

GAO

Report to the Chairman
Committee on Foreign Affairs
House of Representatives

July 1986

CHEMICAL WARFARE

Progress and Problems in Defensive Capability



This is an unclassified version of a classified GAO report.

536485



United States
General Accounting Office
Washington, D.C. 20548

Program Evaluation and
Methodology Division

B-211376

July 31, 1986

The Honorable Dante Fascell
Chairman, Committee on Foreign Affairs
House of Representatives

Dear Mr. Chairman:

This report responds to your August 29, 1984, letter. You asked us to review the Department of Defense program to improve its defensive chemical warfare capabilities.

We note that this is an unclassified version of the classified GAO report GAO/C-PEMD-86-2. Classified sections of the original report have been modified or deleted to permit the issuance in unclassified form.

As we agreed with your office, unless you publicly announce the contents of this report earlier, we plan no further distribution of it until 30 days from the date of the report. At that time, we will send copies to those who are interested and will make copies available to other authorized parties upon request.

Sincerely,

A handwritten signature in cursive script, appearing to read 'Eleanor Chelimsky'.

Eleanor Chelimsky
Director

EXECUTIVE SUMMARY

PURPOSE

The Congress has expressed continuing concern about the ability of U.S. military forces to defend themselves against an attack from chemical weapons. In 1978, the entire chemical warfare budget of the U.S. Department of Defense (DOD) was \$111 million. The 1986 request was \$1.27 billion, of which \$936 million was for chemical defense. The chairman of the House Committee on Foreign Affairs, stating that "a credible chemical defensive capability is an essential element in the deterrence of chemical warfare," asked GAO to evaluate the adequacy and effectiveness of DOD's efforts to improve the chemically defensive posture of U.S. forces.

Since, in many instances, no criteria for establishing and measuring adequacy and effectiveness had been set forth by DOD or the services, GAO, with the committee's concurrence, agreed to address the following questions.

What progress has DOD made in developing the doctrine needed to support individual and joint military operations in a chemically contaminated environment?

What progress has DOD made in developing and procuring equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?

What progress has DOD made in establishing a force structure that would permit U.S. forces to carry out training, reconnaissance, decontamination, and other defensive missions in chemical warfare?

What progress has DOD made in providing training to individuals and units to support the probability that their response to a chemical attack will be automatic and precise and that their discipline will be maintained in a chemically contaminated environment?

The committee also requested information on U.S. relationships with the members of the North

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Atlantic Treaty Organization (NATO) regarding chemical defense. GAO also presents some information on the current threat and DOD's assessments of the U.S. capability.

BACKGROUND

DOD stated in its 1982 report to the Congress that until the ultimate U.S. goal is reached--a complete and verifiable ban on developing, producing, and stockpiling chemical weapons--the United States will maintain a capability for chemical warfare sufficient to deter the use of chemical weapons against the United States and its allies.

In DOD's view, a credible deterrent requires both a defensive and a retaliatory component. Having uncovered serious neglect in DOD's defensive programs, the Congress has repeatedly mandated a higher priority for such programs and, for the most part, has approved DOD's funding requests.

RESULTS IN BRIEF

Progress has been made in some areas. It is lacking in other areas, but DOD has ongoing efforts to make the necessary improvements.

The Army has made substantial progress in rewriting its chemical warfare doctrine, and so has the Air Force to a lesser extent. Across the services, medical doctrine for chemical warfare is inadequate. (See pages 17-25.)

(See pages 26-39.)

(See pages 65-71.)

Despite substantial training improvements in the Army and Air Force, U.S. forces might not react automatically and precisely in a chemically contaminated environment. (See pages 72-85.)

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PRINCIPAL FINDINGS

Doctrines

The Army has rewritten all its nonmedical doctrinal literature on chemical defense since 1982. The Air Force has developed guidelines and procedures. The Navy is just beginning to identify its needs. In general, DOD's doctrine is weakest in the medical area, in part because of the lack of adequate medical equipment. (See pages 17-25.)

Equipment and Materiel

The services put equipment into the field, in most cases before 1982, in all five areas of concern: medical, individual and collective protection, detection, and decontamination. Notable inadequacies remain, however. The research and development efforts to correct these inadequacies have not been successful, on the whole. (See pages 26-64.)

Force Structure

In DOD's 1982 report to the Congress, the Army and Air Force proposed increases that do not seem achievable with present personnel ceilings. The Navy did not propose increases.

(See pages 65-71.)

Training

The Army has improved the training of its Chemical Corps, and the U.S. Air Force in Europe has exercised its troops in an environment simulating a chemical battlefield. Nonetheless,

(See pages 72-85.)

Relationship With NATO

The United States has made several agreements to exchange data with NATO members and has signed numerous NATO standardization agreements on chemical defense. Ministry of defense officials in NATO are generally positive about the U.S. chemical defense establishment and its relationship with their nations. However, they

EXECUTIVE SUMMARY

have some

(See pages 86-92.)

Threat

The Soviet capability for chemical warfare is at least as formidable today as it was in 1982. Chemical weapons appear to be proliferating in the third world, and it is possible that the Soviets have new chemical agents that would defeat U.S. protective equipment. However, U.S. intelligence officials are not unanimous about whether the Soviet Union is likely to use chemical weapons in a conflict with NATO forces. (See pages 14-16.)

DOD's Assessment of Capability

DOD's assessments have concluded that most U.S. forces could survive an initial chemical attack, with the possible exception of the Navy shore establishment, but that

Degradation of performance from operating in protective equipment is expected to be considerable. However, estimating sustainability and degradation levels is impeded by numerous gaps in knowledge about warfare on a contaminated battlefield. (See pages 93-97.)

RECOMMENDATIONS

GAO makes no recommendations in this report.

AGENCY COMMENTS

GAO did not receive comments on this report from DOD. Upon receiving a draft copy, DOD requested an additional 30 days for review, noting the size of the report, the sensitivity of the issues, the number of DOD components involved, and demands for preparations for hearings. The office of the House Committee on Foreign Affairs asked GAO not to grant the extension. When the extension was denied, DOD informed GAO that comments would not be provided.

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ABBREVIATIONS

CAM	Chemical agent monitor
CANE	Combined arms nuclear-chemical environment
DARCOM	Army Material Development and Readiness Command
DIA	Defense Intelligence Agency
DOD	U.S. Department of Defense
DS2	Decontamination solution 2
EUCOM	U.S. European Command
FORSCOM	Army Forces Command
GAO	U.S. General Accounting Office
NATO	North Atlantic Treaty Organization
POMCUS	Prepositioned overseas materiel configured-in-unit sets
TRADOC	Training and Doctrine Command
USAFE	U.S. Air Force in Europe
USAREUR	U.S. Army in Europe
U.S.S.R.	Union of Soviet Socialist Republics

CHAPTER 1

INTRODUCTION

In a 1982 report to the Congress, the Department of Defense (DOD) proposed a 5-year plan for modernizing the U.S. chemical warfare capability. Now that more than 3 years have elapsed, the House Foreign Affairs Committee asked us to review the progress and status of this modernization program as it relates to the U.S. defensive capability--specifically, the ability to survive and sustain operations in a chemically contaminated environment. This report presents the findings from our review.

EFFORTS TO PREVENT CHEMICAL WARFARE

The threat of the use of chemical weapons and the ability of the United States to prevent its eventuality are issues of continuing national concern. The two main U.S. efforts to prevent chemical warfare pertain to banning chemical weapons and maintaining a credible deterrence. DOD's 1982 report to the Congress observed that the ultimate U.S. goal is a complete and verifiable ban on developing, producing, and stockpiling chemical weapons (1).¹ It stated that until this goal is reached, the United States will maintain a chemical warfare capability sufficient to deter the use of chemical weapons against the United States and its allies. In this context, a credible deterrent is commonly held to require defensive and retaliatory components.

Proposed ban

The efforts of the United States to secure a verifiable ban on chemical weapons date back to the end of the 19th century. Recent events include the 1975 U.S. ratification of the 1925 Geneva Protocol and the 1972 Biological and Toxins Weapons Convention. The United States has continued to take initiatives since DOD's 1982 report to the Congress. In 1983, the United States conducted a workshop to demonstrate destruction-verification procedures, and the vice president addressed the Committee on Disarmament to emphasize U.S. support for a complete ban. In 1984, the United States proposed a complete, worldwide ban on chemical weapons in a treaty proposal that included verification by systematic on-site inspection and a combination of other national and international measures. None of these initiatives appears to have brought the United States and the U.S.S.R. closer to a ban.

¹Numbers in parentheses are keyed to the bibliographical references in appendix III.

Deterrence

For the last few years, the decision of whether to increase the U.S. capability for deterrence by producing offensive chemical weapons has been the subject of heated debate in both houses of the Congress. The issues regarding a stockpile of weapons for use in retaliation constitute only one part of credible deterrence. The other part involves the ability to defend against an attack. It is often argued that a strong defensive capability--one that makes both survivability and sustainability highly probable--can render the use of chemical weapons less attractive to an enemy than alternatives.

Efforts to develop, maintain, and improve the U.S. defensive chemical warfare capability have continued for many decades, although at various levels of intensity. The increasing emphasis on this issue in recent years is reflected in budget allocations for defensive activities. In 1978, the entire chemical warfare budget was \$111 million. The 1986 request was \$1.27 billion, of which \$936 million was for the defensive program. One reason often cited for this sharp increase is that the U.S. defensive program was allowed to diminish dramatically during the decade following the ban on production in 1969. During the same period, the Soviet program--both offensive and defensive--appears to have continued without interruption.

PRIOR GAO REPORTS

The U.S. General Accounting Office (GAO) has produced several reports since 1977 on chemical warfare issues, some of which focused attention on defensive capabilities. In 1977, we looked at the condition of the U.S. stockpile of lethal chemical munitions and agents (2). In 1981, we reviewed the status of DOD's implementation of our recommendations concerning the stockpile (3). Also in 1977, we examined the U.S. lethal chemical munitions policy in terms of issues facing the Congress (4). Again in 1977, we reviewed U.S. chemical warfare defense, looking at both readiness and costs (5). In 1982, we investigated the readiness of U.S. forces, equipment, and facilities to survive and recover from a chemical attack (6). Finally, in 1983, we compared U.S. and Soviet chemical warfare capabilities and discussed some of the approaches to modernization that could be considered (7). In the present report, we draw upon these reports, especially our 1982 readiness review.

CHEMICAL DEFENSE BUDGETS

Table 1.1 presents the budgets for chemical and biological defense for the Army, the Navy, including the Marine Corps, and the Air Force for fiscal years 1982-85. Where the information was available, we show the funding requested by DOD as well as the funds actually appropriated. As can be seen by comparing requests and appropriations, the Congress has generally been very

Table 1.1

DOD's Fiscal Year 1982-85 Defensive
Chemical-Biological Budgets:
Requested and Appropriated^a

<u>Item</u>	<u>1982</u>		<u>1983</u>		<u>1984</u>		<u>1985</u>	
Army								
Research, development, test, and evaluation	117.9	--	221.3	195.0	274.0	260.4	332.3	327.6
Procurement	26.9	--	96.9	43.7	56.2	51.9	66.6	66.6
Operations and maintenance	52.1	--	73.9	79.6	108.1	109.0	139.1	105.7
Army stock fund	98.9	--	75.5	75.5	81.0	81.0	86.0	86.0
Total	295.8	--	467.6	393.8	519.3	502.3	624.0	585.9
Navy								
Research, development, test, and evaluation	--	9.5	--	16.7	--	19.2	--	18.5
Procurement	--	3.3	--	4.8	--	7.4	--	12.5
Operations and maintenance	--	0	--	3.1	--	37.1	--	36.3
Total	--	12.8	--	24.6	--	63.7	--	67.3
Air Force								
Research, development, test, and evaluation	8.8	8.8	16.3	16.3	15.6	15.6	18.2	18.2
Other procurement	16.0	16.0	12.8	12.8	28.1	11.8	43.0	37.9
Operations and maintenance	5.3	9.6	2.6	2.6	16.5	16.3	24.9	24.7
Military construction	9.2	0	0	0	7.7	0	13.4	8.5
Total	39.3	34.4	31.7	31.7	67.9	43.7	99.5	89.3

^aUnder each fiscal year column head, the number to the left is millions of dollars requested and the number to the right is millions of dollars appropriated. Data were not available for table cells marked "--."

supportive of the modernization plan for U.S. defensive capability put forth in the 1982 report to the Congress.

OBJECTIVES, SCOPE, AND METHODOLOGY

The House Foreign Affairs Committee requested answers to four questions:

1. Does DOD have or is it developing doctrine adequate to support individual and joint military operations in a chemically contaminated environment?
2. How effectively is DOD developing and procuring equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?
3. Has DOD established force structures adequate to carrying out training, reconnaissance, decontamination, and other defensive missions in chemical warfare?

4. What is the quality of the training given to individuals and units? Does it support the probability that their response to a chemical attack will be automatic and precise and that their discipline will be maintained in a chemically contaminated environment?

These questions were derived from objectives DOD stated in its 1982 report to the Congress. In pursuing answers to these questions, we found that, in many instances, no criteria for establishing and measuring adequacy and effectiveness had been set forth by DOD or the services. Each question covers a wide range of activities across DOD. Consequently, the questions do not readily lead to yes or no answers.

Therefore, in agreement with the committee, we focused on progress rather than on adequacy, and the information in this report is about progress and the shortcomings in progress in each area of interest. We have not provided our own definitions of adequate doctrine, procurement, force structure, and training. Rather than argue unproductively over what should or should not be accepted as "adequate," we have analyzed the changes we observed in terms of DOD's own expectations for progress over time. The questions have been restated as follows:

1. What progress has DOD made in developing the doctrine needed to support individual and joint military operations in a chemically contaminated environment?
2. What progress has DOD made in developing and procuring equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?
3. What progress has DOD made in establishing a force structure that would permit U.S. forces to carry out training, reconnaissance, decontamination, and other defensive missions in chemical warfare?
4. What progress has DOD made in providing training to individuals and units to support the probability that their response to a chemical attack will be automatic and precise and that their discipline will be maintained in a chemically contaminated environment?

The time period we focused on was 1982 to 1985. We selected 1982 because it was the year in which DOD specified some of its chemical warfare defense objectives in the report to the Congress. However, we also note particularly significant events before 1982, such as the reopening of the Army's Chemical School.

In addition to the questions on DOD's capability, the committee requested information on U.S. relationships with the North Atlantic Treaty Organization (NATO) on chemical warfare

defense. This report provides information on this topic. We also present some information on the current threat and DOD's assessments of the U.S. capability.

Most of the information we used to answer the committee's questions was derived from an analysis of DOD documents and from interviews with persons knowledgeable about chemical warfare both within and outside DOD. Within DOD, we met with officials from the Army, the Navy, including the Marine Corps, and the Air Force in the United States and Europe as well as with officials from the Office of the Secretary of Defense, Joint Chiefs of Staff, and Joint Logistics Command. Outside DOD, we met with representatives from the ministries of defense of several NATO nations, the U.S. delegation to NATO, U.S. research and development contractors, European research and development centers, and academics. The congressional request is in appendix I. The list of officials we interviewed is in appendix II. The major documents we reviewed are listed in appendix III.

Field work was conducted between September 1984 and August 1985. We conducted interviews in two phases. Phase 1 covered the United States only. Within DOD, we used a modified "snowball" sample of interviews, progressing from headquarters to commands to programs. We chose snowball sampling as the most efficient method to ensure coverage of all key information sources, given the limited time we had for data collection. In surveying officials on Army research and development, for example, we began at department headquarters, went from there to the Army Materiel Command, and then proceeded to the Chemical Research and Development Center, the Natick Research and Development Center, the nuclear, biological, and chemical program offices of the Tank and Automotive Command and the Aviation Systems Command, and so on.

The interview format was semistructured in order to provide information that would be generally comparable across sites and to permit lines of inquiry specific to services and sites. We wrote interview questions generically, covering the four areas listed above, and then tailored the items to the individual services as necessary.

To identify experts outside DOD, we assembled a state-by-state list from professional symposium programs, Defense Science Board panels, and word of mouth. Whenever it was feasible, we visited experts who were in geographic proximity to our scheduled DOD site visits. Our staff members agreed on the general issues to be pursued at the meetings, but the interview format was unstructured.

Phase 1 culminated in the statement of fact that we provided to the committee on April 23, 1985 (8). Phase 2 covered Europe and the additional information in the United States that we needed in order to follow up leads and track new developments.

To cover DOD and the services in Europe in phase 2, we used a purposive sampling scheme, because it was not feasible to take a census or probability sample of all DOD sites in Europe. We identified sites from the 1984 Institute for Defense Analyses report entitled Analysis of Chemical Warfare Operations (9). This report described, in vignettes and anecdotes, events that might occur in a war waged in conformance with the campaign plans of Warsaw Pact and NATO forces. It identified numerous U.S. combat and support units, including medical units, across the three services that might be chemically attacked by Warsaw Pact forces. The report is highly regarded by DOD officials, and representatives of the three services commended our use of it.

The interview format was semistructured, as in phase 1, with the addition of site-specific questions planned for each location. Outside DOD, we covered NATO headquarters, European chemical defense research and development centers with U.S. representation, and some NATO nation ministries of defense.

THE CHEMICAL WARFARE THREAT

Any discussion of U.S. chemical warfare doctrine, equipment and materiel, force structure, and training should be placed in the context of a perceived threat. We received formal briefings on the Soviet threat from the Defense Intelligence Agency (DIA), the Army's Office of the Assistant Chief of Staff for Intelligence, the U.S. European Command (EUCOM), and the U.S. Army in Europe (USAREUR), and we received informal briefings from various officials involved with chemical warfare intelligence. As it was told to us, the current threat continues to be no less formidable than what was described in the 1982 DOD report to the Congress and in our 1983 report entitled Chemical Warfare: Many Unanswered Questions (1, 7). Both of these documents discussed the Soviet threat in such categories as doctrine, stockpile, delivery systems, and defensive equipment and personnel. Additional issues regarding the current threat that were raised in the course of our review included the uncertainty of Soviet intent, proliferation in third world nations, the potential existence of new agents, and specific needs for better information.

Uncertainty of the Soviet intent

U.S. intelligence officials are not unanimous about whether the Soviet Union is likely to use chemical weapons in a conflict with NATO forces.

Proliferation

The number of nations in possession of chemical weapons appears to be increasing. According to DIA, 16 nations are now known to possess chemical weapons or toxins, including Syria and

Six others, including are alleged to possess them. According to one official, the total number of "terrorist nations" (not defined) with chemical weapons has doubled in the last 5 years. DIA officials also assert that over the long run, the use of chemicals has increased; they say that the number of known uses between 1918 and 1965 doubled between 1965 and 1985.

Officials believe that third world nations view chemical weapons as an attractive and inexpensive alternative to nuclear weapons. In addition, a terrorist chemical threat poses problems that a Soviet Union or Warsaw Pact threat does not. U.S. dependents are not issued protective gear because they would be evacuated in the event of an alert. This policy is more reasonable for an invasion from Warsaw Pact forces than for a situation in which terrorists take hostages. Intelligence officials would not state whether the third world or terrorist threat is greater or less than the threat from the Soviet Union and Warsaw Pact nations; they would state only that there are many areas in which the threat to U.S. forces is viewed as great.

Potential existence of new agents

The Deputy Assistant Secretary for Chemical Matters in the Office of the Secretary of Defense has publicly raised concerns about

This official made the point that since U.S. equipment was designed to protect against old or known agents, its effectiveness against new agents is uncertain. According to intelligence officials and DOD scientists, the concern with respect to U.S. forces is that the Soviets may have developed or are developing an agent that

but the issue has generated enough concern to launch a high-level international task force.

The Army's Chemical Research and Development Center recognizes that relying on

Specific needs for better information

Most of the officials we interviewed believed that they had a clear sense of the chemical warfare threat and that, for the most part, the information they had was sufficient. There were exceptions, however. For example, the need for better information on the threat was cited several times in the discussions of the Navy's research and development.

Depending on the scenario, technological requirements differ. Because intelligence information conveys only a broad sense of how systems can be used, the specific requirements that would be needed to meet a threat are not always well defined.

Chemical and biological intelligence assessment has been primarily concentrated on the threat from the Soviet Union and Warsaw Pact nations. According to U.S. Army officials, intelligence is weaker in the so-called "low-intensity" regions, such as Central America, and "mid-intensity" regions, such as the eastern Mediterranean. This poses problems for some rapid-deployment units that would be likely to be sent into these regions. The Infantry Division Light, the first of five proposed light divisions, comprises such units. Because of its configuration, it has only individual decontamination capability and carries only limited protective gear--a mask, hood, and gloves but no protective suit. The combination of its configuration and the limited availability of intelligence on the probable regions of its deployment creates a potentially serious vulnerability. However, a November 1984 tactical scenario presented to the 7th Infantry Division Light

As can be seen from this short discussion, the likelihood that U.S. forces might be faced with a need to operate in a chemical warfare environment appears real and supports the argument for continuously improving and upgrading the U.S. chemical warfare defensive capability called for in DOD's 1982 report to the Congress. The status of some of the components of this capability is the subject of the following chapters.

CHAPTER 2

DOCTRINE

Doctrine is the foundation on which the military forces base their actions in support of national objectives. It is authoritative but requires judgment in application. The services develop requirements from, and measure performance against, doctrine. It is refined from the feedback from peacetime training and use of equipment. Chemical warfare doctrine helps define how forces are expected to fight and how equipment is expected to operate in a chemical warfare environment. The question we pose here is, What progress has DOD made in developing the doctrine needed to support individual and joint military operations in a chemically contaminated environment?

The Army has rewritten all its nonmedical doctrinal literature on nuclear, biological, and chemical warfare. The doctrinal efforts of the Navy and Air Force are not as structured as the Army's. In the Navy, discussions of doctrine invariably elicit references to policies, directives, concepts of operation, and how-to-do-it manuals. Consequently, it is more accurate to refer to Navy "guidance" than "doctrine." The Air Force considers chemical warfare not as a separate doctrinal issue but as part of its overall air base survivability.

In addition to describing the progress of each service in doctrinal development efforts, we present in this chapter a summary of the assessments by service officials of the areas in which they believe little progress has been, and is being, made. The chapter also contains our summary of progress and needs.

ARMY

For the Army, our focus is on the doctrinal literature that reflects the status of Army doctrine since 1982 and on recent progress in doctrinal actions.

Doctrinal literature

Since 1972, the Army's Chemical School has rewritten its nonmedical doctrinal literature on defense in nuclear, biological, and chemical warfare. The previous doctrine (FM21-40) was issued in 1976. Doctrinal manuals are being developed from the operational concepts in this literature, which sets forth the functions and tasks to be accomplished by the various levels of command during combat.

The Army has published an operational concept for military operations (PAM 525-20, July 1982 (11)) and one for medical support operations (PAM 525-22, January 1983 (12)). These are to be used through the mid-1990's. A multiservice operational concept for NATO's nuclear, biological, and chemical defense

through the 1990's, which is in draft form, reportedly places an increased emphasis on In addition, an interim operational concept for logistics support in a nuclear, biological, and chemical warfare environment was developed in June 1985 and has been commented on by USAREUR. In the nonmedical area, the Army has produced five doctrinal manuals since 1982 (in 1983, FM3-5 on decontamination (13), and in 1984, FM3-100 on operations, the "keystone" (14), FM3-3 on contamination avoidance (15), FM3-4 on protection (16), and FM3-87 on chemical units (17)).

Summary of doctrinal changes

The thrust of the new doctrine is to enable units to continue their missions in a nuclear, biological, and chemical warfare environment. It shifts from 100-percent protection, with the consequent performance degradation, to permit a commander to accept more risks. The new doctrine focuses on the following points: contamination avoidance, hasty decontamination procedures, procedures for unmasking without complete decontamination, the elimination of the shower from personal decontamination procedures, the elimination of the slurry pit from equipment decontamination procedures, flexibility in protective posture, procedures for exchanging protective gear, exit and entry procedures, degradation caused by wearing protective gear, the command and control of chemical units, and camouflaging forward tactical operations with deliberate smoke.

All companies are supposed to receive the new doctrinal manuals. We did not systematically survey field units and, therefore, cannot say whether the manuals are in short supply. The USAREUR units we visited have received drafts of all the new doctrinal manuals on defense and have incorporated the concepts into their standard operating procedures and plans.

NAVY AND MARINE CORPS

The office of the Chief of Naval Operations issued a secret document in December 1983 that has become a primary source of guidance on chemical, biological, and radiological defense (OPNAV Instruction 3400.10C, Offensive Chemical Warfare and Chemical, Biological and Radiological Defense (18)). This instruction sets forth in broad terms the training, materiel, and research and development requirements for improving the Navy's defense capability aboard ships and at overseas bases.

A second source of guidance on defense is a September 1984 message on interim operational procedures for chemical, biological, and radiological protective clothing and equipment,

For ship use, two publications describe the procedures to follow in a chemical warfare environment. Cited by some but not by others in discussing doctrine, these publications contain step-by-step procedures on how to control chemical contamination aboard ships. One is a handbook for officers that contains a chapter on a basic damage-control approach to chemical warfare. The other provides comparable procedural information to enlisted personnel.

Marine Corps doctrine is documented in Fleet Marine Force Manual 11-1, entitled Nuclear, Chemical, and Defensive Biological Operations in the Fleet Marine Force (20). This is a 1975 document distributed to every Marine Corps unit. Except for differences in terminology, the Marine Corps doctrine adheres closely to that of the Army.

AIR FORCE

The basis of all Air Force doctrine is provided, in very broad terms, by Air Force Manual 1-1, Basic Aerospace Doctrine of the United States Air Force (21), and chemical warfare is discussed, also in very broad terms, in Air Force Manual 1-7, Chemical Warfare Doctrine (22). Chemical warfare is mentioned in a general way in the 1984 Air Force Regulation 355-1, Disaster Preparedness Planning and Operations (23). A somewhat more specific discussion of chemical warfare is provided in Chemical Warfare Deterrence and Chemical/Biological Defense Operations (annex J to the war mobilization plan (24)). It covers threat assessment, mission and execution, the concept of operations (including capability goals, tasks for commands, equipment distribution, and stockpiling), and training.

The major commands--including the Tactical Air Command, Military Airlift Command, and theater commands in Europe and the Pacific--provide the next level of specificity of doctrine, on operational concepts and procedures. A disaster preparedness official stated that this guidance could be improved in two areas. It should be more specific on reusing ensembles than on the current visibility check for liquid contaminants, and it should contain specific supply guidance for storing food and water and for refilling water containers for the survivable collective protection system.

The USAFE October 31, 1979, chemical warfare defense guidance for the joint support of operating bases has been updated and expanded twice since 1982, when we were told that it was incomplete. It was replaced on September 30, 1983, and issued in more detailed form on March 15, 1984, as defense planning information for nuclear, biological, and chemical warfare, which provides a checklist and guidelines for disaster preparedness

officials, who are responsible for joint support plans. We were told by the USAFE plans chief for disaster preparedness that joint support plans are improving in their coverage of chemical warfare; they had become more detailed since January 1985 and an estimated 6 of the 43 plans had been reviewed since that time. Further, the plans chief said the 1984 checklist was being updated and that a new checklist would be issued in 1986, suggesting that, in consequence, joint support plans for chemical defense will continue to improve as more plans incorporate the existing guidance and as new planning requirements are added in the revision.

Air base officials at both Spangdahlem and Rhein-Main stated that they have plans for making an integrated response across each base to a chemical attack (see Spangdahlem's 52 TFW Oplan 4102 and Rhein-Main's 435 TFW Oplan 355-1, being revised for inclusion in Oplan 4102).

DOCTRINAL CONCERNS ACROSS THE SERVICES

Progress is lacking in medical doctrine in a way that cuts across the services. The other issues we discuss in this section--decontamination, defensive operations in rear combat zones, air and amphibious operations, and the coordination of U.S. forces with German armies--are specific to more than one service.

Medical concerns

The Army has issued no doctrinal manuals for medical operations in chemical warfare since its 1983 operational concept, PAM 525-22 (12). The first manual to stem from it will be on health service support and is scheduled to be written in 1986. NATO's 1973 "keystone" handbook on the medical aspects of nuclear, biological, and chemical defensive operations is being rewritten (25). A triservice manual on the treatment of chemical agent casualties and conventional military chemical injuries has been republished, because the Air Force and Navy do not concur with it on the use of 2 PAM-chloride with atropine.

According to officials in the USAREUR and combat support hospitals, existing medical doctrine does not address the specifics of operating a general or combat support hospital facility in nuclear, biological, or chemical warfare. The hospital officials we met with said that doctrine is inadequate on decontaminating patients and treating casualties. They also reported that equipment and personnel, among other things, are inadequate for decontamination. In the absence of doctrine, the three hospitals we visited have established decontamination procedures for patients. Only one general hospital has successfully practiced (in June 1985) a mass casualty drill for chemical attack.

Presently, there are no decontamination facilities for patients in USAREUR medical units. Current doctrine calls for maneuver units to decontaminate patients at the forward areas. USAREUR officials argue that this approach is unrealistic and unworkable. Medical personnel point out that hospitals cannot provide proper care for patients who have not been fully decontaminated and placed in an uncontaminated environment. Therefore, the decontamination process must be fully rehearsed by both maneuver and medical units. Another problem is that once the decontamination procedures have been accomplished, there is no adequate means of determining whether a patient has, in fact, been completely decontaminated.

The processing of chemical casualties

The Air Force has an ongoing effort to try to develop treatment protocols for chemical warfare casualties. The current concept of medical doctrine involves four echelons: self care and buddy care in combat; removal for care in a clean environment, removal to a place where more sophisticated care is available, and major hospital care. However, officials of Air Training Command believe that the point at which doctrine can be developed has not been reached. Such doctrine, they said, can be developed only after equipment, which is now in early stages of research, has become available.

The USAFE surgeon and air base medical officials took the opposite viewpoint, arguing that there are no deficiencies in the medical doctrine for chemical warfare casualties. Still a third view came from the USAFE disaster preparedness chief, who stated that medical doctrine is changing, as seen in the new arrangements in which medical professionals will be able to provide care on chemically contaminated air bases through collective protection

medical units that are now being designed and developed. Currently, this type of care is provided in toxin-free areas outside the bases.

Contingency support plans at the three medical sites we visited contain written procedures for handling chemical casualties, including decontamination and triage. The USAFE surgeon and base medical officials stated that chemical casualties should be decontaminated before evacuation for medical treatment. In a briefing at the June 1985 Air Force chemical warfare defense review, the current ability to provide medical care and aeromedical evacuation from a chemically contaminated environment was described as limited (26).

Doctrinal shortfalls identified by USAREUR

Overall, USAREUR officials believe that the doctrinal developments represent a vast improvement over old doctrine. However, they point to many remaining gaps in the doctrine that should be filled. Some gaps in decontamination were noted, but from USAREUR's perspective,

Decontamination

USAREUR officials believe that a major reason for the doctrine being much improved and more realistic is the emphasis on "hasty decon" and contamination avoidance. Moreover, all units are now responsible for personnel decontamination under the new doctrine. However, the officials stated that the doctrine is not specific enough in some important areas of decontamination. One is the procedures for decontaminating vehicles painted with coatings resistant to chemical agents. These vehicles should require less-stringent decontamination procedures, but no specific procedures have been identified for them in the new doctrine. As a result, these vehicles have been decontaminated during field exercises in the same manner as other vehicles, a time-consuming process.

Another area in need of doctrine is the decontamination of vehicles in cold weather. According to the chemical staff officer of the European Command, it is not clear whether vehicles have to be decontaminated in cold weather, because no testing has shown the effects of chemical agents in cold weather.

Chemical company commanders indicated a need for better procedures for decontaminating vehicle interiors. The current doctrine, they told us, leaves some uncertainty over whether vehicles become recontaminated during this process. They also see a need for more specific doctrinal guidance on how much decontamination and what type to apply in decontaminating certain

in this area, just beginning to identify its needs, including doctrine. In the interim, certain Army manuals have been adopted as guidance.

Navy officials also reported to us that there is no existing doctrine to guide naval air operations in a chemically contaminated environment. An official stated that the

In an amphibious chemical warfare exercise, problems associated with both Navy and Marine Corps doctrine were found. Deeming it an immediately critical deficiency, the report on this exercise stated that

(28). This situation adversely affected the accomplishment of missions in flight, surface, and medical areas of operation. The corrective actions recommended for the deficiency were increased training and standardization of procedures and doctrine for nuclear, biological, and chemical defense.

Coordination between U.S. and German armies

The Spangdahlem wing commander stated that there is the U.S. Army unit that defends the perimeter of the base would with the Air Force in a chemically contaminated environment. The commander stated that during a major exercise, for example, base officials learned that the personnel in although the Air Force personnel did. After this Army unit experienced numerous chemical "casualties," the wing commander stated that the

Further, the Spangdahlem operational plans officer stated that the decontamination capability for the Air Force on the base is addressed in its operational plan but that the base does not know what the U.S. Army's decontamination capability is, adding that this area has not been addressed in planning.

According to a Rhein-Main security police official, the security police and a German army unit are jointly responsible for defending the

written plan coordinating the
been

He stated that they have a
but that there have
to practice the plan. Because

of political pressure, and the security police are limited to training

SUMMARY

In this chapter, we have presented information to help answer the question, What progress has DOD made in developing doctrine needed to support individual and joint military operations in a chemically contaminated environment? A summary answer for each service is in table 2.1. The Army has concentrated on rewriting

Table 2.1

Army, Navy, and Air Force Doctrinal Progress and Needs for Chemical Warfare Defense

<u>Service</u>	<u>Progress</u>	<u>Needs</u>
Army	All nonmedical doctrine for chemical warfare defense rewritten	
Navy	Two guidance documents on chemical, biological, and radiological defense; needs beginning to be identified	
Air Force	War mobilization plan annex on chemical and biological defense; command guidelines and procedures	

all its nonmedical doctrine since 1982. The Air Force effort has mostly been carried out by commands and bases, which have developed guidelines and procedures for operating in a contaminated environment. The Navy's guidelines on defensive chemical warfare are limited, and the Navy is just beginning to identify its needs.

There are medical protocols and guidance, but many of them are unrealistic, given the lack of medical equipment.

CHAPTER 3

EQUIPMENT IN THE FIELD

The second question we were asked is, What progress has DOD made in developing and procuring the equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment? We address this question in this chapter and in chapter 4 on the research and development of new equipment. Here in chapter 3, we describe for equipment in the field the five areas DOD identified in its 1982 report to the Congress: medical equipment, individual protection, collective protection, detection, and decontamination (1). We also identify some logistics concerns regarding the effective use of equipment in the field.

MEDICAL EQUIPMENT

Medical equipment in the field includes antidotes, pretreatment drugs, and one additional product for the care of casualties.

Drugs

DOD has no antidotes against blood, blister, or choking agents. Atropine was first issued in World War II and is still stockpiled as the antidote for nerve agents. Atropine incapacitates, so that a soldier who injects it in the absence of a contaminant, as in a false alarm or panic, for example, becomes an atropine casualty. It is also ineffective against the nerve agent soman. In the formula the Army and Navy use, atropine is administered by self-injection in combination with 2 PAM-chloride, an oxime added in 1982. The Air Force still stocks a different formulation, TAB, which contains benactazine. Benactazine works against soman but has hallucinogenic side effects.

In June 1984, the Air Force decided to replace its formulation with pyridostigmine pretreatment, to be used in conjunction with atropine and 2 PAM-chloride (to be exchanged one for one). Pyridostigmine, a British drug that works against all nerve agents and is considered a major breakthrough in medical chemical defense, was the first pretreatment drug introduced into the U.S. inventory. The Army decided originally not to buy the off-the-shelf formulation but reversed this decision in August 1985. The Navy is expected to follow the Army. No pretreatments for blood, blister, or choking agents are available.

For biological defense, the Army has stockpiled vaccines against several infectious diseases, including smallpox and anthrax. However, these represent only a small percentage of all possible biological threats. Moreover, the Army has no vaccination policy.

Other casualty care products

U.S. forces have no effective nontoxic skin decontamination materials. A towlette, M258A1, treated with a decontamination solution, is stockpiled, but this item is itself toxic, and it must be used with digital dexterity while wearing nontactile butyl gloves within approximately 1 minute for nerve agents and 2 minutes for blister agents. Chemical and biological casualty care products for diagnosis and treatment in the field are not available.

INDIVIDUAL PROTECTION

Equipment for individual protection in the field consists of masks that allow respiration in a contaminated environment and ensembles of protective clothing that include suits, gloves, and boots.

Masks

For ground personnel, the standard mask in all the services is the Army's M17 series, first procured in the 1960's. Its most recent improvement was in 1982, when a resuscitator was judged unnecessary and removed.

Second, it has no provision for radio and telephone communication. Third,

Both the Air Force and the Navy have begun procuring the MCU-2/P, a mask for the replacement of the M17. The newer mask was developed by the Army but cancelled because its urethane lens is too soft and fogs up too easily to withstand battlefield conditions, although it is reportedly better in comfort, fit, communication, and visibility. It also has an external filter cannister that can be changed while the mask is being worn. However, USAFE officials report that the head harness is less durable than that of the older mask.

The M17 has counterparts in the M24 for aviators and the M25A1 for combat vehicle crews. The M25A1, unique to the Army, is compatible with the ventilated facepiece for collective protection systems in some Army combat vehicles. Army and Navy aviators use the M24, which aviation officials describe as totally inadequate. Its problems include severe heat stress and other discomfort, breathing difficulty, poor visibility, and incompatibility with eyeglasses.

Air Force pilots use a different mask, the MBU-13. The Air Force mask limits a pilot's field of vision. Of greater concern, however, is that the hood restricts head movement, so that an aircrew's 6 o'clock position cannot be covered. Consequently, it must disengage from dogfights unless a friendly aircraft covers this position. Looking down and ejection are also impeded. USAFE officials report that their pilots will not fly with the hood.

For Navy ship personnel, the standard mask is the Mark V. Noted problems with this mask include little protection, poor fit, high resistance to breathing, distorted communication, severe fogging, and incompatibility with eyeglasses.

Protective clothing

The standard suit for Army, Marine, and Air Force ground crews is the "chemical protective overgarment." In 1980,

The new suit, the "battle dress overgarment," has a polyox foam that

The only other difference between the two suits is that the newer one has a camouflage pattern whereas the other is green. The "battle dress overgarment" does not lower heat stress, which is viewed as a significant problem even in moderate climates, and it has no means for eliminating body waste. Both suits are considered inadequate for aviators, because

For shipboard use, the Navy has been replacing its paraffin-impregnated coveralls with the British suit called Mark III since fiscal year 1983. The British suit was rated superior to its competitors with respect to three major Navy requirements: flame retardation, heat resistance, and convenience for vacuum-packed storage. However, it loses its protective qualities when it is wet; therefore, vinyl rainware must be worn over the suit in high wind and rain and when a ship's water washdown system is operating (as it is during decontamination) or the exposed topside areas of the ship are being decontaminated. This creates a considerable heat burden for the wearer.

The Army first put its protective gloves in the field around 1976. Made of 25-mil butyl rubber, they have limited tactility, making them impractical for operations requiring digital dexterity (such as operating a computer). They do not resist petroleum oils and lubricants and are highly flammable, making it necessary for aviators to wear flame-resistant overgloves. The Air Force has recently put 7-mil and 14-mil butyl gloves in the field, and the Army has decided to adopt them for the near term. They reportedly have greater tactility and allow greater dexterity.

The Army and Air Force adapted their overboots from an English design around 1973. They are flammable, nondurable, take 15 minutes to put on, and cannot be laced up at night. They protect long enough to escape after an attack but not long enough to stand and fight, as prescribed by current Army doctrine. In an exercise at Spangdahlem, airmen were ordered to remove the boots because they posed a safety hazard. Another boot, a green vinyl overshoe, was put in the field in 1976 but soldiers are unsatisfied with it. The primary problem is insufficient traction, despite its having been tested for traction during development.

COLLECTIVE PROTECTION

Collective protection against chemical agents is typically accomplished by an overpressure system. Overpressure systems send pressurized, filtered air to crew compartments, permitting crew members to operate in a contaminated environment without wearing protective gear. We discuss collective protection systems in standing shelters, combat vehicles, and ships and aircraft.

Standing shelters

The Army's current shelter is the M51, used principally for medical operations in forward areas. It has several deficiencies: it is time-consuming to set up, it admits only 12 patients an hour, its power supply must always be on, and no vehicle has been dedicated for moving it. USAREUR found the M51 so deficient that it stopped putting it in the field, despite the fact that there are no other overpressure shelters in the Army's inventory.

The Army has pursued a modular chemical protection concept for noncombat vehicles, vans, and shelters to be used in conjunction with weapon systems. It consists of filter units, protective entrances, and installation kits. Shelters for the TACFIRE and AN/TSQ-73 weapon systems have been put in the field. Other systems programmed for the modular system include the Pershing II, the Patriot, and International Organization for Standardization shelters. Their ultimate application depends on testing for compatibility with the specific system.

A

June 1985 review by the vice chief of staff reemphasized that current collective protection systems for fixed sites at the Army's rear area, as well as Air Force fixed installations, are not adequate; it was also decided that a new concept was required for the survivability of fixed locations in nuclear, biological, and chemical warfare (27). The Army does have

The Air Force has about 160 KMU-450 shelter-modification kits that can be installed in a permanent structure to provide a collective protection facility. According to Air Force documents, the kits would provide only a small fraction of the required shelter space. Additionally, according to USAFE officials, it takes a long time to process personnel through them, they lack storage space for equipment that has been taken off, and they are vulnerable because they cannot be installed underground. We reported in 1982 that only a few of the 74 KMU-450 retrofit units sent to Europe in 1979 had been installed by 1981 (6). USAFE officials report that all but 6 have now been installed but no more were sent, because they were viewed as an interim solution only. The Air Force also has 56 NATO semihardened facilities and plans to request 62 more. There are command posts and squadron operations facilities hardened against chemical attack on at least some European bases but neither rest and recuperation or medical shelters (except for those procured for the Spangdahlem test) nor avionics facilities. In fiscal year 1986, the Congress appropriated funds to chemically protect two hardened avionics facilities in Europe. Work in an avionics facility in protective gear is considered impossible because of the fine dexterity that it requires.

Combat vehicles

There are no U.S. combat vehicles with overpressure in the field. Current Army combat vehicles have either a ventilated facepiece system or no collective protection at all. In use since the 1940's, the facepiece system consists of a filter that services up to five masks. It does not protect a vehicle's interior from contamination, so that its crew members must assume a full protective posture, and this leaves them vulnerable to heat stress. Heat stress is a serious concern even in moderate temperatures, because combat vehicles are 15 to 40 degrees hotter than the ambient temperature. Vehicles currently equipped with the facepiece include the M1 and M60 tanks and the Sergeant York gun. Vehicles lacking collective protection include the Bradley fighting vehicles M2 and M3 and the M113 armored personnel carrier.

Ships and aircraft

The response of a ship to chemical assault would be to activate its water washdown system and crash-stop its fans.

DETECTION

In this section, we discuss liquid-agent detectors and vapor- and aerosol-agent detectors.

Liquid-agent detectors

To detect liquid agent, the three services use two kinds of specially treated paper that changes color upon contact with an agent. The M8 paper discriminates between nerve, blood, and blister agents but not between agents within these types. The M9 paper does not discriminate between types but has the advantage of adhering to a soldier's uniform and equipment.

By February 1985, the Navy had installed the chemical warfare directional detector on 40 ships. It is a remote infrared device that detects agents in liquid and vapor form. An Army device converted for the Navy, its primary purpose is to detect and identify the release in air of nerve agents against ships in a task force or against waves of amphibious assault craft proceeding ashore.

All other Navy detectors of both liquid and vapor agents were purchased off the shelf from the national stock.

Vapor- and aerosol-agent detectors

The M8 detector-alarm put in the field by the Army in 1972 detects only nerve agent and is being replaced by the M8A1, which has greater sensitivity and eliminates the need for refill kits. However, it also makes the detector radioactive, so that it is considered hazardous to use it in enclosed spaces. The Navy also uses the M8A1. The Air Force uses its own detector, the A/E23D-3, which causes false alarms frequently, and its batteries last only 6 hours.

The M256 kit, first put in the field in 1980 and now used by the three services, detects all vapor and aerosol threats from chemical agents. It was approved for production in 1977, despite its not meeting the original requirements for the detection of the nerve agent VX. Subsequent field reports indicated that miosis could occur at concentrations of nerve agent below the kit's detection capacity. An additional limitation of the M256 is its slowness: it takes approximately 12 minutes to work. An item the Army has used since 1983 is the M272 water-testing kit, which

DECONTAMINATION

Decontaminants

There are no nonaqueous decontaminants in the U.S. inventory. The Army and Air Force currently have two aqueous decontaminants: decontamination solution 2, or DS2, and "super tropical bleach." The former is used for painted surfaces, the latter for unpainted surfaces. The Navy uses high-test hypochlorite. All three decontaminants are highly corrosive and unsuitable for interior surfaces and electronic components. USAREUR officials report that they "destroy" equipment. USAFE has turned in its decontaminants because of the corrosion problem. Aqueous decontaminants also require large quantities of water, which creates a logistics concern where water is scarce, as in the Middle East. A 1984 Navy program summary stated that the Navy had no effective fleet decontamination system and that no high-rate, efficient decontaminant had been approved for shipboard use (29).

Decontamination apparatus

The Army and Air Force both use the decontamination apparatus M12A1 and M11. The truck-mounted M12A1, which mixes and disperses "super tropical bleach," is the primary apparatus for large areas. It is large, heavy, expensive, extremely intensive in its use of resources, and available in limited quantity. According to USAREUR officials, training an operator to become proficient with it takes about a year. The M11 is a handheld spray dispenser capable of spraying 1-1/3 quarts of DS2 and is used by equipment operators to decontaminate smaller surfaces that must be frequently touched. The Army is putting into the field a third apparatus, the M13, which is used for the same purpose as the M11 but decontaminates greater surface areas.

The Air Force has begun to use a lightweight, compact, and easy-to-operate decontamination system for equipment and personnel called the lightweight decontamination system. It was developed in Norway under the name Sanator and is being produced

by a U.S. licensee. The Army began testing the Sanator in 1978 but has yet to put it in the field (limited production for Europe was approved in July 1985). It is viewed as important for implementing the new doctrinal emphasis on decentralized decontamination.

The Navy's procedure for decontaminating shipboard structures would be to activate a ship's water washdown system. This would release a continuous flow of seawater over the deck, essentially washing away the agent. The effectiveness of the water washdown system decreases as the time taken to activate it increases.

LOGISTICS CONCERNS

Apart from the technical problems, field equipment entails logistics concerns. Primarily from our survey of Europe, we identified four broad areas of concern: the availability of equipment, its storage and access, its condition and maintenance, and resupply.

Availability of equipment

This is consistent with the U.S. European Command's threat assessment, which stated that

The disaster preparedness representatives we talked with on the bases stated that they were trying to obtain more equipment but that funding was a problem. However, two of the three representatives believed that equipment requirements were not

adequate, implying that even full funding would not allow the needed capability.

USAREUR and USAFE are better equipped. The latest USAREUR equipment status reports showed no serious shortages of individual protective equipment. USAREUR officials claimed that 92 percent of their soldiers had 100 percent of the authorized protective gear. There is also a USAREUR program to procure equipment for civilians essential to missions.

However, there is a general shortage of M8 detector-alarms, and there are no M8 alarms at POMCUS, or "prepositioned overseas materiel configured-in-unit sets," sites (overseeing units do not authorize M8 alarms for them). USAREUR will receive the new M8A1 in fiscal year 1986, but officials claim that they will still not have quantities enough to fill all authorizations. Specifically, they emphasized the lack of detection and warning capabilities at such fixed sites as warehouses and hospitals.

USAREUR officials also noted that

According to the USAFE disaster preparedness chief, the Air Force did not purchase this size, and USAFE is short. All the bases we visited had other spot shortages as well. At Rhein-Main, there were shortages of boots, gloves, detector kits, A/E23D3 detectors, and autoinjectors. Spangdahlem had shortages of M12 decontamination equipment and Sanators (data on the number of individual protection ensembles on hand were not available from Spangdahlem). The regional medical center at Wiesbaden, which had recently conducted an inventory and inspection of chemical defense equipment, identified shortages of cotton glove inserts, filter elements, hoods, and M9 chemical agent detector tape.

The Air Force authorizes two operational suits and one mask for individuals. Officials believed that having only two operational suits is a serious shortfall, and a third suit is in the program for fiscal year 1986. Disaster preparedness officials at Spangdahlem also believed having only one mask per person is a concern.

To meet its first war mobilization plan objective, the Air Force established in 1977 the "constant shelter" program, in which available chemical defense equipment was to be put into the field quickly under the direction of the air staff rather than through the normal base supply system. Reportedly, this has considerably complicated the ability to track the flow of equipment, because the supply of equipment is managed by individual units. Chemical defense equipment for USAFE has been centrally managed since 1984, and the disaster preparedness chief reported better accountability as a result. At Rhein-Main, which is under the Military Airlift Command rather than USAFE, supply is handled by individual units; consequently, the base has 58 separate accounts for protective equipment for individuals. The Air Force is planning to phase out the "constant shelter" by fiscal year 1987 and to put replacement items under standard base supply. New items will still be controlled by air staff.

The one ship we visited had sufficient equipment to outfit its crew of 243 plus a 14-person air detachment, according to the damage control officer. It also had the medical supplies it required.

Storage and access

USAREUR soldiers at the locations we visited normally had ready access to a training suit and one contingency set, the other contingency set having been stored in the nuclear, biological, and chemical warfare supply room or some other central location. There are exceptions, however. Lack of storage space is a major problem at most USAREUR hospitals; consequently, protective ensembles are stored in locations that are not readily accessible to hospital personnel. Additionally, not all hospitals have procedures for issuing the equipment. At one hospital we visited, the operational suits were still in their bulk cartons (there were plans to break them open within the next few months) in a room that was up four flights of steps and expected to serve 370 personnel. Officials believed there would be at least a 6-hour warning of a chemical attack, which they believed would give them enough time.

Storage was also cited as a problem at European Command headquarters. The support personnel there (for example, military police) have ready access, but chemical gear for the command staff is centrally stored by its support activity. Officials believed it would take 3 to 4 hours to get everyone suited up, and they expressed concern about getting off a contaminated base.

USAFE has a requirement that one operational (that is, nontraining) ensemble be stored within 5 minutes of a person's workstation. The second operational ensemble is usually bulk stored according to each unit's requirement. Several methods (typically, names or numbers) are used to mark each ensemble for

identification. The Air Force lacks centralized storage in Europe, but the effect of this is felt mainly in resupply (discussed below).

Equipment at the Navy bases in Europe had not been allocated or distributed, reportedly because of the limited amount of equipment available. It was stored in warehouses, trailers, shacks, and the like. The Mark III suits recently received at Sigonella were delivered in containers marked "keep away from heat and direct sunlight" but had been stored in an outdoor aluminum shack with no temperature regulation. On the ship, equipment had been allocated and individually marked for the decontamination teams, according to the damage control officer. Equipment for the rest of the crew had not been sorted and packaged individually, except that each crew member had been given an M17 mask to keep at the watch station. Written plans for gaining access to equipment did not exist, although damage control personnel at the bases and on the ship had conceptual plans for distributing equipment to military personnel. Civilians were not included in any allocation or distribution plan.

Condition and maintenance

Much of the individual protection equipment in Europe was produced prior to 1980. There are ensembles at all USAREUR locations dating back to 1977-78 and at Air Force bases dating back to 1976. Obviously, units that have received the "battle dress overgarment have newer equipment, but USAREUR has extended the shelf life of the old ensembles. For the most part, the Navy bases had received their equipment more recently, although it was not all new when it was received, some of it dating back to 1962. Navy officials generally did not know the age of the equipment.

USAREUR officials said that equipment is inspected at least quarterly and that defective equipment is either turned in at the property disposal office or converted into training suits. Officials of the 7th Medical Command, however, did not believe that equipment was being maintained in its units and could not guarantee that it was operational. USAREUR officials in general have found no major impediments to keeping chemical defense equipment operational, although 21st Support Command officials cited a problem with maintenance and parts for the M12A1.

For USAFE, masks are to be inspected every 6 months, and other ensemble components are to be inspected annually. Spangdahlem supply officials stated that they inspect the ensembles when they are issued and received by examining the bag that they are in and checking it for tears.

At Navy bases, inspections are performed infrequently (usually during inventories) and are limited. The naval station

representative at Rota stated that that base's equipment had not been inspected in at least 2 years; moreover, representatives at all three bases said they lacked the expertise to inspect the equipment thoroughly. Things were somewhat better aboard the ship, where equipment is reportedly inspected semiannually. Additionally, masks are inspected during training drills. We have no firsthand knowledge of conditions on other ships, however.

Resupply

USAREUR officials said that their limited ability to resupply required amounts of chemical defense equipment was an impediment to sustaining combat operations in a contaminated environment. Even without an attack, the two operational suits per soldier retain their required protective capability for only 14 days each. Defensive equipment stocks are sufficient to resupply forward forces for 6 to 10 days, depending on the intensity of the chemical weapons in use. However, USAREUR officials pointed out that transportation resources are limited and that commanders might have to choose between chemical defense equipment and ammunition. EUCOM officials believed this problem might be solved by preparation if war reserve chemical defense equipment were positioned in advance in the forward corps area.

USAFE has a potential logistics problem with resupply, according to the disaster preparedness chief. Although the new collective protection system can be resupplied in a chemical environment, the chief did not believe that the Military Airlift Command would fly transports into contaminated bases. An additional problem is the shortage of centralized storage for USAFE. According to a disaster preparedness official, Air Force depots are located in the United States, which could mean a delay in resupply.

SUMMARY

In this chapter, we have provided information on equipment presently in the field for use in defense against a chemical attack. This information addresses, in part, our second question: What progress has DOD made in developing and procuring equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?

We found that not much progress has been made in getting equipment into the field. The services have some equipment in the five equipment areas DOD identified in the 1982 report to the Congress: medical equipment, individual protection, collective protection, detection, and decontamination (1). However, most of it was in place before 1982, in some cases decades earlier.

Several logistics concerns further exacerbate the situation.

The status of equipment in the field is summarized below. In general,

1. Medical equipment. The services are beginning to put pyridostigmine in the field, but their nerve agent antidote (atropine) is of limited effectiveness. They have no pretreatments or antidotes for nonnerve agents, and their skin decontamination kit is toxic and difficult to use.

2. Individual protection. Current equipment, in most cases, would enable individuals to survive an initial attack, but all items in the field have a variety of limitations that would degrade individual and collective operations in a chemically contaminated environment.

3. Collective protection. The Air Force has squadron operations facilities and command posts hardened against chemical attack but no hardened rest and recuperation or avionics facilities for sustaining operations. U.S. military hospitals, Navy bases, Army fixed installations, and combat vehicles, ships, and aircraft have no collective protection.

4. Detection. Taken together, various specially treated paper, kits, and devices will detect all known chemical agents, but the equipment is limited in speed, sensitivity, reliability, or other problems in logistics. U.S. forces have no capability for continuous monitoring, detection of aircraft or vehicle contamination, or the detection of biological agents and toxins.

5. Decontamination. Exterior surfaces can be decontaminated, but interior surfaces and electronic components cannot. Available decontaminants are highly corrosive and their use depends on a nearby water supply. U.S. forces have no capability for hot-air or other nonaqueous decontamination in the field.

Finally, we summarize the four areas of logistics concern that we discussed in this chapter.

1. Availability of equipment. The Army and Air Force in Europe have most of the equipment for individual protection that they are authorized to have, but the

There are varying degrees of shortages of most of the other types of chemical defense equipment, and some of the shortages are significant.

2. Storage and access. Front-line soldiers and air base personnel generally have ready access to their protective ensembles, but personnel at hospitals and some other fixed sites

do not. Equipment at Navy bases has not been allocated or distributed, and some of it has been stored in conditions that could degrade it.

3. Condition and maintenance. Much of the U.S. equipment was produced before 1980. Some of it is inspected regularly, with the exception of equipment at the Navy shore establishment.

4. Resupply. Both the Army and Air Force have potentially significant resupply problems that could degrade their ability to sustain operations in a chemical war.

CHAPTER 4

RESEARCH AND DEVELOPMENT

In this chapter, we describe the organization of the U.S. chemical defense research and development effort and the status of specific, ongoing programs. We cite some concerns that have been raised, and finally we describe some recent initiatives that DOD and the services have taken to improve the process of research and development.

ORGANIZATION

It is stated in the 1982 report to the Congress that the Army is DOD's executive agent and lead service for chemical warfare and research and development in chemical defense. However, the other services perform research and development for their unique requirements. The 1982 report specified that the Air Force would concentrate on improved shelters and detection systems for air bases and on special protective clothing for the air and ground personnel who cannot afford a significant loss of visual acuity and manual dexterity. The Navy would concentrate on the development of amphibious requirements, with an emphasis on collective protection systems, decontamination systems, decontaminants, automatic detection, and medical evacuation and treatment.

More recent initiatives such as the new Joint Services Agreement (discussed in a later section of this chapter) have modified interservice coordination guidelines and procedures, but the basic organizational structure, with the Army taking the lead and the Air Force and Navy pursuing unique requirements, has not changed.

PROGRAMS

In describing the research and development programs, we use the categories we used in describing field equipment: medical equipment, individual protection, collective protection, detection, and decontamination.

Medical equipment

The items in the medical program include antidotes, pretreatment drugs, and products for the decontamination of patients and the care of casualties.

Drugs

Despite the recent decision to buy pyridostigmine off the shelf, the Army is continuing a reformulation program for pyridostigmine because of two concerns: the dosage is higher than necessary, and may decrease a soldier's performance, and

soldiers must comply with taking three doses a day. The reformulation has a projected initial operating capability date of fiscal year 1987.

Blister and other antidotes, blood pretreatments, and second-generation nerve pretreatments are scheduled for initial use in the late 1980's and 1990's. The Navy is doing a portion of the early research work on them. The Army, Navy, and Air Force are studying the ways drugs diminish military performance. In biological defense, the Army is continuing its current development program of vaccines, antiserums, and a rapid diagnosis system, with a projected initial operating capability date in fiscal year 1988 or 1989. The program is being expanded to include immunomodulators, microencapsulation for the sustained release of antiviral drugs, and a generic rather than vaccine-specific approach to drug therapy.

Decontamination of patients and casualty care

The three services are doing research and development in the decontamination of patients and casualty care. Selected products in development for the late 1980's and 1990's are decontamination barrier-creams for blister agents, protective wraps, agent-resistant field dressings, detection and decontamination systems for casualties and other personnel, agent dosimeters, and oxygen systems. Each service is also developing heart-rate and vital-sign monitors that will be tested in a "flyoff," with a production decision scheduled for fiscal year 1989. Decontamination and casualty care products for biological defense are not under development.

According to officials in research and development, there are limits to what can be provided for medical use. Specifically, they believe that it is highly unrealistic to expect, even in the far term, systemic or topical prophylactics to prevent agent effects for all chemical agents and simulants or instrumentation for monitoring physiological processes other than basic vital signs. These objectives were specified in DOD's Joint Development Objectives Guide, a 1982 Army document reflecting equipment requirements identified by each service (30).

Individual protection

Masks

After cancelling the XM30 mask, the Army developed the XM40, which has the positive qualities of the XM30 plus the hard lens of the current M17. Its improvements include a periphery turned inward to protect against leakage, a side transmitter for telephonic communications, a provision for a microphone for eventual radio communication, and a screw-on filter cannister that can be changed in seconds. The XM40 will not lower heat buildup

or breathing resistance, unlike the M17; it will not protect against high concentrations of carbon monoxide or unknown agents that penetrate the charcoal, and it is not compatible with devices for ventilation or the resuscitation of patients. For the far term, the Army is looking at alternatives to charcoal filters, including reactive materials and closed-circuit (that is, oxygen-generating) systems.

The projected initial operating capability date for the XM40 is August 1986, but it will first be tested in competition against the British S-10. The XM41 and XM42 are the counterparts of the XM40 for aviators and combat vehicle crews, respectively. A special version, the XM43, will be required for AH64 helicopter crews. The Navy is monitoring the development of the XM40 and will test it in fiscal year 1988.

For use in the nearer term, the Navy is evaluating the MCU-2/P for shipboard use and shore support. It is better in field of vision, breathing resistance, face seal, voice communication, and comfort than the Mark V. Because of the carbon monoxide problem, however, it could not be used in a shipboard fire. The initial operating capability of the MCU-2/P for shipboard use is in fiscal year 1986.

The Air Force cancelled its program to develop an improved mask, or eye and respirator system, for fighter aircraft crews after 7 years of effort, primarily because of incompatibility with ejection seats. The Air Force will continue to buy the existing protection system and, in the meantime, plans to contract for an evaluation of all possible solutions. A quick solution might be the acquisition of a British system designated the AR-5. The Navy has already decided to adopt the AR-5 for Navy and Marine Corps helicopter aircrews. The attributes of the AR-5 include clear visibility and night vision, a portable blower that makes breathing feel natural, provisions for drinking, and a 4-hour capability with the filter blower pack. Approval for production is expected in fiscal year 1986; June 1986 is the initial operating capability date for USAFE. Whatever the solution, aircrew eye and respiratory protection remains the first priority of the Air Force in chemical defense. Its ongoing efforts also include a multipurpose mask for aircrews in nonfighter aircraft.

Protective clothing

The Army's first follow-on to the "battle dress overgarment" for ground crews will be Overgarment 84, or OG84, which the Air Force and Marines will also buy. The OG84 uses the same materials as the "battle dress overgarment," but it has functional improvements such as side-opening pockets compatible with life-support microcooling equipment planned for the future and a gusseted leg-slit to prevent contamination when pulling the suit on over boots.

Because of major problems with the Army's current suit, the Marine Corps has developed a suit to meet its unique requirements in an amphibious environment. A composite of several different suits, it has a nuclear-flash-resistant liner and is designed to self-extinguish in 2 seconds. Unlike the "battle dress overgarment," and the OG84, the Marine Corps suit can be laundered, offers longer protection of up to 24 hours, is more durable for up to 30 days, has a longer shelf life of 5 to 10 years, and is cooler. It has not met the requirements for weight, however, and it has not been tested against the Army's specifications. It is also more expensive than the Army suits.

The development of the Marine Corps suit entails a dilemma: a suit unique to the Marines is contrary to the goal of standardizing the U.S. chemical defense inventory. However, the Marine Corps did not want to wait until the Army's first follow-on to the OG84 in fiscal year 1989. In August 1985, the Marine Corps agreed to buy the Army's OG84 instead of its own suit, provided the Army accelerates the initial operating capability date of the follow-on to fiscal year 1986 or 1987, makes it flame-retardant, and improves its resistance to heat and wetness. The Army has agreed to these requirements and to make the suit more protective, more durable, and launderable.

The Air Force has developed an impermeable chemical defensive protective ensemble for extended wear by ground crews. It provides protection against vapor and liquid agents and includes a liquid-cooled garment, a cooling station, and a decontamination shower. According to an Air Force official we spoke to, it was developed without an adequate concept of operation, but a use for it is being looked for. At a June 1985 review, it was decided that its development should continue and that the Tactical Air Command would develop an operational concept for it (26).

All the services have been developing flight-crew suits, but the Army has assumed the long-term lead. The Air Force maintains the lead in the development of fixed-wing interim fabrics and suits. Specifically, the Air Force is developing a fabric system that provides primarily fire and chemical agent protection, while the Army is developing a flame-resistant suit compatible with a microcooling system. The Army's requirement is to put this suit in the field by the fourth quarter of fiscal year 1986.

The Army also has the long-term lead for gloves and boots. The next generation of gloves will be made of either 7- or 14-mil butyl rubber and will be coated to resist petroleum oils, lubricants, and, to a lesser extent, flame. The projected initial operating capability is the fourth quarter of fiscal year 1988, but it is possible that an interim purchase will be made. The new glove will not have enough flame resistance to permit

aviators to wear it without a nomex overglove. The new glove will have an additional problem in cold weather: an environmental glove worn over it will cause perspiration to build up and freeze the hands.

The Army is still undecided on the next boot. A pair of Canadian boots and a German pair are under evaluation. Both reportedly have problems, but one of these boots or some other, U.S. boot is supposed to be put in the field as an interim issue by late 1986. The Army has not identified the specific materials it requires for a follow-on to the interim boot but hopes for a prototype within a year. It is also trying to reduce the number of sizes. The Air Force is evaluating a French stocking made of blucher material that could be worn inside standard combat boots.

For the longer term, Army developers are looking at microcooling devices to solve the heat-stress problem caused by protective clothing. They are hoping for a prototype design by fiscal year 1987, but units portable by individuals will not be feasible until the 1990's nor will materials with an integral agent-neutralization capability. Finally, the capability for taking food and for removing body waste in a chemically contaminated environment is still several years off.

Collective protection

Standing shelters

The Air Force began its collective-protection research and development efforts by testing the survivable collective protection system called SCPS-1. Originally designated AMF-80 and of French origin, the SCPS-1 provides a clean environment for up to 30 persons in a shelter made of pipes 6 feet in diameter that are connected together. The Congress did not fund the SCPS-1 because of its cost and because it cannot be relocated. In the view of the USAFE disaster preparedness chief, it had been "gold-plated"--that is, configured with costly additions of questionable necessity.

Paralleling the SCPS-1, the SCPS-2 has been developed by the Air Force aeronautical systems division. It is constructed of 12-foot-wide rectangular pipes and provides long-term rest and recuperation facilities for about 84 persons at a time, or 168 on a "12-hours-on 12-hours-off" duty cycle. Six demonstration units of the SCPS-2 were constructed by Systems Research Laboratories and used during the SALTY DEMO air base survivability exercise in March 1985. The plan is to issue the SCPS-2 to central-region main operating bases first and then to 3rd Air Force main operating bases in Great Britain, 16th Air Force main operating bases in Spain, and "colocated" bases, in that order.

The SCPS-2 will be funded as equipment rather than construction, which implies that it is self-contained. Although it does not require all the external connections of the SCPS-1, the SCPS-2 will require waste management and the resupply of food, water, and fuel, which can create logistics problems for local commanders. Officials at Spangdahlem, the one air base where the system has been installed, estimate that its maintenance costs are \$60,000 per unit. These funds would have to come from the base commander's funds for operations and maintenance, and the Spangdahlem base commander admitted that this could strain these funds.

The SCPS-2 can store days of food but days of water, and there are no procedures for resupplying water. This problem did not surface at SALTY DEMO because a chemically contaminated environment never persisted for more than . In addition, the standard duty schedule of 12 hours on and 12 hours off will have to be modified, because the SCPS-2 is not built to handle the flow of ingress and egress resulting from this rotation. The test officials reported that the need for staggered shifts may have emerged as a "lesson learned" from the exercise, but other observers have reported that a constant flow of personnel makes it very difficult to sleep in the shelter. Finally, the management of the SCPS-2 requires 10 persons per unit, personnel who may not be available. The Spangdahlem wing commander reported the necessity of taking people from other mission-critical positions, including the flight line, as the list of available management personnel becomes exhausted, a decision that would obviously be difficult to make.

The Navy has monitored the development of the SCPS-2 and plans to procure eight shelters per year beginning in fiscal year 1987. However, neither the specific equipment needs of overseas bases nor the response of the host countries to outfitting bases with the system is fully known. To address these issues, the Navy is conducting a \$1.7 million survey of eight overseas shore installations and asking the fleet commanders to ensure that the approval of the host nations is obtained.

The Army's system in development, the XM20, uses inflatable liners to convert an interior room of an existing building into an overpressured shelter. Its expected uses are for rest and relief stations and command and control centers. The Army has projected April 1987 as the first-unit-equipped date for the XM20. The other services are also interested in the XM20. The Navy is planning to procure the XM20 for its beach groups and construction forces but is also developing a shelter that has a 50-person capacity and can be erected rapidly.

For medical operations, the Army is developing a system of protected enclosures up to the corps hospital level. It includes

a battalion aid station that would replace the M51; its improvements are that the floor space has been doubled, it can handle 40 patients an hour, and it has a vehicle dedicated to moving it. The system's projected initial operating capability date is fiscal year 1993. The Air Force is adapting the SCPS-2 to provide on-base second-echelon medical care, having tested a prototype at SALTY DEMO.

Combat vehicles

The Army's first overpressured combat vehicle, the M1A1 tank, is scheduled to enter the field in August 1986. Its design includes a hybrid collective protection system (overpressure plus ventilated facepiece), and it incorporates a microcooling system that takes air from the M1's turbine engine. Without microcooling, the crew would be vulnerable to heat stress. Other vehicles are scheduled for the addition of hybrid systems in the future. The Sergeant York gun was scheduled for fiscal year 1987, but it was cancelled by the secretary of Defense. The Bradley M2 and M3 are scheduled for fiscal year 1990 but will require an additional funding decision.

Regenerable filters for collective protection systems are still several years off; the program has recently moved into advanced development. Until regenerable filters are available, the need for replacement filters will pose a significant logistics problem. Blood agents and others shorten the life of filters very rapidly, and vehicle commanders have to change filters after each exposure. The lack of onboard storage space means that spare filters have to be resupplied from the outside. In addition, the maintenance of combat-vehicle collective-protection systems, including their filters, requires specialized personnel other than the crew.

Ships

A prototype collective protection system has been installed and tested on two zones of an amphibious assault ship. The filter and other parts of the system operate full-time, enabling a ship to function continuously for _____ in a chemically contaminated environment. On the average, _____ can be processed through the decontamination station. This is deemed adequate for frigates, cruisers, and destroyers but marginal for amphibious ships. The development of the prototype was more expensive than anticipated, because initially the components did not work together.

Collective protection is being programmed into the design of new ships, and the first two ships with collective protection built into them will be afloat by 1989.

Backfit measures for existing ships have not been decided upon. Several efforts to find a solution are under way.

Aircraft

There are to retrofit aircraft with collective protection. According to aviation officials, aircraft have severe space, weight, and power limitations that combat vehicles do not. Collective protection for helicopters would require a pressurized cockpit, and no helicopter cockpits are currently pressurized. A future helicopter, the LHX, may have collective protection if the chemical defense developers can produce the technology. In the meantime, it is considered both easier and cheaper to develop individual lightweight suits with microcooling.

Detection

Research and development in detection and warning systems covers the detection of liquid, vapor, and aerosol agents and reconnaissance.

Liquid-agent detection

The Army and Air Force have developed an automatic liquid-agent detector, but recently the two programs were merged, and the Air Force will use the Army's version. The detector-alarm system, the XM85/XM86, will detect thickened nerve and blister agents but not blood agents. A central alarm unit continuously monitors a network of individual detector units and automatically warns of on-target liquid-agent attacks. The projected first-unit-equipped date is in November 1989.

Vapor- and aerosol-agent detection

The British chemical agent monitor has been under evaluation since early in 1982. It is portable by individuals and detects and intermittently monitors nerve and blister agents. If the Army decides to buy it, the initial operating capability date, under limited production, will be March 1987. The Army and Air Force have developed their own versions, but the Air Force and the Navy are also interested in the British system. The Army's automatic chemical agent detector-alarm, the XM22, would replace the M8A1, uses British technology, and adds a surface sampling probe to detect agents on the ground. Its projected first-unit-equipped date is February 1989. The Air Force's surface contamination monitor would replace the A/E23-D3. There was to have been a competition between the two detectors at SALTY DEMO, but observers reported that no competitive demonstration took place.

The Army's first remote detector will be the XM21, which will scan the horizon and detect clouds of chemical agents from changes in infrared energy. The XM21 detects nerve agent only. Because the XM21 works by line of sight, the Army will still use the XM22 where the line of sight is blocked. The last published initial operating capability date for the XM21 was March 1990, but the Army recently changed the concept from company to fixed sight,

requiring the rescheduling of all milestones. In addition, the Marine Corps has a program to develop a mobile automatic remote detector that can detect several agents simultaneously.

Two Army detector kits, the M256 and M272, are in the field but scheduled for improvements. Their sensitivity will be increased and the ability to detect T2 toxin will be added. The Army is also developing an integrated detector-alarm for vehicles, vans, and shelters that will automatically initiate and shut down the host system's collective protection system; its projected initial operating capability date is fiscal year 1990. Another system is under exploratory development for aircraft. The Navy is conducting developmental work on additional detection systems: a stand-alone automatic scanning-alarm system for the long-range detection of chemical agents (projected initial operating capability in 1990) and a chemical agent point detector adapted from the Air Force for shipboard installation (projected initial operating capability in 1987).

Reconnaissance

The Army is developing a ground reconnaissance system (with a projected initial operating capability in fiscal year 1991) that will have point detectors, automated sampling, collection and storage, and contamination marking. For the nearer term, the Army and Air Force are both evaluating the German Fuchs reconnaissance vehicle. USAREUR and USAFE officials are impressed with it, but Army materiel officials expressed concern that it will easily stand out from U.S. vehicles and be quickly targeted. There is no adaptability to remotely piloted reconnaissance devices and vehicles planned for the foreseeable future.

Decontamination

Decontaminants

The Army will replace "super tropical bleach" (pending successful completion of testing) with the German emulsion C8, which is expected to cut the logistics burden approximately in half. Beyond the C8, it is not clear what will be used. The C8 will still require mixing, perpetuating the logistics concern about water. No recyclable decontamination solutions will be available in the foreseeable future. The Marines, however, are conducting a program to develop sand, dust, and dirt as ambient decontaminants.

The Army has long had a requirement for a universal decontaminant, a policy that some research and development contractors believe has impeded progress. In addition, the decontamination program has been in flux because of doctrinal movement away from 100-percent decontamination. An effort to

create a master plan for the mid and far terms is under way. Hot air will be used in the near term, pending approval. Later possibilities include strippable coatings, freon, corona discharge, and others.

The Air Force is interested in freon for decontaminating avionics facilities, which water and hot air both destroy. USAFE officials are particularly interested in expediting the freon program. They will soon be constructing new underground avionics facilities designed to survive a direct hit, and they claim that retrofitting the freon system will be five times as expensive as installing it during construction,

However, the Army has the lead on the freon system and has informed the Air Force that the earliest production will be in fiscal year 1990. Consequently, the Air Force is investigating how to accelerate the program to meet USAFE needs. USAFE officials claim that the technology is already proven and may take the matter to a general officer review board if the Army does not accelerate the schedule.

Decontamination apparatus

As we noted in chapter 3, the Air Force is putting its version of the Norwegian Sanator in the field, but the Army has yet to do so with its version. According to USAREUR officials, the delay is caused by concerns over spare parts for the system. Only half the spare parts are available now, and the remaining spare parts will not be available until fiscal year 1987. USAREUR would like to put it in the field, as initially scheduled, with available parts and a special support kit developed by the Army Materiel Command, which wants to delay until all parts are available.

The Army's replacement for the M12A1 is the skid-mounted XM18, which will be used primarily to decontaminate support personnel, equipment, and terrain (the projected first-unit-equipped date is June 1989). The Army's first hot-air decontamination device, the XM15, will be used to decontaminate interior surfaces (the projected first-unit-equipped date is September 1989). Another hot-air device, the XM16, was cancelled after completing advanced development. Some Army Materiel Command officials thought that the device had too detectable a signature, but a representative of the Chemical Research and Development Center said that it would have been no more detectable than the tanks it decontaminates. The Army has two additional nonaqueous systems in development for the 1990's.

Because the Navy has no large-scale way of dispensing high-test hypochlorite, it is looking at alternative delivery mechanisms, including the washdown system, fire hoses, and a fire truck, anticipating initial operating capability in 1989.

CONCERNS

The recent history of U.S. chemical defense acquisition is marked by numerous delays and cancellations, and relatively few items have been put into the field since the 1982 report to the Congress. Consequently, our principal concern is the productivity of DOD's chemical defense research and development establishment. Two related concerns are discussed separately: industry's response and the procurement of technology from U.S. allies.

Productivity

As we noted previously, the Army is the lead service for most of DOD's chemical defense research and development, but a June 1985 review by the Vice Chief of Staff concluded that the Army had yet to bring more capable technology and systems to the field. The vice chief expressed concern that too much research and development was "level of effort" and indicated the need for more evidence of commitment to "deliver X by Y date" (27).

We frequently heard other criticisms from DOD personnel in the United States and Europe, NATO ministry of defense officials, and contractors about the length of the acquisition cycle for chemical defense equipment. The Army was the object of most of but not all these criticisms. Interestingly, the Air Force was criticized by officials and contractors for the opposite problem: pushing items through before securing the technical base to back them up.

Slipped milestones

We tracked the status of specific Army projects funded through the Chemical Research and Development Center after 1982 and agree with the Vice Chief of Staff that "delivering X by Y date" has frequently been a problem. Table 4.1 on pages 51-52 shows the results of our analysis of the change in initial operating capability dates between January 1982 and August 1985 and the reasons that were given for schedule changes for chemical and biological defense projects. The scope of the selected project task fact sheets of the Chemical Research and Development Center, our data source, does not cover protective suits or medical items, which are funded through the Natick and medical research and development commands (31). Note that not all the factors causing delays were under the control of the Army or its contractors. For example, two programs (the XM19/XM2 and XM21) were delayed in part by congressional budget actions.

As far as we could learn, the Air Force has put very few chemical defense items into the field from its research and development projects. Air Force research and development and acquisition activities are guided by the goals set in annex J of War Mobilization Plan (24). The Air Force reports having

Table 4.1

The Projected Initial Operating Capability Dates of 17 U.S. Chemical and Biological Defense Projects in January 1982 and August 1985^a

<u>Project</u>	<u>Jan. 1982 projection</u>	<u>Aug. 1985 projection</u>	<u>Stated reasons for schedule changes</u>
XM13 Portable Decontamination Apparatus	July 1983 ^b	June 1985 completed	Required operating capability date changed; operational testing delayed; system-reliability requirements unmet because of pump failure; FORSCOM did not concur with field plan; contractors requested delay for tooling; contractor delinquent
XM14 (XM18) Truck-Mounted Decontamination Apparatus	Jan. 1987 ^c	June 1989 ^c	Restarted as XM18 because of modifications; initial lead time inadequate for tooling; difficulty making detailed design final; contractor difficulty preparing technical manuals; developmental testing start dates slipped; Army deleted FY 1987 procurement
XM15 Interior Decontamination Apparatus	May 1987	May 1989 ^d	Operational testing and required operating capability approval delayed; schedule accelerated by Army directive; 4-month slip because of unavailable production funds; developmental testing chamber down for at least 1 year
XM16 Jet Exhaust Decontamination Apparatus	Jan. 1987		Required operating capability approval date slipped; contract award delayed; TRADOC cost analysis negative; FY 1984 funds withdrawn; Army Materiel Command terminated program March 1985
XM19/XM2 Biological Detection and Warning System	Sept. 1985		Developmental testing late; Joint Appropriation Committee deleted FY 1983 procurement funds; DARCOM terminated program May 1983
XM20 Simplified Collective Protection Equipment	Nov. 1984	July 1986 ^d	Operational testing slipped because FORSCOM troop support delayed by out-of-cycle request and hardware shipment delayed; problems developing detailed test plan; lack of basis-of-issue plan caused milestones to slip
XM21 Remote Sensing Alarm	Feb. 1988	Not scheduled	Contractors stopped and in-house staff reduced because Congress cut FY 1983 budget; funds for in-house teams and contractor exhausted before congressional reprogramming obtained; developmental testing report delayed; program redirected from unit defense to fixed site concept with milestones to be rescheduled
XM22 Automatic Chemical Agent Detector-Alarm	Mar. 1992	Dec. 1988 ^d	Development program restructured and accelerated; no phase II developmental or operational testing; change from full-transition to limited-production purchase; technical problem required regeneration of signature data to develop algorithms
XM30 (XM40) Mask	Dec. 1982	Aug. 1986	Vice chief of staff directed termination; flexible lens material unacceptable; restart as XM40 combined positive features of XM30 with M17 durable lens; TRADOC review of joint requirement slipped

(Table 4.1 continued)

<u>Project</u>	<u>Jan. 1982 projection</u>	<u>Aug. 1985 projection</u>	<u>Stated reasons for schedule changes</u>
XM82 (XM85/MX86) Automatic Liquid Agent Detector	Sept. 1989	Mar. 1992 ^d	Design converted from 1-way to 2-way communication between central and peripheral units and restarted as XM85/XM86; developmental and operational testing and required operating capability approval dates slipped; updated to include a stand-alone telemetry unit that interfaces with other detectors; discussed and established joint program with Air Force
XM207 Chemical Attack Warning and Transmission System	Feb. 1985		TRADOC terminated May 1983
M256 Detector Kit Product Improvement	Oct. 1983 ^b	June 1986	In-process review rescheduled to allow preparation time; documentation completion date changed to allow VX testing; test results showed that color-development time was 3 times standard kit; schedule changed to include procurement of new test hardware, retest activities, and coordination; test program start date suspended until receipt of additional funds; milestones rescheduled because of reliability requirements for color development at cold temperatures
XM272 Water Testing Kit	Feb. 1986 ^b	May 1984 completed	Expanded and highly successful 6.3 phase prompted acceleration into production, saving 2-1/3 years; contractor delay caused by problem in stability of eel enzyme ticket
Chemical Agent Monitor	Aug. 1989	Mar. 1987	British IME obtained 1982; change from full-transition to limited-production purchase; late deliveries delayed draft independent evaluation review
Modular Collective Protection Equipment for AN/TSQ-73	July 1982	June 1982 completed	
Modular Collective Protection Equipment for TACFIRE	Aug. 1982	June 1982 completed	
Sanator Decontamination Apparatus	Not scheduled	April 1986	Norwegian IME obtained 1978; 6.4 delayed because of unapproved required operating capability and acquisition plan; production testing phase II suspended to resolve failures; delays because spare and repair parts lacked national stock numbers

^aTable is restricted to new operational chemical and biological defense equipment. Training devices, testing equipment, new contracts on existing equipment, technical escort equipment, weapons, and smoke equipment are omitted. The combat vehicle collective protection program is omitted because its schedule depends on applicable vehicles.

^bProjected initial operating capability date not stated; alternative milestone for placement in the field substituted.

^cLimited production.

^dProjected initial operating capability date not available; most recently available projected initial operating capability used.

achieved its initial goal of sustaining operations for at a -percent level of degradation through the acquisition of off-the-shelf equipment and, therefore, requiring nothing new from research and development. (The urgency of the need to achieve its first goal in defensive chemical warfare capabilities caused the Air Force to "back into" its normal research and development process.) The second goal, at -percent degradation, was to be met in 1985 by the acquisition of collective protection shelters. This goal was not met, because SCPS-2, the collective protection shelter that was decided on, was not ready.

An eye and respiratory protection system for air crews was cancelled after 7 years in development upon the discovery that it was incompatible with ejection systems. Consequently, the Air Force has no acceptable capability in this area, although it still is its first priority, according to the most recent chemical defense review, and the Air Force is likely to have to procure a system from a NATO ally. For additional evidence of failure to move items through the pipeline, one Air Force official cited a body-cooling device that was sent back to advanced research. Some believe that progress has been hindered by the lack of a systematic approach, citing the impermeable chemical defense protective ensemble, for which there is still no operational concept.

Navy milestones have also slipped. DOD's 1982 report to the Congress articulated several of the Navy's short-term equipment objectives. The report stated that, beginning in fiscal year 1982, the Navy would procure individual protection items for its forces afloat. An individual protective garment, the British Mark III suit, was distributed to amphibious forces in fiscal year 1983. The report also stated that the Navy was to procure atropine, an item that was in short supply, in fiscal year 1982, but the first centralized order for atropine was made in fiscal year 1984; officials stated that earlier purchases had been made from ship operating funds. A two-zone prototype chemical protection system was installed in an amphibious assault ship as planned, but the plan to install it in other ships beginning in 1984 was not carried out. It was also stated in the DOD report that the long-range chemical warfare directional detector would be installed in fleet units in 1982 but it was not procured until 1984. Similarly, the report stated that the Navy planned to put a modified ionization point detector in the field in fiscal year 1983, but it has not yet been issued.

Apparent lack of urgency

DOD officials and contractors believe the Army lacks a sense of urgency, partly because of the process required for research and development contracts. One contractor said that it took a year to get a \$25,000 project funded, citing bureaucratic

constraints. Another described working with the Chemical Research and Development Center as a "nightmare," because it lets things drag on and does not make decisions. Another complained about having to respond to requests for proposals for every new, short-term contract, each one requiring the redistribution and retraining of staff, which contractors believe hurts quality and efficiency. Army contract officials acknowledged that the Army has many regulations that slow down research and development, particularly in comparison to the Air Force, and that awarding small contracts competitively is not cost effective. However, they defended the practice of refusing to make sole-source contracts unless a truly unique capability is identified.

The perceived lack of urgency extends to testing and field placement as well. According to a Navy materiel official, the recent conflict over a protective suit specially designed for the Marine Corps was brought on largely by the Army's unresponsiveness. The Marines wanted the Army to test the suit but were told that this would not be done before 1988. The Army agreed to accelerate the testing schedule only when the Marines indicated that they might pursue the development of the suit independently. Ultimately, they reached the compromise that we described above.

In another case, the USAFE disaster preparedness chief described the Army's decision to withhold freon from the field until 1990 as "ridiculous," citing that it is already a proven product in civilian applications. As we noted earlier, USAFE will soon be constructing avionics facilities for which it claims that the freon system will be five times as expensive to retrofit as to install during construction. Like the Marines, the Air Force may try to force the issue by taking it to a general officer review board.

Attitudes are similar within the Army. USAREUR officials claim that some of the equipment that would fill its obvious shortfalls has been available for years. They are particularly critical about the Sanator, which has been under evaluation since 1978. The principal reason for delay is the failure to meet the Army's requirement for 400-hour failure-free operation, despite numerous attempts. Many Army officials believe that this requirement was too rigorous; it was recently reduced to 200 hours, but the Air Force requirement is only 100 hours. According to an official in the Army Materiel Command, as the Army continued its tests, some European units bypassed headquarters and bought the Sanator from their discretionary funds. In July 1985, the Army finally approved limited production of the Sanator for USAREUR, but even the 200-hour requirement has not been met, and the limited production model will have a specification for only a 100-hour failure-free operation, the same as that of Air Force.

While the users complain about the developers, the developers put much of the blame on the users, as represented by the Chemical

School, where equipment requirements originate. Several items have been taken through development but were then cancelled by the users, on the grounds that their requirements had not been met. In the view of development officials, this was often because the users had written requirements incorrectly or changed their minds.

Some requirements may simply have been infeasible. The universal decontaminant requirement, for example, is believed by some to be in this category. However, a representative of the Chemical Research and Development Center believed that the most significant problem is differing philosophies on when an item is ready for the field, the Chemical School having a tendency to "only want what's perfect." The example given was CAM, the chemical agent monitor, for which the requirement for a U.S. battery delayed the project 2 years. Another representative stated that users and developers are "closing the gap" on their differences and expect fewer problems in the future.

Conflicts with nonchemical priorities

Not all delays are the responsibility of the chemical defense establishment, which often runs up against conflicts with nonchemical priorities. This may be most apparent with the combat vehicle collective protection program. Public Law 95-79, enacted in 1977, required the secretary of the Army to submit a plan for funding and scheduling the incorporation of collective protection systems in all combat vehicles that would be in development or procurement by fiscal year 1981. The plan was submitted on schedule, but the Army still has no combat vehicles with overpressure systems in the field. The Warsaw Pact armies and at least some U.S. allies (including Great Britain and the Federal Republic of Germany) have had them for years.

Army development officials said that several conflicting priorities have impeded their efforts to put an overpressured combat vehicle into operation. First, U.S. Army doctrine requires an open-hatched fighting capability. This has required developers to design systems combining a ventilated facepiece and overpressure, whereas the Warsaw Pact and allied systems have only overpressure. Second, combat vehicle program managers vary in the priority they place on nuclear, biological, and chemical protection. Officials in research and development believe that this is largely why some but not all vehicles will soon have overpressure. Third, the designs for the M1, Bradley M2 and M3, and Sergeant York gun were already complete when the nuclear, biological, and chemical requirement was made. Officials are hopeful that such requirements will be incorporated into the design of the next generation of vehicles. Fourth, it is considered prohibitively expensive to retrofit vehicles already in the field with collective protection. Finally, Army developers began the program for an overpressured combat vehicle for three applications, but only one (the M1 tank) was put into production.

Industry response

DOD officials expressed concern about the ability and willingness of industry to meet DOD's demands for chemical and biological defensive materiel. A representative of one of the key firms concurred with the concern about willingness. There appear to be at least two issues: a perception about market instability and low market incentives.

Perceived market instability

DOD officials frequently cited concern that industry views work for chemical warfare defense as unstable and, consequently, is wary of involvement. Contractors voiced the same concern. According to one, the instability stems not only from congressional decisions but also from service reprogramming, both areas of uncertainty that decrease the attractiveness of chemical warfare projects. Another contractor, citing the "boom or bust" phenomenon, added that the current boom has contracts bottlenecked.

According to DOD officials, relatively steady growth in the last 5 years has improved matters. To accelerate the trend, they have sponsored regular meetings with industry groups. One effort that has been praised by DOD officials and contractors alike is the qualitative requirements information initiative, which we discuss later in the chapter.

Low market incentives

Another concern of DOD officials is that chemical defense materiel might never offer a market large enough to attract the industries that could produce it. This view is shared by some research and development contractors. The problem might be particularly acute for medical equipment, because chemical and biological defense drugs would constitute a very small share of a pharmaceutical company's business (Army medical officials give an estimate of less than 1 percent). This is in obvious contrast to manufacturers of weapons systems, which need the military business. In addition, chemical and biological defense drugs are limited production items; DOD might place an order for two production runs followed by none for 5 years. There is an additional problem in biological defense, which depends on the production of vaccine. U.S. vaccine production has greatly diminished in recent years, so that fewer facilities are available. Making firms interested in diseases of biological warfare is considered difficult, because these diseases are extremely rare in peacetime, making DOD the only customer. The potential cost of compliance with federal regulations, the 10 to 15 years required for the approval of new drugs, and product liability are also factors. In light of all this, medical officials question whether pharmaceutical and vaccine firms can obtain an acceptable return on investment.

Low investment incentive is a concern in nonmedical areas also. For biotechnology applications such as decontamination, development officials say the incentive for major firms is nonexistent. Chemical and biological defense is simply too small an area compared to the rest of the commercial potential for biotechnology, and developments outside chemical and biological defense do not transfer easily. Also, the work of most firms in this area is highly proprietary; DOD does not have access to it.

Purchase of allied technology

(U)After the decline in U.S. chemical and biological defense activity in the 1970's, DOD thought items might complement U.S. research and development efforts in filling near-term requirements quickly. Several NATO allies had active chemical defense acquisition programs while that of the United States was in decline, and it was widely acknowledged that the United States was in a position to benefit from acquiring European technology. The services procured some defense items from allies: the Army bought a contamination marking kit from Germany, the Air Force bought the Sanator decontamination device from Norway, and the Navy bought the Mark III protective suit from Great Britain. Additionally, the United States made agreements for the exchange of data and materiel with numerous nations, and it exchanges scientists and military liaisons with some of them (these agreements are described in chapter 8).

Nonetheless, many officials, expressing dissatisfaction, believe that more foreign items should have been procured by now. At least three issues appear to have hindered, and continue to hinder, the process of foreign procurement: the "not invented here" syndrome, nonconformance with U.S. requirements, and the international procurement environment.

"Not invented here" syndrome

Army headquarters officials maintain that the "not invented here" syndrome is no longer a major issue, and for evidence they point to the various foreign items in procurement and under evaluation. NATO ministry of defense officials generally concede that the United States is no more subject to this syndrome than their own nations. Army contract officials claim that they still see the syndrome in the midlevel laboratory managers who stand to lose projects but never see it at upper levels. However, U.S. forces in Europe frequently voice the belief that "not invented here" is partly responsible for the delays in getting some items into the field, including the Sanator and Fuchs and the chemical agent monitor called CAM. USAFE officials believe that the principal roadblocks come from the Congress, not DOD, citing textiles legislation that may prevent the purchase of a French protective sock that is worn inside standard combat boots. The same legislation, they claim, delayed the Navy's purchase of the Mark III suit 2 years.

The Navy's decision to procure the British Mark III suit was made in fiscal year 1981 but, as Navy officials report it, pressure from a domestic defense industrial lobby delayed its procurement and compelled competitive testing of domestic suits. In 1983, protective suits proposed by eight U.S. companies were tested. When none was found to be adequate on the major performance criteria, a decision to procure the British Mark III was made again. According to Navy officials, this process delayed the outfitting of U.S. naval forces with protective suits for 2 years. The problem extends to the present: the contract for the procurement in fiscal year 1985 of roughly 95,000 suits was delayed because the Navy was again seeking a U.S. supplier. According to a contractor, European governments engage in similar tactics. They make a first purchase from the United States in order to meet a needed capability and then require that subsequent purchases be domestic.

Nonconformance with U.S. requirements

(U)A foreign item may fill a deficiency but fail to meet the testing standards of one or more of the services. This happened with the Norwegian Sanator decontamination apparatus, which passed Air Force requirements but failed the Army's. As we noted earlier, it is widely believed that the Army's original standard was too rigorous, and it has been lowered. In the view of Army contract officials, not enough consideration is given to the saving in cost and time that could result from loosening technical requirements on foreign and off-the-shelf items.

Another point made by Army officials concerns design incompatibilities between foreign and U.S. systems. Incompatibilities precluded the Army from buying British or German overpressure systems for U.S. tanks. On a larger scale, foreign items are considered problematic if they stand out from other materiel in a unit. For example, the Army has favorably evaluated the German Fuchs reconnaissance vehicle's mass spectrometer but is concerned that the vehicle itself will stick out and be quickly targeted. EUCOM officials, however, believe that the need for nuclear, biological, and chemical reconnaissance is a considerably more pressing concern than the signature problem.

The requirements issue is also relevant to allied firms competing for U.S. contracts. Officials of the Dutch and Belgian ministries of defense stated that the United States tends to specify design rather than performance requirements for a new item of equipment. They said this practice makes it more difficult for European firms to compete for U.S. contracts. In addition, Dutch officials stated that the sales of European chemical and biological defense equipment could be facilitated by informing European firms of specific requirements and educating them about how to enter the U.S. market. They noted that industry-to-industry seminars such as one held in the spring of 1984 are helpful in this regard.

International procurement environment

According to Army contract officials, numerous factors in the international procurement environment impede U.S. purchases of foreign items. First, governments frequently make what are seen as overly rigorous demands, such as specifying that royalty payments continue after the United States develops its own version of an item. Second, foreign contractors are concerned about U.S. grants-in-aid programs that give away their materiel, or resell it at favorable prices, to third world allies. The foreign contractors would prefer to sell to those markets directly.

The worst impediment, however, appears to be legal disputes arising over licensing agreements. Both CAM, the chemical agent monitor, and Sanator were reportedly bogged down in such disputes. Army contract officials believe the situation would be ameliorated if they were involved earlier in the process, but they recognize that this is outside their control. Other officials question the net savings from foreign procurement, given the time and money lost in negotiations and legal disputes.

INITIATIVES

DOD has recently taken several initiatives to improve the chemical defense acquisition. Five are described below: the Joint Service Agreement, the Joint Logistics Command Panel, the Chemical Material Acquisition Initiatives, the Chemical Warfare Defense Review, and Qualitative Requirements Information.

Joint service agreement

In July 1984, the three services approved a new Joint Service Agreement on research, development, and acquisition programs in chemical warfare and chemical and biological defense. Its purpose was to prescribe procedures for coordination, so that the highest priority requirements of each service and the goals of defense guidance could be met. The agreement superseded an earlier one from 1977. According to Army officials, the earlier agreement became outdated by funding increases and program growth. Specific changes included the following:

- the services can now fund unique requirements, whereas previously the Air Force and the Navy had to rely on Army funds and priorities;
- procurement is now included in addition to research, development, testing, and evaluation;
- information needs are now included in addition to materiel needs; and
- procedures for implementation and setting priorities are now prescribed.

A joint service review group has met twice to designate lead services in specific areas of the agreement and to assign priorities to requirements. This group is the official link to the materiel development commands.

One objective of the Joint Service Agreement is to identify redundancies and consolidate programs. Since its approval, 91 materiel requirements have been consolidated into 48. However, the agreement provides only guidance and coordination; specific materiel decisions are executed by the materiel development commands. Moreover, there is no enforcement authority to ensure that the agreement's guidelines are followed.

The agreement will not be fully implemented until July 1987; however, there is some indication that it has already had a positive effect. Army and Marine Corps officials credit the agreement with having played a role in the recent decision to forgo the development of a special Marine Corps suit. Specifically, they say it opened communications and provided a vehicle for the Army to incorporate the Marine Corps requirements.

Officials involved with the agreement cite the need for "adjustments." Specifically, not all requirements have been included, funding profiles are not realistic enough, summaries are not succinct enough, and implementing instructions are too complex. They also see duplication remaining in the areas of alarms, individual protection, and medical equipment.

Joint Logistics Command Panel

The Joint Service Agreement provides guidance, but the execution of specific materiel actions rests with the materiel commands. The Joint Logistics Command is an ad hoc group headed by the top materiel flag officers from all four services. In June 1984, an action team identified 10 principal categories of chemical and biological defense equipment duplication and recommended management initiatives to address these and other joint service issues in air crew respiratory protection, flight crew clothing, gloves, boots, microcooling equipment, mask cannisters, mobile shelter components, and liquid, ionization, and vapor detectors. A joint panel on chemical and biological defense was then established to evaluate and implement the action team's recommendations, among other things.

In November 1984, the joint panel reported the elimination of some obvious duplication. For example, all services had been independently developing gloves and boots, so the Air Force and Navy terminated their developments of them. The panel meets quarterly, providing a forum for the resolution of developmental issues and the coordination of acquisition programs. In 1985, it resolved that the Army and Air Force will merge their programs for

an automatic liquid-agent detector into a joint program, and the Army will buy Air Force gloves for the near term.

Chemical Materiel Acquisition Initiative

The Chemical Materiel Acquisition Initiative, begun by the Army, was first approved in September 1984. Its intent is to streamline the development of nuclear, biological, and chemical warfare equipment. Reportedly, it will lessen the time between concept exploration and approval for production from the usual 8 years to 4 years.

The initiative institutes four major deviations from established practice. First, many decisions normally the authority of the Training and Doctrine Command and Army Materiel Command headquarters are delegated to the Chemical School and Chemical Research and Development Center, including the authority to waive operational testing and cost operational effectiveness analysis. Each has been waived once: the former for the XM20 simplified collective protection equipment and the latter for the nuclear, biological, and chemical reconnaissance system. Second, generic organization and operational plans covering functional areas such as detection and warning replace item-specific plans, reducing the number of documents requiring approval. Third, "preplanned" product improvements will be instituted on a larger scale than previously, speeding up things by phasing in technologies as they become available rather than waiting for support from technologies that are still under development. Fourth, the overall review and approval process has been accelerated. The Army claims that organization and operational plans and test documents are now being approved in half the usual time.

Chemical Warfare Defense Review

In 1984, the Air Force introduced the Chemical Warfare Defense Review, a semiannual forum for the discussion of programs and concerns. Air Force users, developers, logisticians, trainers, and research and development managers, as well as Army research and development personnel, are all represented. The purpose is to recommend actions that will put into the field chemical defense equipment that satisfies the requirements of its users. Priorities for development and production are reviewed and revised as needed.

For example, at the June 1985 review, several directives initiated at the previous review were reported to have been set in motion. They included a requirements document for transportable shelters, the testing of possible eye and respiratory protection devices for air crew by the Military Airlift Command, and a process in which the Air Force can set priorities under the joint service agreement. Directives

proposed at the 1985 review included a plan to determine the service life of filters for the SCPS and KMU-450, a review of the Army's research and development schedule for freon and of future Air Force actions, and a way of ensuring that normal supply procedures will be followed when new equipment is issued.

Qualitative Requirements Information

(U)The Qualitative Requirements Information is an Army initiative in which contractors are invited to offer proposals in particular areas. The bidding is noncompetitive in order to avoid negotiation. The Chemical Research and Development Center is free to fund no contracts or as many as it can afford. Recently, 51 proposals were generated on decontamination equipment. The idea is to put different contractors to work on different aspects of a problem. The contractors we interviewed saw the Quality Requirements Information as a clear improvement.

SUMMARY

In this chapter, we have provided information on research and development for chemical warfare defense. This information complements chapter 3 in addressing the following question: What progress has DOD made in developing and procuring equipment and materiel that will enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?

DOD has an active research and development program in the five areas of chemical defense identified in its 1982 report to the Congress and it is making an effort to pursue both near-term and far-term solutions. However, these efforts have not yet put much new equipment into the field. The status of the program is summarized below.

1. Medical equipment. Pretreatment drugs and antidotes for chemical agents, vaccines, and therapies for biological agents are scheduled for the late 1980's and 1990's. Products for the decontamination of patients and casualty care are scheduled for the late 1980's and 1990's. Some medical requirements that were identified in 1982 are now viewed as highly unrealistic.

2. Individual protection. New masks for ground, vehicle, ship, and air crews are scheduled for fiscal year 1986 and beyond. New ground crew suits made of current materials are in procurement, and improved new follow-on air crew suits are similarly scheduled. Microcooling devices portable by individuals and agent-neutralizing materials are scheduled for the 1990's.

3. Collective protection. Rest and recuperation shelters for Air Force bases are being procured; the Navy is evaluating them under a schedule that would put them into field operation beginning in fiscal year 1987, pending host-nation approval. Equipment that converts an existing room into an overpressured

shelter is scheduled for fiscal year 1987, and a corps level medical protection system is scheduled for completion in fiscal year 1993. The first overpressured tank, scheduled for fiscal year 1986, has logistical problems with filters; subsequent combat vehicles will be operable in fiscal year 1990, pending funding. The first two ships with collective protection are scheduled for fiscal year 1989.

4. Detection. Vapor and aerosol detectors and alarms are scheduled for fiscal year 1987 and beyond. An automatic liquid-agent detector and alarm is scheduled for fiscal year 1990. A ground crew reconnaissance system is scheduled for fiscal year 1991, but a German system may be bought in the interim.

5. Decontamination. The Army has a Norwegian system scheduled for fiscal year 1987 and large-area decontamination apparatus replacement scheduled for fiscal year 1988. The first hot-air decontamination device is scheduled for fiscal year 1989, with additional nonaqueous systems scheduled for the 1990's. The Air Force use of freon for avionics facilities is scheduled for fiscal year 1990 or possibly sooner. An alternative system for dispensing ship decontaminants is scheduled for fiscal year 1989.

Finally, we summarize the three areas of concern that we discussed in this chapter and conclude with a summary statement about DOD's recent initiatives.

1. Productivity. Research and development for chemical warfare defense has been marked by numerous delays and cancellations, and relatively few items have been put into operation in the field. The perception is widespread that the Army, as the lead service, lacks a sense of urgency in bringing chemical defense items to the field. There have been several delays and cancellations from funding cuts and conflicts with nonchemical priorities, over which the proponents of chemical defense have had little control.

2. Industry response. Contractors appear wary of involvement in an area they perceive as unstable, though DOD officials believe that the relatively steady growth has improved matters. Chemical defense may never offer a market large enough to attract the industries that can produce materiel and equipment for it. The problem may be particularly acute in the medical area.

3. Purchase of technology from allies. Numerous allied items have been evaluated and some have been procured, but the "not invented here" syndrome, nonconformance with U.S. requirements, and the international procurement environment appear to have been impediments to progress.

4. Initiatives. Five promising DOD initiatives--the Joint Service Agreement, Joint Logistics Command Panel, Chemical

Materiel Acquisition Initiative, Chemical Warfare Defense Review, and Qualitative Requirements Information--appear promising for improving the acquisition process, but their effects will not be visible for several years.

With respect to research, development, and allied procurement of new equipment and materiel, DOD has not been very effective: it has not yet equipped U.S. forces to sustain operations in a chemically contaminated environment.

CHAPTER 5

FORCE STRUCTURE

While making it clear that the United States was not attempting to match the Soviet force structure, DOD's 1982 report to the Congress said that DOD would continue to increase the number of U.S. forces and units dedicated to chemical warfare defense, subject to personnel constraints. The Army's force structure goal was 24,000 chemical specialists by fiscal year 1987. Over 5 years, the Air Force was to add about 1,000 personnel to its functions related to chemical warfare defense, beyond the 850 disaster preparedness specialists and 375 persons working in other specialized areas. The Navy had no plan to augment its force structure. In this chapter, we address the question, What progress has DOD made in establishing a force structure that will permit U.S. forces to carry out training, reconnaissance, decontamination, and other missions in chemical warfare defense?

ARMY

Table 5.1 shows the Army's progress from fiscal year 1982 through fiscal year 1985 toward increasing the force structure of the Army Chemical Corps. We did not obtain information on the Army's interim goals and, therefore, cannot say whether growth is proceeding as projected. However, it is clear from the table that reaching or even approaching the goal of 24,000 in fiscal year 1987 will require a dramatic increase in the growth rate.

The force structure of the Army Chemical Corps is supplemented by nonchemical military occupational specialists and

Table 5.1

Army Chemical Corps Force Structure
in Fiscal Years 1982-85

<u>Staff</u>	<u>1982</u>	<u>1983</u>	<u>1984</u>	<u>1985^a</u>
Enlisted personnel ^b	5,694	5,997	7,395	7,332
Officers ^c	<u>1,101</u>	<u>1,300</u>	<u>1,546</u>	<u>1,631</u>
Total	6,795	7,297	8,941	8,963

^aProjected.

^bIncludes MOS 54E, 54C, 54Z, and 92D.

^cIncludes MOS 74A, both 1st and 2nd specialty.

others who help make up chemical-warfare teams. Army regulations specify that every company should have one team or more. A "control party" consisting of a commissioned officer, a noncommissioned officer, and an alternate completes a 2-week course in nuclear, biological, and chemical defense at an area school for these subjects or at the Army Chemical School. In turn, they train the teams.

Since 1980, the USAREUR chemical force structure has improved substantially. In July 1985, USAREUR had filled 97 percent of its authorized positions for enlisted personnel and 91 percent for officers, employing 2,180 enlisted personnel and 329 officers. This represented a large improvement over the force structure in 1977, when positions for 369 enlisted personnel and 99 officers were authorized.

There has been no increase in medical force structure related to nuclear, biological, and chemical defense. Army medical officials asked for 26 more positions per battalion for decontaminating patients, but the request was denied. The Army has plans for supplementary medical personnel in the event of mobilization, but medical officials question whether these plans would be implemented.

NAVY AND MARINE CORPS

Discerning changes in the size of the Navy's force structure for chemical warfare defense is impeded by the fact that chemical warfare is not a distinct mission area in the Navy. Instead, chemical warfare defense is a collateral duty assigned to officer damage control assistants and enlisted hull technicians aboard ships and to disaster preparedness officers, specialists, and various other personnel at overseas bases.

None of the three Navy bases we visited had billets specifically authorized for disaster preparedness officers; instead, commanders designated individuals to full-time or collateral duty in disaster preparedness. These individuals were responsible for nuclear, biological, and chemical defense, and some had full-time staff.

Disaster preparedness representatives at all three bases told us that they needed increases in staff and expertise to improve their chemical defense capability. The force structure at one base had been increased in the past year, and one base had requested additional staff. The representatives stated that alternatives to increasing the force structure might include using existing expertise, asking for outside assistance, requiring that the persons who are assigned to disaster preparedness positions have specific skills, and assigning more persons to collateral duty in disaster preparedness.

In the Marine Corps, the principal personnel charged with defensive measures in a chemical attack are nuclear, biological, and chemical defense officers and specialists. Both are spread throughout every Marine Corps unit at battalion level and higher. However, their career advancement is limited; officers cannot progress in rank beyond that of warrant officer, and the specialists can hold no rank higher than enlisted master gunnery sergeant.

The specialists work in the same units as the officers but in greater numbers: the Marine Corps has 75 officers and 895 specialists in nuclear, biological, and chemical defense. The billet structure provides for 95 officers and 659 specialists. Billets that are not filled by occupational specialists may be filled by other officers or enlisted personnel.

Each division, aircraft wing, and force service support group headquarters in the Marine Corps has a platoon for nuclear, biological, and chemical defense. The mission of the platoons is to operate a defense control center and to provide decontamination support and training and expertise.

Though data were not available on changes in force structure, a Marine Corps official told us that "the number of nuclear, biological, and chemical defense personnel in the Marine Corps has increased significantly in the last 5 years." The official added that changes during the last 5 years included the incorporation of the platoons into the organizational structure and the addition of the defense officers to infantry and artillery battalions.

AIR FORCE

The Air Force does not have specialists dedicated to chemical warfare defense. Instead, the chemical warfare duties fall on the disaster preparedness specialists. In addition to their responsibilities for chemical warfare, the disaster preparedness personnel are expected to be able to respond to major nuclear and nonnuclear accidents and natural disasters. Depending on skill, proficiency, and training, a disaster preparedness specialist is expected to monitor chemical contamination, establish decontamination requirements, coordinate chemical exposure control, evaluate operating units' programs in defensive chemical warfare, ensure that defensive chemical warfare equipment and materiel are available and in working order, and develop and supervise the training of operating units' defensive chemical warfare programs. The Air Force has filled the positions requiring higher skill levels with personnel at first-skill level. For example, 50 percent of the disaster preparedness personnel in the Tactical Air Command are noncommissioned officers at the first skill level.

As far as we could determine, the Air Force has approximately 1,500 disaster preparedness specialists, approximately 6 at each base. An Air Force official told us that the number is sufficient if the rest of the personnel on a base are well trained in chemical warfare procedures. However, the specialists have found it necessary to delegate some detection, decontamination, and other responsibilities to operating units.

CONCERNS

The following issues in force structure were raised in our review of the services: personnel shortages, the use of "augmentees," and the misuse of chemical warfare forces. We discuss them in turn.

Shortages

The most acute shortage is in the Army among enlisted personnel in chemical warfare specialist positions. Army officials said that is a residual effect of the disestablishment of the 1970's, when very few recruits enlisted for these positions, and the shortage has begun to affect the higher ranks. Worldwide, only 63 percent of the enlisted specialist positions have been filled. The current authorization is for 2,654, but only 1,948 will be coming up through the ranks.

The authorization for officers who are specialists in chemical warfare is 1,426, and 1,394 positions have been filled. However, these numbers must be interpreted in light of dual-track Army officer careers; officers frequently take on two specializations and divide their time between them. Consequently, many branches fill twice what their authorization allows before considering it filled.

Several of the units that are needed in order to implement the Army's nuclear, biological, and chemical doctrine specified in FM3-87, the "chemical units" manual, do not yet exist. Excluding smoke-generator units, their projected activation dates are chemical company for nuclear, biological, and chemical defense, air assault division, fiscal year 1986; chemical company, smoke and decontamination corps, fiscal years 1987 and 1988; chemical company, nuclear, biological, and chemical reconnaissance corps, fiscal years 1987 through 1991; headquarters and headquarters division, chemical battalion, fiscal years 1987 through 1991; chemical company, armored cavalry regiment, fiscal year 1988; and headquarters and headquarters corps, chemical brigade, no date programmed.

Although the combat maneuver units have more assets, V Corps and 3rd Armored Division officials believe that more decontamination and smoke resources are needed in the forward areas. They believe a decontamination battalion would provide better coverage. The V Corps chemical officer said that a

battalion headquarters for decontamination companies is necessary to provide better command and control of chemical units.

However, officials at the corps level and from combat maneuver, combat service support, and chemical units told us of imbalances in the force structure. There is an abundance of personnel at grade E-5 but shortages in grades E-1 through E-4 and in grades E-6 and E-8. As a result, many persons at E-5 are doing the work of lower and higher ranks.

Officials of the 7th Medical Command told us that readiness for nuclear, biological, and chemical warfare in USAREUR hospitals has been adversely affected by a lack of professional commissioned and noncommissioned officers. Positions for noncommissioned officers were established in fiscal year 1983, for commissioned officers in fiscal year 1984. In June 1985, all but three of the hospitals of the 7th Medical Command had filled 100 percent of their authorizations for commissioned and noncommissioned officers in chemical defense.

The disaster preparedness officer at Sigonella told us that more staff is needed for assistance with disaster preparedness duties. The officer's predecessor had requested an authorization of 3 officers and 14 enlisted personnel for the base in the fiscal year 1987 budget. The authorization request for fiscal year 1988 was for 1 officer and 10 enlisted personnel.

All the disaster preparedness representatives stated that greater force structure and additional expertise were required to improve the chemical warfare defense capability at their bases. They stated that increasing the force structure would improve their ability to account for equipment, train personnel, and plan for a chemical disaster.

At Rhein-Main and Spangdahlem, the two Air Force bases we visited, officials did not identify a significant shortage of the peacetime personnel who are responsible for chemical warfare defense planning, training, and detection and decontamination, except that Rhein-Main officials said that they were short one officer.

Augmentees

Both the Army and Air Force rely on nonchemical corps and nondisaster-preparedness personnel to augment their chemical defense staff. The Army's force structure is supplemented by personnel from maneuver units, who serve as company chemical teams, and that of the Air Force is supplemented by personnel who do detection, decontamination, and shelter management. However, both Air Force bases identified as a problem the requirement that augmentees manage collective protection shelters in a chemically contaminated environment.

Spangdahlem officials told us that the base received requests for 671 augmentee positions, a number that exceeds the base's 361 personnel available for "augmentee" duties at that base. They said that the largest request at Spangdahlem was for 290 in disaster preparedness.

The USAFE disaster preparedness chief said that there is a command concern about the large number of personnel required to operate the SCPS-2. In a December 1984 USAFE message to major commands, the three to five persons necessary for operating the SCPS-2 per shift is described as an unsupportable command requirement, given the SCPS-2 programmed for USAFE. USAFE proposed that there be one shelter manager per shift and that the individuals resting in the shelters assist the shelter manager for 1 to 2 hours.

At Spangdahlem, disaster preparedness officials requested an increase in wartime augmentees, primarily to perform chemical shelter management duties in a chemically contaminated environment. Currently, they have augmentee positions authorized, and they have requested of which would be shelter-management team members. The remainder would be decontamination teams, the disaster preparedness support team, and the nuclear, biological, and chemical warfare cell.

Misutilization

Some Army officers in Europe believe that chemical forces are not used appropriately by some commanders, as when a chemical defense officer is assigned to lead an infantry company. The assignment could be advantageous to the officer's career but not necessarily to the chemical defense program. However, other Army officers in Europe believe that the extent to which chemical specialists are assigned other duties is up to the commander and the emphasis the commander places on chemical defense. Many officials told us that the cause for concern is not as prevalent as it was in the past. USAREUR officials told us that instances appear to occur the most frequently with combat service support units. For example, officials in the 7th Medical Command told us that the chemical warfare officers at hospitals are spending only 20 percent of their time on chemical warfare duties.

SUMMARY

In this chapter, we have presented information to help answer the question, What progress has DOD made in establishing a force structure that will permit U.S. forces to carry out training, reconnaissance, decontamination, and other chemical defense missions? The question is best answered by looking at the force levels in 1982, the levels proposed in 1982 for 1987, and the present levels:

<u>Service</u>	<u>1982</u>	<u>1985</u>	<u>Proposed for 1987</u>
Army	6,800	9,000	24,000
Navy	0	0	0
Air Force			

The Navy has no chemical warfare force structure; all duty is collateral to other specialties. The Air Force personnel are disaster preparedness specialists who are also responsible for accidents and natural disasters.

The proposed increases for 1987 in the Army and Air Force do not seem achievable, given personnel ceilings. The Navy did not propose an increase.

Assuming the proposed increases are valid requirements,

The reliance on augmentees exacerbates the situation, because many of the requests for augmentees cannot be filled.

CHAPTER 6

TRAINING

The objective of chemical warfare training, according to the 1982 DOD report to the Congress, is to train individuals to react to a chemical attack automatically and exactly and to accustom them and their units to the physiological and psychological stress of chemical warfare (1). Our question regarding training is, What progress has DOD made in providing individuals and units with training to support the probability that their response to a chemical attack will be automatic and precise and that their discipline will be maintained in a chemically contaminated environment? We discuss training in terms of specialists, including medical personnel, and nonspecialists and group training or exercises across the services. Before we summarize the chapter, we address some areas of concern.

ARMY

In reviewing Army training in chemical defense, we looked at four areas: specialists, nonspecialists, medical training, and the training of Army troops in Europe.

Chemical Corps specialists

The Army Chemical School was reestablished at Fort McClellan in 1980. All Chemical Corps officers and enlisted personnel are trained there. The officers take a basic course as second lieutenant and an advanced course as senior first lieutenant. Each course runs approximately 20 weeks.

The number of courses the enlisted personnel take varies by individual circumstance. The typical noncommissioned officer who is at grade E5 has taken an advanced individual training course at E1 or E2 and a leadership course (not necessarily at the Chemical School) plus one additional course at E5 and another at E6. These courses run from 6 to 9 weeks. After this, the officer is prepared for a noncommissioned staff or advisory position. At E7, the officer takes an advanced course for noncommissioned personnel, which runs 12 weeks.

Curriculum

Course offerings and enrollment size have substantially increased in recent years. The following numbers are aggregates for all Chemical School courses by fiscal year: in 1982, there were 3,663 students and 148 classes; in 1983, there were 3,857 students and 140 classes; in 1984, there were 4,540 students and 195 classes; in 1985, enrollment was projected at 5,089 students in 220 classes. This includes a course added after fiscal year 1984 for advanced 54E's and one for senior commanders. Overall

attrition rates ranged from 5 to 13 percent for fiscal years 1979-84, with no clear trend upward or downward.

Army officials cautioned us that trends in course iterations are at times misleading, because course lengths change. The course for enlisted personnel includes training in such tasks as decontaminating skin and personal equipment; putting on, wearing, and exchanging protective equipment; replacing filters on protective masks; using detector equipment and using and maintaining alarm equipment; and recognizing and reacting to chemical or biological hazards. In addition, Army regulations mandate that all companies have a chemical team. A nuclear, biological, and chemical "control party," which trains the team, usually consists of an officer, a noncommissioned officer, and an alternate who are trained at area schools or the Chemical School in a 2-week program. The course was 80 hours but was recently shortened to 52, because common tasks that are taught in basic training were dropped.

Evaluation

An internal review branch at the Chemical School ensures that classes are conducted in accordance with lesson plans, programs of instruction, and doctrine. The Training and Doctrine Command headquarters, the inspector general, and the deputy chief of staff for training are also involved in course evaluations. After students leave the Chemical School, they are tracked through a worldwide survey covering all Army combat divisions, brigades, and schools on a 2-year cycle.

Units with nuclear, biological, and chemical warfare officers and noncommissioned officers outside the Chemical Corps are evaluated by the Inspector General, Forces Command, emergency deployment readiness exercises, and the Army training and evaluation program (ARTEP).

Training equipment

Army officials claim that the equipment used in training chemical specialists is as good as or better than the equipment in the field, because the schools receive new equipment first. Simulation equipment is also becoming available for training; an example is a detector kit that mimics the Army's standard issue detection kit upon exposure to chemical simulants. A recently approved acquisition strategy for training devices delineates plans for developing numerous training items for nuclear, biological, and chemical warfare defense.

A live-agent training facility is nearing completion at the Chemical School. It will be the first facility in which U.S. troops can perform detection and decontamination procedures in a contaminated rather than simulated environment. The Army's

Surgeon General approved it, and it is scheduled to be available for use during 1986.

Nonspecialists

Army officials believe that much progress has been made in defensive training for nonspecialists in this decade. Previously, troops could not be expected to survive or operate in a contaminated environment. The training available to them now should enable them to at least survive an initial attack. We describe individual and collective training separately.

Individual training

For enlisted personnel, the module for nuclear, biological, and chemical defense in the basic training course was recently increased from 4 hours to 11 hours. However, Army officials say it is hard to assess compliance with this increase because of the discretion given to platoon sergeants. The new course integrates chemical warfare events with field-training scenarios, including firing a weapon while masked. Basic tasks are taught in schools and units.

For officers, common tasks in the basic course include four in nuclear, biological, and chemical defense that were first standardized in 1982. These tasks are taught in schools and units. The advanced course now incorporates 13 hours of training in nuclear, biological, and chemical warfare, including training support packages distributed to service schools late in 1984.

Collective training

Army Forces Command has established four training objectives to prepare units to survive and operate effectively in an environment contaminated by nuclear, biological, or chemical warfare: accomplish a mission in spite of the effects of an attack, perform the mission in full protective posture for 6 continuous hours, decontaminate personnel and equipment, and use smoke to help complete the mission. Two other objectives are to emphasize defense tasks during testing and evaluation and to integrate realistic defense situations into exercises. Additionally, soldiers are expected to demonstrate proficiency in individual tasks at least once a year. Each unit's specific training regimen is established and enforced by its local commander, who sets the priorities.

Evaluation

The Army's principal means of evaluating nuclear, biological, and chemical warfare training, particularly collective training, is the training and evaluation program it established to help unit

commanders conduct and evaluate training and assess their future needs. Training must include a nuclear, biological, and chemical defense scenario, for which the Chemical School provides tests and drills. For example, in the ARTEP for truck companies, teams are expected to demonstrate their ability to relocate units and reestablish motor transport operations in full protective posture.

Medical personnel

Medical personnel receive training in nuclear, biological, and chemical warfare at several points in their career programs. Enlisted personnel receive it from basic training through advanced training for noncommissioned officers, whereas officers receive it in basic and advanced courses as well as in other professional development courses. These include a medical "precommand" course and a course in care for combat casualties. The latter is an 8-day course for entering physicians that includes 1 full day of nuclear, biological, and chemical warfare training and that graduates approximately 2,700 officers throughout the services each year. Many medical courses have increased the total hours of defensive training since 1982.

At the Academy of Health Sciences, the Army's center for medical training, training is geared toward decontaminating and managing the care of casualties. Fifteen new chemical warfare tasks were incorporated into the courses in October 1985. Specific biological treatments and ways of managing care for patients are not part of the resident training program, and no biological training packages are under development or projected.

Medical personnel are expected to continue on-the-job training in most of their duty assignments, especially in the Army Forces Command units. They are also required to perform unit defensive tasks under field conditions in ARTEP, the Army's training and evaluation program.

Training in Europe

USAREUR's system and environment for nuclear, biological, and chemical warfare training is based on progressive institutional training, sustaining individual and collective skills, and training for missions through field and command post exercises. The members of each USAREUR unit's "control party" are trained at either 1 of the 28 local schools in USAREUR or the primary USAREUR school at the 7th Army Training Command in Vilseck, Germany. Every unit must appoint and train a chemical agent detection team, a radiological monitoring and survey team, and a decontamination team. Under the unit commander, these "control parties" are responsible for overseeing mandatory individual and team training.

All USAREUR officials from combat maneuver, combat services support, and chemical units told us that individual proficiency in nuclear, biological, and chemical warfare is tested at least quarterly. For combat maneuver units, team training can occur during weekly unit training classes, two to three times a year at major training areas, and during field and command post exercises. Unit training for combat service support units is held less frequently, during exercises and varying from weekly to semiannually.

According to USAREUR officials, training in nuclear, biological, and chemical warfare is integrated with other mission training at the three major training areas in Germany. They are the only places where USAREUR can fire large-caliber weapons and introduce chemical simulants and smoke into the environment. Driving vehicles in full protective gear is also practiced.

USAREUR chemical warfare officials told us that the requirement for 6 hours annually in full protective gear was being fulfilled, primarily during training and evaluation at the three areas in Germany and during alerts. Some units have instituted schedules in which unit personnel gradually build up to the 6-hour requirement. Officials point out that fulfilling the requirement depends on a commander's commitment to nuclear, biological, and chemical defensive training.

USAREUR generates interest in nuclear, biological, and chemical defense training by holding annual "NBC days" at the company level. They are conducted like the Olympics or a fair. At these events, some of the annual requirements, such as taking a proficiency test and changing filters, are accomplished.

Integrated training also takes place during major field exercises such as REFORGER and command post exercises such as WINTEX/SIMEX. The exercises also provide a means of testing and examining reporting and warning systems. Tactical units practice in protective equipment and clothing in areas simulating chemical contamination, in order to experience and recognize degradation of performance.

In the 1985 REFORGER exercise, chemical "attacks" were used frequently. According to Inspector General officials in the European Command, simulated chemical warfare play began on the first day. It was judged to be excellent and a considerable improvement over chemical play observed in previous REFORGER exercises. According to USAREUR officials, the REFORGER exercises for 1986 and 1987 will focus extensively on rear combat and communications zone operations in a chemical environment. Some of the objectives are exercising selected continental United States units during forward movement through a chemically contaminated rear combat zone and exercising smoke units to cover forward deployment of reinforcements from continental U.S. bases.

USAREUR has also established a program to procure chemical defense equipment for and train essential U.S. civilian employees and local nationals. The defense training that is required consists of approximately 10 hours of basic survival and operating skills, familiarization with protective equipment, exercises with masks, and tests for mask leaks.

NAVY AND MARINE CORPS

Damage control assistants, who are officers, and hull technicians are the fleet personnel who receive the most training in chemical matters in the Navy, because chemical, biological, and radiological defense is considered to be part of damage control. At overseas bases, disaster preparedness officers and specialists are responsible for chemical defense; designated medical officers and hospital corps personnel bear this responsibility for medical matters. Defensive training is provided to Marine Corps personnel and to Navy surface but not air personnel.

Classroom training

At the most basic level, new recruits receive roughly 4 hours of introductory training in chemical warfare defense in boot camp. Sailors who decide on training as hull technicians attend a 68-day course, of which approximately 7 days are related to chemical, biological, and radiological warfare. Surface officers assigned to fleet units as damage control assistants study approximately 6 days of this type of material during their 47-day training. The length of these courses and their subject matter have not changed since 1982.

Disaster preparedness specialists, who have primary responsibility for chemical, biological, and radiological defense at overseas bases, receive their training through the Air Force. Naval construction personnel take a 12-day course in disaster recovery that is entirely devoted to topics in chemical, biological, and radiological defense.

A basic 5-day course is devoted entirely to chemical warfare defense. It graduated more than 1,500 trainees in 1984, most of whom were enlisted personnel. According to the training manager at one school, the September 1984 release of "Interim Operational Procedures for Chemical, Biological, and Radiological Protective Clothing and Equipment" resulted in a major change in training (19). The course includes a hands-on chemical warfare chamber exercise.

Shipboard training and exercises

Shipboard training activities include instruction from mobile training teams and entail shakedown exercises during refresher training and operational readiness inspections.

Medical training

The Navy has no specific requirement for chemical, biological, and radiological defense training for its medical department. The most advanced training is given to hospital corps personnel, but the type and level vary by individual. Among those who receive the most training are members of medical mobilization augmentation readiness teams and rapidly deployable medical facilities. Since they would be dispatched quickly to set up hospitals in a conflict, they would have a higher risk of entering a chemically contaminated environment. Their preparation for this situation consists of 18 hours of chemical, biological, and radiological training in a 60-hour course and 7 hours in a 9-day course. These courses review the known classes of chemical agents, their effects and symptoms, decontamination and personal protection methods, and treatment. The students also go through a chemical warfare chamber exercise.

Marine Corps training

(U)The chemical defense specialists in the Marine Corps are the nuclear, biological, and chemical defense officer and specialist. They attend the Army's Chemical School at Fort McClellan, although they do not take the Army's course there. The differences in their training reflect the organizational differences between the two services.

Training at naval bases in Europe

Disaster preparedness representatives on Navy bases generally have limited training in chemical warfare defense. Training for base personnel usually consists of an annual refresher course conducted by Navy reserve organizations or other military services. All enlisted personnel are required, when they are initially assigned to a base, to obtain a personnel qualification standard showing that they have demonstrated general knowledge of chemical warfare defense. Civilians do not participate in training.

AIR FORCE

The Air Force does not have a core group of chemical specialists, but the chemical warfare training that disaster preparedness specialists are given differs from that received by nonspecialists. In this section, we describe these two areas of training in addition to the training of Air Force personnel in Europe and medical training.

Specialist training

The disaster preparedness course is intended to provide a minimum capability at the lowest skill level. Higher skill levels are achieved through on-the-job training, which consists of

supervised task performance and correspondence courses, but trainees must have a higher skill level in another career field as a requirement for training in disaster preparedness. The course requires 330 hours of training, of which 80 hours are devoted to chemical warfare, including wearing protective equipment, using detection and decontamination equipment, managing collective protection shelters and processing stations, and learning general policies and procedures but not command-specific doctrine and threat assessment. On the average, 160 officers and enlisted men are trained each year. This average has remained relatively constant.

Training equipment

Disaster preparedness instructors are concerned that new equipment is often made available to the forces sooner than it is received in the schools. During the lag, the technical manuals are available but not the equipment necessary to provide adequate training.

Evaluation

There are no evaluations of the training programs other than operational readiness inspections and the reports of the Air Training Command Inspector General. The courses are monitored by reviews of test results and negative feedback from the commands that receive the trainees.

Nonspecialist training

Individual members of the Air Force receive about 2 hours of introduction to chemical warfare during basic military training. Thereafter, the major commands take individual approaches to additional training, and exercises are conducted at different levels, whether in shop or work areas and in squadrons or on bases. For example, the Tactical Air Command offers a 2-hour refresher course every year. Skills in protective gear are demonstrated during aspects of on-the-job training.

Air Force personnel in Europe

In USAFE, the disaster preparedness chief said that personnel receive 8 hours of initial training within 30 days of their arrival. After this 8-hour course, they attend an annual 2-to-4-hour refresher course. USAFE and base officials said that personnel receive additional training several times a year in various exercises and inspections, in which they are required to work in their individual protection ensembles and masks. Specialized teams receive training in specific tasks such as detection, decontamination, and shelter management, in addition to their annual chemical warfare defense training. Disaster preparedness officials at Spangdahlem and Rhein-Main both believe that there is no lack of emphasis on chemical warfare defense

training. At Rhein-Main, they cited a 90-percent fill rate for their courses.

The disaster preparedness officials said that there is no requirement that personnel wear a full ensemble, including the mask, for 6 continuous hours, as there is in the Army, although wearing the full ensemble for 1 to 2 hours is common in exercises and inspections. The recent trend is that personnel stay in their full ensembles for longer than 1 or 2 hours. For example, in the SALTY DEMO exercise at Spangdahlem, personnel wore full ensembles for hours, removing their overgarments and masks only when they were in collective protection facilities. The longest time they had stayed in full ensemble before that exercise was between 45 minutes and 2 hours. At Rhein-Main, disaster preparedness officials said that their personnel have stayed in full ensemble for no more than 3 to 4 hours during exercises.

At Rhein-Main, disaster preparedness officials said that task qualification training requires security police, civil engineers, and others in functional positions to have their staff perform mission-essential tasks in full ensemble in order to identify additional time or modification necessary to complete such tasks in a chemically contaminated environment and to minimize the degradation of performance under the full ensemble. The Rhein-Main officials do not monitor this training or maintain unit training records, believing that a unit's performance during an exercise or inspection is sufficient to identify any training problems.

According to the USAFE disaster preparedness chief, USAFE personnel are trained to use chemical warfare defense equipment and are familiar with procedures. In addition to the annual training that the disaster preparedness personnel give, USAFE training occurs in various exercises and inspections. Quarterly SALTY NATION exercises include a chemical "attack." NATO tactical evaluations, operational readiness inspections, and management effectiveness inspections also include examinations of equipment and procedures. USAFE and base officials stated that they believe personnel practice chemical defense training probably two to four times a year. Decontamination teams were estimated to practice two to three times a year.

Medical training

Air Force medical officers and medics receive their instruction in chemical warfare defense during their medical readiness training. This portion of their training amounts to a description of agents and introduction to the use of masks. However, the training center does not have enough masks for all the trainees to wear.

According to the USAFE surgeon and base medical officials, medical personnel participate in exercises that include chemical

"attack" scenarios across a base. At Spangdahlem and Rhein-Main, medical personnel have also deployed off base to a nontoxic location in an exercise scenario. At the SALTY DEMO exercise at Spangdahlem, medical personnel practiced providing medical care on the base with the survivable collective protection system in a chemically "contaminated" environment.

Regional medical center officials in Wiesbaden recently conducted an exercise in which one third of the hospital's staff was deployed for three consecutive 3-day weekends to a field-training site. This was in order to meet a new annual field medical Red Flag II training requirement and also to meet the hospital's annual training requirements all at one time.

The Rhein-Main clinic administrator stated that the medical decontamination team trains quarterly, even though regulations require it to train only once a year. Physicians receive formal training in chemical agents and the medical care of chemical casualties under combat in a course offered by the U.S. Army in the United States. The Wiesbaden officials said that they believed most physicians in USAFE attended this course because priority is given to applicants who are to be stationed overseas.

According to the USAFE surgeon and base medical officials, medical personnel receive their annual chemical warfare training from the chemical warfare noncommissioned officers in the bioenvironmental engineer's office rather than from disaster preparedness personnel. Rhein-Main has four noncommissioned officers in chemical warfare and Spangdahlem has two. USAFE Surgeon General Officials said that each USAFE base should have at least one. According to the chemical warfare noncommissioned officer in the Bioenvironmental Engineer's office at Rhein-Main and officials of the regional medical center in Wiesbaden, the annual and refresher training that they provide to all medical personnel is standardized and includes slides and a tape recording provided by Brooks Air Force Base, but at Wiesbaden, they expected to discontinue the slides and tapes and to start conducting their own instruction.

CONCERNS

The major areas of concern raised by officials in the three services are the realism of training exercises, the integration of chemical warfare defense with conventional tasks, support units, civilian personnel essential to missions, and amphibious attack.

Realism

The officials we talked to cited major concerns with unit training and training exercises. Many of their concerns stem from the traditional prerogative of commanders; that is, commanders set their own training and exercise priorities. As a result, some commanders comply with nuclear, biological, and chemical training

requirements and others do not. For example, the requirement to train in full protective posture is frequently subverted, and unpleasant operations like waste-relief procedures are not enforced. Consequently, the troops are not being prepared to survive encapsulated for extended periods of time.

For similar reasons, air operations exercises may not have much realism. For instance, air crews are allowed to fly without protective gear, chemical "attacks" do not occur before aircraft are ready to fly, and chemical warfare tasks are not allowed to interfere with other tasks such as the routine flying schedule.

According to USAREUR officials, a number of limitations on chemical play in major exercises have affected the realism of practicing operations in a simulated chemical environment.

According to V Corps chemical officials, proper and realistic exercises should have scenarios in which chemical "attacks" are sufficient to cause stress to the nuclear, biological, and chemical defense system.

Disaster preparedness officials at USAFE, Spangdahlem, and Rhein-Main stated that they believe exercises and inspections could be more realistic. For example, officials at the two bases said that realism could be improved by requiring personnel to stay in their full ensembles for a longer time. One also suggested that the use of simulants would improve realism and could give unit commanders a better idea of the impact a chemical attack would have. Further, the use of simulants would assist in training the detection teams. However, the USAFE disaster preparedness chief stated that training exercises are becoming more realistic, partly because personnel are being required to spend a longer time in full ensemble.

Integration

Nuclear, biological, and chemical warfare training is reportedly not well integrated with conventional operations training, not only at lower levels, such as weapon use and casualty treatment, but particularly at higher levels, where multiple objectives are pursued. Consequently, the potential for synergistic effects cannot be considered. Similarly, there is a lack of combined exercises across work areas. Training exercises may occur at the top level but not in conjunction with different ways of operating in a chemical warfare environment. Medical participation in exercises has been minimal.

According to USAREUR training command officials of the 7th Army, USAREUR has no plan for progressive, general defense,

position-driven, collective nuclear, biological, and chemical training. USAREUR's training command has recognized the need for a more systematic approach and is developing one that will integrate training in chemical defense with other mission training.

Support units

USAREUR officials told us that adherence to training requirements depends to a great degree on the commitment of commanders, so that it does sometimes slip, especially with combat service support units, whose "real world" missions often compete with training time. USAREUR chemical warfare officials from command, V Corps, the 3rd Armored Division, and the 21st Support Command all acknowledged that combat and combat support units are generally better trained than combat service support units.

According to officials of the 21st Support Command, training standards for operating in a contaminated environment do not exist for combat service support units. For some, there is no training and evaluation program; where there is an ARTEP, it is not fully integrated with tasks and standards in nuclear, biological, and chemical defense. The chemical company and combat equipment group unit we visited in the 21st Support Command did not have an ARTEP, and officials there pointed out that nuclear, biological, and chemical warfare training is often conducted "off-line" because of time constraints and the degrading effect it can have on other exercise objectives. They told us also that one disadvantage is that, unlike the combat units, combat service support units do not practice chemical defense at the military training areas. Their opportunities for realistic, integrated training are, therefore, limited.

Nuclear, biological, and chemical warfare training is unavailable in some USAREUR hospitals. According to officials of the 7th Medical Command, at least 5 of the 11 USAREUR hospitals do not have a training program. They noted that it is very difficult to conduct training because clinic commanders and section chiefs at these hospitals do not support it. We were told that doctors and nurses do not have any special medical expertise for nuclear, biological, and chemical warfare.

During the REFORGER exercises in 1984 and 1985, officials of the 21st Support Command found that

Civilian personnel

Only persons essential to U.S. missions are required to participate in chemical warfare defense training and are issued individual chemical protection ensembles, according to USAFE and

base officials. The Rhein-Main disaster preparedness chief said that 17 U.S. civilians are performing mission-essential tasks and that the base was identifying foreign nationals in mission-essential positions. Some but not all Germans in mission-essential positions would be available for conscription into the German army reserves during war and would probably then be assigned to their mission-essential positions with the U.S. military. But a disaster preparedness official stated that foreign nationals' holding mission-essential positions is an issue that gets more complicated when nationals other than Germans work for the U.S. military in Germany, partly because their obligations in war are not clear.

Support Command officials told us that since training for local citizens has been suspended, there are about 13,400 essential employees within the 21st Support Command who have not received training in nuclear, biological, and chemical warfare. Training them is a priority, however, because they are an integral part of missions in the rear combat and communications zones. The chemical warfare officer was confident that, if it were necessary, essential local citizens could be given postmobilization training in nuclear, biological, and chemical warfare survival techniques in 1 day.

Amphibious training

In late 1983 and early 1984, a simulated attack was launched against Navy and Marine Corps amphibious forces in a full-scale training exercise involving three classes of ships, landing crafts, control boats, beach group equipment, transport and attack helicopters, and engineering and medical equipment. The exercise was formally evaluated for the effects of a chemically contaminated environment on critical tasks during an amphibious operation.

The Marine Corps personnel were found to be knowledgeable about defense procedures and doctrine, but they had not been trained under full protective conditions for extended periods of time. Navy personnel demonstrated a notable lack of mission performance experience under simulated chemical warfare conditions. Medical decontamination procedures were not properly accomplished, because medical and damage control personnel and litter bearers did not understand chemical defense procedures or the requirements for handling casualties in chemical warfare.

and
one of the major corrective actions that were proposed was to increase training in individual and organizational chemical warfare defense.

SUMMARY

In this chapter, we presented information to help answer the question, What progress has DOD made in providing individuals and

units with training to support the probability that their response to a chemical attack would be automatic and precise and that their discipline would be maintained in a chemically contaminated environment? We conclude that the Army has improved the training of its Chemical Corps and that USAFE has improved its exercises in a simulated chemical warfare environment.

However, all the services need more realism in exercises, increased integration of conventional tasks in exercises, and more participation of combat service support units. The chemical warfare readiness of U.S. troops is in doubt, because of these needs. The evidence indicates that many military personnel may be unaccustomed and would not react automatically to the stress of a chemically contaminated environment.

CHAPTER 7

U.S. AND NATO AGREEMENTS AND CONCERNS

In this chapter, we describe some of the formal bilateral and multilateral agreements in effect between the United States and other members of NATO. We also delineate some of the concerns raised by ministry of defense officials in NATO and others knowledgeable about the U.S. chemical defense program.

FORMAL AGREEMENTS

We found two basic types of formal agreement: exchange agreements and standardization agreements.

Exchange agreements

The United States has agreements for the exchange of data with Belgium, Denmark, the Federal Republic of Germany, France, Great Britain, Italy, the Netherlands, and Spain as well as Canada. The U.S. chemical defense establishment also exchanges scientists and has military liaisons with some of these nations. In general, the nations' ministry of defense officials believed that the agreements work well. In the remainder of this section, we describe briefly some of the data-exchange agreements that the United States has signed.

A memorandum of understanding for a cooperative program on the research, development, production, and procurement of chemical and biological defense material was ratified in 1980 by the United States, Canada, and Great Britain. The specific objective of the memorandum is to set up procedures to integrate the chemical and biological defense programs of the three nations in order to maximize their capabilities and standardization while minimizing costs. British research and development officials said that the agreement is the key to cooperation and collaboration, because it provides for joint research, development, and procurement. Our review of the February 1985 status report on the agreement indicates that the various working groups and task forces organized under its auspices are very active and have achieved numerous accomplishments.

The basic standardization agreement of 1964 between the United States and Australia, Canada, and Great Britain has the purpose of ensuring the greatest possible cooperation, coordination, interoperability, standardization, and economy by the use of combined resources and efforts.

The United States has signed general mutual weapons development master data-exchange agreements with the Federal Republic of Germany, Italy, the Netherlands, and Spain. These agreements do not necessarily include specific implementing agreements or annexes on chemical and biological defense.

However, the United States and the Netherlands have added annexes to their agreement in eight technical areas specifically related to chemical and biological defense.

Belgium and the United States established a general agreement in the 1960's on the exchange of data from research and development. In addition, U.S. officials have been considering requesting Italy to enter into a specific implementing agreement for chemical defense, but Italian ministry of defense officials have stated that an agreement such as this is unnecessary.

In late 1984, the U.S. Army Materiel Command submitted eight formal proposals to the Spanish ministry of defense under the provisions of a 1982 complementary agreement on defense industrial cooperation of the agreement on friendship, defense, and cooperation between the United States and Spain. The proposals included the joint identification of specific technological areas for which additional annexes to the master data-exchange agreement might be prepared, the evaluation of Spanish defense products, the standardization of testing procedures, exchange visits, and other cooperative activities. However, these proposals were general rather than related specifically to chemical warfare defense.

Standardization agreements

The purpose of standardization agreements is to enable the NATO signatories to achieve the closest practicable cooperation between their armed forces and the most efficient use of research, development, and production resources. With standardization, they agree to adopt, on the broadest possible basis, the use of common or compatible operational, administrative, and logistics procedures and technical procedures and criteria; common, compatible, or interchangeable supplies, components, weapons, or equipment; and common or compatible tactical doctrine with corresponding organizational compatibility.

The standardization agreements in nuclear, biological, and chemical defense are promulgated by three working groups: a working party on operational agreements and a working party on medical agreements, both under the military committee (on the military side of NATO), and a third group, called Panel VII, under the armaments director (on the civilian side of NATO), which promulgates agreements related to research and development. Table 7.1 on the next page lists the currently applicable agreements in each of these areas and gives their promulgation dates. It should be noted that standardization agreements are not the only NATO documents addressing issues related to standardization, particularly in Panel VII.

According to the U.S. delegates to the working parties, standardization agreements are implemented by the member nations, each under its own doctrine. Without implementation, the

Table 7.1

NATO's Standardization Agreements on Nuclear,
Biological, and Chemical Warfare^a

<u>Number</u>	<u>Title</u>	<u>Type</u>	<u>Effective date</u>
2002	Warning Signs for Marking of Contaminated Land Areas, Equipment, and Supplies	Operational	1980, amended 1982
2047	Emergency Alarm of Hazard or Attack	Operational	1983
2103	Reporting NBC Attacks and Predicting and Warning of Associated Hazards	Operational	1983
2133	Vulnerability Assessment of Chemical and Biological Hazards	Operational	1970, amended 1984
2150	NATO Standards of Proficiency for NBC Defense	Operational	1982, amended 1983
2352	NBC Defense Equipment Operational Guidelines	Operational	1977, amended 1982
2353	Evaluation of NBC Defense Capabilities	Operational	1975, amended 1980
2358	First Aid and Hygiene Training in NBC Operations	Medical	1975
2500	NATO Handbook on the Medical Aspects of NBC Defensive Operations	Medical	1973, updated 1983
2871	First-Aid Material for Chemical Injuries	Medical	1978
2873	Concept of Operations of Medical Support in NBC Environments	Medical	1978
2941	Guidelines for Air and Ground Personnel Using Collective Protective Structures on Permanent Air Force Installations	Operational	1983
2984	Graduated Levels of NBC Threat and Minimum Individual Protection	Operational	1983
3864	The Measurement of Protection Provided to the Respiratory Tract and Eyes by Aircrew Equipment Assemblies Against NBC Agents in Particulate, Aerosol, and Vapor Form	Research and development	1981
3943	Physiological Requirements for Aircrew NBC Respirators	Research and development	1984
4155	NBC Protective Mask and Filter Screw Threads	Research and development	1981
4192	Design Criteria and Construction Parameters for the Contamination Associated with Combat Operations Centers and Pilot Briefing Facilities on Permanent Air Force Installations	Research and development	1983

^aThis table omits the agreements on nuclear defense that have no relevance to biological and chemical defense. "NBC" = nuclear, biological, and chemical.

agreements would be worthless. However, officials of the U.S. mission to NATO said that the agreements on nuclear, biological, and chemical defense are innocuous and, generally, very few nations formally implement them. In a similar vein, ministry of defense officials stated that the agreements are phrased so broadly that deviations are difficult to demonstrate.

As is evident from table 7.1, there are no standardization agreements on decontamination. According to U.S. officials, the reasons for this are largely political. The governments of some NATO nations believe that decontamination activities might give the appearance that they were preparing to fight a chemical war and might be reported this way in the domestic press. Nonetheless, the NATO decontamination-force goal states that the

United States will work with its NATO allies to resolve their differences regarding decontamination procedures.

MINISTRY OF DEFENSE CONCERNS ABOUT
THE U.S. PROGRAM

Ministry of defense officials were generally positive about the U.S. chemical defense establishment and its relationship with their nations. Similarly, some stated that some criticisms leveled against the U.S. program (for example, a tendency to "reinvent the wheel") were applicable to European programs. Nonetheless, they did in varying degree note some concerns with the U.S. program in testing, internal coordination, information-sharing, and cooperative research and development projects.

Testing

The ministry of defense officials generally agreed that the United States often retests or conducts additional tests on items produced and tested in Europe, but their attitudes toward this practice varied. The British stated that U.S. test standards are sometimes higher and sometimes lower than Great Britain's standards, because the United States uses a different testing methodology and reporting format and has a completely different philosophy on operational testing. The United States specifies every testing detail, while Great Britain provides broad testing guidance and allows greater discretion. The British officials believed that their methods are more subjective but allow items to be put into the field more quickly. They also implied that the U.S. expenditure of an additional \$1 million to retest the chemical agent monitor (CAM) was excessive.

The Dutch officials said that retesting is a general problem shared by European nations but that the United States is the worst offender. The problem is serious enough that Dutch firms are reluctant to enter the U.S. market because it is too much trouble and too expensive to submit their products to retesting in the United States. The Belgian officials concurred that the United States takes an unreasonably long time to complete tests and cited examples. However, even the Dutch officials, who were perhaps the most vocal critics, acknowledged that U.S. global defense commitments, and their inherent variety of climatic conditions, require higher design and testing standards.

Officials from some of the ministries of defense reported actions under way that may improve the situation. The British officials said that a multilateral group is currently working toward the greater standardization of tests. The Spanish officials cited some 1984 negotiations with the U.S. Army Materiel Command for the standardization of test procedures to avoid redundant testing, and the German officials referred to another ongoing bilateral effort. In a more general vein, the German officials suggested that problems may have resulted in the

past from their own failure to fully describe their testing procedures.

Internal coordination

The ministry of defense officials were generally unable to cite problems with the U.S. dissemination of European information on chemical defense. However, some officials stated that they believed that an apparent lack of coordination between the many independent offices and laboratories with chemical defense responsibilities in the U.S. Army, Navy, and Air Force may prevent or delay the dissemination of information. One Dutch research and development official viewed U.S. dissemination of foreign chemical defense data as a major problem, much worse than with other NATO allies. For example, a research report sent to several U.S. organizations, including the foreign technical exchange group at Wright-Patterson Air Force Base, was never circulated to other U.S. organizations as expected. We had heard a similar complaint from a British exchange officer at the U.S. Army Chemical School, who said that very few reports from the Army's research, development, and standardization group in Great Britain were made available to the Chemical School personnel.

Some officials cited an apparent lack of coordination in the U.S. program as the reason for dissemination problems. One Dutch research and development official said that no one seems to know how to locate or use the enormous amount of published information that is available in the United States. For example, one U.S. researcher proposed a major research effort to evaluate the effects of mustard gas, although similar U.S. research had already been done. The Dutch official recommended that a panel of European chemical defense experts review U.S. research proposals to avoid wasting research efforts. British officials also recommended that the various U.S. agencies and offices with chemical defense responsibilities coordinate their programs and activities before sending representatives to international chemical defense events.

Information-sharing

The ministry of defense officials generally stated that the numerous information-exchange agreements that the United States has with its NATO allies work well and that, overall, U.S. cooperation in chemical defense matters is excellent. However, while some members stated that the United States shares its test results and other chemical defense information, Belgian and Italian officials expressed a particular interest in obtaining more intelligence information on chemical threats. A former U.S. representative to NATO's Panel VII agreed that the U.S. unwillingness to share such information causes tension with its allies but added that the United States cannot risk compromising its sources in any intelligence area. U.S. officials contended

that each NATO nation receives information sufficient to direct its own chemical defense program.

British, Dutch, and German officials all stated that they had experienced difficulty obtaining timely U.S. test results. The German officials stated that U.S. officials are not permitted to share preliminary or draft test results and that final U.S. test reports seem to take a very long time to prepare. For example, Germany requested U.S. test results on the XM20 inflatable liner in mid-1983 but still had not received the report in August 1985. British officials in research and development stated that their relationship with the U.S. Chemical Research and Development Center is excellent but that many other chemical defense agencies within the U.S. services are sometimes slow in providing copies of test reports.

The Dutch officials stated a more general concern about U.S. policy on the exchange of technical information. They said that they had heard complaints from all types of technical experts in the Netherlands, not solely chemical defense experts, that obtaining information from U.S. sources is difficult and takes a long time. The Dutch officials in research and development added that the regular rotation of U.S. military personnel lessens the productivity of the exchange of data.

Cooperative research and development

Although the United States and members of NATO coordinate their research and development efforts to some degree, no cooperative research and development project has joint funding for specific items. In the opinion of a former U.S. representative to NATO's Panel VII, this is probably because each NATO nation is looking out for its own industry. The British officials stated that the United States and Great Britain are currently planning their first truly collaborative project--research and development for a detector. They credited the director of the Chemical Research and Development Center with motivating increased efforts at U.S.-British collaboration and expected to see more collaborative efforts in the future.

SUMMARY

The United States has several bilateral and multilateral agreements to exchange data with other NATO nations, and it exchanges scientists and has military liaisons with some of these nations. Some agreements are specific to chemical and biological defense, while others are more general. NATO ministry of defense officials generally believed that the agreements work well. The United States has also signed several of NATO's standardization agreements on the operational, medical, and research and development of chemical and biological defense (we identified 17 in all). The standardization agreements are supposed to be

implemented by each nation's doctrine, but officials of the U.S. mission to NATO believed that few nations formally implement them. They are described as innocuous and as having been phrased so broadly that deviations are difficult to demonstrate. There are no standardization agreements for decontamination, apparently because of its political sensitivity.

NATO ministry of defense officials were generally positive about the U.S. chemical defense establishment and its relationship with their nations. However, they noted some concerns. With respect to testing, concern was voiced about the U.S. tendency to retest equipment previously tested by other NATO nations. While acknowledging that this is partly justified by U.S. testing requirements, which differ from those of the other nations, the officials described the time and money spent on some retesting as nonetheless unreasonable and excessive. With respect to internal coordination, several officials remarked on its apparent lack within the U.S. chemical defense establishment and expressed concern about how poorly chemical defense information from Europe gets disseminated within that establishment. Several European officials reported difficulty obtaining timely U.S. test results. Others stated a particular interest in obtaining more intelligence information on the chemical threat, but U.S. officials believed that what is available is sufficient. With respect to cooperative research and development, officials noted that there are no specific, jointly funded development projects, although the collaborative development of a detector is being planned and other possible projects have been identified.

CHAPTER 8

DOD'S ASSESSMENT OF THE ABILITY TO SURVIVE

AND OPERATE IN CHEMICAL WARFARE

In the previous chapters, we presented information on the areas that, taken together, are critical to U.S. chemical warfare defense. In this chapter, we provide DOD's assessment of the ability of the U.S. armed forces to survive and operate in a chemically contaminated environment.

CAPABILITY ASSESSMENTS

Allowing for a Soviet chemical warfare threat, various DOD units have attempted to assess the effect of a chemical attack on the armed forces of the United States. It appears that DOD's assessments typically address capability in terms of survivability and sustainability. Sustainability is generally measured in numbers of days (or hours) and degree of mission degradation. We did not have the opportunity to critically review any of DOD's assessments, and we offer no judgment about the credibility of their results.

The office of the Deputy Assistant Secretary for Chemical Matters recently completed an assessment of the ability of each of the services to sustain operations in a chemically contaminated environment.

We requested either oral or written information on how these estimates were derived, but officials in the Office of the Secretary of Defense declined to provide any additional information, on the grounds that the contents of an internal document could not be released.

DOD officials in Europe generally agreed with the assessment described above. USAREUR officials concurred that supply is a potential problem not because replacement equipment is unavailable but because it is difficult to move forward (as we discussed in chapter 3). They also believed the command and control problem could be partly resolved with the addition of chemical battalions in Europe; the only U.S. chemical battalion is at Fort Hood, Texas. The USAREUR nuclear chemical division chief saw a serious command and control problem within units as well, simply from the

physical and psychological constraints of commanding in protective gear: the degradation of a commander's performance would be more severe than that of the troops.

USAFE and the Navy shore establishment concurred that their present ability to sustain operations is and agreed with the assessment of what is needed for improvement. However, USAFE forces would appear to be in a better position to survive an initial attack than Navy shore forces, because

They expected that the antisubmarine surveillance of aircraft squadrons and missions such as those of fleet ocean surveillance centers and communications, including gathering intelligence for the support of 6th fleet ships,

The results of other capability assessments have also pointed to the extreme vulnerability of U.S. Navy bases. A 1983 Navy survey of five overseas bases concluded that the bases had with respect to chemical defense (32). The report stated that the results of a chemical attack would be

A theater-wide survey by EUCOM looked at U.S. land, air, and sea forces; only the Navy shore establishment was assessed (33). When survival capability was divided by all NATO regions, the results were that

USAREUR, attempting to assess its own capability, estimated that its forces could operate on a chemical battlefield for and that

Degradation estimates ranged from depending on such factors as temperature. The factor that gave Army combat units some sustainability was mobility; unlike personnel at Air Force and Navy bases, they would not have to sustain operations in a contaminated environment. However, their mobility did not extend to rear facilities where, according to EUCOM officials, the loss of a unit's effectiveness could last In addition, repair and maintenance functions would be disrupted, and the movement of munitions from storage areas to bases would be severely restricted. A chemical warfare officer at a POMCUS site made a rough assessment, guessing that there would be

Degradation has been assessed from exercises also. The Army's principal exercise for this purpose is called the combined arms nuclear-chemical environment (CANE) force development training exercise. It is a force-on-force exercise to measure combat degradation from operating in protective posture. Phase I, conducted in 1984 with combat troops only, identified numerous sources of degradation. (Future phases were planned for combat support and combat service support troops.) Compared to soldiers in conventional warfare, soldiers in the nuclear and chemical environment believed they could not

Finally, degradation has been assessed from individual performance tests. For example, a 1979-80 Army study to establish the range of effects from heat stress in terms of combat efficiency was partly responsible for the Army's subsequent doctrinal shift away from 100-percent protection (34).

KNOWLEDGE GAPS

DOD officials concede that estimating sustainability and degradation reliably is difficult. An important reason for the difficulty is the large knowledge gap about warfare on a contaminated battlefield. Below, we describe the lack of knowledge in three areas: the medical effects of chemical agents, their nonmedical effects, and performance degradation from fighting in a protective posture. Our presentation is not exhaustive.

The medical effects of chemical agents

The following is essentially a list of what is not known about the chemical agents. Little or nothing is known about the interactions of wounds from chemical and conventional warfare, the compatibility of planned chemical therapies with anesthesia, and the synergistic effects of two or more chemical agents. The long-term physiological and psychological effects of chemical agents are unknown. Medical symptoms have not been translated into military symptoms, such as the effects of miosis on aiming

a rifle. Current models cannot predict casualty rates and are viewed as 20 years out of date, and the data on the numbers and types of patients expected to require treatment for contamination are viewed as inadequate. Estimates of medical effects have been based on extrapolations from data on animals, but their applicability to humans is not known.

The nonmedical effects of chemical agents

The following are knowledge gaps about the nonmedical effects of chemical agents. The data and qualitative and quantitative estimates of the effects of chemical agents and contaminated fuel on personnel and equipment are viewed as inadequate. The available data do not permit clear definitions of the degree of protection that protective gear should be designed for. Chemical and conventional weapons are expected to be used in combination, yet models of ballistics and chemical effects have never been integrated. There are no realistic models of the effects of chemical agents beyond 6 to 12 hours.

Army officials consistently cite the open-air test ban legislated in 1968 as a major impediment to building a data base on the effects of chemical agents. For example, a piece of metal can be contaminated in a chamber, but what this means for a tank, which has cracks, crevices, and great mass, is not known. According to Army officials, modeling chemical effects is in order of magnitude more complicated than modeling high explosives because of factors such as temperature, humidity, terrain, time of day, and so on. Simulants can help estimate dispersion and penetration, but Army testing officials have expressed little confidence in extrapolating from data on simulants to live agents.

Performance degradation

Unlike the effects of chemicals, the degradation of human performance can be tested empirically on human subjects, in collective exercises and individual performance tests, as we noted earlier. But constraints on these studies have left knowledge gaps. For example, a contractor hired to make an independent evaluation of the exercise called CANE I cited numerous flaws in it: a late start on planning and a lack of coordination with the test agency, uncharacteristic weather conditions, poorly trained troops, inadequate tactical realism, and inadequate data-collection plans with inexperienced data collection personnel. In addition, EUCOM officials stated that the scale of CANE was too small. They believed a force-on-force exercise at corps level would be needed to determine the degradation of a large force. In the meantime, the Army's mission area development plan continues to cite as doctrinal deficiencies both the unavailability of data on the relationship of protective posture to mission capability and an inability to estimate force effectiveness in a nuclear and chemical environment (35).

Studies assessing individual performance degradation can exploit physiological models and are probably more reliable than collective exercises, but they have limitations. For example, the Army Surgeon General prohibits pushing soldiers to the point of collapse, so that some extrapolation from models is required. According to Army experts, physiological models cannot predict when soldiers will become casualties of heat stress, particularly under battle conditions, and the models have tremendous sensitivity to meteorological and other parameters. Finally, the models assume that soldiers are well trained, implement doctrine by the book, and become chemical casualties as the models predict, assumptions that are limited by the models' limitations.

SUMMARY

Assuming a Soviet chemical warfare threat, DOD has attempted to assess the effect of a chemical attack on U.S. armed forces. In general, DOD's assessments conclude that

Exercises measuring decrements in performance from operating in protective equipment show them to be considerable.

Estimating sustainability and degradation is complicated by the large gaps in what is known about warfare on a chemically contaminated battlefield. Much remains unknown about the medical and nonmedical effects of chemical agents and about performance degradation.

CHAPTER 9

CONCLUSIONS

In this chapter, we bring together the information we found on the four questions we discussed in the previous chapters on doctrine, equipment and materiel, force structure, and training. It is clear that the data that were available did not permit clear-cut answers on adequacy and effectiveness: progress has been made in some areas and is lacking in others. However, DOD has ongoing efforts to improve the unsatisfactory areas.

DOCTRINE

In this section, we summarize our answers to the question about DOD's progress in developing the doctrine needed to support individual and joint military operations in a chemically contaminated environment. The Army has implemented an intensive program for revising and rewriting nonmedical chemical warfare doctrine and is well along in this effort. The Air Force is also making progress, to a somewhat lesser extent, in its program of doctrine development. The Navy is further behind the other services, having made progress mainly toward identifying its basic doctrinal needs.

Our review shows that medical doctrine is not yet well along in development, and this constitutes an important gap. Concern has also been raised about doctrine for decontamination and defense operations in rear combat zones. DOD and the services are aware of these deficiencies and are attempting to overcome some of the impediments to developing appropriate doctrine in these areas. At present, therefore, chemical warfare doctrine can best be described as in transition; it is too early to judge the adequacy of the present doctrine.

The data required for a judgment such as this have to be collected from training and field exercises over a period of time. The Air Force and Navy programs need to move forward, so that the necessary information on the appropriateness of the new doctrine can be accumulated and analysed.

EQUIPMENT AND MATERIEL

What progress has DOD made in developing and procuring equipment and materiel that would enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment? Early in our review, top-level DOD officials explained to us that the long period of neglect in chemical warfare capability has meant the use of off-the-shelf equipment and materiel in a crash program to implement the

modernization program while research and development programs were being launched to address the many known inadequacies and gaps. With this policy, it is not surprising that the procurement of equipment and materiel cannot be viewed as effective for improving DOD's defensive capability, at least this early into the modernization program. Most of the equipment procured since DOD's 1982 report to the Congress consists of previously available items with well-documented problems, so that the best that can be said

Progress in recent research and development efforts appears to be extremely slow, and most of the programs seem plagued with delays. Only a small percentage of the presently available items can be attributed to these efforts. DOD officials are aware of this and have taken several initiatives to improve the process, but their effectiveness cannot yet be assessed. Generally, a major increase in defensive capability through newly developed equipment and materiel is several years from realization. Moreover, some of the requirements for equipment that were identified in 1982 are now regarded as highly unrealistic, even in the long term.

FORCE STRUCTURE

What progress has DOD made in establishing a force structure that would permit U.S. forces to carry out training, reconnaissance, decontamination, and other defensive missions in chemical warfare? In the 1982 report to the Congress, the Army proposed an increase from 1982's 6,800 chemical specialists to 24,000 by 1987. The 1985 number was 9,000. The Air Force proposed an increase in disaster preparedness specialists from 850 to 1,850 in the same period. The 1985 number was 1,500. It does not seem feasible, given personnel ceilings, that the Army and Air Force can meet their proposed numbers for 1987. The Navy does not have a chemical warfare force structure; it is a duty collateral to duties in other specialties. The Navy proposed no increase in 1982, and the present number of individuals responsible for chemical duties in the Navy cannot be determined because of the lack of force structure.

It is evident from the shortages in personnel numbers and skills that the services do not have sufficient chemical forces to accomplish missions in a chemically contaminated environment. Their reliance on augmentees is a clear indication of this. Moreover, a reliance on augmentees exacerbates the situation, since requests for them often exceed the number of personnel available for such duties. Similarly, additional new equipment will require additional personnel. For example, the requirement

to operate the SCPS-2 for USAFE is described as an unsupportable command requirement, given the number programmed for the decade.

TRAINING

Does the training received by individuals and units support the probability that their response to a chemical attack would be automatic and precise and that discipline would be maintained in a chemically contaminated environment? The Army Chemical School has a very impressive training program for Chemical Corps officers and enlisted personnel. The Air Force training of disaster preparedness specialists has not changed recently, but USAFE has considerably improved its efforts to exercise its troops in a simulated environment. Nevertheless, across the services, there are major problems with unit training and exercises.

DOD officials believe that many of the problems stem from the prerogative of local commanders--that is, commanders traditionally set training and exercise priorities. Some comply with training requirements, and others do not. Other problems cited frequently include the following: (1) Important functions such as taking food and eliminating body waste are not integrated into chemical warfare exercises, and it is difficult to accomplish these functions in a contaminated environment. (2) Chemical warfare exercises are not allowed to interfere with areas perceived to be more important, such as flight schedules, logistics, supplies, and communications. (3) Medical participation in exercises is minimal. (4) Exercises are rarely performed across functional areas in an operational environment. (5) Chemical warfare training is not well integrated into a conventional warfare context; consequently, the potential for synergistic effects cannot be measured. Overall, the evidence indicates that many troops might not react automatically, because they are unaccustomed to stress in a chemically contaminated environment.

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CHIEF OF STAFF

Congress of the United States
Committee on Foreign Affairs
House of Representatives
Washington, D.C. 20515

August 29, 1984

Mr. Charles A. Bowsher
Comptroller General
of the United States
General Accounting Office
Room 7026
441 G. Street, N.W.
Washington, D.C. 20548

Dear Mr. Bowsher:

In 1982, DOD submitted a five year plan to upgrade both our defensive and retaliatory chemical warfare capability. A previous GAO report, entitled Chemical Warfare: Many Unanswered Questions, used a synthesis methodology to develop information for this Committee on many aspects of this capability.

In view of the fact that a credible chemical defensive capability is an essential element in the deterrence of chemical warfare, and given the substantial financial resources that are being dedicated to this area, the Committee would now like GAO to follow-up on the previous study and evaluate the effectiveness of DOD's efforts to enhance the chemical defensive posture of U.S. forces. Clearly, a primary data collection methodology would be appropriate for this follow-up study.

The following questions, which are derived from the objectives stated in DOD's 1982 plan, are of particular interest to the Committee:

- Does DOD have, or is it developing, adequate doctrine to support individual and joint military operations in a chemically contaminated environment?
- How effectively is DOD developing and procuring equipment and material that will enable U.S. forces to survive chemical attacks and sustain operations in a chemically contaminated environment?

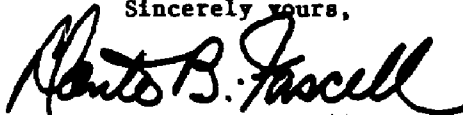
Mr. Charles A. Bowsher
August 29, 1984
Page Two

- Has DOD established adequate force structures to carryout training, reconnaissance, decontamination and other chemical defensive missions?
- What is the quality of the training received by individuals and units? Does it support the probability that their response to a chemical attack will be automatic and precise, and their discipline maintained while in a chemically contaminated environment?

We recognize that a comprehensive evaluation of DOD's defensive chemical warfare program is not possible in a short time frame. However, discussion between my staff and staff of your Program Evaluation and Methodology Division indicate that a Statement of Fact could be provided by the spring of 1985, with an expanded report to follow later in the summer of 1985.

If you have any questions regarding this request please contact Mr. Ivo J. Spalatin of my staff at 225-8926.

Sincerely yours,



Dante B. Fascell
Chairman

DBF:EHdmh

ORGANIZATIONS WE VISITED

During our review, we interviewed officials of the following organizations.

OFFICE OF THE SECRETARY OF DEFENSE

Assistant to the Secretary (Atomic Matters), Deputy Assistant
(Chemical Matters)

Director, Program Analysis and Evaluation

Joint Logistics Command

Under Secretary--Research and Engineering, Panel on CB Defense

JOINT CHIEFS OF STAFF

Director J-5 (Plans and Policy), Assistant Deputy Director for
Force Development and Strategic Planning

Nuclear/Chemical Division, Chemical Warfare Branch

DEFENSE INTELLIGENCE AGENCY

Defense Intelligence Analysis Center

U.S. ARMY

Armament, Munitions, and Chemical Command:

Chemical Research and Development Center

Army Material Command, Headquarters

Chemical Division

NBC Materials Branch

Assistant Chief of Staff, Intelligence, Foreign Intelligence
Directorate

Aviation Systems Command, Aviation Life Support Equipment Office

Deputy Chief of Staff, Operations and Plans, Nuclear and Chemical
Directorate, Chemical and NBC Division

Deputy Chief of Staff, Personnel, Military Personnel Management,
Combat Support

Deputy Chief of Staff, Research, Development and Acquisition:

International Office

Support Systems Division, Coordinating Office for Chemical
Matters

Forces Command:

Nuclear Chemical Division, Chemical Branch

III Corps (Fort Hood)

7th Infantry Division--Light (Fort Ord)

Health Systems Command, Academy of Health Sciences

Medical Research and Development Command:

Medical Chemical Defense Research Program

Military Diseases, Hazards Research Program

Military Personnel Center:

Office of Personnel Management, Chemical Branch

Nuclear and Chemical Agency, Chemical Division

Surgeon General:

Assistant Surgeon General for Research and Development,
Director, Research Programs

Directorate of Health Care Operations, Doctrine Policy and
Organization Division

Tank and Automotive Command, Project Office of Vehicle NBC
Protection

Test and Evaluation Command, Dugway Proving Ground

Training and Doctrine Command:

Army Chemical School

NBC and Tactical Nuclear Warfare Directorate

Troop Support Command, Natick Research and Development Center

U.S. ARMY IN EUROPE

V Corps Headquarters, Frankfurt, Germany

3rd Armored Division Headquarters, Frankfurt, Germany

22nd Chemical Company, Frankfurt, Germany

7th Medical Command Headquarters, Heidelberg, Germany

Heidelberg Army Hospital, Heidelberg, Germany

Bad Canstaat Army Hospital, Stuttgart, Germany

32nd Combat Support Hospital, Weisbaden, Germany

21st Support Command Headquarters, Kaiserslautern, Germany

29th Area Support Group, Kaiserslautern, Germany

General Support Center, Kaiserslautern, Germany

66th Maintenance Battalion, Kaiserslautern, Germany

Equipment Support Maintenance Center, Kaiserslautern, Germany

10th Chemical Company, Kaiserslautern, Germany

Combat Equipment Group, Karlsruhe, Germany

U.S. NAVY

Chief of Naval Education and Training:

Surface Warfare Training

Combat Readiness and Tactical Development

Commander of Training, Atlantic Fleet, Fleet Training Center,
Damage Control School

Deputy Chief of Naval Operations, Air Warfare, Aircraft
Requirements Branch

Deputy Chief of Naval Operations, Surface Warfare:

Ship Characteristics and Improvement Board Staff

Surface Training Branch

Headquarters, U.S. Marine Corps, Plans, Policies, Operations
Division

Marine Corps Development and Education Center:

Doctrines Department

Firepower Division

Naval Facilities Engineering Command:

Readiness Planning Division

Assistant Commander of Research, Development, Testing and
Evaluation Division

Naval Material Command, Theater Nuclear Warfare Office

Naval Medical Command:

Deputy Commander for Fleet Readiness and Support

Health Sciences Education and Training Command

Military Professional Training Branch

Navy Medical Research and Development Command

Naval Sea Systems Command:

Research and Development Technology Office

Collective Protection System Project Office

Ship Survivability Subgroup

Naval Surface Weapon Center:

Chemical Systems Branch

Survivability Office

Naval Training Equipment Center, Human Factors Laboratory

Office of Naval Research:

Chemistry Division

Naval Research Laboratory

Office of Naval Technology

U.S. NAVY IN EUROPE

Commander in Chief Naval Forces in Europe

U.S. NAVSTA Rota Headquarters, Rota, Spain

Air Operations Division, NAVSTA Rota, Sigonella

U.S. Naval Station (NAVSTA) Keflavik Headquarters, Keflavik,
Iceland

Iceland Defense Force Headquarters, NAVSTA Keflavik, Iceland

Explosive Ordnance Disposal Detachment, Disaster Preparedness
Office, NAVSTA Keflavik, Iceland

Naval Hospital, NAVSTA Keflavik, Iceland

Naval Security Group Activity, NAVSTA Keflavik, Iceland

U.S. Naval Facility, NAVSTA Keflavik, Iceland

VP-10 Patrol, NAVSTA Keflavik, Iceland

Sixth Fleet Headquarters, U.S.S. Puget Sound (AD-38), Gaeta,
Italy

U.S.S. Moinester (FF-1097), Gaeta, Italy

U.S. AIR FORCE

Air Training Command:

Health Education and Training Division

3460 Technical Training Group, Disaster Preparedness Branch

Assistance Chief of Staff--Intelligence, Strategic Branch

Deputy, Chief of Staff--Research, Development and Acquisition:

Tactical Division

6.2/6.3 and 6.4 Chemical Warfare Program Element Monitors

Deputy Chief of Staff--Plans and Operations:

Air Base Survivability Group

Disaster Preparedness Resource Center

Doctrine and Concepts Division

Logistics Command:

Wright Patterson Air Force Base

Kelly Air Force Base

Surgeon General, Medical Readiness Division

Systems Command:

Aeronautical System Division, Life Support System Program
Office

Armaments Division, Air Base Survivability

Aerospace Medicine Division, 6.2 Chemical Warfare Research and
Development

Tactical Air Command:

Disaster Preparedness Office

Tactical Air Warfare Center, Chemical Warfare Division

U.S. AIR FORCE IN EUROPE

Headquarters U.S. Air Force Europe:

Vice Commander in Chief

Disaster Preparedness

Logistics

Surgeon

52nd Tactical Fighter Wing, Spangdahlem Air Base:

Wing Commander

Vice Wing Commander

Base Commander

Deputy Base Commander

Disaster Base Commander

52 TFW Supply Squadron

USAF Clinic Spangdahlem

Plans

Military Personnel Office

Civil Engineering

435th Tactical Air Wing, Rhein-Main Air Base:

Disaster Preparedness

USAF Clinic Rhein-Main

Bioenvironmental Engineers

NONDEFENSE DEPARTMENT

Computer Science Corp.

Harvard University, Biochemistry Department, Cambridge,
Massachusetts

Honeywell, Inc., Chemical Defense Center, Clearwater, Florida

Illinois Institute of Technology, Chemistry Research Section,
Chicago, Illinois

Southern Research Institute, Chemical Defense Division,
Birmingham, Alabama

Southwest Research Institute, Division of Chemistry and Chemical
Engineering, San Antonio, Texas

Rice University, President, Houston, Texas

BELGIUM

U.S. Mission to the North Atlantic Treaty Organization, Brussels

Political-Military Office, U.S. Embassy, Brussels

Ministry of Defense, Brussels

FEDERAL REPUBLIC OF GERMANY

Defense Attache Office, U.S. Embassy, Bonn

U.S. Army Research, Development, and Standardization Group, Bonn

German Atomic, Biological, and Chemical Self Protection School,
Sonthofen

GREAT BRITAIN

U.S. Army Research, Development, and Standardization Group,
London

Chemical Defense Establishment, Porton Down

Nuclear, Biological, and Chemical Confer, Porton Down

Ministry of Defense, London

ITALY

Political-Military Office, U.S. Embassy, Rome

U.S. Office of Defense Cooperation, U.S. Embassy, Rome

Ministry of Defense, Rome

THE NETHERLANDS

Defense Attache Office, U.S. Embassy, The Hague

U.S. Office of Defense Cooperation, U.S. Embassy, The Hague

Prins Maurits Laboratorium, The Hague

Ministry of Defense, The Hague

SPAIN

Political-Military Office, U.S. Embassy, Madrid

Defense Attache Office, U.S. Embassy, Madrid

Joint U.S. Military Assistance Advisory Group, Madrid

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