shown that 90 percent, or 156, of 174 known carcinogens cause mutations in their bacterial strains. By contrast, few of the 109 "noncarcinogens" that they have tested are mutagens. Because a wide variety of classes of chemical carcinogens are mutagens in his system, Ames argues that this bacterial test system provides a reliable screen for potentially harmful chemicals.

As an example of the usefulness of quick tests for carcinogenicity, Ames tells the story of a preservative (furofuramide) that was extensively used in Japan. It was tested in animals and found not to cause cancer. The chemical, however, did cause mutations in bacteria. It was subsequently retested in animals, found to be carcinogenic, and banned. Now, Ames reports, bacterial mutagenicity tests are extensively used in Japan. In particular, the Japanese require that all pesticides be shown not to cause mutations in bacteria. The Japanese are also taking very seriously the finding that hair dyes are potent bacterial mutagens and are currently trying to develop hair dyes that do not have this drawback, according to Ames.

Despite these arguments in favor of the Ames and similar tests, it is by no means clear how results of these tests are to be interpreted. One problem is that, with the data obtained so far, the logic behind the test evaluations goes the wrong way. Ames can say that 90 percent of all tested carcinogens are mutagens in his bacterial strains but he cannot say what the probability is that a chemical that is a mutagen will turn out to be a carcinogen.

Some investigators believe that this difficulty can be partially remedied by the use of more than one test system. A positive result in several quick tests might carry more weight than a positive result in the Ames test alone. Mammalian cell systems are of particular interest to some investigators who believe it would be intellectually more satisfying to detect DNA damage to these cells or transformation of them into tumor cells than to detect mutations in bacteria. Mammalian cell test systems are not yet extensively used, however, because these tests cost 5 to 10 times more than the Ames test and neither they nor the other quick tests have the data base or the sensitivity of the Ames test.

Legislators and officials at the National Cancer Institute have expressed interest in the quick tests but have hesitated to endorse any of them because of the difficulties in interpreting results. Yet rapid and inexpensive screens for harmful chemicals are needed if the Toxic Substances Control Act is to be economically feasible. The ultimate solution to the problem with the quick tests lies in obtaining more data. Then it will be possible to correlate results from quick tests with results from animal tests for carcinogens in a statistically convincing manner. By their recent extensive use of the quick tests, industries seem to be making a substantial contribution to the data base that must exist for these tests to be evaluated.—GINA BARI KOLATA

Nuclear Testing: U.S.–Soviet Treaties Viewed with Doubts and Misgivings

Control of nuclear arms is a matter about which the public, aware of the generally frustrating history of arms negotiations, has learned to lower its expectations. Accordingly, the treaties negotiated by U.S. and Soviet officials to limit underground weapons tests and peaceful nuclear explosions have not been awaited with much excitement or anticipation. But, now that the Ford Administration is finally ready to submit them to the Senate for ratification, these treaties give rise to so many doubts and objections that many senators will find it a close question whether they are marginally better than nothing or whether they are actually worse than nothing.

The treaties now subject to ratification go back to the Moscow summit of July 1974, Richard Nixon's last hurrah before he was forced to resign over Watergate. With the strategic arms limitations talks still at an impasse, the President seized the opportunity to sign a treaty limiting underground tests to a certain maximum yield or "threshold."

Had the treaty banned all underground tests or even all tests susceptible to unambiguous "verification" by seismic monitoring, it would have been applauded by the private arms control community that is made up in good part of groups such as the Federation of American Scientists (FAS) and the Arms Control Association (ACA). (A number of former government officials with responsibilities for arms control are active in both the FAS and the ACA.) But the treaty Nixon brought back from Moscow was instantly put down as a mockery by many of these arms controllers, who wanted a treaty that would effectively discourage further weapons development and inhibit nuclear proliferation.

By prohibiting testing in the atmosphere, in outer space, and under water, the Limited Test Ban Treaty (LTBT) of 1963 had stopped the dangerous radioactive contamination of the world environment. But the United States and the Soviet Union had simply moved their ambitious programs of testing underground, and, consequently, the LTBT had constrained the arms race little if at all.

The Threshold Test Ban Treaty (TTBT) signed by President Nixon and General Secretary L. I. Brezhnev in 1974 clearly would not do much to constrain the arms race, either. The threshold, set at 150 kilotons, would allow the testing of weapons 10 times more powerful than the one that destroyed Hiroshima. Also, this threshold would bear no relation to verification capabilities, which have been improved to the point that even explosions at yields of 10 kilotons or less may not escape detection.

Furthermore, many arms controllers objected strongly to the fact that, permissive as it was, the treaty would not take effect until 31 March 1976, thus leaving time for each of the two superpowers to carry out a series of tests at high yields. They objected, too, to a glaringly evident loophole in the TTBT—"peaceful" explosions, of whatever magnitude, were not covered even though such explosions can be indistinguishable from weapons tests.

Administration officials acknowledged that plugging this loophole was priority business. Assurances were given that the TTBT would not be submitted for ratification unless it was accompanied by an agreement on peaceful nuclear explosions, or "PNE's." And, sure enough, after a year and a half of hard negotiations, a PNE treaty (PNET) was signed on 28 May, in ceremonies conducted simultaneously in the White House and the Kremlin.

After its fashion, the PNET does address some of the concerns of the arms

controllers. No individual PNE would be allowed to exceed 150 kilotons, which is to say that the threshold for weapons tests would also apply to PNE's. And, in the event either nation should plan a simultaneous detonation of two or more peaceful devices with an aggregate yield greater than 150 kilotons, the other could have observers present to monitor the event on-site.

With the yield limited to 150 kilotons, no PNE would produce militarily useful information not otherwise obtainable through weapons tests allowable under the TTBT. Also, properly equipped observers present for simultaneous multiple explosions could verify that no individual explosion has exceeded the threshold, something which could not be accomplished by seismic monitoring at a distance.

The negotiations for the PNET began in late 1974 and were not successfully concluded until this past April. The United States would have readily agreed to ban PNE's altogether. After spending more than $160 million on earth-moving (cratering) and gas-stimulation experiments with PNE's, the U.S. government had pretty well decided that their promise was illusory. But the Soviets, who had experimented with a number of different PNE applications, professed an especially keen interest in pursuing grandiose plans to use PNE's for canal building. There might be some simultaneous multiple explosions having an aggregate yield of several megatons, with some individual explosions of up to 400 kilotons or greater. In the hope that they would be able to continue conducting PNE's without restrictions, the Soviets had agreed in principle at the Moscow summit to allow some PNE's to be witnessed by on-site observers, subject to such terms and conditions as the negotiators might later arrive at. And this was, in fact, a significant concession in light of the traditional Russian aversion to the idea of on-site inspections.

But, by the time negotiations for the PNET got under way it had become apparent that the Senate would probably reject the TTBT unless PNE's as well as weapons tests were made subject to the 150-kiloton threshold, with adequate provisions for verification.

The on-site observer provisions ultimately agreed to testify to the delicate balance that had to be struck to satisfy both the U.S. negotiators' insistence on effective verification and the Soviets' insistence on minimizing any American intrusion. For instance, American observers witnessing a Soviet PNE would bring two identical sets of yield monitoring equipment and allow the Soviets to choose the set actually to be used; the other set would be turned over temporarily to the Soviets. This, together with other conditions meticulously spelled out in the treaty, would make any unauthorized snooping hard to get away with.

The nation carrying out PNE's would be required to provide the other party with a substantial amount of geologic, hydrologic, and other data bearing on the interpretation of seismic signals and the measurement of explosive yields. In general, the larger the PNE, the more data required. Such data would be essential to verification because, unlike weapons tests conducted solely at designated test sites (about which there would be information exchanges), PNE's might be carried out under widely varying conditions.

The question whether the TTBT and the PNET represent a gain or a loss for the cause of arms control must be considered from the standpoint of weapons development, nuclear proliferation, and the chances for a comprehensive test ban.

The TTBT would impose some constraints on weapons development, but they would be clearly marginal, especially in light of the numerous kinds of high-yield weapons already in the U.S. and Soviet inventories and of all the testing done between July 1974 and the end of March 1976. During this period, the United States conducted 12 announced tests at yields over 200 kilotons; a number of these tests were at yields of up to a megaton. The Soviets also detonated a number of high-yield devices, including several in the multimegaton range.

From the standpoint of nuclear proliferation, the 150-kiloton threshold does indeed seem to make light of the superpowers' solemn obligation under the Nonproliferation Treaty of 1970 to seek arms reductions and a comprehensive test ban. Furthermore, the PNET in a sense legitimizes PNE's, although it does underscore the fact that a PNE and a weapons test can be indistinguishable.

Arms controllers can only hope that, as some people in the Ford Administration are now suggesting, the PNET's on-site observer and data requirements may discourage the Soviets from undertaking a major program of PNE's. But, if such a PNE program is carried out by the Soviets, this could encourage some nonnuclear nations to develop nuclear devices, either out of a genuine interest in PNE technology or from a recognition that PNE's offer a convenient mask for a fledgling nuclear weapons program.

As for whether the TTBT and the PNET would improve chances for a comprehensive test ban or harm them, one person's speculation may be as good as another's. The treaties would establish a threshold from which negotiators could work downward. But many arms controllers believe that, if the treaties are formally ratified, the U.S. and Soviet governments will not resume serious test ban negotiations during the TTBT's initial 5-year term (renewal is automatic unless either party withdraws).

The treaty does call for negotiations looking toward a comprehensive test ban, but, in light of its other provisions, this has the ring of an empty promise. There is even the very real likelihood that, if the Soviets try to employ PNE's in canal building, they will violate the 1963 test ban treaty. Expert opinion holds that some "venting" of radioactive debris would inevitably occur and that part of this material probably would drift across international boundaries.

Yet, despite all doubts and migivings, if the TTBT and the PNET are sent to the Senate floor this year and brought to a vote, they are likely to be ratified. This is so because even such senators as Edward Kennedy, sponsor of a resolution calling for a comprehensive test ban, are afraid that Senate rejection of the treaties might undermine hopes for further arms control agreements.

On the other hand, there may be a better than even chance that in this election year time will run out before the Senate brings itself to act. Indeed, senators who regard the treaties dubiously may contrive to make this happen. If time does run out this year, the question of ratification will go over until 1977 when a newly elected President will have to review it. If the president should be someone like Jimmy Carter, who favors an immediate moratorium on testing, the treaties' fate will be in serious doubt.

—LUTHER J. CARTER

Clarification: The article, "Pesticides: Three EPA attorneys quit and hoist a warning flag" (19 March) referred to aldrin and dieldrin and heptachlor and chlordane as "two pairs of compounds found to be potent carcinogens." Most uses of both aldrin/dieldrin and heptachlor/chlordane were in fact ordered suspended by the administrator of the Environmental Protection Agency as an "imminent hazard" to human health and the environment. But some readers may take the words "potent carcinogen" to mean that a compound has been determined by federal authorities to be carcinogenic in laboratory animals at relatively low dose levels. No such finding has been made with respect to heptachlor/chlordane.

In the case of these compounds, the administrator overruled the decision of the administrative law judge, who held that to suspend their use as an imminent hazard was not justified. He felt "hesitantly unwilling at this time to find that heptachlor/chlordane are conclusively carcinogens in laboratory animals." The administrator concluded, however, that heptachlor is a carcinogen in both the rat and the mouse. Weighing the risks of continued use of heptachlor/chlordane against the benefits, he decided that most uses should be suspended. His ruling is now under review by the U.S. Circuit Court of Appeals for the District of Columbia.—L.J.C.