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to provide information and to stimulate discussion. Not to be attributed as official FAS policy unless specifically so indicated.

SENATE APPROVES TEST BAN

By a vote of 80 to 19, the United States Senate on September 24 gave its consent to ratification of the partial nuclear test ban treaty. Approval by this substantial margin, and defeat of proposed reservations to the treaty, followed several weeks of Senate debate. Earlier, extensive hearings had been held by the Senate Foreign Relations Committee, with participation by Senators belonging to two other key Committees, Armed Services and Atomic Energy.

The treaty was initiated by the U.S., U.K., and U.S.S.R. in Moscow on July 25. A delegation of U.S. Senators, Secretary of State Rusk, and others went to Moscow for a formal signing of the treaty on August 5. Since then, more than 90 other countries have signed the treaty, and only France, Communist China, Albania, and North Korea have indicated their refusal to sign.

Among the supporting witnesses before the Foreign Relations Committee were: Secretary of State Rusk; Secretary of Defense McNamara; AEC Chairman Seaborg; the Joint Chiefs of Staff; Director of Defense Research and Engineering Harold Brown and his predecessor, Herbert York; the former presidential science advisor, George Kistiakowsky; and the Director of Los Alamos Scientific Laboratory, Norris Bradbury. The FAS was represented by Freeman Dyson and Donald Brennan, who discussed the technical problems of a ballistic missile defense and the importance of the treaty in

terms of the effort to influence Soviet policies in peaceful directions and to promote further agreements. Main opposing witnesses were John Foster, Director of the Lawrence Radiation Laboratory at Livermore, Admiral Lewis L. Strauss, and Edward Teller. (Some technical aspects of the hearings are reviewed below.) At the conclusion of the hearings, the Foreign Relations Committee voted 16-1 to recommend Senate approval of the treaty.

The simultaneous release of a report by the Preparedness Subcommittee of the Senate Armed Services Committee, headed by Senator Stennis, somewhat clouded the issue, since it concluded that there were "serious—perhaps even formidable—military and technical disadvantages to the United States that would flow from the ratification of the treaty." However, the impact of this report seems to have been diminished by its clear military emphasis (the only persons quoted in the report are Gen. Power, Gen. Schriever, Gen. LeMay, and Marshal Malinovsky!) This report was also counteracted by the very important support given the treaty on the same day by Sen. Dirksen. Senators Stennis and Russell, powerful members of the Armed Services Committee, announced their opposition—primarily on military grounds—but apparently too late to sway many votes. Significant, although far from enthusiastic support, came from Senators

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FAS CALLS FOR ARMS CONTROL STEPS TO FOLLOW TEST BAN

(The FAS issued the following statement upon Senate approval of the test ban treaty.)

With the Senate's ratification of the partial nuclear test ban treaty, the U.S. has taken a first and significant step to slow the pace of the arms race and reduce the danger of nuclear war. The treaty manifestly enhances the long-range security of our country and that of other nations. The Senate has acted wisely.

But it is clear that the treaty is only a first step on the long road to more substantial arms control and to eventual disarmament. The United States must now take advantage of the favorable international situation to pursue energetically additional useful measures.

There appear to be several opportunities for U.S. initiative. Specific avenues are open for reducing the possibility of surprise attack. The Soviets have indicated their willingness to discuss an exchange of observers at ports, airfields, rail centers, and other locations. Such an exchange would represent a form of "on-site" inspection and would be an important concession from the Soviets. And the presence of these observers would definitely inhibit certain types of military deployments and attack preparations. An exchange of observers could be accompanied by other cooperative measures—limited aerial inspection, exchanges of radar warning information, exchanges of mobile observer teams, prior notification of certain military movements—all designed to reduce risks and tensions and increase security on both sides. In a related area, it now appears that an agreement to ban nuclear weapons in space may be possible. Since the U.S. has publicly announced that it has no intention of deploying such weapons, banning them formally should present no military risks.

A compromise formula can very probably be found which will permit an East-West nonaggression pact, or at least a bilateral declaration of nonaggression between the NATO Alliance and the Warsaw Pact. This step would have political advantages and could significantly reduce specific tensions and risks of conflict which have long existed, especially—but not exclusively—in Europe. The Soviets have indicated

their particular interest in such an arrangement, and this might be used to encourage them to consider in turn measures of more particular interest to the West.

With the partial test ban in force, the major nuclear powers must continue to seek ways to ban underground tests as well. The successful operation of the present treaty should help greatly, and there is no reason to believe that the dilemma of on-site inspection cannot be overcome in time and with further improvements in detection technology.

The major nuclear powers now have a clearly recognized and heightened interest in limiting the spread of nuclear weapons to new countries. Neither France nor Communist China pose immediate military threats. Now is a good time to explore anti-proliferation measures such as nuclear-free zones and international inspection of peaceful nuclear technology.

The present climate favors cooperative U.S.-U.S.S.R. ventures in various peaceful activities. These can be valuable in reducing tension and in developing a spirit and tradition of cooperation. Opportunities lie in joint space exploration—perhaps in the joint moon expedition mentioned by President Kennedy, in geophysical research, peaceful nuclear research and technology, oceanographic research, and public health measures. The Soviets, encouragingly, seem to be growing more specific in their discussions in these areas.

Many of the measures noted here have, of course, already been undertaken or proposed by the United States. They will significantly reduce the risk of war, but they will not remove it. They will, from a longer-range point of view, facilitate progress toward more comprehensive agreements beginning, perhaps, with weapons production cutoffs, delivery vehicle limitations, and increased mutual inspection, and leading to substantial disarmament. It is important that the goal of eventual disarmament under international control be constantly borne in mind as we undertake these limited measures.

The Federation of American Scientists urges our government to take full and immediate advantage of the opportunities which lie before us, now that the partial test ban has been ratified.

FAS TEST-BAN STATEMENT — (Continued from page 1)

Jackson and Symington, respected specialists in military matters.

Senator Fulbright led off the Senate debate with a remarkable speech dealing with both the military and political context of the treaty, including the need to coexist with the Russians in a nuclear age. Because of senatorial concern over possible "euphoria" following ratification of the treaty, President Kennedy reiterated in a letter to Senators Mansfield and Dirksen his intention to maintain an active nuclear weapons program and to provide other military safeguards. It was clear that many Senators, including ones in positions of power on major committees, were going along with the treaty reluctantly and were dubious of any agreement with the Soviet Union that could affect U.S. security. It has been widely reported that this reluctance is placing a damper on President Kennedy's plans for further arms control measures.

Issues in Hearings

In the hearings before the Foreign Relations Committee, the disputes between proponents and opponents of the test ban revolved around three major questions. Should the United States enter into a solemn treaty which limits its military capability without the Soviet Union's abandoning its avowed aim of communizing the world? Is the Soviet Union ahead in some critical military area, so that the treaty would leave the U.S. at a serious military disadvantage? Are further atmospheric tests needed to perfect weapon systems or ensure that existing systems will perform as intended?

Discussion of the first question centered on divergent views of whether the Soviet Union and the U.S. have national security interests in common so that it is possible to reach agreements that are advantageous to both, or whether Soviet policy is dominated by a desire to spread its control and influence. The Administration contended that there could be at least five reasons why the Soviets had agreed to this test ban treaty: fear of nuclear war; the economic burden of armaments; a desire to show that the Russian policy of peaceful coexistence is superior to the hard-line policy of the Chinese; concern with the spread of nuclear weapons; and a presumed feeling on the part of Soviet scientists that their nuclear weaponry was adequate to meet military requirements. Proponents of the treaty were questioned sharply by Senators Hickenlooper, Lausche, Russell, Thurmond, and Goldwater on whether the U.S.S.R. would ever sign a treaty that was not to its unilateral advantage. This discussion reemphasized the sharp congressional split between those who favor the search for accommodations with the Soviet Union, from a position of strength, and those who advocate an all-out competition with the Soviet Union.

The latter group was strengthened by the testimony of Edward Teller, who contended that there was a good chance that the Soviets had achieved a "decisive lead" in their 1961 and 1962 test series. He testified that "in 1960, he [Khrushchev] wasn't willing to sign, but now he had these magnificent test series of 1961 and 1962. He now knows how to defend himself. He now knows, probably, where the weaknesses lie in our defense. He has the knowledge, and he is now willing to stop and prevent us from obtaining similar knowledge."

On the other hand, Secretary McNamara contended that a broad assessment of the relative military balance shows "a picture of existing and continuing U.S. superiority." Thus, "the Soviet Union appears to be technologically more advanced than we are in the high yield range, that is to say, in the tens of megatons; below that yield, the relative capability shifts progressively in favor of the United States. Below a few megatons, the United States appears to be clearly superior in yield-to-weight ratios . . . The U.S. advantage in the low and intermediate part of the yield spectrum is in my judgment a very important advantage . . . It is because of this that the United States has had the advantage over the Soviets of being able to deploy large numbers of hardened and dispersed Minuteman missiles and a large number of long-range sublaunched Polaris missiles . . . The consensus is that the United States is presently superior in design, diversity, and numbers in [tactical nuclear weapons and delivery systems]." McNamara asserted that the U.S. has more than twice as many long-range bombers and many more ICBMs than the Soviet Union and that "our ballistic missile numerical superiority will increase both absolutely and relatively."

In the area of ballistic missile defense, the most-discussed topic during the hearings, McNamara said that "the best present judgment is that our design efforts are comparable in magnitude and success with those of the Soviets. Any deployed system which the Soviets are likely to have in the near future will probably not be as effective, almost certainly not more effective, than the Nike-Zeus system. It should be noted that the United States decided not to deploy the Nike-Zeus because its effectiveness was inadequate."

Sec. McNamara concluded that the test ban treaty would "retard Soviet progress and thereby prolong the duration of our technological superiority. A properly inspected comprehensive test ban would, of course, serve this purpose still better. This prolongation of our technological superiority will be a principal direct military effect of the treaty on the future military balance, and I consider it a significant one."

Demands for Tests

There were four specific technical areas in which it was claimed by opponents that further testing was needed by the United States:

- (1) to develop very high yield weapons, as the USSR had done;
- (2) to check the survivability of missile sites;
- (3) to develop and evaluate an effective ballistic missile defense, including weapons effects tests;
- (4) to determine the ability of missile warheads to penetrate any Soviet ballistic missile defense.

In response to these claims, Sec. McNamara and the scientific witnesses (Drs. Brown, Bradbury, York, and Kistiakowsky) made the following points:

(1) During the 1950's the U.S. had the ability to develop very high yield weapons, but repeatedly decided against such a development. As Sec. McNamara said, "for a given resource input we achieve higher target destruction with our smaller systems" and systems which could deliver such weapons would be "relatively inferior as second strike, retaliation weapons; it is much more difficult and costly to make them survivable." In addition, the witnesses did not feel that the possession of these weapons gave the U.S.S.R. any significant military advantage.

(2) The large number and variety of U.S. retaliatory systems were felt to provide high assurance that, in McNamara's words, "even after a Soviet strike, the total surviving U.S. strategic nuclear force will be large enough to destroy the enemy." In addition, "the United States now has a substantial amount of information in this area of hardened missile-site vulnerability. Our knowledge of the Soviet testing program leads us to believe that their uncertainties are at least as great as ours. Uncertainties of this kind . . . will continue to be compensated for by conservative designs, wide dispersal, and large quantities of missiles."

(3) The point made most often regarding the relation between the nuclear test ban and ballistic missile defense was that there was little relation. As Harold Brown said, referring to the radar and computer problems, "the ABM problem involves the capability to acquire early, to discriminate decoys from warheads, to handle large volumes of traffic, that is, many incoming objects, and to hit and kill the targets. By 'hit' I mean coming close enough to kill. Most of these problems have little or nothing to do with further nuclear testing." Enough was known about weapons effects to permit the design of an anti-ballistic missile system, and the warheads could be developed with underground tests.

It was also pointed out, especially by Dr. York, that the way to meet the challenge of any Soviet anti-ballistic missile system was to improve the penetration characteristics of warheads. As Dr. York said, "In any development race between anti-ballistic missiles and ballistic missiles, I believe the offense will always, and by a large margin, have the advantage over the defense . . . The race between offense and defense is a race between a tortoise and a hare, and if only the hare does not go to sleep, the tortoise has no chance. Therefore, in connection with the so-called Soviet ABM problem, I believe the concern expressed by many is misplaced and that primary emphasis should be placed on making sure that our own ballistic missiles will penetrate, and not placed on the question of precisely where we stand vis-a-vis the Soviets in the development of antiballistic missiles themselves."

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(4) Referring to the penetration problem, Sec. McNamara said, "Current penetration philosophy concentrates on saturation, and is dominated by problems of decoy design and salvo techniques, as well as of nuclear technology. The problems of nuclear technology here relate to the vulnerability of the ballistic missile warhead to kill by blast or by radiation. The latter vulnerability, as to radiation, can be tested underground, but the former cannot be fully tested underground." It was nevertheless noted that, even with full-scale testing of warheads under re-entry conditions in the presence of an explosion from an anti-ballistic missile system, there would remain great uncertainties. Thus, for instance, uncertainties in the characteristics of possible Soviet ABM systems would remain no matter how many tests were made using U.S. systems.

There was little discussion of the detection problem. Harold Brown said that a violator would not be able to conduct tests above 1 kiloton in the atmosphere or high altitude region if he wanted to be reasonably sure that the shot would not be detected. A 10-kiloton test could be detected out to 100 million kilometers, and greater ranges could be achieved by using a satellite system (the first satellites developed under the Vela Hotel program are due to be launched shortly). Some questions were raised as to the political advisability of an agreement that did not require on-site inspection, but there were no technical arguments made to justify such inspections.

Military "Safeguards"

The Joint Chiefs of Staff stated that "while there are military disadvantages to the treaty, they are not so serious as to render it unacceptable . . . If this treaty attracts signatories representing the vast majority of the nations of the world on both sides of the Iron Curtain, it should make an important contribution toward the restraint of the further proliferation of nuclear weapons and the reduction of causes of world tension. Both of these advantages, if achieved, should contribute to the fundamental objective of the U.S. Armed Forces; namely, the deterrence of war and maintenance of peace on honorable terms." However, their support was conditioned upon the establishment of certain "safeguards" including a comprehensive underground test program, maintenance of the vitality of nuclear weapons laboratories, a readiness to resume atmospheric testing promptly in the event of violation or abrogation, and improvement of detection capability. There was much discussion of these safeguards, with almost no one questioning the need for them, although there was some suggestion by the technical witnesses that the test ban, by itself, did not necessarily require a great increase or speed-up in these activities. For instance, it was pointed out that the immediate resumption of testing after a possible Soviet violation was not essential. When Senators questioned whether the U.S. could afford to wait the 90 days required by the treaty before abrogating if events should require it, Dr. Kistiakowsky pointed out that the development of a typical weapon system, including the non-nuclear as well as nuclear components, requires three to eight years.

The discussion of these safeguards became so intense that several witnesses stated that this treaty might speed rather than retard the arms race. Most of the technical witnesses thought this need not be the case, partly because the treaty would limit certain developments, such as the testing of very high yield weapons. However, the Administration said "the underground test program will expand over that currently programmed for fiscal year 1964." The emphasis on maximum readiness and the continuing discussion of the possible military disadvantages of the treaty prompted even the *New York Times* to editorialize that, contrary to appearances, the test ban treaty was *not* intended to give another spurt to the arms race nor was it an occasion for greater hostility between East and West. It stated the hope that calm would return and Americans would view the treaty as a step toward peace.

Testimony of Scientists

Broad questions concerning the role of scientists in an issue such as this were raised by the hearings. Many Senators found themselves perplexed by the apparent contradictions between the testimony of different scientists. Most of the scientific witnesses attempted scrupulously to limit themselves to testimony on scientific matters with which they were technically familiar. A few, however, gave opinions on other topics; Edward Teller's testimony was the most

wide-ranging and widely publicized example. Dr. Teller repeatedly expounded the need for atmospheric testing to perfect an anti-ballistic missile system, even though several of the technical witnesses noted that he had worked "single-mindedly" on bomb technology rather than on weapons systems such as an ABM. Dr. Teller also went into broad areas with only marginal scientific content. For instance, he emphasized his belief that the treaty would weaken U.S. alliances and would hinder the use of nuclear weapons to defend allies against an attack. He also offered apocalyptic statements such as that in the following exchange:

"Senator Long. In the event they [the Russians] were able to develop a missile defense against our ballistic missiles, and then proceed to breach the treaty just long enough to prove it out, would there be time for us to do the same thing after we found out that they had violated the treaty?"

"Dr. Teller. I am virtually certain there would not be time enough. We would be lucky to get off to meaningful testing in 3 months, whereas they, if they have indeed perfected, installed, but not completely proven out their anti-ballistic missile equipment, they could abrogate the treaty in a day, use the next week for 100 or 500 detonations, and if they find the results unsatisfactory, they will have lost a treaty.

"If they find it satisfactory, they will have won the world."

Perhaps the best summary of the technical background underlying the need for this treaty and for succeeding steps was given by Dr. York. He said, "In the early 1950's the Soviet Union, on the basis of its own sole unilateral decision, and if it had been willing to accept the inevitable retaliation, could have launched an attack against the United States with bombers carrying atomic or fission bombs.

"Some of these bombers would have penetrated our defenses and the number of American casualties would have been some millions.

"In the later 1950's, again on its own sole decision, and again if it had been willing to accept the inevitable massive retaliation, the Soviet Union could have launched an attack against the United States using more and better bombers, this time carrying hydrogen bombs.

"Some of these bombers would have penetrated our defenses and the number of American casualties could have been in the tens of millions.

"By the mid-1960's, the Soviet Union, again solely on the basis of its own decision, and again, if it were willing to accept the inevitable retaliation, could launch an attack upon the United States using intercontinental missiles and bombers carrying thermonuclear weapons.

"This time, the number of American casualties which would result from such an attack could be in the neighborhood of, perhaps, 100 million.

"This steady decrease in national security was not the result of any inaction on our part, but simply the result of the systematic exploitation of the products of modern science and technology by the Soviet Union. . . .

"It is my view that the problem posed to both sides by this dilemma of steadily increasing military power and the steadily decreasing national security has no technical solution. If we continue to look for solutions in the area of science and technology only, the result will be a steady and inexorable worsening of this situation.

"I am optimistic that there is a solution to this dilemma; I am pessimistic only insofar as I believe that there is absolutely no solution to be found within the areas of science and technology. . . ."

HIGH FALLOUT LEVELS REPORTED

Fallout Higher this Year than Last

The U.S. Public Health Service announced in August that the strontium 90 content of milk was twice as high in May 1963 as in May 1962. The exact figures are 26 picocuries per liter compared to 14 picocuries per liter a year ago. A picocurie is one millionth of a microcurie. The strontium 89 level was increased 50% to a level of 95 picocuries per liter. The Federal Radiation Council's "acceptable" levels are 200 picocuries per liter for Sr 90 and 2000 picocuries per liter for Sr 89. The increased contamination of milk (which was expected to decrease after June) is due to the intensive testing in 1962, fallout from which equalled the total fallout from all previous testing since 1945. (*N.Y. Times*, 8/10.)

High Milk Sr 90 Tied to Poor Fertilizing

From the first survey in 1957, St. Louis milk has generally had a higher content of Sr 90 than that of other major cities although fallout in the St. Louis area has not been unusually high. The St. Louis County Public Health Department now believes that poor fertilization of marginal dairy farms may be the explanation. Poor land results in slow growth of forage plants which then have a higher concentration of Sr 90 than rapidly growing plants in well fertilized fields. (N.Y. Times, 8/21.)

Nevada-Utah Fallout Hazard

In a report to the Joint Congressional Atomic Energy subcommittee, the St. Louis Citizens Committee for Nuclear Information concluded that on several occasions since 1951 radioactive iodine levels in the milk exceeded permissible levels in areas of Nevada and Utah near the Nevada Test Site. Dr. Eric Reiss, Associate Professor at Washington University School of Medicine, estimated that some 3000 children in that area received excessive radiation that would possibly lead to 10 to 12 cases of thyroid cancer. It was calculated that children in two Utah cities received doses to the thyroid (which concentrates dietary iodine) of 100 to 700 rads. The report was critical of the AEC for allegedly inadequate monitoring procedures; if detected in time radioactive milk could have been removed from the market. (N.Y. Times, 8/22.)

U.S., INDIA REACH ACCORD ON ATOMIC POWER REACTOR

Nearly a year of difficult negotiations came to a successful conclusion this summer when the U.S. and India reached agreement on building a 380-million-watt nuclear power station near Bombay with American aid. The stumbling block in the negotiations had been India's refusal to accept U.S.-proposed inspection by the International Atomic Energy Agency (IAEA). The Indians reportedly felt that the IAEA's safeguard requirements infringed on their national sovereignty, although they did not object to inspection safeguards by the country supplying the uranium fuel, i.e., the United States. Inasmuch as the reactor would be one of the first with weapons potential to be constructed on the territory of a nuclear have-not nation, the safeguards issue was crucial if IAEA were ever to have a significant role in preventing the proliferation of weapons material from nuclear power facilities. Had the U.S. and India signed an agreement to build the plant without agreeing on safeguards by IAEA, such a course would have been a severe blow to IAEA's prestige.

A week before India agreed to international inspection, the IAEA Board of Governors voted to extend the agency's code of safeguards to reactors above 100-million watts. Heretofore, the limitation has been a convenient excuse for nations that did not want IAEA inspectors looking into their nuclear power facilities. Nevertheless, some nations, including the United States, have admitted IAEA inspectors to small, experimental reactors even though such reactors were constructed without IAEA assistance and were technically outside the agency's jurisdiction. Until the Agency is ready with an inspection system for such large atomic facilities, the U.S. will conduct inspections of the Indian reactor under the agreement between the two countries. When the IAEA is ready, it will take over the inspections, provided its safeguards are consistent with those set up under

the U.S.-Indian arrangement.

Two other points may be noted in connection with IAEA's status. First, in the matter of raising the megawatt limit of IAEA's jurisdiction, the Soviet Union reversed its previous stand and voted for the change. Several members of IAEA, at the meeting of the Board of Governors, interpreted the new Soviet position as a good sign for the disarmament talks in Geneva and nuclear test-ban talks, which, at that time, were just coming up in Moscow. Second, it has been announced that the bilateral safeguards agreement on atomic materials between the U.S. and Japan will be administered by IAEA. The U.S. has about 40 such bilateral agreements with other nations despite the fact that this country simultaneously supports the IAEA. Thus, the switch by Japan to allowing inspection by the IAEA is another sign in favor of the agency and it may be that other nations will similarly change their attitude toward IAEA. (Science, 7/5/63; W. Post, 6/30.)

AIR POLLUTION

Prospects for passage of an air pollution bill during the current Congressional session appear more promising. In July, the House passed Rep. Kenneth A. Robert's (D-Ala.) bill giving to the Federal government the power to enforce the abatement of interstate air pollution problems and to make "control grants" to local, state, interstate, and regional agencies. (\$5 million a year for four years.) (W. Post, 8/12.) In the Senate, Edmund S. Muskie's (D-Me.) Public Works Subcommittee is currently holding hearings on a comparable bill. Previously, the Federal government has been limited to conducting and supporting research and providing technical assistance and training.

Testimony on the bill by various chemical and industrial representatives, as well as the American Medical Association, has been that the proposed Federal enforcement powers be eliminated. Some of their statements brought forth "absolute amazement" and "indignation" from Public Works Subcommittee member Maurine Neuberger (D-Ore.). Sen. Ribicoff (D-Conn.) hopes to avoid what he considers to be two flaws in the House bill: the four year grant limitation, and a clause prohibiting the Federal government from filing abatement suits until the governor of a complaining state has "certified" that he has made a good faith effort to reach a compact with the governor of the offending state. (W. Post, 8/10, 1963.)

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