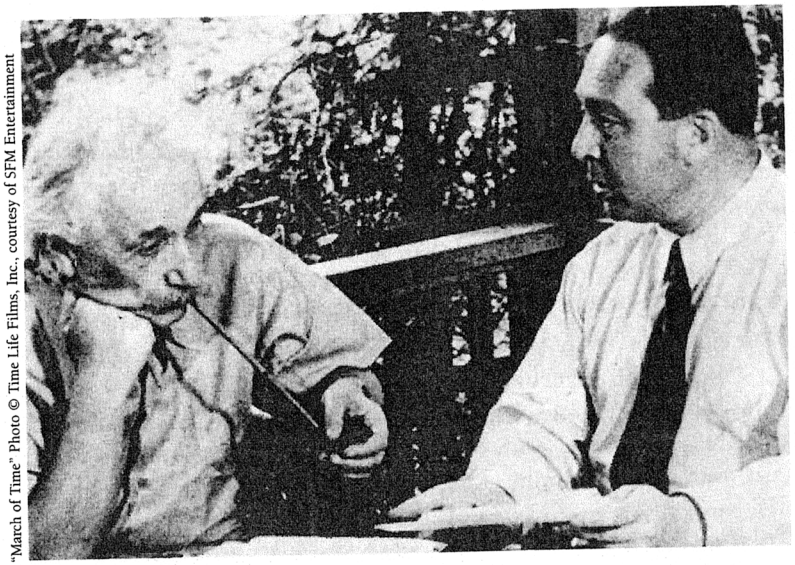

Albert Einstein and Leo Szilard reenact the drafting of the 1939 letter that alerted President Franklin D. Roosevelt to the urgency of an atomic bomb project.

Albert Einstein to F. D. Roosevelt

Albert Einstein, the world's most renowned physicist and a Nobel Prize winner, had fled Germany in the 1930s. At the urging of Hungarian refugees Leo Szilard and Eugene Wigner, Einstein warned President Franklin D. Roosevelt about a possible German atomic bomb. On October 19, 1939, the President responded to Einstein, explaining that he had created a committee to investigate making an atomic bomb.

Albert Einstein
Old Grove Rd.
Nassau Point
Peconic, Long Island

August 2nd, 1939

F. D. Roosevelt,
President of the United States,
White House
Washington, D.C.

Sir:

Some recent work by E. Fermi and L. Szilard, which has been communicated to me in manuscript, leads me to expect that the element uranium may be turned into a new and important source of energy in the immediate future. Certain aspects of the situation which has arisen seem to call for watchfulness and, if necessary, quick action on the part of the Administration. I believe therefore that it is my duty to bring to your attention the following facts and recommendations:

In the course of the last four months it has been made probable—through the work of Joliot in France as well as Fermi and Szilard in America—that it may become possible to set up a nuclear chain reaction in a large mass of uranium by which vast amounts of power and large quantities of new radium-like elements would be generated. Now it appears almost certain that this could be achieved in the immediate future.

This phenomenon would also lead to the construction of bombs, and it is conceivable—though much less certain—that extremely powerful bombs of a new type may thus be constructed. A single bomb of this type, carried by boat and exploded in a port, might very well destroy the whole port together with some of the surrounding territory. However, such bombs might very well prove to be too heavy for transportation by air.

The United States has only very poor ores of uranium in moderate quantities. There is some good ore in Canada and the former Czechoslovakia, while the most important source of uranium is Belgian Congo.

In view of this situation you may think it desirable to have some permanent contact maintained between the Administration and the group of physicists working on chain reactions in America. One possible way of achieving this might be for you to entrust with this task a person who has your confidence and who could perhaps serve in an inofficial capacity. His task might comprise the following:

a) to approach Government Departments, keep them informed of the further development, and put forward recommendations for Government action, giving particular attention to the problem of securing a supply of uranium ore for the United States.

It is a property of these super-bombs that there exists a "critical size" of about one pound. A quantity of separated uranium isotope that exceeds the critical amount is explosive; yet a quantity less than the critical amount is absolutely safe. The bomb would therefore be manufactured in two (or more) parts, each being less than the critical size, and in transport all danger of a premature explosion would be avoided if these parts were kept at a distance of a few inches from each other.

The bomb would be provided with a mechanism that brings the two parts together when the bomb is intended to go off. Once the parts are joined to form a block which exceeds the critical amount, the effect of the penetrating radiation always present in the atmosphere will initiate the explosion within a second or so.

The mechanism which brings the parts of the bomb together must be arranged to work fairly rapidly because of the possibility of the bomb exploding when the critical conditions have only just been reached. In this case the explosion will be far less powerful. It is never possible to exclude this altogether, but one can easily ensure that, say, one bomb out of 100 will fail in this way, and since in any case the explosion is strong enough to destroy the bomb itself, this warrant is not serious.

We do not feel competent to discuss the strategic value of such a bomb, but the following conclusions seem certain:

1. As a weapon, the super-bomb would be practically irresistible. There is no material or structure that could be expected to resist the force of the explosion. If one thinks of using the bomb for breaking through a line of fortifications, it should be kept in mind that the radioactive radiations will prevent anyone from approaching the affected territory for several days; they will equally prevent defenders from reoccupying the affected positions. The advantage would lie from the side which can determine most accurately just when it is safe to re-enter the area; this is likely to be the aggressor, who knows the location of the bomb in advance.

2. Owing to the spreading of radioactive substances with the wind, the bomb could probably not be used without killing large numbers of civilians, and this may make it unsuitable as a weapon for use by this country. (Use as a depth charge near a naval base suggests itself, but even there it is likely that it would cause great loss of civilian life by flooding and by the radioactive radiations.)

3. We have no information that the same idea has also occurred to other scientists but since all the theoretical data bearing on this problem are published, it is quite conceivable that Germany is, in fact, developing this weapon. Whether this is the case is difficult to find out, since the plant for the separation of isotopes need not be of such a size as to attract attention. Information that could be helpful in this respect would be data about the exploitation of the uranium mines under German control (mainly in Czechoslovakia) and about any recent German purchases of uranium abroad. It is likely that the plant would be controlled by Dr. K. Clusius (Professor of Physical Chemistry in Munich University), the inventor of the best method for separating isotopes, and therefore information as to his whereabouts and status might also give an important clue. At the same time it is quite possible that nobody in Germany has yet realized that the separation of the uranium isotopes would make the construction of a super-bomb possible. Hence it is of extreme importance to keep this report secret since any rumour about the connection between uranium separation and a super-bomb may set German scientists thinking along the right lines.

4. If one works on the assumption that Germany is, or will be, in the possession of this weapon, it must be realized that no shelters are available that would be effective and could be used on a large scale. The most effective reply would be a counter-threat with a similar bomb. Therefore it seems to us important to start production as soon and as rapidly as possible, even if it is not intended to use the bomb as a means of attack. Since the separation of the necessary amount of uranium is, in the most favourable circumstances, a matter of several months, it would obviously be too late to start production when such a bomb is known to be in the hands of Germany, and the matter seems, therefore, very urgent.

5. As a measure of precaution, it is important to have detection squads available in order to deal with the radioactive effects of such a bomb. Their task would be to approach the danger zone with measuring instruments, to determine the extent and probable duration of the danger and to prevent people from entering the danger zone. This is vital since the radiations kill instantly only in very strong doses whereas weaker doses produce delayed effects and hence near the edges of the

danger zone people would have no warning until it was too late. For their own protection, the detection squads would enter the danger zone in motor-cars or aeroplanes which would be armoured with lead plates, which absorb most of the dangerous radiation. The cabin would have to be hermetically sealed and oxygen carried in cylinders because of the danger from contaminated air. The detection staff would have to know exactly the greatest dose of radiation to which a human being can be exposed safely for a short time. This safety limit is not at present known with sufficient accuracy and further biological research for this purpose is urgently required.

As regards to the reliability of the conclusions outlined above, it may be said that they are not based on direct experiments, since nobody has ever yet built a super-bomb, but they are mostly based on facts, which by recent research in nuclear physics, have been very safely established. The only uncertainty concerns the critical size for the bomb. We are fairly confident that the critical size is roughly a pound or so, but for this estimate we have to rely on certain theoretical ideas which have not been positively confirmed. If the critical size were appreciably larger than we believe it to be, the technical difficulties in the way of constructing the bomb would be enhanced. The point can be definitely settled as soon as a small amount of uranium has been separated, and we think in view of the importance of the matter immediate steps should be taken to reach at least this stage; meanwhile it is also possible to carry out certain experiments which, while they cannot settle the question with absolute finality, could, if their result were positive, give strong support to our conclusions.

Working for Otto Frisch

J. Wechsler waited in alphabetical order alongside the other new army recruits for job placement at Los Alamos. Once inside, he had "a very strange job interview." Curious about his new boss, Wechsler recalls looking up his name in Who's Who in Physics.

From AHF Oral Histories
INTERVIEW WITH J. WECHSLER

The Ws are pretty far down the alphabet and I became a little concerned that all the good jobs might disappear. But they finally got to me and I went inside. The person who was interviewing me had a pretty heavy Austrian accent. He asked me about what I like to do. He asked me if I liked music. I told him I played the piano and the trombone and he seemed very interested in that.

I thought that this was a very strange job interview. He asked me what kind of pieces I like to play on the piano. I had not been playing much since I joined the army but I told him some of the things I liked. Then he talked about interests I had in technical things. I was kind of intrigued with him but I was not sure who he was.

Finally he said, "You're going to work with me. You should be back tomorrow. There will be instructions for you when you show up at the gate." I was done with my interview. I wasn't sure what I was getting into or what I would be doing.

The only thing I knew was that the name of my new boss was Otto Frisch. I asked some others who this fellow was and someone suggested, "You probably have access to the technical library. Why don't you go over and find out who Otto Frisch is?" That seemed like a pretty good idea so I headed over there.

I looked up the *Who's Who in Physics* and found Otto's name. I read what he was known for in physics and got very, very impressed.

Back at the laboratory the next day, I was sitting there at my bench looking at Otto. He looked up all of a sudden and said, "What are you looking at?"

I said, "I'm looking at you."

"Why are you looking at me?"

"Well, I know who you are."

He said, "I told you who I was."

"Yeah, but I think I know what we are doing and I think I know what this piece of junk is here that I am working on."

And he said, "Well, if you think you know what we are doing, you had better get back to work."

That was my introduction to the field of weapons. It turned out I was working on a large fission chamber which had been modified. Otto told me later he had originally worked on it in Denmark, shipped it to England with him and then over here to Los Alamos. He had had all kinds of people working on it but it had never quite worked right. He said, "You have a challenge." I modified the monstrosity and within a week, I had it working. Otto was mighty impressed and started suggesting other things we would work on.

Otto had so many ideas and regardless of the problem, he could think of a way of approaching it. While he was a great pianist, he was not really skilled with his hands. He wanted me to bounce ideas off of and to be his hands. Although I only worked with Otto for four months, we became very close friends.

THE MAUD BEHIND THE MAUD COMMITTEE

The name "MAUD," adopted as the code name for the British committee looking into the feasibility of producing an atomic bomb, is actually not an acronym. Instead, "Maud" is the name of a former governess employed by Danish physicist Niels Bohr. After Germany occupied Denmark in April 1940, Bohr sent a telegram to his former colleague Otto Frisch in England that ended with instructions to pass his words along to "Maud Ray, Kent." Mistakenly thinking that "Maud" was a cryptic reference to something related to their work, the committee called itself the "M. A. U. D. [or MAUD] Committee." Not until after the war was Maud Ray identified as the Bohrs's governess.

"A weapon of devastating power... will soon become available"

In this letter to Winston Churchill, Niels Bohr confesses his awe at the gigantic production facilities and top secret laboratories being built for the Manhattan Project in the United States. Aware of the initial tensions, he assures Churchill that the collaboration between the British and American scientists has been harmonious and productive. Finally, Bohr anticipates the problem of competition for nuclear weapons and the need to establish effective controls, a challenge for Churchill and the world's statesmen.

22nd May 1944

The Rt. Hon. Winston S. Churchill, C.H., M.P.

Sir,

In accordance with your kind permission, I have the honour to send you a brief report about my impressions of the great Anglo-American enterprise, in the scientific aspects of which I have been given the opportunity to participate together with my British colleagues.

The principles on which the enormous energy stored in the nuclei of atoms may be released for practical purposes were, as a result of international scientific collaboration, already perceived in outline before the war

and are, therefore, common knowledge to physicists all over the world. It was, however, by no means certain whether the task would surpass human resources, and it was therefore a revelation to me, on my arrival in England last October, to learn with what courage and foresight the effort had been undertaken and what an advanced stage the work had already reached.

In fact, what until a few years ago might be considered as a fantastic dream is at present being realized within great laboratories and huge production plants secretly erected in some of the most solitary regions of the United States. There a larger group of physicists than ever before collected for a single purpose, working hand in hand with a whole army of engineers and technicians, are preparing new materials capable of an immense energy release, and are developing ingenious devices for the most effective use of these materials.

To everyone who is given the opportunity to see for himself the refined laboratory equipment and the gigantic production machinery, it is an unforgettable experience, of which words can only give a poor impression. Moreover it was to me a special pleasure to witness the most harmonious and enthusiastic cooperation between the British and American colleagues, and on my departure I was expressly asked by the leaders of the American organization to convey their genuine appreciation of the help they are receiving, on an ever increasing scale, from their British collaborators.

I will not tire you with any technical details, but one cannot help comparing the situation with that of the alchemists of former days, groping in the dark in their vain efforts to make gold. Today physicists and engineers are, on the basis of firmly established knowledge, controlling and directing violent reactions by which new materials far more precious than gold are built up, atom by atom. These processes are in fact similar to those which took place in the early stages of development of the universe and still go on in the turbulent and flaming interior of the stars.

The whole undertaking constitutes, indeed, a far deeper interference with the natural course of events than anything ever before attempted, and it must be realized that the success of the endeavours has created a quite new situation as regards human resources. The revolution in industrial development which may result in coming years cannot at present be surveyed, but the fact of immediate preponderance is, that a weapon of devastating power far beyond any previous possibilities and imagination will soon become available.

The lead in the efforts to master such mighty forces of nature, hitherto beyond human reach, which by good fortune has been achieved by the two great free nations, entails the greatest promises for the future. The responsibility for handling the situation rests, of course, with the statesmen alone. The scientists who are brought into confidence can only offer the statesmen all such information about technical matters as may be of importance for their decisions.

In this connection it is significant that the enterprise, immense as it is, has still proved to demand a much smaller effort than might have been anticipated, and that the development of the work has continually revealed unsuspected possibilities for facilitating the production of the materials and for intensifying their effects.

These circumstances obviously have an important bearing on the question of an eventual competition about the formidable weapon, and on the problem of establishing an effective control, and might therefore perhaps influence the judgment of the statesmen as to how the present favourable situation can best be turned to lasting advantage for the cause of freedom and world security.

I hope you will permit me to say that I am afraid that, at the personal interview with which you honoured me, I may not have given you the right impression of the confidential conversation in Washington on which I reported. It was, indeed, far from my mind to venture any comment about the way in which the great joint enterprise has been so happily arranged by the statesmen; I wished rather to give expression to the profound conviction I have met everywhere on my journey that the hope for the future lies above all in the most brotherly friendship between the British Commonwealth and the United States.

It was just this spirit of co-operation that the President's friend [Felix Frankfurter], believing the matter to be of the highest importance for the two countries, and knowing that, at the Chancellor's request, I was coming to England for technical consultations, entrusted me, in strictest confidence, to convey to you, that the President is deeply occupied in his own mind with the stupendous consequences of the project, in which he sees grave dangers, but also unique opportunities, and that he hopes together with you to find ways of handling the situation to the greatest benefit of all mankind.

Most respectfully,
[Niels Bohr]

One Top Secret Agreement Too Many

This document was an attempt between Winston Churchill and Franklin D. Roosevelt to preserve an Anglo-American duopoly in nuclear matters after the war. The substitution of "might perhaps after mature consideration" for the single word "should" is open to at least two interpretations: (1) the two statesmen agreed that there would be full discussion before using the bomb against Japan; (2) the record was changed with an eye to history and it was always planned to use the bomb as soon as it became available. The final clause suggests that an ill FDR capitulated to Churchill's visceral distrust of Niels Bohr.

Roosevelt did not disclose the existence of this agreement to anyone in the U.S. government and after he died it was misfiled with some naval documents because the codename 'Tube Alloys' seemed likely to refer to a naval construction project. Again FDR may have kept its existence to himself because he thought it a bad agreement or because he believed it would be unenforceable or perhaps because he just overlooked it. After the war, the British would irritate U.S. politicians by referring to the aide-mémoire when trying to obtain nuclear information from the Americans, and ultimately it served as a source of resentment rather than cooperation. It also marked a crucial turn away from Bohr's concept of an open nuclear world.

Churchill's copy of the Hyde Park Aide-Mémoire (AM) with his handwritten amendments, September 19, 1944.

1. The suggestion that the world should be informed regarding Tube Alloys, with a view to an international agreement regarding its control and use, is not accepted. The matter should continue to be regarded as of the utmost secrecy; but when a "bomb" is finally available, it might perhaps, after mature consideration, be used against the Japanese, who should be warned that this bombardment will be repeated until they surrender.

2. Full collaboration between the United States and the British Government should continue after the defeat of Japan unless and until terminated by joint agreement.

3. Enquiries should be made regarding the activities of Professor Bohr and steps taken to ensure that he is responsible for no leakage of information, particularly to the Russians.

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10, Downing Street.
Whitehall.

TOP SECRET

TUBE ALLOYS

Conclusions of discussion between the President and the Prime Minister at Hyde Park, September 18, 1944.

1. The suggestion that the world should be informed regarding Tube Alloys, with a view to an international agreement regarding its control and use, is not accepted. The matter should continue to be regarded as of the utmost secrecy; but when a "bomb" is finally available, it might perhaps after mature consideration be used against the Japanese, who should be warned that this bombardment will be repeated until they surrender.

2. Full collaboration between the United States and the British Government in developing Tube Alloys for military and commercial purposes should continue after the defeat of Japan unless and until terminated by joint agreement.

3. Enquiries should be made regarding the activities of Professor Bohr and steps taken to ensure that he is responsible for no leakage of information, particularly to the Russians.

British Archives

Churchill's copy of the Hyde Park memo reveals his thinking through his handwritten comments.