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

SWAY CONGRESSIONAL OPINION ON ABM

For the statement which follows, entitled as above, the NEWSLETTER is indebted to FAS Vice-Chairman Cameron B. Satterthwaite, who suggests that now is a good time to try to influence Congressmen. Satterthwaite suggests the following as readable literature on the ABM question:

Hearings, Subcommittee on Military Applications of the Joint Committee on Atomic Energy, Nov. 6 and 7

Scientist and Citizen, *April, 1967*

Garwin and Bethe, Scientific American, *March, 1968*

Bulletin of the Atomic Scientists, *May and June, 1967*

"The Grand Illusion," Editorial in Newsweek, *Oct. 2, 1967*

The FAS has now made two statements of ballistic missile defense, one to the Joint Committee on Atomic Energy (FAS Newsletter, Nov. 1967) and one as a public statement. In both of these statements the implications of deployment of an Anti-Ballistic Missile (ABM) defense system were explored and, on balance, it was concluded that the arguments against deployment far outweighed the arguments for.

It appears that in spite of these criticisms and many others that have been made to President Johnson and the Department of Defense, the present administration is determined to go ahead with the thin or "Sentinel" ABM system at an initial cost of five billion dollars or more. The 1968 budget contains several hundred million dollars for this purpose.

If this wasteful expenditure is to be avoided a significant number of members of the House of Representatives and the

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FAS COUNCIL TO MEET IN WASHINGTON; PHYSICAL SOCIETY WILL HAVE PANEL DISCUSSION ON "UNIVERSITY RESEARCH AND THE NATIONAL DEFENSE"

The next meeting of the FAS Council, which all FAS members are welcome to attend, will be held at 7:30 on Tuesday and Wednesday evenings, April 23rd and 24th. The meeting room, convenient for members of the American Physical Society, will be announced in the next NEWSLETTER.

Also of particular interest to FAS members will be the panel discussion sponsored by the APS. It is scheduled for 8:00 on Monday evening, April 22nd, and its location will be announced in the next NEWSLETTER. The Chairman will be Dale Corson of Cornell University. The speakers will be: John A. Wheeler, Princeton University; John O. Rasmussen, University of California; Richard L. Garwin, Columbia University and IBM; and William C. Davidon, Haverford College.

FAS PITTSBURGH CHAPTER CAUTIONS ON PROPOSED NUCLEAR TEST IN PENNSYLVANIA

On February 16th the Executive Committee of the Pittsburgh FAS Chapter issued the following statement.

The proposed experimental underground nuclear explosion to create a gas-storage cavity in central Pennsylvania (Project Ketch) involves serious potential health hazards to the population which have not been adequately explored and evaluated.

Release of radioactivity to the environment may result from (1) prompt escape due to ground rupture (some 27 of about 70 underground nuclear explosions between Sept. '61 and June '63 are known to have leaked to some extent); (2) cleaning the cavity by flushing radioactive gases into the atmosphere; (3) leakage of gas stored under pressure (gas loss from natural underground storage areas has for instance been experienced at the Dice Storage Depot, Peoples Natural Gas Company, Murrysville, Pennsylvania); and (4) delivery of radioactive gas to homes, buildings, and factories.

An accidental release of even a very small fraction of the iodine-131 and strontium-90 generated in the detonation would do irreparable harm, particularly to children, who are more sensitive to radiation-induced leukemia and cancer than adults, and even to future children of exposed women and girls. Liberation of krypton-85 and tritium could appreciably elevate the long-term contamination of the atmosphere and hydrosphere. These hazards and the probable extent of radiation exposure of the population would be enormously increased in an economically effective program of gas storage involving dozens or hundreds of nuclear-explosion cavities. Many of these questions about meeting acceptable levels of radioactivity have already been raised by the Advisory Committee to Governor Shafer on Atomic Energye Development and Radiation Control in a Report of Phase I of "Project Ketch Safety Concept" dated August 3, 1967.

The further experiments necessary to develop the techniques of containment, flushing, and insuring the absence of harmful radioactivity in the distributed gas should be carried out in areas of low population density, far from the large dairy-farming regions of the northeastern United States. Large segments of the population should not be exposed to the inevitable risks which attend such a nuclear explosion as a result of our limited present knowledge and technology.

NEWS ITEMS

(For reasons of space, a number of News Items—and the "Interesting Reading" section of this NEWSLETTER—must be held until next month.)

Former Presidential Science Advisor George B. Kistiakowsky has cut all his ties with the Defense Department in protest over U.S. policies in Vietnam. His break is only with the military establishment, which he has advised for more than two dacades. He remains a member-at-large of the

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CONGRESSIONAL OPINION ON ABM

(Continued from page 1)

Senate must be convinced that the deployment of an ABM system is unwise and that they should oppose further authorization and funding.

At this time, when Congress is faced with huge deficits to finance the war in Vietnam, when the unfavorable balance of payments threatens the stability of the dollar and when it is evident that to stem the tide of unrest in the nation's cities, many more billions must be spent, Senators and Congressmen may be particularly receptive to arguments that the ABM system is one place where we can and should save some money.

Some of the arguments against the deployment of an ABM system are given below. It is hoped that Newsletter readers will use these and perhaps some of their own to persuade their Senators and Congressmen against further ABM authorization.

1. The ABM will signal a new round of escalation in the arms race.

Ex-Secretary of Defense McNamara has said that it is a "virtual certainty" that the Soviet Union will take whatever steps are necessary to maintain their deterrent in the face of our ballastic missile defense. They can and will build more offensive missiles so that they always have enough to swamp our defenses. They will also provide their offensive force with means of confusing and penetrating our missile defense. Many possible measures exist as described by Bethe and Garwin in the *Scientific American*, March 1968.

The U.S. will also certainly maintain its capability of "assured destruction" of the USSR in the face of their missile defenses. There will be a great tendency for both sides to over-react because of the uncertainties in the effectiveness of any missile defense, and the tendency to overrate the capabilities of the enemy's defenses and to underrate one's own.

2. The ABM will destabilize the arms balance and again put a high premium on a first strike.

For some time now, the US and USSR have maintained nuclear strike capabilities that, because of hardened sites, mobile launchers, and missile launching submarines, have given both the assurance of being able to inflict intolerable damage on the other even after a first strike. This balance has removed much of the incentive to increase nuclear missile arsenals on both sides. But with the ABM defenses, either side may fear that the fraction of its missile force that can survive a first strike may be successfully countered. Therefore, in addition to encouraging further missile buildups, the ABM will put a premium on a first strike.

3. The effectiveness of an ABM system is bound to be highly uncertain.

It is recognized by nearly all who are knowledgeable about missile defense that a determined nuclear power can maintain an offensive force capable of overwhelming any defense system and probably at less cost. The effectiveness of an ABM system will be further uncertain, first, because there are a host of possible measures that can be used to penetrate the system and the offensive side has the choice of which measure or combination of measures it will use, and, second, it will never be possible to test an ABM defense system under anything approaching realistic attack conditions.

4. The introduction of ABM systems into the arms race may make steps toward arms control and disarmament even more difficult.

Because of the uncertainty in the capabilities of missile defense systems and the inherent asymmetry with which they are viewed, it may be increasingly difficult for the US and USSR to agree on levels at which armaments can be limited to provide security to both sides. The non-nuclear nations may be reluctant to sign a non-proliferation treaty if the nuclear powers are expanding their own arsenals of nuclear weapons. If the US needs a missile defense against the Chinese nuclear force, do not India and Japan need one even more? In addition, the one successful treaty for nuclear arms control—the Atmospheric Test Ban Treaty—may be threatened by pressure to test nuclear warheads in defensive missiles.

5. ABM systems mean more megatonnage in event of war.

Not only will the planned strikes be of larger magnitude in order to assure penetration of the defense system but the defense system itself will release quantities of radioactivity. To quote the testimony of Dr. Thomas W. Wolfe, of the Rand Corp. and George Washington University before the Subcommittee on Military Applications of the Joint Committee on Atomic Energy, "in the event nuclear war should occur either deliberately or by accident, the presence of ABM systems would probably have the effect of increasing rather than minimizing the release of megatonnage, and there are, of course, deep-seated humanitarian and biological reasons for wanting to avoid this situation, which could despoil the biosphere we are all obliged to share."

6. Proponents justify the "Sentinel" system on the basis of defense against the Chinese, but there is no evidence that the Chinese of the 1970's and 80's will be less susceptible to nuclear deterrence than the Russians have been for the last several years.

Again quoting from the testimony before the Subcommittee on Military Applications, Mrs. Alice Langley Hsieh, a noted analyst of Communist China's political and military policies and a senior staff member of the Rand Corp., responded to what she called "the image of China as a militarily reckless, adventurous regime" which is persistent in the thinking of many Americans. She said, "Far from conforming with this public image of warlike bellicosity, China's external military policies in pursuit of her long-term foreign policy objectives —great power status, hegemony in Asia, removal of US power and influence from the Western Pacific— have been characterized by a considerable degree of caution." She further asserted that "Chinese thinking concerning a nuclear war with the United States has been and remains, despite the detonation of six nuclear devices, entirely defensive." Chinese thinking is not apt to become more adventurist since the United States will maintain a preponderent nuclear superiority over China for the foreseeable future.

In view of these arguments, it would appear that security is to be lost, not gained, by deploying an ABM system, and that it would be a waste of human and material resources—resources that should be devoted to the betterment of human life.

A wiser course would be to continue to press the Soviet Union for a mutual agreement to abandon plans for ballistic missile defenses. If these attempts fail and if the USSR makes moves to expand her ABM system, we should respond by maintaining our own deterrent striking force always at a level which is able to penetrate or overwhelm their defense systems.

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Chairman ..... Jay Orear

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The FAS, founded in 1946, is a national organization of scientists and engineers concerned with the impact of science on national and world affairs.

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.

NEWS ITEMS

(Continued from page 1)

President's Science Advisory Committee (PSAC) and a member of the General Advisory Committee of the Arms Control and Disarmament Agency (ACDA). Kistiakowsky's break with the Pentagon was first reported in *Science*. Neither Kistiakowsky nor John S. Foster, the Pentagon's Director of Defense Research & Engineering, would comment on the matter. But colleagues said Kistiakowsky had been "deeply distressed" over the course of the Vietnamese War and had withdrawn from all activities directly related to the war. They said he had not urged any colleagues to follow his lead.

Kistiakowsky is a Russian-born Harvard University chemist and an expert on explosives. He was the chief designer of the conventional explosive techniques that were used in the first atomic bomb in 1945. He was President Eisenhower's second science advisor and was prominent in the Scientists and Engineers for Johnson and Humphrey movement in 1964. (*New York Times;* 1 March 1968)

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A UN study of the world social situation in 1967 is gloomy: the rich are still getting richer, the poor relatively much poorer, and population growth is outstripping food production and other resources needed to sustain life. The UN study is the first of a series of reports to be presented every three years under the auspices of the Economic and Social Council. The report reinforces the frequently noted point that improvements in medicine and health have the effect of making certain problems worse by increasing average life span—and thus population—in poor countries.

Although generally gloomy in tone the report finds a few causes for limited optimism. Development plans are getting better and more realistic, and incorporating more technical refinements. Some developing countries, including India and the United Arab Republic, have recognized flaws in earlier plans and scrapped them in favor of better ones. (*New York Times;* 31 January 1968)

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The Soviet manned space program may be picking up speed. Soviet space officials may be emerging with renewed confidence from a year of trouble, including the death of a cosmonaut in a crash landing last April. They may be poised for a stepped-up drive leading to a manned flight around the moon, possibly by the end of this year. These are conclusions from recent conversations American scientists have had with their Soviet counterparts, informed guesses by American officials, and some hints from well-informed Soviet sources.

The Soviet plans may be along the following lines: A manned, earth-orbiting flight of the Soyuz space craft, in which astronauts could practice rendezvous and docking, could come in the next two or three months. An unmanned flight of the Soyuz around the moon and back to earth might come some time this Summer. A manned circumlunar flight, but without a landing, could come some time this Fall, if the preceding missions go well.

There is no informed speculation on the possible timing of a Soviet attempt to land men on the moon. Despite the fatal Apollo fire in January 1967, the U.S. still hopes to put men on the moon and return them to earth by the end of 1969. The U.S. schedule now calls for another unmanned Saturn V rocket test late in March, the first flight of astronauts in the Apollo space craft in earth orbit about August, and some time after that the first manned flight including all the vehicles for the moon mission—the Saturn V, the 16-ton Lunar Module, and the Apollo. Under present plans, no U.S. circumlunar flight would precede the landing mission.

In recent Congressional testimony, NASA Administrator James E. Webb said that the Russians could be expected soon to test a much larger rocket, possibly one with 10 million pound thrust, compared with the Saturn V's 7.5 million pounds. If the Soviets do not employ high-energy liquid hydrogen fuel—and so far as anyone knows they have not yet developed such a rocket, which the U.S. now uses in the two upper stages of Saturn V—they would need about 10 million pounds thrust in the first stage to compete with the Saturn V's 7.5 million pounds. *New York Times;* 18 February 1968)

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Chinese scientists may still be too "revisionist" and therefore lagging both politically and technically. A Chinese newspaper that has traditionally given advance hints of the twistings and turnings of the Chinese cultural revolution drew attention to a present phase of the revolution involving research workers. The aim of Peking seems to be on two objectives: to halt any mass exodus of highly trained people from Chinese research institutes, and to develop what is labeled a socialistic system of scientific research. There has been a continuing feud in China over whether intellectuals should put their work ahead of party endeavors. One Peking wall poster—apparently one of the more effective means of keeping up with the cultural revolution in China—asks "If things go on like this, how can our scientific research work serve proletarian politics and how can we develop socialistic scientific work with greater, quicker, better and more economical results, and catch up with and overtake the advanced world levels in the shortest time?" A newspaper article suggested these steps for research institutes: scientists and technicians should follow the mass movement of studying and applying Mao Tse-tung's work and strengthening the Communist Party cells in institutes; the "revolutionary masses" must be more energetic in making exposures and complaints to eliminate "revisionist and capitalistic practices"; and scientific leadership must be strengthened to "really grasp scientific research work by putting revolution in command of professional work." *New York Times;* 4 February 1968)

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The French Government may soon announce a decision to build ICBM's. These missiles, hinted at in a statment by Defense Minister Messmer, would be the fourth generation of the controversial French nuclear force and would be a major expansion of that force. Messmer declared that France had reached the point where, for technical and financial reasons, a decision had to be made so that the ICBM program could be started in 1970 and completed by 1980. The statement is regarded as an effort to prepare public opinion for a definite announcement, which will mean substantial new funds for the nuclear program at the expense of both civilian uses and conventional armaments. Messmer wrote that the nuclear striking force, formed through President de Gaulle's initiative had become "an irreversible, accomplished fact." He continued: "Nobody will throw our atomic bombs on the scrap heap. Nobody will transform our nuclear submarines into diesel-driven submarines. Nobody will shut down Pierrelatte [the plant that produces enriched uranium for French weapons], and nobody will make France re-enter NATO."

Messmer's article is the third statement in as many months about the need for expanding France's "force de frappe." The first generation of French nuclear forces, now operational, consist of about 50 Mirage IV supersonic bombers carrying weapons of about 50 kilotons. The second generation consists of 27 intermediate-range ballistic missiles, capable of carrying 100 or 200 kiloton warheads about 1,800 miles. These missiles will be operational, in silos in southeastern France, in 1970. The third generation of the nuclear force will consist of nuclear submarines carrying ballistic missiles with warheads of about half a megaton and a range of 1,500 miles. The French ICBM's, now evidently planned, would be the fourth generation of the nuclear force and would come into operation about 1980. *New York Times;* 28 February 1968)

The scientist-astronauts want more time for research. NASA, faced with the prospects of astronauts who think they have to spend too much time on flight training, is looking for a way to give its 16 scientist-spacemen the best of both worlds. Dr. Curtis Michel, a physicist and a member of the first scientist-astronaut group chosen in 1965, has asked for one-year leave-of-absence to catch up on astrophysical research and teach a course at Rice University where he taught before he joined the space program. Curtis' request was apparently turned down at first but is now being reconsidered.

A second group of scientists, selected as astronauts last August, are in their year of jet pilot training which they must complete before they do anything else. An apparent cause of the scientist-astronauts' concern is the slow-down in the space flight schedule. Congressional cuts have reduced or postponed the science-oriented space flights that attracted scientists to the astronaut corps in the first place. The earliest scientific flight now planned is an embryonic space station in 1970-71, with a sun-watching telescope. (*New York Times;* 11 February 1968)

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Significant progress on controlled thermonuclear fusion was reported at the American Physical Society meeting at the end of January. Specifically, it was suggested that within three to five years enough should be known to select the single most practical route for harnessing the energy of the hydrogen bomb. Once the best path toward controlling fusion reactions is identified, it should be possible to put the resources now going into exploring many different possible routes—totaling about $25 million a year in the U.S. alone—into a single, intensive development effort.

Current optimism on the possibilities for thermonuclear power depends chiefly on progress in the design of "magnetic bottles." Experiment and theory have now progressed to the point where "bottle" design can be undertaken much more systematically than before. But it was pointed out that a long period of reactor development would have to follow any laboratory achievement of fusion, and that this stage might take another 20 to 30 years. Probably fusion reactors, to be economical, will have to be huge, generating more than a billion watts of power. Controlled thermonuclear fusion holds out the possibility of electric power so cheap as to bring about an economic and social revolution. (Walter Sullivan in the *New York Times;* 4 February 1968)

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The U.S. has discontinued airborne alert flights with nuclear weapons. The major Defense Department policy change occurred after the highly publicized crash in Greenland of a B-52 bomber carrying four hydrogen bombs. It is reported that outgoing Secretary of Defense McNamara ordered the nuclear weapons taken off the flights a day or two after the Greenland crash on January 22nd. The strategic Air Command continues to conduct airborne alert training flights with the B-52 jets, but nuclear weapons are no longer carried on these missions.

The most highly-publicized crash of a U.S. bomber carrying nuclear weapons occurred over the Spanish coastline two years ago. One of four hydrogen bombs fell into the sea and was finally dredged up after a month's-long effort. "Informed sources" placed the number of nuclear armed bombers recently kept aloft under the airborne alert system at "less than six." The airborne alert was first announced by the U.S. in January 1961, at the start of the Kennedy Administration. Except for the 1962 Cuban crisis, it is believed that the airborne alert has been gradually curtailed since then as the U.S. strategic weapons emphasis has shifted from bombers to missiles. (*New York Times;* 29 February 1968)

A showdown between Congress and the Defense Department over nuclear powered surface ships may be approaching. At issue is a Congressional demand last year that the Defense Department construct two nuclear-powered frigates unless President Johnson ruled that such a step would "not be in the national interest." The President may be considering just such a step. But Representative L. Mendel Rivers, the South Carolina Democrat who is Chairman of the House Armed services Committee, has said that he may block authorization of any major defense budget items until either the Pentagon contracts to build the two ships or the President declares them not in the national interest. Rivers has crossed swords frequently with outgoing Defense Secretary McNamara. The complexion of the issue may change with the new Secretary, Clark Clifford, in charge of the Defense Department. (*New York Times;* 9 February 1968)

The Joint Congressional Committee on Atomic Energy is also pressing the Defense Department to build more nuclear-powered ships. The Committee, long a supporter of nuclear power for Navy ships, has criticized the Defense Department for delay in building both nuclear submarines and surface ships. It suggested that Congress should take the initiative in overturning Defense Department policies and specifying that all future escort ships for naval striking forces should be nuclear powered. The Committee presented its views, highly critical of Defense Secretary McNamara's policies, in a foreword to a 505-page study of the Navy's nuclear propulsion program. The Committee made public testimony earlier in February by Vice Admiral Hyman Rickover, Director of the Naval Reactor Program, in which Rickover predicted that the United States would lose its numerical advantage over the Soviet Union's nuclear submarines "in a few years." Rickover said that while the Russians experienced technical difficulties with their earlier nuclear submarines, they are overcoming these problems and are now building at an increased rate.

The U.S. now has 74 nuclear submarines in operation, including 41 missile-firing Polaris submarines. Thirty-three more submarines have been authorized, but no more polaris submarines are planned. The Soviet Union now has some 55 nuclear submarines and is reportedly adding to the fleet at the rate of about five per year. (John W. Finney in the *New York Times;* 26 February 1968)

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The Dutch are reported to have made newly significant progress on uranium isotope separation by centrifugation. The centrifugation process, mentioned in various news reports in the last few years, could be substantially cheaper than the gaseous diffusion process used by the major nuclear powers. A Dutch Government announcement said that in 1961 the Netherlands, Britain, and West Germany had made a secret pledge to the U.S. not to divulge any secrets on new atomic projects to other countries, but that the Dutch Government may now seek a revision of the agreement to enable it to cooperate with other countries in the production of fissionable material.

It was reported in Washington that Administration officials had received no indication that the Dutch Government wished to modify the 1961 secrecy agreement controlling, among other things, information about centrifuge technology for uranium isotope separation. AEC officials, who have been kept informed of the Dutch work, said that they were not aware that Dutch scientists had scored a "breakthrough" in the centrifuge process. But the U.S. impression was that the Dutch work had proceeded to the point where a feasibility study on building a pilot plant might be undertaken. It was suggested that the Dutch interest lay more in producing enriched uranium for fuel rather than for weapons. Reactor fuels require enrichment only to a few percent of uranium 235; weapons need much higher enrichment, in the range of 90% or more.

The U.S. is known to be pursuing work on centrifuge technology, but such work is classified. The U.S. has enough large gaseous diffusion plants to meet its fissionable materials needs and has no particular incentive for developing a new process for uranium isotope separation. (*New York Times;* 1 March 1968)

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"The Coupling of Physics and Society in the 70's" formed the subject of a lively panel discussion at the Chicago meeting of the American Physical Society at the end of January. The session was chaired by John A. Wheeler of Princeton. Harvey Brooks of Harvard noted that from the start of World War II to the early 1960's there was a "marriage" between physics and the national establishment, stemming from wartime needs such as radar and the atomic bomb and continuing with post war development such as the transistor. Brooks suggested that the marriage is not moving toward divorce, but said that the current disenchantment is deep. There appears to be, he said, "a revulsion against science by the whole society, but especially among young people." Brooks noted a decline in graduate enrollment in physics.

Louis M. Branscomb of the National Bureau of Standards pointed out that the fraction of students who take physics in high school dropped from 23% in 1890 to less than 5% in the 1960's. Fred Hoyle of Cambridge University noted what he called the growing remoteness of physics from everyday experience. The search for a satisfactory theory of nuclear particles which depends heavily on "current algebra," a branch of mathematics that is obscure to all but a few specialists, was cited as one illustration of this remoteness. Branscomb suggested that the answer to the "question of relevance" is for physicists and scientists in general to enter vigorously into the national life. "It is clear," he said, "that the present planning mechanisms of government, both legislative and executive, are not adequate to the task of forseeing the future consequences of present decisions." He proposed, as a possible solution, combining the NSF with various national laboratories to form a National Science Policy Agency. (Walter Sullivan in the *New York Times;* 4 February 1968)

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The federal budget for fiscal year 1969 includes $25 million for the 200 GEV accelerator to be built at Weston, Illinois. Plans for the new accelerator were outlined at the Chicago meetings of the American Physical Society by Robert R. Wilson, Director of the project. Some 2000 people will be needed to man the machine, including a normal complement of about 400 visiting scientists. The project is administered by the Universities Research Association, representing some 48 universities. The total cost of the machine is expected to be about $250 million, with an added $60 million for experimental equipment and other facilities. An initial appropriation of $75 million had been sought, but in view of the current budget squeeze, the project leaders are pleased to receive a third of that sum. Construction will not begin until Congress has voted the appropriation, which it is hoped will come by early fall.

Wilson observed, in a talk to the Physical Society, that "I have found that it is easier to accelerate particles than society." Until the Weston machine goes into operation, the Russians will have a significant lead in experimental high energy physics with their 76 GEV machine at Serpukhov. But Wilson observed that sooner or later "escalation to the international level" in high-energy accelerators seemed inevitable. (*New York Times;* 31 January 1968)

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Benefits to the U.S. and to other countries from the practical application of space satellites are potentially very great—on the order of billions of dollars a year. But the realization of these gains will depend on extensive and coherent programs of development at home and, because satellite systems are essentially global in character, on the solution of complex practical and political problems at the international level. These are among the major conclusions of a National Academy of Sciences report issued in February by the National Aeronautics and Space Administration. The report is based on the first phase of a two-part summer study of space applications.

The report predicts sizable economic gains from the use of satellites in such fields as public communications, long-range weather forecasting, map making, global crop yield surveys, and natural resources management. Direct benefits from reliable two-week weather forecasts alone are estimated in the range of $1 billion a year. Among other things, the report recommends a doubling in fiscal 1969 of that portion (two percent) of NASA's budget which is presently allotted to development of such satellite applications. (*News Report,* National Academy of Sciences; February 1968)

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A moon-orbiting Soviet satellite will carry French equipment. The Soviet-French agreement is the third joint space project planned by the two nations. Together, these projects represent the most significant space cooperation arrangements that Russia has established with any country. The other two projects plan for a Soviet-built rocket to launch a French-built satellite, probably in 1972; and use of Russia's Molniya communications satellite to exchange experimental color television broadcasts.

Russia is not known to have any cooperative space projects with non-Communist nations, except for these plans with France. By contrast, the United States has cooperative arrangements with about 70 nations on space projects. Soviet-U.S. agreements all involve exchange of information— not joint use of space hardware. (*New York Times;* 18 January 1968)

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The AEC has released a new summary on U.S. nuclear power plants. As of 31 December 1967, the status of all nuclear power plants, and their capacity in *millions of kilowatts* (shown in parentheses) was as follows: 16 in operation (2.8); 21 under construction (14.7); 40 planned (reactors ordered) (32.2); 12 planned (reactors not ordered) (10.1). These numbers total nearly 60 million kilowatts. Conventional power plant capacity in 1967 totaled about 263 million kilowatts; but in 1967 the output of planned nuclear plants exceeded that for planned conventional plants for the first time. Geographically, the nuclear power plants, both built and planned, are concentrated in the Northeastern U.S., with a few plants in the South, and several in California but very few in the Midwest. (*AEC Release;* 11 January 1968)

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The AEC will shut down two more of its plutonium producing reactors, one at its Hanford plant near Richland, Washington, and the other at the Savannah River plant near Aiken, S. C. The shut-downs will save about $25 million per year. The AEC will have remaining in operation four production reactors at Richland and three at Savannah River. Since 1964 the Commission has shut down four reactors at Richland and one at Savannah River. The AEC says that these actions "reflect the restraint being exercised by the U.S. in production of materials for weapons." (*AEC Release;* 18 January 1968)

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India may be the first developing country to orbit her own artificial satellite for bringing television to millions. The feasibility of a pilot project to orbit a communications satellite was recently confirmed by a special five-man mission of the United Nations Educational, Scientific and Cultural

Organization (UNESCO). The team spent three weeks in India last November and will soon make a number of recommendations to the Indian Government. The satellite, which would require India's entering into a bilateral agreement with a major space power would cost about $35 million. It would be placed in a synchronous orbit and would relay TV signals to ground stations spread over the whole sub-continent, comprising India, Pakistan, and Ceylon. With 160 ground stations, the Indian Government could reach 80% of its population. Fifty-six stations would reach 25% of the Indian population. The team recommended that India produce 50,000 home TV receivers by 1970 or 1971, and this is within the capability of Indian manufacturing technology. So far India has only one TV station, located in New Delhi. The Indian satellite would be a "distribution" satellite, with more power for relaying TV signals than the current "point to point" satellites such as Early Bird. Although a distribution satellite is itself more complex and costly, it can utilize much simpler and cheaper ground facilities, and would in the long run probably cost India substantially less than any other nationwide TV system. (*New York Times;* 28 January 1968)

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Weather prediction may undergo a "quantum jump" in reliability in about another decade. This is the consensus of experts of the American Meteorological Society, meeting in San Francisco at the end of January. Within the last few years weather prediction has progressed from the "showers likely tomorrow" stage to the "there's a 75% chance of rain tomorrow" stage, but there is still a long way to go. One "great step forward" will be the Global Atmosphere Research Program that 130 nations are planning through the world meteorological organization. This will involve a concentrated effort for six months in 1976-77 to collect all the information needed for accurate forecasting of any area's weather two weeks or more ahead. Among other results, this will test the facilities that would be needed around the world to put such forecasting on a permanent basis. Present weather forecasting limitations stem from the fact that over major portions of the earth there are only about 20% of the observations necessary for good forecasting, and from the limitations of present computers. Data processing capacity probably needs to be improved by about two orders of magnitude over the largest computers available today, but such an improvement may come in about the next decade. The data collection problem can be handled in various ways: weather ships or automated buoys, satellite observations, more weather balloons, and systematic reporting from commercial airliners. At any rate, it is estimated that both the data collection and processing problem can possibly be solved in a period as short as the next ten years. (*New York Times;* 1 February 1968)

The American Institute of Physics is tackling the growing traffic jam in physics information. A $1 million program, begun with a $239,000 grant from the National Science Foundation, will assess a variety of computer techniques, data search ideas, and distribution methods. The number of pages reporting physics research published annually is doubling about every ten years. The AIP project will study ways in which physics information is communicated, including journals, pre-prints, telephone calls, personal visits, and professional meetings. The AIP says that the rapid growth of published literature "threatens a breakdown in communications among scientists." The two-year program will involve two parts. One part will focus on the analysis and retrieval of physics knowledge with computers. The other part will involve a "systems analysis" directed toward a nationwide information program. The development of classification ideas for automatic information searching and journal indexing will be explored, along with the optimum use of computers for information dissemination in general. (*New York Times;* 28 January 1968)

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The NSF has formed a special Commission on the social sciences. Its job will be to devise better ways of deriving practical benefits from social scientific research results, and to apply social research to public problems. The Commission is made up of six members from the universities and business. In announcing the Commission's formation, the NSF noted the vigorous growth of basic research in social and behavioral science and "the need to increase the nation's capacity to use knowledge thus gained." (*Washington Post;* 1 February 1968) (*In view of the long history of confusion and effective inactivity of the NSF in the social science area, it certainly remains to be seen whether another special commission will accomplish much—HLP*)

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A large area of the western U.S. was shaken by an underground nuclear explosion. The January 19th explosion of nearly a megaton yield—perhaps the biggest yet in this country—swayed buildings hundreds of miles away after it was set off near Hot Creek Valley, in central Nevada. The AEC is known to be seeking sites for explosions larger than are now possible at its usual Yucca Flat test site near Las Vegas. The one megaton blast was noticeable as far away as Los Angeles, Salt Lake City, and San Francisco. (*New York Times;* 20 January 1968)

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