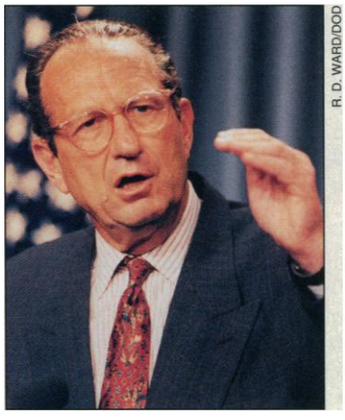
The Defense Initiative of the 1990s

The Pentagon is quietly expanding a wide-ranging effort to develop technologies to counter weapons of mass destruction in the hands of potential enemies—whether nations or terrorists

When then–Secretary of Defense Les Aspin delivered his annual report to Congress and the president a year ago, he offered up an apocalyptic vision of the post–Cold War world. More than 20 nations, Aspin estimated, have or are developing "nuclear, biological, and/or chemical weapons and the means to deliver them." Worse, while U.S. strategists were able to understand the nature of threats to national security during the Cold War, neither military planners nor the general public can count on such expertise in the future. What has changed, Aspin explained, is that proliferators may have acquired weapons of mass destruction, not necessarily to use them, but "for the express purpose of blackmail or terrorism." This, he added, presents "a fundamentally different calculus not amenable to deterrence."



R. D. WARD/DOD

Counterproliferation point man. Deputy Secretary John Deutch.

As if Aspin's vision weren't dismaying enough, it seems decidedly understated compared to the reality of the daily news. The past few years have already witnessed Islamic terrorists allegedly trying to blow up the World Trade Center. Hundreds of former Soviet scientists trained in the weaponry of mass destruction are now reduced to states of joblessness and poverty—and thus prone to the financial inducements of malevolent figures on the world stage. And that particular threat is not hypothetical: Weapons-grade nuclear materials have already been intercepted after crossing Russian borders on the black market. And all this is rendered more scary by the fact that scientific advances have made weapons cheap to make, easy to disguise or transport, and ever more destructive.

Welcome to the new era of counterproliferation. In the year since Aspin issued his dire assessment of the threats posed by the spread of weapons of mass destruction, the Defense Department (DOD) has begun a counterproliferation initiative that some experts are calling the major defense initiative of the 1990s. The focus will be on developing technologies that can be used to detect weapons of mass destruction—WMDs as they are known in the lingo of the defense community—and, if necessary, destroy them. It will be an unprecedented scientific challenge that could draw the big three weapons labs—Los Alamos, Livermore, and Sandia—more deeply into work on biological and chemical defenses.

And, like the major defense initiative of the 1980s, the Strategic Defense Initiative (SDI), this one is likely to be controversial. Some experts are complaining that the Defense Department is placing too much emphasis on protecting its own troops on the battlefield and not enough on countering the threat to civilians, especially from nuclear terrorists. Others are suspicious that the initiative will simply provide a way for the labs to supplement their dwindling weapons-research budgets to develop technologies that—like many of those pursued under SDI—will never be effective. Yet, in spite of these complaints, there seems to be little disagreement in the defense community that some kind of counterproliferation initiative is needed.

The Defense Department's thinking was laid out in an interagency report prepared by Deputy Defense Secretary John Deutch, a former Massachusetts Institute of Technology chemist and provost, and released last May. That report received little media attention at the time, and has barely been discussed in public since. There has been scant public comment on its recommendations by scientific experts who have for decades worried about proliferation. Consequently, *Science* recently canvassed the nonproliferation community about the key underlying assumptions and scientific responses endorsed by Deutch. The following article examines some of the technologies that the labs are hoping to pursue as part of the new initiative, and it offers comment from weapons experts inside and outside the government on the department's new venture.

Deutch's prescription

The Deutch report, put together by security experts drawn from a variety of government agencies, identified 16 technological areas that the panel says will be key to countering threats from nations or terrorist groups armed with weapons of mass destruction (see table on p. 1097). And it recommended a major hike in funding for 14 of these technologies—an eventual increase of $400 million beginning in fiscal year 1996, which would be reallocated from other defense programs. The total for the entire effort would be well over $1 billion a year. Much of the work would come from expanding research already under way at the national labs.

"The emphasis on technology is indispensable," says Robert Kupferman, a defense analyst with the nonprofit Center for Strategic and International Studies in Washington, D.C. "The plain fact is that we're going to be facing increasingly our own [nonproliferation] failures. We're going to end up in a proliferated world whether we like it or not, and we need to devote time, energy, and technology to the problem of minimizing the effects of these crises."

The emphasis is heavily weighted toward technologies designed to counter chemical and biological weapons, rather than nuclear weapons. This emphasis has provoked some controversy (see box on p. 1098). "Nuclear is out of the picture," laments Bob Kelley, who runs the Nuclear Emergency Search Team at Los Alamos. "The Pentagon is worried about bugs and gas, what they see as a threat to troops. ... Worrying about nuclear terrorism is not part of the equation." But Deutch says the rationale was to provide "a judgment of those things that weren't being addressed" and to concentrate on the threats nearest at hand.

Most experts who have reviewed the report agree. "The world has in recent years experienced chemical warfare—in the Iran-Iraq conflict. And in biology one sees a world with tremendously rapid developments in biotechnology," says Sidney Drell, former director of the Stanford Linear Accelerator Center and a longtime analyst of defense programs. Adds Drell: "When we're talking about nuclear, it's still more a nonproliferation problem than a counterproliferation problem."

The labs take stock

In the 9 months since the Deutch report emerged, administrators and researchers at the weapons labs have been busily assessing their research to see what programs might fit into the framework laid out by Deutch and his panel of experts. They have been submitting preliminary proposals to DOD for a

range of technologies mostly aimed at three objectives: to provide early warning that biological and chemical weapons have been deployed on the battlefield, to improve intelligence-gathering, and to seek out and destroy WMDs that a nation or terrorist group has hidden in underground bunkers.

Among the more promising of the early-warning technologies—or at least among those publicly discussed—is a laser detection and ranging system (LIDAR) that Los Alamos researchers have been working on. The Los Alamos team, led by Bob Karl, believes it could be used to detect biological and chemical agents at distances of up to 50 kilometers. The technique uses laser beams of red light, which can propagate tens of kilometers through the atmosphere to illuminate distant aerosol clouds. The technique relies on what's known as elastic backscattering to detect whether or not aerosol clouds are out there.

A prototype LIDAR system, weighing 10,000 pounds and carried on a C-130 cargo plane, was developed for the Gulf War. Since then, the Los Alamos group has been working to make it less bulky and more user-friendly. Last year, they field-tested a helicopter-based version at the Dugway Proving Grounds in Utah. According to Walt Kirschner, director of Department of Defense programs at Los Alamos, the system detected simulated bioagents at distances of 30 to 40 kilometers, and he says that with improved telescopes the limits of detection might be stretched another 10 kilometers.

The chief challenge now is in techniques and data analysis needed to differentiate between manufactured clouds—consisting of particles on the order of 2 microns in diameter, a size designed to be inhaled easily—and natural background materials. The Dugway tests proved that LIDAR could tell the difference between aerosols and dust clouds kicked up by trucks or troops, says Kirschner. But differentiating between biological weapons and pollen, for instance, will be a far more difficult problem. Los Alamos researchers are optimistic that it's feasible, says Kirschner, using ultraviolet lasers to cause fluorescence of the particles and then decoding the spectral signature, but considerably more work is required.

Nonetheless, whether any laser-based system such as LIDAR will be able to penetrate a dust-laden battlefield effectively, which was the norm in the Gulf War, is a debatable question. Light scattering by dust particles could effectively block any laser probe and render its range hopelessly short. Considering all the ifs, say researchers familiar with the technology, it's not likely that LIDAR will ever be much more than an early-warning system for troops that suspected biological and chemical agents are heading their way; it is unlikely to be able to tell them exactly what they may be facing.

To accomplish that task, researchers at all three labs are working on a wide variety of sensors that could be distributed in a battle zone or flown on crewless air vehicles. The potential technologies being tested to recognize chemical weapons include the following:

■ *Electrochemical devices*. One type of sensor consists of an electrochemical cell, with two oppositely charged electrodes in a bath of water. The cell is designed so that it can only pass a current between the two electrodes if a particular ionic species—in this case, say, a particular chemical agent—is present in the water. The technical challenge is to make a cell that will only respond to a single chemical agent. A variation on this theme is a gas sensor equipped with a filter that only lets certain gases through to start the current. These types of sensors are used in coal mines for detecting carbon monoxide.

■ *Ion-trap mass spectrometry*. This technique uses magnetic fields to confine single ions, whose mass can then be identified by the frequency at which they oscillate when another magnetic field is applied externally. The catch is that such devices need ultrahigh vacuums to function; while the required vacuum pumps might fit in a field laboratory or even a mobile lab, it is pushing the limits of feasibility to miniaturize the technology to the point where it could be carried on a crewless aircraft.

■ *Laser-induced breakdown spectroscopy*. When a substance is vaporized by intense lasers, the resulting ions fluoresce and produce a signature spectral pattern. The technique works fine for identifying a substance made up of a single chemical species, but it is hard to identify a specific chemical in a mixture of compounds, which is likely to be the case in chemical weapons.

To identify biological agents, Los Alamos researchers are testing versions of a laboratory technique for sorting cells, known as flow cytometry, coupled with DNA analysis. "That gives you a rather unique fingerprint for biological molecules," says Kirschner. The catch, of course, is that these kinds of analyses require a substantial laboratory setting, and they may never be adaptable to the task of identifying a specific biological agent in a cloud of gas heading toward troops in the field.

Smarter intelligence

Researchers at Los Alamos are also pushing less ambitious technologies to supplement traditional intelligence-gathering in pinpointing clandestine weapons programs and

THE DEUTCH REPORT'S RECOMMENDATIONS

Objective	Current Funding	Recommended Increase
Real-time detection and characterization of BW/CW agents	$110 million	$75 million
Underground structures detection and characterization	$25 million	$75 million
Hard underground target defeat, including advanced non-nuclear weapons (lethal or nonlethal) capable of holding targets at risk with low collateral effects	$35 million	$40 million
Detection and worldwide tracking of shipments and control and accountability for stocks of WMD-related materials and personnel	$87 million	$25 million
Capability to detect, locate, and render harmless WMDs in the United States	$35 million	$10 million
Enhancement of collection and analysis of intelligence	Classified	$25 million
Support of Chemical Weapons Convention and Biological Weapons Convention	$45 million	$10 million
Support of a Verifiable Comprehensive Test Ban Treaty	$50 million	$10 million
Capability to detect, locate, and disarm WMDs hidden by a hostile state or terrorist in a confined area outside the United States	$3 million	$15 million
Passive defense capabilities enabling military operations to continue in contaminated conditions	$5 million	$15 million
Rapid production of protective BW vaccines	$305 million*	$15 million
Detection and interception of low flying/stealthy cruise missiles	$60 million	$50 million
Transparency and control of foreign fissile material	$12 million	$15 million
Safe disposition for foreign missile- and WMD-related materials (except fissile material)	$1.5 million	$20 million
Intercept capability in boost phase	None given	Adequately funded
Prompt mobile target kill	None given	Adequately funded

*Includes $300 million for production

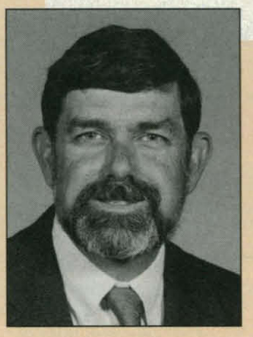
Countering Nuclear Terrorism: Dwindling Capabilities?

"If I find a bomb," says Bob Kelley, head of the Nuclear Emergency Search Team (NEST) at Los Alamos National Laboratory, "I want to be able to guess whether it will work or not. I'd like to be able to make radiation measurements and then make some sense out of the measurements. If it goes off—and God help us if it goes off—I want to make additional measurements of debris and find out what we have. One of the scariest things is if someone confronts you with one device, and now comes back and says he has five more. Do you want to believe him?"

It is not just Kelley who finds this scenario scary. The prospect of a terrorist group armed with a nuclear "device," in defense parlance, or a weapon capable of disseminating large amounts of radioactivity, must surely rank as one of the worst nightmares of the post–Cold War world. Indeed, to many in the nuclear weapons business—and among the general public as well—the things that trouble Kelley should be high on the list of priorities for the new era of defense planning. Yet the Department of Defense's new counterproliferation initiative focuses almost entirely on biological and chemical weapons and virtually ignores nuclear terrorism.

"The Pentagon is not going to put a nickel into helping DOE deal with the [threat of nuclear terrorists]."

—Bob Kelley



The logic behind the initiative, says Kelley, is to support the Defense Department's prime mission: to ensure that U.S. troops in foreign theaters of operation can counter the weapons of mass destruction that are most likely to be serious threats—biological and chemical weapons. "A nuclear bomb used against troops is a fait accompli," he says. "The Pentagon is not going to put a nickel into helping DOE [the Department of Energy] deal with the [threat of nuclear terrorists]," says Kelley.

This may be so, says Deputy Defense Secretary John Deutch, whose office prepared the report that provides the blueprint for the initiative, but only because the aim of the report was to judge what technologies were not being pursued vigorously enough. "The view," says Deutch, "was that the balance of the ongoing effort was very much on nuclear." He adds that as far as terrorism goes, "terrorists can always deliver—more conveniently and more easily—chemical and biological weapons than nuclear weapons. We spent a lot of time assessing what can be done about terrorist threats, and they are not only nuclear."

To Kelley, what makes the threat from nuclear terrorists so worrisome is that U.S. capabilities for dealing with it depend on the nuclear weapons budgets and the ability to carry out nuclear tests. But the budgets are shrinking, and there is a moratorium on testing. NEST is one of seven nuclear emergency response teams run out of DOE that provide the technical response to nuclear emergencies—including nuclear terrorism, whether threats or the real thing (see box on p. 1099). These programs receive approximately $70 million a year from DOE, but they rely on volunteers from the nuclear weapons programs at the national laboratories for 95% of their personnel. Because those weapons programs have been cut in half in the last three fiscal years, says DOE's Lisa Gordon-Hagerty, director of the overall Emergency Response Program, the nation's ability to respond to nuclear terrorism has deteriorated. The reason: Many skilled weapons designers have moved out of weapons work and so are no longer available for NEST.

The Los Alamos NEST program receives some $6 million a year from DOE, says Kelley, and this is spent on research and development and on training and exercises designed to keep the team deployed for readiness. "Everybody in the program has inoculations and passports," he says. "They can be on their way to Timbuktu in 5 minutes, if that's what it takes."

"Finding a hidden nuclear device requires tools that don't exist [outside the weapons program]," says Kelley. "Shipping a damaged weapon requires tools that don't exist otherwise. Dealing with a nuclear device once you find it, disabling it—those tools don't exist otherwise." Adds Gordon-Hagerty, "Nobody else around can look at a potential bomb and say, 'I know what that is, and that can initiate a nuclear explosion,' or 'That device cannot obtain nuclear yield, no way.' The nuclear designers go in, look at all the information, whether with radiography or by gathering other kinds of radiation data, and determine the best way to render it harmless or useless."

Not only is NEST losing this expertise, but it is also losing some ability to test possible techniques for disabling a terrorist device. "If we wanted to evaluate disablement schemes," says Gordon-Hagerty, "we can only do that underground, because we might initiate a nuclear yield, and we can't even do that anymore because of the moratorium on underground nuclear testing. Currently we don't even have anyplace to dispose of a terrorist device if we come across one, for the same reason."

If DOE cannot count on help from Defense's counterproliferation initiative, can DOE itself come to the rescue? The department already spends $180 million a year on technology to prevent the spread of nuclear weapons—nonproliferation rather than counterproliferation. These funds mostly support satellite surveillance technology for detecting proliferation signatures (*Science*, 4 February 1994, p. 627) and materials, accounting, and control systems for nuclear-stockpile stewardship. Its primary focus is to seal up nuclear materials and weapons that might leak out of the former Soviet Union—a key objective that is likely to require more rather than less funds.

Yet experts in nuclear counterterrorism argue that the focus of the nonproliferation effort should be broadened. "Suppose you have a rogue state producing its own material," says one Lawrence Livermore National Laboratory administrator, who requested anonymity, "and that rogue state produces a few nuclear weapons and decides it wants to use them to some advantage. They can either use them on the battlefield, which seems like a particularly stupid thing to do, or it can take those weapons and give them to a terrorist group and employ the terrorist group as a surrogate." In that case, concentrating on Russian nuclear materials doesn't address the problem. "So what we're doing," he says, "is focusing on one hole in the dike, and ignoring the fact that there can be other holes." Adds William Nelson, who runs the Emergency Preparedness and Response Team at Livermore, "What we do is a form of insurance, and the question is how much are you going to invest in insurance?"

–G.T.

monitoring materials and personnel on the battlefield. Sandia, for instance, has been working on ground sensors for intelligence gathering since the 1960s. Early versions were used in Vietnam to listen in on the Ho Chi Minh trail, although their effectiveness was limited. Since then, says Gerald Yonas, a former chief scientist for SDI who manages DOD-related work at Sandia, "that technology has come a long way. You can picture in your own mind what's happened in video and electronics. So miniaturized sensors that can feel and listen and smell and look will play a big role in providing an exquisite level of awareness of what is going on."

The labs are also pushing synthetic aperture radar (SAR)—another 25-year-old technology that has benefited from the electronics revolution—for a counterproliferation role. With traditional radar, the sharper the resolution, the larger the required antenna—and that poses a problem for airborne monitoring. SAR gets around this difficulty by creating in essence a large virtual antenna. "As the radar moves through space, and in every point in space, it acts as if it was part of a big antenna. A computer collects the information of the deflected wave at each point and then integrates and assembles it as if it were coming from a huge synthetic antenna," says Yonas. Like all radar, SAR has the advantage of being able to see at night or through clouds. The technology was used in Desert Storm, with SAR mounted in planes that flew over Saudi Arabia and looked out into Iraq. Now Sandia researchers are working on miniaturizing SARs so they can be mounted on crewless air vehicles.

PHOTOS BY SANDIA

Bunker mentality. Hypervelocity projectile for attacking underground facilities passes through reinforced concrete block; entry hole is shown in the photograph above, left, and exit hole above, right.

Seeking out hidden weapons

One of the lessons proliferating nations and terrorist groups will have learned from Iraq, says Kathleen Bailey, a proliferation specialist at Livermore, is that "one of the safest places" for developing WMDs is underground. Not surprisingly, the counterproliferation effort rates among the highest priority activities developing technologies to destroy hardened underground facilities.

Researchers at Sandia, for example, are pushing hypervelocity projectiles with precision strike capabilities to do the job. These missiles could be launched from the ground to a height of several hundred kilometers and achieve re-entry velocities of up to 5000 feet per second, says Yonas. Bombs, in comparison, hit their targets at about 1000 feet per second.

"It's a very simple phenomenon," says Yonas. "You can penetrate through large amounts of material if you're going fast enough. And if the object is long compared to its diameter, it can penetrate through the material. And then, as it's moving through the material, it can deliver energy into the material instead of on the surface. People always think about delivering explosives to a target. This is more like delivering a bullet to a target. If you've seen a pane of glass hit by a bullet, there's a small hole in front and a big spall in back. That's the kind of damage we're talking about, but with 15 feet of concrete, a small hole in front, big spall in back."

What brings hypervelocity projectiles into the realm of the thinkable, says Yonas, is the precision that can be obtained using global positioning satellites and miniaturized receivers that can be packaged on the missiles. Yonas calls it an "affordable package that can make a very smart projectile. And the nature of that kind of high precision is that it would have low collateral damage. It either hits the target or it doesn't. And if it hits, it can create substantial damage." Global positioning receivers are already carried on the most recent version of the Tomahawk land-attack cruise missile, and Sandia has tested high-velocity projectiles on various targets with a gun that launches them at the right velocity at a block 20 feet away. "They have been able to penetrate 12 to 15 feet of

The Front Line of Nuclear Defense

The first line of defense against a nuclear threat in the United States is the Department of Energy's seven nuclear emergency response teams. They cover the range of possibilities in a nuclear accident or terrorist incident.

- ARG, the Accident Response Group, will respond at a moment's notice to any nuclear or "radiological" accident, including, for instance, earthquake damage to a nuclear power plant. ARG is funded at $11 million a year and is staffed by some 500 volunteers at the national laboratories.
- ARAC, the Atmospheric Release Advisory Capability, will take weather, aerial, mapping, and radioactive source material data concerning a nuclear incident or accident and churn out three-dimensional models of downwind contamination for use by emergency preparedness personnel. The budget is $7 million for a full-time staff of 25.
- AMS, the Aerial Measuring System, operates several fixed-wing and rotary aircraft that can fly through radioactive plumes and do radiological characterization, which can be crucial in the first few hours of a nuclear reactor accident. The aircraft can also analyze nuclear signatures on the ground from lost or stolen nuclear material. The operating cost is $7 million per year.
- FRMAC, the Federal Radiological Monitoring and Assessment Center, was created after the Three Mile Island incident. It is responsible for all off-site radiological monitoring and assessment and for providing consistent information to all authorities involved. The budget is $1 million.
- NEST, the Nuclear Emergency Search Team, is staffed predominantly by volunteers from the nuclear weapons programs. NEST provides domestic or international response to active nuclear terrorism or malevolent nuclear threats. NEST personnel provide technical expertise and work closely with Defense Department personnel who provide what's known in the business as explosive ordnance disposal. The NEST budget is $35 million a year.
- RAP, the Radiological Assistance Program, is split between eight regional offices and is the first line of response to a potential nuclear accident. RAP personnel can be on-site anywhere in the country within an hour or two, when it might take NEST personnel, for instance, 5 or 6 hours to fly in from Albuquerque, New Mexico. Budget: $2.5 million.
- REAC/TS, the Radiation Emergency Assistance Center/Training Site, is one of two World Health Organization Centers that train emergency-room physicians and medical personnel to provide triage in case of a radiation accident and to recognize exposure to ionizing radiation when they see it. The budget is $800,000 a year.

–G.T.

Counterproliferation Initiative Blurs Agency Lines

Ever since the Manhattan Project, the U.S. government has run a substantial nonproliferation program aimed at preventing other countries from acquiring weapons of mass destruction, especially nuclear weapons. The Department of Defense's (DOD's) new counterproliferation initiative starts from an assumption that those efforts will occasionally fail and asks what technologies can be employed to deal with an enemy—be it another country or a terrorist group—armed with weapons of mass destruction. However, the initiative includes efforts in nonproliferation that have traditionally been the responsibility of other agencies. And that is sparking a debate in Washington over what is meant by counterproliferation and how the effort should be divided up.

Historically, says Lawrence Scheinman, assistant director for nonproliferation and regional arms control at the Arms Control and Disarmament Agency (ACDA), nonproliferation has been the purview of ACDA and the State Department, and the development of technologies to prevent nuclear proliferation has largely been the responsibility of the Department of Energy's laboratories. DOD, says Scheinman, "was almost entirely involved in strategic issues and the U.S.–Soviet arena. Nonproliferation was really like a flea on an elephant's back."

DOD's new initiative has begun to blur this division of responsibilities, while focusing mostly on efforts of direct relevance to the military: protecting troops on the battlefield against chemical and biological weapons. But just what should come under the rubric of counterproliferation is still unclear. Says William Nelson, who heads the Emergency Preparedness and Response Team at Lawrence Livermore National Laboratory: "Counterproliferation means whatever DOD decides it wants to do in that arena. It's not terribly clear yet." Adds Scheinman, "You could talk to three or four people from defense and get three or four slants on what exactly is meant by counterproliferation."

Observers in Washington, however, say definitions and organizational boundaries are not critical. The aim of the initiative is to get the Pentagon and the national laboratories jump-started on a problem area in the post–Cold War world. "The whole point behind this exercise," says Steve Fetter, an associate professor in the School of Public Affairs at the University of Maryland and a former DOD staffer, "is to get the government, and the services especially, mobilized to take the threat seriously, by giving it a new name and giving it new money."

–G.T.

concrete and cause substantial spallation of the concrete block."

But simply having the capability to destroy a hardened facility might not be enough. "Imagine a scenario," says Alan Spero, who is in charge of the counterproliferation effort at Livermore, "in which the military in an engagement believes a facility is being used to produce some sort of WMD, either chemical or biological or nuclear. Even if that facility is located in enemy territory, you'd still like to preclude the opponent from accessing it without thoroughly contaminating the countryside."

With biological agents, in particular, one objective would be to ensure that the agent is killed when the facility is disabled. Researchers are proposing ideas for warheads that will explode with a high enough temperature to kill "a vast majority" of any biological agents in the structure, says Spero. "The other possibility," says Spero, "is a warhead that would deny access to a facility rather than destroy it. The one most commonly discussed is a foaming warhead, which would release a foam that fills up the room."

Pie in the sky, or affordable and doable?

As the national labs make their cases for technologies to be included in the counterproliferation initiative, technical and military experts have been sizing up the venture. So far, they have generally welcomed the initiative, although many express reservations about some aspects of the plans. Because the whole enterprise has yet to emerge as a coherent program, however, little of this controversy has taken place in public.

For starters, the Deutch report suggested that the $400 million increase for counterproliferation be taken from existing defense programs and not simply added onto the defense budget. "That means that anything spent on [counterproliferation] has to come out of somebody else's hide," says William Nelson, head of the Emergency Preparedness and Response Team at Livermore. "So that has slowed things down. We don't know what the programs are going to be; we've only seen a variety of recommendations."

A potential problem, say some Washington nonproliferation experts interviewed by *Science*, is that the initiative simply provides an excuse for Defense Department officials to relabel otherwise marginal projects as suddenly necessary for counterproliferation. Indeed, many of the technologies discussed in the Deutch report, says Dave Albright, a nonproliferation analyst with the nonprofit Institute for Science and International Security in Washington, are defensive measures that the department should be pursuing in any case—for instance, battlefield defensive measures against biological and chemical weapons. "You could just as easily call it standard operating procedures," says Albright.

As for the technical soundness of the proposals, at the request of the Defense Department, the Deutch report and the relevant technologies were reviewed by JASON, an independent advisory panel of civilian scientists that includes some of the best experimental physicists and chemists in the country. JASON gave the report generally good grades, but some of the scientists involved in the review did express reservations. Will Happer, a Princeton physicist, former head of JASON, and former head of the Office of Energy Research at DOE, called the Deutch report "a good start, considering there's no prior art." But Happer added that it did include a few technologies that "were more likely not to work than to work."

Another JASON scientist, who requested anonymity, suggested that the report had a "shopping list" mentality, with a potentially alarming emphasis on looking for "fancy gizmo Star Trekky things that bleep out the bad guys." In particular, say Happer and his colleague, some of the sensing technologies being proposed to sniff out and identify biological and chemical weapons are unlikely ever to work in a real-world battlefield situation.

In general, however, most of the administrators and scientists at the national laboratories interviewed by *Science* agreed with Los Alamos Director Sig Hecker, who called the initiative and the Deutch report an "extremely good start" in dealing with a critical problem. If anything, added Hecker, the report is "long overdue," considering that it is now 4 years since the Gulf War raised public consciousness about the proliferation of weapons of mass destruction. Defense strategists realized that Iraq had been armed with both chemical and biological weapons, although it had chosen not to use them, and U.S. intelligence grossly underestimated the progress of Iraq's nuclear weapons program.

"As a result of Desert Storm, we learned a lot," says Sandia's Yonas. "But so did the people who are the potential proliferators. And they've now had 4 years to make it more difficult for us to locate and destroy, or deny access to, these kinds of very threatening targets."

–Gary Taubes