significantly from this policy. Unlike the Department of Defense, the AEC has, on the whole, tended to strengthen and reaffirm its original policy on a broad front. It is true that the contracting procedures of the AEC are rather more complex and cumbersome than those of some of the other agencies. This, however, is a detail, and adjustments can be made in due course.

Since the space agencies, including NASA, are much more mission-oriented than either the National Science Foundation or the National Institutes of Health, I see little reason to expect them to provide the same general type of support to universities that NSF and NIH provide, unless evidence arises to show that certain specialized areas are being grossly neglected. It is clear that more appropriate bases for comparison are provided by the Atomic Energy Commission and by the Department of Defense. It is particularly important that NASA make such a comparison at this time, while it is in the process of establishing its own policies. There are two good reasons for this: (i) the quality of NASA's own effort will depend significantly upon the quality of the product of the universities, and (ii) NASA presumably has a long life ahead of it and may well determine the course of many aspects of science and technology in our country, not the least of which may be the vigor and effectiveness of some aspects of university life.

On the whole, I strongly recommend that NASA consider adopting policies relative to the universities more nearly like the present policies of the Atomic Energy Commission than like those of the Department of Defense. I realize that NASA, unlike the AEC, operates its own in-house laboratories directly instead of depending upon contractors, but this, I feel, is a detail in the larger picture, since the large contract laboratories of the AEC are, in a sense, also in-house laboratories. What strikes me as the most significant consequence of the differences in the policies now followed by the AEC and the Department of Defense is that a very large number of university scientists and engineers have a sense of direct responsibility for the program and welfare of the AEC, whereas the trend is in the opposite direction for the Department of Defense. I find very few scientists or engineers under 40 in universities who feel the sense of close communion with the Department of Defense that my own generation did in the corresponding age period. I believe an important part of this difference stems very directly from the fact that the Atomic Energy Commission has continued to support university research broadly and in depth while remaining well within the framework of its mission, whereas the agencies of the Department of Defense have tended to become more and more selective and restrictive. This gradual withering of the bonds between the Department of Defense and the universities can be justified only if one assumes that the very indirect channels which now exist are adequate. Such an assumption strikes me as being exceedingly dangerous. I think the policy adopted by the Atomic Energy Commission is a far more conservative and reliable one in the long run.

Conclusion

In brief, then, it is my hope that, once this period of organization and adjustment is over and NASA has become established, it will adopt policies resembling those of the Atomic Energy Commission, to the extent that its frame of reference permits. This, I feel, will assure a long and intimate period of communication between NASA and the universities, with optimum benefits to both. I see no reason why the establishment of such a policy should affect the in-house laboratories of NASA adversely. On the contrary, it seems to me that such a relationship will result in the NASA laboratories' obtaining the services of an appropriate number of the most talented graduates of the universities.

News and Comment

Test Ban: Testimony on Technical Aspects To Help Senators Decide if Treaty Is a Boon or a Bane

No issue in foreign policy is more entangled in scientific and technical considerations than that of arms control, and recent progress toward a limited test ban treaty has changed the questions somewhat but by no means eliminated the technological context of debate.

Devising an inspection system which would satisfy both sides was a chief technical difficulty preventing a comprehensive test ban and, when political circumstances altered, this technical Gordian knot was cut by excluding underground tests from the ban. Nuclear devices can be tested in the atmosphere and above it, underwater, and underground, and the last environment has persistently presented the greatest difficulties for detectors. The new test ban treaty simply forbids tests where they can be monitored more successfully.

The treaty is signed, sealed, but not quite delivered, because of the requirement of ratification by the Senate. Full-dress combined hearings before the Senate Foreign Relations and Armed Services committees and Senate members of the Joint Committee on Atomic Energy began Monday, with Secretary of State Dean Rusk, an advocate of ratification, as the first witness. Monday afternoon, the Armed Services preparedness subcommittee, in closed session, heard Edward Teller, an anti-test-ban advocate of long standing. It is clear from the pre-hearing statements of senators and the early testimony that the hearings will cover scientific and technical as well as political and strategic questions and that matters of weapons development and test detection will get special attention.

In the past few years a whole new technology and vocabulary of test detection has emerged. Serious efforts in the United States to develop a sophisticated test-detection capability date from the so-called "conference of experts" in Geneva in 1958, an East-West meeting devoted to assessing techniques for detecting nuclear testing.

A consensus that the state of the art was highly unsatisfactory at that time resulted in this country in the organizing by Presidential Science Adviser James V. Killian, Jr., of a blue ribbon Panel of Seismic Improvement headed by Lloyd V. Berkner, then president of Associated Universities. The realization that the seismologists had their work cut out for them with underground testing sharpened early in 1959 with the confirmation that "decoupling"—detonation of a nuclear device in a large chamber in the ground—would significantly reduce the size of the seismic signal.

The Berkner panel report led to the assignment of responsibility for research on nuclear test detection to the Defense Department's Advanced Research Projects Agency, which operates under the supervision of the director of defense research and engineering, Harold Brown.

The agency is responsible for basic and applied research and development on advanced projects which cut across the jurisdictions of the individual military services. ARPA is a research agency which selects and funds research projects but assumes no operating functions. It might, for example, let contracts for some pilot seismological detection stations, but would not run a full-scale system of detection stations.

The research effort on detection was named Project Vela and separated into three main sections: Vela Uniform for the detection of underground tests; Vela Sierra for the detection from the ground of high-altitude detonations; and Vela Hotel for detection by satellites of high-altitude detonation.

Vela is only one of a number of projects managed by ARPA—research on ballistic missile defense is a much larger one. Vela is, however, the main Western effort in test-detection research. The British also have a modest program which Americans in the field regard as productive considering its size.

During the years when a comprehensive test ban was the diplomats' apparent quarry, underground test detection claimed a priority. And testimony at Joint Atomic Energy Committee hearings in March indicated that some $101.9 million was spent from the beginning of Project Vela in 1959 to 1 February of this year, while perhaps half that was spent on the other two Vela sections.

Over the past 5 years, seismologists have refined their equipment so that they are able to detect disturbances of smaller magnitude. They have also learned a good deal about earthquake activity in various parts of the world, which is very useful in discriminating between natural and man-made shocks. In the Vela hearings in March ARPA staff members testified, for example, that studies showed that the incidence of earthquakes in the Soviet Union was much lower than had been estimated in 1960.

To establish that an underground disturbance is a nuclear explosion four steps are required: detection of the event, identification as an explosion, location, and verification.

Range of Uncertainty

In the Project Vela hearings in March—the third round of such hearings held by the Joint Committee on Atomic Energy since 1960—ARPA officials said that seismologists were confident of detecting underground explosions of over 100 kilotons (explosions releasing energy equal to that of 1000 tons of TNT). At the lower end of the scale of certainty they indicated that it was not possible to be sure of detecting explosions of 3 to 5 kilotons in alluvial soil, which, compared to rock, tends to muffle explosions.

Identification is viewed as an even trickier proposition, but progress seems to have been made there too. Analysis of aftershock patterns on seismographs, for example, has been viewed as a significant way to distinguish natural disturbances from explosions. On this subject, however, the public record is somewhat cloudy since a full revelation of what one side has learned would presumably yield information useful to a nation which was considering a clandestine fling at testing.

While detection techniques had been improved significantly, there remained a detection gap. And early this year, when hopes for a test ban seemed to be budding again, stiff opposition developed inside and outside Congress. The opponents argued, in effect, that because safeguards against cheating were not 100-percent reliable, a comprehensive test ban was unacceptable.

Particularly active was a Republican Conference special subcommittee on test ban negotiations headed by Representative Craig Hosmer (R–Calif.), a former attorney for the Atomic Energy Commission and now a member of the Joint Committee on Atomic Energy. Hosmer concentrated on the charge that the administration was reducing its demands on inspections in order to get a test ban. Because of this assault, and others like it, against the test ban, and because of the fresh memory of the Soviets' clandestine installation of missiles in Cuba, it is most unlikely that a comprehensive test ban treaty could have been ratified even if the Soviets had liberalized their restrictions on inspections.

The advent of the agreement on the limited test shifted the main focus of the technical debate from underground to deep space. It is generally agreed that a test-ban recreant could sneak small tests in the atmosphere over the wastes of the Pacific, for example, or during thunder storms, and stand a good chance of escaping detection. It is pointed out, however, that such tests would have to be limited to devices of a size which could be detonated underground. And, therefore, interest has turned to the possibilities of clandestine testing in space.

In Project Vela research on detection of high-altitude tests, some $26 million was spent by the United States through the end of 1962—$18.5 million for satellite-based research and $7.5 million for the ground-based project. At the Vela hearings in March it was estimated that $31 million would be spent in fiscal 1963 on the satellite program and $4.7 million for the ground-based studies.

Budget plans for fiscal 1964 called for something of a reduction, with satellite research put at $27.5 million and research on ground-based systems at $3.7 million. Whether, however, the proposed test ban will have any effect on this planning remains to be seen. ARPA last week buttoned its lip officially and declined to discuss the effect of the test ban on its plans and budget. On Monday, however, Secretary Rusk, without giving details, said that the present network for test detection will be expanded.

The best information generally available on the techniques of detecting tests in outer space is again to be found in the March Vela hearings. At these hearings Alois W. Schardt, deputy director of the nuclear test detection office, said that space probes like the Mariner II Venus shot demonstrate that it is possible to test in deep space and to retrieve results.

Substantial development work has been done on ground-based detection techniques, in part through the experience gained during the last series of United States tests in the atmosphere. ARPA officials testified that ground-based equipment is reliable in detecting tests in the area between the earth and the moon—more precisely, that "unshielded" explosions of 10 kilotons could be detected out to 300,000 kilometers.

It is assumed that any nation which undertook to test in space and to keep it secret would choose deep space and attempt to shield an explosion, probably through use of lead shielding around the device—referred to rather jocularly during the hearings as a "lead balloon"—which would attenuate the x-ray flux, the most readily detectable indication of a nuclear explosion in space.

Shielding in Space

Shielding is regarded as possible to achieve, but it raises formidable engineering problems and involves the risk of something going wrong which may reveal the test. Testing in space is also extremely expensive; one scientist not in the ARPA program estimated that testing in space is a hundred times as expensive as testing underground.

There seems to be no question that the greatest capacity to detect tests in space would be provided by a satellite-based detection system operating beyond the Van Allen belts and their interfering radiation. ARPA has an experimental program under way aimed at developing a satellite system capable of detecting unshielded 10-kiloton tests at eventual range of 300 million kilometers from the earth. The first pair of experimental detection satellites is scheduled to be put into orbit this fall. This, incidentally, is not a crash program triggered by the test ban but the result of a program begun in 1960.

Satellites, it is said, would provide a means to catch would-be cheaters testing behind the moon or during solar flares. Solar satellites are also being studied for their value in detecting far-out tests.

Government scientists are working on the problem of detecting shielded space shots, and this necessarily includes efforts to learn ways to shield explosions so that the scientists will know what they must guard against.

At present there is no complete information available on either ground-based or satellite-based detection. Techniques of ground-based detection are much further advanced, however, and testimony at the Vela hearings indicated that for the next 2 or 3 years the main burden of surveillance would fall on the ground-based detectors.

The question of who would operate a detection system—the satellite research is a joint ARPA–Air Force–NASA undertaking—is yet to be settled.

It has been clear from the outset that one matter which particularly agitates what can be called the anti-test-ban bloc is that of anti-missile defense. A representative statement on the subject came this month in the Washington newsletter of the American Security Council, a Chicago-based organization concerned with security matters, which has taken a hard line on test ban matters. (The Hosmer panel early this year published position papers by Teller, Stefan Possony, Admiral Chester Ward—all members of ASC's national strategy board—and Frank Johnson, editor of the ASC Washington newsletter, as well as by several other persons not affiliated with the ASC, whose views ranged to warmer estimates of the value of a possible test ban.)

The test ban treaty, said the ASC newsletter, "from the standpoint of Soviet cheating is less dangerous to American security than is a total test ban without adequate inspection. This, however, is only one part of it. The Joint Chiefs of Staff may be pressured into giving approval on political grounds, but they are known to have military reservations. The Soviets are sacrificing very little. Since 1961 they have completed two massive atmospheric tests in which they made at least enough progress on the anti-missile missile to be able to begin deployment of an operational system. No one knows just how effective their system is, but it seems certain that the ban freezes them in a position superior to the United States in this vital area."

A different view of the same terrain of controversy was taken in a statement containing an endorsement of the nuclear test ban treaty by the Federation of American Scientists, which has 2500 members, including many who have worked on the development of nuclear weapons, and which has demonstrated a continuing interest in proposals for arms control.

According to the FAS statement, "It is sometimes asserted that further testing is necessary for the United States to develop a defense against missiles. In fact, nuclear weapons technology is only one of the many fields that must be mastered if a missile defense is to be achieved, and it appears that these other areas represent far more significant barriers to the achievement of such a system than does the area of weapon technology. Thus the problem of discriminating between an incoming missile warhead and various decoys that might be accompanying it is exceedingly difficult, as is the related problem of handling a large number of incoming vehicles at the same time. If these critical technical problems are solved, warheads for the anti-missile missile can be developed underground. It is only measurements of radar blackout, warhead vulnerability, and actual live system tests that might require atmospheric testing. Measurements of blackout were made in recent tests in the Pacific."

Damper on Debate

Certainly the major assumptions underlying both lines of reasoning will be closely examined in the current hearings, though much of the discussion may go on behind closed doors. Full ventilation of the issues will hardly be possible, since much of the relevant information—about Soviet tests and our own, for example—is classified and highly technical, and a full-scale public debate might well serve to satisfy Soviet curiosity about what we know and can do.

One question sure to be raised concerns the effect of a test ban on the momentum of United States nuclear weapons development. The charge has been made, apparently with some justification, that during the voluntary testing moratorium, which the Soviets shattered in 1961, our weapons laboratories lost key personnel, and that when testing was resumed we were not prepared to make the most of our tests.

This time underground testing will be permitted. Work in the labs will continue, not only on underground testing but, it is safe to predict, on preparations for other possible eventualities.—JOHN WALSH