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By C. J. Jones, Capt. C.E.
Date 12 June 1945

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June 16, 1945

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U-4-4-XXVII-3a

Secretary of War,

Washington, D. C.

Attention: Mr. G. L. Harrison

Dear Mr. Secretary:

We are transmitting herewith copies of three reports which have been drawn up by the Scientific Panel of the Interim Committee on Nuclear Power.

The first of these is a set of recommendations on the future policies, and primarily on future technical prospects, which we would like to call to the attention of the Committee, and constitutes a partial answer to the request for such recommendations made to us at the Committee meeting of May 31, 1945.

The second report has been made at the request of Mr. G. L. Harrison, and gives our views, insofar as these were reasonably unanimous, on the subject of the immediate use of nuclear weapons. Because of the urgency of this matter, the Panel was not able to devote as extended a collective deliberation to the problem as it undoubtedly warrants.

The third report is a brief recommendation touching upon the immediate future, before the creation of a permanent nucleonics authority. The purpose of this recommendation is to make it possible for effective work to be done during the coming months on problems of long-range importance to this field.

Respectfully Submitted,

E. C. Lawrence
A. H. Compton
E. Fermi
J. R. Oppenheimer

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J. R. Oppenheimer
For the Panel

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Authority of the District Engineers

By *John C. Lee*
Date 17 June 1945

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RECOMMENDATIONS ON FUTURE POLICY

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E. O. Lawrence
A. H. Compton
J. R. Oppenheimer
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For the Panel

June 16, 1945

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The background for the recommendations which follow is simple. Atomic bombs are weapons of overwhelming potential power; and this military development must be pursued on a commensurate scale. The ultimate possibilities of atomic power can revolutionize our economy: the raw material is available, and the technical problems can be solved. These developments can and should play as large a part in the national economy as other major technical advances, such as the internal combustion engine and electronics. For the near future an activity of the order of a billion dollars a year seems appropriate. In the first years this will require a large measure of Federal support. The recommendations submitted herewith are predicated on a vigorous and healthy activity in this field, for national security and well-being.

I. Technical Recommendations.

We would like to outline in the following paragraphs a few projects which appear to us, in the light of what we now know, to be deserving of support and effort. This list is not meant to be exhaustive; we believe that no list should attempt to be exhaustive, for it must be a continued and unremitting responsibility to examine all proposals and to meet them with an open and hopeful mind. In the case of research proper we believe that a liberal willingness to support activities, even though their relevance to the national defense or national welfare may not be immediately apparent, can be the only guarantee of a free and profound cultivation of this field.

We should like to emphasize that no fixed or programmatic approach to the technical problems can be successful, and that the suggestions offered herewith are for illustrative purposes only. Certainly we would wish to see work carried out on the problems mentioned below. We would not mean by that to exclude many other programs which happen not to have come to our attention, or which to us personally seem of rather lesser interest:

A. We believe the subject of thermo-nuclear reactions among light nuclei is one of the most important that needs study. There is a reasonable presumption that with skillful research and development fission bombs can be used to initiate the reactions of deuterium, tritium, and possibly other light nuclei. If this can be accomplished, the energy release of explosive units can be increased by a factor of a thousand or more over that of presently contemplated fission bombs. We think that there are several experimental approaches to this problem, and that perhaps the

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possibility is not completely excluded that significant thermo-nuclear reactions may be initiated without the use of fission bombs, by refinements in the application of ordinary high explosives and by other methods not yet explored. Work in this whole field bears some analogy to the development of the fission bombs themselves, in that a close cooperation of fundamental physical studies, of semi-industrial techniques, and of rather novel, radical variations in ordnance procedures will be needed to carry the work through. Just for this reason it is the intention of the New Mexico Laboratory to do as much work in this field as is consistent with more immediate wartime commitments. It is quite certain that the close of the war will leave these problems in a preliminary and unresolved state.

B. Another project of comparable importance is the development of piles to convert the abundant isotope of uranium, and the more abundant thorium, into readily fissionable materials. Here again it would seem that these new piles, which are called "breeders", could, with a high presumption, be made to work; but there are difficult and as yet unexplored technical problems to be solved, both in the field of physics and in the field of engineering. The Metallurgical Project has devoted much thought to these problems and relevant experiments have been carried out; here again, however, only a beginning has been made. The operation of a breeder is expected to involve the use of readily fissionable materials and to increase their amount at the expense of ordinary uranium or thorium. The rate of increase of the amount of valuable fissionable materials is hard to predict at present, but may, perhaps on full-scale operation, be of the order of twenty to thirty percent per year. Rate of production on these lines may thus be expected to increase proportionately to the accumulated reserve of fissionable materials that can be fed into breeders. This point stresses the importance of accumulating a stock by methods of production not essentially different from the present ones, while the development of satisfactory breeders is in progress. The rewards for the successful prosecution of this program would be very great; the stock of fissionable materials available for military, scientific, and industrial purposes could be multiplied many-fold.

C. Thorough exploration of uranium and thorium deposits, and development of methods for effective exploitation of poor ores should be pursued very vigorously.



Uranium is present to the extent of a few parts per million in most rocks. This means that the total amount of the element, if it could be made available, would be for all practical purposes inexhaustible. The rich ores, on the other hand, seem to be limited. Study of the availability and use of intermediate ores appears, therefore, as one of the most valuable developments. The energy content of a pound of uranium or thorium is equivalent to that of three million pounds of coal, and at present market values is worth some ten pounds of gold.

D. Nuclear physics is a quite young subject, and its regularities are almost all empirical. We would all be agreed that the pursuit of fundamental studies on the structure of nuclei, on their reactions, and the nature of the forces governing their stability, should be encouraged on a very broad basis. It is unlikely that the financial costs of such studies could amount to an appreciable fraction of the total investment in this field. The possibilities that may, and in our opinion will, be opened up by such studies are very great indeed. These are things which should in all probability not be centralized, but which should be pursued in the university, and to a lesser extent in the industrial laboratories of the country. It is primarily in these laboratories that the scientists of the future will be trained.

The general fields outlined above, and perhaps in the end most of all the fundamental studies to which we have referred, seem to us the most important. We list below a number of major fields of development, whose contribution to the national welfare may be very great:

A. There seems to be little doubt that the fission products produced in piles, and radioactive materials which can be made by irradiation in piles, will be useful in chemistry, biology, medicine, and industry. We would feel that these materials should be made available to industry and to research organizations; that it might well be appropriate to consider releasing Governmental patent rights in this field in order to make discovery of new applications and new materials attractive to industry. In certain cases, such as the production of the isotope tritium, which may be of military value, the Government should undoubtedly protect itself by a provision which would enable it to manufacture and use this material whatever private patent rights existed. We believe that a relatively free system whereby radioactive materials such as C₁₄, could be readily obtained by hospitals, industry, and research institutions would, in a few years, lead to their widespread use.

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B. A related recommendation would be that small chain-reacting units should be made available, perhaps on a regional basis, so that the radiations and products produced by them could be used by scientists, doctors, and engineers in a fairly free and flexible manner. Since this involves the commitment of active materials, or of essential raw materials, we would expect that such piles could operate only under a license, and a certain measure of Federal control; but since they provide powerful tools for research, it is of great importance that their use should not be severely restricted and that anyone with a reasonable chance of taking effective advantage of them should be given access to their radiations.

C. Thorium is about ten times as abundant as uranium. Piles using thorium as a primary fuel can probably be developed. Present indications are that thorium has less favorable properties than uranium for use in a breeder, but it is very likely that thorium units can be developed for production of power and of radio elements.

D. During the war, notably in the work of the Berkeley and Columbia projects, several new methods of separating isotopes have been developed on an industrial scale, and others have been brought to the pilot plant stage. We believe that work in this field should be largely encouraged in the first instance, because it has a good chance of increasing the effectiveness of present separation methods for materials of military value, and also because we are convinced that new uses will be found for many of the separated isotopes which are not now available.

E. It is most unlikely that fission bombs, as they are made at the end of this war, will realize the possibilities inherent in such weapons; neither from the point of view of performance nor from the point of view of convenience and adaptability in tactical application will they constitute more than a beginning. Many of the problems of improving such weapons could appropriately be undertaken by the ordnance organizations of the Army and Navy, but there are others which will require a very great extent of the techniques and personnel of such organizations, or the establishment of special projects to accomplish these purposes. In any case, the development of weapons should be brought into much closer co-ordination with military ordnance organizations than it has been during this initial period of development.

F. There are probably some fairly special applications of nuclear power as power which should be listed in a preliminary way. These range from the clearly possible use of power generated by piles designed for the production of

active materials to provide heat for near-by communities, to the much more speculative development of piles for the generation of electrical power in situations where transportation limits the use of ordinary fuels. Here again is a field which might be opened on a financially attractive and competitive basis to industry. The future of this development may revolutionize our technology.

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II. General Recommendations.

A. The technical recommendations made above, and in fact the whole prospect of the achievement of active, free, and fruitful development of the field of nuclear physics, depend on preconditions which are not technical. One of these is that every effort should be made to avoid bureaucratic inbreeding in the commission or agency in which the national authority is vested. It would, in our opinion, be a mistake to allow this commission to operate directly its own laboratories, plants, bureaus, etc., for experience has shown that this tends to create a vested interest and to prevent the encouragement of essential work at institutions under less direct control. Speaking more generally, we feel that the members of the commission should be chosen to represent, in the broadest possible sense, the public interest, and that the commission be free to supplement its technical, military, industrial, and political competence by the creation of sub-committees and panels.

B. Almost all scientists who have been concerned with the development of this project have indicated their despair of continuing to work effectively under conditions of extreme secrecy or extreme control; and it must certainly be the hope and the effort of the future to reduce these to a minimum. It is not only the direct consequence of a policy of secrecy which we deplore. As is well known, this reduces effectiveness by withholding from those who may have need of them essential facts, or essential insight; and this alone would condemn such a program to frustration in anything but in a national emergency. There are also more far-reaching things, in that the whole temper, spirit, value, and dignity of science is incompatible with secrecy. In the long run scientists will leave this field or will devote to it only the poorest part of their efforts if it is not carried out in an open way and in the full high confidence that knowledge is a good thing and its spread a good thing for humanity.

We believe that the feelings of industry will be somewhat less extreme, but will tend in the same direction,

and that active, sincere participation by industry requires that it participate in decisions of policy, and have real insight into the technical actualities. We believe that these conditions are as important as those other necessary arrangements by which industry can hope to profit from participation in this work.

C. The hopes expressed above will be academic and illusory, and in fact will not be fulfilled, if the use of nuclear power is pursued by this nation in secret competition with the rest of the world. For these reasons alone, the whole future health of scientific and technical development in this country is dependent on our good faith and good will in developing this great new field in a cooperative way with other powers, on our unceasing efforts to use the present modest but not inconceivable hegemony which we have attained to the benefit, not of this nation alone, but of all peoples. We make this argument with full realization of the difficulties of the problem, and with full realization of our inability to lay down in detail a course of action which will resolve them. Nevertheless, we believe just this aspect of the problem to be the key to the whole future of the things with which we have been concerned. We would come with a heavy heart to the prospects of postwar work unless these obligations are undertaken with the highest motives and with complete sincerity. There have been, and are, other profound arguments for trying to make of this great development a bond between nations, and not a new source of potential warfare. To these arguments we subscribe; but we would add to them the warning that without this openness the prospects of retaining our present leadership in the field do not look bright to us.

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We would again like to emphasize that even so modest a thing as an unequivocal expression of our desire to work cooperatively in this field could at the present time add greatly to the honor and to the moral prestige of this country, and to the true commitment of our scientists in support of this national effort.

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By *James C. Gage*
Date *17 June, 1945*

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RECOMMENDATIONS ON THE IMMEDIATE USE OF NUCLEAR WEAPONS

A. H. Compton
E. O. Lawrence
J. R. Oppenheimer
E. Fermi

J. R. Oppenheimer
J. R. Oppenheimer
For the Panel

June 16, 1945

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You have asked us to comment on the initial use of the new weapon. This use, in our opinion, should be such as to promote a satisfactory adjustment of our international relations. At the same time, we recognize our obligation to our nation to use the weapons to help save American lives in the Japanese war.

(1) To accomplish these ends we recommend that before the weapons are used not only Britain, but also Russia, France, and China be advised that we have made considerable progress in our work on atomic weapons, that these may be ready to use during the present war, and that we would welcome suggestions as to how we can cooperate in making this development contribute to improved international relations.

(2) The opinions of our scientific colleagues on the initial use of these weapons are not unanimous: they range from the proposal of a purely technical demonstration to that of the military application best designed to induce surrender. Those who advocate a purely technical demonstration would wish to outlaw the use of atomic weapons, and have feared that if we use the weapons now our position in future negotiations will be prejudiced. Others emphasize the opportunity of saving American lives by immediate military use, and believe that such use will improve the international prospects, in that they are more concerned with the prevention of war than with the elimination of this specific weapon. We find ourselves closer to these latter views; we can propose no technical demonstration likely to bring an end to the war; we see no acceptable alternative to direct military use.

(3) With regard to these general aspects of the use of atomic energy, it is clear that we, as scientific men, have no proprietary rights. It is true that we are among the few citizens who have had occasion to give thoughtful consideration to these problems during the past few years. We have, however, no claim to special competence in solving the political, social, and military problems which are presented by the advent of atomic power.

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By *Dr. J. R. Oppenheimer*
Date *June 17, 1945*

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INTERIM RECOMMENDATIONS

J. R. Oppenheimer
E. O. Lawrence
A. H. Compton
E. Fermi

J. R. Oppenheimer
J. R. Oppenheimer
For the Panel

June 16, 1945

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It is clear that the creation of a permanent nucleonic authority must wait on Congressional action; and this in turn depends on a release of information that can only take place after the military fruition of the present project. There are, however, rather urgent and immediate problems: the prosecution of work that is vital to our progress in this field, but unlikely to contribute to the present war; and the effective use of organizations now in existence and qualified to undertake such work.

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We, therefore, propose as an immediate interim measure the extension of the directive on the Manhattan Engineer District to include work of postwar importance. The work to be done under this interim directive should not exceed an annual budget of twenty million dollars.

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