made available to us may be inexact. For example, the Army indicated that, while its record searches show that the Army used no land mines, it is unsure whether archived Gulf War records include evidence of Army land mine use that it has not uncovered.

[10] These are the minefields defined in the Army's 1985 version of its *Field Manual 20-32*, which applied during the Persian Gulf War. The 1998 version lists the types of minefields as protective, tactical, nuisance, and phony. Protective minefields are employed to protect soldiers, equipment, supplies, and facilities from enemy attacks or other threats. Tactical minefields are employed to directly affect enemy maneuver and to give the defender a positional advantage over the attacker. Nuisance minefields impose caution on enemy forces and disrupt, delay, and sometimes weaken or destroy follow-on forces. Phony minefields are areas of ground altered to give the same appearance as a real minefield and thereby deceive the enemy.

The services reported no confirmed use of any nonself-destruct land mines during the Gulf War. In other words, U.S. forces reported no use of antipersonnel land mines such as the over 6 million available (over 200,000 in theater) M-14 "Toe Popper" or M-16 "Bouncing Betty" and no M-15, M-19, or M-21 antitank land mines, which numbered over 2 million in U.S. stockpiles (over 40,000 in theater). (See fig. 6 and table 10 in app. II.) The Army reported no confirmed use of any land mines, with the qualification that it is unsure whether it had emplaced two minefields of an unknown type. The other military services reported that they used a total of 117,634 U.S. self-destruct land mines, whose destruction time-delay periods were set at 4 hours, 48 hours, or 15 days. The type of land mine used in the largest quantity was the aircraft-delivered surface-laid Gator land mines, which were dispersed from cluster bomb units containing both antitank and antipersonnel mines. Air Force, Navy, and Marine aircraft employed a total of 116,770 Gator land mines. Table 1 and appendix II provide additional details on the numbers and types of land mines available for use and used by the U.S. military services during the Gulf War.

Table 1: U.S. Land Mines Reportedly Used in the Gulf War

	Service			
Land mine type	**Army**	**Air Force**	**Navy and Marine Corps combined[a]**	**Total land mines**
Gator CBU bombs containing	0	1,105	215	
• antitank mines	0	79,560	9,675	**89,235**
• antipersonnel mines	0	24,310	3,225	**27,535**
RAAM artillery rounds containing	0	0	48[b]	
• antitank mines	0	0	432[b]	**432**
ADAM artillery rounds containing	0	0	12[b]	
• antipersonnel mines	0	0	432[b]	**432**
Total land mines	**0[c]**	**103,870**	**13,764**	**117,634**

[a] The service-reported data combined Navy and Marine Corps usage of Gator land mines and are included here in that format.

[b] All ADAM and RAAM numbers indicate use by only the Marine Corps.

[c] The Army stated that it is unsure whether it had emplaced two minefields of unknown type.

Note: DOD and the services reported that no U.S. land mines of any type were employed except those shown in this table. DOD said that available Gulf War records do not permit estimating the number of land mines used by calculating the difference between the number brought to the war and the number returned unused.

Source: DOD and service documents.

DOD Records Contain Little Information on Why Land Mines Were Used

DOD records on the Gulf War provided us include little detail on why land mines were used. Available records indicate that U.S. forces employed land mines both offensively and defensively when fighting in Iraqi-controlled Kuwait. For example, U.S. aircraft offensively employed concentrations of surface-laid Gator land mines to deny Iraqi use of Al Jaber airbase in Kuwait and to hamper the movement of Iraqi forces. In addition, Gator land mines were used extensively with the intent to inhibit free movement in and around possible staging and launch areas for enemy Scud missiles.[11] Possible Scud missile transporter "hide sites" included culverts, overpasses, and bridges in Iraq. In a defensive mode, Gator land mines were employed along the flanks of U.S. forces. In addition, U.S. Marines defensively employed concentrations of artillery-fired ADAM and RAAM land mines to supplement defenses against potential attacks by enemy forces north of Al Jaber airbase in southern Kuwait.

Procedures for commanders to approve land mine use were established, disseminated, and included in all major unit war plans. A senior U.S. force commander who participated in the Gulf War told us that

- U.S. forces had no restrictive theaterwide or forcewide prohibitions on the employment of land mines,
- U.S. commanders understood their authority to use mines whenever their use would provide a tactical advantage, and
- U.S. commanders decided to use land mine or nonland-mine munitions based on their determinations as to which were best suited to accomplish assigned missions.

Effects of U.S. Land-Mine Use on the Enemy Are Unknown

The services reported no evidence of enemy casualties, either killed or injured; enemy equipment losses, either destroyed or damaged; or enemy maneuver limitations resulting, directly or indirectly, from its employment of surface-laid scatterable Gator, ADAM, and RAAM land mines during the Gulf War. (See app. II, fig. 5.) U.S. forces intended to adversely affect the enemy by using 116,770 Gator land mines, but no service has provided specific evidence that these land mines or the 864 ADAM and RAAM land mines reported as employed actually caused or contributed to enemy losses. Because neither DOD nor the services provided us evidence or

[11] During the Gulf War, the Iraqis launched more than 90 Scud missiles, which are liquid-fueled, short-range ballistic missiles. The Iraqi missiles were developed from the Soviet version.

estimates of actual effects and losses inflicted on the enemy by these U.S. land mines, we were unable to determine the actual effect of U.S. land mine use during the Gulf War.

DOD and service documents detailing when land mines were used did not provide evidence of the effects of that use. For example, in one case, the Marine Corps reported that it had fired artillery-delivered ADAM and RAAM land mines to supplement a defensive position. However, the enemy was not reported to have been aware of or have actually encountered these land mines. Similarly, air Gator drops on possible Scud missile sites were not reported to have destroyed any Scud missiles or transporters. The services provided no evidence indicating whether the enemy had ever encountered the Gator land mines dropped on possible enemy maneuver routes or whether Gator employments had resulted in enemy destruction.

Extent of U.S. Casualties from Land Mines and Unexploded Ordnance

Service reports indicate that 81 of the 1,364 U.S. casualties attributed to the Gulf War[12] were caused by land mines. None of these were attributed specifically to U.S. land mines, but rather to an Iraqi or an "unknown" type of land mine. Because of service data limitations, the possibility cannot be ruled out that some of the casualties now attributed to explosions of unknown or ambiguously reported unexploded ordnance were actually caused by land mines. Service casualty reporting indicates that at least 142 additional casualties resulted from such unexplained explosions. However, there is no way to determine whether some portion of these might have been caused by U.S. or other land mines or by unexploded ordnance. Of all casualties reported to have been caused by explosions, a relatively small percentage were reported to have been caused by the unauthorized handling of unexploded ordnance.

Numbers of Service Members Reported Killed and Injured during the Gulf War

The services reported that there were 1,364 U.S. casualties associated with the Gulf War. Of these, 385 were killed, and 979 were injured. Army personnel suffered 1,032 casualties, or 76 percent, of all U.S. deaths and injuries. Table 2 shows the numbers of U.S. casualties by military service.

[12] Combined reporting totals of Gulf War casualties reported to us by each service differ from figures previously reported by DOD. DOD-reported figures provided to us used different and broader categories to report casualties. Because we believe the services have the most accurate data available for their casualties, we report service-provided data.

Table 2: Total U.S. Gulf War Casualties

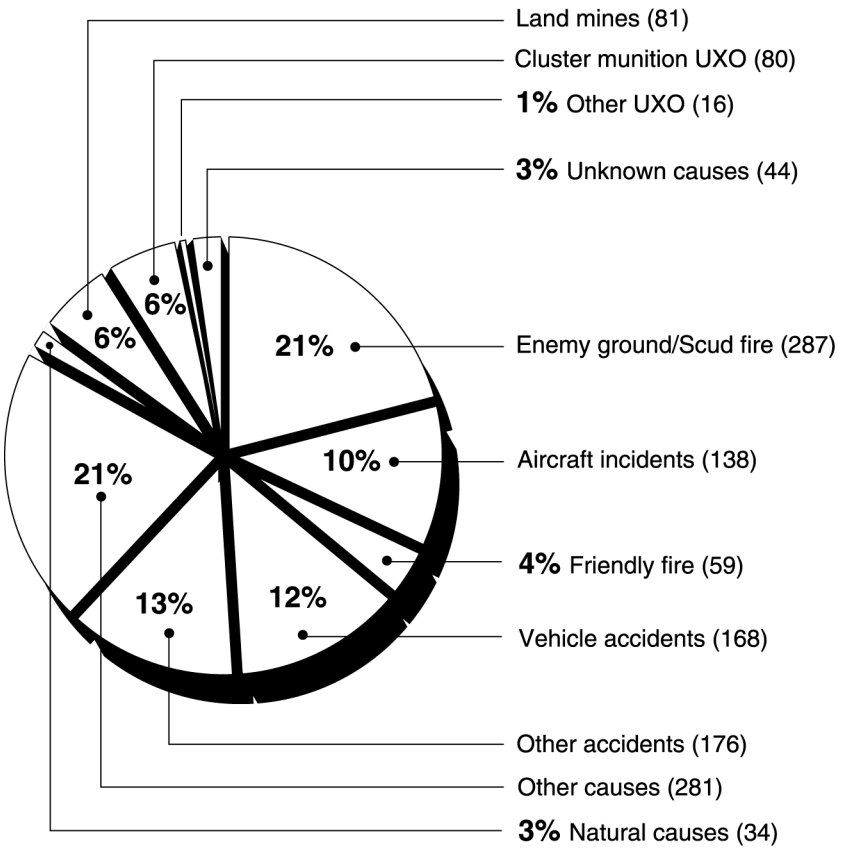
Service	Killed	Injured	Total	Percentage of total
Army	226	806	**1,032**	**76**
Marines	69	153	**222**	**16**
Air Force	35	9	**44**	**3**
Navy	55	11	**66**	**5**
Total	**385**	**979**	**1,364**	**100**

Source: Service casualty data.

Causes of U.S. Casualties

To determine what number of these casualties could have been caused by U.S. or other land mines, we obtained information from the services on the causes of all Gulf War deaths and injuries. Service officials attributed casualties to causes and categories based on battlefield casualty, accident, after-action, and other reports. As shown in figure 1, enemy ground and Scud missile fire caused the largest number of identifiable casualties to Gulf War service members. The services assigned 287, or 21 percent, of all casualties during the Gulf War to the "enemy ground/Scud fire" category. In particular, the Army attributed 128 of the 287 in this category to an Iraqi Scud missile attack. In addition, enemy fire caused some "aircraft incident" casualties. The second and third largest categories of identifiable causes of casualties were vehicle accidents and aircraft incidents. Available data indicate that explosions from some type of ordnance caused 177 casualties: land mines caused 81; cluster munition unexploded ordnance (UXO) caused 80; and other UXO caused 16.

Figure 1: Causes of U.S. Casualties during the Gulf War



Source: Service casualty data.

The casualty categories depicted in figure 1 are defined in table 3.

Table 3: Descriptions of Casualty Categories

Casualty category	Number of casualties	Description of category
Land mines	81	This category includes all deaths and injuries attributed by the services to Iraqi or unidentified land mines. The services attributed no U.S. Gulf War casualties to U.S. land mines.[a]
Cluster munition UXO	80	This category includes all deaths and injuries attributed by the services to a type of U.S. submunition unexploded ordnance categorized as cluster bomb units and dual-purpose improved conventional munitions.[a]
Other UXO	16	This category includes all deaths and injuries attributed by the services to explosions of unexploded ordnance of an unidentified type.[a]
Unknown causes	44	This category includes only Army casualties attributed by the Army to unknown causes.[a]
Enemy ground/Scud fire	287	This category includes deaths and injuries attributed by the services to enemy ground weapons and Scud missile fire against U.S. forces. This category does not include aircraft incidents.
Aircraft incidents	138	This category includes all deaths and injuries attributed by the services to airplane and helicopter incidents due to enemy fire, weather conditions, pilot error, or mechanical failure.
Friendly fire	59	This category includes all deaths and injuries attributed by the services to friendly fire.
Vehicle accidents	168	This category includes all deaths and injuries attributed by the services to accidents involving vehicles other than aircraft.
Other accidents	176	This category includes all deaths and injuries attributed by the services to accidents other than vehicle or aircraft accidents. It includes noncombat-related incidents, such as accidental grenade explosions, drownings, and training accidents.
Other causes	281	This category includes all deaths and injuries not attributed by the services to the other categories.[a]
Natural causes	34	This category includes all deaths and illnesses attributed by the services to natural physical causes, such as heart attack.
Total casualties	**1,364**	

[a] Service casualty reporting does not rule out the possibility that this category may include mine, cluster munition, and other UXO casualties.

Source: Service-reported casualty data.

As would be expected, the various services experienced different types and numbers of casualties. For the Marine Corps, "enemy ground fire" caused the largest number of casualties—84; for the Air Force, "aircraft incidents" was the largest cause—39; and for the Navy, "other accidents" caused the largest number—33.

For the Army, "other causes" was the largest category—267. Our comparison of casualty-related documentation, however, indicates that at least some of these casualties should have been categorized elsewhere. For example, documentation shows that one casualty placed in "other causes" might have been a land mine casualty. In a second case, documentation indicates that one of these casualties suffered a heart attack and should have been placed in the "natural causes" category. In

other documentation, we found indications that five casualties placed in this "other causes" category suffered what were "other accidents." For these reasons, it is unclear whether all 267 of these Army-reported casualties should have been placed in the "other causes" category. However, Army officials indicated that available data limited the Army's ability to identify more specifically the causes of these casualties. See appendix III for the reported numbers of casualties by service and cause.

Explosion Casualties Caused by Land Mines, Cluster Munition UXO, and Other UXO

Service data show that 34 persons were killed and 143 were injured during the Gulf War by the explosion of some type of ordnance other than enemy fire. These 177 casualties—caused by land mines, cluster munition UXO, or other UXO—represent 13 percent of all casualties suffered by service members. (See table 4.)

Table 4: U.S. Gulf War Casualties from Explosions and All Other Causes

	Army			Marines			Air Force			Navy			DOD		
Category	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**
Explosion casualties[a]	32	132	164	2	10	12	0	1	1	0	0	0	34	143	**177**
All other casualties	194	674	871	67	143	210	35	8	43	55	11	66	351	836	**1,187**
Total	**226**	**806**	**1,032**	**69**	**153**	**222**	**35**	**9**	**44**	**55**	**11**	**66**	**385**	**979**	**1,364**

Legend

K = Killed/died
I = Injured
T = Total

[a] Explosion casualty totals are comprised of three categories - land mines, cluster munition UXO, and other UXO.

Source: Service casualty data.

Of the 177 Gulf War casualties that DOD reported were caused by an explosion from some type of land mine, cluster munition, or unidentified type of UXO, the services reported no U.S. casualties were caused by U.S. land mines. However, as shown in table 5, U.S. cluster munition UXO (CBU or dual-purpose improved conventional munitions) or other UXO (unidentified) caused more U.S. casualties—96—than Iraqi and unidentified land mines—81.

Table 5: U.S. Gulf War Explosion Casualties by Category

	Army			Marines			Air Force			Navy			DOD		
Category	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**
Land mines	10	61	71	2	7	9	0	1	1	0	0	0	12	69	**81**
Cluster munition UXO	22	58	80	0	0	0	0	0	0	0	0	0	22	58	**80**
Other UXO	0	13	13	0	3	3	0	0	0	0	0	0	0	16	**16**
Total	**32**	**132**	**164**	**2**	**10**	**12**	**0**	**1**	**1**	**0**	**0**	**0**	**34**	**143**	**177**

Legend

K = Killed
I = Injured
T = Total

Note: U.S. combat explosion casualties from enemy fire and accidental U.S. or allied fratricidal fire are not included in the land mine, cluster munition UXO, and other UXO explosion casualty totals shown in table 5.

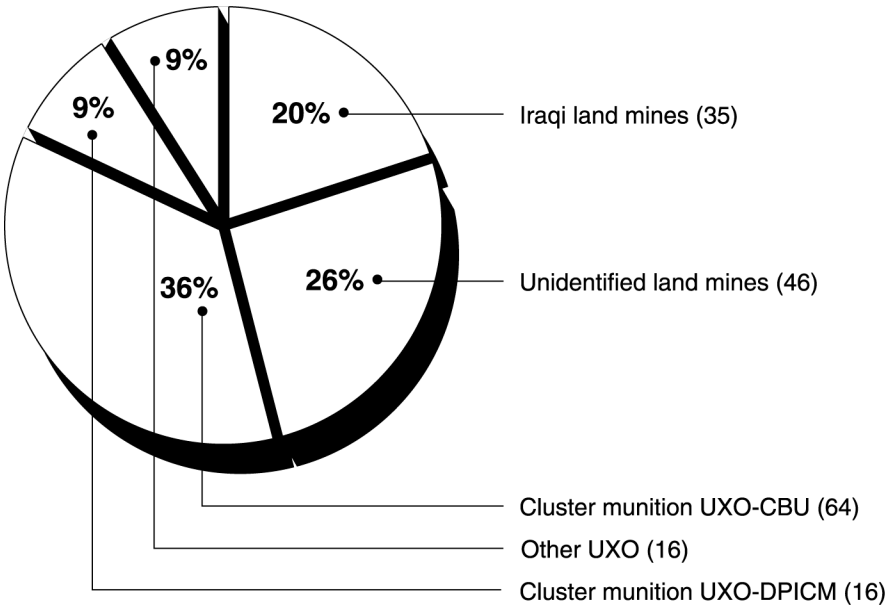
Source: Service casualty data.

Of all persons killed or injured by explosions from land mines (either Iraqi or unidentified), cluster munition UXO (either CBUs or dual-purpose improved conventional munitions), and other unidentified UXO, Army personnel represented 164, or 93 percent. In addition, 12 Marine Corps personnel were killed or injured, and 1 Air Force service member was injured by these explosions.

Additional Casualties Could Have Been Caused by Land Mines

Of the 177 explosion casualties attributed by the services to some type of ordnance explosion, service records specify that 35 were caused by Iraqi land mines (see fig. 2). Casualty records for some of the 142 other explosion casualties are inexact or ambiguous. Thus, the other explosion categories—cluster munition UXO from CBU and dual-purpose improved conventional munitions, unidentified land mines, and other UXO—could include some U.S. casualties by U.S. or other land mines because casualty records did not always permit DOD to identify definitively the type of UXO causing the casualty.

Figure 2: Types of Munitions Causing 177 Explosion Casualties



Legend

DPICM = dual-purpose improved conventional munition.

Source: Service casualty data.

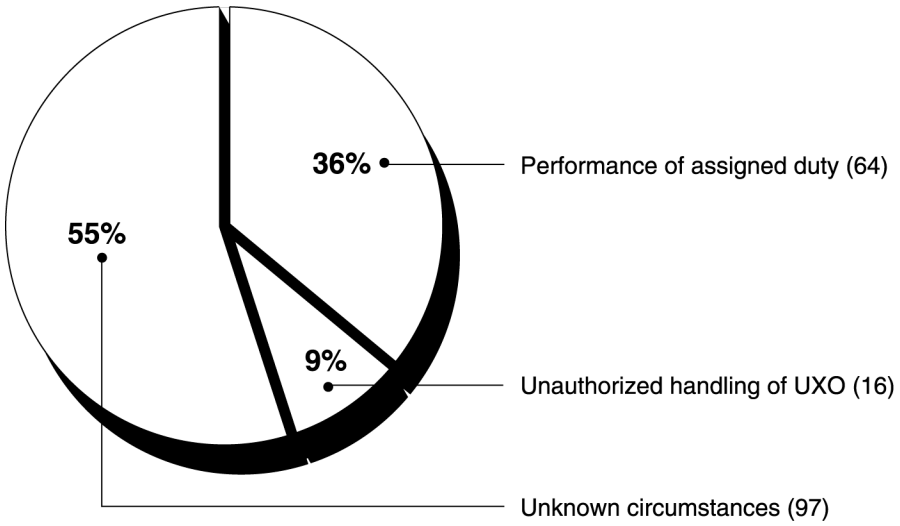
While the UXO causing a casualty might have been reported as a cluster munition CBU, it could have been misidentified and actually have been a U.S. land mine cluster munition from Gator, ADAM, RAAM, or some other munition. Casualty records show numerous cases in which all these terms are used interchangeably. For example, in one reported case, a casualty is first attributed to a mine and next to a dual-purpose improved conventional munition. In a second case, the service member was said to have driven over a cluster munition, which was later called a "mine." In a third case, the soldier is reported in one document to have "hit a trip wire causing mine to explode" but in another document to have "stepped on an Iraqi cluster bomb." In other words, the terminologies used in these casualty reports are inconsistent and imprecise, thus preventing a definitive analysis by the services of the causes of some casualties. DOD indicated that it is possible also that some of the casualties attributed to land mines were actually caused by unexploded ordnance.

Percentage of Soldiers Injured or Killed by Unauthorized Handling of UXO Is Relatively Small

DOD data did not always allow it to identify how service members had triggered the UXO that caused each casualty. Because of the many ways that ordnance and UXO can be triggered and because some ordnance can be triggered from a distance, DOD was unable to always determine the circumstances causing an explosion and the type of ordnance that exploded. DOD-reported data, however, indicate that relatively few persons who became casualties of unexploded ordnance were handling it without authorization.

In attempting to determine what percentage of service members were injured or killed while handling ordnance in an unauthorized manner, we consulted all available descriptions of these incidents. We grouped these casualties into three categories based on service-reported information concerning how the explosion was triggered: (1) in performance of duty, (2) unauthorized handling of UXO, and (3) unknown circumstance. As shown by figure 3, DOD data indicate that more than half of the explosion casualties resulted from unknown circumstances.

Figure 3: Circumstances Causing 177 U.S. Casualties from Land Mines, Cluster Munition UXO, and Other UXO



Source: Service casualty data.

Of the 177 explosion casualties, DOD records indicated that 64 casualties (36 percent) resulted from explosions that were triggered in the performance of assigned duties. For example, one Army ground unit reported that when it began its ground attack, its first casualty resulted from a soldier encountering an artillery submunition dud that exploded.

In another incident, seven Army engineers were killed while clearing unexploded BLU-97 (nonland-mine) duds at an Iraqi airfield. DOD attributed these casualties to "incorrect or incomplete training in mine neutralization techniques and the handling of UXOs." An expert in explosive ordnance demolition who was advising the engineers on how to clear safely Gator land mine duds and other submunitions reported, "I feel worse because the guys who died probably died of ignorance. This is a[n] EOD [explosive ordnance disposal] related problem which was ill handled by others who thought they could handle the job." This situation illustrates that UXO can be so dangerous that even engineers with some training in handling UXO were thought by an explosive ordnance disposal expert to be inadequately prepared to deal with UXO on the battlefield.

Soldiers who represent the 16 casualties (9 percent) attributed by DOD to unauthorized handling of UXO were generally performing their military duties but for some unknown reason touched or otherwise triggered UXO. These soldiers were typically on duty in or traversing U.S. dudfields on the battlefield while performing such actions as pursuing the enemy. DOD reported that some soldiers were casualties as a result of disturbing battlefield objects that they thought were not hazardous, while others might have known they were handling a piece of some sort of ordnance. For example, a DOD document cited a case in which soldiers handled UXO that they thought was harmless. This report stated that two persons were killed and seven injured when soldiers "collected what they thought were parachute flares." Furthermore, soldiers might not have recognized that a battlefield object was hazardous because UXO comes in many shapes, sizes, and designs, much of which inexperienced soldiers have never seen before. Some common U.S. submunitions appear to be harmless while actually being armed and dangerous. Moreover, many soldiers are not aware that some UXO can cause injuries at distances of 100 meters.

A small number of DOD casualty reports describing unauthorized handling of UXO attribute soldier casualties to souvenir hunting. For example, one incident resulted when a soldier who was examining an object was told by fellow soldiers to get rid of it. When the soldier threw the object away from him, it exploded. In other cases, soldiers might have known that handling UXO was unauthorized and handled it anyway. Gulf War documents indicate that DOD and the services called for soldiers on a battlefield to be warned not to handle UXO unless directed to do so.

The remaining 97 (55 percent) of the 177 explosion casualties fell into the unknown circumstances category. Because battlefield casualty reports did

not identify the circumstance or activity of these soldiers, it is unknown whether or not these soldiers became casualties while performing assigned duties.

The Army's Safety Center provided us data on 21 Gulf War U.S. explosion casualties that occurred in Kuwait, Iraq, and Saudi Arabia (5 deaths and 16 injured). The Center attributed 7 of these casualties to land mines of unknown type and 14 to U.S. dual-purpose improved conventional munitions and CBU submunitions. These casualties were associated with unintentional entry into minefields or dudfields or disturbance of UXO. These casualties are included in the Gulf War casualty totals presented in this report.[13]

DOD Reports Express Fratricide and Mobility Concerns Relating to the Safety of, and Lack of Knowledge about, Land Mines and Dudfields

Numerous issues included in service and DOD Gulf War lessons-learned, after-action, and other reports concerned the safety and utility of conventional and submunition U.S. land mines. Fratricide and battlefield mobility were cited often as important overall concerns associated with both available and used U.S. land mines and nonland-mine submunitions. These concerns led to the reluctance of some U.S. commanders to use land mines in areas that U.S. and allied forces might have to traverse.[14] Commanders' fears arose because of two basic reasons: The first reason involved both the obsolescence of conventional U.S. mines and safety issues with both conventional and scatterable land mines. A higher-than-anticipated dud rate for land mines and other submunitions during the Gulf War was one safety issue. Reflective of the safety issues, DOD reports recognized that de facto minefields created by all unexploded submunitions—land mine and nonland-mine alike—threatened fratricide and affected maneuvers by U.S. forces. The second reason involved concern that reporting, recording, and, when appropriate, marking the hazard areas created by the placement of self-destruct land mines or dudfields were not always accomplished when needed. On the basis of its

[13] In addition, the Army Safety Center provided us data for U.S. land mine casualties outside the Gulf War theater for 1990 to 2001. It reported 22 U.S. casualties, including 2 killed and 20 injured. These U.S. casualties include 2 in Egypt, 10 in Germany (these 10 casualties are described elsewhere in this report), 7 in South Korea, and 3 in the United States. These 22 casualties are not included in the Gulf War casualty totals included in this report.

[14] *Field Manual 20-32* states, "The modern tendency toward maneuver warfare and the disappearance of the linear battlefield places repositioning forces at an increased risk of fratricide by minefields."

Gulf War experience, DOD recognized the importance of commanders' taking into consideration the possible effects of unexploded munitions when making and executing their plans and identified a variety of corrective actions. (App. IV cites DOD-reported actions related to land-mine and UXO concerns. Because it was beyond the scope of this report, we did not evaluate DOD's progress in these areas.)

Conventional U.S. Land Mines Were Considered Obsolete and Unsafe

In Gulf War lessons-learned and other documents, DOD and the services reported that U.S. conventional nonself-destructing land mines were obsolete and dangerous to use and that the newer self-destructing land mines also posed safety concerns to users. For example, one Army after-action report recommended that U.S. conventional antitank and antipersonnel land mines be replaced because of safety concerns. Army officials stated that U.S. conventional mines needed better fuzing and the capability of being remotely turned on or off or destroyed. In a joint service lessons-learned report, officials stated, "Commanders were afraid to use conventional and scatterable mines because of their potential for fratricide." The report said that this fear could also be attributed to the lack of training that service members had received in how to employ land mines. In particular, prior to the Gulf War, the Army restricted live-mine training with conventional antipersonnel land mines (M-14s and M-16s) because they were considered dangerous. The joint lessons-learned report argued, "If the system is unreliable or unsafe during training, it will be unreliable and unsafe to use during war."

Since before the Gulf War, the Army has known about safety issues with its conventional nonself-destruct M-14 and M-16 antipersonnel land mines. For example, because of malfunctions that can occur with the M605 fuze of the "Bouncing Betty" M-16 antipersonnel land mine, the Army has restricted the use of the pre-1957 fuzes that are thought to be dangerous. However, the concern extends beyond the fuze issue to include also the land mines themselves. A DOD reliability testing document states that the M-16 mines "are subject to duds; the mine ejects but fails to detonate. [The] mine is then unexploded ordnance and still presents a danger." A DOD 2001 report on dud rates for land mines and other munitions states that the dud rate identified by stockpile reliability testing for M-16 land mines is over 6 percent.[15] In a specific case, a currently serving senior

[15] United States Army, Defense Ammunition Center, United States Army Technical Center for Explosives Safety, *Report of Findings for Phase II Study of Ammunition Dud and Low Order Detonation Rates* (McAlester, Okla.: July 2001).

Army officer told us that he had trained his unit with these antipersonnel land mines in Germany in 1990 to get ready for the Gulf War. According to the officer, during the training, his unit suffered 10 casualties from the M-16 land mine. This officer said that U.S. "Bouncing Betty" M-16 and "Toe Popper" M-14 antipersonnel land mines should be eliminated from Army stockpiles because they are too dangerous to use.[16]

Due to safety concerns, the Army placed prohibitions on live-fire training with these land mines before and after the Gulf War, with restrictions being lifted during the Gulf War. But DOD reporting does not indicate that any U.S. unit chose to conduct live-mine training in the theater with any type of mines. According to an Army engineer after-action report, "Some troops even reported that they were prohibited from training on live mines after their arrival in Saudi Arabia." Moreover, DOD reporting states that U.S. forces employed no M-14 or M-16 mines in combat. Because of renewed restrictions following the Gulf War,[17] service members still are prohibited from live-fire training[18] on M-14 antipersonnel land mines, and training on live M-16 mines is restricted to soldiers in units assigned or attached to the Eighth U.S. Army in Korea.[19]

[16] The 1992 version of *Field Manual 20-32* states, "Mine training is inherently dangerous. Between FY [fiscal year] 85 and FY 88, there were eight accidents in the active Army during mine warfare training. . . . These accidents resulted in the deaths of three soldiers. In FY 90, there were two mine accidents, resulting in eleven casualties."

[17] Current U.S. national security policy, established by Presidential Decision Directive (PDD) 48, dated June 26, 1996, limits the use of, and live-mine training on, M-14 and M-16 antipersonnel nonself-destruct land mines to training personnel engaged in demining and countermining operations and to U.S. forces in Korea. See also Department of the Army Policy Message 290845Z, July 29, 1997. PDD 48 also directs the Secretary of Defense to undertake a program of research, procurement, and other measures needed for the eventual elimination of the M-14 and M-16 mines from U.S.-owned stockpiles of mines intended to be used by U.S. personnel. Further, by PDD 64, June 23, 1998, the President directed the Department of Defense to develop antipersonnel land mine alternatives to end the use of all antipersonnel land mines outside Korea by 2003.

[18] *Field Manual 20-32* defines "live-mine training" as "preparing, laying, arming, neutralizing, and disarming live mines (with live fuses and components) in a training environment."

[19] See Department of the Army Policy Message 290845Z, July 29, 1997.

Land Mines and Other Scatterable Munitions Had Higher-Than-Expected Dud Rates During the Gulf War

Another safety concern expressed in lessons-learned reports was that higher-than-expected dud, or malfunction, rates occurred for the approximately 118,000 U.S. self-destruct land mines and the millions of other U.S. scatterable submunitions employed in the Gulf War. These included duds found by a U.S. contractor while clearing a portion of the Kuwaiti battlefield. These duds created concerns about potentially hazardous areas for U.S. troops.

Expected Dud Rates for U.S. Self-Destruct Land Mines

According to briefing documents provided by DOD's Office of the Project Manager for Mines, Countermine and Demolitions,[20] testing over the past 14 years of almost 67,000 self-destructing antitank and antipersonnel land mines at a proving ground has resulted in no live mines being left after the tests. The office also reports that all U.S. self-destruct mines self-deactivate, that is, their batteries die within 90 to 120 days. The office stated that the reliability rate for the self-destruct feature is 99.99 percent and that the reliability rate for the self-deactivation feature is 99.999(+). According to the program office, these features mean that self-destruct land mines leave no hazardous mines on the battlefield.

According to the Army's 1998 Field Manual 20-32, all scatterable mines have similar life cycles, though the times they are set for and the dispensing systems can vary. The self-destruct mechanism for scatterable mines operates as follows:

"For safety reasons, SCATMINEs [scatterable mines] must receive two arming signals at launch. One signal is usually physical (spin, acceleration, or unstacking), and the other is electronic. This same electronic signal activates the mine's SD [self-destruct] time.

"Mines start their safe-separation countdown (arming time) when they receive arming signals. This allows the mines to come to rest after dispensing and allows the mine dispenser to exit the area safely . . . .

"Mines are armed after the arming time expires. The first step in arming is a self-test to ensure proper circuitry. Approximately 0.5 percent of mines fail the self-test and self-destruct immediately.

"After the self-test, mines remain active until their SD time expires or until they are encountered. Mines actually self-destruct at 80 to 100 percent of their SD time. . . .

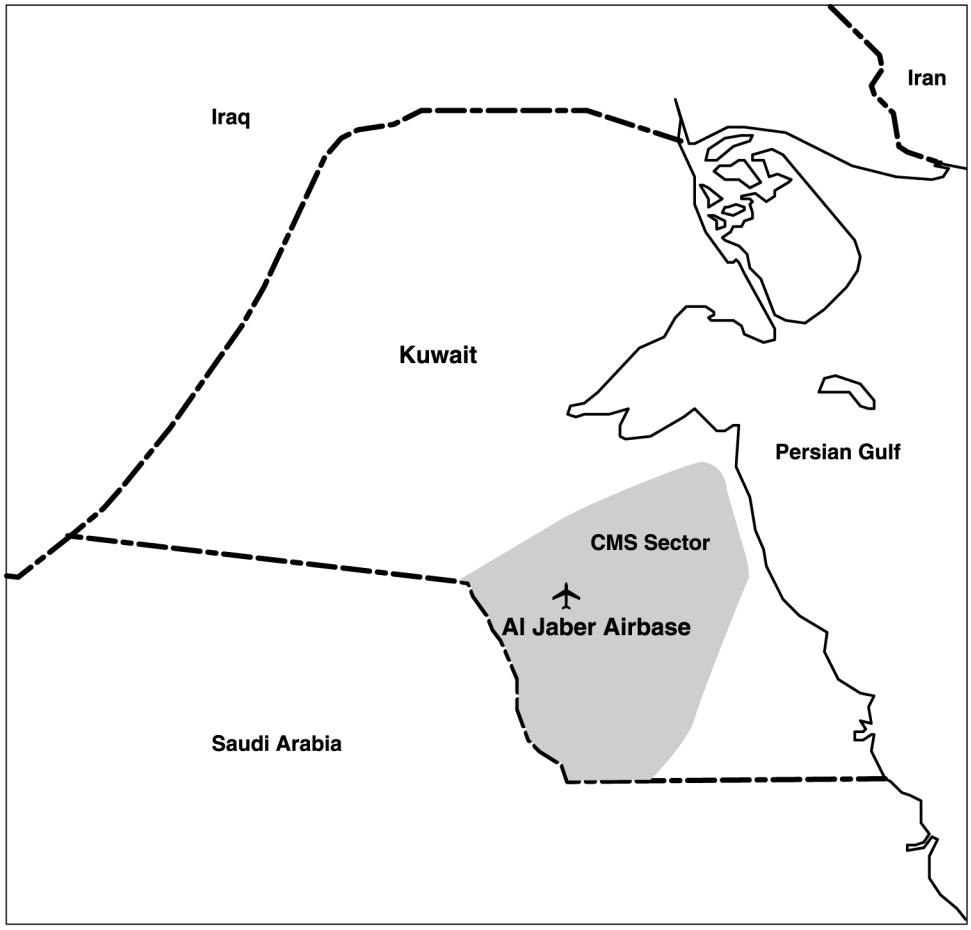
[20] The Office of the Program Manager, Mines, Countermine and Demolitions is now organizationally assigned to Close Combat Systems, U.S. Army Program Executive Office for Ammunition.

No mines should remain after the SD time has been reached. Two to five percent of US SCATMINES fail to self-destruct as intended. Any mines found after the SD time must be treated as unexploded ordnance. For example, mines with a 4-hour SD time will actually start self-destructing at 3 hours and 12 minutes. When the 4-hour SD time is reached, no unexploded mines should exist."

Conventional Munitions Systems, Inc., Found Thousands of Duds on the Kuwaiti Battlefield

Conventional Munitions Systems (CMS), Inc., a U.S. contractor that specialized in explosive ordnance disposal, was paid by the government of Kuwait to clear unexploded ordnance from one of seven sectors of the battlefield in Kuwait, which included Al Jaber Airbase (see fig. 4). CMS reported finding substantially more U.S. land mine duds than would be expected if dud rates were as low as DOD documents and briefings stated they are. DOD indicated that it cannot confirm the accuracy of the CMS-reported data.

Figure 4: Map of Kuwait Showing the CMS Explosive Ordnance Disposal Sector Surrounding Al Jaber Airbase



The shaded area surrounding Al Jaber Airbase represents the CMS explosive ordnance disposal sector. The CMS sector size equals about one-seventh of Kuwait, which is about the size of New Jersey.

Source: GAO.

After the Gulf War, CMS employed more than 500 certified, experienced, and trained personnel to eliminate the unexploded ordnance in its sector of Kuwait. About 150 CMS employees were retired U.S. military explosive ordnance disposal experts. In a report for the U.S. Army, CMS recorded the types and numbers of U.S. submunition duds it found in its explosive

ordnance disposal sector of the Kuwaiti battlefield.[21] The report illustrates how the dangers of the battlefield during the Gulf War were compounded by the large numbers of unexploded U.S. submunitions, including land mines.

According to the CMS report, it found 1,977 U.S. scatterable land mine duds and about 118,000 U.S. nonland-mine submunition duds in its disposal sector. CMS's report stated that "many tons of modern bombs called Cluster Bomb Unit[s] were dropped," each of which "would deploy as many as 250 small submunitions." The report states, "A significant number of the bombs and more importantly the submunitions, did not detonate upon striking the ground resulting in hundreds of thousands of 'dud' explosive devices laying [sic] on the ground in Kuwait." While the vast majority of these duds were from nonland mine submunitions, they included the more modern self-destructing RAAM, ADAM, and Gator land mines.[22] Table 6 lists the types and amounts of U.S. dud submunitions CMS reported finding in its disposal sector of the Kuwaiti battlefield.

[21] U.S. Army Armament, Munitions, and Chemical Command, Contract DAAA21-92-M-0300 report by CMS, Inc. (Tampa, Fla.: July 1993).

[22] Members of the CMS explosive ordnance disposal team were interviewed in "The Battlefield," a 13-minute segment of the Oct. 25, 1992, televised CBS news magazine *60 Minutes*. "The Battlefield" was about the unexploded ordnance left on the Kuwaiti battlefield during the Gulf War and the dangers inherent in the U.S. and other explosive ordnance disposal experts' efforts to clear battlefield sectors of Kuwait. During the cleanup, 84 operators, including at least 2 private U.S. contractors, were killed.

Table 6: U.S. Scatterable Mines and UXO Reported by CMS, Inc., as Found on One Kuwaiti Battlefield Sector

Type of dud	Number of duds
Land mines	
• RAAM (antitank)	746[a]
• ADAM (antipersonnel)	185
• Gator BLU-91 (antitank)	205
• Gator BLU-92 (antipersonnel)	841
Total land mine duds	**1,977**
Nonland-mine submunitions	
• BLU 61	2,621
• BLU 63/86	6,639
• BLU 97	2,102
• BLU 73	396
• MK 118	95,799
• M 42/46/77	10,288
Total nonland-mine submunition duds	**117,845**
Total land mine and nonland-mine submunition duds	**119,822**

Note: In addition to the U.S. submunition duds that CMS destroyed, it disposed of non-U.S. ordnance duds and Iraqi ordnance found on both the battlefield and in Iraqi ammunition stockpiles. CMS reported destroying a total of over 1 million pieces of ordnance, including 350,000 land mines, that it found in its disposal sector of Kuwait. CMS was contracted by the government of Kuwait to clear battlefield debris and unexploded ordnance from about 3,100 square kilometers. CMS personnel stated that its contract performance was based on Kuwait's acceptance of UXO-cleared areas rather than on quantity of UXO cleared. The fact that CMS was paid by cleared area rather than by piece of ordnance found is described by the then-DOD Project Manager for Mines, Countermine, and Demolitions in his trip report of November 9, 1992, to Kuwait to examine the cleanup operation being performed by CMS. The government of Kuwait also hired contractors from other countries to clear the rest of the Kuwaiti battlefield. Similarly, large amounts of UXO were cleared from these sectors, but information on the types and quantities of UXO destroyed was not available to us. In addition, the types and quantities of UXO found on the Iraqi battlefield are unknown.

[a] CMS reported finding 746 M75 RAAM duds in its disposal sector, though DOD reports firing only 432 RAAM and no M75 mines during the war, a data inconsistency that remains unresolved. The CMS report includes photographs of ADAM and RAAM land mine duds found. DOD questioned the reliability of CMS data, indicating it might include misidentified ordnance and confused nomenclatures of land mine systems. However, DOD did not provide alternative data.

Source: U.S. Army Armament, Munitions, and Chemical Command, Contract DAAA21-92-M-0300 report by CMS, Inc.

Dud Rates for Self-Destruct Land Mines Appear to Be Higher Than Expected

DOD reports that it employed in the Gulf War a total of about 118,000 self-destruct land mines (see table 1) and that their self-destruct failure, or dud, rate is 0.01 percent (1 in 10,000). However, if, as DOD reported, about 118,000 of these self-destruct land mines were employed and they produced duds at the DOD-claimed rate of 0.01 percent, there should have been about 12 duds produced, not 1,977 as CMS reported finding in one of seven Kuwaiti battlefield sectors. Thus, a substantial inconsistency exists

between the DOD-reported reliability rate and the dud rate implied by the number of mines that CMS reported finding from actual battlefield use. At the time CMS was completing this UXO disposal work in Kuwait, the DOD program manager for Mines, Countermine and Demolitions visited the CMS cleanup operation. His report of that trip indicates that he thought CMS's techniques, training of personnel, and recording of ordnance recovered were thorough and accurate. The project manager said in his report that he had personally seen unexploded U.S. ordnance on the battlefield. The mine database developed by CMS to record the location of land mines, the project manager believed, was "extremely useful" to the U.S. soldiers working in that area.

We interviewed several former employees of CMS to obtain their views on these issues. All of those we interviewed were retired senior U.S. officers and noncommissioned officers whose rank ranged from major general to sergeant first class. All but one were experienced in military ordnance and explosive ordnance disposal. They included the then-CMS president, the Kuwaiti on-site manager, and leaders of ground UXO disposal teams. They made two major points: (1) U.S. submunition UXO found in their sector was tactically employed, unexploded ordnance duds that had failed to explode as designed and could have been hazardous, meaning that if disturbed, the ordnance might have exploded, and (2) U.S. Gator, ADAM, and RAAM land-mine duds had not self-destructed as designed and were treated as hazardous. CMS explosives disposal personnel stated that they had personally experienced what they thought were Gator duds exploding on the battlefield in Kuwait, caused by no apparent triggering event, over a year after the Gulf War ended. CMS experts speculated that these detonations might have been caused by the extreme heat in a desert environment.

DOD has been unable to explain the circumstances that caused the nearly 2,000 U.S. self-destruct land mine duds found in the CMS disposal sector of the Kuwaiti battlefield not to self-destruct. Several DOD land mine and explosive ordnance disposal experts speculated that these dud land mines could have resulted from (1) mines that had malfunctioned or had been misemployed; (2) greater-than-expected and reported dud rates; or (3) the use by U.S. forces of many thousands more scatterable land mines than DOD has reported having used. Some Army land mine-related officials discounted the accuracy of some data included in the CMS report. However, these officials did not provide us with any factual evidence supporting these views.

Other DOD experts in explosive ordnance disposal confirmed in interviews that scatterable mine duds can exist after their self-destruct times have elapsed and that these duds may be hazardous. A DOD explosive ordnance disposal expert said that procedures for eliminating Gator duds specify that explosive ordnance disposal should be postponed for 22 days, and then the duds should normally be destroyed remotely by blowing them up in place. The 22-day period is calculated by adding a 50-percent safety factor to the maximum possible self-destruct period of 15 days. Explosive ordnance disposal personnel thus attempt to reduce the possibility of a munition detonating or self-destructing while they are near it.

DOD did not provide us with records to show the results of reliability testing for ADAM, RAAM, or Gator land mines done prior to the Gulf War or any safety-of-use messages that might have been in effect for these or other U.S. land mines that were in U.S. stockpiles at that time. However, DOD did provide some post-Gulf War test records that document reliability problems with eight of its self-destruct land mine systems.[23] Specifically, testing showed that some land mines did not self-destruct at the selected times. For example, a July 2000 Army study of dud rates for ammunition reports that the submunition dud rate for RAAM land mines with short duration fuzes is over 7 percent, and the dud rate for RAAM land mines with long duration fuzes is over 10 percent.[24] In an Ammunition Stockpile Reliability Program test for the ADAM, the Army suspended one lot because it failed. In a test for the Volcano system, 66 out of 564 land mines failed the test. Among the failures were 1 hazardous dud (meaning that it could explode), 24 nonhazardous duds (meaning that they had not armed), 6 mines that detonated early, and 1 mine that detonated late. In another case, DOD testing of the Selectable Lightweight Attack Munition (SLAM) land mine showed that it also did not destruct at the selected time. While this problem was investigated, SLAM use was suspended and a safety-of-use message was put into effect advising personnel "never to approach an M2 SLAM that has been armed" and, in training, "to assure that it can be detonated if it fails to go off as intended." According to DOD,

[23] These eight systems are the RAAM, the Gator, the Ground-Emplaced Mine Scattering System (GEMSS), the Pursuit Deterrent Munition, the Volcano, the Modular Pack Mine System, the ADAM, and the Selectable Lightweight Attack Munition (SLAM). Some of these systems are depicted in figures 5 and 6 in appendix II.

[24] United States Army, Defense Ammunition Center, United States Army Technical Center for Explosives Safety, *Report of Findings for Study of Ammunition Dud and Low Order Detonation Rates* (McAlester, Okla.: July 2000).

the same self-destruct and self-deactivation design has been used in all U.S. mines since 1970. Because of this design similarity, it is possible that U.S. self-destruct land mines could be subject to similar failures.

Failures of self-destruct land mines that are induced by extremes in temperature and other variations in environmental conditions are well-documented in service field manuals and after-action reports. Field manuals state that the reliability of self-destruct land mines degrades when they are employed on sand, vegetation, hillsides, snow, or hard surfaces. Also, self-destruct land mines have reportedly "reduced effectiveness" on hard surfaces such as concrete and asphalt. They break apart and can easily be seen. Also, the high detectability of scatterable mines on bare and lightly covered surfaces permits the enemy to seek out unmined passageways or pick a way through lightly seeded areas. An Army document states that "FASCAM [family of scatterable mines] must be covered by either observation or fire, since FASCAM minefields are surface laid and an undisturbed enemy could breach those obstacles quickly….FASCAM is not suitable for use in road interdiction due to its tendency to malfunction on hard surfaces." In snow, self-destruct land mines may settle into the snow at unintended angles, causing their antihandling devices to prematurely detonate them. In deep snow, self-destruct land mines are considered "ineffective," and at least 40 percent of their blast is smothered. Soft sand, mud, or surface water can have similar effects. During the Gulf War in particular, Marines found that in the constantly blowing and shifting sand, surface mines became buried, and buried mines came to the surface. Slope or unevenness of the terrain may also have an adverse impact on self-destruct land mines. Specifically, between 5 and 15 percent of scatterable mines come to rest on their edges when deployed. RAAM and ADAM land mines must come to rest and stabilize within 30 seconds of impact, or the submunitions will not arm. Very uneven terrain such as ground covered by vegetation or rocks also may prevent the ADAM or Gator trip wires from deploying properly.[25]

[25] *Field Manual 20-32* identifies the advantages and problems of using scatterable mine systems in urban terrain [i.e., cities]. For example, it indicates that ADAMs/RAAMs "are the most rapidly deployed SCATMINE systems," and "these mines can be delivered under enemy fire." It also identifies problems: "Using ADAMs/RAAMs in urban terrain involves five specific problem areas: Difficulty in precise minefield siting. . . . Uncertainty of ADAM and RAAM survivability upon impact with a building or ground surfaces. . . availability of artillery firing units. . . . High detectability of these mines on bare and lightly covered surfaces. . . . Difficulty in achieving a good random pattern. Hard-surfaced areas cause mines to bounce and roll. Some mines (especially AT [antitank] mines) will land on top of buildings and are ineffective."

Gator testing indicates that various reliability problems can increase dud rates. For example, in 58 tests, seven submunition land mine dispenser failures were observed, reducing the reliability rate of the dispensers to 88 percent. Of the submunition mines delivered, 99 percent survived ground impact. Of those, 97 percent of the antitank mines armed, and 95 percent of the antipersonnel mines armed. Various other problems can affect a mine's explosion. For example, one antitank mine did not explode when triggered, but it did activate when it was picked up and shaken.

Nonland-Mine Submunitions Also Had Higher Dud Rates Than Expected

During the Gulf War, accumulations of thousands of U.S. nonland-mine submunition duds on the battlefield created unintended de facto minefields. This problem was exacerbated by dud rates for these submunitions that appear to have been higher than the 2- to 4-percent submunition dud rate that DOD had previously reported. In a study of UXO issues, the Army identified an estimated 8-percent overall dud rate for submunitions. Another Army document said that an explosive ordnance disposal (EOD) commander estimated that an area occupied by the 24th Infantry Division during the war experienced at least a 15- to 20-percent dud rate for some Army submunitions. The document stated that "An unknown amount was covered by sand suggesting an even higher rate." EOD personnel estimated that the dud rate for Air Force submunitions was 40 percent for one area. They commented that these submunitions "did not function well in soft sand." In addition, DOD reported that at the time of the Gulf War, over half of the 133 Multiple Launch Rocket System (MLRS) submunition lots in inventory exceeded the Army's 5-percent dud-rate goal.[26] Each Multiple Launch Rocket System contains 644 M77 submunitions. One DOD document stated that the dud rate for the M77 for the Gulf War ranged from 10 to 20 percent.

U.S. ammunition stockpile sample testing also indicated that DOD has experienced past problems with submunition reliability rates. For example, in 1990, testing of artillery-delivered nonland-mine submunitions identified two lots that had duds in excess of 40 percent. According to a testing document, one way to compensate for this high dud rate is to increase the quantity fired. Instructions contained in the testing document were to "Notify the user of the increase in submissile defect rate so that he can make adjustments in the tactical employment plans." The July 2000

[26] U.S. General Accounting Office, *Operation Desert Storm: Casualties Caused by Improper Handling of Unexploded U.S. Submunitions*, GAO/NSIAD-93-212 (Washington, D.C.: Aug. 6, 1993). See table 6 for a list of duds found by CMS, Inc., on the Kuwaiti battlefield. This list includes M77 duds.

Army study of dud rates for ammunition reports that the dud rate for artillery-fired M42/46 submunitions is over 14 percent.

Like land mines, nonland-mine submunitions experience higher failure rates in various environmental conditions. According to an Army field manual, about 50 percent of the submunitions that fail to detonate are armed and hazardous. Firing them into mountainous areas or uneven terrain further increases the dud rate. The effectiveness of these rounds also decreases in snow, water, marshy areas, mud, vegetation, and soft sand.

According to one DOD document, the improved conventional munitions used, including dual-purpose improved conventional munitions, and CBUs, experienced a high dud rate and caused obstacles for maneuvering forces. Units perceived the dud rates as "considerably greater than the 2-4 percent anticipated," creating a dud minefield. The document continued that because the dud rates were "too high," some maneuver commanders hesitated to use submunition weapons, especially if they believed that their units would move through the area later. Hazardous dudfields caused delays in movement on the battlefield, and high winds and shifting sands often covered many duds. According to this report, "This became especially dangerous for high hazard missions such as refueling operations."

According to an Army after-action report written in 1991, "The large number of dud U.S. submunitions … significantly impeded operations" during the Gulf War. In one case, the XVIIIth Airborne Corps attempted to position a combat command post, but because of U.S. dud submunitions, it had to relocate. According to the XVIIIth Airborne Corps report, "The assault CP's [command post's] position was untenable due to the presence of numerous USAF CBU duds." A second Army document cited a case in which previously dropped U.S. munitions caused maneuver problems and a significant delay in operations:

"In one case, the 1st Cavalry Division moved into Kuwait along the Wadi al Batin. Twenty miles of this route was saturated with both USAF submunitions (BLU97 and Rockeye) and Army M77 submunitions. . . . Maneuvering through this area was no problem for the tracked vehicles of the division. However, the 1st Cav selected the same route for its main supply route (MSR). Because the division's CSS [combat service support] consisted of mainly wheeled vehicles, EOD [explosive ordnance disposal] support was required. It took the 64th EOD and a British unit about five days to clear a two lane path through the area. In this case, the unit's progress was clearly slowed by the duds."

Because Gulf War records are not always specific, it is not clear how frequently U.S. forces experienced problems in maneuvering through areas previously attacked by U.S. ordnance. However, available records indicate that such problems did occur to some degree and were an operational concern. In fact, DOD reported that in some instances "ground movement came to a halt" because units were afraid of encountering unexploded ordnance. Moreover, Army officials reported that, in the case of the M77 submunitions, the Army believed that the weapon would most likely be used against the Soviet threat in Europe, where U.S. troops would probably be in a defensive position. Therefore, U.S. soldiers were not expected to occupy submunition-contaminated areas.

Land Mine and Dudfield Reporting, Recording, and Marking Problems Created Fratricide and Mobility Concerns

During the Gulf War, the placement of self-destruct land mines was not always reported, recorded, or marked when appropriate. This situation was exacerbated by the possibility that self-destruct land mines did not always self-destruct as designed after their preset periods of time. Consequently, safety issues involving Gulf War self-destruct land mines, as well as other submunitions, focused on the potential for fratricide resulting from U.S. forces' unknowingly maneuvering into areas where scatterable land mines had been employed but had not yet self-destructed.

Shortly after the Gulf War, one DOD fact sheet reported that DOD's joint procedures for coordinating the use of air-delivered mines had not been widely disseminated. Further, according to the fact sheet, the procedures were outdated with respect to the rapid mobility of the modern Army. Thus, the warning information—such as the locations and self-destruct timing durations—"was next to impossible to obtain and pass to ground component commanders." According to the document, this situation dramatically increased the probability of friendly fire casualties. The Army's *Field Manual* on *Mine/Countermine Operations* states the importance of such coordination: "Because SCATMINEs [scatterable mines] are a very dynamic weapon system, great care must be taken to ensure that proper coordination is made with higher, adjacent, and subordinate units. To prevent friendly casualties, all affected units must be notified of the location and duration of scatterable minefields."

Gulf War records include numerous reports indicating that scatterable minefields were employed in locations that were not reported to maneuver commanders. For example, one DOD report stated that neither the Air Force nor the Navy could accurately track the location or duration of Gator minefields. An Army after-action report stated that the Air Force "flew over 35 GATOR missions (the exact number is not known) without

reporting or recording the missions." According to this report, the result was that "[d]uring the ground offensive, units found themselves maneuvering in GATOR minefields without any knowledge of their existence." Another Army after-action report stated, "Some friendly Gator-scatterable Air Force-delivered scatterable minefields were encountered in Iraq." The report highlighted the lack of a scatterable minefield self-extraction capability for units to avoid fratricide. A DOD fratricide lessons-learned document noted that casualties from friendly minefields were a "major problem" due to the lack of coordination, failure to disseminate obstacle plans, and failure to report the location of mines throughout the chain of command.

Another Army after-action report attributed fatalities to the failure to mark hazardous areas. According to this report, "In many cases GATOR minefields and large areas which contained DPICM [dual-purpose improved conventional munitions] and CBU duds were left unmarked due to the lack of a fast and simple method for marking hazardous areas." After-action reports also cited planners' ignorance of "the capabilities, limitations and reporting, recording, and marking requirements of our scatterable mine systems," as well as a lack of training regarding unexploded ordnance, as the causes of fatalities.[27]

Tracking nonland-mine dudfields presented similar concerns. A case in which one U.S. unit had moved through an area where another U.S. unit had earlier dropped cluster munitions is presented in an historical account of the Gulf War written by a retired Army lieutenant general. According to this account, a U.S. Army 101st Airborne Division aviation battalion traversed an area that had previously been seized by the U.S. Army VIIth Corps, which had fired cluster munitions. The battalion's commander cited a case in which one of his soldiers was injured when he stepped on a cluster munition. "Keeping track of DPICM -dudded areas," said the

[27] *Field Manual 20-32* requires minefield marking: "Minefields must be marked to prevent fratricide. Marking ensures that friendly soldiers do not accidentally enter a minefield, and it is a requirement under STANAGs [Standardization Agreements] and Geneva Convention agreements. . . . For scatterable minefields, a commander may choose to remove markings once the self-destruct (SD) time of the mines has expired; but the location of the minefield must still be recorded and forwarded to higher and adjacent units in case some of the mines did not self-destruct. . . . To prevent friendly casualties, all affected units must be notified of the location and the duration of scatterable minefields. . . . Due to the large footprint created when the minefield is fired, many mines will scatter outside the planned minefield area. It is therefore necessary to plot the safety zone in order to prevent fratricide."

commander, "was complicated by the fact that one Corps moved into another Corps area."

Senior U.S. Gulf War commanders were aware of the incidence of fratricide from unexploded CBU, dual-purpose improved conventional munitions, and other ordnance. For example, one U.S. Army artillery general sent a safety message that read, "In recent days I have received numerous reports of soldiers being injured and killed by duds. . . . I am firmly convinced that each case could have been averted. Every soldier must be warned. . . ."

According to one DOD official, the main reason hazardous dudfields were not always reported or marked was that doctrine did not require commanders to always report or mark nonland-mine hazard areas, as is required for minefields. However, DOD has noted, "Although UXO is not a mine, UXO hazards pose problems similar to mines concerning both personnel safety and the movement and maneuver of forces on the battlefield."

DOD Has Recognized the Need for Action Related to Land Mine and UXO Concerns

According to after-action, lessons-learned, and other reports, DOD and the services recognize the nature, extent, and implications for fratricide and battlefield maneuver of reported concerns, as well as the need to act upon their concerns about land mines and other submunition UXO. According to an Army after-action report, "The large amount of UXO found in Iraq and Kuwait caught Allied forces by surprise. Lessons learned from past conflicts were not learned, leading to unacceptable casualties among our soldiers, allies, and civilians." These reports suggested that changes to address these concerns would increase submunition battlefield utility and effectiveness while simultaneously reducing casualties and increasing freedom of maneuver. In after-action reports, a number of actions were identified to improve the safety of troops and their mobility through land mines and other employed submunitions. These included, among others, that DOD

- replace the current conventional land mines with modern, safer ones;
- add a feature to scatterable land mines that would allow them to be turned on and off, giving the land mines a long-term static capability and providing U.S. commanders with the ability to create cleared lanes for friendly passage when and where needed;
- develop submunitions with lower dud rates and develop self-destruct mechanisms for nonland-mine submunitions;

- consider the magnitude and location of UXO likely to be on the battlefield when deciding the number and mix of submunitions, precision-guided munitions, or other munitions to use and, when planning maneuver operations, avoid dudfield hazard areas or breach them with troops inside armored vehicles;
- develop training aids—such as manuals and working models of U.S. scatterable mines—to provide service members with the ability to recognize U.S. scatterable mines and other unexploded ordnance and the knowledge of the proper actions to take to safely avoid and/or deactivate/detonate explosive submunitions and to safely extract themselves from minefields or dudfields; and
- establish and standardize procedures for the reporting, recording, and, when appropriate, marking of concentrations of submunition bomblets as hazard areas.

DOD has reported a number of actions that relate to these land mine and UXO concerns. These actions are summarized in appendix IV. Because it was beyond the scope of this report, we did not evaluate DOD's progress in these areas.

Agency Comments and Our Evaluation

In its comments on a draft of this report, DOD stated that it believes the report is flawed because it "makes assertions and speculations that are not based on fact" and because we used "unreliable or unrelated data." In particular, DOD made the following main points:

- Our report implies that U.S. casualties caused by land mines were higher than DOD records show.
- Our report relied heavily on the report by CMS, Inc., even though there are weaknesses and mistakes in the CMS report.[28]
- Our report confuses issues dealing with unexploded ordnance and land mines.
- By focusing on the Gulf War experience as one "case study," our report is not a credible analysis of land-mine utility and employment.

We have made some changes to the report to clarify and elaborate on the issues DOD has raised, but we do not agree that the report is flawed or

[28] U.S. Army Armament, Munitions, and Chemical Command, Contract DAAA21-92-M-0300 report by CMS, Inc.

makes unsubstantiated assertions. In regard to each of DOD's comments, we offer the following response:

- Our report states that DOD records show no U.S. casualties attributed to U.S. land mines and that 81 casualties were attributed to Iraqi or other land mines. In addition, we point out that it is possible that some portion of the casualties in the "other" or "unknown" categories reported by DOD could have been caused by land mines—there is simply no way of knowing. This is a statement of fact, not an assertion that casualties were greater than reported. As we gathered data on Gulf War casualties, our service points of contact worked with us to ensure that we had the most complete information on this issue that was available. Some records were ambiguous and/or incomplete. However, DOD officials who provided us with this data agreed that our interpretation of the records was accurate.
- Much of DOD's concern about "unreliable data" stems from our use of the report by CMS, Inc., on UXO cleanup of the battlefield. Most of our discussion of the CMS report is in the section addressing DOD's lessons learned from the Gulf War. Our use of CMS data in that section corroborates in most cases the lessons learned contained in DOD after-action reports. While DOD claims that the CMS report contained inaccuracies, DOD did not provide any data to challenge the main message of the CMS report, which was that a very large number of U.S. land mine and cluster munition duds were found on the Kuwaiti battlefield. In fact, a DOD study that discusses the magnitude of the unexploded ordnance problem and that calculates the relative cost of cleaning up the battlefield compared to retrofitting or reprocuring U.S. submunitions with self-destruct fuzes in order to lower dud rates uses the same CMS data we cite in our report.[29] In its 2000 report to Congress, DOD uses the results of these calculations to discuss the cost and feasibility of retrofitting the Army's ammunition stockpile.[30]
- UXO is discussed in our report from two standpoints. First, casualty data presenting the causes of casualties cannot always distinguish between a land mine and other types of UXO, so we believed it was important to discuss both to provide a proper context. Secondly, DOD's own after-action reports on lessons learned discuss the problems of unexploded

[29] U.S. Army Materiel Systems Analysis Activity, *Unexploded Ordnance (UXO) Study*, Technical Report No. TR-654, (Aberdeen Proving Ground, Md.: Apr. 1996).

[30] Office of the Under Secretary of Defense (Acquisition, Technology & Logistics)/Strategic & Tactical Systems/Office of Munitions, *Unexploded Ordnance Repor*t, Report to Congress (Washington, D.C.: Feb. 29, 2000).

ordnance in terms of both land mines and cluster munitions, so our discussion of land mines needs to be in this overall UXO context. We have tried throughout the report to make clear distinctions between land mines and other ordnance, and we have made further clarifications as a result of DOD's comments.

- Lastly, we recognize that this report focuses exclusively on the Gulf War; this was the agreed-upon scope of our work as discussed with our congressional requester, and this is stated in the objectives and scope and methodology sections of our report. As such, we agree that it is not a comprehensive analysis of the utility of land mines in modern warfare; it was never intended to be. As our report makes clear, we do not make any conclusions or recommendations in this report. Nevertheless, we believe the report provides important historical context—the Gulf War was the largest U.S. conflict since Vietnam, and both sides in the battle made use of land mines.

Unless you publicly announce the contents of this report earlier, we plan no further distribution of this report until 30 days from its issue date. At that time, we will send copies of this report to the Chairmen of the House and Senate Committees on Armed Services; the Chairmen of the House and Senate Committees on Appropriations, Subcommittees on Defense; the Secretaries of Defense, the Air Force, the Army, and the Navy; and the Commandant of the Marine Corps. We will also make copies available to other congressional committees and interested parties on request. In addition, the report will be available at no cost on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions about this report, please call me at (757) 552-8100 or e-mail me at CurtinN@GAO.GOV. Key staff who contributed to this report were Mike Avenick, William Cawood, Herbert Dunn, M. Jane Hunt, Jim McGaughey, and Bev Schladt.

Sincerely yours,

Neal P. Curtin
Director, Defense Capabilities and Management

Appendix I: Current U.S. Land Mine Inventory

According to DOD and service data, the current DOD land-mine stockpile contains about 18 million land mines—over 2.9 million nonself-destruct land mines and over 15 million self-destruct land mines. The Army owns the vast majority of the nonself-destruct land mines, including over 1.1 million M-14 and M-16 mines (see fig. 6 in app. II). The Marine Corps has a relatively small number of these mines and has no M-14 land mines. The Air Force and the Navy stock no nonself-destruct land mines.

Of the over 15 million self-destruct land mines in the U.S. stockpile, over 8.8 million are antipersonnel, and about 6.2 million are antitank land mines. Artillery-fired ADAM antipersonnel land mines (over 8 million) and RAAM antitank land mines (over 4 million) are stocked mainly by the Army but also by the Marine Corps. (See table 7 and fig. 5 in app. II.)

Table 7: DOD Land Mine Stockpile Totals as of 2002

Category	Total
Nonself-destruct land mines	
• Antipersonnel	**1,565,226**[a]
• Antitank	**1,349,767**[b]
Subtotal—nonself-destruct	**2,914,993**
Self-destruct land mines	
• Antipersonnel	**8,838,922**[c]
• Antitank	**6,177,996**[d]
Subtotal—self-destruct	**15,016,918**
Total land mines in stockpile	**17,931,911**

[a] This includes about 700,000 M-14 and about 465,000 M-16 nonself-destruct antipersonnel land mines. This total also includes over 400,000 Claymore M-18 nonself-destruct command-detonated antipersonnel land mines, which DOD reported are not approved for use with triggering tripwires or other unattended fuzing devices outside Korea.

[b] The M2 Selectable Lightweight Attack Munition (SLAM), M3 Demolition Attack Munition (DAM), and M4 SLAM munitions have selectable triggering mechanisms including sensors and a timer. These munitions are used against various targets, including vehicles.

[c] Of these, over 8 million are artillery-fired ADAM antipersonnel land mines, contained in about 232,000 dispenser artillery rounds.

[d] Of these, over 4 million artillery-fired RAAM antitank land mines are contained in about 462,000 dispenser rounds.

Source: The services reported that the stockpile data were complete and current as of the following dates: Army 5/24/02, Marines 1/18/02, Air Force 3/29/02, and Navy 3/27/02.

The DOD land mine stockpile includes over 150,000 mixed land-mine dispensers, which contain a mixture of both antipersonnel and antitank land mines. All together, these mixed land-mine dispensers contain over 2 million land mines, of which over 400,000 are antipersonnel land mines

and over 1.6 million are antitank land mines. (See table 8.) The services report that land mine types are mixed in three dispenser systems: the Gator, the Volcano, and the Modular Pack Mine System.[1] For example, the Air Force and the Navy stockpile the Gator air-delivered CBU, which is one type of mixed land mine dispenser. The two services together have almost 14,000 CBU dispensers, which contain nearly 1.2 million land mines. The Army stocks over 134,000 Volcano mixed dispensers, which contain over 800,000 antipersonnel and antitank land mines.

Table 8: Land Mines in Mixed Dispensers as of 2002

In 150,401 mixed land-mine dispensers[a]	Land mines
Antipersonnel land mines in all mixed dispensers	424,846
Antitank land mines in all mixed dispensers	1,615,594
Total land mines in all mixed dispensers	**2,040,440**

[a] Of the 150,401 total mixed land-mine dispensers, 13,995 are Gators; 134,200 are Volcanoes; and 2,206 are Modular Pack Mine Systems.

Source: The services reported that the stockpile data were complete and current as of the following dates: Army 5/24/02, Marines 1/18/02, Air Force 3/29/02, and Navy 3/27/02.

Table 9 contains the total current U.S. inventory of land mines by mine type and common name; self-destruct capability; dispenser type, if any; service that maintains them; and quantity.

[1] The Air Force version of the Gator (CBU-89) dispenser contains 72 antitank and 22 antipersonnel land mines, and the Navy and Marine version of the Gator (CBU-78) dispenser contains 45 antitank and 15 antipersonnel land mines. (See fig. 5 in app. II.) Mixed Volcano dispensers each contain 5 antitank and 1 antipersonnel land mines. Modular Pack Mine System dispensers contain 17 antitank and 4 antipersonnel land mines.

Table 9: Total U.S. Worldwide Inventory of Land Mines as of 2002

				Service-managed inventories of unitary land mines & land-mine dispensers					
Designation	Common name	Self-destruct Yes/No	LM type: unitary (U) or dispenser (D), and number & type of land mines per dispenser	Army	Marines	Air Force	Navy	DOD total number of unitary land mines and dispensers of submunition land mines	DOD total number of unitary land mines and sub-munition land mines
Mine, antitank: M15, metallic, (M603 fuze)	M-15 (antitank)	No	(U) 1 AT	1,057,800	28,894	0	0	1,086,694	1,086,694
Mine, antitank: M19, nonmetallic (M606 fuze)	M-19 (antitank)	No	(U) 1 AT	54,100	9,026	0	0	63,126	63,126
Mine, antitank: M21, metallic (M607 fuze)	M-21 (antitank)	No	(U) 1 AT	163,000	15,426	0	0	178,426	178,426
Mine, antipersonnel: M14, nonmetallic[a]	M-14 (anti-personnel)	No	(U) 1 AP	696,800	0	0	0	696,800	696,800
Mine, antipersonnel: M16A1 or M16A2, metallic (M605 fuze)	M-16 (anti-personnel)	No	(U) 1 AP	441,700	23,630	0	0	465,330	465,330
Mine, antipersonnel: M18A1, nonmetallic[b]	M-18 (anti-personnel)-Claymore	No	(U) 1 AP	368,100	34,996	0	0	403,096	403,096
Projectile, 155 millimeter: M692	ADAM long SD (anti-personnel)	Yes	(D) 36 AP	36,700	23,920	0	0	60,620	2,182,320
Projectile, 155 millimeter: M731	ADAM Short SD (anti-personnel)	Yes	(D) 36 AP	125,000	46,771	0	0	171,771	6,183,756
Projectile, 155 millimeter: M718, antitank	Basic RAAM Long SD (antitank)	Yes	(D) 9 AT	68,200	24,517	0	0	92,717	834,453
Projectile, 155 millimeter: M718 A1, antitank	Improved RAAM Long SD (antitank)	Yes	(D) 9 AT	76,400	0	0	0	76,400	687,600
Projectile, 155 millimeter: M741, antitank	Basic RAAM Short SD (antitank)	Yes	(D) 9 AT	207,700	53,717	0	0	261,417	2,352,753
Projectile, 155 millimeter: M741A1, antitank	Improved RAAM Short SD (antitank)	Yes	(D) 9 AT	31,500	0	0	0	31,500	283,500

				Service-managed inventories of unitary land mines & land-mine dispensers					
Designation	**Common name**	**Self-destruct Yes/No**	**LM type: unitary (U) or dispenser (D), and number & type of land mines per dispenser**	**Army**	**Marines**	**Air Force**	**Navy**	**DOD total number of unitary land mines and dispensers of submunition land mines**	**DOD total number of unitary land mines and sub-munition land mines**
Dispenser and mine, aircraft: CBU-89/B	Gator (anti-personnel / antitank) - Air Force version	Yes	(D) 72 AT 22 AP	544 (User is Air Force)	0	9,727	0	10,271	965,474
Dispenser and mine, aircraft: CBU 78C/B	Gator (antiper-sonnel / antitank) - Navy version	Yes	(D) 45 AT 15 AP	122 (User is Navy)	0	0	3,602	3,724	223,440
Mine, antipersonnel: M74, metallic	GEMSS anti-personnel mine	Yes	(U) 1 AP	32,900	0	0	0	32,900	32,900
Mine, antitank: M75, metallic	GEMSS antitank mine	Yes	(U) 1 AT	195,800	0	0	0	195,800	195,800
Mine, antipersonnel: M86, metallic	PDM	Yes	(U) 1 AP	15,100	0	0	0	15,100	15,100
Dispenser and mine, ground: M131 (with M71 remote control unit)	MOPMS (antitank / anti-personnel)	Yes	(D) 17 AT 4 A P	2,206	0	0	0	2,206	46,326
Canister, mine: M87A1	Volcano (antitank)	Yes	(D) 6 AT	34,678	0	0	0	34,678	208,068
Canister, mine: M87	Volcano (anti-tank/anti-personnel)	Yes	(D) 5 AT 1 AP	134,200	0	0	0	134,200	805,200
Munition, wide area: M93	Hornet/ WAM (antitank)	Yes	(U) 1 AT	228	0	0	0	228	228
Selectable Lightweight Attack Munition M2	SLAM[c]	No (Timer)	(U)	12,900	0	0	0	12,900	12,900
Demolition Attack Munition M3	DAM[c]	No (Timer)	(U)	4,100	0	0	0	4,100	4,100
Munition, Selectable Lightweight Attack: M4	SLAM[c] (antitank)	No (Timer)	(U) 1 AT	4,521	0	0	0	4,521	4,521
Total				**3,764,299**	**260,897**	**9,727**	**3,602**	**4,038,525**	**17,931,911**

Legend

AP = antipersonnel land mine
AT = antitank land mine
LM = land mine
SD = self-destruct

[a] DOD reports that all M-14 land mines have been retrofitted with metal and therefore are no longer nonmetallic.

[b] DOD reported that the nonself-destruct M-18 Claymore is authorized to be detonated only by command and never by unattended triggering devices, including tripwires, outside Korea.

[c] The M2 SLAM, M3 DAM, and M4 SLAM munitions have selectable triggering mechanisms including sensors and a timer. These munitions are used against various targets, including vehicles. The M2 SLAM is self-neutralizing, and the M4 SLAM is self-destructing. They are both multipurpose munitions with an antitamper feature.

Source: The services reported that the stockpile data shown were complete and current as of the following dates: Army 5/24/02, Marines 1/18/02, Air Force 3/29/02, and Navy 3/27/02.

Appendix II: U.S. Land Mines Available for Use in the Gulf War

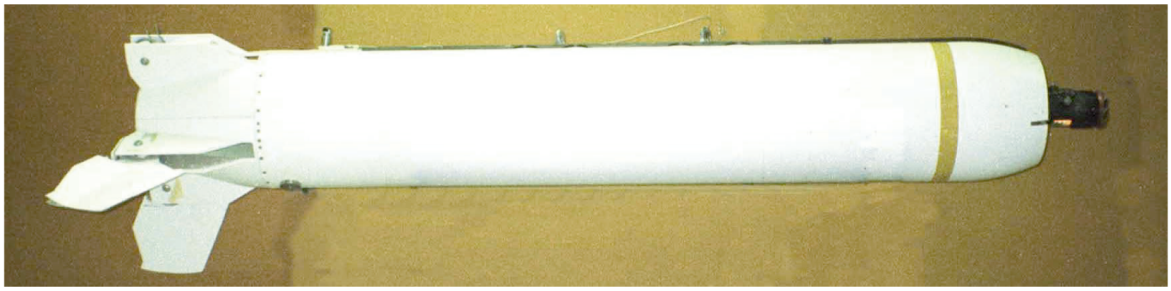
Figures 5 and 6 illustrate types of land mines that were in the U.S. inventory and available for use during the Gulf War.

Figure 5: U.S. Land Mines Available and Used in the Gulf War

Aircraft-delivered Gator self-destruct "smart" land mines used by the Air Force, Navy, and Marines

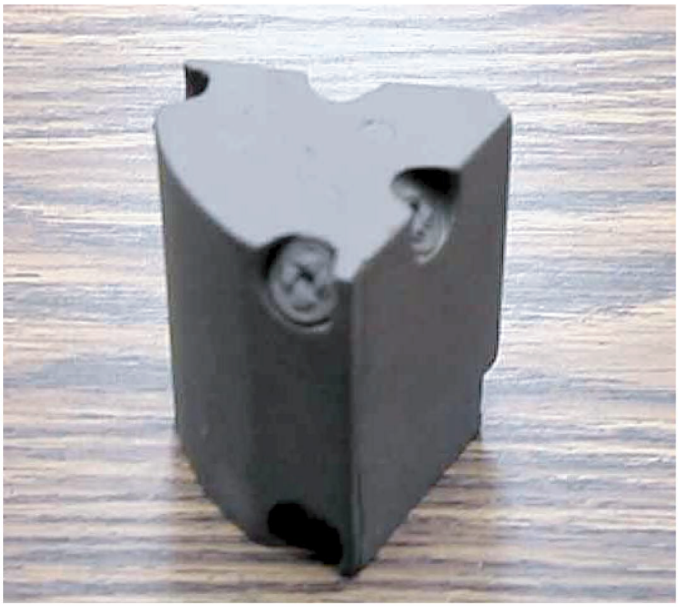
Gator (CBU-78/89) antitank submunition (BLU-91) land mine.

Gator (CBU-78/89) antipersonnel submunition (BLU-92) land mine.



Navy/Marine Gator CBU-78 cluster bombs contain 15 antipersonnel and 45 antitank submunition land mines. Air Force Gator CBU-89 cluster bombs contain 22 antipersonnel and 72 antitank submunition land mines.

Artillery-fired ADAM and RAAM self-destruct "smart" land mines used by the Marines



ADAM (M-692/731) antipersonnel submunition land mine.

RAAM (M-718/741) antitank submunition land mine.

ADAM (M-692/731) artillery round contains 36 ADAM antipersonnel submunition land mines.

RAAM (M-718/741) artillery round contains 9 RAAM antitank submunition land mines.

Source: DOD.

Figure 6: U.S. Land Mines Available but Not Used in the Gulf War

Nonself-destruct "dumb" land mines

"Toe Popper" M-14 antipersonnel land mine.

"Bouncing Betty" M-16 antipersonnel land mine.

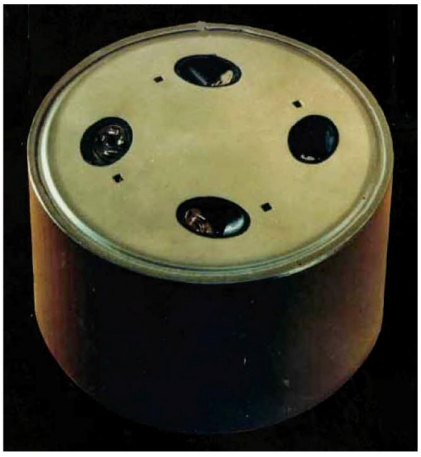
M-15 antitank land mine.

M-19 antitank land mine.

M-21 antitank land mine.

Self-destruct "smart" land mines

GEMSS (M-128 Ground Emplaced Mine Scattering System) dispenses 800 M-74 antipersonnel and M-75 antitank submunition land mines.



M-74 antipersonnel land mine.

M-75 antitank land mine.

Note: Mine dispensers available for use in the Gulf War in addition to the GEMSS include the M131 Modular Pack Mine System (MOPMS), which dispenses 17 antitank and 4 antipersonnel land mines, and the M138 Mine Dispenser, or Flipper. The GEMSS, MOPMS, and Flipper dispenser systems were available during the Gulf War but not used to actually deploy M74 antipersonnel, M75 antitank, or other scatterable surface-laid land mines, according to DOD.

Source: DOD.

Figure 7 shows the M-18 Claymore antipersonnel land mine. DOD has stated that it is employed in only the command-detonation mode and therefore is defined to be a nonland mine. Army Field Manual 20-32 alternately calls the M-18 Claymore a "land mine" and a "munition." See appendix IV for DOD's statements.

Figure 7: M-18 Claymore Nonself-Destruct Command-Detonated Antipersonnel Land Mine

Claymore M-18 command-detonated antipersonnel land mine.

Note: Nonself-destruct antipersonnel land mines available for use in the Gulf War but not used, according to DOD, included the M-18 Claymore, which DOD states is not a land mine when employed in the command-detonation mode. See appendix IV for DOD's statement. FM 20-32 indicates that it is current U.S. policy that the M-18 Claymore may be used with trip-wire only in Korea.

Source: DOD.

Table 10 cites the U.S. land mines—by mine type and common name and by service—that were available and used during the Gulf War.

Table 10: Types and Numbers of Certain U.S. Land Mines Stockpiled Worldwide in 1990, Available in the Southwest Asian Theater, and Used during the Gulf War

U.S. land mine types		U.S. land mines available in 1990 for use in the Gulf War		
Designation	**Common name**	**Number available in DOD worldwide stockpile in 1990**	**Number available in SWA theater for potential Gulf War Use**	**Number of U.S. land mines reported used in the Gulf War**
Mine, antitank: M15, metallic	M-15 (antitank)	1,805,300	41,200	0
Mine, antitank: M19, nonmetallic	M-19 (antitank)	74,200	100	0
Mine, antitank: M21, metallic	M-21 (antitank)	219,700	300	0
Mine, antipersonnel: M14, nonmetallic [a]	M-14 (antipersonnel) Toe Popper	3,909,500	55,600	0
Mine, antipersonnel: M16, metallic	M-16 (antipersonnel) Bouncing Betty	2,332,700	149,000	0
Mine, antipersonnel: M18, nonmetallic [b]	M-18 (antipersonnel) Claymore	771,000	32,500	0
Projectile, 155 millimeter: M692/731, high explosive	ADAM long/short duration SD (antipersonnel)	(124,600 rounds x 36 AP =) 4,485,600	(37,100 rounds x 36 AP =) 1,335,600	Marine-employed:(12 rounds x 36AP =) 432
Projectile, 155 millimeter: M718/741, antitank	Basic RAAM, long/short duration SD (anti-tank)	(279,200 rounds x 9 AT =) 2,512,800	(23,800 rounds x 9 AT =) 214,200	Marine-employed: (48 rounds x 9 AT =) 432
Dispenser and mine, aircraft: CBU89	Gator (antipersonnel/antitank) - Air Force version	(5,673 bombs x 72AT/22AP = 408,456/124,806 =) 533,262	3,165 bombs x 72AT/22AP = 227,880/69,630 =) 297,510	Air Force-employed: (1,105 Gator CBU bombs x 72AT/22AP = 79,560/24,310 =) 103,870
Dispenser and mine, aircraft: CBU78	Gator (antipersonnel/antitank) - Navy version	(2,682 bombs x 45AT/15AP = 120,690/40,230=) 160,920	Navy/Marine in-theater quantity unknown, but at least equal to the number used (215 Gator CBU bombs x 45AT/15AP = 9,675/3,225 =) 12,900	Navy/Marine-employed: (215 Gator CBU bombs x 45AT/15AP = 9,675/3,225 =) 12,900
Mine, antipersonnel: M74, metallic	GEMSS antipersonnel mine	1,805,300	32,800	0
Mine, antitank: M75, metallic	GEMSS antitank mine	297,900	43,900	0
Total		**18,908,182**	**2,215,610**	**117,634**

Legend

SD = self-destruct
GEMSS = Ground-Emplaced Mine Scattering System
AP = antipersonnel
AT = antitank
SWA = Southwest Asia

Notes: DOD reports that all types of land mines available for U.S. use from worldwide stockpiles and theater and unit supplies, and all land mines used by the U.S. in the Gulf War are included in this table. The services reported that all standard types of U.S. land mines in their inventories, which DOD estimated to contain about 19 million land mines, were available for use if needed by U.S. Gulf War units, including over 2.2 million that were transported to the Gulf War theater of operations. DOD and service officials reported no U.S. theater command restrictions on the use of any type or quantity of U.S. land mines, except that actual land mine use needed to be approved by the appropriate U.S. commander. DOD reported that U.S. commanders ordered employment of only those land mine quantities shown as used in this table and that no U.S. land mines were known by DOD or the services to have been employed except those shown in this table. The service-provided numbers in this table represent actual and estimated numbers. DOD indicated that, because of incomplete Gulf War data, the numbers and types of land mines shown as part of the 1990 U.S. stockpile, available in theater, and used might be inexact.

[a] DOD reports that all M-14 land mines have been retrofitted with metal and therefore are no longer nonmetallic.

[b] DOD reported that the nonself-destruct M-18 Claymore is authorized to be detonated only by command and never by unattended triggering devices, including tripwires, outside Korea.

Source: Service reports.

Appendix III: U.S. Gulf War Casualties by Service

	Army			Marines			Air Force			Navy			DOD		
Category	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**	**K**	**I**	**T**
Land mines	10	61	71	2	7	9	0	1	1	0	0	0	12	69	**81**
Cluster munition UXO	22	58	80	0	0	0	0	0	0	0	0	0	22	58	**80**
Other UXO	0	13	13	0	3	3	0	0	0	0	0	0	0	16	**16**
Unknown causes	1	43	44	0	0	0	0	0	0	0	0	0	1	43	**44**
Enemy ground/ Scud fire	39	160	199	14	70	84	0	0	0	0	4	4	53	234	**287**
Aircraft incidents	39	26	65	18	0	18	31	8	39	13	3	16	101	37	**138**
Friendly fire	15	38	53	3	2	5	0	0	0	0	1	1	18	41	**59**
Vehicle accidents	48	77	125	13	24	37	2	0	2	4	0	4	67	101	**168**
Other accidents	9	85	94	9	40	49	0	0	0	33	0	33	51	125	**176**
Other causes	22	245	267	4	5	9	2	0	2	0	3	3	28	253	**281**
Natural causes	21	0	21	6	2	8	0	0	0	5	0	5	32	2	**34**
Total	**226**	**806**	**1,032**	**69**	**153**	**222**	**35**	**9**	**44**	**55**	**11**	**66**	**385**	**979**	**1,364**

Legend

K = Killed/died
I = Injured
T = Total

Source: Service casualty data.

Appendix IV: DOD-Reported Actions That Relate to Land Mine and UXO Concerns

DOD has reported a number of actions that are related to the land-mine and unexploded ordnance concerns raised in Gulf War after-action and lessons-learned reports. These actions fall into three areas: (1) developing antipersonnel land-mine alternatives and more capable and safer self-destruct land mines, (2) revising doctrine and procedures to better address hazardous submunition dudfields, and (3) increasing ammunition reliability and reducing dud rates. DOD-reported actions in these areas are described below. However, because it was beyond the scope of this report, we did not independently assess DOD's progress in these areas.

Developing Antipersonnel Land-Mine Alternatives and More Capable and Safer Self-Destruct Land Mines

Presidential directives establish and direct the implementation of U.S. policy on antipersonnel land mines.[1] Presidential Decision Directive 48 states that the United States will unilaterally undertake not to use and to place in inactive stockpile status with intent to demilitarize by the end of 1999, all nonself-destructing antipersonnel land mines not needed for (a) training personnel engaged in demining and countermining operations and (b) defending the United States and its allies from armed aggression across the Korean demilitarized zone.[2] The Directive also directs the Secretary of Defense to, among other things, undertake a program of research, procurement, and other measures needed to eliminate the requirement for nonself-destructing antipersonnel land mines for training personnel engaged in demining and countermining operations and to defend the United States and its allies from armed aggression across the Korean demilitarized zone. It further directs that this program have as an objective permitting both the United States and its allies to end reliance on antipersonnel land mines as soon as possible. Presidential Decision Directive 64 directs the Department of Defense to, among other things, (1) develop antipersonnel land mine alternatives to end the use of all antipersonnel land mines outside Korea, including those that self-destruct, by the year 2003; (2) pursue aggressively the objective of having

[1] Presidential Decision Directive 48, June 26, 1996, and Presidential Decision Directive 64, June 23, 1998. Because it was beyond the scope of this report, we did not assess land-mine policy topics.

[2] The organization of the Joint Chiefs of Staff (JCS) in 1996 directed the commanders-in-chief (CINC), except for the CINC United Nations Command (Korea), to undertake actions related to eliminating M-14 and M-16 antipersonnel land mines from unit supplies, prepositioned land mine stockpiles, and land mine warfare plans. See JCS messages UUU 162338Z, May 1996, "Anti-Personnel Landmine Policy Implementation," and UUU 061520Z, Aug. 1996, "Implementation of Presidential Decision Directive on Anti-Personnel Mine Warfare." Because it was beyond the scope of this report, we did not assess DOD's progress in completing these directed actions.

alternatives to antipersonnel land mines ready for Korea by 2006, including those that self-destruct; (3) search aggressively for alternatives to our mixed antitank land mine systems; (4) aggressively seek to develop and field alternatives to replace nonself-destructing antipersonnel land mines in Korea with the objective of doing so by 2006; and (5) actively investigate the use of alternatives to existing antipersonnel land mines, as they are developed, in place of the self-destructing/self-deactivating antipersonnel submunitions currently used in mixed antitank mine systems.[3]

In April 2001, DOD reported to the Congress[4] on its progress in meeting the objectives of Presidential Decision Directives 48 and 64. Although DOD has pursued programs to develop and field systems to replace land mines and has plans to spend over $900 million to do so, it reported to us

[3] For an overview of land mine issues, including the role of land mines, international treaties, legislative actions, administrative policy, and land mine technology, see Congressional Research Service, CRS Report for Congress, *Landmines: Background and Congressional Concerns*, 96-362F (Washington, D.C.: updated Aug. 28, 1998).

[4] U.S. Department of Defense, Office of the Under Secretary of Defense (Acquisition, Technology & Logistics), Report to Congress, *Progress on Landmine Alternatives* (Washington, D.C.: Apr. 1, 2001). DOD indicated that this report responds to section 248 of the Strom Thurmond National Defense Authorization Act for Fiscal Year 1999, Public Law 105-261, which requires the Secretary of Defense to submit to the congressional defense committees, not later than April 1 of 2000 and 2001, a report describing the progress made in identifying technologies and concepts with regard to antipersonnel land mine alternatives that

a. would provide a combat capability that is equivalent to the combat capability provided by nonself-destructing antipersonnel land mines,

b. would provide a combat capability that is equivalent to the combat capability provided by antipersonnel submunitions used in mixed antitank mine systems, or

c. would provide a combat capability that is equivalent to the combat capability provided by current mixed mine systems.

DOD reported it has undertaken a three-tracked approach to identifying, evaluating, selecting, and developing alternatives. The DOD report describes numerous programs and activities related to land mines and land mine alternatives. Because it was beyond the scope of this report, GAO did not assess DOD's progress in identifying and developing alternatives or in achieving objectives and dates established by Presidential Decision Directives (PDD) 48 and 64.

in May 2002 that it will not be able to meet the dates established in Presidential Decision Directives 48 and 64.[5]

Begun in 1997 and led by the Army, DOD's "Antipersonnel Landmines Alternative" program is aimed toward producing what DOD calls a Non Self-Destruct Alternative (NSD-A). According to the program office, however, DOD does not now anticipate that it will be able to field this alternative system by the presidential goal of 2006. The alternative system, which DOD expects to cost over $507 million, is now on hold pending a decision on whether to include a mechanism that would allow a command-controlled "man-in-the-loop" feature to be turned off so that unattended mines could remain armed and detonate on contact.[6]

[5] U.S. Department of Defense, Project Office for Mines, Countermine and Demolitions, "Anti-Personnel Landmine Alternative Program Status Briefing for General Accounting Office" (Picatinny Arsenal, New Jersey: May 6, 2002).

[6] U.S. Army, *Engineer Systems Handbook* (Ft. Leonard Wood, Mo.: May 2001) characterizes this alternative: "The NSD-A system relies on a man in the loop to achieve Ottawa [Treaty} compliance. An operator remotely controls grenades and M16 warheads. Operational war-fighter requirements include a target-activated option that is not Ottawa compliant. The operational requirements document (ORD) is approved by the Joint Requirements Oversight Committee. The USD (ALT) [Under Secretary of Defense (Acquisition, Logistics, and Technology)] decision to enter engineering manufacturing design is pending NSC [National Security Council] policy guidance." Because it was beyond the scope of this report, we did not assess this policy topic.

In response to the June 1998 Presidential Decision Directive 64, DOD has also been pursuing alternatives to pure antipersonnel land mine systems[7] to end the use of all antipersonnel land mines outside of Korea by 2003

[7] "'Pure' APL [antipersonnel land mines] are used alone and not part of a mixed [including antitank land mines] system." See National Academy of Sciences, *Alternative Technologies to Replace Antipersonnel Landmines (*Washington, D.C.: Mar. 21, 2001). On Sept. 3, 2002, a representative of the Office of the Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict) (ASD/SOLIC), provided to us the following DOD statement to include in this report. The statement in part defines "pure" and "mixed" land mine systems, PDD-64 requirements, and the Ottawa Convention and interprets how one DOD land mine program concept—the Remote Area Denial Artillery Munition—is related: "Among its other provisions, PDD-64 directed DoD to develop alternatives to anti-personnel land mines in order to end the use of anti-personnel land mines outside Korea by 2003. PDD-64 also directed development of the Remote Area Denial Artillery Munition (RADAM) for use outside Korea. RADAM combines anti-personnel and anti-tank land mines into one 'mixed' system. Since the PDD directed development of a mixed anti-tank system for use outside Korea, the requirement 'to end the use of anti-personnel land mines outside Korea by 2003' has been interpreted to mean ending the use of 'pure' anti-personnel land mines rather than mixed systems that include anti-personnel land mines along with anti-tank land mines. (The Ottawa Convention permits use of mixed systems consisting of anti-tank land mines that have an anti-personnel device physically attached to the anti-tank mine. In this case, the use of the anti-personnel device, called an 'anti-handling device,' has the same function as do separate anti-personnel land mines used as part of mixed systems—the anti-personnel element protects the anti-tank minefield from easy breaching by enemy forces.)" By comparison, the U.S. Army's *Engineer Systems Handbook*, May 2001, contains an alternative interpretation: "The RADAM is a mixed system that combines seven remote-antiarmor-mine (RAAM) AT mines and five area-denial-artillery-munition (ADAM) AP mines in one 155 shell. Because of its AP component, this mixed system is not Ottawa compliant. The directive is to develop alternatives to AP land mines to end the use of all pure AP land mines outside of Korea, including those that self-destruct, by 2003 (2006 for Korea). Without RADAM production, tactical commanders will lose their ability to emplace a mixed system during this period. Under the Secretary of Defense (Acquisition, Logistics, and Technology) (USD [ALT]), the production decision is on hold until new guidance is received from the National Security Council (NSC). Production remains on hold pending the OSD decision." Because it was beyond the scope of this report, we did not assess these DOD policy-related determinations.

and in Korea by 2006.[8] These efforts are being led by the Army, the Defense Advanced Research Projects Agency, and the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics). The program office indicated that the Army-led project to end the use of all pure antipersonnel systems outside Korea by 2003 by fielding artillery-fired mixed land mine ammunition, budgeted at about $145 million, might now be discontinued. A second effort, budgeted at $24 million and led by the Defense Advanced Research Projects Agency, is to seek long-term alternatives for mixed land mine systems. One concept under development is the self-healing minefield, which does not require antipersonnel land mines to protect antitank land mines because the antitank mines in the system are able to independently hop around the battlefield to intelligently redistribute themselves in response to breaching attempts. This system is not expected to be fielded before 2015. A third effort, budgeted at about $230 million and led by the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics), is aimed at replacing all U.S. mixed land mine systems by removing the antipersonnel land mines in them. These mixed systems include the Modular Pack Mine System, the Volcano, and the Gator. At present, DOD does not expect any of these alternatives to be fielded by 2006. Although DOD has numerous land-mine-related program activities underway, it has not reported to us that it has identified the land mine alternative concepts or systems or the specific

[8] U.S. policy regarding the use and employment of antipersonnel land mines in Korea is outlined in *Field Manual 20-32*. This policy, according to the field manual, "is subject to the Convention on Certain Conventional Weapons and Executive Orders. Current US policy limits the use of non-self-destructing APLs [antipersonnel land mines] to (1) defending the US and its allies from armed aggression across the Korean demilitarized zone and (2) training personnel engaged in demining and countermine operations." The three types of nonself-destruct antipersonnel land mines that may be used only in Korea include the M-14 (a low metallic pressure-detonated blast mine), the M-16 (a bounding fragmentation mine that can be detonated by pressure or by trip wires), and the M-18A1 Claymore (when employed in the trip-wire detonation mode). The use of the M-18A1 Claymore in the trip-wire mode is permitted only in Korea. According to *Field Manual 20-32*, the M18, when employed in the command-detonation mode, may be used in Korea or elsewhere: "The use of the M18A1 claymore in the command-detonation mode is not restricted under international law or Executive Order." *Field Manual 20-32* refers to the M18 Claymore alternately as a "land mine" and a "munition." A representative from ASD/SOLIC said that DOD does not consider the M-18A1 Claymore in the command-detonated mode as a land mine. This representative provided for inclusion in this report the following description of the M-18 Claymore: "The M18 Claymore is not a land mine. Land mines are detonated by the 'presence, proximity or contact of a person or vehicle.' The M18 is detonated by a human operator's command." Regarding the use of the Claymore in Korea, the field manual states that U.S. forces may use the Claymore in Korea in the trip-wire mode. Because it was beyond the scope of this report, we did not assess these DOD policy-related determinations.

land-mine programs that it plans to develop or procure and field as its next generation of land mines or land mine alternatives, which would comply with presidential directives and meet DOD's military requirements. Because it was beyond the scope of this report, we did not assess DOD's progress in these areas.

Revising Doctrine and Procedures to Better Address Hazardous Submunition Dudfields

Since the Gulf War, DOD and the services have updated their manuals and procedures dealing with unexploded ordnance to increase the attention paid to reporting and tracking possibly hazardous areas. These revisions are intended to improve the integration of UXO-related planning into military operations and provide improved procedures for the services to use when operating in a UXO environment. However, DOD has provided to us no manuals that require combat commanders to always report and track all potential hazardous submunition dudfields. Instead, commanders are allowed to determine when reporting, tracking, and marking of potentially hazardous submunition dudfields are required.

DOD's post-Gulf War UXO manuals[9] increase attention to procedures for operations in a UXO environment. DOD's guidance is based on Gulf War lessons learned: "Experience from Operation Desert Storm revealed that a battlefield strewn with unexploded ordnance (UXO) poses a twofold challenge for commanders at all levels: one, to reduce the potential for fratricide from UXO hazards and two, to minimize the impact that UXO may have on the conduct of combat operations. Commanders must consider risks to joint force personnel from all sources of UXO and integrate UXO into operational planning and execution." DOD's manuals conclude that "Although UXO is not a mine, UXO hazards pose problems similar to mines concerning both personnel safety and the movement and maneuver of forces on the battlefield."

DOD's manuals describe the UXO problem as having increased in recent years: "Saturation of unexploded submunitions has become a characteristic of the modern battlefield. The potential for fratricide from UXO is increasing." According to DOD, "The probability of encounter is roughly equal for a minefield and a UXO hazard area of equal density [though] the lethality of the UXO hazard area is lower." DOD lists three

[9] See U.S. Department of Defense, *Multiservice Procedures for Operations in an Unexploded Ordnance Environment*, FM 100-38, MCRP 4-5.1, NWP TP 3-02.4.1, ACCPAM 10-752, PACAFPAM 10-752, USAFEPAM 10-752 (Air Land Sea Application Center, Langley Air Force Base, Va.: July 1996).

Army and Marine Corps systems as causes of UXO: the Multiple Launch Rocket System (MLRS), the Army Tactical Missile System (ATACMS), and the cannon artillery-fired dual-purpose improved conventional munition (DPICM). The manuals warn that, based on the types of ammunition available for these weapons in 1996, "every MLRS and ATACMS fire mission and over half of the fire missions executed by cannon artillery produce UXO hazard areas." With a 95-percent submunition reliability rate, a typical fire mission of 36 MLRS rockets could produce an average of 1,368 unexploded submunitions. Air Force and Navy cluster bomb units (CBUs) contain submunitions that produce UXO hazard areas similar to MLRS, ATACMS, and cannon artillery-fired DPICM submunitions.

In its post-Gulf War manuals, DOD's guidance includes "recommended methodologies for use by the services for planning, reporting, and tracking to enhance operations in an UXO contaminated environment." Of primary concern to DOD is the prevention of fratricide and the retention of freedom of maneuver. DOD's manuals state that U.S or allied casualties produced by friendly unexploded submunitions may be classified as fratricide. In planning wartime operations, the guidance suggests that commanders be aware of hazardous areas and assess the risk to their operations if their troops must transit these areas. Such planning is necessary for any type of mission, regardless of the unit. Without careful planning, according to the manuals, commanders' ability to maintain the required operational tempo could be difficult. Planners should allocate additional time for the operation if a deliberate breach or a bypass of a UXO hazard area is required. When encountering locations where unexploded submunitions have been or may be encountered, commanders should immediately report these areas. According to the manuals, "Immediate reporting is essential. UXO hazard areas are lethal and unable to distinguish between friend and foe." After reporting hazardous areas, commanders should carefully coordinate with other units to prevent the UXO from restricting or impeding maneuver space while at the same time decreasing fratricide. Such areas should be accurately tracked and marked.

When describing the need for improved procedures, DOD's UXO manuals state, "Currently no system exists to accurately track unexploded submunitions to facilitate surface movement and maneuver." DOD now highlights staff responsibilities for joint force planning, reporting, tracking, and disseminating UXO hazard area information and tactics, techniques, and procedures for units transiting or operating within a UXO hazard area. For example, the joint force engineer is responsible for maintaining the consolidated mine field records and historical files of UXOs, minefields,

and other obstacles. The manuals conclude that "Properly integrated, these procedures will save lives and reduce the impact of UXO on operations." Some of the suggested procedures are as follows:

- Coordination between component commanders and the joint force commander may be required before the use of submunitions by any delivery means.
- Units should bypass UXO hazard areas if possible. When bypassing is not feasible, units must try to neutralize the submunitions and scatterable mines.
- Combat units that have the assets to conduct an in-stride breach can do so. Extraction procedures resemble in-stride breach or clearing procedures.
- Dismounted forces face the greatest danger of death or injury from UXO. Unexploded ordnance is a significant obstacle to dismounted forces. Dismounted forces require detailed knowledge of the types and locations of submunitions employed.
- The chance of significant damage to armored, light armored vehicles, and other wheeled armored vehicles is relatively low. Personnel being transported by unarmored wheeled vehicles face nearly the same risk to UXO as dismounted forces. The protection afforded by unarmored wheeled vehicles is negligible.
- Air assault and aviation forces are also at risk from UXO. Aircraft in defilade, flying nap-of-the-earth or in ground effect (hovering) are vulnerable to submunitions. Certain submunitions are sensitive enough to function as a result of rotor wash.

DOD has issued manuals that alert U.S. forces to the threat of UXO and identify procedures to mitigate risks. For example, Field Manual 20-32 states that "Mine awareness should actually be entitled mine/UXO awareness. If only mines are emphasized, ordnance (bomblets, submunitions) may be overlooked, and it has equal if not greater killing potential." Despite this recognition, DOD officials have not indicated to us that they plan to require commanders to report and track all potential hazardous nonland-mine submunition dudfields and to mark them when appropriate, as is now required for scatterable submunition minefields. Because it was beyond the scope of this report, we did not assess DOD's post-Gulf War implementation of doctrinal and procedural measures to minimize UXO-caused fratricide, maneuver limitations, and other effects.

Increasing Ammunition Reliability and Reducing Dud Rates

In 1994, the Army formed an Unexploded Ordnance Committee after the commanding general of the Army's Training and Doctrine Command expressed concern about the large number of submunition duds remaining on the battlefield after the Gulf War. The commanding general sent a message to the Army's leadership that stated, "This is a force protection issue. Based on number of submunitions employed during ODS [Operation Desert Storm], dud rate of only two percent would leave about 170K-plus unexploded Army submunitions restricting ground forces maneuver. Add in other services' submunitions and scope of problem mushrooms…. Need to reduce hazards for soldiers on future battlefields from own ordnance." As one of the Army's efforts to reduce the dud rates of these submunitions, the commander stated that all future requirements documents for submunitions should state that the hazardous dud rate should be less than 1 percent.

The committee's work also resulted in calculations of the cost of retrofitting or replacing the Army's submunition stockpile to lower hazardous dud rates and the relative costs of cleaning UXO from a battlefield. The Army estimated in 1994 that the cost would be about $29 billion to increase submunition reliability by retrofitting or replacing submunitions to add self-destruct fuzing for the nearly 1 billion submunitions in the Army stockpile. In a different estimate in 1996, the Army estimated the cost to retrofit the stockpile to be $11-12 billion. The Army also estimated lesser costs to retrofit or procure submunitions with self-destruct fuzing for only those munitions most likely to be used, including those in unit basic ammunition loads and pre-positioned ships. These Army cost estimates to equip Army submunitions with self-destruct fuzing do not indicate that they include costs to similarly equip Air Force, Marine, and Navy submunitions. Using actual CMS, Inc., costs to clean up UXO from the CMS sector of the Kuwaiti Gulf War battlefield, the Army also estimated that the cost to reduce the dud rate by adding self-destruct fuzes for the submunitions actually used on a battlefield was comparable to the cost to clean up duds left by unimproved submunitions. The Army further recognized that, while the costs of reducing and cleaning up duds may be similar, the detrimental battlefield fratricide and countermobility effects of duds also need to be considered, as well as humanitarian concerns.[10]

[10] U.S. Army Materiel Systems Analysis Activity, *Unexploded Ordnance (UXO) Study*, Technical Report No. TR-654 (Aberdeen Proving Ground, Md.: Apr. 1996).

In 1995, DOD reported that its long-term solution to reduce UXO "is the ongoing efforts to incorporate self-destruct mechanisms in the DoD's high density munitions which would limit further proliferation of unexploded ordnance on the battlefield." DOD called the UXO detection and clearance problem "of enormous magnitude."[11]

DOD has reported that it is taking actions to increase land mine and submunition reliability rates and reduce dud rates. In a 2000 report to Congress,[12] DOD summarized its overall approach to addressing UXO concerns. DOD stated in that report, "An analysis of the UXO problem concluded that UXO concerns are viable and, using existing weapons, the potential exists for millions of UXO." The report further stated that the majority of battlefield UXO will result from submunitions that "are not equipped with self-destruct features, [and thus] pose the greatest potential for UXO hazards."

Importantly, DOD's approach to ammunition reliability improvement is to emphasize adding reliability to future procurements rather than fixing the existing stockpile. According to DOD's 2000 report to Congress, "The Department does not plan to retrofit or accelerate the demilitarization of its current inventory of weapons containing submunitions that pose UXO hazards. Notwithstanding, the Department will monitor the Service submunition development programs to make sure that every effort is taken to develop a mechanism within the submunition that will increase its overall reliability, thus reducing the potential for UXO." The report went on to state that DOD will also monitor future procurement programs to ensure that reprocured weapons that contain submunitions were improved to increase their overall reliability.

In addition to DOD actions aimed at controlling the UXO problem, there are a number of procurement-related efforts in place by the services to reduce and/or eliminate potential UXO from new purchases of ammunition. For example, in its 2000 report to Congress, DOD states, "The Army is in the process of producing new weapons that contain self-destruct mechanisms. In addition, the Army is considering developing

[11] U.S. General Accounting Office, *Unexploded Ordnance: A Coordinated Approach to Detection and Clearance Is Needed* (GAO/NSIAD-95-197, Sept. 20, 1995).

[12] Office of the Under Secretary of Defense (Acquisition, Technology & Logistics)/Strategic & Tactical Systems/Office of Munitions, Report to Congress, *Unexploded Ordnance Report* (Washington, D.C.: Feb. 29, 2000).

requirements for new weapons systems aimed at controlling unexploded submunitions." The report also states that Air Force and Navy munitions procurements likewise address reliability concerns. DOD has concluded in this report that "[w]hile it has been deemed infeasible to attempt to retrofit legacy weapons systems with self-destruct features, new and future submunition-based weapon systems for the Services have or will incorporate self-destruct features to contain the UXO problem."

In January 2001, the Secretary of Defense issued a memorandum[13] directing the services to adhere to DOD policy on submunition reliability. This memorandum states, "Submunition weapons employment in Southwest Asia and Kosovo, and major theater war modeling, have revealed a significant unexploded ordnance (UXO) concern . . . . It is the policy of the DoD to reduce overall UXO through a process of improvement in submunition system reliability—the desire is to field future submunitions with a 99% or higher functioning rate." The memorandum did accept lower functioning rates under operational conditions due to environmental factors such as terrain and weather. The memorandum allows the continued use of current lower reliability munitions until superseded by replacement systems. Because it was beyond the scope of this report, we did not assess DOD's actions to increase ammunition reliability and reduce dud rates.

[13] See Secretary of Defense, *Memorandum for the Secretaries of the Military Departments*, "DOD Policy on Submunition Reliability" (Washington, D.C.: Jan. 10, 2001).

Appendix V: Scope and Methodology

At least in part because the Gulf War took place over a decade ago, DOD reported that many records on the U.S. use of land mines and U.S. casualties had been destroyed, were lost, were incomplete, conflicted with each other, or were archived and not easily accessed. Resulting inconsistencies and gaps in data provided to us by the services and DOD on U.S. Gulf War land mine use, casualties, and lessons learned required that we perform extensive cross-checking and comparisons to check facts and identify associated themes. To create a picture of what happened during the Gulf War, DOD assisted us in obtaining available records and documents from various DOD sources in many different locations. We relied heavily on original service casualty reports as well as service and DOD after-action and lessons-learned reports written soon after the Gulf War. Based on our request, the Army conducted a reevaluation of original Gulf War casualty data and arrived at more exact data on causes and circumstances of Army-reported casualties. Our resulting compilation of service data used in calculating U.S. usage of land mines, U.S. casualties, and lessons learned during the Gulf War is the most complete assembled to date for the topics in this report. DOD officials believe that the service-provided information on land mine usage and casualties shown in this report is as accurate as service records permit. DOD, the Joint Chiefs of Staff, and the services confirmed the accuracy of the information they provided us on casualties and land-mine use and the information included in DOD lessons-learned and after-action reports.

To obtain information on land mine issues, we reviewed numerous reports and analyses of land mines by such organizations as the Office of the Under Secretary of Defense (Acquisition, Technology and Logistics); the Center for Army Analysis; the National Academy of Sciences; Lawrence Livermore National Laboratory; the Army Training and Doctrine Command; and the Congressional Research Service.

No one DOD or service office maintained complete records on the Gulf War, and existing DOD and service records were stored in various locations around the country. For example, the Headquarters of the U.S. Central Command, which had directed the war, retained no records of the war, and the services had no central repositories for the Gulf War documentation we sought. We therefore visited the following locations to obtain all available detailed descriptions of land mine systems, the doctrine governing their use, documents and records on Gulf War land mine usage and effectiveness, and historical records on the Gulf War:

- Office of the Project Manager for Mines, Countermine and Demolitions, and Close Combat Systems, U.S. Army Program Executive Office for Ammunition, Picatinny Arsenal, New Jersey;
- U.S. Army Communications-Electronics Command, Night Vision and Electronic Sensors Directorate, Fort Belvoir, Virginia;
- Headquarters, U.S. Central Command, MacDill Air Force Base, Florida;
- U.S. Army Engineer Center, Fort Leonard Wood, Missouri;
- U.S. Army Field Artillery Center, Fort Sill, Oklahoma;
- Naval Explosive Ordnance Disposal Technology Division, Indian Head, Maryland;
- Marine Corps History and Museums, Headquarters, U.S. Marine Corps, Washington, D.C.;
- Marine Corps Combat Development Center, Capability Assessment Branch, Quantico, Virginia;
- Army Center of Military History, Fort McNair, Washington, D.C.; and
- Air Force Headquarters, Washington, D.C.

To determine the extent to which land mines and unexploded ordnance caused U.S. casualties, we gathered data from the services and consulted original casualty reports. Because DOD data was not sufficiently detailed to allow identification of land mine or related casualties, we used the services' more detailed data. In collaboration with service officials, we reconciled inconsistencies in order to identify the most authoritative data available for casualties. We visited or received information on Gulf War casualties from the following locations:

- Army Records Management Declassification Agency, Springfield, Virginia;
- Army Safety Center, Ft. Rucker, Alabama;
- U.S. Marine Corps Casualty Section, Quantico, Virginia;
- Army Casualty Office, Washington, D.C.;
- U.S. Air Force Personnel Center, Casualty Branch, Randolph Air Force Base, San Antonio, Texas;
- U.S. Navy Casualty Division, Millington, Tennessee; and
- Office of the Secretary of Defense's Directorate for Information Operations and Reports, Arlington, Virginia.

Lessons learned- and after-action reports and documents on the Gulf War were similarly not available in a central location but rather were located in various service organizations and libraries. Therefore, to identify concerns expressed in these reports about the use of land mines and related unexploded ordnance issues, we visited and examined documents at the following locations:

- Center for Army Lessons Learned, Ft. Leavenworth, Kansas;
- Army Training and Doctrine Command's Analysis Center, Ft. Leavenworth, Kansas;
- U.S. Army Materiel Systems Analysis Activity, Aberdeen Proving Ground, Maryland;
- U.S. Naval Historical Center, Washington Navy Yard, Washington, D.C.;
- U.S. Air Force Historical Research Agency, Maxwell Air Force Base, Alabama;
- Combined Arms Research Library, Ft. Leavenworth, Kansas;
- U.S. Air Force Headquarters, Washington, D.C.; and
- Marine Corps Combat Development Center, Quantico, Virginia.

To identify U.S. policy on the U.S. use of land mines during the Gulf War, we interviewed or obtained documentation from DOD and service officials in Washington, D.C. These included officials from the Office of the Joint Chiefs of Staff, the Office of the Under Secretary of Defense (Acquisition, Technology, and Logistics); Office of the Deputy Assistant Secretary for Peacekeeping and Humanitarian Assistance, Assistant Secretary of Defense (Special Operations and Low-Intensity Conflict); the Army Office of the Deputy Chief of Staff for Operations and Plans, Strategy, Plans and Policy Directorate; Office of the Deputy Chief of Staff for Logistics, Army Headquarters; and service headquarters officials of the Air Force, Marine Corps, and Navy. To obtain detailed information on the U.S. policy concerning the use of land mines during the Gulf War, we interviewed the U.S. commander-in-chief of all forces participating in the Gulf War.

To obtain details on what ordnance was found on the battlefield after the Gulf War, we interviewed in person or by telephone seven former employees or officials of Conventional Munitions Systems (CMS), Inc. These persons were all retired U.S. military service members, ranking from major general to sergeant first class, and all but one had extensive experience in ordnance and explosive ordnance disposal. We confirmed with each CMS interviewee that they believed that the CMS data reported to the Army were accurate. We did not examine the evidence CMS used to prepare its report contracted by the Army.

To discuss U.S. policy and legal issues related to land mines, we interviewed officials from the Department of State's Office of the Legal Adviser, Office of International Security Negotiations, and Office of Humanitarian Demining Programs. In addition, we discussed the major topics and themes in this report with an official from the State Department's Bureau of Political-Military Affairs.

We conducted our review between June 2001 and September 2002 in accordance with generally accepted government auditing standards.

Appendix VI: Comments from the Department of Defense

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301-2500

SPECIAL OPERATIONS/
LOW-INTENSITY CONFLICT

SEP 12 2002

Mr. Neal P. Curtin
Director, Defense Capabilities and Management
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Curtin:

This is the Department of Defense (DoD) response to the GAO draft report GAO-02-1003, "MILITARY OPERATIONS: Information on U.S. Use of Land Mines in the Persian Gulf War," dated August 6, 2002 (GAO code 350068).

The Department found a number of factual inaccuracies in the draft report. These inaccuracies were pointed out to GAO representatives during the August 7, 2002 draft report meeting and in subsequent exchanges. This response addresses DoD concerns with the report in general, rather than reiterating a list of line-by-line corrections.

The basic flaw in this GAO assessment is that it makes assertions and speculations that are not based on fact and which cannot be substantiated. The draft report confuses the issue of unexploded ordnance with that of landmines and implies, wrongly, that landmines (including U.S. use of landmines) caused greater casualties to U.S. forces than the available data substantiates. For example:

Now on p. 3.

- "*Some portion of the 142 casualties caused by unknown type of landmine or unknown type of ordnance might have been caused by U.S. or other landmines*" (page 3). There is no evidence that U.S. landmines caused any of these casualties.

Now on p. 11.

- "*. . . the possibility cannot be ruled out that some of the casualties now attributed to explosions of unknown or ambiguously reported unexploded ordnance were actually caused by landmines*" (page 11). Again, there is no factual basis for this claim, and it could just as easily be argued that some of the casualties attributed to landmines were actually caused by unexploded ordnance.

Now on p. 16.

- "*Additional casualties could have been caused by landmines*" (page 17). Additional casualties "could" have been caused by many other things, such as unexploded ordnance.

The Department also is concerned about the draft report's use of unreliable or unrelated data. For example, the report draws heavily from questionable data provided by Conventional Munitions Systems, Inc. (CMS). Among the weaknesses of the CMS data are misidentified ordnance and confused nomenclatures of landmine systems. For example, CMS reported finding 746 Remote Anti-Armor Mine System (RAAM) "duds" in its post-Desert Storm cleanup efforts. DoD only fired 432 RAAM mines during the war.

See comment 1.

See comment 2.

Now on pp. 31-33.

See comment 3.

CMS also reported evidence that landmines had been used to attack an aircraft. While landmines may be used to deny enemy use of airfields, they are not used to attack aircraft.

The draft report also states that there is no evidence that GATOR landmines were effective in destroying Scud missiles. While landmines may be used to deny maneuver of Scud transporters, they are not used to attack the missiles themselves. The report should be adjusted to reflect this important distinction.

Another concern is the way draft report deals with unexploded ordnance and submunitions, including a lengthy discussion of failed submunitions as a "de facto minefield" (pages 31-33). The report confuses unexploded ordnance with landmines. This skews the data, erroneously implying a higher failure rate of U.S. landmine systems and a greater number of U.S. casualties from landmines. We suggest that the GAO study clarify its terms to avoid confusing issues.

In short, the draft report's inclusion of unsubstantiated and/or misleading conclusions, use of unreliable or unrelated data, inappropriate use of data on other weapon systems to reinforce conclusions about landmines, and diversion from its original scope (effectiveness of mixed landmine systems) to an exclusive focus on one case study (the Persian Gulf War) undermines the report's credibility as an objective analysis of landmine utility and employment.

We recommend to those interested in a factual analysis of the landmine issue several other studies: *Alternative Technologies to Replace Antipersonnel Landmines*, National Research Council, March 2001; *Battlefield Utility of Antipersonnel Landmines and Proposed Alternatives*, Lawrence Livermore National Laboratory, September 2001; *Recommendations Regarding Alternatives to Antipersonnel Landmines*, Los Alamos National Laboratory, August 2001; and *Landmines and U.S. Leadership: A View from the Field*, Patricia S. Huntington, National Committee on American Foreign Policy, December 2000. While we may disagree with the policy recommendations of some of these studies, we believe that these studies provide a rigorous and objective analysis of a number of issues regarding U.S. landmines and their effectiveness. Finally, we refer interested readers to the hearing record in the United States Senate regarding the *Amended Mines Protocol Treaty*, and especially the associated report of the Senate Foreign Relations Committee.

Sincerely,

Marshall Billingslea
Principal Deputy

The following are GAO's comments on the Department of Defense's (DOD) letter dated September 12, 2002.

GAO Comments

1. We have deleted from the report the example of Gator land mine use against an aircraft on an airfield.

2. We have changed the report to clarify the fact that Scud transporters were targeted rather than the Scud missiles they carried.

3. In conducting our review, we consulted these and other reports, as we state in our objectives and scope and methodology sections. We cite the National Research Council's report in appendix IV. However, because it was beyond the scope of our report to evaluate land mine policy and program alternatives, which is the general subject of these reports, we do not discuss them in detail.

GAO's Mission

The General Accounting Office, the investigative arm of Congress, exists to support Congress in meeting its constitutional responsibilities and to help improve the performance and accountability of the federal government for the American people. GAO examines the use of public funds; evaluates federal programs and policies; and provides analyses, recommendations, and other assistance to help Congress make informed oversight, policy, and funding decisions. GAO's commitment to good government is reflected in its core values of accountability, integrity, and reliability.

Obtaining Copies of GAO Reports and Testimony

The fastest and easiest way to obtain copies of GAO documents at no cost is through the Internet. GAO's Web site (www.gao.gov) contains abstracts and full-text files of current reports and testimony and an expanding archive of older products. The Web site features a search engine to help you locate documents using key words and phrases. You can print these documents in their entirety, including charts and other graphics.

Each day, GAO issues a list of newly released reports, testimony, and correspondence. GAO posts this list, known as "Today's Reports," on its Web site daily. The list contains links to the full-text document files. To have GAO e-mail this list to you every afternoon, go to www.gao.gov and select "Subscribe to daily E-mail alert for newly released products" under the GAO Reports heading.

Order by Mail or Phone

The first copy of each printed report is free. Additional copies are $2 each. A check or money order should be made out to the Superintendent of Documents. GAO also accepts VISA and Mastercard. Orders for 100 or more copies mailed to a single address are discounted 25 percent. Orders should be sent to:

U.S. General Accounting Office
441 G Street NW, Room LM
Washington, D.C. 20548

To order by Phone:	Voice:	(202) 512-6000
	TDD:	(202) 512-2537
	Fax:	(202) 512-6061

To Report Fraud, Waste, and Abuse in Federal Programs

Contact:

Web site: www.gao.gov/fraudnet/fraudnet.htm
E-mail: fraudnet@gao.gov
Automated answering system: (800) 424-5454 or (202) 512-7470

Public Affairs

Jeff Nelligan, managing director, NelliganJ@gao.gov (202) 512-4800
U.S. General Accounting Office, 441 G Street NW, Room 7149
Washington, D.C. 20548

PRINTED ON RECYCLED PAPER