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OFFICE OF SCIENTIFIC RESEARCH AND DEVELOPMENT
1530 P Street, N. W.
Washington, D.C.

September 30, 1944.

The Secretary of War,
Washington, D. C.

Dear Mr. Secretary:

In response to your suggestion we outline in the two attached memoranda our thoughts on the international post-war aspects of the special projects. We believe that the following points are correct, and of great importance to the future peace of the world.

1. By next summer this will become a matter of great military importance.
2. The art will expand rapidly after the war, and the military aspects may become overwhelming.
3. This country has a temporary advantage which may disappear, or even reverse, if there is a secret arms race on this subject.
4. Basic knowledge of the matter is widespread and it would be foolhardy to attempt to maintain our security by preserving secrecy.
5. Controlling supplies of materials cannot be depended upon to control use, especially in forms which the subject may take in the future.
6. There is hope that an arms race on this basis can be prevented, and even that the future peace of the world may be furthered, by complete international scientific and technical interchange on this subject, backed up by an international commission acting under an association of nations and having the authority to inspect.

Very sincerely yours,

/sgd/ V. BUSH

/sgd/ J. B. CONANT

SEP 2 1953

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September 30, 1944.

MEMORANDUM

To: The Secretary of War

From: V. Bush and J. B. Conant

Subject: Salient Points Concerning Future International Handling of Subject of Atomic Bombs.

1. Present Military Potentialities. There is every reason to believe that before August 1, 1945, atomic bombs will have been demonstrated and that the type then in production would be the equivalent of 1,000 to 10,000 tons of high explosive in so far as general blast damage is concerned. This means that one B-29 bomber could accomplish with such a bomb the same damage against weak industrial and civilian targets as 100 to 1,000 B-29 bombers.

2. Future Military Potentialities. We are dealing with an expanding art and it is difficult to predict the future. At present we are planning atomic bombs utilizing the energy involved in the fission of the uranium atom. It is believed that such energy can be used as a detonator for setting off the energy which would be involved in the transformation of heavy hydrogen atoms into helium. If this can be done a factor of a thousand or more would be introduced into the amount of energy released. This means that one such super-super bomb would be equivalent in blast damage to 1,000 raids of 1,000 B-29 Fortresses delivering their load of high explosive on one target. One must consider the possibility of delivering either the bombs at present contemplated or the super-super bomb on an enemy target by means of a robot plane or guided missile. When one considers these possibilities we see that very great devastation could be caused immediately after the outbreak of hostilities to civilian and industrial centers by an enemy prepared with a relatively few such bombs. That such a situation presents a new challenge to the world is evident.

3. Present Advantage of United States and Great Britain Temporary. Unless it develops that Germany is much farther along than is now believed it is probable that the present developments in the United States undertaken in cooperation with Great Britain put us in a temporary position of great ascendancy. It would be possible, however, for any nation with good technical and scientific resources to reach our

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present position in three or four years. Therefore it would be the height of folly for the United States and Great Britain to assume that they will always continue to be superior in this new weapon. Once the distance between ourselves and those who have not yet developed this art is eliminated the accidents of research could give another country a temporary advantage as great as the one we now enjoy.

4. Impossibility of maintaining complete secrecy after the war is over. In order to accomplish our present gigantic technical and scientific task it has been necessary to bring a vast number of technical men into the project. Information in regard to various aspects of it is therefore widespread. Furthermore, all the basic facts were known to physicists before the development began. Some outside the project have undoubtedly guessed a great deal of what is going on. Considerable information is already in the hands of various newspaper men who are refraining from writing our stories only because of voluntary censorship. In view of this situation it is our strong recommendation that plans be laid for complete disclosure of the history of the development and all but the manufacturing and military details of the bombs as soon as the first bomb has been demonstrated. This demonstration might be over enemy territory, or in our own country, with subsequent notice to Japan that the materials would be used against the Japanese mainland unless surrender was forthcoming.

5. Dangers of partial secrecy and international armament race. It is our contention that it would be extremely dangerous for the United States and Great Britain to attempt to carry on in complete secrecy further developments of the military applications of this art. If this were done Russia would undoubtedly proceed in secret along the same lines and so too might certain other countries, including our defeated enemies. We do not believe that over a period of a decade the control of the supply could be counted on to prevent such secret developments in other countries. This is particularly true if the super-super bomb were developed for the supply of heavy hydrogen is essentially unlimited and the rarer materials such as uranium and thorium would be used only as detonators. If a country other than Great Britain and the United States developed the super-super bomb first we should be in a terrifying situation if hostilities should occur. The effect on public reaction of the uncertainties in regard to an unknown threat of this new nature would be very great.

6. Proposed international exchange of information. In order to meet the unique situation created by the development of this new art we would propose that free interchange of all scientific information on this subject be established under the auspices of an international office deriving its power from whatever association of nations is developed at the close of the present war. We would propose further

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that as soon as practical the technical staff of this office be given free access in all countries not only to the scientific laboratories where such work is contained, but to the military establishments as well. We recognize that there will be great resistance to this measure, but believe the hazards to the future of the world are sufficiently great to warrant this attempt. If accurate information were available as to the development of these atomic bombs in each country, public opinion would have true information about the status of the armament situation. Under these conditions there is reason to hope that the weapons would never be employed and indeed that the existence of these weapons might decrease the chance of another major war.

/sgd/ J. B. CONANT

/sgd/ V. BUSH

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September 30, 1944.

MEMORANDUM

To: The Secretary of War

From: V. Bush and J. B. Conant

Subject: Supplementary memorandum giving further details concerning military potentialities of atomic bombs and the need for international exchange of information.

1. Present military potentialities. The present schedule of production should yield sufficient materials during the spring and summer of 1945 to provide either several bombs each having the equivalent effect of 10,000 tons of high explosives, or a correspondingly larger number of bombs each having the equivalent of 1,000 tons of high explosive. When it is recalled that each B-29 bomber was designed to carry about 8 tons of high explosive, it is clear that the military effect of these atomic bombs is to reduce enormously the number of bombers required to produce damage to the type of target found in civilian and industrial centers. For example, one 10,000 ton HE equivalent bomb would produce the same order of effect as 1,000 B-29 bombers carrying full load. If, as seems probable at the outset, the smaller atomic bombs would be developed, then one B-29 bomber carrying such a bomb (1,000 ton equivalent HE) would produce the same damage as 100 B-29 bombers fully equipped. Which of these two types of bombs comes into use first depends upon certain technical developments now in progress. It is probable that the most efficient use of the material from the point of view of causing the maximum damage for every pound expended would be through the smaller bombs accurately placed on an industrial target, which, to repeat, would be the equivalent of 100 B-29 normal loads.

It should be pointed out that these bombs, like all high explosive bombs, give a maximum of damage when used against weak targets, that is industrial installations and large collections of buildings. The protection against them would be underground installations and heavy concrete structures. Just as in the case of ordinary high explosive bombs such structures would be relatively safe even against super bombs unless a direct hit were made, although in the case of an atomic bomb the definition of a direct hit would probably include bombs which landed within a few hundred yards.

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Although these memoranda are directed to the international situation, we would like to point out again at this time that the manufacture of these atomic bombs and any further experimentation in the whole field of atomic power presents very great hazards to the health of a country unless the experiments are carefully controlled. It is now relatively easy to construct a device which develops atomic energy in the form of heat using relatively small quantities of separated uranium. Such atomic energy machines, which can produce heat but not explosive energy, are known as "water boilers". These small water boilers also produce intense neutron radiation which is fatal to anyone coming within 100 feet or so unless adequate shielding is provided. Furthermore, in the operation of these water boilers radioactive poisons are produced. Clearly such establishments should be allowed only under careful regulation by the government, yet such installations will be of prime importance to the further development of the sciences of physics, chemistry, and biology. It would be unthinkable to prohibit developments of this sort in private laboratories, yet clearly all such experimentation must be carefully supervised and controlled.

A great many industrial companies will want to work in this whole field because there are many applications of the byproducts of this new science. Quite apart from the major development of atomic energy as a source of industrial power industrial concerns will wish to experiment with water boilers and their products, radioactive poisons. Clearly all such developments should be licensed and all patent rights should come to the government. No one can tell what may be the new developments in this field of science, or what will come out of the experiments performed in many different places with these new materials and these new techniques. Results of all such experiments should be made available to the United States Government and, as proposed later, through an international arrangement to the world. As suggested in our earlier memorandum to you, the legislation to control this whole field of experimentation and development, as well as to provide for a national agency for furtherance of the art, might derive its power from an international treaty.

2. Future military potentialities. Two materials are at present in production for use in atomic bombs. One is an isotope of uranium commonly called "25", the other a product of a fission reaction of uranium, a new element known as "49". Both these substances produce energy under certain conditions by the fission of their nuclei into fragments.

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Some of our theoretical physicists believe that it is extremely probable that the energy generated by the fission of the nuclei of "25" and "49" could under certain circumstances produce such a high temperature as to initiate a reaction which has never taken place on this earth, but is closely analogous to the sources of energy of the sun. This reaction involves the transformation of heavy hydrogen into helium. Enormous amounts of energy are released in this reaction. A super bomb using heavy hydrogen (in the form of heavy water) and detonated by an atomic bomb using "25" or "49" would be of a different order of magnitude in its destructive power from an atomic bomb itself. We may therefore designate it as a super-super bomb. While such a possibility lies in the future, it could even happen that a bomb of this type would prove feasible within six months or a year after the first atomic bomb is constructed.

When one considers that such a super-super bomb might be delivered on an enemy target by the principle of a robot bomb or guided missile, or even without this possibility from a bomber coming at night or in overcast guided by modern radar devices, we see how vulnerable would be centers of population in a future war. Unless one proposed to put all one's cities and industrial factories under ground, or one believes that the anti-aircraft defenses could guarantee literally that no enemy plane or flying bomb could be over a vulnerable area, every center of the population in the world in the future is at the mercy of the enemy that strikes first.

In painting this lurid picture of the future it is hardly necessary to add, however, that it seems extremely unlikely that any nation would thus destroy large industrial centers or civilian centers unless it was prepared to follow up with air, naval, or land forces. Therefore it seems unnecessary to be disturbed about the possibilities of small countries, particularly countries with little industrial potential, disturbing the peace of the world by secret development of such weapons. The possibility of any major power or former major power undertaking this development, however, seems great indeed.

3. Present advantage of United States and Great Britain temporary. The probabilities are great that Germany is not far advanced along the road of development of atomic bombs. It is also extremely unlikely that Russia has as yet had opportunity to carry this subject far. On the other hand,

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once the war is over Russia, at least, and possibly Germany and other countries, could quite easily make up the advantage which we now possess in technical knowledge and scientific information. Much that we have found out in the way of basic facts were just over the horizon when the war came on and secrecy prevailed. Quite apart from any leakage of information which would be bound to occur if we foolishly attempted to maintain a secrecy order on our present scientific information, foreign scientists would soon come to the same scientific point of view as we now hold. Our present advantage lies entirely in the construction of plants for the manufacture of materials. Even this could be much more quickly overcome and at much less cost than at first sight would seem to be the case. It is an old story in the advance of technology that after the first person has shown how something can be done there are soon developed cheaper and easier ways of accomplishing the same end. Lest we be deluded on this point by the large sums of money expended by the United States, we must recall that in order to save time and to arrive with assurance at our goal, we proceeded to ride three horses at the same time. We now know that probably any one of four or five methods could produce material from which an atomic bomb could be constructed. The erection of a plant to operate any one of these methods would not be nearly as costly an undertaking and certainly could be accomplished in a few years. We also believe now that the fundamental basis for the construction of an atomic bomb from the material presents no great difficulty and the way that anyone would naturally try to accomplish this end will succeed. Our present difficulties in this area and our large expenditures of money and manpower on the ordnance aspects of the problem are only because we wish to produce as rapidly as possible bombs using small amounts of material. This requires difficult experimentation which is not yet complete. The way through on a more orthodox procedure is now clear and would not be difficult for anyone to undertake. In short, it now seems that it is by no means a prohibitively difficult, expensive, or laborious undertaking to construct a plant to produce atomic bombs. There is the further point that the basic scientific information would be essentially rediscovered, if necessary, by another group of scientists starting in the field when the war is over. The advantage, therefore, that the United States and Great Britain possess in this area is very temporary indeed. We cannot overemphasize this point.

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4. Impossibility of maintaining complete secrecy after the war is over. This point is so obvious that it needs very little further expansion of what was said in our summary memorandum. Only strict censorship of the press or a continuation of the present voluntary arrangement would prevent free discussion of this subject. Furthermore, to attempt to impose complete secrecy would be to interfere seriously with scientific advance in many related fields. It seems to us from every point of view of the greatest importance to have this whole subject out in the open as soon as military conditions allow, so that (a) there may be a public understanding of the dangers, (b) we may have open control by a newly-authorized agency set up by Congress, (c) we may regulate whatever experiments may now be going on without our knowledge in private places, and (d) we may use this new field to advance the sciences of physics, chemistry, and biology including medicine.

5. Dangers of partial secrecy and international armament race. As has already been pointed out in this memorandum, certainly the Russian scientists and perhaps the Germans and others may be before long hard in the race of developing this new type of weapon. They could catch up with our present position in the course of three or four years. The danger is that we would never know, if secrecy prevails as between countries, whether indeed this were the case. Hence our own thoughts about using this weapon in a future war might be based on the false premise that our enemies could not retaliate in kind. But more dangerous still are the possibilities of the super atomic bomb referred to in Section 2. The devastating effects of this bomb would be of another order of magnitude from the atomic bomb itself and it would require materials that are readily available. One cannot say with certainty that such a bomb can be constructed, but it seems as probable as was the atomic bomb development when this research was first undertaken by the government. But whether or not this particular line should prove profitable from a military point of view one can be certain that there will be unexpected developments which would increase enormously the effectiveness of atomic energy for destructive purposes.

If we are in a situation in which several powerful countries are proceeding in secret to develop these potentialities we shall be living in a most dangerous world. One need

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not elaborate on the repercussions of such a situation on public opinion or on any attempts to develop an association of nations to keep the peace. We should like to emphasize, however, how closely all these developments are tied up with advances in physics and chemistry; any attempt to shroud developments in this country with secrecy for military reasons would run into innumerable problems involving various branches of science. By the same token, however, this subject is by its very nature ideal for free international exchange of scientific information. And if there be such free interchange of information anyone will know fairly clearly what is the status of the armament situation in so far as this weapon is concerned.

6. Proposed international exchange of information.

For the reasons already outlined we come to the conclusion that the safety of the United States and the prospects of world peace will be furthered by providing for free interchange of scientific information with all countries in the field of atomic energy. We believe this should not be left to the usual haphazard methods of scientific publication, but should be centered in an international office responsible to an association of nations. The signatories of the treaty would guarantee that all their scientists would make their results freely available to the agents of this international office, who in turn would see that they were given worldwide publication as fast as they are obtained. The nations in the association would further agree to allow the agents of the international office to visit freely within their countries and discuss all matters of atomic energy with all the scientists, including the government employees in the country in question. It appears to us that Russia would be the one most reluctant to enter into this combination, but since we hold the advantage, if only temporary, in this art it would seem that the quid pro quo was evident.

While we believe that arrangements for free interchange of scientific information would be a great step forward in removing some of the dangers to civilization inherent in this new development, we believe that arrangements should proceed further, if not at once, as the second step. The same international office should provide not only for the free circulation of its agents among the scientific laboratories of all countries and the free publication of all the scientific aspects of the subject of atomic energy, but should also provide

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for inspection of all technical installations. This presents still greater difficulties and would presumably be violently opposed in this country as well as Russia since it would mean in the last analysis the opening of all industrial plants to officials of an international organization. We believe, however, that if people in this country and in other countries are convinced of the terrific potentialities of the new weapons which now lie just over the horizon they will be willing to provide for such an arrangement with due safeguards to commercial secrets. Since the inspecting agents would be scientific and technical men with the traditions of the professions, we believe there could be developed before long in such an international corps of experts a tradition of integrity and responsibility that would insure that their inspectorial powers would not be abused. That is to say, they would resist the temptation to divulge secret information not in the field in question which they obtained in the course of their duties to their own government or to some commercial concern.

We recognize that even at the scientific level there is some chance for evasion and that at the technical and industrial level there are very great chances for evasion. Nevertheless, we believe that along the path we outline it would be possible to proceed toward a definite goal, and that even if the achievements were far less than ideal the attempt would be worth while. We have been unable to devise any other plan which holds greater possibilities that these new developments can be utilized to promote peace rather than to insure devastating destruction in another war.

(SIGNED) J. B. CONANT

V. BUSH

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