had different objections to the measure. Durenberger, who favors a bigger federal role in preventing ground water contamination and has talked about introducing ground water legislation in the future, argued that the House provision did not establish clear minimum standards of protection. The legislation merely says that well water should be protected from contaminants that are hazardous to human health, but leaves it to the states to set limits.

The fight over the provision threatened to tie up the whole bill. Then, after several months of negotiation, House and Senate conferees reached a compromise that only affords ground water limited protection, according to staff aides from both chambers. House legislators agreed to drop the language regarding future use of ground water. And, "it was never resolved what 'contaminants' should mean," an aide to Durenberger's subcommittee says. Although the wellhead protection plan would require states to develop their own strategy to protect public wells, the penalty is mild if they do not.

In the wake of the battle, one Senate subcommittee aide remarked, "We came away feeling that federal ground water legislation was impossible." Another staff member acknowledges the difficulties in crafting federal ground water legislation, but adds, "It's doable. We just have to find the right incentives," such as money for federal programs.

Congress probably will not consider any major ground water legislation before this session ends. A ground water bill was introduced last fall in the Senate, but hasn't gone anywhere. Legislators who would have jurisdiction over ground water issues have been devoting most of their attention to the reauthorization of Superfund this year, which still has not been settled. As a practical matter, any ground water legislation on the House side would have to pass through five committees. An aide to Durenberger says the next session might be the right time to introduce a bill. When Congress gets around to it, ground water protection may be one of the toughest national environmental issues that federal legislators, states, and EPA have faced yet. ■ **MARJORIE SUN**

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‡P. Holden, *Pesticides and Groundwater Quality,* National Academy Press, 1986.
§S. Z. Cohen, C. Eiden, M. N. Lorber, "Monitoring ground water for pesticides in the U.S.A.," American Chemical Society Symposium Series, in press.
‖*Groundwater: Saving the Unseen Resource,* The National Groundwater Policy Forum sponsored by the Conservation Foundation, 1985.
¶*Hazardous Waste: Responsible Party Clean Up Efforts Require Improved Oversight*, General Accounting Office, May 1986.

GAO Blasts Bigeye Chemical Weapon

A new study says that technical problems and inconsistencies in test results indicate that the bomb should not be produced

FOR nearly a quarter-century, the Department of Defense has been working to develop a persistent, highly toxic chemical weapon that could be safely delivered by aircraft far behind enemy lines. After spending roughly $75 million, it now believes that the item is in hand, and that Congress should approve the initial production of a chemical bomb widely known as the Bigeye.

Until 10 June, the Bigeye's prospects on Capitol Hill looked fairly good. An energetic lobbying effort was undertaken to convince legislators that the Bigeye's technical bugs have finally been eradicated. That morning, however, the proposal ran into a buzz saw in the form of Eleanor Chelimsky, the director of the program and evaluation division of the General Accounting Office (GAO).

Reporting on the results of a lengthy, independent Bigeye review, Chelimsky said that tests of the bomb "present major and continuing inconsistencies," that significant test data have not been collected, and that several technical repairs had created new "constraints and uncertainties," some of which may be intractable. As a result, she said, "the GAO believes that the bomb is not ready for production" and suggests that the Bigeye be shunted aside in favor of a new bomb, as yet undeveloped.

Although the GAO analysis does not specifically challenge the need for a new long-range chemical weapon, it provides considerable fodder for those who do. The report was released at a press conference called by several of the program's strongest opponents, including Representative Dante Fascell (D–FL), chairman of the House Foreign Affairs Committee, and Senator Mark Hatfield (R–OR), chairman of the Senate Appropriations Committee. "The only reliable bombshell we have today is this report by the GAO," Fascell said. "The evidence is overwhelming: the Bigeye bomb is a persistent failure with no reasonable prospect of it ever working properly or safely."

Some of the data in the new report were released last October, immediately creating a fierce debate between Chelimsky and Donald Hicks, the under secretary of defense for research and engineering (*Science*, 15 November 1985, p. 784). Since then, the GAO has not only refused to back down, but added substantially to its list of complaints about the program and its management. Details of various tests, as well as a substantial portion of the GAO's comments, have been excised from the unclassified version of the study, complicating an assessment of the debate. But a few themes are apparent.

One is that the Bigeye tests conducted thus far are inadequate. A so-called "binary," the bomb consists of two compartments filled with nonlethal chemicals, which combine in flight to produce a deadly nerve agent. As such, proper mixing is considered essential. Yet, out of 41 mixing tests, only a dozen replicated the conditions likely to be experienced in battle, and of these, only a few generated results that met DOD's minimum stated requirement, the report indicates.

Part of the problem is that mixing creates enormous pressure inside the bomb, a phenomenon that the Pentagon first learned about in 1966 and acted on in 1982, when a shell exploded during a test. Since then, most of the bombs have been vented during critical tests in order to prevent another explosion. Unfortunately, GAO says, none of the bombs to be produced for actual combat will have such vents, and some could explode prematurely as a result. The risk is not to the planes or pilots that will transport the Bigeye, as the mixing sequence will not begin until after the bombs are released. It is instead that an explosion would cause the bomb "to be rendered useless," the GAO says.

Similarly, the report complains, no tests were performed to determine the likelihood of another potential failure scenario caused by a phenomenon known as flashing. This would occur when a small explosion at the cap of the bomb, generated to facilitate the nerve agent's dissemination, instead causes it to catch fire and fall harmlessly to the ground. "GAO believes the likelihood of flashing in Bigeye is speculative, but *a very important issue to address*," the report says.

GAO is also critical of the fact that, since the decision in 1961 to use the binary method, no tests have been performed of the

nerve agent's persistence. Several prominent chemists, including Tetsuo Fukuto, chairman of the entomology department at the University of California at Riverside, told GAO that such tests were needed. Finally, the report notes that overall bomb toxicity is determined by a complex relationship between its temperature at release and the length of time it takes to reach its target. Yet no temperature sensors have been incorporated in the bomb and scant information exists about the temperature effects of various flight profiles. "How does the pilot know when to drop the bomb?" the GAO asks. It calls this an intractable problem.

A second major theme of the report is simply that what few data exist are unclear. In particular, the GAO states, test criteria have frequently been relaxed and different results have been presented to different audiences. "Because of vague or nonexistent criteria, tests could, and were, added to and dropped from reporting of results, at the discretion of the reporter. Tests were moved from failure to success categories without explanation." Data on Bigeye reliability have been especially pliable, the report indicates, and last December, a senior program official acknowledged that they lacked statistical significance.

Chelimsky of GAO describes the Bigeye as "one of the worst" weapons research endeavors she has ever seen.

Chelimsky, a former Mitre Corporation analyst who describes the Bigeye as "one of the worst" weapons research endeavors she has ever seen, says that "most troubling of all, perhaps, with regard to the design and to the overall credibility of DOD's testing of the Bigeye, is the way in which important evaluation questions are posed at the start of a test, fail to be answered or are answered inconclusively, and then disappear from serious consideration." Even when components were redesigned, in many instances they were not retested, she adds.

Thomas Welch, the principal official in charge of the chemical weapons program, was out of town and unavailable for comment as *Science* went to press, but a special assistant in his office, Colonel Hugh Stringer, provided responses to some of the questions raised by GAO. Despite the use of venting during Bigeye pressure tests, he says, "we know what the pressure curve looks like at the worst case, and it is . . . out of the realm of interest." He calculates that the bomb would have to remain in free-flight for 5 minutes before an explosion could occur, whereas its expected free-flight time is roughly 30 seconds, a point that GAO disputes. He acknowledges that some uncertainties exist about the toxicity of the bomb in operational use, but notes that its lethality is so great that even an agent with low potency will be strong enough to meet the military requirement.

Flashing, he says, is a well-known phenomenon, whose "likelihood is virtually nil. This is a case where [the GAO has] asked virtually every question that can be asked, whether or not the answer is important." No studies have been performed of the binary nerve agent particle size and degradation rates, he acknowledges, although some may be conducted in the future. "When you've worked with a weapon as long as we have, you get to the point where you can exercise a degree of intuition about how it behaves," he says. The changes in the test protocols are routine, he adds.

At present, he says, "we have not achieved the level of system reliability that we would like to have on the Bigeye, but we are on a growth curve that indicates it will be achieved by the end of the operational testing. . . . I don't doubt that we can come up with a better bomb than Bigeye, if we spend enough time and money. We are, for example, looking at bombs that are terminally guided. But right now, we have extremely limited long-range capabilities, principally spray tanks and old iron bombs that contain nonpersistent nerve agent. The real deciding factor is: Does the Bigeye give you an operational effectiveness today that makes it worth the cost? We think it does."

Representative Fascell disagrees, of course. "Let's not spend millions of dollars on a fatally flawed weapon for use by our soldiers on the front line," he says. As if this were not enough, GAO is presently putting the final touches on another report for his committee, to be released next month, that points out numerous problems in the defensive component of the Pentagon's chemical weapon program. These include an anticipated shortfall in personnel trained and equipped to operate in a chemical environment, poor planning for medical treatment of chemical warfare victims, scant progress in the development of protective equipment, and highly unrealistic training exercises.

The report is expected to suggest that senior defense policy-makers devote additional time and effort to the defensive program. Altogether, the defensive and offensive chemical initiatives are expected to cost $15 billion to $25 billion over the next 10 years. ■ R. JEFFREY SMITH

Briefing:

OMB Floats New Indirect Cost Plan

The Office of Management and Budget (OMB) has withdrawn its controversial proposal to cut the overhead costs that are paid to universities for administering federal research grants and contracts. Instead, it has come up with a new plan that university officials apparently find equally unpalatable.

The new plan would make a big cut in a narrow area of indirect costs—reimbursement for the the time that department heads and faculty members spend on general administrative duties associated with federally sponsored research, such as service on some faculty committees. The proposal would cut payment for these activities by almost half, saving more than $100 million a year, according to OMB. In return, faculty members would no longer be required to fill out odious "effort reports," documenting how they divide their time between research, teaching, administration, and other duties.

Under the proposal, all universities would be paid an amount equal to 3% of the direct costs of a research project to cover a portion of the salaries of faculty members attributable to general research administration. Currently, the national average is between 5.5% and 6.0% of direct costs. (Salaries associated with the conduct of a particular research project are included in the direct costs of the project and are not affected by the proposal.)

The new proposal does not affect payment for overhead costs such as heating, lighting, depreciation of buildings, and part of the salaries of most nonfaculty administrators. These will be negotiated by individual universities in the same Byzantine manner as before.

The proposal was announced in a curious document released to reporters on 2 June, which outlined the highlights of the new rules. Details were supposed to be published in the *Federal Register* within a few days but had not appeared by 6 June. However, a draft of the final document was quickly circulating around Washington.

The original OMB proposal, which was put forward on 12 February and was initially scheduled to take effect on 1 April, would have capped payments for all administrative overheads—including salaries of nonfaculty members—at 26% of direct costs in fiscal year 1986. The ceiling would drop to 20% in FY 1987. Universities complained that the rules were being changed without consultation, and argued that a fixed national limit discriminates against universities