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A national organization of natural and social scientists and engineers concerned with problems of science and society.

SPECIAL ISSUE ON COMPLETE TEST BAN

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Marvin L. Goldberger, Chairman
S. E. Luria, Vice Chairman

FAS CALLS FOR TOTAL TEST BAN WITHOUT ON-SITE INSPECTION

(Background Material on Pages 3-8)

We believe that the United States should now seek to negotiate a treaty banning all underground nuclear tests without requiring any on-site inspection. The risks are minimal and the gains could be very substantial.

Given recent improvements in seismology and other means of detection, we believe that the United States would detect Soviet violation of a test ban treaty long before the Soviets could carry out enough tests to score a breakthrough that would threaten the stability of the nuclear balance. Indeed, we are aware of no persuasive argument explaining how even unrestricted Soviet testing below the level easily detected by seismic means could threaten the balance. Moreover, the Soviet leaders could not be given any confidence by Soviet scientists that even a single violation would go undetected.

Without any on-site inspections, clandestine cheating is far less plausible now than it would have been in 1963 with on-site inspections when President Kennedy urged such a treaty. Indeed, we believe on-site inspection would be of only marginal significance, amongst other present methods, in monitoring Soviet test activity. We urge greater declassification of non-seismological methods (and seismological ones also) to permit the public a better appraisal of our ability to monitor a ban.

Much of the opposition to the Test Ban Treaty in the United States does not arise from fear of Soviet cheating. It springs from the desire to continue American nuclear testing in order to develop new weapons, to retest existing weapons and to keep our laboratories vigorous.

We see no need to develop new weapons to maintain the reliability of the American deterrent. A SALT agreement banning ABMs, or restricting them to low levels, would eliminate the need for much planned additional testing to develop improved MIRV and ABM warheads. But even without a SALT agreement, existing warheads would be sufficient. The vigor of the weapons laboratory is not an end in itself. And we can design around any uncertainty which may be created in the future by our inability to test old or modified designs.

There are a variety of means, all consistent with American interests, of dealing with peaceful explosions; our goal should be to find the means which have the greatest international support.

The positive advantages of a Test Ban Treaty are obvious and need not be labored. The treaty could slow down the strategic arms race indirectly. It would greatly reinforce the nonproliferation treaty and decrease the probability that additional nations would seek to develop nuclear weapons. It would eliminate the ecological dangers of further testing. It would inhibit the development of cheaper weapons whose technology might spread to other nations. Finally, it would contribute to an environment in which further steps leading to nuclear disarmament would be possible.

Ad Hoc Committee on Test Ban*

Morton H. Halperin, Chairman
Herbert F. York
Marvin L. Goldberger
Herbert Scoville, Jr.
Franklin A. Long
Adrian Fisher
George B. Kistiakowsky
George W. Rathjens

NO "FIRST USE" OF NUCLEAR WEAPONS WITHOUT CONGRESSIONAL AUTHORIZATION

On December 9, an FAS press conference urged the Congress to limit the President's authority to order American Armed Forces to escalate conventional hostilities into nuclear war through an American first-use of nuclear weapons. It proposed that Congressional authorization be secured for any American first-use and it noted that time will be available. Although it does not oppose a policy of nuclear deterrents, the Federation of American Scientists has long been on record as opposing any first-use of nuclear weapons at all. FAS made this proposal, in the context of Congressional interest in "war powers" legislation, in order to appeal to a broader class of persons who may oppose "no-first-use" policies but still support the notion that power to use nuclear weapons first should not be vested in any one man.

In addition to its executive committee the FAS proposal for an amendment to any "war powers" act that Congress might consider was specifically drafted, endorsed and approved by the following Federation members with long and deep experience with these same issues:*

Marvin L. Goldberger, Herbert Scoville, Jr., Herbert F. York, George W. Rathjens, Morton H. Halperin, Leslie H. Gelb, Eugene Skolnikoff, Richard H. Ullman, Adrian Fisher. (See page 2 for text.)

*See page 8 for the credentials of these specialists.

(from Page 1)

TEXT OF NO-FIRST-USE STATEMENT

Congress now has before it the "War Powers Act of 1971". The Act provides that, in the absence of a declaration of war, the Armed Forces shall not be employed for more than thirty days except as provided for in specific legislation enacted by Congress for that purpose. Further, the President is required to make periodic reports to the Congress not less often than every six months. Legislation of this kind is desirable. As the Act indicates, the "collective judgment" of Congress and the President ought to apply to the "initiation" and to the "continuation" of hostilities.

We wish to point out that, in at least one particular, a war powers act should also limit the President's right to *conduct* hostilities.* We have in mind the President's right to turn conventional hostilities into nuclear war, through an act of American nuclear escalation. This is a matter on which "collective judgment" of Congress and President ought to apply as well. And there would be time for Congress to share with the President the responsibility for such escalation, since no conventional conflict demands an *immediate nuclear* response.

It is present U.S. policy to threaten to *initiate* the use of nuclear weapons if necessary. The United States has not, for example, announced that it would never use nuclear weapons first (the so-called no-first-use policy which has been announced by the People's Republic of China). Quite the contrary, especially in NATO affairs, the United States has declared that it would use battlefield nuclear weapons — even in the absence of enemy use — if our forces were being overrun by conventional attack. The Federation of American Scientists opposes such "first-use" policies and has long supported a policy in which the United States would foreswear such first use.

No One Man Should Escalate

We do not wish to restate here our reasoning. But we believe that many who do not agree with us would nevertheless still agree that the responsibility for such nuclear escalation is too great a responsibility for one man alone, or even for one branch of Government. We propose that the Congress should require the President to secure its consent before employing nuclear weapons except after the use (or irrevocable launch) of nuclear weapons by an adversary.** Whether or not the Congress votes the President a declaration of war — or just continuing authority to engage in hostilities — Congress should retain control over the conventional or nuclear quality of the war.

We should be clear about what such a requirement would do, and what it would not do. It would not — and this is critically important — tie the hands of the President in the event that the United States or its allies are attacked with nuclear weapons. This is because it does not affect our nuclear *retaliation* power. Thus it would not in the slightest erode the effectiveness of our *deterrent*. The retaliatory power of our own nuclear force is the strongest assurance that we have — in the absence of a guaranteed enforceable international ban on all nuclear weapons — that nuclear weapons will not be used against us. We would not want to limit the deterrent effect of that retaliatory power in the slightest.

Ample Time for Consultation

With regard to Europe, the President would have ample time to obtain Congressional authorization if a European crisis develops that would require the use of nuclear weapons. The President could even request authorization from Congress before he had made any final decision to use nuclear weapons. He could inform the Congress that a situation could develop in which he would want to use nuclear weapons, and he could ask for this prior approval. The authority could even be sought in advance of a conflict if our intelligence indicated the imminent outbreak of large-scale conventional hostilities.

It should be noted that even our allies, who rely upon us for a nuclear deterrent, do not wish nuclear war unleashed on their territories, and worry that the finger on the nuclear trigger may be too quick. This is why, ever since the early 1960's, we have concentrated on increasing the capabilities of our conventional military forces with the express purpose of raising the nuclear threshold.

We have built up these strong conventional forces precisely in order that we should never be rushed to the brink of nuclear war — to guarantee that there will be time for careful deliberation. The sort of legislation which we propose would insure that the Congress, as well as the circle of advisers immediately around the President, would share in this deliberation. It should be recognized, moreover, that the requirement of Congressional authorization before escalation to nuclear war would give the President another potentially powerful instrument of policy. The granting of such authorization in the midst of a crisis would constitute for our adversaries a warning of the gravest sort — a warning even more effective, and at the same time less risky, than the so-called "demonstration use" of nuclear weapons which are advocated by some strategists as an alternative to massive nuclear attack.

Requiring Congressional authorization would also inhibit rumors that the United States was about to use nuclear weapons in one world crisis or another. In several such crises (the Korean War and the Indochina War at the times of Dien Bien Phu and at the time of Khesahn), the rumor had gone around the world that the United States was about to use nuclear force. Such rumors can be dangerous and politically costly.

We repeat the all-important point we wish to emphasize: *no* conventional conflict demands an immediate nuclear response. There *will* be time for Congress to share with the President the responsibility for nuclear escalation, if escalation is being considered. And the nuclear escalation issue warrants the broadest possible deliberation.

It goes without saying that the first use of nuclear weapons would offend the conscience of mankind: the U. N. General Assembly called this "a crime against mankind" in a vote of 55 to 20. But such use would also be a crime against our own national security. If we were to break a now-established 26-year-old precedent against the use of nuclear weapons, the risk would rise substantially that nuclear weapons would someday be used against us — if not in the conflict at hand, then in some later conflict. It is not sensible for the strongest nation in the world to encourage the use of a weapon with the potential to become — as the Colt revolver became in the Old West — the "great equalizer".

*Such restrictions are fully in accord with our treaty obligations, all of which make American action conditional on Constitutional requirements; i.e., Congressional consent.

**We would consider a nuclear armed enemy bomber, or ICBM, that was irrevocably launched as nuclear weapon "use" so that the firing of defensive nuclear weapons would not be inhibited.

SOME POLICY CONSIDERATIONS OF A COMPREHENSIVE TEST BAN

A Treaty banning the testing of nuclear weapons would contribute to world security and to the security of the United States by: (1) reinforcing the distinction between nuclear and non-nuclear weapons and hence reducing the likelihood that nuclear weapons would ever be used; (2) slowing down the strategic nuclear arms race and thereby contributing to the stability of the balance; and (3) contributing to prevention of the spread of nuclear weapons through the adherence of non-nuclear powers. The arguments advanced against the treaty are: (1) continued American testing is necessary to develop weapons that we need such as advanced MIRVs and ABMs and to "proof test" existing weapons; and (2) without (and even with) on-site inspection the Soviet Union could cheat and make a breakthrough that would unset the stability of the nuclear balance. An examination of these considerations follows.

The test ban treaty would greatly enhance the existing arms control measures designed to strengthen the belief that nuclear weapons are different and should not be used even when nuclear powers fight. Much has already been accomplished in this direction from the time in the late 1950's when President Eisenhower was asserting without serious contradiction that nuclear weapons were now "conventional" and would be used in a future conflict. The total test ban treaty would make a reversal of this process extremely unlikely. There is great symbolism in agreeing not to test a weapon. Military men are reluctant to rely on, or to recommend, the use of weapons which have not been tested. Overtime the military bureaucracies of these nuclear powers that adhered to the treaty would plan less and less for nuclear warfare except in defense against a nuclear attack.

A prohibition on nuclear testing would slow the strategic arms race. It is worth noting that a complete test ban five years ago would have slowed down if not prevented the installation of both MIRVs and ABM, two developments now clearly seen to be de-stabilizing. A test ban now would make the development of highly accurate MIRVs on either side more difficult if not impossible.

The effects of a test ban on the proliferation of nuclear weapons could be most important. Some countries which have refused to sign the NPT would find it difficult, if not impossible, to refrain from adhering to the test ban treaty. India, in particular, has long pressed for the test ban and would thus find it difficult not to join.

Of equal importance, the test ban treaty would increase the probability that adherents to the NPT would not, at some future date, renounce that treaty. The NPT is disliked in many countries because it imposes an unequal obligation. The nuclear powers give up nothing that they are doing, and simply promise not to do what they had no intention of doing — sharing nuclear weapons with non-nuclear powers. The non-nuclear powers are asked, on the other hand, to give up for all time their right to make nuclear weapons or to possess them. The test ban treaty seems a more equal bargain. The nuclear powers give up what they are now doing — testing weapons — and the non-nuclear powers give up the right to decide to test in the future.

It is generally conceded that, despite the large number of tests done by both sides, more can always be learned about weapons effects, weapons design and development. But, with one possible exception, none of this seems likely to have major military consequences. For example, yield to weight ratios have improved 1,000 times since Hiroshima but could hardly go up by more than about two times more. Of far greater importance today are the changing characteristics of the weapon systems themselves — accuracy, warhead carrying capacity and so on.

The one possible exception of major importance concerns the possibility of a thermonuclear weapons which did not require a fission trigger. [See, for example, "Nuclear Weapons Technology" by J. Carson Mark in *Impact of New Technologies on the Arms Race,* MIT Press 1971.] Such a discovery would lead to very cheap powerful weapons. But this would unquestionable *undermine* the security of the United States as the secret spread. It would encourage proliferation more than any other single discovery. In general, a continuation of testing will encourage proliferation in any case as other nations decline to practice a rule that we only preach.

Validation Tests

In recent testimony, the Assistant to the Secretary of Defense for Atomic Energy, Dr. Carl Walske has put forward what may become a major new argument against halting tests — the need to validate the continued reliability of stockpiled nuclear weapons. Pressed by the Muskie Subcommittee, Dr. Walske noted that since the mid-fifties there have been "five principal cases in which a nuclear test was an integral part of a corrective program for a nuclear weapon in our stockpile." These arose be-

—Continued on Page 4

WIESNER ON TEST BAN

. . . as Science Advisor to President Kennedy, I participated in the decisions leading up to the Limited Test Ban Treaty. . . . Actually, there was no technical reason why we should not have concluded a comprehensive test ban treaty at that time. We now know that only political considerations on both sides prevented reconciliation of the minor differences that existed at the time.

Today, the feasibility of an underground test ban is even greater. It was recently announced that a scientists' panel at a test detection conference of the Advanced Research Project Agency of the Defense Department concluded that progress in seismology now makes it possible to distinguish all but the smallest tests from earthquakes. A test ban agreement without on-site inspection, therefore acceptable to the Soviet Union and practical to implement, would now appear possible.

—Dr. Jerome B. Wiesner, President of MIT, July 22, 1971, statement to Senator Edmund Muskie, on opening of hearings by the Senate Subcommittee on Arms Control on the Test Ban.

POLICY CONSIDERATIONS, from Page 3

cause important modifications of the design of the nuclear assembly system were being made for mechanical, metallurgical or safety standard reasons.

It is significant that Dr. Walske was forced to return to the Dulles-era analysis of the test ban that the test ban is desirable only if linked to other agreements in order to keep his requirement for continued testing consistent with the Administration position that a "suitably verified test ban" *was* desired. He said:

> I strongly endorse, as does the Defense Department, a comprehensive test ban treaty with adequate safeguards. . . . You may wonder how that is compatible with worrying about the reliability of stockpile. . . . My view is, my personal view, that a comprehensive test ban treaty should be judged as a first step in arms control, or another step since we have already had some and beyond that point you should go into real disarmament before too long. I don't mean one month, but I mean before too long. If you have a comprehensive test ban treaty and you do not eventually follow it up with real disarmament, then you would be faced with nuclear powers with large arsenals of nuclear arms and decreased reliability, which could be destabilizing.

Further investigation is required to put on the public record the extent to which these tests were required by aging on the one hand, or by planned changes on the other (new safety standards, etc.). But Dr. Walske's argument that a failure to be able to validate the continued workability of the warheads was "destabilizing" is questionable at best.

Is Unreliability Destabilizing?

A destabilizing effect is one which increases the ability of an aggressor to attack. Uncertainty on each side about the workability of its own, and its opponent's weapons, does not have that character. In the first place, the aggressor must have high confidence that his planned attack will work in virtually all particulars. The defender needs only ensure a much lower weapons reliability to retaliate effectively. And the aggressor cannot be sure that the defender's weapons are not working — when even the defender does not know. A more plausible argument suggests that a roughly comparable degree of uncertainty about weapon reliability would *discourage* aggressive use of nuclear weapons.

Nor was Dr. Walske correct in suggesting that the destabilization could be removed by eliminating "large" stockpiles. Short of general and complete disarmament, questions of reliability of weapons would, all political things being equal, tend to *increase* with dimunitions in weapons stockpiles. Interestingly, in contrast, to the comment quoted above, Dr. Walske's later noted that:

> If nuclear testing were stopped, uncertainties regarding the reliability of existing stockpiles of nuclear weapons could become quite large over a period of years, an effect which might be *stabilizing or destabilizing* depending on the circumstances.

In any case, the problems of deterioration of stockpiles could be resolved in direct ways by using a previously tested method or warhead, or even by replacing the warhead completely thereby restoring whatever effectiveness it had at the time of its entry into the stockpile. The Department of Defense statement adds:

> Of course, the reliability of the stockpile will be affected by the willingness of the government to spend possibly large sums of money to work around recognized deficiencies without nuclear tests. With such funding available the loss in reliability could often be avoided or delayed, although in the absence of nuclear testing corrective measures might involve longer periods of system degradation and might involve settling for a warhead performance well off the optimum.

The question of weapon reliability must also be put in some perspective; most of the concern about weapons firing has to do with their reaction to nuclear-weapons-effects of enemy warheads rather than with anything analogous to simple mechanical or chemical failure. Thus the Defense Department recently testified:

> Since the environments in which weapons may be required to perform are complex, hard to define, and often hostile, it is almost always impossible to guarantee their reliability by actual nuclear tests of the final stockpile design in all the various required combinations of physical environments.

Thus, for example, the partial test ban treaty is already restricting the ability of weapons designers to find out, in realistic tests, how our weapons will be affected by atmospheric nuclear bursts. But this is true for both sides.

The small possibility of a systematic defect in all the weapons in a strategic system, after all U.S. testing to date, could be covered by the withdrawal clause in arms control treaties of this kind.

It should also be pointed out that the long-term apprehensions about validating weapons in stockpiles will arise in a political context that is different from this one. As the cold war wanes dramatically over periods as short as five or ten years, fears appropriate to older periods often go unmentioned later. Still more predictably, the technology of detecting Soviet tests by seismological and non-seismological methods can be expected to continue to increase dramatically as it has steadily for years. No comparable improvement in methods for hiding nuclear tests has occurred. While these political and military trends need not be relied upon, it would be foolish to consider the policy issues of the comprehensive test ban treaty in the absence of speculative judgment upon these central issues.

We have mentioned as military motivation for testing: improvements in "Yield to Weight Ratio"; reduction in radiation (Low Fission); Validation Tests; and Missile

TWO TREATY COMMITMENTS TO SEEK TOTAL TEST BAN

October 10, 1963

Seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time, determined to continue negotiations to this end. . . .

Partial Test Ban Treaty

July 1, 1968

Recalling the determination expressed by the Parties to the 1963 Treaty banning nuclear weapon tests in the atmosphere, in outer space and under water in its Preamble to seek to achieve the discontinuance of all test explosions of nuclear weapons for all time and to continue negotiations to this end. . . .

Nonproliferation of Nuclear Weapons Treaty

Design problems — as in ABM penetration. Other reasons for continued testing given by the Defense Department in recent testimony were: the return to the economy of now necessary special materials as plutonium, oralloy and tritium (Reduced Special Materials); smaller diameter weapons (Special Geometry); still greater weapon safety (Safety); needed improvements in lifetime of weapons (Lifetime); and improvements in a catogory called "Special Output" — this presumably refers to output of x-rays or other special weapons effects for special purposes. None of these latter reasons seem persuasive objections to a comprehensive test ban treaty and some seem minor indeed.

Clandestine Testing

As a related article (see below) shows, clandestine testing would be limited to detonations of a few to several kilotons — with great effort warheads of a few tens of kilotons might be involved. It is a startling and important fact that no one seems to suggest a way in which even *unlimited* clandestine testing by the Soviets at this level could shift the strategic balance in any significant way. In effect, if the United States agreed to halt all tests while permitting the Soviet Union to test below the threshold of, for example, 20 kilotons — no important strategic effect is foreseen. Thus if the test ban is desirable, it is desirable without regard to the problem of cheating, or the problems of inspecting for cheating.

Moreover, the problems of cheating are substantial. They include great uncertainty about the effects of any particular explosion. They include also even the human problems of preventing scientists from revealing that the Nation has cheated. Most important, there are the problems of conventional espionage, satellite reconnaissance and so on (see page 6). It seems likely that any series of tests, perhaps even a single test, would have to be carried out with the willingness of the Soviet leadership to be exposed if necessary and to accept that exposure with all the political and arms race consequences inherent in it.

UNDERGROUND TEST DETECTION

Although inspection of underground nuclear tests is generally assumed to depend entirely on seismology, in fact the U.S. now relies on a variety of intelligence means (see page 6) to detect Soviet underground nuclear tests. Together these methods give the U.S. high confidence that it would detect Soviet cheating long before the Soviets could conduct a sufficient number of tests to affect the security of the United States in any way. This is the relevant test — not whether any single explosion might conceivably go undetected.

Seismologists measure earth tremors by measuring body wave (mb) magnitudes. A body-wave magnitude of 4 (mb4) corresponds to the tremor that would result from an explosion of about 2 kilotons in solid rock. Because the scale is logarithmic, a body-wave magnitude of 5 (mb5) corresponds to an explosion of about 20 kilotons in hard rock. As the Berkner Panel observed in March, 1959, larger explosions might, in principle, give the same body-wave signiture if conducted in softer material (salt, alluvium) or if detonated in a large hole — thus "decoupling" the force of the explosion from the earth. Indeed, if the explosion is set off in soft, dry alluvium, the explosion might be approximately "8" times larger and give the same body-wave magnitude.

However, explosions of this kind larger than several kilotons would leave large observable (by satellite) collapse structures. Similarly decoupling for explosions larger than several kilotons requires large amounts of excavation and risks detection by other means of intelligence. (Firing during earthquakes has also been mentioned but it obviously requires involved complicated maintenance of readiness around the clock over long periods if any useful measurements are to be taken — and infrequent tests.)

Part of the renewed interest in the test ban has arisen from recent advances in seismology. These have, in effect, demonstrated that criteria for discriminating between earthquakes and explosions previously established above a magnitude mb4.5 could be applied to magnitudes of mb4.0. Thus explosions of approximately 2 kilotons (i.e., two thousand tons of TNT equivalent or one-tenth the size of the Hiroshima bomb) in hard rock could be detected and identified about 90% of the time from stations outside the Soviet Union.

Foster On On-Site Inspection

The Defense Department has not, however, given up its insistance on on-site inspection. In recent testimony, Dr. John S. Foster testified that "we have established the need for on-site inspection":

a) for events "sufficiently large to detect but sufficiently small that positive identification cannot be made"

b) "to establish the nuclear or non-nuclear nature of low-yield explosions"

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IMPROVED IDENTIFICATION vs. ON-SITE INSPECTION

It does seem to me a quite reasonable estimate that a system for accomplishing distant identification can be established which will permit identification of distant nuclear explosions in rock as small as perhaps 2 or 3 kilotons. . . .

. . . as the capability for identification approaches more closely the limit for detecting, it is getting to the point where the number of suspect events detected but not identified is becoming somewhat less significant in terms of numbers. That is why I myself believe that the current capabilities and the clear indications of improvements by installing better systems and so on makes it really entirely reasonable to contemplate a comprehensive test ban treaty in which on-site inspections are not called for.

—Pg. 49 Muskie Committee Hearings, July 22, 1971, Franklin A. Long, former Assistant Director for Science and Technology of the Arms Control and Disarmament Agency, 1962-63.

TEST DETECTION, from Page 5

c) "to restore international confidence in any cases where earthquakes are misidentified"

d) "to deter violations by increasing the chance of getting caught"

At the present time, the Defense Department has estimated that a seismic monitoring system could be built to identify all but two or three events per year over magnitude four and a half (five to fifty kilotons in hard or soft rock respectively). At magnitude 4, there would be about 25 identified events per year. But many, if not all, of these events could be quickly disposed of on the basis of satellite reconnaissance — for example, many would occur in the midst of an untracted wilderness. Public reports on the extraordinary resolution of satellite photography have suggested that garbage can tops can be seen from satellite altitudes.* DOD announced comparable variations in Soviet missile silo diameters.

According to one witness before the Joint Atomic Energy Committee many of these events would be hard to resolve seismologically because obscured by the accidental occurrence of large earthquakes elsewhere in the world at the same time. Here a judgment on the feasibility of useful clandestine testing on the basis of "waiting for earthquakes" might eliminate our concern.

More information is required to believe that there is a serious problem of confusing Soviet nuclear explosions for conventional ones. How often does the Soviet Union set off thousands of tons of TNT equivalent in conventional explosions? And are there not ways in which the Soviet Union could communicate its intention reliably without on-site inspection — perhaps to watching satellites. During the Cuban crisis we accepted a visual look at boxes of missiles leaving Cuba as a solution to a similar on-site inspection problem.

International Confidence

The case for restoring "international confidence' after misidentification really means giving the Soviet Union a chance to prove its innocence after the United States has mistakenly decided that the treaty has been violated. But no treaty need embody this right. The Soviet Union could always act to avoid U.S. abrogation by offering to permit an observer to visit the scene if and when other explanations did not suffice.

Finally, a few on-site inspections will not much increase the deterrent effect on violations. The on-site inspection method can only confirm deeply felt suspicions of the inspecting party. A successful clandestine test will avoid giving out signals that would trigger inspection. And if identifiable signals of violation may be emitted, on-site inspection or not, the violator must assume that abrogation may well follow.

It is significant also that these four reasons could be used to support on-site inspection notwithstanding any possible seismological advance. There will, after all, always be the possibility — with or without on-site inspection — of clandestine tests under the threshold, and of ambiguous events and misinterpretations.

If on-site inspections are of marginal significance for the U.S., and of deeply felt importance to the Soviets, there is a prima facia case for considering closely whether the treaty can go forward without them. Persumably this is why a representative of the Arms Control and Disarmament Agency, Mr. Philip Farley contented himself, in recent testimony, with saying that on-site inspection "could" play an important role in deterring violators and "could" provide parties with added confidence that the treaty was being complied with. In answer to questions he noted that he did not exclude the possibility of an agreement without on-site inspection.

It should also be mentioned that on-site inspection could be the source of misunderstanding. The U.S.-Soviet disagreement over *numbers* of permitted inspections has always masked a more complicated unresolved negotiation over the modalities of inspection. Disputes over timing, rights of movement, and so on could turn an unnecessary inspection into a world incident producing heightened and unwarranted suspicion.

Non-Seismological Methods of Verification

Eight years ago, the President of Itek Corporation, Franklin Lindsay wrote:

> Soon it may even be possible to detect clandestine underground nuclear explosions with satellite cameras that can observe subtle changes in the surface of the ground above the point of detonation.

Among the subtle and not so subtle observed events might be: drilling, general site activity, subsidence craters, dust clouds raised by the explosion, or crater subsidance, radiation sensors or radar observation of the ground.* These methods do not require on-site inspection.

SEISMOLOGICAL IDENTIFICATION

"For underground testing in hard rock, we can assume that the superpowers are in a position to achieve a detection threshold of about 1 kt and an identification threshold of about 5-10 kt. Theoretically these numbers are higher by a factor of ten for testing in alluvium and much higher still for testing in a large hole (i.e. decoupling). But taking into account technical realities we can say that underground testing above 10-20 kt can be made extremely risky for the tester, by the use of seismic monitoring alone."

SIPRI assessment, October, 1971 "The Test Ban"

*Public reports on the resolution of satellite photography have been compiled in a chapter authored by Jeremy J. Stone in "ABM," (edited by Abram Chayes and Jerome B. Wiesner, Harper & Row, 1969).

*This list of possibilities, and indications that these kinds of methods are being exploited in the U.S. Vela Satellite program, appears in a Swedish Peace Research Institute (SIPRI) report, "The Test Ban", October 1971.

DISARMAMENT EXPERT SUFFERS LEGAL OUTRAGES

Thomas S. Lough served five years in the Arms Control and Disarmament Agency, and another year in the U.N. Disarmament Affairs Secretariat. His sound judgment and good character is well known to many FAS specialists in this field. While teaching as a professor of sociology at Kent State University, Professor Lough became one of many innocent persons indited as scapegoats for the Kent State killings committed through police error. Although these cases have now been dropped, Professor Lough's legal expenses left him $10,000 in debt. In view of Professor Lough's long service to FAS goals, members are advised that contributions to his defense could be sent to him through the Department of Sociology at Kent State University, Kent, Ohio 44242.

HISTORY OF TEST-BAN NEGOTIATIONS

On March 1, 1954, a U.S. thermonuclear explosion at Bikini Atoll contaminated a local Japanese fishing vessel with radioactive fallout and produced radioactive rain over wide areas of the Pacific ocean. From 1955 to mid-1957, the Soviet Union pressed for an agreement on nuclear tests as a separate measure while the U.S. linked such an agreement to progress in arms limitation or disarmament. When the Soviet Union began to talk in concrete terms of "control," the United States conceded the possibility of a "temporary suspension" of testing as "part of an agreement for a first step in disarmament" and proposed a Committee of Experts be convened to consider the matter.

By the beginning of 1958, the United States had completed about 110 announced tests and the Soviets had held about 30.* The Soviets then set off about 10 more and announced, on March 31, 1958 that they would halt but would feel free to resume testing if others did not follow suit. President Eisenhower did not accept Premier Khrushchev's moratorium offer but persuaded a reluctant Khrushchev to agree to a Geneva Conference of Experts that began in July. After the Conference, President Eisenhower agreed to halt testing for one year with a view to negotiating an agreement along the lines the experts had sketched; the year would begin when the negotiations began.

Starting a month after the Soviet moratorium proposal, the United States had performed 50 more announced tests in six months halting with the onset of negotiations on October 31, 1958. Noting that the offer of a moratorium had not been accepted, the Soviet Union claimed the right to perform as many tests as the West had since the moratorium had been announced; it proceeded to conduct 16 atmospheric tests between September 30 and November 3 — two of these overlapped the onset of negotiations on October 31 by a few days. President Eisenhower announced that the U.S. was relieved of any obligation to suspend tests but would continue "for the time being." Thus began a three year stoppage of tests.

Negotiations Begin

In the negotiations, in January the West dropped its link between a ban on testing and progress toward disarmament. But it introduced new evidence from recent underground tests that suggested seismic detection would be less effective than had been supposed and proposed reconsidering the conclusions agreed to at the conference of experts. A great deal of discussion followed concerning the modalities of on-site inspection: the makeup of inspection teams, the rights of movement, logistic support, staffing of control posts, and control headquarters, rights of veto, and so on.

After a special U.S. panel on Seismic Improvements (the Berkner Panel) confirmed, on March 16, 1959 that underground tests would be harder to monitor than anticipated, President Eisenhower wrote Premier Khrushchev urging a separate atmospheric ban. The Soviet Union rejected this proposal and there then ensued, among other strands of negotiation, haggling over the number of onsite inspections to be permitted. The West had asked 20 inspections and the Soviets had offered three.

Technically the unofficial and informal moratorium had come to an end on December 29, 1959 when President Eisenhower stated that "America considered itself free to resume nuclear weapons testing" subject to advance notice of such intention. (See, for example, Senator Foreign Relations Committee analysis of The Test Ban, September 3, 1963.) But neither side tested until, on August 30, 1961, the Soviet Union began a two month series of about 30 atmospheric tests. With regret, President Kennedy followed suit.

In December, after the Cuban Crisis, Premier Khrushchev wrote President Kennedy and, alluding to the risks of war just passed, offered to settle the test ban problem on these terms: 2-4 on-site inspections (he noted that Ambassador Arthur Dean had used this number in discussions with First Deputy Foreign Minister V. V. Kuznetsov), and automatic seismological stations as suggested by "British" scientists. President Kennedy responded that Ambassador Dean had suggested "eight to ten" inspections, that three automatic stations would not be sufficient, and that he had been informed that the automatic station notion was a "Soviet" idea, endorsed by independent scientists of other countries.

The Partial Test Ban Treaty

Finally, on June 10, 1963, President Kennedy announced in an American University speech:

> To make clear our good faith and solemn convictions on the matter, I now declare that the United States does not propose to conduct nuclear tests in the atmosphere so long as other states do not do so. We will not be the first to resume.

The Partial Test Ban Treaty negotiations followed swiftly and the draft treaty was initialed on July 25, 1963.

Hearings before the Foreign Relations Committee revealed only one official witness opposing the treaty: Dr. John S. Foster, then Director of the Lawrence Radiation Laboratory, now Director of Defense Research and Engineering (DDR&E) in the Department of Defense. Of scientific consultants to the Government, only Edward Teller opposed the treaty. —Continued on Page 8

*These announced tests understate the number of tests of both sides but they are probably indicative of relative numbers.

PARTIAL TEST BAN TREATY OPPONENTS STRESSED "KNOWLEDGE"

To acquire more knowledge in order to know how to defend ourselves, this, I would suggest, is not quite properly called an arms race.

This treaty will not prevent the arms race. It will stimulate it. This treaty is not directed against the arms race. This treaty is directed against knowledge, our knowledge.

—Edward Teller, August 20, 1963, Test Ban Hearings, Senate Foreign Relations Committee.

The proposed treaty would limit not only our knowledge of the actual state of Soviet military deployment, but would also restrict our knowledge of what may even be technically possible. Specifically, this requires that the United States explore vigorously all areas of technology critical to our security.

—John S. Foster, August 21, 1963, Test Ban Hearings, Senate Foreign Relations Committee. (Dr. Foster was then Director of the Lawrence Radiation Laboratory.)

HISTORY from Page 7

The Joint Chiefs of Staff argued that the risks of the treaty could be reduced through certain safeguards: (a) continuation of a comprehensive, aggressive, underground nuclear test program; (b) maintenance of the vitality of our nuclear laboratory facilities and weapons programs (c) the maintenance of a state of readiness to resume atmospheric nuclear testing in the event of violation or abrogation of the treaty and (d) the improvement of detection methods for Soviet and Chinese tests. President Kennedy reassured the Senate on these points in his letter of transmittal of the treaty to the Senate, and in a special letter to Senator Everett Dirksen. Supporting the treaty, the Joint Chiefs had their most serious reservations about the possibility of unwarranted "euphoria" in the West. They considered possible Soviet progress due to clandestine testing to be only a "relatively minor factor" in the overall balance and they argued that the "broader advantages" of the treaty in terms of world tension and proliferation justified the risks.

The Partial Test Ban Treaty entered into force on October 10, 1963. Since that time, both powers have overlooked violations of the other in which explosions have vented to the point where radioactivity leaked over boundaries. Each side has engaged in vigorous underground testing.

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Except for FAS, all other professional organizations of scientists, are tax-exempt and thus precluded from offering advice and suggestions to Government unless specifically requested to do so. FAS is non-profit and a registered civic organization. But FAS is not tax-exempt. We can and do raise the voice of science on Washington's Capitol Hill.

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CREDENTIALS OF CO-SIGNERS

In addition to the necessary approval of the Executive Committee of the Federation, both statements released on page 1 had the explicit endorsement of certain FAS specialists in these matters. Their credentials for endorsing one or both statements appear below. Because both statements involved strategic weapons, there is some overlap in co-signers. (However, an expression of support for one statement and *not* the other does not in any of the present cases constitute disapproval. It simply means, that the statement in question was not circulated to that co-signer for his support.)

Marvin L. Goldberger, formerly Chairman of the Strategic Weapons Panel of the President's Science Advisory Committee, and now Chairman of the Department of Physics of Princeton University. (FAS Chairman)

Herbert Scoville, Jr., former Deputy Director for Science and Technology of the Central Intelligence Agency, former Assistant Director for Science and Technology of the Arms Control and Disarmament Agency. (FAS Secretary)

Herbert F. York, former Director of Defense Research and Engineering (under Presidents Eisenhower and Kennedy), now Chancellor of the University of California at San Diego. (FAS Chairman 1969-70)

George W. Rathjens, who has been Deputy Director of ARPA, Deputy Assistant Director for Science and Technology of ACDA, Director of the Weapons Systems Evaluation Division at IDA, and Special Assistant to the Director of ACDA, now professor of Political Science at MIT.

Morton H. Halperin, former Deputy Assistant Secretary for Arms Control and Policy Planning (under President Johnson) and Senior Staff Member of the National Security Council under President Nixon.

Leslie H. Gelb, former Acting Deputy Assistant Secretary for Arms Control and Policy Planning and Director of the Policy Planning Staff.

Eugene Skolnikoff, who has been Special Assistant to three Presidential Science Advisors and is now Chairman of the Department of Political Science at MIT.

Richard H. Ullman, Professor of Politics and International Affairs at Princeton University and a former member of the Policy Planning Staff in the Pentagon's ISA and the National Security Council in the White House.

Adrian Fisher, former Deputy Director of the Arms Control and Disarmament Agency under Presidents Kennedy and Johnson, now Dean of Georgetown Law School.