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Classification Cancelled or Changed

7 August 1944
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Subject: Atomic Fission Bombs - Present Status and Expected Progress.

To: The Chief of Staff.

RESTRICTED DATA

I. GENERAL

1. This report is presented by Major General L. R. Groves in behalf of the Military Policy Committee. It has been approved by Dr. V. Bush, Director of O.S.R.D., Chairman, Dr. J. B. Conant, his alternate, and Rear Admiral W. R. Purnell, U.S.N. Major General W. D. Styer, U.S.A. left the country just before the report was prepared.

II. PREVIOUS REPORTS

1. The last report on uranium atomic fission bombs was made to the Chief of Staff, the Secretary of War, and the Vice President on 4 February 1944. The Secretary of War and Dr. Bush discussed the report with the President who read it in its entirety and approved the recommendations contained therein. These were:

a. That this program continue to be carried forward vigorously and that it continue to be given the highest priorities and allocations on materials, equipment and personnel, with a view to accomplishing the desired end at the earliest possible date.

b. That the Belgian Government-in-Exile be strongly encouraged to insure the reopening of the Shinkolobwe Mine in the Belgian Congo.

c. That the highest authorities in the United States and the United Kingdom take such steps as may be necessary to insure the

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joint control of the Belgian Congo uranium and deposits involving similar political considerations, not only for the period of the war, but for all time to come.

2. a. The program has continued to be carried forward with the utmost vigor. Construction of production facilities is proceeding at the expected rate. As each unit of a major plant has been completed it has been placed into operation. A relatively small auxiliary plant, using the thermal diffusion process developed at the Naval Research Laboratory, is being constructed to improve production rate and to insure against possible delay.

b. The machinery necessary for the reopening of the Shinkolobwe Mine has been ordered by the Belgians.

c. An agreement has been executed between the United States and the United Kingdom providing means for securing joint control of uranium in the Belgian Congo, the largest and richest known source, and other countries. A joint governmental agency has been established; this is known as the Combined Materials Trust. Joint negotiations with the Belgian Government have been underway for a number of months and although general agreement in principle has been reached no formal agreement has been concluded. Our relations with the British and their cooperation in the entire effort remain entirely satisfactory.

III. TYPES OF ATOMIC FISSION BOMBS

1. There are two atomic fission explosive materials which we are planning on using in these bombs:

a. Uranium 235. Code Name: "25". The lighter isotope of uranium.

[redacted]

b. Plutonium 239. Code Name: "49". One of the isotopes of a previously unknown element transmuted from uranium.

2. The quantity of material which will be needed for a bomb is still unknown but our research is continuously narrowing the range of the probable unit amount. It must be emphasized that unless a certain amount is assembled in a proper geometrical form the material will not explode at all. This minimum amount required for an explosion is known as the critical mass. Depending upon a number of factors, particularly the geometry, this amount would vary from [redacted] and the explosive effect from 500 to 2,000 tons of TNT per kilogram of atomic fission material.

3. Two types of atomic fission bombs are being developed:

a. The Gun Type.

b. The Implosion Type.

4. a. The Gun Type Bomb is enclosed in a cylindrical casing about 10 feet in length and of varying cross sections, the diameters of which range from 1½ ft. to 2½ ft.; its total weight is 10,000 pounds. Within the cylinder is a 6½" gun, a heavy metal receptacle or target, a projectile, various auxiliary apparatus and elaborate fusing devices. The projectile, composed of the atomic fission material is fired into the matching target which is made of the same material. The seating of the projectile in the target creates the more than critical mass of the material which is necessary for the explosion. A source of neutrons is arranged to trigger off the explosion as the projectile seats itself in the target.

b. The Implosion Type Bomb is enclosed in a casing with a hemispherical nose, 5 ft. in diameter, from which it tapers down to

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a diameter of about 3 ft. The overall length including stabilizer fins is about 9 ft., the total weight is 11,000 pounds. Within the outer casing is a spherical shell of about [redacted] of torpex, or similar type of explosive, surrounding an inner hollow metal sphere, the tamper, which in turn is lined with a thin layer of the atomic fission material. Also included in the bomb assembly are the necessary auxiliary apparatus and elaborate fusing devices. The torpex, or similar explosive, is detonated in many points so as to produce a spherically symmetrical explosion. The inward force of the explosion brings together with great velocity the atomic fission material in the form of a ball and then compresses this ball, thus forming a more than critical mass which explodes spontaneously.

c. Both types of bombs will be provided with a variety of fuses to insure detonation as well as to insure complete scattering of the atomic fission material in the event it should not explode.

IV. FACTORS AFFECTING TACTICAL USE

1. a. Both types of bombs can be carried in a B-29 airplane with reasonable alterations of the bomb bay and release mechanism. Dummy bomb tests have already been made using a modified B-29. Necessary arrangements have been made with the Chief of the Army Air Forces to provide the aircraft which will be required for combat operations.

b. It will be necessary to assemble the bomb at the base from which the plane leaves on its actual bombing mission. This final assembly involves the introduction of the atomic fission material which obviously must be handled with many precautions. This will

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require the presence of a considerable group of specially trained scientists and technicians together with special laboratory equipment and test instruments. Such a group will be available. The bomb must be accompanied in flight by one or two specially trained scientists.

c. For maximum effectiveness the bomb should be exploded at a considerable height above the ground. This height will depend on the size of the expected explosion but will be of the order of 1,000 feet. In order to insure the safety of the plane from the explosion, the bomb must be dropped from at least 20,000 feet. The fusing is designed to insure the explosion at the desired height.

V. STATUS OF DEVELOPMENT

1. Gun Type Bomb using "25". The production of effective gun type bombs using "25" now appears to present no major difficulty. We are confident that a workable bomb can be constructed as soon as the material is available in sufficient quantity. It will require [redacted] kilograms of "25" for such a bomb, the effect of which would be equivalent to about 20,000 tons of TNT, and would produce "Class B" damage to 75% of the buildings over an area of 5 to 10 square miles. Beyond this area the "Class B" incidence would decrease: the total area in which 10% of the buildings would suffer "Class B" damage and in which general damage would be widespread is estimated at between 50 and 100 square miles. "Class B" damage is damage to first class structures of a degree requiring major repairs to make them habitable. Based on present knowledge we would be willing to recommend the dropping of the first bomb in combat operations without prior test.

2. Gun Type Bomb Using "49". It now seems impossible to use "49" in a gun type bomb because of a spontaneous neutron emission, which would cause the nuclear reaction to start before the projectile was properly seated; as a result the explosion would be a fizzle. This unexpected property of plutonium was not previously known because it had only been produced in microscopic quantities by means of a cyclotron where the radiation intensity was far below that of the uranium pile necessary in the large-scale production of "49". It has now been discovered that at this necessary high intensity of radiation an unsuspected, and unwanted, isotope is produced which spontaneously emits neutrons.

3. Implosion Type Bomb Using "25" or "49". The difficulties due to the spontaneous neutron emission from plutonium do not affect the use of "49" in the implosion method. There appears to be but little doubt that an effective implosion type bomb, using either "25" or "49" can be produced, although there are several problems in connection with this type on which further research and experimentation must be performed if the quantities of "25" or "49" required are not to be excessive. There is every indication that an implosion type bomb can be designed with efficiencies and effectiveness much greater than the gun type but the first models may not be greatly superior.

If experiments, which should be completed this fall, are moderately successful it should be possible to design an implosion type bomb using about [redacted] of "25" or about [redacted] of "49" which should be equivalent to a minimum of 5,000 tons of TNT and capable of producing "Class B" damage to 75% of the buildings over an area of 2 to 5 square miles with lesser damage over an area of 25 to 50 square miles.

If experiments are highly successful it may be possible to reduce the amount of "25" from that given above to about [redacted] and the "45" to about [redacted] Thus, implosion bomb experiments which should be completed this fall will have an important bearing on what can be expected in the way of performance, and when this part of the program will reach the point of military effectiveness. Unlike the gun type bomb it will probably be desirable to make a full scale test explosion of this bomb before dropping the first one in combat. This is because of the many departures from known practices in this unusual but potentially far superior bomb.

VI. WEAPON PRODUCTION SCHEDULE

On the basis of our present schedules for the production of material and assuming reasonable success with experiments yet to be conducted, the following schedule of atomic bombs available in the United States should be met:

a. From March 1945 through June 1945 - [redacted] implosion type bombs capable of "Class B" destruction to 75% of the buildings over an area of 2 to 5 square miles, with a lesser damage over an area of 20 to 50 square miles. First bomb preceded by one full scale test - 31 March 1945. This date might be moved forward one month if developments were favorable.

b. From July 1945 through December 1945 - [redacted] implosion type bombs of the same size as in a above.

c. Alternate to a. and b. above. If experiments yet to be conducted with the implosion type bomb do not fulfill present

expectations and we are required to rely upon the gun type alone, the schedule given above under a. and b. will not apply and the following will replace them:

From July 1945 through December 1945 - [redacted] gun type bombs capable of "Class B" destruction to 75% of the buildings over an area of 5 to 10 square miles, with a lesser damage over an area of 50 to 100 square miles. First bomb without previous full scale test - 1 August 1945. This minimum schedule can now be put forth with assurance.

VII. ESPIONAGE

There have been definite indications from time to time of continuous espionage efforts by the Russian Government in connection with the work being carried on at the University of California on the development of the electromagnetic method of producing "25". Definite indications of espionage activities abroad by the Axis nations have been uncovered, but no determined effort has yet been found to have been made in this country.

VIII. GERMAN ACTIVITIES WITH ATOMIC FISSION

Active work on atomic fission in Germany dates from early 1939. Through 1941 the work appears to have been confined to scientific research and development. Sometime during 1942 the research disappeared from public view and it was felt by many that the work had been abandoned. Our intelligence indicates that this is not probable. Late in 1942 the Germans moved 700 tons of uranium oxide, the total stockpile, from Belgium into Germany. Various scientists of the highest stature have been reported to be working on this problem at secret government installations in southern

Germany. If the enemy has made an active and uninterrupted effort it is a possibility that he could be ready in the near future to use the weapon on a limited scale.

IX. RECOMMENDATIONS

It is recommended that this report be shown personally and informally to the other three members of the Joint Chiefs of Staff.

For the Military Policy Committee:

L. R. GROVES,
Major General, C. E.