from government support of water reactors, and to marshall his forces for a concerted thrust on the commission's prime objective—an economical breeder. By all accounts, he took on both these tasks with immense energy and with a lesson learned from Admiral Rickover—namely, that a tough, centralized management stressing a "disciplined engineering approach" both to research and to construction of new reactors may not win friends, but it gets results.

The results so far are mixed, but certainly few friends have been won. Within months after taking office in December 1964, Shaw began a series of drastic reorganizations at Idaho that finally brought the demise of the Phillips organization last year, the rise of Aerojet in its place, and a continuing series of purges of old Phillips people from the new Aerojet structure.

Simultaneously, amid this turmoil, Shaw began imposing a rigorous and unfamiliar regimen of quality control standards and procedures on research projects in all the AEC's laboratories, Idaho included. It was all part of the new era of engineering discipline, and it was necessary, Shaw says, in order to rectify slipshod practices in the conduct of research. But to workers in the laboratories, the new regulations and the paperwork that came with them placed a staggering and, they felt, inappropriate and unnecessary burden on their work with little benefit in return.

"Engineering is the name of the game," says Shaw, an engineer.

"When he came in, science died," says a physicist at Idaho.

Thus, by 1967, the present conflicts had been kindled, and the forces were set in motion that would bring safety research of the highest priority to a virtual standstill.—ROBERT GILLETTE

Herbicides: DOD Study of Viet Use Damns with Faint Praise

An in-house, for-official-use-only study prepared in the Department of Defense (DOD) has concluded that herbicides were of only limited usefulness in the Vietnam war and, in effect, damns them with faint praise.

The report is the first major review of the military effectiveness of herbicides and was intended to complement the ongoing National Academy of Sciences (NAS) study of the ecological and physiological effects of herbicides. The study's conclusions are so far from a glowing endorsement, that they could signal an important weakening in DOD support for herbicides and possibly even a change in the Administration's exemption of herbicides from international arms limitations treaties. The treaty which would affect herbicides, the 1925 Geneva Protocol, is currently stymied in the Senate, thanks to President Nixon's "interpretations" that riot control agents and herbicides are not included under the agreement. The United Nations, by a vote of 80 to 3, has voted the contrary.

The three-volume study, titled *Herbicides and Military Operations,* was conducted between May 1971 and January 1972. The group that performed the work was the Army Corps of Engineers Strategic Studies Group (ESSG), a type of in-house think tank that, according to a variety of officials, has a high reputation for objectivity in the sometimes-warring factions of the Pentagon.

The first two volumes, obtained by *Science*, carry a survey of the experience of several hundred military officers who had direct knowledge of or participation in the herbicide program in Vietnam. The third volume, which is classified, contains some data on specific missions and computer wargames of herbicide use in future conflicts, such as in Western Europe. It was the focus of an article 2 weeks ago in the Washington *Post*, having been obtained by Daniel S. Greenberg, publisher of the *Science & Government Report* newsletter.

The ESSG study was conducted as part of an overall review of the implications of herbicide use which Secretary of Defense Melvin R. Laird was requested to make by Congress in October 1970. According to nondefense sources, the purpose of commissioning it was to present the strongest possible case in favor of herbicides; but instead, the field data from Vietnam simply did not support a ringing endorsement.

The ESSG study concludes rather weakly by comparison with the enthusiasm typical of military reports: "Herbicides can be useful as a specialized support to military operations as long as several specific circumstances exist." And, later, "significant net changes occurred after spraying. But the evidence is not sufficient to attribute the net changes to direct or indirect effects of herbicides delivered from fixed wing aircraft. . . ." Still later, "Herbicides were useful in supporting military operations in RVN in selected instances." Comparing the Vietnam experience with potential future conventional wars, it summarizes: "Herbicides are a significant aid to military operations in counterinsurgency and of less value in terms of force requirements in conventional (linear) warfare."

There are three critical points in the first two volumes of the ESSG's study, at which the effectiveness of the defoliation experience in Southeast Asia appears very questionable. The most obvious of these are the responses to a question asked at the end of each questionnaire about future need for herbicides. The results are shown in Table 1.

Even though the question was phrased as broadly as possible, that is, not specifying what "future conflicts" or "needs" might arise, the officers answered with an extraordinarily large number of "no" and "perhaps" replies. A number of those familiar with military reporting, including Congressman Les Aspin (D–Wis.) who is himself a former DOD analyst, see the "perhaps" and "no"

replies as an indication of grave doubts concerning the effectiveness of defoliation. Aspin said, reviewing the findings, "The fact that such a large number of military personnel and a majority of aviators have doubts about the future need for herbicides raises serious questions about the findings of the study. . . . The large number of 'perhaps's,'" Aspin said, "is a pentagonese equivocation for the serious doubts that many of these officers have about the effectiveness of herbicides." Also, other observers who have reviewed the study pointed out that, if the same question were asked about some obviously useful weapon, such as a tank, rifle, or helicopter, the responses would be a near-unanimous "Yes."

A second weak hinge in the ESSG argument is that in "friendly-initiated actions" after spraying, "enemy fatalities" declined by 33.3 per cent, while "friendly fatalities" declined by only 20.9 per cent. The ESSG correlated data concerning 175,444 military encounters involving the deaths of 435,149 people (personnel). The deaths were categorized as to which occurred within sprayed areas, which were outside sprayed areas, and which occurred before and after spraying. The areas not sprayed served as the control group.

A related finding was that, in sprayed areas after spraying, the overall number of military "actions" decreased by an average of 2.8 percent, a number which Aspin calls of "questionable significance. In pentagonese, a 'significant' change usually is 5 percent or more."

A third obvious point of weakness in the study's pro-herbicide conclusions is the responses of commanders and advisers to questions on crop destruction. The crop destruction program, until it terminated in 1971, was one of the most controversial parts of the U.S. use of herbicides in the war, the key issue having been the reliability of data on who was farming which fields and for whom the crops were intended. Despite the official DOD line that intelligence for the program was excellent, the commanders' and advisers' replies tell another story. Asked about the "distinction between crops grown for use by the enemy and crops grown by noncombatants who were not supporting the enemy," 21 replied that it was "completely reliable," 53 replied it was "usually reliable," 63 said it was "fairly reliable," and a total of 22 said it was not reliable or of "unknown reliability." The study itself concludes, in volume 1, "At most, the crop destruction program harassed the enemy."

Table 1. Answers to the question "Is there a need for herbicides in future conflicts?" (Percentages derived from ESSG, survey results.)

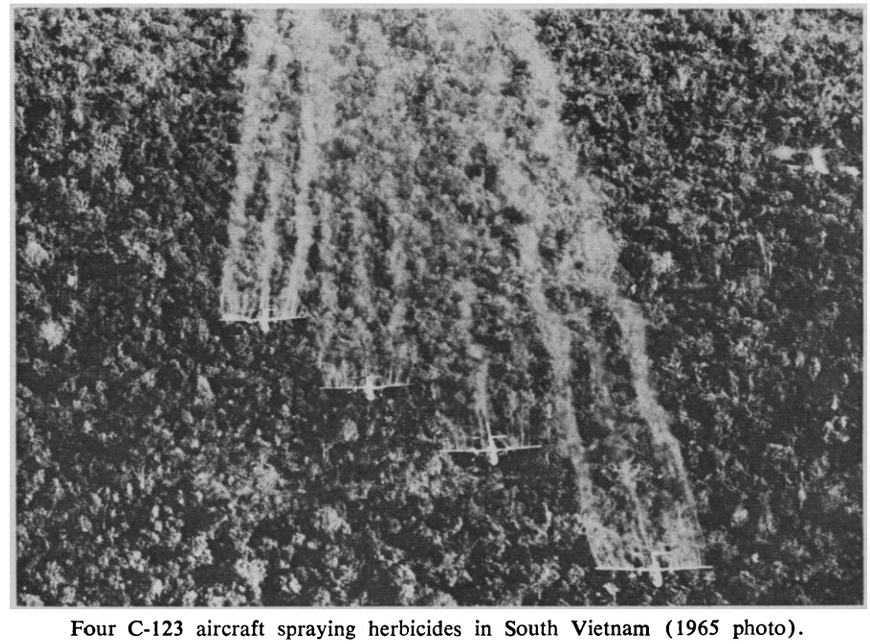
Service	Yes	Perhaps	No	Yes (%)	No and Perhaps (%)
Air Force and Marine Air	145	116	38	48.5	51.5
Army and Marine Commanders and Advisors	238	83	20	69.8	30.2
Navy	107	35	9	70.9	29.1
Army Chemical Officers	28*	5	0	84.9	15.1
Total	518	239	67	62.9	37.1

* On the actual survey summary sheet in volume 2, this number is 22, a figure which lowers the percentage of chemical officers responding "yes" to 81.5 percent and raises those responding "perhaps" and "no" to 18.5 percent.

Besides these three obvious points, the ESSG report contains other weaknesses. One official who has read the report pointed out that the "I don't know" replies to ESSG's survey were eliminated in tabulating the various replies thus altering the relative weight among answers. Also, most of the officers were asked to rank the frequency of the occurrence of a given military event after spraying on a five-point scale ranging from "significantly increased," "slightly increased," "unaffected," to "slightly reduced" and "significantly reduced." But the overwhelming number of replies said that a given event was "slightly" reduced or increased after spraying with herbicides; similarly, they said that specific battle conditions were altered "somewhat" rather than "greatly" altered. While these replies were enough to enable ESSG authors to draw conclusions favoring herbicide use, the actual data on which their conclusions are based are tentative and, so to speak, slight.

A final part of ESSG's assignment was to investigate the military effectiveness of herbicides in future conflicts. According to the *Post* article, in volume 3, ESSG "recommended that herbicides be included in top-secret contingency battle plans in case of war in Western Europe, Cuba, Korea, Ethiopia, and Venezuela." This was the conclusion drawn from ESSG's factoring herbicide use into 5 of the 106 SPECTRUM scenarios which serve as computer models of possible battle situations worldwide.

One thing which remains unclear, however, is whether ESSG found any real data base for these recommendations. Volume 1 states that herbicides can be more valuable in counterinsurgency wars than in conventional



Four C-123 aircraft spraying herbicides in South Vietnam (1965 photo).

war, and, according to the *Post*, the scenarios show friendly force reductions of up to 50 percent in some counterinsurgency situations—but reductions of only 3 to 4 percent in conventional battle scenarios. Nonetheless, despite this weak evidence concerning conventional war, ESSG allegedly recommended inclusion of a herbicide capability in various contingency plans.

DOD, for its part, maintains that "The SPECTRUM scenarios are completely hypothetical computer models of various warfare situations and have nothing to do with existing battle plans or contingency plans." That is, DOD has not included herbicides in its official battle plans—yet.

Aspin, reacting to the *Post* disclosures, labeled the scenarios "computer lunacy" and said: "Herbicides have been of little use in Vietnam and promise little real advantage in a European conflict."

Another reaction to the report is a written commentary, drawn up by two former DOD analysts, John P. Wheeler, III, and Han Swyter. In talking about military effectiveness, says the Wheeler-Swyter critique, the ESSG study failed to note that herbicides are becoming technologically obsolete:

> A critical point with respect to conventional and counterinsurgency warfare is that the technology of electronic and infrared sensors is becoming such that herbicides could be labeled obsolescent, possibly obsolete.
>
> The reason for this is that sensors can provide surveillance of an area without stripping vegetative cover for friendly use, that sensors can be delivered or used fairly independently of weather, and that an enemy is not likely to know that a sensor is present, whereas he would be aware of defoliation.

The ESSG report also reveals that the generally unanimous pro-herbicide position taken by DOD in public conceals a variety of warring factions. As mentioned earlier, herbicides proved least popular with the air officers. One long-term observer of DOD said this finding confirmed his view: "The Air Force has never been wild about offering combat support for the Army, which is what they were doing in the herbicide program." In the same survey, almost 30 percent of the Navy officers had doubts. A former officer observed that Navy officers had "gut-

Fischer-Spassky Charges: What Did the Russians Have in Mind?

Many exorbitant propositions have punctuated the chess championship being played out in Reykjavik, but by far the strangest was last week's accusation by the Russian player's side that Fischer was using "electronic devices and chemical substances" to debilitate Spassky's playing skills. The Icelandic Chess Federation gravely summoned a chemist and an electronics engineer to investigate, but not a tatter of evidence was found that might invest the Russian complaint with respectability. Assuming the Russians believed their own charges —and they would be unlikely otherwise to put them to public test—just what did they expect to find?

It was obvious to others besides the Russians that Spassky had not been behaving like his usual self. "He does not smile. He acts like a man in jail. There is something on his mind besides Fischer," commented Argentine grand master Miguel Najdorf. As Spassky's second, Efim Geller, said in making the charges, "Having known [Spassky] for many years, it is the first time that I observe such unusual slackening of concentration and display of impulsiveness in his playing, which I cannot account for by [Fischer's] exclusively impressive playing."

Other observers have attributed Spassky's listlessness to "Fischer-fear," the trancelike state which similarly affected the three grand masters—Taimanov, Larsen, and Petrosian—who preceded Spassky as obstacles in the path of Fischer's road to victory. To the Russians it may have seemed that possibly something more practical than mesmerism underlay the obliging propensity of Fischer's opponents to despair before their time was up.

In the Russian medical literature is the description of an ailment known as "asthenic syndrome." The symptoms include weakness, fatigability, depression, antisocial tendencies, sense of fear, impairment of memory and general mental function, and an inability to make decisions.

The cause of asthenic syndrome is said to be low intensity microwave radiation. Soviet physiologists explain the syndrome in terms of a theory of Pavlov's which views the central nervous system as particularly sensitive to radiation. Western physiologists acknowledge that intense microwaves may produce mental discomfort by a simple heating of the brain, but they have generally had difficulty in confirming the low intensity effects described by the Russian school.

An opportunity for the physiologists on both sides to study the question was the alleged bombardment with microwaves of the United States Embassy in Moscow during the 1960's. The purpose of this remarkable incident, according to syndicated columnist Jack Anderson, was to alter the personalities of American diplomats. Under Operation Pandora, the Advanced Research Projects Agency exposed a number of monkeys to the same microwave environment as that detected in the embassy, but psychologists could reach no absolute conclusion that the monkeys' minds were affected, Anderson reported in his column last 10 May. (No comment on the alleged incident could be obtained from the State Department last week.)

Did the Russians believe Fischer was making microwaves at Spassky? "That's what occurred to me—the reports in their literature are typical of that," says Herbert Pollack, a consultant to the Institute of Defense Analyses who is expert in this esoteric field. But the Russians in last week's statement did not specify the nature of the electronic devices they suspected Fischer of using. They had received letters, Geller said, indicating that Fischer's chair and the special lighting fixtures might be the sites of the unseen influences. Professor Sigmundur Gudbjarnason of the University of Reykjavik analyzed samples of the two players' chairs by gas chromatography but the two showed identical profiles with not a hint of toxin, pheromone, or untoward alchemy. And nothing but the now celebrated two dead flies was discovered in the lighting fixtures at the chess hall.

The Russian side is now bearing the brunt of the humor which their complaint evoked. Yet, absurd as the accusation may have seemed to the spectators at Reykjavik, from a different perspective, in the distant office of a Kremlin bureaucrat, it may have seemed a plausible key to a strange and disturbing set of facts.—NICHOLAS WADE

type" reasons for disliking chemical weapons. "Among other things, a ship is one massive, self-containing, ventilation system; the minute any of that stuff gets released accidentally, you'd just have to abandon ship. Its too dangerous."

On the other hand, 85 percent of the chemical officers voted that there will be a future need for herbicides. This was explained by several sources as doing just what comes naturally. Chemical weapons are the Corps' *raison d'être*, or, as one official said, more baldly, "Its their meat and potatoes. Asking the Chemical Corps to vote against future use of herbicides is like asking it to cut its own throat."

Although the ESSG report reveals these intraservice factions, the study itself, according to a number of accounts, was the product of a larger scale factionalization within DOD. Allegedly, in mid-1971 when the report was commissioned, the Joint Chiefs of Staff (JCS) favored use of herbicides, while the Office of the Secretary of Defense (OSD) opposed it. The office of Defense Research and Engineering (DR & E), which commissioned the report, tended to side with the pro-herbicide JCS. "DR & E was at loggerheads with OSD on whether you need them," said a source. Another official outside the defense department who followed the ESSG study commented: "I remember being surprised that this was handed to ESSG and not to systems analysis [an office in OSD]. But possibly that was because systems analysis had already established a track record of taking a dim view of it [the herbicide program]".

An official who was involved in the genesis of the report, explained why ESSG was chosen. "Systems analysis really doesn't do that sort of thing. Weapons systems evaluation group might have done it. ESSG was chosen because of the large background of information they had of the geology, climatology, and flora of the area. They have made a number of very good surveys of the country so they would understand the problem, and they could also look into the war-gaming type of problems."

A non-DOD official explained that one reason the military has always favored herbicides in the past was because the JCS, which coordinates the activities of the Army, Navy, and Air Force, was always willing to "go along with" Army leaders' backing of the Chemical Corps' enthusiasm for these weapons. Now that the ESSG study has come out, however, the official speculated on what would happen. "One thing it would be interesting to know is just how actively the Department of the Army and the JCS are willing to lobby for the Chemical Corps."

The relative weakness of the ESSG study's endorsement of herbicides, in the eyes of some, could pull the rug out from under the DOD and the Nixon Administration's interpretation of the Geneva Protocol as exempting herbicides from its ban. As the Wheeler-Swyter review says:

> The data in the Engineer Report strongly supports a position that the incremental military effectiveness secured by retaining the option to use herbicides is outweighed by the costs of retaining the option.
>
> "Among these costs . . . are . . . retardation of further arms limitation agreements, as is currently the case with the Geneva Protocol.

One of the experts who has testified before Congress on the Protocol, George Bunn, dean of the University of Wisconsin Law School, does not take a position on whether herbicides legally are included under its ban. However, Bunn does think that the issue of their military effectiveness or ineffectiveness is relevant to U.S. arms control policy. Bunn gave *Science* the following statement:

> If the legal question is not clear, that is, if the Protocol does not clearly prohibit herbicides, then the United States should consider from a policy point of view whether it wants to have them prohibited or not.
>
> Then, certainly, you should consider their military effectiveness and if they're not very effective from the military point of view, and they raise serious diplomatic and arms control problems, then that's good reason why they should be prohibited, that is, included under the Protocol.

One former White House staffer who recalls the President's historic 1969 decision to seek ratification of the Protocol says that some military inputs to the White House were overruled when the decision was made. "I always had the feeling they [the White House] had their eyes on the Russians more than anyone. This was one of the gestures made in courting the Soviets. The CBW decision was a first step toward SALT." Now that a SALT agreement has been reached, and the DOD's staunch support for herbicides seems to be wilting, perhaps the obstacles to fuller U.S. participation in international CBW agreements will be fewer.—DEBORAH SHAPLEY

Correction

An article in the 18 August issue of *Science* stated that, in his 1960 congressional testimony relating to the use of diethylstilbestrol, Thomas P. Carney, the then vice president for research at Eli Lilly, ignored the fact that human cancers may have a long latency period. This is incorrect, in that Carney's testimony cited a history of the use of DES extending over more than 20 years.

The same article stated that the chairman of the Food Protection Committee of the National Academy of Sciences is William J. Darby. Dr. Darby resigned as chairman in July 1971. The present chairman is Lloyd J. Filer of the University of Iowa College of Medicine. These errors are regretted—N.W.

RECENT DEATHS

William Antopol, 69; director of laboratories and research, Beth Israel Medical Center; 19 June.

Edward B. Bunn, 76; chancellor and former president, Georgetown University; 18 June.

Farrington Daniels, 83; professor emeritus of chemistry, University of Wisconsin; 23 June.

H. Claire Lawler, 49; biochemist and research associate, psychiatry department, Columbia University College of Physicians and Surgeons; 7 July.

J. Holmes Sturdivant, 66; professor of chemistry, California Institute of Technology; 21 April.

Joseph L. Sutton, 48; former president, Indiana University; 28 April.

William M. Whyburn, 70; professor emeritus of mathematics and former vice president, University of North Carolina; 5 May.

Griffith W. Williams, 75; professor emeritus of psychology, Rutgers University; 22 April.

Erratum: In the report "Rostroconchia: A new class of bivalved mollusks" by J. Pojeta, Jr., *et al.* (21 July, p. 264), the second sentence in the second paragraph on page 264 should read "As in other motile bivalved animals in which the midsagittal plane passes between the valves, the fused junction *(hinge) of the valves is regarded as* dorsal and the margin opposite the hinge ventral."