Atomic bomb test at Eniwetok Atoll in 1948—"very encouraging."

Our Progress in Atomic Energy

by ROBERT F. BACHER

A leading physicist—and former member of the Atomic Energy Commission— answers some pertinent questions concerning the future of atomic energy.

IT IS NOW nearly seven years since the first controlled chain reactor started operation. It is over four years since the first atomic bomb was exploded. Perhaps more important—it is just a little more than a month since the President announced that an atomic explosion had taken place in Asia. You may ask: "How are we getting ahead with the development of atomic energy? Where do we stand today in the development of weapons and atomic power? Are we going to get a new source of electrical energy soon? What are other countries doing about atomic energy?"

These are some of the questions that are often asked, and I shall try to give some answers to them.

During the war the atomic energy enterprise was aimed solely at the development and production of atomic weapons to use in the war. This enterprise, as you may recall, was based upon the fundamental scientific discovery of fission of the nucleus of the uranium atom in 1938, and upon a number of later discoveries that showed how this fission took place and what happened when the uranium nucleus did divide.

By the end of 1941 a considerable amount of scientific work related to fission was going on in this country. By the end of 1942 the first controlled chain reactor had been put into operation. During 1943 tremendous plants were constructed for the separation of the vital com-

ponent, Uranium 235, from ordinary uranium and for the production in reactors of a new element hitherto unknown in nature—plutonium. These elements were destined to become the critical materials of the atomic bomb. Also during 1943 a laboratory was built, staffed, and put into operation in a remote region of New Mexico for the development of the bomb itself. All of this happened in a little more than four years.

In the development of the atomic bomb everything was sacrificed for speed. The whole enterprise was undertaken on a wartime basis. Industrial companies were pressed into the development work, and into the construction program and production operation, with promises that they would be relieved at the end of the war. Personnel for technical and scientific work was borrowed from many different types of organizations. A large fraction of the experienced personnel was obtained on a loan basis for the duration of the war.

As a wartime project this worked and resulted in the development in 1945 of a successful atomic weapon. But at the end of the war the whole project started to fall apart. This was more or less inevitable from the way it had been set up. Industrial companies wanted to be relieved of their responsibilities; scientists wanted to go back to their peacetime work; technical experts from various industries and research laboratories were called home. In addition, there was great uncertainty as to what would happen to the atomic energy project, and this was being debated vigorously in Washington.

The discussions in Washington led to the passage of the McMahon Act or Atomic Energy Act, in the summer of 1946, establishing an Atomic Energy Commission. This commission, appointed by the President, took office in November, 1946, and assumed control of the atomic energy project at the beginning of 1947. During 1946, amid all these uncertainties, the atomic energy project continued to disintegrate.

When the Commission took over, on January 1, 1947, it was indeed a sad situation that we found. Although I had had a rather close connection with the atomic energy project during the war years, I was deeply shocked to find what our position was on weapon development and production. Our development work was going slowly, hampered by many difficulties; our stock of bombs and production rate were frighteningly low.

Workers' homes at Los Alamos atomic weapons plant.

In the production of Uranium 235 the situation, while by no means excellent, was in very much better shape. But in the production of plutonium there was another emergency. According to the experts, the big reactors or atomic furnaces which had been built to produce plutonium at Hanford, Washington, on the Columbia River, were in bad shape and getting worse fast. No one was optimistic about how long they would last. It was essential to find ways of stopping this deterioration, and to ensure that the country would not be left without means of producing plutonium.

In research in the various sciences associated with atomic energy, the end of the war brought temporary confusion and a great deal of readjustment. The research and development work needed strong encouragement, but efforts in this direction had to await the solution of the emergency problems in weapons and production. Although we had available to us many of the necessary ingredients for producing new types of nuclear reactors, this development work had to take second priority.

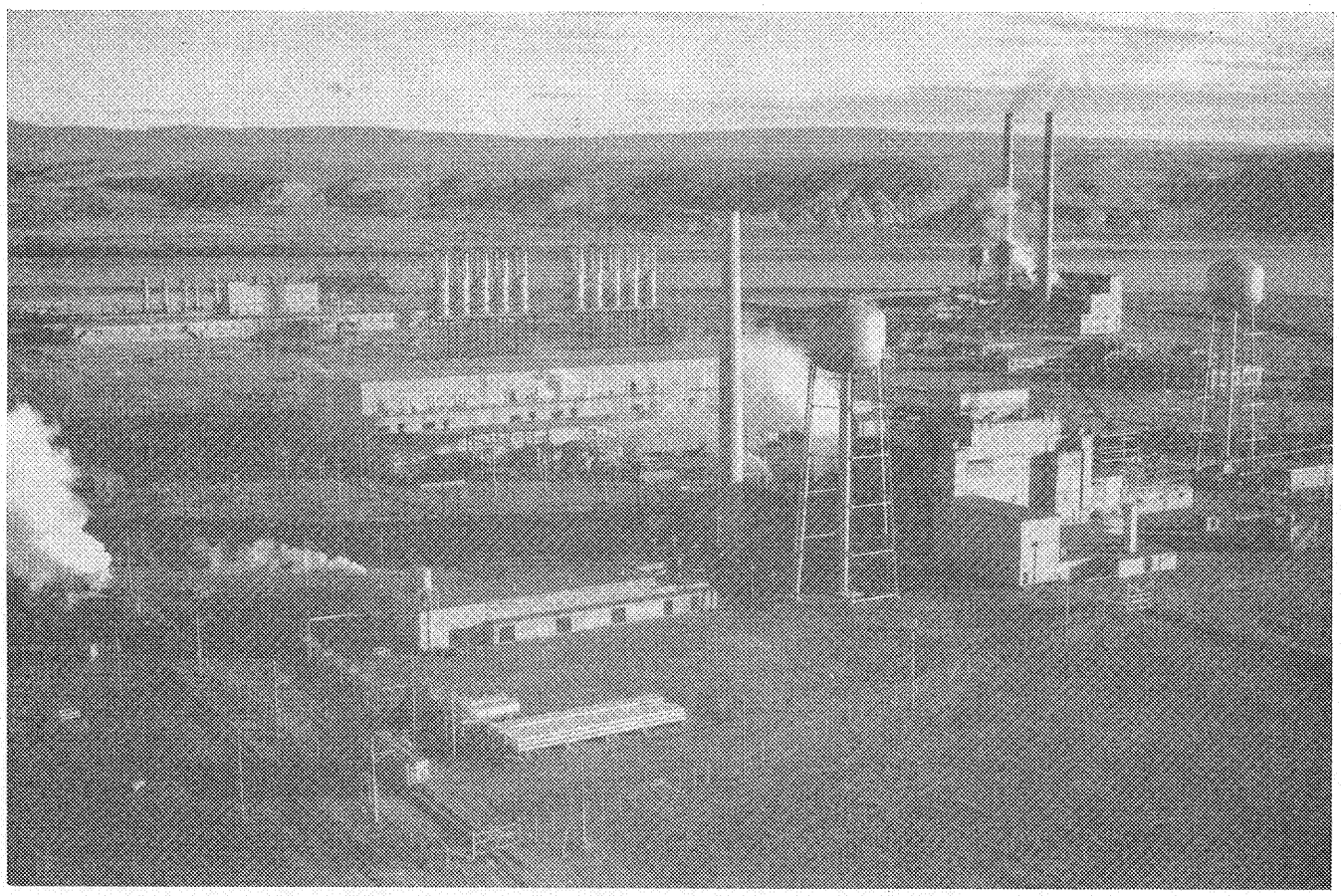
Where do we stand today?

You may well ask, "How was this situation met—and where do we stand today?" During 1947 the main effort of the Atomic Energy Commission was directed toward correcting the situation in atomic weapons—toward increasing weapon production and toward development of new types of weapons. This work was pushed and encouraged by the Commission in every way that it knew. The members of the Los Alamos laboratory, who are mainly responsible for the weapons work, deserve a great deal of credit for their efforts to bring the laboratory back to a satisfactory state. The recovery was encouraging, leading, in the spring of 1948, to a series of atomic bomb tests at Eniwetok Atoll in the Pacific. The 1946 tests at Bikini had been made to determine the effects upon various types of ships of the same type of weapon used in the war. At Eniwetok new types of atomic weapons were tested and examined in action. These tests were very encouraging. They showed that the laboratory developments were good, and they gave us a much better understanding of how an atomic bomb works than we ever had before. It was a terrific boost to this enterprise.

During 1947 new reactors were started at the Hanford works to replace those already in operation, should they go bad. During 1948 considerable success was achieved in the correction of the deterioration which was taking place in the units already constructed, and today the prospect for those units seems much better than it once did. It now seems quite unlikely that the country will be left without facilities for the production of plutonium.

During the past year there has been increased effort on the development of new kinds of nuclear reactors. The present production reactors are structures of graphite and uranium which produce large quantities of energy. This energy is removed by water from the Columbia River and it is wasted. One of the aims of reactor development is to make some good use of the energy which a reactor can produce. Some of the present work is aimed at the construction of a mobile reactor which might be used as a source of energy to drive a ship or submarine. Such a vessel would be able to have an extraordinarily large cruising range.

Other work is aimed at the development of a nuclear reactor called a breeder. A nuclear reactor burns nuclear fuel but the process of burning generates nuclear particles called neutrons which, if properly utilized,



One of the large manufacturing areas at the AEC's Hanford, Washington, plutonium production plant.

can be made to produce new nuclear fuel. There is the possibility, not yet proved, that a reactor may be built which will burn nuclear fuel, produce electrical energy, and generate more nuclear fuel than is burned. Whether it is possible to make such a breeder remains to be seen. Whether it is practical is a still further question. And whether it can be run economically—even if possible—nobody knows today. But since this astounding process *may* be possible, it needs a vigorous study.

For static reactors one question is, "Will atomic energy provide us a cheaper way of producing electrical energy?" Nobody knows how to answer this today. Present estimates indicate that it would be somewhat more expensive to produce electrical energy from a nuclear reactor in a place like New York City than to produce the same electrical energy from coal—even if all the technical problems now confronting us were solved. But the atomic energy enterprise is new, and many short-cuts may be found. New developments may lead to lower production costs, but whether atomic energy can compete with coal will probably not be decided for some years.

In any event, even if it turns out to be economically feasible to produce electrical energy from nuclear reactors, it seems quite unlikely, because of the magnitude of the undertaking, that any appreciable fraction of our electrical energy will be produced from nuclear reactors within the next twenty years. It is much more likely that the development of nuclear reactors may provide cheaper power for remote and inaccessible regions of our country, and thus stimulate their growth and productivity. The successful development of atomic energy as a source of electrical energy will have a stupendous effect upon our country, even if it does not entirely replace other sources of electrical energy.

It has sometimes been stated that there just isn't enough uranium in the world to furnish the raw material for a big production of energy from nuclear reactors. Unfortunately, there are no reliable estimates of how much uranium there is in the world. The Russians seem to have obtained enough to support their atomic project without having access to many of the known sources. We do know that rich deposits of uranium are very rare, but we also know that there are large deposits in very low concentration, and until quite recently, little effort has been made toward recovering this material. A few years ago, uranium was a drug on the market. Its main use was for the extraction of radium, and after the radium had been extracted there was practically no use for the uranium itself. Also there has been little prospecting for uranium, and many new discoveries will probably be made as the attention of prospectors turns in this direction. Up to the present time more uranium has been taken out of the earth than some people said, ten years ago, would ever be available.

One difficulty is that we are not using the raw material as efficiently as we should. We must try to produce more fissionable material from a given amount of raw material. Some steps in this direction have already been made, and further progress seems assured. A tremendous step forward could be made if thorium, as well as a larger fraction of natural uranium, could become available to us as a source of fissionable material through the development of the breeding process.

The recent announcement by the President of the evidence of an atomic explosion in Asia has made it clear that the Russians have been engaged in an all-out effort in atomic energy. To have arrived at this state,

they must have been successful in their scientific and technical work as well as in large-scale industrial development. Ever since the war scientists have warned that the atomic bomb could, and probably would, be developed by other nations. The main secret of the bomb was the fact that it could be exploded, and this became known to everyone more than four years ago. There are, to be sure, many other secrets about its design and construction which have been very closely held. But the fact that an atomic bomb can be made must have greatly simplified the Russian problems. Many of the difficulties of the construction of the first bomb never needed to be encountered by anyone who knew it could be done.

At this time it would be interesting to speculate on the objectives of the Russian atomic energy program. The Russians are most certainly interested in bomb development and production. They are probably engaged in an all-out effort to make better bombs and more bombs, realizing that it is the possession of a large stock pile of bombs that determines their military effectiveness. But it seems to me most unlikely that this is the only aim of their program. I surmise that they recognize in atomic energy a new field, the successful development of which, on a broad front, would allow them to achieve in one jump a position of more equal industrial development with the rest of the world. They would, under such an incentive, be willing to devote strenuous efforts to this accomplishment. Success would mean a stronger country both in industry and in military potential. New developments in atomic energy can be expected to contribute both to peacetime and wartime strength without possibility of sharp distinction.

In other countries

The uncertainties of the future have by no means discouraged other nations in this work. Many of them are pushing ahead just as hard as they can with the development of atomic energy. Britain has two experimental reactors in operation at the present time, one of which is of sufficient power to produce all the radioisotopes that are needed. In addition, the British have under construction larger units which should be able to produce fissionable material in considerable quantity. Canada has in operation, at the Chalk River Laboratory in Ontario, a nuclear reactor which probably gives a more intense neutron bombardment to samples inserted in it than any other reactor now in operation. This is primarily an experimental machine, and it has served to train many people, both Canadian and British, in the fundamentals of atomic energy.

France is in the midst of an atomic energy program and has already constructed and put into operation its first reactor. The French have said that the purpose of their program is the development of the peacetime uses of atomic energy. Sweden, Norway, India, and a host of other countries have set up atomic energy commissions to foster nuclear research and promote the development of atomic energy. Most of these are at present engaged in the scientific and technical development stage of the work and are not yet involved in production facilities.

The announcement of the recent atomic explosion means that the Russians have moved a long way in the development of atomic energy. Since this announcement was made we have heard many suggestions about what this country should do, now that we know roughly what the Russian state of development is. Fortunately, during the past three years the main effort of the United States atomic energy project has gone into the development and production of bombs and the production of fissionable material. This year somewhat more effort has gone into the development of nuclear reactors, either to breed new fissionable material, to provide mobile power sources, or to test materials. This work is now an important part of our atomic project and may be expected to furnish the technical developments for new accomplishments.

Do we now abandon our development work and put all effort into exploiting our present knowledge? Such a policy might lead to a somewhat greater strength in the very near future. But for a longer pull I do not believe that this policy would be wise, and it might be disastrous. The secret of our national strength is progress and we must take care to provide every encouragement for that progress.

In order to achieve sustained progress in atomic energy it is essential to push ahead on a broad front. We need new technical developments and we need fundamental research from which still further technical developments will spring. We can say emphatically that the technical progress of the future depends upon the fundamental research of today. Unless we have scientific progress now there will come a time when our technical progress will bog down

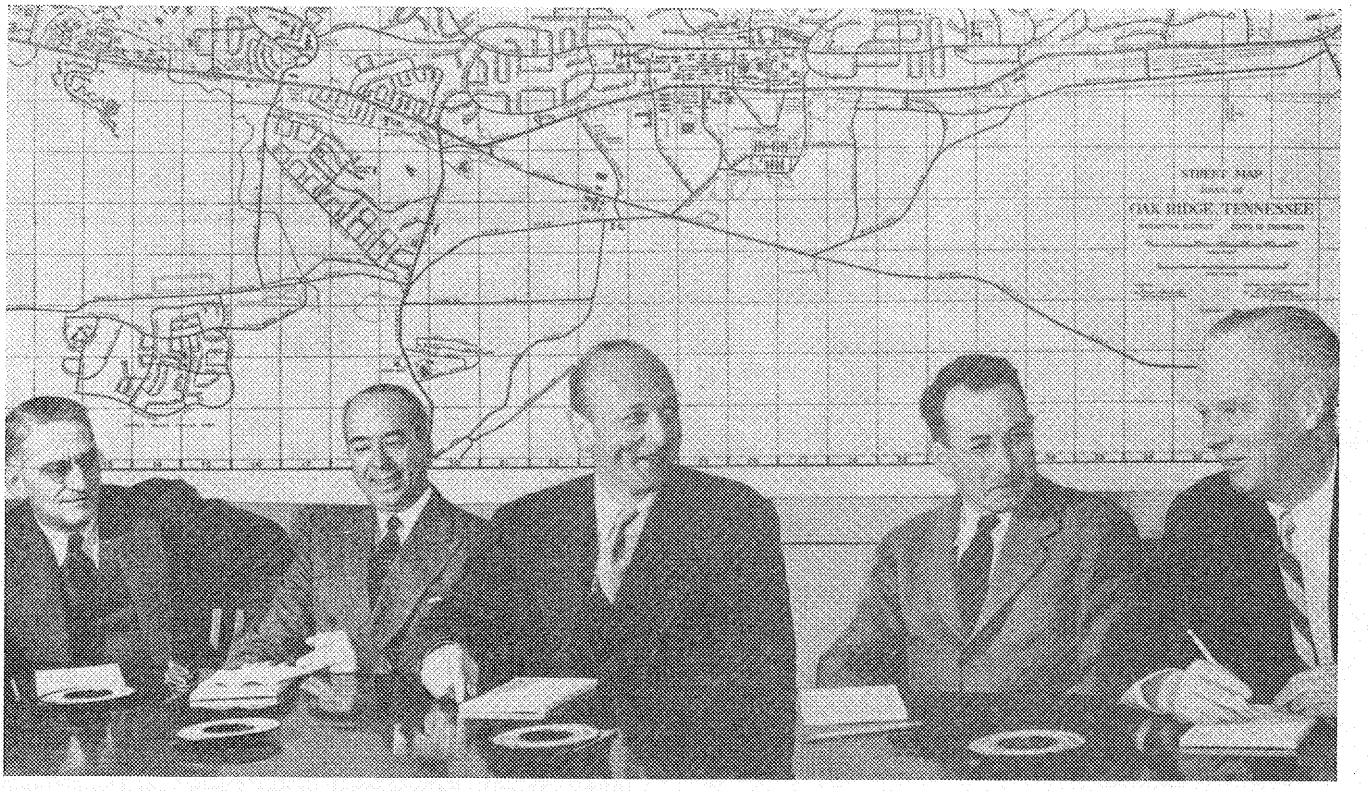
Both scientific and technical progress have been adversely affected during the current year by the time-consuming congressional investigation into the atomic energy project. This investigation has shown that the sensational charges which precipitated the investigation were quite unjustified. The right of congressional investigation is an important part of our democratic system, but abuse may not only weaken our democratic structure; in the case of atomic energy it may hold back our technical and industrial progress.

The extent of secrecy in atomic energy work has been the cause of many serious problems. A good many of the developments in atomic energy have been shrouded in a veil of secrecy. Information about the design and production of weapons and the production of fissionable material has been very closely held. But the veil of secrecy has a tendency to spread like a fog and cover all sorts of other subjects as well. No one wants to be responsible for making information generally available which someone might claim should remain a secret. As a result, many developments are kept secret which might have led to major advances elsewhere in American industry. Secrecy does not contribute to our own progress; it holds it back.

Of course, we must be prepared to accept some disadvantages if we are to keep secret the development of new weapons, and this is undoubtedly sensible. But it is not sensible to keep information only remotely related to weapons unavailable to our own scientific laboratories and industries. Now, with the knowledge that there has been an atomic explosion elsewhere in the world, we should stop impeding our own progress with excessive secrecy.

One of our present great difficulties is that too many things about atomic energy are called secret to keep them *all* under wraps. If we persist in this direction it is inevitable that, sooner or later, we are going to lose some real secrets. A little more hard-headed thinking would show us that we are not only holding up our own development by our present policy of blanket security, but also jeopardizing some information that we would really like to keep secret.

When the Atomic Energy Act was passed in 1946 the wartime cooperation with the British and Canadians was abruptly halted in accordance with the provisions of that Act. Our agreements about raw material pro-



Original members of the AEC—William W. Waymack, Lewis L. Strauss, Chairman David Lilienthal, Robert F. Bacher, Sumner T. Pike. Waymack and Bacher have now been replaced by Gordon E. Dean and Henry T. Smyth.

curement did continue, and in addition for the past year and a half there has been a limited exchange of information in a few areas. Such limited exchange is a long way from full cooperation. We are at present using a joint stock of raw materials to pursue independently-conceived programs in atomic energy. We are exchanging information on such a limited front that it is almost certain that the same problems are being studied in the United States, Britain and Canada. If the aim is mutual progress, such a policy makes little sense. Especially now that the Russian position in the development of atomic energy is somewhat clarified it is probably most unwise not to cooperate with our friends. Because of their wartime collaboration in the development of the atomic bomb they are generally well informed about work in this field up to 1946. Closer relations in the development of atomic energy with Britain and Canada will contribute to our mutual strength.

Speeding Up

Today our atomic energy project is moving ahead rapidly. Our weapons production and development are in much better shape than they were three years ago. Our production of fissionable materials has shown major strides forward and we are today getting more fissionable material produced from a given amount of raw uranium. The development of nuclear reactors, while greatly impeded by the fact that the high priority on effort had to be given to production of fissionable material and weapons, is now moving ahead at an accelerated pace, and I believe that we can expect outstanding accomplishments in this direction in the coming years.

The basic research on which these developments are founded is by no means in such good shape. During the war our development of atomic energy was largely based on scientific discoveries which had been made some time before. There were, of course, some new discoveries and quite a number of technical developments. At the end of 1945 scientists started again to pursue the fundamental research that had been abandoned in the wartime emergency. While progress in basic science is faster today than it was during the war, it certainly has not kept pace with technical developments. With all the stupendous effort in atomic energy, we have no better understanding today of the forces which hold the atomic nucleus together than we had twenty years ago. It is quite unsound to base our atomic energy program upon such flimsy foundations of knowledge as we now have. This is but one example of our lack of knowledge in basic science. Our knowledge of the solid state is very fragmentary and it has hampered us in understanding the behavior of materials that are put in nuclear reactors. There are many other examples.

Progress in science depends primarily upon the availability of competent scientists and suitable equipment. The number of scientists in this country today is far too small, and we must take steps to produce more and better-trained research workers. On the side of available equipment, basic research in the physical sciences is today almost entirely dependent upon grants from the federal government. This is a dangerous situation, but the work in basic science would be going much more slowly were it not for the government's help.

No one would argue today that our national security is not closely tied to our present position in atomic energy. But it is vital to realize that our security and continuing national strength are tied to the future development of atomic energy. In order to make the best progress in this work we should remove unnecessary road blocks set up by excessive secrecy; we should cooperate with Britain and Canada, making the most of their work as well as our own; and we must advance not only in the solution of our immediate technical problems but on the broad front of scientific research.