THE OPPENHEIMER YEARS

1943-1945

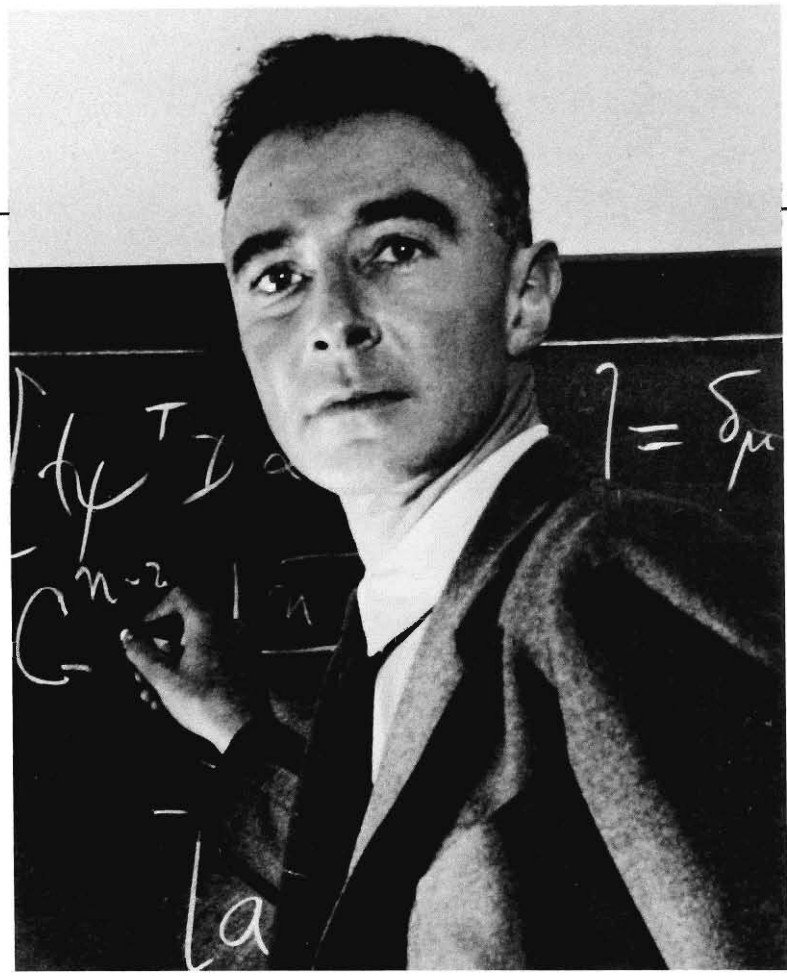


Photo courtesy of the J. Robert Oppenheimer Memorial Committee

"... I think surely if I were asked to do a job I could do really well and that it needed doing, I'd not refuse."

Robert

Berkeley, 1941

Reasons for project

The first step toward a more concerted program of bomb development was the appointment, in June 1942, of J. Robert Oppenheimer from the University of California as Director of the work. By October of 1942, it had been decided that the magnitude of the difficulties involved made necessary the formation of a new project. Even the initial work of providing nuclear specifications for the bomb was seriously hampered by the lack of an organization united in one locality; it was clear that without such an organization the ordnance work would be impossible.

David Hawkins, "Manhattan District History: Project Y," Los Alamos Laboratory report LAMS-2532 (1946), Chapter I.

"What is wrong with us?"

September 21, 1942

These lines are primarily addressed to those with whom I have shared for years the knowledge that it is within our power to construct atomic bombs. What the existence of these bombs will mean we all know. It will bring disaster upon the world if the Germans are ready before we are. It may bring disaster upon the world even if we anticipate them and win the war, but lose the peace that will follow. . . .

We may take the stand that the responsibility for the success of this work has been delegated by the President to Dr. Bush. It has been delegated by Dr. Bush to Dr. Conant. Dr. Conant delegates this responsibility (accompanied by only part of the necessary authority) to Compton. Compton delegates to each of us some particular task, and we can lead a very pleasant life while we do our duty. We live in a pleasant part of a pleasant city [Chicago] in the pleasant company of each other, and have in Dr. Compton the most pleasant "boss" [at the Metallurgical Laboratory] we could wish to have. There is every reason why we should be happy, and since there is a war on, we are even willing to work overtime.

Alternatively, we may take the stand that those who have originated the work on this terrible weapon and those who have materially contributed to its development have, before God and the World, the duty to see to it that it should be ready to be used at the proper time and in the proper way.

I believe that each of us has now to decide where he feels that his responsibility lies.

L. Szilard

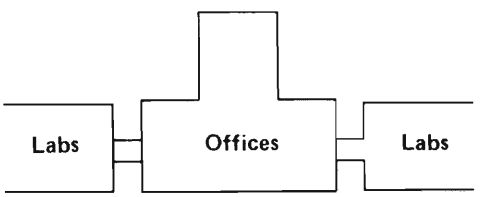
Logistics

Metallurgical Laboratory
October 12, 1942

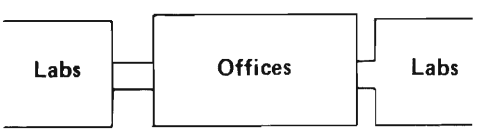
Dr. J. R. Oppenheimer
Le Conte Hall
University of California, Berkeley

Dear Oppy:

I enclose two copies of the material submitted to Stone and Webster [Boston architects for initial planning of facilities at Project Y] on Saturday. The plot plan submitted was essentially like the sketch I sent you except that two schemes for the office building were turned in. Scheme A looks like this . . .



and Scheme B looks like this . . .



Jackson (University architect) will prepare the more detailed study plan here so that we can keep in close touch with him. . . . Do you see any harm in letting some of our group know about these plans? . . .

Has anyone considered thorium for our purposes?

Sincerely yours,

John H. Manley

Los Alamos, N. Mex. SPELA November 25, 1942

SUBJECT: Acquisition of land for Demolition Range, Los Alamos, New Mexico. The Commanding General, Services of Supply.

1. There is a military necessity for the acquisition of land indicated under subject above and described more in detail in paragraph 2 below:

2. Description of land and other pertinent data are as follows:

a. BRIEF DESCRIPTION OF THE LAND: The area is located near Santa Fe and within Sandoval County, New Mexico, as shown in blue on the enclosed map.

b. PROPOSED USE: The land is required for the establishment of a Demolition Range.

c. ACREAGE INVOLVED: approximately 54,000 acres. . . .

d. IMPROVEMENTS: One established boys school containing expensively constructed improvements and personalty, altogether having a value of $246,600. . . .

e. ESTIMATED COST: $440,000. . . .

Thomas M. Robins,
Major General
Assistant Chief of Engineers

February 8, 1943

Mr. R. M. Underhill
Secretary to the Regents
University of California, Campus

Dear Mr. Underhill:

At your suggestion I am writing to ask for permission to waive in certain cases the University rules which forbid the employment of a man and his wife in the same department of the University. The reason for this request is that in the work on our new project we shall be in an isolated community where it will be difficult to procure the services of secretaries, stenographers, technicians, librarians, etc. Furthermore, it will be a great help . . . from the point of view of . . . reinforcing the morale of our people to allow those women who are qualified and experienced to work. . . . In addition, there are a few cases where a man and his wife are both trained physicists, and it would be a great waste for us if we had to exclude one or the other. . . .

Very sincerely yours,

Robert Oppenheimer

Robert Oppenheimer

February 19, 1943

Professor Robert Oppenheimer
Radiation Laboratory, Campus

Dear Professor Oppenheimer:

Mr. Underhill has referred to me your letter of February 8. . . .

I am quite willing to relax this rule in isolated communities. . . .

Yours sincerely,
Robert G. Sproul

Within the meaning of the Espionage Act, the contents of this document are not to be discussed. . . .You may discuss them with your wife if she accepts these limitations in all strictness. . . .

MEMORANDUM OF THE LOS ALAMOS PROJECT

We know you will want to have as clear a picture as possible, before coming to Los Alamos, of the many aspects of life here. . . . It is set in the pines at 7300 feet in very fine country. . . .

The country is a mixture of mountain country such as you have met in other parts of the Rockies, and the adobe-housed, picturesque, southwest desert that you have seen in Western Movies. . . .

Rent for furnished, equipped single rooms including utilities is $13.00 a month. Room service is $2.00 extra a month.

Rents for unfurnished apartments of all sizes are based on salaries and not on space occupied and are as follows:

Less than $2600	$17.00 a month
$2600 - 3100	23.00 " "
3100 - 3400	29.00 " "
3400 - 3800	34.00 " "
3800 - 4400	42.00 " "
4400 - 5200	50.00 " "
5200 - 6000	59.00 " "
Over 6000	67.00 " "

Persons now under OSRD contract will be paid the same amount without subsistence allowance.

Persons not now holding an academic position but who were in academic work will be paid according to the following schedule:

BS	$200
MS or BS plus 1 yr. education or experience	220
MS plus 1 yr. or BS plus 2 yrs.	240
MS plus 2 yrs. or BS plus 3 yrs.	260
PhD or MS plus 3 yrs. or BS plus 4 yrs.	280
PhD plus 1 yr.	305
PhD plus 2 yrs.	330
PhD plus 3 yrs.	355
PhD plus 4 yrs.	380
PhD plus maximum (Maximum of this scale)	400

Under a recent ruling of the War Manpower Commission, it is necessary to classify employees according to their duties and to freeze the wage range of each class of employees. The range for our technicians is $185.50 to $300.00 per month.

NOTES ON MEETING
March 6, 1943

Steering Committee: There was some discussion of the frequency of meetings of the whole planning committee. Dr. Oppenheimer said about once a month. Dr. Condon felt it should meet one night a week. Dr. Serber questioned the need of a steering committee. Dr. Oppenheimer felt that a planning committee of seventeen people could not act. He said, "We have one great problem of secrecy. I take it very seriously. If we muff it, we will get clamped down on so completely that a lot of us will leave, and the rest will work under conditions that they won't like at all. . . . I have asked Groves that a man from G-2 be assigned to us." . . .

April Conference: Dr. Oppenheimer asked for opinions on the question of inviting to the conference men who were not definitely committed to Los Alamos. . . . It was agreed that Fermi should come. Dr. Oppenheimer said that Rabi was not willing to join the project, but that he had said, "You can have half of my time free of charge in anything useful I can do." Dr. Oppenheimer said he . . . would also like Feynman and all the theorists . . . [and] that he did not want either Groves or Conant present; . . . it was agreed that the meeting was scientific and completely independent of the administrative work. . . .

The Conference, 15-24 April 1943

OUTLINE OF PRESENT KNOWLEDGE
[J. Robert] Oppenheimer

Materials and Schedules: . . . The isotope 25 [^{235}U] will support a chain reaction because neutrons of all energies can cause fission in it and because there are no known competing processes. . . . It has been shown that there is no appreciable fraction of neutrons delayed by more than 10^{-5} sec. . . . It (25) is being produced in two ways.

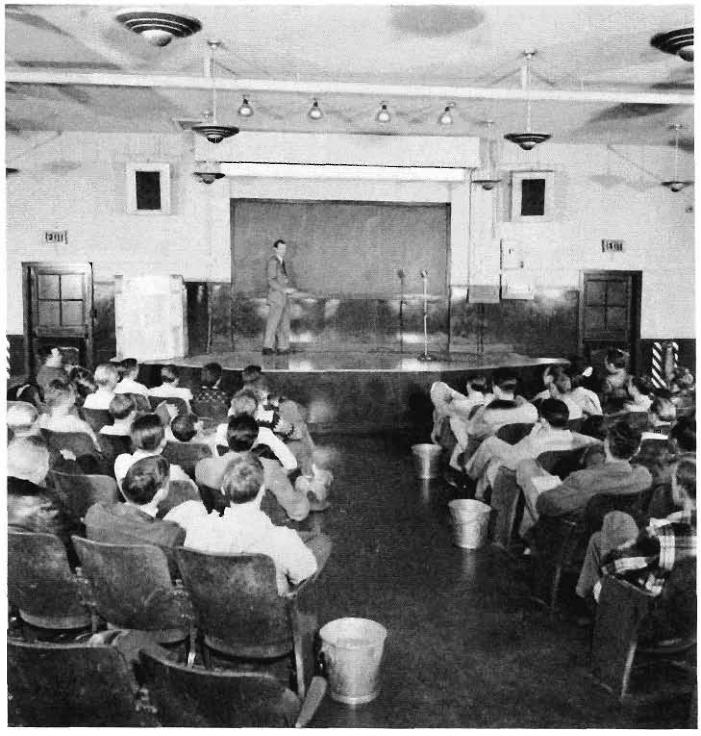
Lawrence's group [Berkeley] is separating the isotope 25 by mass spectrographic means. It is planned to have 500 tanks of two each installed by January 1, 1944. It is expected that each arc will give 100 milliamps of 28 [^{238}U] and 3 milliamps of enriched beam.

Urey's group is separating 25 by a diffusion process [Columbia University]. . . .

The element 49 [^{239}Pu] is produced from 28 by the absorption of neutrons. The material is to be produced on a large scale by the Chicago pile. 300 gms per day is hoped for by Jan. 1945.

Isotope 23 [^{233}U] can be produced by putting thorium around a pile. The yield is small, 5% of 49, for a carbon pile. The yield would be 20% for a deuterium pile.

Energy Release: The destructive effect of the gadget is due to radiative effects and the shock wave generated by the explosion. . . . The shock wave effect seems to extend over the biggest area and would be, therefore, most important. The area devastated by the shock wave is proportional to the 2/3 power of the energy release and may be simply calculated by comparing the energy release with that of TNT. If the reaction would go to completion, then 50 kg of 25 would be equivalent to 10 tons of TNT. Actually it is very difficult to



There was . . . a weekly Colloquium which all staff members were privileged to attend . . . [and which] was less a means of providing information than of maintaining the sense of common effort and responsibility . . . [This] policy adopted concerning communication represented a considerable departure from the customs normally surrounding the protection of military secrets. Hawkins, "Project Y," Chapter III.

obtain a large percentage of the potential energy release.

Detonation: The second major difficulty facing us is connected with the question of detonation. . . . It is important that . . . no neutron should start a premature chain reaction. . . . Possible sources of neutrons are 1) Cosmic ray neutrons . . . and 2) Spontaneous fission neutrons. . . .

EXPERIMENT RESULTS AND DESCRIPTION OF AVAILABLE EQUIPMENT

John Manley

Experimental Nuclear Research Facilities: . . . We shall have a cyclotron, obtained from Harvard, which should give us about 50 μa of 10 MeV deuterons. . . .

Two pressure Van de Graaffs have been obtained from Wisconsin. . . .

Illinois has loaned us a Cockcroft-Walton outfit which when used as a D-D [deuteron-deuteron] source, delivers 300 μa of 0.3 MeV deuterons producing some 10^8 n/sec.

Neutrons may also be produced from chain reactions. Fermi's pile operates conveniently at 100 watts, at which power it gives 10^{13} n/sec or about 5×10^5 n per sec per cm^2. These include both fast and thermal neutrons. . . .

The natural source situation is not completely clear, but we are obtaining from Chicago the following sources: 200 mc pressed Ra-Be mixed source, yielding 2×10^6 n/sec; 500 mc RdTh for a photo source which should yield about 5×10^6 n/sec of .9 MeV with Be; 2000 mc pressed Ra-B mixed source, yielding about 5×10^6 n/sec. . . .

THE CHAIN-REACTING PILE

[Enrico] Fermi

The first chain reacting pile was built in the fall of 1942. It contained 6 tons of metal, 40 tons of oxide, and 400 tons of graphite. The shape was a sphere of 26′ diameter with the best materials in the center. . . . This first chain reaction was obtained on December 2, 1942. . . .

The present chain reacting pile is designed for convenient performance of experiments. Its dimensions are $20' \times 22' \times 18'$ and it has a removable 33″ section in the center. It is shielded to a factor $10^4 - 10^5$ by a 5′ concrete wall. On top, a 6′ graphite column for a source of thermal neutrons projects through the shield.

The pile has two types of uses. First it is a relatively intense and very stable source of neutrons. The intensity can be controlled within 0.1% . . . .

The other main use of the pile is to measure changes in the critical position of the control rod due to insertion of various materials in the pile. This is especially useful for rapid determination of absorption cross sections.

EXPECTED DAMAGE OF THE GADGET

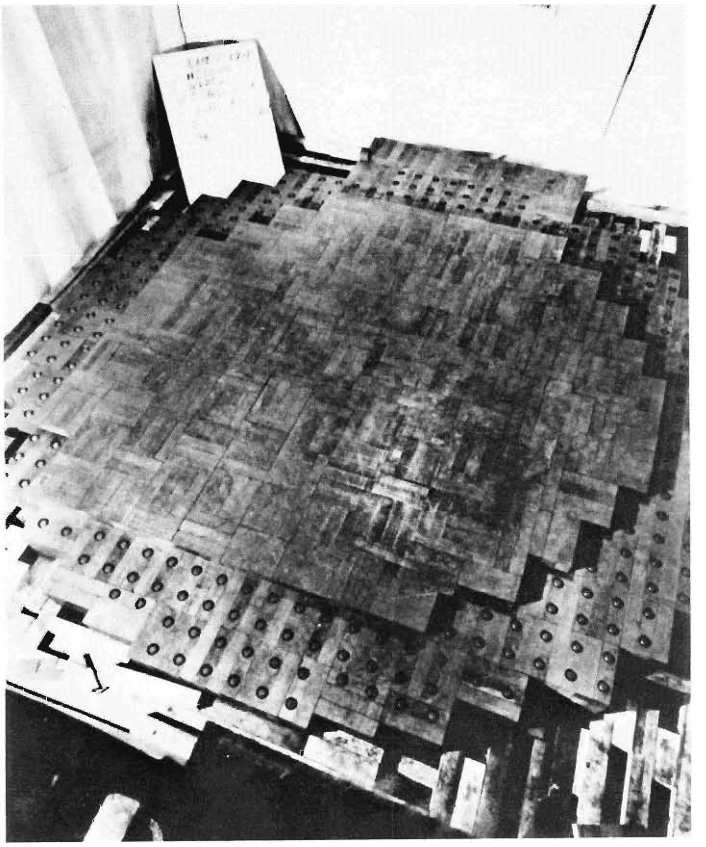
[Hans] Bethe

Comparison with TNT: The most striking difference between the gadget and a TNT charge is in the temperatures generated. The latter yields temperatures of a few thousand degrees whereas the former pushes the temperature as high as [tens of millions of degrees]. . . .

The actual damage depends much on the objective. Houses begin to be smashed under shocks of 1/10 to 1/5 of an atmosphere. For objects such as steel supported buildings and machinery, greater pressures are required and the duration of the shock is very important. If the duration of the pressure pulse is smaller than the natural vibration period of the structure, the integral of the pressure over the duration T of the impulse is significant for the damage. If the pulse lasts for several vibration periods, the peak pressure is the important quantity. . . .

Other Damage: The neutrons emitted from the gadget will diffuse through the air over a distance of 1 to 2 km, nearly independent of the energy release. Over this region, their intensity will be sufficient to kill a person.

The effect of the radioactive fission products depends entirely on the distance to which they are carried by the wind. If 1 kg of fission products is distributed uniformly over an area of about 100 square miles, the radioactivity during the first day will represent a lethal dose (≈500 R units); after a few days, only about 10 R units per day are emitted. If the material is more widely distributed by the wind, the effects of the radioactivity will be relatively minor.



The chain-reacting pile at Chicago.

July 29, 1943.

Dr. J. R. Oppenheimer
P. O. Box 1663
Santa Fe, New Mexico

Dear Dr. Oppenheimer:

. . . It is requested that:

(a) You refrain from flying in airplanes of any description; the time saved is not worth the risk. . . .

(b) You refrain from driving an automobile for any appreciable distance (above a few miles) and from being without suitable protection on any lonely road, such as the road from Los Alamos to Santa Fe. . . .

(c) . . . In driving about town a guard of some kind should be used, particularly during hours of darkness. The cost of such guard is a proper charge against the United States.

I realized that these precautions may be personally burdensome. . . .

Sincerely,

L. R. Groves
Brigadier General, C. E.

LIAISON WITH X [Oak Ridge]

Dear General Groves,

I enclose the list of questions you requested. The list is not exhausted—I am. You surely know that one cannot think of or ferret out all the pertinent questions. . . .

I am not able to understand your feeling that whoever tried to act as liaison for this project would be in any sense competing with you. I should certainly not want to have any part in such a duty if this feeling exists. . . .

As to the nature of the questions, I have endeavored to ask only those which have a direct and immediate bearing on the program here. Two examples will serve to illustrate:

1. We cannot properly assign a given small quantity of 49 among the numerous experimental uses without knowing when and how much will arrive later.

2. We cannot specify the amount of polonium required for a certain application if 49 production could compete unless the details of both polonium and 49 production are known, so that relative production costs (time, chiefly) can be weighed against physical advantages and disadvantages. . . .

I hope that this execution of the task you assigned to me meets with your approval. . . . You cannot have been unaware that I left our conference on this subject with little conviction or enthusiasm for this task, except in so far as you considered it as a preliminary to what we regard as a necessary liaison.

Very truly yours,
J. H. Manley

September 18, 1943

Dr. R. G. Sproul, President
University of California, Berkeley

Dear President Sproul:

At the time when the special project in New Mexico was opened, my salary was set by the University. . . at $10,000 a year. . . .

In peacetime I was, both at the University of California and at California Institute of Technology, a professor of physics and not a director of anything. Thus my present salary exceeds by a little over $200 a month that which I would get if we applied our usual formula to my peacetime salaries. I think that neither the University nor I would want to regard work done for the Government of the United States in time of war as the occasion for any essential increase in income, and I am therefore suggesting that in the future my salary might be reduced in accordance with the procedure which we in general follow. . . .

Very sincerely yours,
J. R. Oppenheimer

September 30, 1943

Note to President Sproul:

As I told you yesterday in Los Angeles, I do not see any particular reason why the salary of Dr. J. R. Oppenheimer should be reduced. . . .

Robert M. Underhill
[Secretary of the Regents]

War Department
P. O. Box 2610
Washington, D.C.
20 June 1944

Dr. J. R. Oppenheimer
P. O. Box 1663
Santa Fe, New Mexico

My dear Dr. Oppenheimer:

This refers to your proposal to develop the one kilowatt water boiler for use as a strong source of neutrons for experiments at Y, as proposed orally to me last week. . . .

Our main and actually our sole interest at this time lies in procuring, at the earliest date possible, the necessary but small number of the final gadgets, properly designed and fabricated. . . .

From the teletype Fermi and Bacher appear to feel that the water boiler project will make such a contribution to the desired end. If you . . . feel the same way, then we should go ahead with the proposed project. . . .

Sincerely,
L. R. Groves
Major General, C.E.

"We are free to start things, free to go about them, but then the rock of what the world is really like limits and shapes this freedom."

J. Robert Oppenheimer

August 1944 reorganization

During the first six months of the Laboratory, the gun method of assembly was the focus of administrative and technical activities in the ordnance program. By February 1944 . . . sufficiently accurate calculations had been made so that, for the U^{235} gun, Group T-2 specified the actual bore. During the period to August 1944 the main focus of activity was the plutonium gun. In the summer of 1944 . . . when the first Clinton plutonium made by chain reactor arrived—much more heavily irradiated than the previous samples made by cyclotron bombardment—the existence of Pu^{240} was verified, as was the fear that it might be a strong spontaneous fissioner. Neutron background in the plutonium which would be produced at full power was punched up into the region where, to prevent predetonation, assembly velocities would have to be much greater than those possible with the plutonium gun. The implosion was the only hope, and from current evidence a not very good one. It was decided to attack the problems of the implosion and with every means available, "to throw the book at it." Administratively, the program was taken out of the Ordnance Division and divided between two new divisions. One of these was to be concerned primarily with the investigation of implosion dynamics, the other primarily with the development of adequate HE [high explosives] components.

Hawkins, Project Y, Chapter IV.

R F Bacher

August 14, 1944

R. F. Bacher
J. R. Oppenheimer

Organization of Gadget Division

. . . I am sending you a directive on the functions of the Gadget Division and of its relations to other parts of the laboratory. . . .

1. To develop methods and to apply them for the determination of the hydrodynamics of implosion. . . .

2. To conduct semi-integral and integral studies of the materials to be used in implosion gadgets from the point of view of their multiplication properties.

3. To be immediately responsible for the design specifications of the tamper [neutron reflector], active material, source, etc., to be used in implosion gadgets. . . .

4. To collaborate wherever possible in providing instrumentation for studying the problems of the Explosives Division.

. . . keep Captain Parsons promptly and fully informed. . . .

It is clearly appreciated by me that in undertaking at this late date the grave responsibilities of the direction of the Gadget Division you are in no way assuring me that the program for which you will be responsible can be successful within the short time limits set by our directives and by the war.

J. R. Oppenheimer

S B. Kistiakowsky

August 14, 1944

G. B. Kistiakowsky
J. R. Oppenheimer

Organization of Explosives Division

. . . I would like to formulate as follows the functions of the Explosives Division of which you are assuming the direction.

1. To investigate promising explosives, methods of initiation, boosting, detonation, etc. for implosion.

2. To develop methods for improving the quality of castings.

3. To develop lens systems and methods for fabricating and testing them.

4. To develop a suitable engineering design for the assembly. . . .

5. To cooperate closely with the Gadget Division in providing the necessary charges for their investigations.

. . . keep Captain Parsons promptly and fully informed. . . . Feel free to present me with any problems in whose solution I could prove useful.

J. R. Oppenheimer

September 15, 1944

Captain W. S. Parsons, USN

Subject: Organization

W. S. Parsons

Your thoughtful and considered memorandum on the subject of organization has focused attention on points which need to be clarified. On the whole my reaction to what you say is sympathetic.

1. I have always understood your position here as including responsibility and authority for the determination of the actual components of the weapon subject to the fact that these components must attempt to meet certain specifications imposed by physical requirements which can be defined only by physical and mathematical research. It has not been my intention to take the direct responsibility for this determination myself; I have neither the qualifications for, nor the intention of, doing so in the future. . . .

2. The kind of authority which you appear to request from me is something that I cannot delegate to you because I do not possess it. I do not in fact, whatever protocol may suggest, have the authority to make decisions which are not understood and approved by the qualified scientists of the laboratory who must execute them. . . [and] I should not consider making a decision which was not supported by responsible and competent men in the laboratory. Therefore any authority which I might ask you to assume in connection with the conduct of your part of the work would have to be similarly qualified. . . .

Nothing that I can put in writing can eliminate this necessity. . . . I will support decisions reached by you . . . as long as these decisions are reached after competent technical discussion and after the opinions of all vitally concerned have been given appropriate weight. I am not arguing that the laboratory should be so constituted. It is in fact so constituted. . . .

J. R. Oppenheimer

October 6, 1944

Major General L. R. Groves
P. O. Box 2610
Washington, D. C.

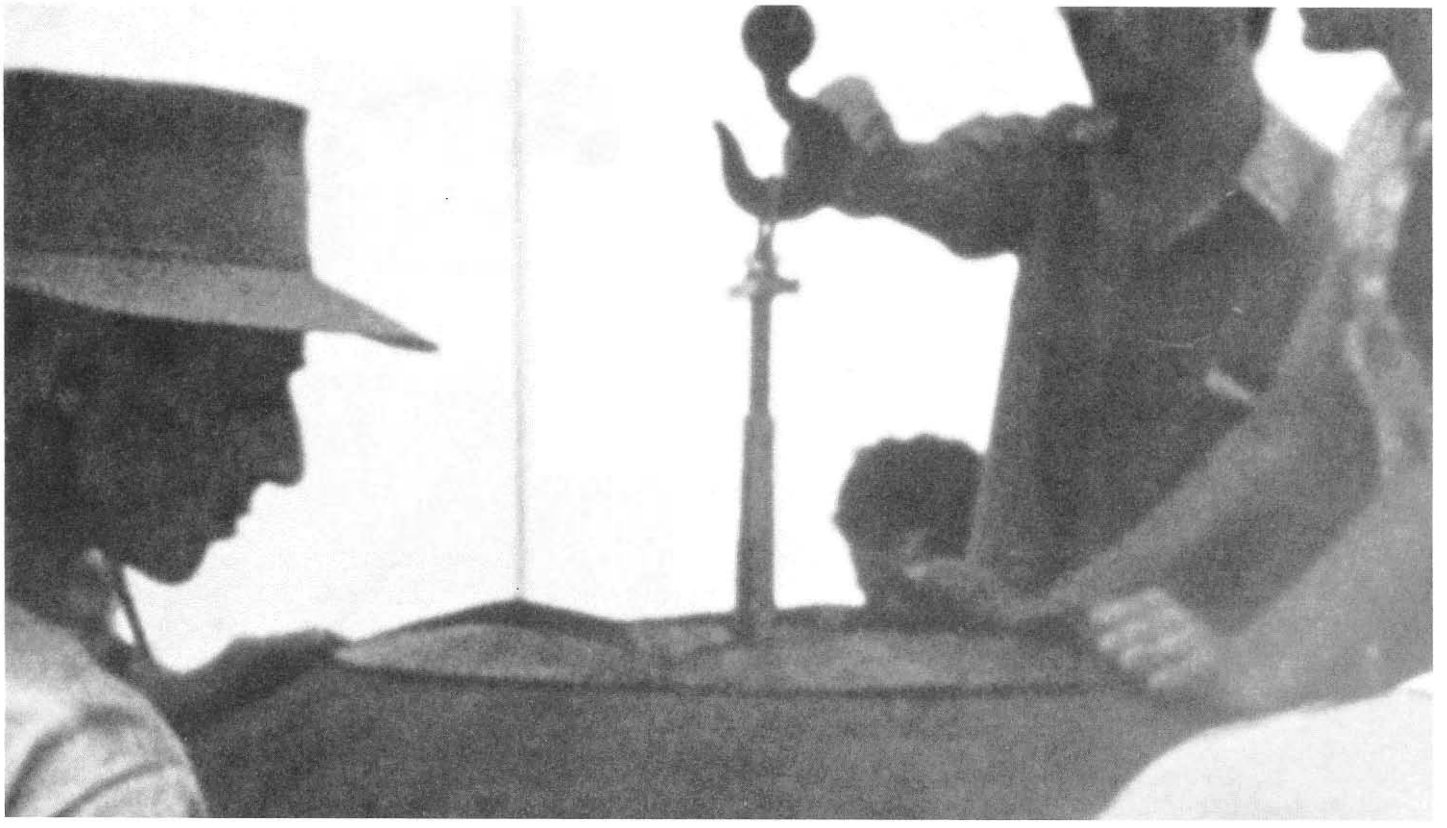
Leslie R. Groves

Dear General Groves:

I am glad to transmit the enclosed report of Captain Parsons, with the general intent and spirit of which I am in full sympathy. There are a few points on which my evaluation differs somewhat from that expressed in the report and it seems appropriate to mention them at this time.

I believe that Captain Parsons somewhat misjudges the temper of the responsible members of the laboratory. It is true that there are a few people here whose interests are exclusively "scientific" in the sense that they will abandon any problem that appears to be soluble. I believe that these men are now in appropriate positions in the organization. . . .

Sincerely yours,
J. R. Oppenheimer



"In every investigation, in every extension of knowledge, we're involved in action. And in every action we're involved in choice. And in every choice we're involved in a kind of loss, the loss of what we didn't do. We find this in the simplest situations. . . . Meaning is always obtained at the cost of leaving things out. . . . In practical terms this means, of course, that our knowledge is always finite and never all encompassing. . . . This makes of ours an open world, a world without end."

J. Robert Oppenheimer

Final work

As the implosion program developed and the time schedule tightened, . . . functions were taken over by various interdivisional committees and conferences. Among the most important of these were the Intermediate Scheduling Conference under Captain Parsons, the Technical and Scheduling Conference, and the "Cowpuncher" Committee, . . . organized to "ride herd on" the implosion program. Both of the last named committees were under the chairmanship of S. K. Allison, former Director of the Metallurgical Laboratory, who arrived at Los Alamos in November 1944. In this shift from the single Technical Board to the more flexible structure of specialized committees, the Director had the advice not only of these committees, but also of certain senior consultants, notably Niels Bohr, I. I. Rabi, and C. C. Lauritsen, who served in the capacity of elder statesmen to the Laboratory. . . .

Early in March 1945 two new organizations were created with the status of divisions—the Trinity Project and the Alberta Project—one to be responsible for the test firing of an implosion bomb at Trinity, and the other to be responsible for integrating and directing all activities concerned with the combat delivery of both types of bombs.

Hawkins, Project Y, Chapter IX.

MEMORANDUM ON TEST OF IMPLOSION GADGET February 16, 1944

1. The implosion gadget must be tested in a range where the energy release is comparable with that contemplated for final use. . . . This test is required because of the incompleteness of our knowledge. Thus the reaction will proceed at a temperature unobtainable in the laboratory, which corresponds to energies at which nuclear properties are, and will probably remain, rather imperfectly known. Further, pressures under which the gadget will operate are likewise unobtainable in the laboratory and the information which we may obtain on the spacio-temporal distribution of the pressures will in all probability be not only imperfectly known to us, but somewhat erratic from case to case.

Various attempts have been made to propose an experimental situation which would enable a test of the kind mentioned above to be carried out under conditions so controlled that the energy release was small. . . . All present proposals seem to me unsatisfactory, at least in the sense that they cannot replace more realistic tests. The proposals which have been made are the following:

a. That the amount of active material used be so limited that the nuclear reaction proceeds over a matter of some 30 ± 15 [neutron] generations to give a readily detectable radio-activity or neutron burst, but no appreciable energy liberation.

b. That the reaction be limited by the thermal stability and increased time scale of excess hydrogenation.

c. That the reaction be limited with normal or excess hydrogenation by the addition of appropriate resonance absorbers which will quench the reaction at temperatures of the order of tens of volts.

As for the first of these proposals, . . . we do not now have, and probably will never have, information precise enough to predict an appropriate mass with any degree of probability. . . . This would involve, among other things, knowing the radius of the compressed core to within 5 per cent. Furthermore, it is doubtful whether one could approach this limited explosion by gradual stages with any certainty and without very numerous subcritical trials since there is no a priori assurance, and some a priori doubt, that the implosions will be reproducible to the extent required.

As for the second and third proposals, which have been advocated with eloquence by Dr. Teller, it appears at the present time extremely doubtful whether a sufficiently complete knowledge of the hydrodynamics and nuclear physics involved will be available to make these tests either completely safe or essentially significant. We should like to leave open at the present time the possibility that either these experiments or others not yet proposed may, some months from now, be capable of essentially unambiguous interpretation. . . .

4. . . . It is my decision that we should plan . . . an implosion . . . so designed that the energy release be comparable with that of the final gadget, but possibly smaller by as much as a factor of 10; . . . that no definite decision against more controlled experiments be made at the present time. . .; and that in the light of the above considerations, all methods which hold promise of giving reliable information about the hydrodynamics and nuclear physics of the implosion be pursued with greatest urgency. . . . It would appear to be very much less difficult to predict and interpret the dimensions and construction of a gadget releasing some thousands of tons of TNT equivalent in nuclear energy than to make the corresponding predictions for nuclear explosions whose energy release, though finite, is negligible.

J. R. O.

March 10, 1944

Brig. Gen. L. R. Groves
P. O. Box 2610
Washington, D. C.

Dear General Groves:

. . . [In regard to] a containing sphere [Jumbo] for proof firing, there were a number of points made which I should like to have down in the record. . . .

. . . It was not known to us whether it could be made in the form of a single sphere or would have to be built up from plates. Excluding the extra weight introduced by manholes and reinforcements, the weight of the sphere was given by us as 80 tons provided steel could be obtained of yield strength 60,000 psi or better. You expressed the conviction that individual castings in excess of a hundred tons would introduce very serious transportation problems which should be avoided if possible. . . .

We shall attempt to have a container fabricated and completely assembled by September so that it may play as useful a part as possible in the later stages of implosion development.

[J. Robert Oppenheimer]

December 22, 1944

K. T. Bainbridge
J. R. Oppenheimer

[Gadget Testing Using Water for Recovery and Control]

After the meeting Tuesday I had some further opportunity to discuss with General Groves and Dr. Conant the matter of water recovery at Trinity. I think the factors affecting this are well known to you, namely that we do not at the present time plan a test implosion with 25 and that water recovery with 49 looks like a most difficult and hazardous undertaking.

. . . Under these circumstances it seemed to all of us that no further plans should be made for water recovery at Trinity. . . .

J. R. Oppenheimer

May 18, 1945

Capt. W. S. Parsons
K. Bainbridge

Thank you very much for your fine cooperation in obtaining information concerning helicopters and blimps [for collecting air samples] in the TR [Trinity] program.

The rockets have worked out so well. . .we will proceed with the use of rockets only, and no further inquiries on blimps or helicopters will be required.

K. Bainbridge

April 17, 1945

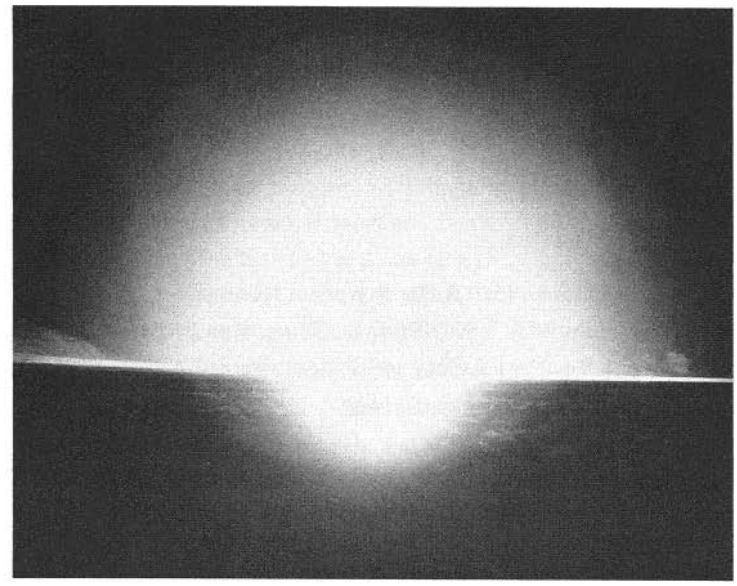
Mr. K. T. Bainbridge
H. L. Anderson

Plutonium Spiking for 100 T Shot

Please consider the advisability of adding 10 grams of plutonium to the active solution of the 100 T shot. Sugarman would like to try a plutonium as well as a fission product extraction from the dirt recovered after this shot. . . .

H. L. Anderson

[The firing of 100 tons of TNT was used as a rehearsal test of blast effects. The stack of HE was provided with tubes containing 1000 curies of fission products derived from a Hanford slug to simulate at a low level of activity the radioactive products expected from the nuclear explosion. (Hawkins, Chapter X)].



The 100 T shot.

Dec. 15, 1944

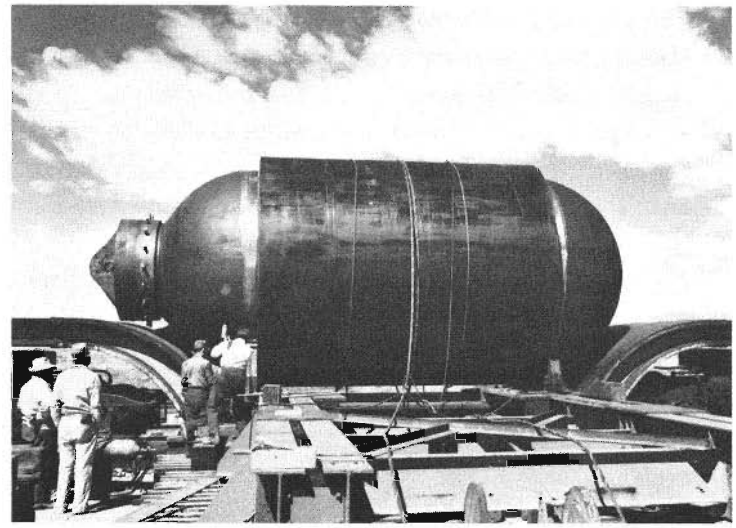
Mr. Carlson and Mr. Mack
Mr. Penney

The Heat of Combustion of Jumbo

. . . The energy needed to vaporize one gram of iron is between 300 and 400 calories. Taking the mass of Jumbo to be 220 tons, and the heat of detonation of HE to be 1000 calories per gram, it is seen that Jumbo cannot be vaporized if the energy released by the gadget is less than about 100 tons HE equivalent. . . .

If Jumbo is completely vaporized, there is a strong probability that the iron vapor will burn rapidly, and the energy thereby released will be right up in the front of the blast wave. The energy of combustion of one gram of solid iron at room temperature is about 1950 calories. Hence the HE equivalent of Jumbo is about 400 tons.

W. G. Penney



Jumbo was designed to withstand the explosion of HE and permit recovery of active material should the Trinity shot fail. It was not used.

July 11, 1945

Comdr. N. E. Bradbury
K. Bainbridge

Jumbo

Jumbo is a silent partner in all of our plans and is not dead yet. . . .

K. Bainbridge

9 July 1945

Personnel Concerned
Comdr. N. E. Bradbury

TR [Trinity] Hot Run

The firm dates for the TR Hot Run are as follows [in part]:

Monday, 9 July, 0830 Schaffer Shake Test charge given eight-hour road test. Remove polar cap and dummy plug and inspect top of charge only after three hours riding.

Thursday, 12 July, 0830 Use two groups—one at V Site [shops] to assemble TR charge . . . .

Friday, 13 July, 0001 TR charge starts on its way to TR. G-2 escort cars fore and aft. G. B. Kistiakowsky to ride in fore car.

Friday, 13 July, 1300 Assembly at TR

- With jib hoist, remove polar cap and dummy plug. Special polar cap and funnel put in place. Gadget now belongs to tamper people (at about 1400 on Friday). Prior to their taking over, a fifteen minute period will be available for generally interested personnel to inspect the situation. After this time, only G engineers and two representatives from the assembly team will be present in the tent.
- Place in hypodermic needle *in right place.* (Note: check this carefully.)
- At this point another 15-minute period will be available for inspection . . . .
- Insert HE—this to be done as slowly as the G Engineers wish. Have on hand extra paper if charges are slightly small. Also grease and hypodermic needle grease gun. Be sure glass tape and/or shim stock shoe horn is on hand.
- Another inspection period of 15 minutes will be available.
- Leave tent in place till morning.

Saturday, 14 July, 0800 Lift to tower top

- Remove tent with main hoist.
- Lift sphere to tower top.

Saturday, 14 July, 0900 Operations aloft

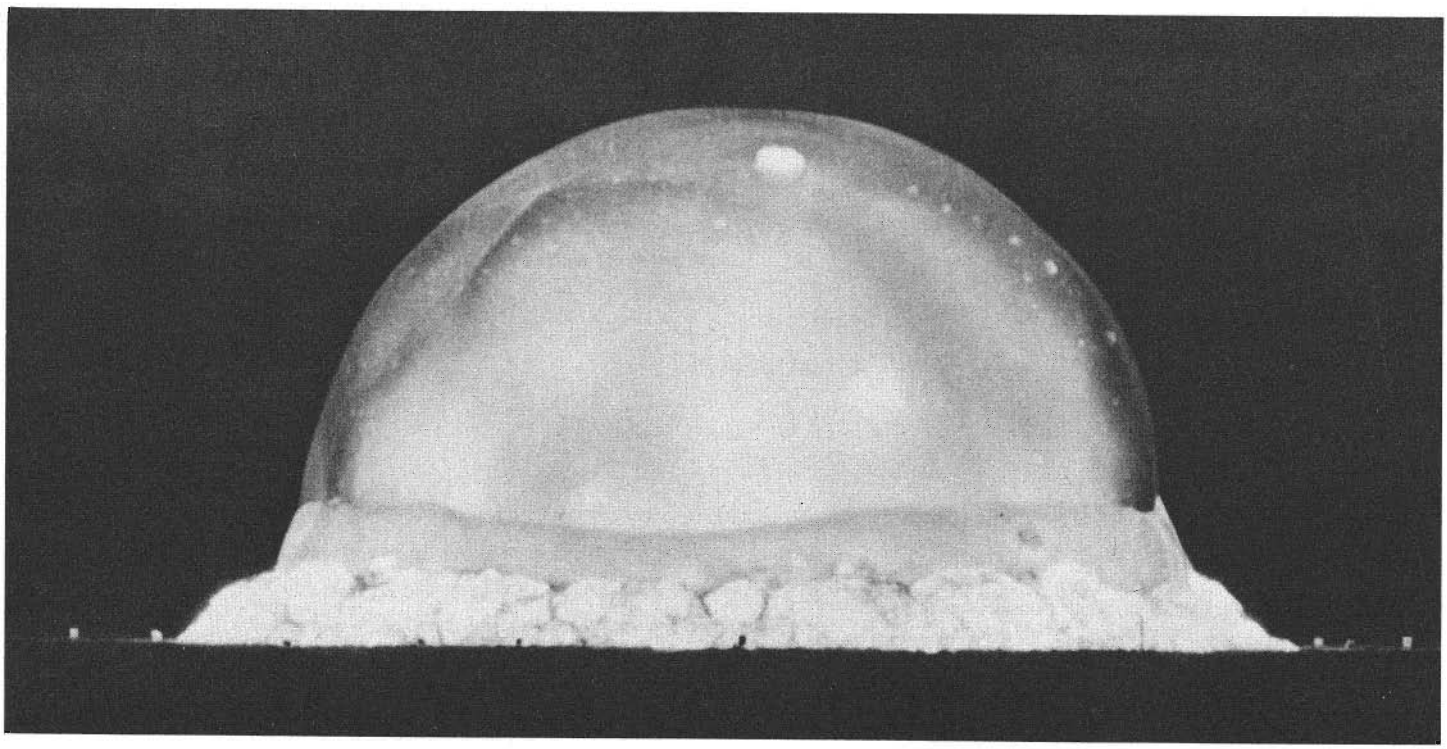
- Wiring of X unit proceeds . . . .
- Detonators are staked to co-ax . . . .
- X unit and informer unit safed—verified by Bradbury or Kistiakowsky. . . .
- Note that once detonators are on sphere, no live electrical connection can be brought to X unit, informer unit, or anywhere else on sphere. Hence all testing must be done before sphere is lifted to tower. After that it is too late.

Saturday, 14 July, 1700 Gadget complete

Sunday, 15 July, all day. Look for rabbit's feet and four leafed clovers. Should we have the Chaplain down there? Period for inspection available from 0900-1000

Monday, 16 July, 0400 BANG!

N. E. Bradbury



"History of Project A"

[1945]

The history of Project A [Alberta] is essentially the history of the combat use of the ATOMIC BOMB and of the preparation and planning to make this use possible . . . . Project A as such was not established until March of 1945. However, . . . the first major activities . . . concerned with the delivery program began in June of 1943. . . . The only United States aircraft in which such a bomb [Pu^{239} gun assembly] could be . . . internally carried was the B-29. . . .

In the fall of 1943 . . . two external [bomb] shapes and weights were selected. . . . For security reasons these were called by the Air Forces representatives the "Thin Man" and "Fat Man" respectively—the Air Forces officers tried to make their phone conversations sound as if they were modifying a plane to carry Roosevelt (the Thin Man) and Churchill (The Fat Man). . . .

Tests with the modified aircraft and full scale dummy bombs were begun at Muroc on 3 March 1944. The negative results . . . thoroughly justified the holding of preliminary tests at such an early date. The fuses proved to be unreliable and the Fat Man . . . proved to wobble badly with its axis departing 20° from the line of flight. Although the B-29 release mechanism worked satisfactorily for the Fat Man, it failed completely for the Thin Man. . . .

Between the end of the first tests and June 1944 . . . it became apparent that Pu^{239} could not be used in a gun due to neutrons of Pu^{240} almost certainly causing a predetonation. . . . For U^{235} the gun velocity could be reduced . . . and the length of its bomb correspondingly. . . . This model finally acquired the appropriate name of Little Boy. . . .

Tests at Muroc were resumed in June of 1944. . . . The Fat Man models with their tails modified . . . still had an undampable wobble. As a desperate last resort Ramsey suggested a drop be made with internal 45° baffle plates welded into the inside of the shroud. . . . To everyone's surprise this modification was successful . . . the ballistic coefficient being improved rather than decreased as anticipated. . . .

The first tests [with a combat unit] began at Wendover [code name, "Kingman"] in October 1944. . . . tests which continued intermittently, then monthly, and finally almost continuously up to August of 1945. . . .

The chief design activities during this period were . . . the exact design of the tamper sphere, incorporation of . . . a trap door assembly. . . , etc.

The unfortunate failure of the Raytheon Company to meet its delivery schedule on X-Units (electrical detonators) added markedly to the difficulty of the test program. . . . It was not until the end of July that sufficient X-units had been tested to confirm their safety with HE: the first HE filled Fat Man with an X-unit was tested at Wendover 4 August, . . .[another] at Tinian [the overseas base] 8 August, and the first complete Fat Man with active material was dropped on Nagasaki 9 August.

On 26 July the U^{235} projectile for the Little Boy was delivered by the cruiser Indianapolis. The U^{235} target insert arrived in three separate parts in three otherwise empty Air Transport Command C-54's during the evenings of 28 to 29 July. . . . Although the active unit was completely ready in plenty of time for a 2 August delivery, the weather was not. Finally on the morning of 5 August we received word that the weather should be good on 6 August. . . . The progress of the mission is best described in the log which Capt. Parsons kept during the flight.

N. F. Ramsey

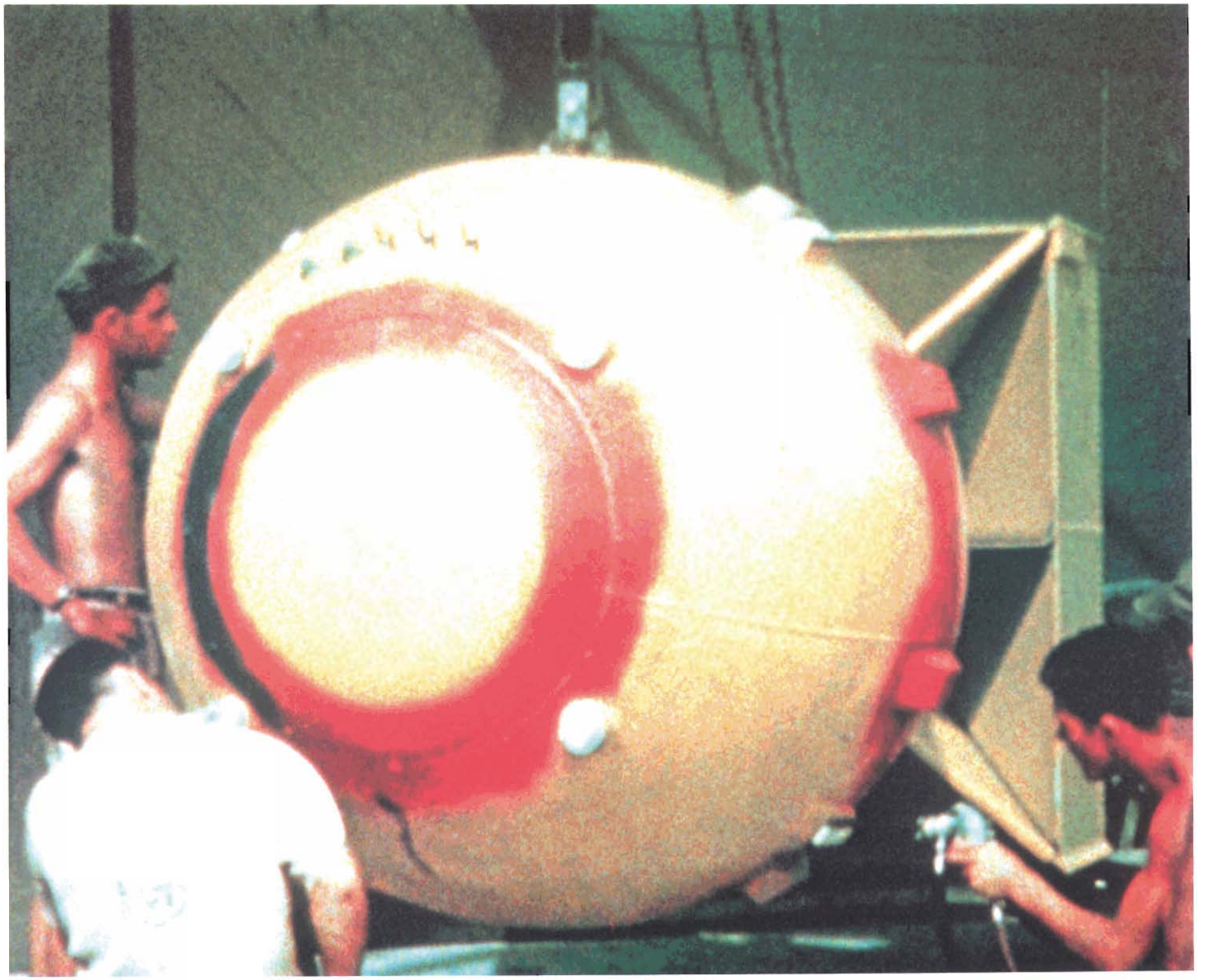
With the exception of three italicized quotations, the material for "The Oppenheimer Years" was drawn directly from the archives and from the report library of Los Alamos National Laboratory.

". . . I think surely . . ." is a line from a letter written by Robert Oppenheimer to William A. Fowler shortly after the latter left California Institute of Technology to serve as assistant director of research for the National Defense Research Committee. Reprinted by permission from Robert Oppenheimer: Letters and Recollections, *edited by Alice Kimball Smith and Charles Weiner (Cambridge: Harvard University Press, 1980), p. 215.*

The quotations "We are free to start things . . ." and "In every investigation . . ." are excerpts from a talk given by Robert Oppenheimer at the University of Colorado, June 6, 1961. The talk was published under the title "Reflections on Science and Culture" in the Colorado Quarterly, *Vol. 10, No. 2, 101-111 (Autumn 1961). Reprinted by permission.*

6 August 1945

0245	Take off
0300	Started final loading of gun
0315	Finished loading
0605	Headed for Empire from Iwo
0730	Red plugs in (these plugs armed the bomb so it would detonate if released)
0741	Started climb
	Weather report received that weather over primary and tertiary targets was good but not over secondary target.
0838	Leveled off at 32,700 feet
0847	All Archies (electric fuses) tested to be O.K.
0904	Course west
0909	Target (Hirsohima) in sight
0915	Dropped bomb (Originally scheduled time was 0915)
	Flash followed by two slaps on plane. Huge cloud
1000	Still in sight of cloud which must be over 40,000 feet high
1003	Fighter reported
1041	Lost sight of cloud 363 miles from Hiroshima with the aircraft being 26,000 ft. high.



It is with appreciation and gratefulness
that I accept from you this scroll
for the Los Alamos Laboratory, and for the men and women
whose work and whose hearts have made it.
It is our hope that in years to come we may look at the scroll
and all that it signifies, with pride.

Today that pride must be tempered by a profound concern.
If atomic bombs are to be added as new weapons
to the arsenals of a warring world,
or to the arsenals of the nations preparing for war,
then the time will come when mankind will curse
the names of Los Alamos and Hiroshima.

The people of this world must unite or they will perish.
This war that has ravaged so much of the earth, has written these words.
The atomic bomb has spelled them out for all men to understand.
Other men have spoken them in other times,
and of other wars, of other weapons.
They have not prevailed.
There are some misled by a false sense of human history,
who hold that they will not prevail today.
It is not for us to believe that.
By our minds we are committed, committed to a world united,
before the common peril, in law and in humanity.

J. Robert Oppenheimer
Acceptance Speech, Army-Navy "Excellence" Award
November 16, 1945