

THE NEED FOR DETECTION

*Some comments on our negotiations with the Russians
on nuclear testing.*

by Robert F. Bacher

Our present negotiations with the Soviets on nuclear testing really started almost three and a half years ago. In the spring of 1958, President Eisenhower, after consulting with Prime Minister Macmillan, proposed to Chairman Khrushchev that a conference be called to discuss the technical problems which would be encountered in monitoring a nuclear test ban. After an extended exchange of letters, arrangements were made for East-West talks to start July 1 in Geneva.

The Western group consisted of representatives

from the United States, Britain, Canada, and France; the Soviets brought representatives from Czechoslovakia, Poland, and Rumania. It was not clear, just before the talks were scheduled to start, whether the Soviet group would appear at all. The conference did start as scheduled, but with a most inauspicious introduction, since the Soviets wanted a guarantee that the technical discussions would be followed automatically by political agreement for a test ban. The United States and other western nations were completely unwilling to go ahead on this assumption. However, after some rather strained meetings, the conference did get down to the problems of detection and inspection.

The detection of nuclear explosions had been studied by both East and West. Work on the detection of atmospheric tests had been going on for many years in the United States and had been successful in detecting the first Soviet test in 1949. This test was verified by the collection of nuclear debris from high in the atmosphere. In the succeeding years, these and other methods had been developed and improved, and by 1958 it was possible to detect relatively small atmospheric tests by their electromagnetic effects or their pressure pulses, as well as by the collection and analysis of the nuclear debris which was formed.

A few days ago I saw some equipment which had detected the air-pressure pulse from the large Soviet explosion on October 30, 1961, on three successive transits around the earth—the first one being off scale on the most insensitive setting. This equipment was located inside a college laboratory, and it was no larger — and considerably less complicated — than a portable television set.

Our knowledge of underground explosions was very

"The Need for Detection" has been adapted from a talk given by Dr. Bacher at a colloquium on Detection of Underground Nuclear Explosions held at Caltech on December 14 and 15, 1961. Dr. Bacher, provost of the California Institute of Technology, served as a member of the original U. S. scientific team at the Geneva test ban conference in 1958.

About 200 scientists and government administrators from Canada, England, France, and the United States attended this Caltech colloquium, which was sponsored by the Institute's Office of Industrial Associates. Arthur H. Dean, chairman of the U. S. delegation to the Conference on the Discontinuance of Nuclear Weapons Tests, and U. S. Representative to the 16th session of the General Assembly of the United Nations, was originally scheduled to address the colloquium, but "public business of the highest importance" prevented him from attending the meeting.

"Despite the present unhappy status of the negotiations in Geneva," said Ambassador Dean in a message to the colloquium, "I am absolutely convinced that achieving a nuclear test ban treaty will continue to be one of the principal objectives of United States foreign policy . . . If I may be allowed to strike the keynote of the colloquium in absentia, I would say that constructive optimism should be the order of the day."

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fragmentary in 1958 and was based on observations of a single underground explosion, the Ranier test. The results of this test were difficult to understand and there were sizable differences in the seismic records produced at various stations nearly equidistant from the explosion. The relation of this test to natural seismic disturbances, both as to the nature of the record received and as to the magnitude of earthquake to which it corresponded, was known only roughly.

Technical and political problems overlap

Our preparations during May and June of 1958, for the conference scheduled for July, showed that talks which would involve complicated technical problems raised many difficulties new to political negotiations. This Geneva conference was to be technical in nature and political problems were to be deferred until later negotiations, if these were desired by both sides. Nevertheless, technical and political problems often overlapped. For example, worldwide coverage for a nuclear detection network cannot be achieved if major land areas are excluded. Clearly, the participation of Communist China would be required for a successful system, whether or not this was politically easy. The same could be said about Africa and Australia.

This much was clear and had been recognized publicly by Secretary Dulles. But there were many other ways, not so obvious, in which technical problems became involved in political problems. Our government was not well prepared to handle problems of this sort, and somewhat similar difficulties arose in the East-West conference on the prevention of surprise attack held later in 1958 in Geneva.

During the 1961 session of Congress, the United States Arms Control and Disarmament Agency was established to prepare for United States participation in international negotiations in arms control, as well as to foster necessary research and to prepare for participation in such control systems as may become part of United States arms control and disarmament

activities. The director of this agency is Mr. William C. Foster, former Deputy Secretary of Defense, who has had extensive experience in this subject. The establishment of this agency is a major advance.

Our preparations for the talks in 1958 naturally led to the consideration of the detection of small nuclear explosions as well as large ones. Small nuclear devices are considered to be useful for certain military operations, and in addition are important in the development of larger-yield weapons. For explosions in the atmosphere or in the oceans it is possible to detect even rather small explosions quite effectively. For small underground nuclear explosions the problems are much more difficult. The most difficult problem of all is to distinguish a suspected underground explosion, detected by the seismic disturbance it causes, from the rather large number of small seismic disturbances which occur naturally. In preparing our position it was suggested that we might set a threshold and not try to limit nuclear explosions below some particular yield. This raised a great many non-technical problems and this procedure was not followed, even though it might have simplified the technical difficulties.

Differences of opinion

As far as we know, the Soviets had not carried out any underground tests prior to the 1958 conference. After the talks got under way there were wide differences of opinion as to how the seismic signal from a nuclear explosion decreases with distance. The differences between seismic signals from a nuclear blast and those caused by an earthquake also gave rise to heated discussions. No data were brought forward except those from the Ranier test, and most of the discussions had to depend on general seismic information, and on information available about natural disturbances. The frequency of earthquakes in various parts of the world, which is important if natural phenomena are difficult to distinguish from nuclear explosions, was also known only very roughly.

The really sensitive question, of course, was—and

still is—inspection. Could a nuclear detection network function so well that the explosion of a nuclear weapon could be established beyond all reasonable doubt by technical means alone, so that inspection would not be necessary? For underground explosions there seemed to be very little chance that this could be done. The best one could do would be to provide grounds for suspecting that a nuclear explosion had occurred at some location, and that a careful inspection of the region would be necessary in order to arrive at a definitive answer.

Since the Soviets were most reluctant about inspections of their territory, and later, in the political discussions, tried to limit drastically the number of inspections which would be allowed, the criteria for determining that there were sufficient grounds for suspecting that a nuclear explosion had occurred came in for detailed examination. For the underground explosions, the principal difficulty was lack of experimental information. Furthermore, it was clear that a much greater effort would be needed to improve the means of detecting underground explosions and natural disturbances as well. In the last three years a great effort has been focused on this area under the Vela Project, a government research program devoted to improvement in the technique for the detection of nuclear explosions.

The need for detection

But what about the need for detection? A better understanding of seismic disturbances, and better means for the detection of these effects, and for nuclear explosions as well, may be sorely needed if we are to have a nuclear test ban. But the chances for such a ban in the immediate future do not look very good today. It has been argued that the last three years of political negotiations on a test ban—which culminated last August with the breaking off of these talks, and the start of a Soviet test series which ran to around 50 tests and 120 megatons of nuclear explosions—have made it clear that nothing will be achieved in this area of negotiations, and that efforts on the improvement of detection are a waste of time. I must say that I find it impossible to accept this view. Although the events of the past few months are certainly most discouraging, it is hard to believe that in time the Soviets will not come to the conclusion that both they and we will benefit by a limitation in the arms escalation that is now going on. In particular, we would both benefit by a limitation in the spread of really powerful weapons and delivery systems to nations not now possessing them. The Soviets have given indications that they are sensitive to this view.

This is precisely the position that has been taken by our government, in the proposals which President Kennedy made to the United Nations in September, 1961, for an extensive program aimed at general

and complete disarmament. While the international climate today does not seem to be very favorable for these proposals, nevertheless they do appear to be sound objectives. It is difficult to see how our national security—and, indeed, that of the Soviets, too—can fail to be diminished by the spread of the most modern and most powerful weapons.

The proposals made by our government in the United Nations provide for the establishment of an International Disarmament Organization. Under this organization, there would be provision for arms limitation and disarmament in a series of stages. The first stage provides for the reduction of armed forces and the so-called conventional armaments, as well as for steps to contain and reduce the nuclear threat, and to reduce strategic nuclear weapons delivery systems. There would be provisions to promote the peaceful use of outer space, a subject on which a little progress has just recently been made, and provisions to reduce the risks of war by accident, miscalculation, and surprise attack. Later stages would provide for further steps in all these areas, and for the establishment of a United Nations Peace Force.

Reducing the nuclear threat

The provisions to contain and reduce the nuclear threat start with the effective prohibition of nuclear tests by all states that had not already so agreed. The proposals go on to a cessation of the production of fissionable material for use in weapons and provision for the transfer of material produced in the past to non-weapons purposes. Provision is made that the states owning nuclear weapons will not transfer them to any nation not owning them; nor will these latter states be allowed to manufacture or develop them. These are tremendous steps that are proposed, but they are only the first of the steps required.

For the very first step, the effective prohibition of nuclear testing requires careful monitoring and also inspection. Monitoring and inspection are central to *any* agreement for effective arms limitation and control. Unilateral actions which do not provide for these combined functions are not very meaningful, as we have recently seen. But if monitoring and inspection are to be important in the future, we need to understand them and we must be prepared to use them where they are required.

The limitation of nuclear tests is almost certain to be a requirement for any agreement in the whole area of arms limitation and control. Our present proposals make it one of the earliest steps. If such a step is to be successful, it is most important that we improve our methods of detection and identification of underground nuclear tests, and that we understand what can be detected and what can not be detected. Success will depend heavily on the accomplishments of those who are attending this conference, so you have great opportunities and great responsibilities.