CONCERNING A COMPREHENSIVE NUCLEAR TEST BAN

by

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In his initial press conference after being elected, President Carter stated, "As far as nuclear arms limitations are concerned, I would like to proceed quickly and aggressively with a comprehensive test ban treaty." He added, "I am in favor of eliminating the testing of nuclear devices, instantly and completely."[1] This endorsement of a comprehensive test ban was further emphasized in March 1977, when Senator Kennedy introduced the following resolution in the Senate:

> *Resolved*, That it is the sense of the Senate that the President of the United States (1) should propose an immediate suspension of underground nuclear explosions to remain in effect so long as the Soviet Union abstains from conducting underground explosions, and (2) should set forth promptly a new proposal to the Government of the Union of Soviet Socialist Republics and other nations for a permanent treaty to ban all nuclear explosions.[2]

More recently, as a result of the March 1977 Moscow talks between Secretary of State Vance and Soviet Foreign Minister Gromyko, diplomatic efforts have begun. In June 1977, several days of exploratory talks between the US and USSR were conducted in Washington. Beginning on 13 July 1977, trilateral discussions of a preliminary nature (including the US, USSR, and UK) concerning a comprehensive test ban were held in Geneva. Formal talks began in October 1977. On 2 November 1977, in an address marking the 60th anniversary of the Bolshevik Revolution, Secretary Leonid Brezhnev announced a new Soviet position concerning a comprehensive test ban, proposing a halt to all nuclear explosions for both military and peaceful purposes.[3] Both the US and the USSR now appear intent upon reaching an agreement to ban all nuclear tests. Although many think these initiatives are new, actually a comprehensive test ban has been under discussion between the two superpowers for nearly 20 years.

BACKGROUND

In 1958, the Soviets announced that they would cease nuclear testing if the US did the same. In response to this challenge, President Eisenhower proposed that scientists from the US, USSR, and UK meet to discuss the "technological feasibility of detecting and thus policing nuclear tests."[4] Later that year, the US and USSR agreed to a moratorium on nuclear testing while negotiations were held in pursuit of a permanent agreement. A test ban at that time was deemed to be very much in the interests of the United States. In the words of negotiator Arthur Dean:

> With its lead in nuclear power the US could enter into a comprehensive ban without serious risk to the national security and indeed . . . our security may benefit from a 'freeze' in the testing for new weapons.[5]

During the negotiations, however, differences between the US and USSR on the issue of on-site inspections became a major obstacle. The US maintained that on-site inspections were essential in order to verify Soviet compliance. However, the Soviets

"decisively rejected a comprehensive test ban treaty with on-site inspection as 'legalized espionage.'"[6] As negotiations continued, so did the moratorium. In view of the lack of progress in the negotiations, President Eisenhower announced in December 1960 that the US would no longer be bound by its commitment not to test. The announcement further stated that a resumption of testing by the US would be announced in advance. Then in 1961, the Soviets suddenly announced that they would resume nuclear weapon testing. The rapidity with which the tests followed indicated that the Soviets had planned an extensive series of tests while continuing the talks. The US was caught off guard. Although a weapons proof test was conducted by the US within two weeks, it took nearly a full year to prepare a full-scale test program. During that time, the Soviets made substantial gains. In fact, General Nathan Twining, Chairman of the Joint Chiefs of Staff, who headed the group of technical experts that analyzed the Soviet test series, told the Preparedness Investigating Subcommittee:

> In April, 1959, . . . it was generally agreed that the United States held a substantial lead in nuclear technology. . . . [But by August 1963] this lead has essentially disappeared, as a result of the Soviet test series which began in September 1961 and ended in December 1962.[7]

It became apparent that the Soviet Union would not accept proposals that involved on-site inspections. As a result:

> The US delegation recommended that consideration should be given to a test ban treaty which would not cover tests carried out underground, the one environment in which we regarded such inspection as absolutely essential.[8]

The result was the Treaty to Ban Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water. This treaty, known as the Limited Test Ban Treaty, was signed in Moscow in August 1963 and ratified in October of that year. During the ratification hearings, serious concern was expressed over the risks involved with the treaty. Consequently, four safeguards were implemented:

- Safeguard A provided for "comprehensive, aggressive, and continuing underground nuclear test programs."
- Safeguard B was designed to insure "the maintenance of modern nuclear laboratory facilities and programs" so that the US will "attract, retain, and insure the continued application of our human scientific resources to those programs on which continued progress in nuclear technology depends."
- Safeguard C provided for "the maintenance of the basic capability to promptly resume nuclear testing in the atmosphere should that be determined essential to national security."[9]
- Safeguard D addressed the need to improve US ability "to monitor the terms of the treaty, to detect violations, and to maintain our role of monitoring Sino-Soviet nuclear activity, capabilities, and achievements."

Originally, only the US, UK, and USSR were signatories to the Limited Test Ban Treaty. However, it is now in force for more than a hundred countries. In addition to its primary purpose, the treaty obliges the signatories to continue negotiations "seeking to achieve the discontinuance of all test explosions of nuclear weapons for all time."[10] In accordance with this commitment, the US has continued to seek a comprehensive test ban treaty. In 1964, President Johnson proposed a ban on all nuclear weapon tests "under effective verification and control."[11] At the same time, the Soviets were advocating a comprehensive test ban, but they claimed that "actual experience has fully confirmed that no special international control need be organized to detect underground tests."[12]

Ten more years passed before significant progress was made.[13] In 1974, President Nixon and Secretary Brezhnev signed the

Treaty on the Limitation of Underground Nuclear Weapons Tests, also known as the Threshold Test Ban Treaty. In the view of the US Government, this step demonstrated "the continuing desire of both ourselves and the Soviet Union to achieve a complete cessation of nuclear testing."[14] The Threshold Test Ban Treaty prohibits the underground testing of nuclear weapons having yields above 150 kilotons (kt), seeks to keep the number of underground tests to a minimum, and restricts testing below 150 kilotons to certain specified sites. Verification is to be through national technical means, but a protocol to the treaty provides for an exchange of data regarding geographic boundaries and geological and geophysical characteristics of the testing areas. Further, each party is to provide the other specific data for two nuclear weapon tests from geographically distinct testing areas for calibration purposes. This data will include yield, date, time, depth, and coordinates. For future tests, the geographic coordinates of the test location are to be given.[15]

When the Threshold Test Ban Treaty was negotiated, no limit was placed on nuclear explosions conducted for peaceful purposes. This is an important aspect, because military benefits can be derived from peaceful nuclear explosions. As explained by Philip C. Habib, when he was US Undersecretary of State for Political Affairs:

> There is no distinction between the technology of a nuclear explosive device which could be used as a weapon and one which could be used for peaceful purposes.[16]

Therefore, it was agreed within the provisions of the Threshold Test Ban Treaty that peaceful nuclear explosions would be addressed during future talks. In 1976, negotiations concerning peaceful nuclear explosions resulted in the Treaty on Underground Nuclear Explosions for Peaceful Purposes, generally known as the Peaceful Nuclear Explosion (PNE) Treaty, a companion of the Threshold Test Ban Treaty.

The PNE Treaty limits the yield of all devices for peaceful nuclear explosions to 150 kilotons, the same limit prescribed by the Threshold Test Ban Treaty. Although multiple explosions are permitted (up to an aggregate yield of 1500 kilotons), individual explosions must be distinguishable to insure that individual yields do not exceed 150 kilotons. In concluding this treaty, the US pursued three objectives:

- Peaceful nuclear explosions must not provide weapon-related benefits which are otherwise precluded by the Threshold Test Ban Treaty.
- The fact that peaceful nuclear explosions do not contribute such benefits must be adequately verifiable.
- The treaty must be consistent with existing international obligations, particularly the Limited Test Ban Treaty.[17]

US officials feel that these objectives have been reached. First, since peaceful nuclear explosions are prohibited for yields above 150 kilotons, weapon-related benefits are not a problem. Second, a more extensive data

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exchange is provided for by the PNE Treaty. Included are procedures for on-site access by observers with technical equipment, as well as for the exchange of detailed information concerning any project involving peaceful nuclear explosions both before and after the fact.

At this writing, both the Threshold Test Ban Treaty and the PNE Treaty are pending ratification (although the 150 kiloton threshold went into effect on a *de facto* basis on 31 March 1976). These treaties are significant not only for the limitations placed on nuclear testing, but also for the precedents established in the area of verification. For the first time, provisions are made for both data exchange and on-site inspections. This, of course, is a radical change from past Soviet policy and may have implications relating to a possible comprehensive test ban treaty. Even though negotiations are continuing for a comprehensive test ban, US officials feel it is still important to pursue ratification of the Threshold Test Ban Treaty and the PNE Treaty. Ratification would provide a hedge against a long negotiation process for a comprehensive test ban treaty; it would cement the important verification precedents established; and, it would create a more promising environment for comprehensive test ban negotiations by demonstrating the reliability of the US as a negotiating partner.[18]

It may well be true that these treaties enhance the opportunity for comprehensive test ban negotiations, but many concerns still exist. To fully understand these concerns, one must first understand the current underground nuclear testing program which was conceived out of Safeguards A and B of the Limited Test Ban Treaty.

THE US NUCLEAR TESTING PROGRAM

Two agencies conduct nuclear tests—the Department of Energy and the Department of Defense. The Department of Energy responds to Defense Department requirements for new operational weapon systems by designing and developing nuclear warheads. These warheads are necessarily constrained by the delivery system desired and the military mission. In order to be most efficiently used, nuclear warheads must be custom-designed for specific weapon systems. The Energy Department's underground test program is the means by which these complex new warheads are proven to be fully effective and reliable. It should be understood that nuclear testing today serves a far different role in this regard than the atmospheric tests of the 40's and 50's. Then, weapons with awesome power were being developed for the purpose of mass destruction of an enemy. Such weapons have been in the inventory for many years, and that type of testing is history. Today, weapon development tests are part of the process to modify warheads or create new warheads in an effort to decrease collateral effects; to increase efficiency, safety, and security; and to maintain reliability in existing designs over the long term.

In contrast to the Energy Department program, Defense Department tests are concerned with nuclear effects to assure the nuclear survivability and the most effective employment of our weapon systems. These tests are conducted with low-yield nuclear devices furnished by the Energy Department as compact, rapid energy sources to determine the effects of hostile nuclear environments on our systems. Although these devices do not create perfect simulations, they are the closest thing attainable in view of limitations currently imposed. The program helps to provide the understanding of target response to weapon effects so that enemy vulnerabilities can be best exploited. In addition, effects tests can have a major impact on weapon development. Once warheads or component hardware have successfully passed development tests at a given level, their vulnerability to enemy weapons is assessed as part of the warhead/reentry vehicle system by the Defense Department test. Weaknesses or incipient failures in the design or materials used can be identified and corrective action taken. Both of our strategic missile systems which have been subjected to this testing cycle were initially proven deficient, were

redesigned and retested, and are now deployed with high confidence in their survivability.[19]

Underground nuclear weapon development tests and underground nuclear effects tests are the only two types of nuclear explosion programs conducted by the US today. Both, of course, would be banned by a comprehensive test ban treaty.

BENEFITS OF A COMPREHENSIVE TEST BAN TREATY

Senator Kennedy has provided a summary of the benefits a comprehensive test ban would provide. He names five:

- A comprehensive test ban would fulfill an obligation made in both the Limited Test Ban Treaty and in the Treaty on the Non-Proliferation of Nuclear Weapons.
- It would be a "strengthening and stabilizing support for quantitative agreements on nuclear arms" and would "spell out an end to further refinement of warheads, hopefully thereby adding a restraint to the qualitative contest of nuclear one-upmanship."
- It would provide "significant support to the non-proliferation effort," and it would state "to other nations which have not yet entered the nuclear club that the time has come for a halt to the nuclear arms race."
- It would place greater pressure on China and France "to halt their own testing and weapons development."
- It would close "the gaps and . . . the loopholes that are present in the threshold treaty and its companion treaty on the conduct of peaceful nuclear explosions."[20]

The key arguments for a comprehensive test ban revolve around the second, third, and fourth points, which involve arms control and nuclear non-proliferation. These same points are stressed by the Carter Administration in its support of a comprehensive test ban. Paul C. Warnke, while Director of the US Arms Control and Disarmament Agency, stated in this regard:

> Such an agreement could promote US and global security in a number of ways. By placing balanced constraints on Soviet and US nuclear weapon programs, a [comprehensive test ban] would be an important factor in stabilizing the bilateral strategic relationship and would therefore enhance the security of both countries. . . . An effective comprehensive measure . . . would also make a major contribution to our non-proliferation efforts.[21]

What of these benefits? Would a comprehensive test ban really slow the arms race? Would it contribute to non-proliferation? Actually, there is little reason to believe that a comprehensive test ban treaty, in and of itself, would have a stabilizing effect on the arms race. Arms competition is more often dominated by delivery systems than by the technology of nuclear devices. This point was conceded by Dr. Wolfgang Panofsky, a proponent of a comprehensive test ban, during a 1973 congressional hearing:

> The arms race is much more decisively affected by nonnuclear developments, both for strategic and tactical warfare, than it is by nuclear developments. . . . Nonnuclear [developments] rather than nuclear developments are of greatest concern in relation to maintenance of strategic stability and . . . the strategic balance cannot be critically affected by advances in nuclear weapons technology on either side.[22]

The significance of this point becomes clear when one considers that today a state of rough equivalence exists between the US and the USSR, despite the fact that the Soviets hold advantages in numbers of delivery vehicles and throw-weight. Our equivalence comes from the technological superiority which we maintain. For example, the US strategic missile force is characterized by accuracy and relatively low yields. The Soviets, on the other hand, have

less accurate systems with much larger yields. By testing their delivery systems and developing accuracies which approach what the US has today, the Soviets would accrue a distinct advantage without any change in warheads. If we thought our technological advantage was about to erode and the balance of power shift in favor of the Soviets, we would naturally take steps to improve our force. Hence, an arms race could evolve without the direct involvement of nuclear devices. Further, with a comprehensive test ban, very conservative design and construction practices would be required to help insure the integrity of a nuclear weapon package. In no way could we, or the Soviets, assure the reliability of that package to a high confidence level. This actually suggests a *destabilizing* effect brought about by the constraints of a comprehensive test ban; for without testing there will be *less* confidence in nuclear weapon systems. Contrary to the view of comprehensive test ban supporters, a ban on testing could easily fuel the arms race, not necessarily slow it. Certainly, there will be no less of a threat posed by either the US or the USSR. Both will maintain large stockpiles of weapons, and where there are weapons there is bound to be arms competition. The only difference will be greater uncertainty in each side's nuclear capability.

The nuclear non-proliferation argument is sound, but only if *all* nuclear weapon states (present or potential) become signatories. If only the US and the USSR agree to a comprehensive test ban treaty, they will set an example for the rest of the world and apply severe pressure on other nations to refrain from testing; however, scenarios depicting weapon development tests can easily be drawn despite the political pressures which would exist. For example, US allies are now protected by a US nuclear umbrella. If they perceived a serious erosion of the US capability to defend them, Japan or Germany might feel compelled to pursue major nuclear arsenals of their own. In fact, a precedent has been set: France and China have conducted nuclear tests in the atmosphere, one of the environments prohibited by the Limited Test Ban Treaty. The countries which are parties to that treaty have complied with its provisions, but France and China are not signatories. If the non-proliferation objective of the comprehensive test ban treaty is to be fulfilled with any level of confidence, then the ban must be agreed upon throughout the world. It would seem that refusal to sign such a treaty could only be taken as an overt indication that a nation intends to pursue a nuclear weapon development program. If one nation attempts to go the nuclear road alone, others will be sure to follow.

COSTS OF A COMPREHENSIVE TEST BAN TREATY

Senator Kennedy's list of benefits, whether real or just perceived, can only be achieved by paying a high price. The following list suggests significant costs of a comprehensive test ban treaty:

- Reduction in the reliability and effectiveness of the nuclear weapon stockpile.
- Increased reliance on conventional forces.
- Degradation in the capability of US weapon laboratories.
- Elimination of US capability to modernize its nuclear weapon force.
- Increase in dollar costs associated with requirements for larger weapons, nonnuclear tests, and simulators.

With regard to the first of these costs, confidence in the US nuclear stockpile would be reduced over time. Key components of a nuclear weapon inevitably deteriorate or their properties change over the course of time. When this happens, weapon laboratories take on the task of fixing the weapon through a rebuild or redesign program. Although in theory a weapon could be rebuilt exactly as it had been built originally, this has rarely been done. This is because very subtle changes almost always occur due to such factors as the unavailability of original materials, new safety requirements, economy measures, and the dynamic technology inherent in the nuclear field. When these changes are built

into a weapon today, reliability is determined through testing. Under a comprehensive test ban, this would be impossible. Although there is some controversy over the seriousness of this problem, it is generally agreed that nuclear tests are important in keeping the weapon stockpile in good operating condition. Without the benefit of testing, there would be a risk that rebuilt or redesigned weapons would not work. If there is doubt, confidence cannot be high. Harold Agnew, Director of the Los Alamos Scientific Laboratory, has stated that "with ample money, no restrictions on materials, and adequate nonnuclear testing the stockpile could be maintained as is for a period of at least ten years."[23] However, it is more than likely that sufficient funds will not be authorized and some materials will not be available. Roger Batzel, Director of the Lawrence Livermore Laboratory, believes that "it would be very difficult to maintain confidence that existing weapons could operate properly if circumstances required their employment."[24] Although weapon scientists may differ in opinion as to how quickly reliability would decrease, the point cannot be dismissed. Inevitably there would be a loss of confidence.

Along with a decrease in reliability in the nuclear stockpile, there would be an increase in dependence on conventional forces. Our nuclear force serves to deter aggression by any enemy. As confidence in that force decreased over time, so would its ability to deter. As a result, conventional forces would be used to a greater extent to provide leverage in world politics. Based upon today's estimates, the USSR and Warsaw Pact far outnumber the US and NATO in conventional forces. The US would certainly be at a disadvantage if nuclear weapons were discounted. Once again, arms control ramifications come into play. A comprehensive test ban treaty would destabilize the nuclear balance and dramatically emphasize the asymmetry in the US-USSR conventional balance. If successful Strategic Arms Limitations Talks and effective Mutual Balanced Force Reductions were to result in equal conventional capabilities, then this problem might be overcome. However, agreements of this nature are nowhere in sight. Without them, a comprehensive test ban would place the US at a serious disadvantage.

With regard to US weapon laboratories, it is virtually certain that vital scientific capability would be degraded. Scientists agree that the basis for learning is experimentation. Without the benefit of nuclear testing, nuclear scientists will be unable to maintain a high level of competence. Highly capable, experienced scientists will tend to leave the weapon laboratories for other fields. Younger scientists will seek more rewarding and more challenging areas in which to work. Those scientists remaining with the laboratories would lose competence through the inability to test. Donald G. Brennan, Director of National Security Studies at the Hudson Institute, indicates that this factor "looms as the largest potential cost to the US" in the eyes of senior weapon scientists.[25] Harold Agnew flatly states, "I do not believe the USA can maintain a nuclear weapons design capability for more than a few years if nuclear device testing is not allowed."[26] If one has any doubt, our experience with the 1958-61 moratorium should be convincing. The quality of our nuclear teams suffered during that time span, and it took the resumption of testing and some valuable time to restore it. In the interim, the Soviets made significant gains with their surprise abrogation. Experience is often the best teacher, if one is willing to learn.

The fourth cost listed concerns force modernization. Earlier the point was made that the arms race is fueled more by nonnuclear technological improvements than by nuclear advances. A nuclear weapon development program begins when the military departments request a specific warhead design to be used in conjunction with a new or improved weapon system. Currently, for example, warhead candidates are in the development phase for updated strategic systems such as the MX missile, as

well as for a number of tactical systems. Although the Threshold Test Ban Treaty precludes testing of devices with yields above 150 kilotons, partial yield testing is necessary to minimize concerns for safety and reliability. If a comprehensive test ban treaty were to be placed in force, these tests would be impossible, as would future development tests. As a result, modernization of the nuclear weapon force would be impossible. Any changes that would occur would be based upon the need to replace deteriorated materials or to correct stockpile problems. No definitive warhead improvements could be made without the benefit of testing to insure safety and reliability. This would preclude such things as the continued reduction of the lethality of nuclear weapons, the reduction of collateral damage, and improvements in safety and security.

The final point concerns increased dollar costs associated with a comprehensive test ban. Many proponents of a comprehensive test ban believe that it would reduce costs due to the cessation of the underground test program. However, upon examination of the entire issue one can see that the US will still continue to deploy nuclear weapons. Without underground testing, resources would have to be devoted to such things as nonnuclear testing and simulation devices in order to maintain some reliability and weapon system knowledge. For example, complex simulators can now create some limited nuclear environments in order to test weapon effects. With a comprehensive test ban in effect, more advanced designs would be essential. Long lead times and huge sums of money would be needed to meet this requirement.[27] Additionally, the design of nuclear weapons would have to be quite conservative to allow greater margin for error. The economies possible today would be unavailable in the future. This would result in greater costs associated with warhead design and construction, and ultimately a need for larger delivery vehicles. It is interesting to note that the Soviets, with greater throw-weight capacity, can build in those conservative designs much more readily and more cheaply than the US. Between nonnuclear testing, advanced simulators, and more costly weapon systems, the dollar price of a comprehensive test ban would surely not reduce the budget; it would more likely raise it significantly.

BARRIERS TO A COMPREHENSIVE TEST BAN TREATY

Two issues remain to be discussed, and they do not fall into the categories of a cost or a benefit. Rather, they may be construed as barriers to a comprehensive test ban treaty. One is the issue of peaceful nuclear explosions; the other is the historic problem of adequate verification. If both of these barriers are overcome, a comprehensive test ban treaty could very well become a reality in the near future.

Peaceful Nuclear Explosions

In the past, the US and the USSR have had a basic disagreement concerning peaceful nuclear explosions. The US has held that they must be included in any comprehensive test ban, defining an effective comprehensive measure as "one that covers all nuclear explosions, whether designated to be for weapon testing or peaceful purposes."[28] As was pointed out earlier, military-significant nuclear data can be obtained from any nuclear explosion, whether conducted for peaceful or other reasons. Consequently, it is necessary to ban peaceful nuclear explosions as well as weapon-related tests, or the purpose of the ban would be defeated.

The US desire to disallow peaceful nuclear explosions is strengthened by the fact that we have no program involving peaceful nuclear explosions and no plans for pursuing one. This is not due to any lack of technology. The tools are there, it is the will which is lacking. Political and environmental considerations have stood in the way of a potentially useful program.

In July 1957, Dr. Edward Teller and his associates at the Lawrence Livermore Laboratory conceived the first program for peaceful uses of atomic energy. They named it Project Plowshare. During the same time

period, the US was preparing for its first underground nuclear explosion, which was detonated on 19 September 1957 at the Nevada Test Site. The experience provided by this event, and others which followed, indicated the enormous potential of peaceful nuclear explosions.

Project Plowshare reflected the conclusion of scientists who determined that it would be much more economical to move large volumes of earth by nuclear rather than conventional means. Actually, it was the 1956 Suez crisis which prompted the idea behind Plowshare.[29] At that time, the Suez was closed to shipping as a result of the Israeli occupation of the Sinai Peninsula. Dr. Harold Brown, now Secretary of Defense, envisioned the possibility of building a sea-level canal across Israel by using nuclear blasts. At a February 1957 meeting of top nuclear scientists, this idea and a number of other possibilities were discussed in some detail. It was determined that such things as excavating sea-level canals, open-pit mining, constructing large harbors, and producing oil could be accomplished with nuclear explosions. These ideas were combined in Project Plowshare.

Although this project has gone nowhere in the 20 years since its conception, the following examples show how peaceful nuclear explosions could be applied in the United States:

- On the western slope of the Rocky Mountains, there is reported to be 1.8 trillion barrels of oil locked in oil shale. Oilmen have not been able to find an economical way to extract it. One possibility, however, is "in situ" retorting. This would involve setting off explosions deep underground in the shale, then setting a subterranean fire to extract the oil substance. Plowshare proposed this type of process, but with the use of a nuclear explosion to create the underground furnace. The result would be a hollow column, loosely filled with oil shale. Set afire, oil substance (kerogen) would be produced and could be pumped to the surface. Not only has this process never been tried, but Dr. Teller has been criticized for even considering such a proposal.
- Large Alaskan coal deposits cannot be mined because of the lack of harbor facilities. The rich deposit at Ogoturuk is an example. According to Dr. Teller:

> The harbor basin and the canal connecting it to the ocean would cost less than ten million dollars. Only four nuclear explosions, each with a yield of twenty kilotons, would be needed to dig a deep-water canal with a width of 250-300 yards. A turn-around harbor basin 600 yards in diameter could be dug at the end of the canal with a 200 kiloton nuclear explosion.[30]

However, the American people are still unable to consider the idea of a nuclear explosion without great fear. For this reason, it would appear that peaceful nuclear explosions will never be accepted as a viable option in solving any problem.

The Soviets, on the other hand, have had an interest in using peaceful nuclear explosions for projects such as excavating harbors or canals and improving production of oil and gas. According to a recent congressional report:

> The USSR has a very strong PNE program and one which would require detonations higher than the 150kt threshold over a number of months. . . . The most notable project is the Pechora-Karma Canal which will divert water now flowing into the Arctic Ocean to the Caspian Sea.[31]

In fact, according to Warren D. Johnson, former Director of the Defense Nuclear Agency, the Soviets have plans to detonate some 250 nuclear charges over the next decade.[32] They firmly believe in the economies and ease of using nuclear explosions rather than conventional means for completing major projects. Secretary Brezhnev has indicated that the Soviets may be willing to adjust their position on peaceful nuclear explosions and include them in a comprehensive test ban.[33] If details can be effectively worked out, this barrier may well be overcome.

The Problem of Verification

The US defines adequate verification as "that which would reduce to an acceptable level the risk that clandestine test programs of military significance could be conducted under a [comprehensive test ban]."[34] The US has steadfastly held that adequate verification is a necessity for a comprehensive test ban treaty. In the words of Congressman Melvin Price, "If the US is to enter into a [comprehensive test ban treaty], it is important to know precisely what US experts can unilaterally detect, locate, and identify."[35] Today, there is serious doubt that enough can be detected to assure adequate verification.

The US might accomplish verification of a comprehensive test ban treaty through national technical means, through in-country monitoring systems, or through on-site inspections.[36] The emphasis here is on detection of underground nuclear explosions, since it is generally accepted that nuclear explosions conducted in the atmosphere, in space, and underwater can be detected by national means.

Detection through national technical means involves the use of remote seismic stations. The primary means for monitoring nuclear testing activities in the Soviet Union is the Atomic Energy Detection System. This system consists of seismic stations located throughout the world and is considered adequate to detect explosions with yields from 2 to 10 kilotons which are fired in hard rock. Tests of lower-yield devices in hard rock probably cannot be detected. However, if evasive tactics are used, explosions of greater magnitudes could escape detection by this system. Four means of evasion must be considered:

- The first of these, *low-coupling media*, reflects the fact that the teleseismic signal produced by a nuclear explosion is strongly affected by the geophysical properties of the surrounding environment. If an event occurs in a dry, low-density medium, for example, the yield estimated from the teleseismic signal is reduced by more than a factor of 10 over that produced by an event fired in hard rock or below the water table.
- In the use of *decoupling activities*, a nuclear explosion inside a large air-filled cavity is "decoupled" from the surrounding rock. Using this method, the yield estimated from the teleseismic signals would be reduced by a factor of from 10 to 100. Realistically, practical problems limit the size of cavities that can be developed; therefore, yields that can be "decoupled" in this manner are believed to be limited to about 50 kilotons.
- A third evasive course is the production of *earthquake simulations*. By firing a group of nuclear explosions appropriately located and timed, a seismic signal can be produced that looks very much like that of an earthquake. Using this technique, it may be possible to test nuclear explosives with yields as large as 50 to 100 kilotons.
- The fourth method is referred to as *hiding in an earthquake*. By firing a nuclear weapon shortly after an earthquake occurs somewhere in the world, the weapon's seismic signals can be hidden in the tremors of the earthquake. Although this would require maintaining a nuclear test in readiness for some time period and firing it within a minute or so after the earthquake, this would present no significant technical or operational difficulty.

The second detection technique involves in-country monitoring systems. A network of unmanned seismic stations could be installed and operated within the US and the USSR in order to improve national technical means of detecting underground nuclear explosions. It is believed that a network of 15 to 20 stations (adequately flexible in location, instrumentation, and so forth) could improve seismic detection by a factor of between 5 and 10. This system would not provide for the detection of events below one kiloton, however, and the effectiveness of evasion techniques has yet to be evaluated.

The third detection option is to permit on-site inspections. If the right to make a number of inspections per year in order to confirm or

deny a suspicious event detected by other means were permitted, the ability to deter unauthorized events would surely be enhanced. Many techniques are possible, including gas sampling of the air and soil, core drilling to obtain melt samples, and seismic listening for aftershocks. However, information from other detection sources would be quite important in pinpointing the area to be inspected. The hope of finding evidence of a suspected event somewhere within a seismically located area of a few thousand square kilometers would be rather small.

These strands of information on verification capability can be tied together to produce a much less complex summary: Without an in-country monitoring system, the Soviets could carry out any number of low-yield (5 to 10 kiloton) nuclear tests with very little risk of detection by the US. Tests of larger yields, even of 50 to 100 kilotons, could be conducted with the use of evasion tactics. An in-country monitoring system and on-site inspections could help somewhat, and they are essential to enable the US to have the highest confidence of detecting and deterring clandestine Soviet tests. Yet, there appears to be no foolproof system that could be employed to deter a determined treaty violator.

As an outgrowth of Safeguard D to the Limited Test Ban Treaty, the US initiated a program called "Vela" to upgrade its capability of detecting nuclear explosions. Despite the considerable research that has taken place since then, little progress has been made. Dr. Stephen J. Lukasik, former director of the Defense Department's Advanced Research Projects Agency, said in a 1971 review of the technical results of Vela:

> In retrospect, the conclusions of the Conference of Experts who met in Geneva in 1958 were overly optimistic. . . . After more than a decade of extensive research, the science of seismology has not been able to achieve what was then believed possible, despite the considerable advance in technology since 1963.[37]

Detection capability has not increased significantly since then. In fact, evasion tactics have so improved that a determined evader can conduct certain tests without fear of detection. In the view of Donald Brennan:

> It is absolutely clear that inspection technology will never advance to the point where we could have confidence that the Soviets were not conducting clandestine tests of potential significance.[38]

If the Soviets can conduct undetectable low-yield underground tests, can military advantages be gained from these tests? The answer is an unequivocal yes. Arthur Dean acknowledged this point as early as 1962:

> Based on recent United States scientific experience, which is verifiable, . . . relatively small tests conducted underground can be very important. . . . [Further,] truly scientific progress in weapons development can be and has been achieved through underground tests which, even though they might be detected by a seismic network, cannot be identified except by an objective on-site inspection. In other words, big results militarily could come from very small unidentified tests. . . . Tests of such nuclear weapons can be valuable on many counts. They will include proof tests, development tests and a variety of weapons effects tests.[39]

Things have not changed in this regard. Many recent US weapon development and weapon effects tests have been in the low-yield range, and these have continually produced significant military benefits. According to Roger Batzel, "Low-yield testing, that is from one kiloton to a few tens of kilotons, has in the past been a major factor in the development and maintenance of nuclear weapons in the US."[40]

Thus, US detection capability is such that clandestine Soviet underground tests of military significance can go undetected. Further, even if the verification precedents established by the Threshold Test Ban Treaty and the PNE Treaty were to be used, many difficulties would still exist in detecting an underground nuclear explosion in the low-

yield range. This is especially true if evasion tactics are employed, and they surely would be if the Soviets were to conduct such tests. A comprehensive test ban treaty cannot be totally verified. The question is, can the US afford to accept the risk that the Soviets will abide by it?

CONCLUSION

Even if the issue of peaceful nuclear explosions should be resolved favorably from the US point of view, and even if a comprehensive test ban treaty were totally verifiable, US concurrence would still be a serious mistake. To think that a US-USSR ban on nuclear testing would result in arms control and nuclear non-proliferation is unwise. Arms competition between the US and the USSR is inevitable as long as arms are a fact of life. Limitations on numbers and costs can only be achieved through the Strategic Arms Limitation Talks and agreements on Mutual Balanced Force Reductions. As for non-proliferation, a ban on US and USSR nuclear tests will not insure a halt to worldwide nuclear development. Experience with the Limited Test Ban Treaty has shown this to be true. Only if all nations agree could we be reasonably hopeful that a comprehensive test ban treaty would aid non-proliferation efforts.

We have been able to deter nuclear war for more than 30 years. During that time, our conventional forces and our allies have been able to operate under the nuclear umbrella furnished by US strategic nuclear forces. This deterrence is based upon assurances that US forces could survive a first strike and still inflict severe retaliatory damage. In other words, it is based on a high level of confidence in the reliability of the force. Without nuclear testing, this reliability cannot be assured nor maintained. Weapon system capability would erode; the capability of nuclear weapon laboratories would erode; and our capability to improve the force would erode. There are those who will say that safeguards would prevent these erosions, just as the Limited Test Ban Treaty safeguards have resulted in a strong US nuclear program since 1963. However, these safeguards would be without substance under a comprehensive test ban treaty. The underground nuclear test program has been almost totally responsible for the maintenance of Safeguards A and B, for what little is left of Safeguard C, and for a significant part of Safeguard D. Without underground tests, very little could be done to counter the capability degradations identified above.

In the final analysis, we must understand that as long as nuclear arms exist, nuclear testing is essential to insure reliability, safety, security, and efficiency. To view this subject differently is a miscalculation that could have the most serious consequences.

NOTES

1. US Congress, *Congressional Record*, 95th Cong., 1st Sess., 24 March 1977, 123, S4771.
2. *Ibid.*
3. "Brezhnev Asks For Halt to All Nuclear Tests," *The Virginian-Pilot* (Norfolk, Va.), 3 November 1977, p. 1.
4. Stanley A. Blumberg and Gwinn Owens, *Energy and Conflict: The Life and Times of Edward Teller* (New York: G. P. Putnam's Sons, 1976), p. 406.
5. Arthur H. Dean, *Test Ban and Disarmament: The Path of Negotiation* (New York: Harper and Row, 1966), p. 103.
6. *Ibid.*, p. 91.
7. James H. McBride, *The Test Ban Treaty: Military, Technological, and Political Implications* (Chicago: Henry Regnery Company, 1967), p. 25.
8. Dean, p. 90.
9. Recently the word "promptly" has been removed from this safeguard. For several years after the Limited Test Ban Treaty, efforts and funding to maintain a sufficient readiness to test capability were strong. However, by the early 1970's considerably less attention was devoted to this safeguard. US capability in support of Safeguard C had deteriorated so badly by 1975 that it was judged inadequate to generate a rapid return to atmospheric testing. Currently, it is estimated that two to three years would be required to implement meaningful atmospheric tests.
10. "Treaty Banning Nuclear Weapon Tests in the Atmosphere, in Outer Space and Under Water." See US Arms Control and Disarmament Agency, *Arms Control and Disarmament Agreements: Texts and History of Negotiations*, Publication 94, June 1977 (Washington: US Government Printing Office, 1977), p. 40.
11. US Arms Control and Disarmament Agency, *Documents on Disarmament—1964*, Publication 27, October 1965 (Washington: US Government Printing Office, 1965), p. 8.
12. *Ibid.*, p. 17.
13. Although nuclear testing was not specifically addressed, a milestone was reached in 1968 when President Johnson signed the Treaty on the Non-Proliferation of Nuclear Weapons, usually referred to as the Non-Proliferation Treaty.

This serves to prevent the spread of nuclear weapons, promote the peaceful uses of atomic energy, and encourage effective measures to end the nuclear arms race. Some 103 countries have ratified the treaty, and another 9 have signed but not yet ratified it.

14. US Congress, Senate, Committee on Foreign Relations, *Hearings, Threshold Test Ban and Peaceful Nuclear Explosion Treaties*, 95th Cong., 1st Sess., 28 July 1977, p. 3. Hereafter cited as *Hearings, Threshold and PNE Treaties*.
15. *Ibid.*, p. 4.
16. *Ibid.*
17. *Ibid.*
18. *Ibid.*, pp. 8-9.
19. Warren D. Johnson, "Comprehensive Test Ban," unpublished manuscript prepared for congressional testimony, 31 March 1977, p. 3.
20. *Congressional Record*, 95th Cong., 1st Sess., 24 March 1977, 123, S4771.
21. *Hearings, Threshold and PNE Treaties*, p. 7.
22. US Congress, Senate, Committee on Foreign Relations, Subcommittee on Arms Control, International Law and Organization, *Hearings, To Promote Negotiations for a Comprehensive Test Ban Treaty*, 93d Cong., 1st Sess., 1 May 1973, pp. 111-13.
23. Harold M. Agnew, letter to Congressman Jack F. Kemp, 19 April 1977, p. 1.
24. Roger E. Batzel, letter to Congressman Jack F. Kemp, 11 April 1977, p. 2.
25. Donald G. Brennan, "A Comprehensive Test Ban: Everybody or Nobody," *International Security*, 1 (Summer 1976), 101.
26. Agnew, p. 1.
27. Johnson, p. 14.
28. *Hearings, Threshold and PNE Treaties*, p. 7.
29. Blumberg and Owens, p. 400.
30. *Ibid.*, pp. 401-02.
31. US Congress, Joint Committee on Atomic Energy, *Development, Use, and Control of Nuclear Energy for the Common Defense and Security and for Peaceful Purposes*, Second Annual Report, 94th Cong., 2d Sess. (Washington: US Government Printing Office, 1976), p. 16.
32. Johnson, p. 4.
33. *The Virginian-Pilot*, p. 1.
34. US Arms Control and Disarmament Agency, *Documents on Disarmament—1972*, Publication 69, May 1974 (Washington: US Government Printing Office, 1974), p. 589.
35. US Congress, Joint Committee on Atomic Energy, *Status of Current Technology to Identify Seismic Events as Natural or Man-Made*, Joint Committee Print, 92d Cong., 1st Sess. (Washington: US Government Printing Office, 1971), p. 1.
36. Information on verification and evasion techniques has been extracted from an attachment to Roger Batzel's letter to Congressman Kemp.
37. *Status of Current Technology to Identify Seismic Events as Natural or Man-Made*, p. 7.
38. Brennan, p. 115.
39. US Arms Control and Disarmament Agency, *Documents on Disarmament—1962*, Publication 19, November 1963 (Washington: US Government Printing Office, 1963), pp. 771-72.
40. Batzel, p. 4.