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CHEMICAL AND BIOLOGICAL DEFENSE

Observations on Nonmedical Chemical and Biological R&D Programs

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Mr. Chairman and Members of the Subcommittee:

We are pleased to be here today to discuss our report on the coordination of federal nonmedical research and development programs that address chemical and biological threats.[1] In the last decade, concerns about the possible use of chemical and biological weapons in both military and civilian settings led Congress and federal agencies to implement new or expanded programs to address these threats. Overall funding in this area increased significantly from 1996 to date. Today, several civilian and military agencies are now conducting research and development programs designed to counter these threats. Without effective coordination among the different agencies, efforts might be unnecessarily duplicated and important questions might be overlooked.[2] Our testimony today identifies similarities among nonmedical research and development programs and explains how coordination mechanisms may ineffectively address potential duplication, research gaps, and opportunities for collaboration.

Nonmedical research and development focuses on developing techniques for detecting, identifying, or protecting against chemical and biological agents as well as for decontaminating personnel and equipment. The scope of our work was limited to federal programs that fund unclassified research and development. We examined four programs: (1) the Department of Defense's Chemical and Biological Defense Program, (2) the Defense Advanced Research Projects Agency's Biological Warfare Defense Program, (3) the Department of Energy's Chemical and Biological Nonproliferation Program, and (4) the Counterterror Technical Support Program conducted by an interagency working group called the Technical Support Working

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[1] *Chemical and Biological Defense: Coordination of Nonmedical Chemical and Biological R&D Programs* (GAO/NSIAD-99-160, Aug. 16, 1999).

[2] See, for example, *Evaluating Federal Research Programs: Research and the Government Performance and Results Act,* National Research Council, National Academy Press, 1999.

Group. The intended users of the technologies developed in these programs may be a single military service (such as the Army), multiple services, or organizations that are responsible for addressing threats to civilians (e.g., federal, state, and local emergency response personnel).

SUMMARY

Each of the federally funded programs conducting nonmedical research and development on threats from chemical and biological agents has its own mission objective. However, we found many similarities among these programs in terms of the research and development activities they engage in, the threats they intend to address, the types of capabilities they seek to develop, the technologies they pursue in developing those capabilities, and the organizations they use to conduct the work. For example, these programs conduct a similar range of research and development activities, such as evaluating the feasibility or showing the practical utility of a technology. With regard to threat, two of the programs (those in the Department of Defense and Defense Advanced Research Projects Agency) focus on threats to the military, and the other two (those in the Department of Energy and the Technical Support Working Group) focus on threats to civilians. However, the military and civilian user communities are concerned about many of the same chemical and biological substances (such as nerve agents) and possible perpetrators (such as foreign terrorists). In addition, we found that these programs are seeking to develop many of the same capabilities, such as detection and identification of biological agents. Furthermore, the types of technologies (such as mass spectroscopy) they pursue to achieve those capabilities may overlap. Finally, these programs may contract with the same groups of laboratories to perform research and development work.

Although the four programs we examined currently use both formal and informal mechanisms for coordination, we found several problems that may hamper their coordination efforts. First,

participation in formal and informal coordination mechanisms is inconsistent. For instance, several of these mechanisms do not include representatives of the civilian user community. Second, program officials cited a lack of comprehensive information on which chemical and biological threats to the civilian population are the most important and on what capabilities for addressing these threats are most needed. Third, several programs do not formally incorporate existing information on chemical and biological threats or needed capabilities in deciding what research and development projects to fund. Having and using detailed information on civilian chemical and biological threats and the capabilities needed to respond to those threats would enable coordination mechanisms to better assess whether inefficient duplication or critical research gaps exist, and if so, what changes should be made in federal research and development programs.

BACKGROUND

Four federal programs that currently fund nonmedical research and development (R&D) on chemical and biological threats are described in table 1.

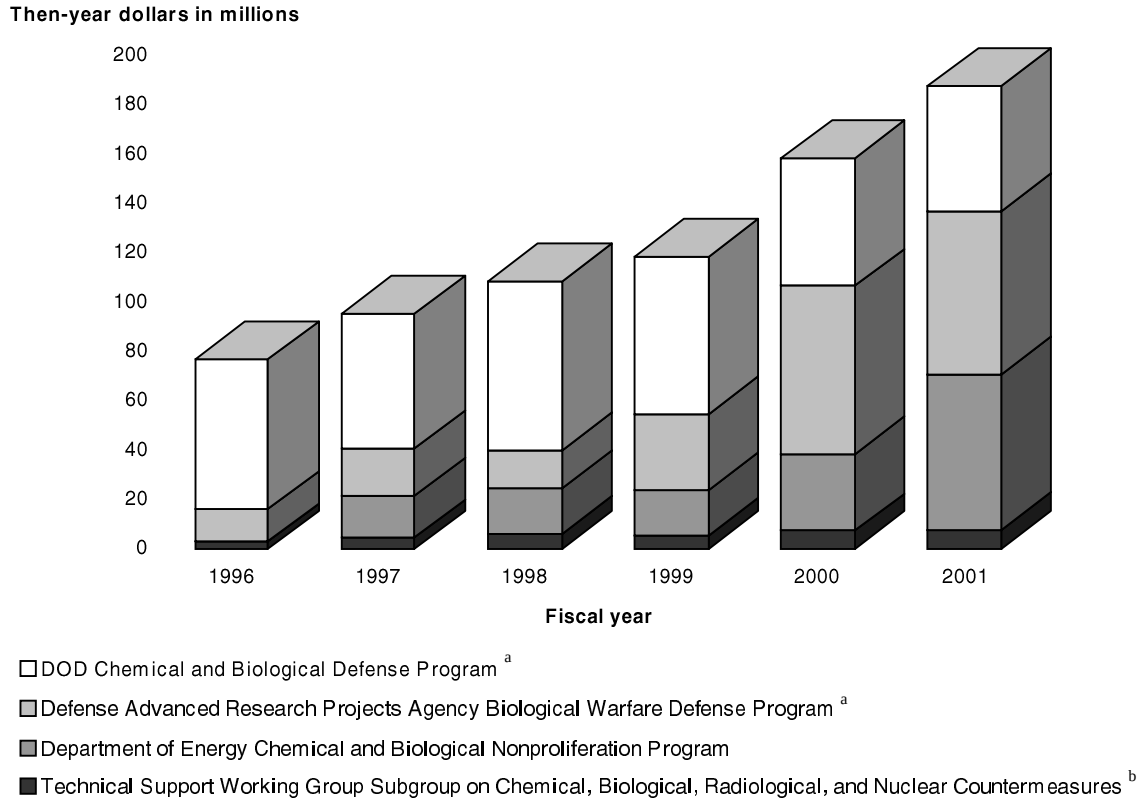
Table 1: Federal Programs Funding Nonmedical R&D on Chemical and Biological Threats

Agency	Program	Description
Department of Defense (DOD)	Chemical and Biological Defense Program	The objective of DOD's Chemical and Biological Defense Program is to enable U.S. forces to survive, fight, and win in chemically and biologically contaminated environments.
Defense Advanced Research Projects Agency	Biological Warfare Defense Program	This program funds R&D projects supporting revolutionary approaches to biological warfare defense, emphasizing high-risk, high-potential technologies.
Department of Energy	Chemical and Biological Nonproliferation Program	This program funds R&D to develop advanced technologies to enable the United States to more effectively prepare and respond to the use of chemical and biological weapons.
Technical Support Working Group	Counterterror Technical Support Program	The Technical Support Working Group is an interagency working group whose mission is to facilitate interagency R&D for combating terrorism primarily through rapid research, development, and prototyping. Their Subgroup on Chemical, Biological, Radiological, and Nuclear Countermeasures oversees, among other activities, the development of techniques to detect, protect from, and mitigate chemical and biological weapons.

Sources: GAO compilation of information from DOD, the Defense Advanced Research Projects Agency, the Department of Energy, and the Technical Support Working Group.

Program funding information, as of July 1999, is summarized in figure 1. Recently initiated non-DOD R&D programs have grown rapidly as compared to DOD's program. R&D funding for DOD's Chemical and Biological Defense Program decreased from $54.6 million in fiscal year 1997 to a projected $50.7 million for fiscal year 2001. In contrast, over the same period, R&D funding for Energy's program as well as for the Defense Advanced Research Projects Agency's program increased to the point of surpassing DOD's program. For instance, Energy's program went from $17 million in fiscal year 1997 to $63 million projected for fiscal year 2001.

Figure 1: Actual and Projected Funding for Nonmedical Basic Research, Applied Research, and Prototype Development Addressing Chemical and Biological Threats



[a] DOD and Defense Advanced Research Projects Agency budgets include only the nonmedical R&D categories of the DOD budget activities of basic research, applied research, and advanced technology development. The fiscal year 1997 DOD Chemical and Biological Defense Program budget excludes Defense Advanced Research Projects Agency funds, which were consolidated into the Chemical and Biological Defense Program for fiscal year 1997 only.

[b] The Technical Support Working Group is funded primarily through the Counterterror Technical Support Program within DOD. Our figures for the Working Group's budget only include funding originating in DOD for the Chemical, Biological, Radiological, and Nuclear Countermeasures Subgroup. Funding for fiscal years 2000-2001 assumes the same annual percentage change as that of total Working Group funding from DOD.

Sources: GAO compilation, as of July 1999, of data from DOD, Defense Advanced Research Projects Agency, and Department of Energy.

According to DOD, three key areas must be addressed in planning and implementing R&D for chemical and biological defense: (1) identifying, validating, and prioritizing chemical and biological threats; (2) delineating the capabilities needed to address those threats; and (3) allocating program resources to activities that develop those capabilities.[3] Assessing threats

[3] Other issues that DOD considers include their overall military vision, military concepts of operation, and opportunities stemming from technological advances.

may involve multiple dimensions of a threat, such as which particular chemical or biological agents may be used, how they may be delivered, and who might be the perpetrators. Delineating capabilities requires risk-based assessments to determine what capabilities, such as the ability to detect biological agents, are needed to address the threat. Allocating program resources includes deciding what research, development, testing, and evaluation projects to fund and making sure that projects address needed capabilities. We have previously testified before this subcommittee that civilian programs to combat terrorism require threat and risk assessments to help determine program requirements and to target resources where most needed.[4] By coordinating analyses of threats and user requirements, military and civilian programs could preclude duplication, address research gaps, and identify research projects that might benefit from consolidation or collaboration.

SIMILARITIES EXIST AMONG FEDERAL NONMEDICAL R&D PROGRAMS

We found similarities in terms of the research and development activities[5] that the four federal R&D programs engage in, the threats they intend to address, the types of capabilities they seek

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[4] See *Combating Terrorism: Observations on Federal Spending to Combat Terrorism* (GAO/T-NSIAD/GGD-99-107, Mar. 11, 1999) and *Combating Terrorism: Observations on the Threat of Chemical and Biological Terrorism* (GAO/T-NSIAD-00-50, Oct. 20, 1999). For more details on threat and risk assessment, see *Combating Terrorism: Threat and Risk Assessments Can Help Prioritize and Target Program Investments* (GAO/NSIAD-98-39, Dec. 1, 1997)."

[5] Types of R&D activities are as follows:

- Basic research involves the investigation of fundamental scientific knowledge, such as the basic physical properties of chemical and biological agents.
- Applied research refers to scientific investigation directed towards a technical goal, such as developing and evaluating the feasibility of proposed detection technologies. Applied research generally tests such technologies within a controlled laboratory environment.
- Prototype development is intended to show the practical utility and feasibility of a technology. In general, the initial prototype must be able to perform in an environment similar to that in which it will ultimately be used, though it may not be able to withstand all the stresses of operational use.
- Two other types of R&D activities, conducted primarily by DOD, are Demonstration/Validation and Engineering and Manufacturing Development. These two activities are part of DOD's acquisition cycle, and include the testing and evaluation of technologies.

to develop, the technologies they pursue in developing those capabilities, and the organizations they use to conduct the work. For example, all four programs engage in applied research and initial prototype development. Moreover, two—DOD's and Energy's—engage in basic research.

With regard to threat, two of the programs (those in the Department of Defense and the Defense Advanced Research Projects Agency) focus principally on threats to the military, and two (those in the Department of Energy and the Technical Support Working Group) focus on threats to civilians. However, some threats to the military and to the civilian population are similar and may involve the same chemical or biological agents or the same perpetrators. For instance, assessments of both military and civilian threats include concerns about biological toxins such as ricin, biological pathogens such as anthrax, toxic industrial chemicals such as chlorine, and chemical agents such as sarin. The military has traditionally concentrated on the battlefield use of chemical and biological agents by enemy nation-states. However, it has recently expanded its assessment of potential perpetrators to include foreign terrorists—one of the primary concerns of civilian programs.

In addition, we found that these programs are seeking to develop many of the same capabilities and are pursing similar technologies to achieve those capabilities. For example, all four programs are pursuing capabilities to detect and identify biological agents, and three of the four programs are pursuing the capability to detect and identify chemical agents. A summary of the capabilities pursued by each program is presented in figure 2. Furthermore, programs sometimes pursue similar technologies in developing these capabilities. Examples of technologies funded by both DOD and Energy include mass spectroscopy and flow cytometry, both of which may be used for detecting and identifying biological agents.

Figure 2: Chemical and Biological-related Capabilities Sought by R&D Programs

R&D area	DOD's Chemical and Biological Defense Program	Defense Advanced Research Projects Agency's Biological Warfare Defense Program	Department of Energy's Chemical and Biological Nonproliferation Program	Technical Support Working Group's Counterterror Technical Support Program
Biological detection and identification	X	X	X	X
Chemical detection and identification	X		X	X
Individual protection	X			X
Collective protection	X			X
Decontamination, restoration, and mitigation	X		X	X
Modeling and simulation	X		X	X
Other applied research (e.g., threat assessment, aerosol technology)	X		X	
Other basic research (e.g., aerosol science, genomic sequencing)	X		X	

Note: An **X** indicates that the program covers the specified capability, by either funding or soliciting for (e.g., through a broad agency announcement) R&D projects in that area. A blank indicates that the program does not cover the specified capability.

Sources: DOD, Defense Advanced Research Projects Agency, Department of Energy, and Technical Support Working Group.

Finally, these programs may contract with the same groups of laboratories to perform the research and development work. All four programs may contract with Energy's national laboratories, and these laboratories have been involved in multiple programs. DOD, Defense Advanced Research Projects Agency, and Technical Support Working Group programs also may contract with laboratories in DOD, industry, and academia.

CURRENT MECHANISMS MAY NOT FACILITATE EFFECTIVE COORDINATION OF R&D PROGRAMS

Although the four programs we examined currently use both formal and informal mechanisms for coordination, we found several problems that may hamper their coordination efforts. First, we found that participation in current coordination mechanisms, whether formal or informal, is inconsistent. Second, program officials cited a lack of comprehensive information on which chemical and biological threats to the civilian population are the most important and on what capabilities for addressing threats are most needed. More detailed information could help guide and coordinate R&D. Third, several programs do not formally incorporate existing information on chemical and biological threats or needed capabilities in deciding which R&D projects to fund. Because of these problems, these programs may not be developing the most important capabilities or addressing the highest priority threats.

Participation in Coordination Mechanisms Is Inconsistent

The four R&D programs we examined are coordinated through both formal and informal mechanisms. For example, the Counterproliferation Program Review Committee—which consists of representatives from DOD, Energy, and the intelligence agencies—is a formal mechanism that reviews and makes recommendations to Congress regarding programs addressing threats from nuclear, chemical, and biological weapons. According to officials involved in these four programs, informal coordination also occurs, through such means as informal briefings, scientific conferences, and participation in each other's planning and review meetings. We found, however, that participation in coordination mechanisms is inconsistent. For instance, the Counterproliferation Program Review Committee's responsibilities include reviewing Energy's program aimed at chemical and biological threats to civilians. However, the Committee does not formally include representatives from the civilian user community. Nor

have Energy's project planning and review processes involved potential civilian users. In addition, although Energy officials are invited to participate in R&D planning and review meetings of DOD's Chemical and Biological Defense Program, they have not consistently attended.

Comprehensive Information Is Lacking on Threats to Civilians and on Capabilities Needed to Address Those Threats

Program officials noted that they lack comprehensive information on civilian chemical and biological threats and on the capabilities needed to address civilian threats—information that could help guide and coordinate R&D. In our previous work on civilian programs to combat terrorism, we have found that these programs lack a comprehensive threat assessment for terrorist chemical and biological threats.[6] For instance, we reported that assessments of domestic-origin terrorists do not rank the specific chemical and biological agents that would most likely be used. By contrast, more detailed military threat assessments exist for chemical and biological threats from nation-states. In addition, specific chemical and biological agents are placed in priority categories that depend on the estimated likelihood of the threat.

Furthermore, the capabilities needed by civilian users are not well defined. We have previously reported that a standardized equipment list developed for civilian emergency response personnel is not based on a validated set of requirements or on a consensus in the civilian community on needed equipment.[7] Attempts to identify R&D needs to improve domestic capabilities to respond to chemical and biological incidents lack detailed performance specifications and do not incorporate threat analyses. By contrast, written specifications of military user needs and

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[6] See *Combating Terrorism: Need for Comprehensive Threat and Risk Assessments of Chemical and Biological Attacks* (GAO/NSIAD-99-163, Sept. 7, 1999), pp. 17-19.

[7] *Combating Terrorism: Analysis of Potential Emergency Response Equipment and Sustainment Costs* (GAO/NSIAD-99-151, June 9, 1999).

requirements are coordinated among the military services and are relatively detailed. For example, DOD's Chemical and Biological Defense Program initially identifies broad needs (such as "individual protection" or "contamination avoidance") from which it develops detailed system performance requirements based on analyses of threats and military missions.

Existing Information on Threats and Needed Capabilities Not Always Used to Determine Project Funding

Among the programs we examined, only DOD's Chemical and Biological Defense Program integrates formal threat assessment into its R&D activities. For instance, DOD's project review process includes a System Threat Assessment Report. This document describes the most important chemical and biological threats that military equipment being developed should address. By contrast, the other three programs do not utilize threat information to the same degree. According to program officials, the Defense Advanced Research Projects Agency's program is meant to address broad categories of threats or threats that are not yet present. As a consequence, their program uses threat information primarily for overall program planning. With regard to civilian programs, although the Energy and the Technical Support Working Group have incorporated threat assessments in overall program planning, the threat assessments are not project-specific.

Finally, the two larger R&D programs—in the Department of Energy and the Defense Advanced Research Projects Agency—do not formally incorporate existing information on user needs in deciding on which R&D projects to fund. Projects in the Energy program do not incorporate existing requirements developed by the Technical Support Working Group or the Institute of

Medicine for civilian programs.[8] Similarly, projects in the Defense Advanced Research Projects Agency's program do not necessarily support a documented military need. By contrast, DOD's program has various mechanisms to tie its R&D projects to military needs. For example, DOD's program uses Defense Technology Objectives to specify a particular technology to be pursued and the specific military benefits of that technology. The Technical Support Working Group develops its own list of civilian user needs, which it uses to solicit R&D proposals.

Potential Benefits From Improving Coordination

As a result of these problems, R&D programs may not be developing the most important capabilities and addressing the highest priority threats.[9] To eliminate duplication, these programs need detailed information on civilian chemical and biological threats and the capabilities needed to respond to those threats. For example, after the four military services—which have such detailed information—began coordinating their chemical and biological defense efforts in fiscal year 1994 through DOD's Chemical and Biological Defense Program, they were able to consolidate 44 service-specific developmental efforts in the program's contamination avoidance research into 10 joint-service projects. Having comprehensive information can also help program officials determine whether critical gaps in research exist that could be filled by refocusing one or more programs.

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[8] A prioritized list of needs is developed by the Technical Support Working Group annually; and, in a recent Institute of Medicine study, *Chemical and Biological Terrorism: Research and Development to Improve Civilian Medical Response* (Institute of Medicine and National Research Council, National Academy Press, 1999), some nonmedical R&D needs were delineated.

[9] To facilitate coordination of R&D projects, DOD and Energy are planning on merging their R&D roadmaps through the Counterproliferation Program Review Committee, but this will not be completed for at least 1 year from now.

This concludes our formal statement. If you or other members of the committee have any questions, we will be pleased to answer them.

For future contacts regarding this testimony, please contact Kwai-Cheung Chan at (202) 512-3652. Individuals making key contributions to this testimony include Dr. Sushil K. Sharma, Dr. Weihsueh Chiu, and Dr. Jeffrey Harris.

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