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NON-PROLIFERATION: SOME PROGRESS BUT MANY PROBLEMS

Here is a short and somewhat simplified review—divided into problem areas, with some chronology—of developments relating to a non-proliferation treaty (NPT) in February and March.

U.S.-Soviet differences: It had appeared that the U.S.'s willingness to omit from the draft treaty any provision for West German or other states' "co-possession" of nuclear weapons in an allied nuclear force would make it possible for the U.S. and the Soviet Union to table a joint draft at the opening of the Eighteen Nation Disarmament Conference in Geneva on February 21st. But last minute Soviet objections apparently arose chiefly over the IAEA inspection system (see article by Leslie Gellert in this NEWSLETTER) —with the implied possibility of international inspectors in Soviet terrtory—even though the U.S. draft would not involve inspection of countries that already have nuclear weapons. (*New York Times*, 21 February 1967). But it does not appear that the particular question of U.S.-Soviet differences over inspection cannot be resolved and that it now ranks as a main obstacle to NPT progress.

IAEA vs. Euratom inspection: Among the Euratom countries, Germany and Italy especially oppose IAEA inspection, which would presumably be done partly by Soviet inspectors. The U.S. suggested (*New York Times*, 23 February 1967) a compromise under which Euratom teams would initially inspect in Euratom countries, using IAEA standards. The IAEA itself would be brought into the inspection role in stages and eventually take over entirely. Reactions to this proposal, both from the Euratom countries and the Soviets is not yet clear.

"Haves" vs. "Have-nots"—peaceful technology: Many relative "have not" countries are worried about the handicaps a NPT would impose on their developing nuclear energy for peaceful purposes. President Johnson offered some general assurances on providing nuclear technology and "nuclear explosive services" under "appropriate international safeguards" (*New York Times*, 22 February 1967). Later, the U.S. suggested that an international organization, rather than individual nuclear powers, take over decisions on peaceful nuclear explosions (*New York Times*, 10 March 1967). Non-nuclear powers would belong to the organization and help make the decisions.

"Haves" vs. "Have-nots"—the arms balance: Various non-nuclear powers have objected for some years to the idea of signing away their right to develop nuclear weapons without limitations on the nuclear stockpiles of the "haves," or other major steps toward disarmament. Recently, Italy indicated that, in exchange for signing a NPT, it expected the nuclear powers to reduce and eventually abolish their stockpiles (*New York Times*, 1 March 1967). India hopes, as a minimum, to get the U.S., Britain, and the Soviet Union to agree not to make more nuclear weapons, and hopes also for some form of guarantees—not yet elaborated—of protection against the Chinese nuclear threat (*New York Times*, 8 March 1967). Japan, while content for now to forego a weapons program, apparently seeks guarantees to the non-nuclear powers against attack and asks that the "responsibilities and sacrifices" of a NPT be "shared equally by all" (*New York Times*, 12 March 1967).

5000 SIGNATURES ON CBW PETITION

The open letter to President Johnson on CB Weapons (see text in October 1966 NEWSLETTER), circulated last fall through the FAS and other scientists' groups, went to the President on February 14th with about 5000 signers. Signers included 17 Nobel laureates and 127 National Academy of Sciences members.

The petition asked the President to: institute a White House study of overall Government policy on CBW; stop the use of anti-personnel and anticrop chemical weapons in Vietnam; and declare that the U.S. will refrain from initiating the use of chemical and biological weapons. The petition was received by Donald Hornig, Special Assistant to the President for Science and Technology, who said it would be brought to the President's attention promptly.

At a news conference the four scientists who delivered the petition (Paul Doty, John Edsall, and Matthew Meselson of Harvard; and Irwin C. Gunsalus of the University of Illinois) said their aim was to get some statment of a clear U.S. policy against initiating the use of CB weapons. They pointed out the highly unclear state of U.S. policy in this area, and noted the relative lack of interest in CB weaponry in contrast to nuclear weapon policy. (*New York Times*, 15 February 1967)

FAS PUBLIC MEETING, COUNCIL MEETINGS—

On Sunday night, April 23rd, at 8:00 p.m., the FAS will have a public meeting—speaker to be named—in the Delaware Room of the Sheraton-Park Hotel in Washington.

The FAS Council will meet in the Madison Room of the Sheraton-Park at 7:30 p.m. on Tuesday, April 25th, and again on Wednesday, the 26th, at the same time. (Note change of days from the announcement in the last NEWSLETTER.)

J. ROBERT OPPENHEIMER

In Oppenheimer's death on February 18th the F.A.S. lost a distinguished member of its Advisory Panel, a good friend, and an effective supporter of many of its causes.

"Oppie" was very active in the first F.A.S. chapter, started in the fall of 1945 at Los Alamos. He was often the center of lively, daily arguments about the future of atomic energy. Beginning in 1946, as his involvement with the Acheson-Lilienthal panel and his other official responsibilities grew, he participated less directly in FAS activities. But he lent his name and contributed money—including, on one occasion, the proceeds from the sale of a painting he owned—to the FAS and the National Committee on Atomic Information. During his years as Director of the Institute for Advanced Study, Openheimer remained accessible to FAS members who, on many occasions, sought and got his sound advice and his unfailing encouragement.

SPACE TREATY SIGNED; SENATE RATIFICATION LIKELY

The space treaty agreed upon by most members of the United Nations in December (see the December 1966 NEWSLETTER) was signed by the United States, the Soviet Union, and 60 other countries on January 27th. Similar signing ceremonies were held in Washington, Moscow, and London. (*New York Times*, 28 January 1967).

The treaty prohibits weapons of mass destruction in orbit, and bars such weapons, military installations and sovereignty claims on the moon and celestial bodies. It guarantees reasonable access to installations on celestial bodies. It requires the return of astronauts and space vehicles to their countries of origin, and establishes liability for damages from space vehicles. The treaty does not, however, prohibit the use of statellites for military purposes such as reconnaissance.

On February 7th, President Johnson asked the Senate for prompt ratification of the treaty, and leaders of both parties pledged their support. (*New York Times*, 8 February 1967)

But in early March, the treaty ran into some unexpected questioning in the Senate Foreign Relations Committee. (*New York Times*, 8 and 14 March 1967). It now appears that provisions found to be "fuzzy" by some Senators, will be clarified by "understandings" in the Committee's report on the treaty. This should avert the possibility of a Senate attempt to attach reservations—which could mean renegotiation—to the treaty. In particular it is an "understanding" of the Committee that Article 1 of the treaty which states that "the exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind," does not diminish or alter "the right of the United States to determine how it shares the benefits and results of its space activities."

Senator Gore had argued that the broad language of Article 1 might be used by the Soviet Union to object to the launching of U.S. reconnaissance satellites, or might be seized upon by some countries to demand free access to U.S. communications satellites.

EDITOR'S NOTES—

This NEWSLETTER contains three new features which will hopefully turn out to be useful and can be continued.

A minor innovation is the insertion in the regular NEWSLETTER box for each issue of an approximate closing date for items in that issue. "Approximate" is necessary because some items always seem important enough to include even after most of the NEWSLETTER has been put in draft.

The section on "Interesting Reading" will aim to list articles and other items which aren't normally digested or cited elsewhere in the NEWSLETTER, but which many FAS members might want to read. For this section I hope to be able to scan a fairly broad group of periodicals and other information sources.

The article by Leslie Gellert on the IAEA is the first of what may be occasional "review articles," written for the NEWSLETTER and generally providing useful background information on topics of interest to FAS members.

—H.L.P.

ON DECOUPLING

The January NEWSLETTER reported Project Sterling, the apparently successful attempt to decouple (i.e., to greatly reduce the seismic signals from) an underground nuclear explosion. Following are two critiques of the Sterling test. One is by incoming FAS Chairman Orear and the other is from SCIENCE.

A Short Critique on Project Sterling

(by Jay Orear)

It is literally correct, but misleading to say that the Project Sterling results indicate a decoupling factor of about 150. A test in a big hole must be in salt or hard rock, whereas many other underground tests are conducted in alluvium. Since the seismic signal from alluvium is already a factor 10 smaller than from an equivalent explosion in salt, the net gain of the big hole was a factor 15 rather than 150.

In order to keep the Project Sterling results in proper perspective, it must be pointed out that the nuclear device used was less than 2% the size of the Hiroshima bomb, and that it took six years before even this small test of the big hole theory could be made. Since Project Vela and the Defense Department are well funded, one might question the practicality and expense of construction of a hole large enough to serve a 20 kiloton Hiroshima bomb. If one is willing to make the assumption that the Project Sterling results can be extrapolated two orders of magnitude, then the equivalent hole of a 20 kiloton bomb would be 50 times larger in volume.

Dr. E. Teller along with some of his colleagues has suggested that it is technically possible to construct large holes of several hundred feet diameter by washing them out of salt domes. A sign that those early estimates might have been overly optimistic is indicated by the fact that after many years and many millions of dollars, Project Vela and the Defense Department still have not succeeded in such a test. But even if large holes could be constructed in less than six years time by washing out in salt domes, such a vast engineering project could probably be detected by satellite reconnaissance (river water would be diverted) and by salinity measurements of river outlets. Finally, it should be pointed out that any seismic signal, no matter how weak, coming from a salt dome region would be highly suspicious.

Test Detection: Decoupling Theory Verified, But Does it Matter?

(*by Luther J. Carter*, SCIENCE, 27 January 1967)

Although extension of the 1963 test-ban treaty to underground detonations continues to be an objective of U.S. arms control policy, the Russians are showing little interest at the moment in negotiating such an agreement. One recalls, however, that the successful negotiations which led to the 1963 treaty had been preceded by years of discouragingly slow progress. Thus, there is always the possibility that U.S. research on test detection problems will take on a real immediacy and political significance. "Project Sterling," a recent experiment which tends to verify the theory that an underground nuclear explosion can be "decoupled" or muffled to avoid detection, is a case in point.

Should prospects improve for a ban on underground tests, the results of Sterling will be cited by those who oppose such a ban. Already Representative Craig Hosmer, a California Republican and member of the Joint Committee on Atomic Energy, is saying, "now that undetectable cheating has been proved even more possible than before believed, there is more reason than ever to stay away from this kind

of national security trap." The U.S. insists that a comprehensive test ban treaty must provide for a limited number of inspections for the verification of suspicious events. But Hosmer argues that if, through decoupling, the Soviet Union can prevent detection of their tests, the right to make inspections would constitute no real safeguard.

Government arms control experts strongly dispute the contention that agreeing to a comprehensive test ban treaty need entail high risk. In their view, Sterling merely supports a theory already widely accepted. The decoupling theory, first advanced in 1959 by a group of scientists of the Rand Corporation, holds that the seismic signals from an underground blast can be reduced by a factor of as much as 200 or more if the nuclear device is suspended in the center of a sufficiently large cavity.

In Project Sterling, a small nuclear device, equivalent in explosive power to 350 tons of TNT, was exploded in a cavity of 110-foot diameter at a depth of 2700 feet. Detection stations less than 150 miles from the explosion did not record the event. Sponsored by the Advanced Research Projects Agency (ARPA). Sterling was conducted by the Atomic Energy Commission in the Tatum Salt Dome near Hattiesburg, Mississippi, on 3 December.

The problems associated with forming and using the cavity required for decoupling are difficult—so difficult, in fact, that it remains very much a matter of dispute whether decoupling is a practical possibility for a nation wishing to cheat on a test-ban commitment. The 5-kiloton nuclear explosion by which the Sterling cavity was formed in October 1964 was detectable at distances of thousands of miles. Moreover, so much heat was left by the explosion that the Sterling experiment was delayed by more than 2 years. Even with the delay, the temperature in the cavity was 200°F when Sterling was conducted.

Despite the heat problem, there is at least a small chance that a hostile nation might resort to nuclear blasts to form and "stockpile" some cavities before agreeing to a comprehensive test ban treaty. However, none of the Soviet Union's underground tests are believed to have been conducted in areas where salt domes occur. Salt domes are large solid masses of salt, regarded as an especially favorable medium for the formation of cavities.

Although nuclear blasting is but one of several ways by which cavities might be formed, the alternative methods involve major problems, too. The Advanced Research Projects Agency has asked AEC to study the feasibility of forming a cavity by mining, or by leaching with large quantities of hot water. The cavity would be 290 feet in diameter; this, ARPA believes, is large enough for decoupling a 5-kiloton explosion. While there is little doubt that a cavity of this size can be mined or leached, ARPA does not know whether it will stand. The wall of a cavity for decoupling cannot be shored up, for the shoring material would transmit shock waves.

Some if not most of the scientists interested in weapons development and arms control believe that tests in the low-kiloton range are not likely to produce results significantly affecting the military balance. This is so, even though these scientists are aware that small tests can contribute to technological advance for all classes of nuclear weapons. The larger the nuclear test, the more formidable the problem of decoupling. According to ARPA, decoupling a 100-kiloton test would require a cavity of 770-foot diameter at a depth of 3300 feet. Even if the cavity should stand, the work of building it might be detected by satellite reconnaissance. Detected or not, the work would cost many millions of dollars, and, if leaching were the method employed, serious water pollution could result.

Thus, advocates of a comprehensive test ban treaty are able to cite a variety of reasons why Project Sterling has produced no arguments to shake their convictions. Nevertheless, Sterling's apparent confirmation of the decoupling theory will be cited by Congressman Hosmer and others as evidence that the U.S. goal of obtaining a ban on underground tests, subject to effective verification procedures, is illusory.

PEACEFUL NUCLEAR EXPLOSIVES AND NON-PROLIFERATION

Following is the text of a letter sent by FAS Chairman Marvin Kalkstein to the Editor of the WASHINGTON POST on March 6th, and subsequently printed in the POST.

In recent editorials you have suggested that non-nuclear nations may be justified in their apparent desire to maintain the option to develop peaceful explosives in order that they might reap the direct and indirect benefits of the application of such explosives. You then concluded that the United States should not insist in the Non Proliferation Treaty (NPT) on prohibiting such developments. However, for reasons indicated below, it is essential that the development by non-nuclear countries of all explosives be banned if a NPT is to be effective. Also, such restrictions do not lead to economic disadvantage for the non-nuclear countries. This assessment of the situation derives from the following aspects of a nuclear technology:

1. There is basically no difference between a "peaceful" nuclear explosive and a nuclear weapon; any nation which has succeeded in developing "peaceful" nuclear explosives has, in effect, succeeded in developing nuclear weapons. In fact, the devices required for excavation projects require some of the most sophisticated weapons technology. Peaceful nuclear explosives for excavation must produce a minimum of radioactive debris, a property which is now found in only the most advanced nuclear weapons.

2. With regard to technological side benefits which might be derived from a nuclear explosives program, those applications of nuclear technology which have demonstrated economic significance do not involve explosives. Instead, the important applications of nuclear technology, such as power generation and isotope production, entail use of nuclear reactors; development of these would not be restricted by any NPT. The development of such facilities has proceeded in this country and elsewhere completely separate from the nuclear weapons program.

3. Finally, based on the economic experience, there is no evidence whatever to suggest that a nuclear explosives program produces economic benefits which are at all commensurate with its costs. There is, therefore, no reason to believe that a program aimed at the development of peaceful nuclear explosives could be justified on economic grounds, and any non-nuclear nation which claimed this could be justifying the costs to itself by the military value of the program. However, to assure the non-nuclear nations that they would benefit in the event nuclear explosives were found to have important peaceful applications, the United States should actively follow up its offer to work out procedures for conducting such explosions for the benefit of all nations, without deriving any material advantage for itself.

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Chairman .....Marvin Kalkstein

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Sources of information (given in the articles in parentheses) are for further reference. Items reprinted directly from other publications are designated as such in an introductory paragraph.

SECRET RESEARCH AT UNIVERSITIES

Printed here is a report from the FAS Committee on Secrecy in University Research (submitted by the Committee Chairman, Jay Orear, who is also incoming FAS Chairman). Also printed are reports on secret research at Cornell (also by Orear) and at the University of Pennsylvania (mainly from information supplied by faculty members there).

REPORT FROM CHAIRMAN OF FAS COMMITTEE ON SECRECY IN UNIVERSITY RESEARCH

At the FAS Council meeting in September at Columbia University university sponsored research in CBW was discussed and it was decided that the FAS should try to formulate guidelines for university sponsored research. A committee was formed to receive information and suggestions. Based on preliminary findings the FAS Council on January 30 took its first action in recommending guidelines for university sponsored research. The following guideline was adopted by unanimous vote:

> "Except when a national emergency has been declared by the President of the United States, and then only in circumstances which require university participation, a university, as a corporate entity, should accept or administer external contracts or grants only for research projects whose principal purpose is to produce results which will be freely available and freely publishable in the ordinary manner of open research in the relevant discipline."

It is hoped that further steps will be taken at the Washington FAS Council meeting in April and that a position paper will be adopted which gives the reasoning behind the FAS objections to secrecy in university research. Meanwhile we urge the readers of this to send information on the current research policies of their universities. This information should either be sent to me or to the *FAS Newsletter*. We hope to publish it in the *Newsletter*, as it is received.

In addition to the articles already printed here explaining the situations at Penn and Cornell, we have also received short communications from members at Harvard, Yale, Carnegie Tech, and the U. of California at Berkeley indicating that their universities are not in conflict with the above guidelines. Also we are happy to state that both Brookhaven National Laboratory and the Lawrence Radiation Laboratory at Berkeley have no classified research. On the other hand we have received information from MIT and Columbia indicating that these institutions along with Penn and Cornell are presently in conflict with the above guideline.

Information given by Elinor Langer in the January 13 issue of *Science* indicates that NYU, Stanford University, Illinois Institute of Technology, U. of Arizona, John Hopkins, U. of Pennsylvania, Hahnemann Medical College and the U. of Utah have or are engaged in chemical or biological weapons research. Another group of institutions which have done or are doing unclassified research supported by the CBW program are the universities of Chicago, Minnesota, Michigan, and Texas, Ohio State University, and MIT.

STATUS REPORT ON CLASSIFIED RESEARCH AT CORNELL UNIVERSITY

Since 1948 Cornell University has adhered to a policy of no classified research on campus and no classified theses. However, for 20 years Cornell University has been the full owner of Cornell Aeronautical Laboratory, a non-profit applied research laboratory loacted in Buffalo, N.Y. At present about one-third of the 25 million dollar a year research at C.A.L. is classified. Over 70% of the total research at C.A.L. is supported by the federal government, and most of this is military research. Cornell Aeronautical Laboratory has recently been doing research studies on dissemination and targeting of chemical and biological weapons. Although a subcontract from the University of Pennsylvania on this subject was terminated on Aug. 31, 1966, C.A.L. has an expanding program in chemical munitions research and is presently engaged in such research.

In spite of several efforts, the faculty has been unable to learn whether C.A.L. has been supplied information on the use of chemical weapons in the Vietnam war. This illustrates the point that whenever a university associates itself with classified research, the faculty loses its right to know what is going on.

Cornell University has had very little educational and research interaction with C.A.L. and on these grounds alone the relationship has been questioned. The only financial gain to Cornell University amounts to the equivalent of about $70,000 per year. At the first faculty meeting of this year President Perkins announced he would appoint a committee to study the situation. At the same meeting action was taken to form an independent faculty committee. These committees are in liaison and the faculty committee will present its report in time for action at the 5 April 1967 faculty meeting. So far the university administration has been cooperative with the faculty and appears to be working toward a solution of the problem in good faith. On the other hand the university has not taken the drastic step of asking its laboratory in Buffalo to postpone all CBW research pending the results of the current investigations.

THE SITUATION AT PENN

The September and November 1966 Newsletters gave the incomplete and faulty impression that the University of Pennsylvania had decided to discontinue secret research. Following is an outline of developments through March, 1967.

The University Senate, an advisory body which acts as a faculty forum, voted on 4 November 1965 and again on 10 November 1966 to reaffirm a 1953 policy which agrees word-for-word with the guideline adopted by the FAS Council on 30 January 1967. (See above report of FAS Committee. The FAS guideline was evidently adopted ready-made from the Penn policy.)

The particular objects of controversy at Penn are on Air Force-supported Project Spicerack and an Army-supported Project Summit, both concerned with CBW and both conducted by the University's Institute of Cooperative Research. University President Harnwell announced last Fall that, to relieve sharp objections from the Penn faculty, the administration would try to find alternative auspices for Spicerack and that the Institute of Cooperative Research "would no longer be needed." It is not clear what, if any, concrete actions followed. But in January, Harnwell signed a one-year extension to the Spicerack contract, which he subsequently disclosed with the explanation that the extension was to facilitate the transfer of Spicerack away from the University. The Spicerack extension drew a sharp reaction from many members of the Penn faculty.

On March 15th (*New York Times*, 16 March 1967), Harnwell announced that Spicerack and Summit would not be continued beyond their March 1968 expiration dates. On March 30th, Harnwell announced that work on both projects would be transferred to the University City Science Center by the end of July of this year. The Center is an applied research organization, owned by a number of educational institutions in the Philadelphia area. It appears that, although Penn is the largest shareholder in the Center, it does not control the Center's policies.

THE IAEA: TEN YEARS OF SLOW BUT SOLID PROGRESS

by Leslie Gellert

Recent signs of progress toward a non-proliferation treaty have focused attention on the International Atomic Energy Agency. The IAEA, with headquarters in Vienna and a membership of 97 States, is the world-wide body which works to separate the peaceful and military sides of atomic energy. The Agency was founded in 1957, to foster peaceful programs, but above all to provide international safeguards on the spread of power reactors and their uranium fuel, since these reactors would also produce plutonium (or U-233)—which could in theory be used either to fuel more reactors or to make nuclear weapons. While an IAEA role in policing a non-proliferation treaty is an uncertain hope, and international safeguards are still a very experimental field, it may be useful to give a brief review of the IAEA and its present work.

The origin of the Agency was President Eisenhower's 1953 UN speech proposing that the major atomic powers take the lead in a worldwide program of atoms for peace. It took long negotiations to draw up a Statute blueprint, which was designed to allow an ambitious program of both safeguards and aid, especially a supply of enriched uranium from the U.S., U.K., and Soviet Union. However, most Agency activities depended on the demand from member States, and its safeguards would operate only when States entered specific agreements with the Agency. In its early years, the Agency had little hard business: hopes for nuclear power were generally deferred; also, other atoms for peace programs had gone ahead, via bilateral agreements and regional bodies (especially U.S. bilaterals and the six-member Euratom).

The Agency's hardest job, however, was to set up a working safeguards system. All questions of safeguards policy had to be settled by the Board of Governors, where large and small States were arguing for their views of just what an international control system should be. Step-by-step, this led to dull-looking but important documents dealing with safeguards and inspection. While a formal system was approved by the end of 1961, it had met severe opposition from the Soviet bloc, India, and some others. From 1963 on, the atmosphere for safeguards and the Agency's prospects have steadily improved, coinciding with new efforts towards arms control, and also with the imminent spread of nuclear plants (now estimated likely to be producing 100 kilograms of plutonium per day by 1980). By September 1965, the Agency had a revised safeguards system which was approved without significant dissent.

Outline of IAEA Safeguards System

The IAEA safeguards system concentrates above all on how the Agency is to supervise nuclear materials which have been put under its supervision or materials being used in a reactor or other facility which is under Agency safeguards. The 1965 document attempts to stake out the general controls over all such material and facilities, including the crucial principle that the Agency will continue its chain of control on byproduct plutonium (or U-233). However, the safeguard details set so far are full enough only for certain facilities, especially reactors: special procedures would be added for other major plants, such as those for fabricating fuel or reprocessing used reactor fuel. The Agency has been dealing step-by-step with the difficult problems it faces when fuel is reprocessed, to recover the unused material and by-product plutonium. To steer around the possibility that the reprocessing plant might not be under Agency safeguards (the immediate case, since only a few leading States have plants), the safeguards system allows the Agency either to supervise the actual processing or to accept an agreed amount of substitute fissionable material to come under its safeguards. As the next step, in mid-1966 the Agency Board approved an experimental set of procedures to safeguard reprocessing, which will be tested at a U.S. plant.

As the main methods to ensure that nuclear materials would be fully accounted for and used as intended, the Agency Statute listed broad rights to review the design of reactors and other facilities and equipment, to require a State to provide reports and operating records, and to conduct on-the-spot inspections. It has been no easy matter to spell out the idea of an Agency "right to know" while limiting it to the legitimate aims of safeguards. The Agency of course wants to be sure it knows enough about the technical characteristics of a reactor and its fuel, first of all to minimize the danger of diversion and then to ensure that diversion is not occurring. On the other hand, some States have wished to restrict these rights, fearing the Agency might arbitrarily meddle in plans to build and operate a reactor, or its officials might misuse confidential information. The safeguards system, staff rules, and other documents have tried to clarify the Agency's main rights and duties, but a good deal of emphasis is put on the assumption that details of specific cases will have to be worked out by mutual agreement.

Inspection has been perhaps the most important problem, since the Statute provided for a special staff of inspectors with specific responsibilities of visiting a State's relevant facilities to verify compliance with safeguards agreements, in particular to confirm the use of nuclear materials. After inspection policies and staff rules were worked out under the Board's close eye, this staff began to function on a small scale by 1962. The Board passes on the Director General's appointments to the inspectorate, which by mid-1966 numbered 14, carefully chosen to represent a broad range of countries. Rules for inspectors reflect the suspicion many States show towards any hint of invading their sovereignty. The Government concerned must approve Agency assignment of the individuals who are then to conduct inspections, can have its representatives accompany inspectors, and must often be allowed advance notice and approve matters such as travel routes. (The Soviet Union has been very insistent that individuals must be acceptable to the State; other States, however, might use the right to bar any Communist nationals as inspectors.)

The main safeguards document deals with a number of measures which inspection may involve: steps to audit and sample stocks of safeguarded material, testing of reactor or other instruments, checking operations of the reactor or other facilities containing nuclear material. The maximum frequency of regular inspections of a facility depends on the amount of fissionable material involved. For large amounts (e.g., a reactor producing more than 60 kilograms of plutonium a year), "access at all times" will be required, but specific agreements will have to spell out how this sensitive right will be handled. Agency inspectors are specifically barred from operating a facility or ordering its staff to perform particular operations. In other words, they have a right to carry out their tasks, and to expect the cooperation of local authorities in the steps required and in resolving any problems.

The 1965 safeguards system covers many other detailed matters, such as when safeguards would be terminated, changes in the location or use of safeguarded nuclear material, exemptions or nominal safeguards (e.g., for limited quantities of material or certain small reactors). Its provisions also emphasize that safeguards are to be applied flexibly, in proportion to the danger, and by close consultation between Agency staff and the State concerned.

What happens if trouble arises in applying safeguards? Safeguards documents indicate that in many cases either the Director General or the State would take a major dis-

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agreement to the Board, for instance if a State kept refusing to approve the proposed inspectors. Safeguards agreements may provide other methods for settling some disputes. However, the ultimate question would arise if Agency inspectors were finally convinced there was diversion of material or other serious non-compliance. Under the Statute, this would be reported to the Board, which decides if there has been non-compliance and must report the fact to Agency members and the UN Security Council and General Assembly. Though the Board would call on the State to correct the non-compliance, the Statute gives the Agency no enforcement power, and its main sanction would be possible termination and recall of aid provided by the Agency or a supplier State.

Some other issues concerning safeguards can only be listed. The Agency Statute gave it a general authorization to set up safeguards to ensure that "fissionable and other materials, services, equipment, facilities, and information made available" by the Agency or under its supervision are not used "to further any military purpose." There has been no definition of "military purpose," a very broad standard which the Board may have to interpret in future. The 1965 safeguards system does not deal in detail with information, general services, or equipment (which has been especially controversial), and any such controls would have to be set in particular agreements. Another issue is whether safeguards should generally be financed through the Agency's regular budget, assessed on members roughly according to ability to pay. So far, the U.S. has successfully defended this idea of international financing, but there have been demands for payment by the individual State or States concerned. While the Agency has managed to keep costs quite low, financing may be more important if its work, especially inspections, becomes large-scale.

Some Prospects for the IAEA

Perhaps more emphasis should be given to the progress the IAEA has made already, and to the fact that it has considerable capacity to work out further problems. While the Agency's 25-member Board makes policy and supervises, it is the Agency staff which carries out the work, from preparing rules and agreements to on-the-spot handling of inspection. From the start, the Agency staff has quietly pursued general work on safeguards problems, including of course, study of control experience of the U.S. and others. Special mention should be made of some efforts on the practical problems of safeguards. One area is what is called materials managements, where the safeguards aim is reliable accounting for materials; the need for safety and the high value of nuclear fuels give this work a much broader basis of interest to States. Despite its limited resources, the Agency has also actively promoted research (mainly by members) on technical problems, seeking cheaper, better, and automatic methods of control. One of the Agency's first research contracts, for example, helped develop possible methods for non-destructive analysis of fuel elements. By 1965, the Agency was stressing the need for tamper-proof reactor seals and monitoring equipment (to reduce inspection tasks) and prodding members to work on the difficulties of realiable reprocessing control.

Application of Agency safeguards has been expanding in the last two years, though it as yet covers only a small fraction of the world's peaceful nuclear programs. By the end of 1966, the Agency had concluded some 31 safeguard agreements with 25 States, which will involve 60 or more reactors (most relatively small, but including large power reactors in Japan and the United Kingdom). In the year ending June 1966, the Agency had inspected 25 operating facilities in 12 States; it was planning for an increase not only in the number of safeguarded facilities, but in their size, complexity, and plutonium production, requiring by 1968 perhaps 80 inspections at a cost of $600,000.

The Agency's safeguards business involves three major categories. One class is for specific projects by which a State receives materials and other aid via the Agency, originally intended to be a major dual purpose function of the IAEA. So far there have been only about 10 such aid-and-safeguards projects. (Most involved U.S. supply of enriched uranium for research reactors, with Agency assistance mainly a formality.

Second is application of safeguards, on request of the parties, to bilateral or multilateral arrangements. In the last few years, safeguards transfer agreements have been concluded for activities under about 20 bilateral aid agreements (mainly of the U.S., two U.K., one Canadian). The Agency's standard agreement is called an "umbrella", since its scope is to depend on the transactions under the bilateral, including possible safeguards in the supplier State (e.g., on byproduct material). The Agency's Director General, Sigvard Eklund, has expressed hope that the Agency would soon be safeguarding more than 50 of an estimated total of 60 to 70 such bilaterals. Certainly the U.S. has by now moved to insistence that safeguards by the Agency should be accepted as soon as possible by all its bilateral partners—even in the case of a new peaceful bilateral with the U.K. last year. So far, however, the Agency safeguards system has not touched bilateral activities of the Soviet Union or France, which are fairly limited, or multilateral arrangements. The most important regional body is Euratom, whose independent safeguards system was recognized by the U.S. in 1958.

The third safeguards application is, on request, to "any" of a State's independent activities. The U.S. has, since 1962, put several research reactors and the large Yankee power reactor in Massachusetts under safeguards, for limited periods, mainly to give the Agency experience and encourage acceptance of safeguards, and reprocessing controls will be tested on the privately-owned NFS plant in New York. After considerable U.S. urging, the U.K. submitted two large power reactors to Agency inspection, as of last June. Though the U.S. has made a number of overtures, so far the Soviet Union has made no move to join this new nuclear club.

The critical question today is whether IAEA safeguards will be accepted on a significant scale. A great expansion would occur if the Agency were to safeguard peaceful programs under the proposed non-proliferation treaty (NPT) whereby most States would renounce nuclear weapons programs. The U.S. is seeking this, and apparently the Soviet Union has taken the view that safeguards were not vital but could be included in the NPT if the job went to the IAEA. The U.S. is now trying to find a way of making this acceptable to Euratom (especially Italy and West Germany; France generally won't help on the NPT). More tentatively, the U.S. has suggested that the Agency or a special body might deal with the difficult question of supervising future plans for peaceful nuclear explosions. (Controversy has mounted over demands, notably from India and Latin American States, that the NPT should not bar development of such explosives; since the peaceful and military technology are inseparable, the U.S. proposes that existing weapons States should supply any such devices.) What role the Agency may have is very uncertain, and many other NPT issues remain to be bargained.

Aside from the proposed NPT, there are hopes for fairly wide acceptance of Agency safeguards on a regional or State-by-State basis. The main step so far is an agreement just drafted for prohibition of nuclear weapons throughout the region of Latin America: this would require each State to put peaceful programs under Agency safeguards, while a regional center would handle other questions. Though the treaty is full of knots (to be accepted by all Latin American States and recognized by all weapons States!), the safeguards system can operate *ad hoc*, if some States are willing. In the last few years there have been a number of other proposals for extending the Agency's supervision of national and international activities, and some suggestions that the Agency's aid role should also be strengthened (see September *Newsletter* for proposals of Sterling Cole, the IAEA's first Director-General.)

NEWS ITEMS

The U. S. and the Soviet Union began arrangements for their highly-publicized **bilateral negotiations to limit the arms race in offensive and defensive missiles** on March 23rd. U.S. Ambassador Thompson had 30 minutes of "preliminary discussions" with Soviet Foreign Minister Gromyko in Moscow (New York Times, 24 March 1967). (The April Newsletter will hopefully contain a review of the missile/anti-missile situation, and the prospects for progress in this area of the arms race.)

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A panel organized by the National Academy of Sciences has suggested **methods for improving the quality of US participation in scientific meetings abroad** and recommended a continuing critical study of the kind, size, and frequency of international scientific meetings to insure the most effective use of available travel support. Some suggestions: travel to international meetings on topics that are developing rapidly and significantly should be preferred to routinely scheduled meetings. The desirability of going to meetings should be considered in relation to the thoroughness of the organization and planning the meeting. Special consideration may be needed for meetings aimed at coordination of international cooperative research programs.

Travel to international meetings is especially important when either (a) the individual will make a genuine substantive contribution (even though this may be done informally), or (b) the research potential of the individual will be enhanced by the meeting, as may be especially the case with younger scientists. The panel concluded that there are probably more international meetings than necessary and that some means for minimizing duplication of subject matter is advisable. But it also noted that probably less than half of one percent of the cost of research is spent on travel abroad by scientists. (National Academy of Scientists News Report, February 1967)

INTERESTING READING

"Science Can End Arms Race," article by Jerome B. Wiesner, in the *Washington Post*, 22 January 1967.

"Technology Gap Upsets Europe," articles by Henry R. Lieberman and by Richard E. Mooney, in the *New York Times*, 12 March 1967.

"J. Robert Oppenheimer," editorial by Don K. Price, in *Science*, 3 March 1967.

"Oppenheimer: 'Where He Was There Was Always Life and Excitement,'" article by Hans A. Bethe, in *Science*, 3 March 1967.

"Federal Science Policy: Roles of the President's Science Advisory Committee and the National Science Board," article by Philip Handler, in *Science*, 3 March 1967.

"Federal Funds for Science," review by Ruth Adams of data from the NSF Annual Report, in the *Bulletin of the Atomic Scientists*, February 1967.

"Social Sciences: Harris Bill Evokes Limited Support," article by D. S. Greenberg, in *Science*, 17 February 1967.

"The Ever Widening Gap," article (in which the "gap" is between the rich and the poor countries) by P.M.S. Blackett, in *Science*, 24 February 1967.

"The National Space Program—Its Values and Benefits," Staff Study for the Committee on Science and Astronautics, House of Representatives, U.S. Government Printing Office, 1967.

"Major Activities in the Atomic Energy Programs, January-December 1966," report (495 pp) from the AEC, January 1967. (Available from the Government Printing Office, $1.75.)

"Missile Defense: LBJ's Bid to Curb Arms Race Gains Support," article by Luther J. Carter, in *Science*, 31 March 1967.

The AEC has decided "that national security interests would best be served" if privately sponsored—although classified—work on the **gas centrifuge process for isotope separation** were discontinued. But the AEC will review private work to see if some companies "could make a substantial contribution to the Commission's own classified program under direct governmental contractual arrangements." The AEC "presently concludes that the gas centrifuge process probably will not be economically competitive with the U.S. gaseous diffusion process for the next decade or longer." (AEC release, 21 March 1967)

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The **Canadian Government has been advised to enter the space race** for risk of losing to the United States its control over domestic communications. Canada's first official study of space problems reported, to the new Science Council of Canada, that satellites for communications and television would be especially important to hundreds of relatively isolated communities in the Canadian North. (New York Times, 8 March 1967)

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On February 10th the U.S. **"temporarily postponed" a nuclear excavation experiment** scheduled for later in February at the Nevada test site. The postponement was an attempt to avoid complicating discussions toward a non-proliferation treaty, or a Latin-American nuclear-free zone. It appears that the Administration will now put off development of nuclear explosives for peaceful purposes until this touchy issue can be resolved in relation to a non-proliferation treaty. (New York Times, 11 February 1967)

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Scientists testifying before the Senate Sub-Committee on Government Research have repeated **warnings of the hazards of trying to apply the results of biomedical research too quickly.** The new warnings echo the comments heard last summer when President Johnson demanded greater attention to practical benefits from health research programs. The Sub-Committee hearings, chaired by Senator Fred B. Harris, will continue the theme in the hearings begun on February 28th, of "Research in Service of Man." (New York Times, 1 March, 1967)

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American scientists met with the 63 scientists aboard the **Soviet oceanographic ship,** MIKHAIL LOMONOSOV, when that ship put into San Francisco, January 18-23 for provisions and repairs. The National Academy of Sciences took the initiative in arranging the meetings, which included a trip to the Lawrence Radiation Laboratory and the Geology Department at Berkeley. (National Academy of Sciences News Report, February 1967)

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A report issued by the Department of Health, Education and Welfare says that **air pollution from sulphur oxides** often exceed safe levels in virtually all major American cities and many smaller ones. The assumption is that detectable increases of human illnesses and deaths begin to occur when the sulphur dioxide concentration averages over 0.015 parts per million, over a year's time. Public Health Service studies show that this level is very often exceeded. (New York Times, 23 March 1967)

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A U.S.-Greek **feasibility study of desalting plants for Athens** has been completed. Single and dual purpose desalt-plants that might be located near Athens were studied. A nuclear desalting plant would probably be more economical than a plant using fuel oil. The Greek government is studying alternative sources of fresh water for Athens and will compare the results of these studies with the estimates for the nuclear plant. (AEC release, 2 March 1967).

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Scientist and Citizen, a monthly journal published for 8 years by the St. Louis Committee for Nuclear Information

(Continued on Page 8)

NEWS ITEMS

(Continued from Page 7)

has been designated a publication of Scientists' Institute for Public Information. The announcement, from the Institute for Public Information, noted that Scientist and Citizen has earned a reputation as a prime source of reliable information on questions of environmental contamination. (SIPI Release, 31 January 1967)

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A **catalog of major international science programs** in which the federal government participates is contained in a report issued by the Science Policy Research and Foreign Affairs Division of the Legislative Reference Service of the Library of Congress. The 167-page report was drawn up at the request of the Science, Research, and Development Subcommittee of the House Committee on Science and Astronautics. The report, "The Participation of Federal Agencies in International Scientific Programs," may be obtained from the Committee on Science and Astronautics, 2318 Rayburn Office Building, Washington, D. C. 20515. (Science, 3 March 1967)

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Industry is substantially increasing its own expenditures for research and development, according to an NSF study, but the Federal Government remains the major source of financial support for industrial R and D. The NSF reported that between 1964 and 1965 industry increased its expenditures by 11%, while the federal contribution rose only 1%. Of some $14.2 billion spent on industrial R and D in 1965, 55% was federal funds. The aircraft and missiles industry funded about 36% of the total R and D activity and, of this, almost 90% was financed by the federal government. (Science, 10 March 1967)

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The President's Science Advisory Committee has recommended **astronomical space observatories** as a primary goal of the post-Apollo Space Program. PSAC recommended a $3.5-$7 billion program that also includes **limited extension of the moon project and early unmanned planetary exploration.** There continues to be strong opposition by many scientists who believe that the PSAC recommendations do not reflect the views of the scientific community, and that non-space sciences are neglected. Ralph Lapp suggests that "a national dialogue on the space program is a necessity, and scientists should communicate their views to the White House." (Physics Today, March 1967)

The Construction of **two cities devoted entirely to scientific research** is under way near Moscow, according to recent Soviet newspapers. One of the two science cities, known as Pushchino, is situated 60 miles south of the Soviet capital and will be devoted entirely to research in biology and related fields. The other, Krasnaya Pakhra, 25 miles southwest of Moscow, will specialize in physics of the earth. The two towns are the latest in a growing list of specialized science communities developed throughout the Soviet Union in the last 10 years. (New York Times, 23 January 1967)

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The Administration, in a budget-motivated gesture toward slowing the atomic arms race, announced a **further cutback in the production of fissionable materials** for nuclear weapons. On or about July 1, the Atomic Energy Commission will shut down another of its large plutonium production reactors at Hanford, Wash. This will bring to five the number of production reactors that have been closed by the United States since 1964. In contrast to the earlier shutdown, however, the Administration played the latest move in a very low key, with no direct appeal to the Soviet Union to follow the example of the United States. (New York Times, 25 January 1967)

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