Fermi Prize: J. Robert Oppenheimer Named to Receive Annual AEC Award

The White House announced last week that J. Robert Oppenheimer would be the recipient of the Atomic Energy Commission's 1963 Fermi prize. The prize, which is accompanied by a $50,000 award, is given for "especially meritorious contribution to the development, use or control of atomic energy," and, as such, is strictly a recognition of scientific merit. This fact cannot be overstated. Nevertheless, because of the bitter and emotional controversy that surrounded the removal of Oppenheimer's security clearance in 1954, the Oppenheimer case has come to symbolize the dark hour to which nonconformity and scientific integrity were subjected in the McCarthy era. Oppenheimer's selection for the award is thus widely regarded as an effort by the scientific community and the Kennedy administration to right a long-standing wrong. The following account is an appreciation of Oppenheimer, written especially for SCIENCE *by his colleague, Hans Bethe, of Cornell University.*

The General Advisory Committee of the Atomic Energy Commission has made an excellent choice in awarding the Fermi prize for 1963 to J. Robert Oppenheimer.

Oppenheimer was the wartime director for the Los Alamos Laboratory, which was responsible for developing the atomic bomb. Without this development, atomic energy would not have attained the prominence it now has, and neither the AEC nor its General Advisory Committee would be likely to exist.

Oppenheimer, as the director, was the true leader of the Los Alamos Laboratory. He had complete technical understanding of all phases of the laboratory work—work which ranged all the way from theoretical physics to the precision casing of high explosives, from machine-shop work on precious and dangerous radioactive materials to analytical chemistry on minute trace elements. Probably he was the only one in the laboratory who was familiar with all these problems, and probably he was the only one who could be, thanks to his wonderfully quick mind.

Everybody who had known Oppie before Los Alamos knew his quick mind and his knowledge of physics, so that it was perhaps not too great a surprise to find that he would be a great technical leader. But the director of Los Alamos also had to take a lot of tough administrative actions. The most important, perhaps, were the decisions on which of the several possible methods for assembling an atomic bomb should be selected and on how to distribute the emphasis of the work. It is very easy to run a scientific development laboratory by pursuing all ideas which do not seem completely absurd. This keeps all the scientists happy who propose ideas, and at present some laboratories are run on just this principle. But in wartime we could not afford such luxury. Even though many of the ablest scientists were assembled at Los Alamos, we still had severe limitations of manpower, and we had to deliver an atomic weapon as quickly as possible—in other words, as soon as enough fissionable material was available. Oppenheimer was equal to the task. He made the correct technical decisions, and even in retrospect, one can see that he made them at just about the optimum time. There was often opposition to such decisions within the laboratory, but they were carried out. When necessary for the progress of the work, a new division of the laboratory was started—for instance, the Explosives Division under Kistiakowsky, when it became clear that the most promising method of assembling an atomic bomb was the implosion. Similarly, to make the many physical experiments required to observe the details of the implosion, the Bomb Physics Division was established under Bacher. Though he had the advice of others, it was up to Oppenheimer to make these administrative changes.

One of the factors contributing to the success of the laboratory was the fact that Oppenheimer organized it in a very democratic fashion. There was the governing board, consisting of the division leaders (about eight of them), in which questions of general and especially technical laboratory policy were discussed. The coordinating council included all the group leaders, about 50 in number, and kept all of them informed on the more important technical progress and problems of the various groups in the laboratory. All scientists having a B.A. degree were admitted to the colloquium in which summary talks about laboratory problems were given. Each of these three assemblies met once a week. In this manner everybody in the laboratory felt a part of the whole and felt that he should contribute to the success of the program. Many ideas were contributed in these sessions, but it was Oppenheimer who sorted out the good ones and saw to it that they were pursued.

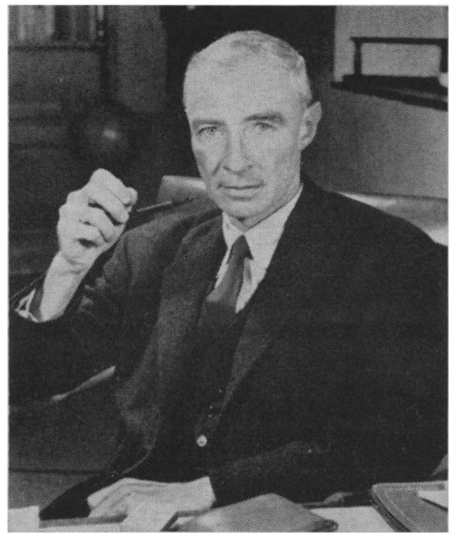
When Los Alamos was planned it was believed that the chief questions were in nuclear physics, and the staff was chosen accordingly. But the main problem was really to assemble the fissionable material in the bomb sufficiently rapidly. Otherwise, a stray neutron might start a chain reaction before full assembly, which would greatly diminish the energy yield. The first assembly method called for a gun to shoot one subcritical piece of fissionable material into another. Calculation showed the gun to be satisfactory for uranium-235 if this material could be purified of all traces of light elements, down to a few parts per million or less. Both the chemistry and the engineering work were successfully accomplished for the Hiroshima bomb.

But it soon turned out that in plutonium, even the best purification would not reduce the number of neutrons to a tolerable level because the isotope Pu^{240} emits neutrons continually in spontaneous fission. A faster method of assembly was therefore required, and this was available in the suggestion, made previously, of using high explosives to "implode" a plutonium sphere. Enormous technical difficulties had to be solved in developing the implosion, and even in finding out whether success had been achieved. Had the sphere remained a sphere under the impact of the explosive? It was difficult to look into it. This illustrates the need for constant shift of technical emphasis for decisions on whether to pursue a seemingly impossible program against a deadline. Opinions of the laboratory scientists naturally differed, and it was the director's job to decide. He also had to de-emphasize work that was not absolutely essential. So the H-bomb, conceived a year before Los Alamos was started, had to take a back seat. The distribution of effort and emphasis at Los Alamos was as nearly perfect as I have ever seen it in a big laboratory, and I have seen and worked in many such laboratories since the war.

After the war Oppenheimer stayed in close touch with atomic energy. He had been greatly impressed by Niels Bohr's ideas about the need to have atomic energy become international, so as to avoid future atomic wars. He became a member, perhaps the driving spirit, of the Lilienthal committee which formulated this country's plan for an international authority to control all atomic energy work. The plan emphasized the need for a positive task for the international authority. It should develop atomic reactors for power and other peaceful uses and also atomic weapons if desired; it should not have merely the function of a policeman preventing individual nations from developing atomic energy and weapons on their own. This wise plan was endorsed by a State Department committee under Acheson and became official U.S. policy. It was presented to the United Nations by Baruch but unfortunately was totally rejected by the U.S.S.R.

Oppenheimer gave counsel to the newly established AEC, as the chairman of its first General Advisory Committee. The GAC recommended an extensive research effort by the AEC which contributed greatly to the present preeminence of the U.S. in high-energy and nuclear physics. National laboratories like Brookhaven, Oak Ridge, and Argonne were established during this period, and the Berkeley Radiation Laboratory was strongly supported. In these years the groundwork was laid for the development of nuclear power reactors by the AEC. The main task of AEC and its GAC was to ensure an ample supply of fissionable material for reactors, as well as atomic weapons, by constructing production facilities. Thanks to this effort we are now living in an age of atomic plenty.

Before the Los Alamos years Oppenheimer had had a brilliant career



J. Robert Oppenheimer

as a theoretical phsyicist. In his early years he found, together with Born, the fundamental approximation for the treatment of molecules in quantum mechanics—namely, the separation of the electronic state of the molecule from the relatively slow vibration and rotation of the nuclei. Back in the 1920's he made the first quantum-mechanical calculation of the opacity of hydrogen at very high temperatures. For many years astrophysical evidence seemed to contradict his results, until it was found that the fraction of hydrogen and helium in the stars had been greatly underestimated, and that Oppenheimer's theory was correct.

In 1928 Dirac wrote his famous paper on the relativistic wave equation of the electron, and in 1930 he advanced the hypothesis that the vexing negative-energy states predicted by that equation were all normally occupied, except for a few which he assumed to be protons. Oppenheimer quickly showed that this last hypothesis was untenable but that the holes must have the same mass as an electron. This led to the theoretical prediction of the positron, discovered 2 years later by Anderson. Almost immediately Oppenheimer and Plesset found a theory to account for the production of a pair of positive and negative electrons by gamma rays. Much of Oppenheimer's work in the 1930's was devoted to the understanding of radiation and pair production at high energy. He and his collaborators developed an elegant theory of electron showers which explained the soft component of cosmic radiation. Others of his school calculated the radiation from a particle of spin 1 and demonstrated that μ mesons, the main penetrating component of cosmic rays, cannot have so large a spin.

All the time he was concerned with the most fundamental questions. In the 1930's he was worrying about the problem of divergences of quantum theory at high energies. This concern for the fundamental difficulties of physics he communicated to his students. He never gave them the easy and superficial answers but trained them to understand the deep problems. He held two professorships, at Berkeley, and at Pasadena. Many graduate students passed through his school, and all of them, theorists and experimenters, remember the profound and challenging lectures he used to give. Here was a man who understood physics very deeply but who still found that there were far more open questions than answers. It is no wonder that more students of Oppenheimer's later became prominent physicists than of any other teacher in the United States.

The tradition of California in the 1930's was continued at the Institute for Advanced Studies at Princeton when Oppenheimer became its director in 1947. Ever since, the Institute has been a gathering point for ambitious young theoretical physicists—now Ph.D.'s rather than graduate students. There are also many prominent scientists, both on the permanent staff and among the visitors. The group is international and includes physicists from Great Britain, France, Italy, Germany, Japan, and many other countries. Just like Berkeley before the war, the Institute concentrates on the most challenging problems of theoretical physics, especially field theory and fundamental particles. Much of the progress in these fields has come from the Institute, and most of the leading younger theorists have gone through the Institute at some time in their life. Oppenheimer, while not publishing much himself, is following all the exciting developments from year to year, and his advice and criticism have stimulated many; he sets the taste and style of the work.

Oppenheimer's love for the fundamental problems also shows in his work outside physics, in his few but profound talks and publications on general problems of the time. He is one of the most educated men I know, combining all of a classical scholar's knowledge with that of a scientist. He is a master of language; it is an experience to listen to him, in private conversation as in lectures.

In the years immediately after the war Oppenheimer became much involved in giving advice to the government, especially on defense problems. While he advised that our atomic armaments be efficient and strong, he belonged to the group which advocated restraint in this field. With many others he advised against exclusive emphasis on the strategic use of large atomic weapons and for more emphasis on tactical warfare and air defense. The battles he fought are still going on.

The most famous advice was the recommendation of the GAC late in 1949 against a U.S. crash program to develop the hydrogen bomb. After a bitter fight President Truman decided for the H-bomb program. This fight left its mark, as did Oppenheimer's earlier and subsequent recommendations against overemphasis on strategic atomic weapons. In 1953, under the influence of the McCarthy madness, the government withdrew Oppenheimer's clearance for secret work for the Defense Department and the AEC. Oppenheimer requested and obtained a hearing. The transcript has become one of the most widely read of political and military documents. From the testimony of over 20 witnesses, American and foreign readers could form a rather complete picture of the development of U.S. defense thinking in the early postwar years.

The hearing board, with a majority of 2 to 1, and then, on Oppenheimer's appeal, the AEC, with a vote of 4 to 1, decided that Oppenheimer could no longer be cleared for secret information. Oppenheimers' opinions on defense matters, while presumably the cause of the attacks on him, did not constitute legal reasons for withdrawing the clearance. Instead, the decision, especially of the commission, was based on early associations of Oppenheimer's with Communists. The main argument was that in 1942 when Oppenheimer had been asked to reveal secrets of the electromagnetic separation of uranium isotopes to the Russians, he had given to the FBI the name of the person who originated this request but not the name of the personal friend who had transmitted it. Of course Oppenheimer had refused to give any information to the Russians.

I could not understand then, and I cannot understand now, how anyone could argue that this misdemeanor of Oppenheimer's, being then 12 years in the past, could justify the withdrawal of his clearance.

The award of the Fermi prize recognizes the outstanding merit of J. Robert Oppenheimer in connection with the development of atomic weapons in wartime Los Alamos and in advising the government on the further development of atomic energy for war and peace afterward.

It also recognizes his stature as a physicist who has greatly influenced theoretical physics and who has, through many years, led the most important school for theoretical physicists in America. By this award the U.S. Government has shown, though somewhat belatedly, that it can recognize unusual merit regardless of political controversy

World Atom Agency: Negotiations on Indian Reactor Hold Promise of Brighter Future for IAEA

United Nations, New York. Prospects appear to be brightening for the International Atomic Energy Agency (IAEA) to come out of the wings and play a significant role in the promotion and safeguarding of nuclear energy.

IAEA has a long way to go before it will attain the position envisioned for it in the Atoms for Peace proposal that led to its founding. But despite gloomy forecasts that were made toward the end of last year, it now seems that the Kennedy administration has resolved whatever doubts it may have had and is pushing a number of measures aimed at strengthening the organization.

For reasons that are rooted in IAEA's beginnings, the critical issue now facing it is the matter of safeguards for a 380-megawatt power reactor that the Indian government is planning to buy in this country (*Science*, 14 December). IAEA's *raison d'être* was to provide assurance that the spread of nuclear power would not be accompanied by the spread of nuclear weapons, and throughout its 6-year history the agency has sought to win acceptance as the international organ for making certain that power reactors were not diverted to the production of weapons-grade plutonium. So far it has failed to win such acceptance, largely because nuclear power has come along far more slowly than was anticipated, but also because most nations, the U.S. included, are not eager to have international inspectors poking around their atomic installations. The projected Indian reactor is of especial significance because it will be the first reactor with weapons potential to be placed in the hands of a nuclear have-not. Thus, IAEA has looked with especial concern on the safeguards issue, and it was understandably demoralized to learn that the Indians were opposed to IAEA safeguards and that the United States was willing to consider applying safeguards on a bilateral basis. It is on such a basis that the United States has provided nuclear materials for some 40 nations, but the very size and potential of the Indian reactor made this particular case a critical crossroads for the agency.

Against this background, deep fears were aroused in the agency's supporters last December when Harlan Cleveland, Assistant Secretary of State for international affairs, stated that the United States "preferred" international safeguards but was not rigidly tied to this principle. His remarks caused some supposedly knowledgeable people to predict that IAEA was bound for ruin, but there appears to be little basis for such despair.

Negotiations between the United States and India have been going on over the past several months, and while no firm results have yet been attained, the United States has been pushing hard for IAEA safeguards and is reasonably optimistic that some arrangements beneficial to the agency can be worked out.

In addition, a seven-nation committee is now meeting in Vienna to discuss raising the 100-megawatt (thermal) limit on IAEA safeguards, presumably in anticipation of the Indian reactor. The limit has given the major powers a seemingly sound technical excuse for not accepting IAEA inspection themselves, but now that a power outside the nuclear club has prospects of obtaining a major reactor, proposals to remove the limit have gained momentum.

And finally, the United States is prodding its bilateral partners in nuclear affairs to replace American safeguards with IAEA safeguards. This is difficult business to negotiate, since many smaller nations regard IAEA inspection as a sign of second-class status, but an effort is being made to convince them that it doesn't hurt to do business with IAEA, and administration officials are optimistic that they can swing some of the bilaterals over to the international organization.—D. S. GREENBERG