

ADDRESS REPLY TO  
COMMANDING GENERAL, ARMY AIR FORCES  
WASHINGTON, D. C.

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WAR DEPARTMENT  
HEADQUARTERS OF THE ARMY AIR FORCES  
WASHINGTON, D. C.

15 September 1945

MEMORANDUM FOR MAJOR GENERAL L. R. GROVES:

Subject: Atomic Bomb Production

1. The attached study has been directed toward establishing an official Army Air Forces' view as to the number of atomic bombs which should be available in order to insure our national security.
2. This paper is still on the working level. Prior to concluding this study and forwarding it to the CG, AAF, your comments are requested.

Incl:  
Study abv  
subj w/Tabs A,B,C.

*Lauris Norstad*  
LAURIS NORSTAD,  
Major General, U.S.A.  
AC/AS-5.

THE DIVISION OF CLASSIFICATION, U.S. ENERGY  
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*Lauris Norstad 9/25/75*  
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PROBLEM

1. To determine the United States requirements for atomic bomb stocks in the interim post-war era.

ASSUMPTIONS

2. It is assumed that:

- a. The United States must be prepared to conduct offensive operations against any other world power or combination of powers.
  - b. The United States will maintain sufficient bases and air forces capable of attacking the strategic heart of any potential enemy.
  - c. The immediate destruction of the enemy's will and capacity to resist is the primary objective of the United States Army Strategic Air Forces.
  - d. Extensive research regarding the strategic vulnerability of all major powers will be conducted later and will permit a more complete analysis of bomb requirements.

FACTS BEARING ON THE PROBLEM

3. At the conclusion of World War II the United States first employed the revolutionary atomic bomb. Only two such bombs were dropped on Japan but these were spectacularly successful. Various conditions limit the reliability of information obtained on the properties of this weapon, and it is impossible to catalogue the full capabilities of any bomb by dropping two. Satisfactory experimentation is extremely difficult. However, photo analysis of the results at Hiroshima indicates the radius of destruction to be approximately 7000 feet. Tab "B" is a more complete description of the results of the Hiroshima bomb as interpreted from photo reconnaissance.

4. The characteristics of this weapon are such that it cannot be regarded as "just another bomb." These bombs are very expensive, cannot be produced in mass, require special storage conditions, require highly technical shipment and assembly procedures, and must be assembled and placed on the objective by highly skilled and specially trained personnel.

5. There is no approved production program for the atomic bomb.

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DISCUSSION

6. In determining the quantity of atomic bombs to be stocked, it is necessary to establish a basic requirement for their use. It is assumed that the United States may be required to conduct military operations against any other nation or combination of nations in the world, and that, finding herself at war with these powers, the United States would be desirous of immediately crippling the ability of the enemy to wage war. It is to be noted that the requirements established in this paper contemplate an M-Day force capable of being employed immediately upon initiation of hostilities and the estimated quantities of bombs required must be available at that time. There has been no attempt to estimate the quantity of atomic bombs which would be required to conduct a prolonged war of attrition. Therefore, the assumption was made that the initial mission of the air force units allocated for preparation, transportation, and delivery of these atomic bombs should be the immediate destruction of the enemy centers of industry, transportation, and population.

An exhaustive analysis of the strategic vulnerability of all the nations of the world would require extensive research and consequently consume time inconsistent with the urgent need to establish some definite principals for the employment of this powerful weapon. Because of the unlimited possible applications of the fundamental atomic energy in conjunction with future developments of rockets and guided missiles, both in their propulsion and in their explosive characteristics, it has been decided to limit the scope of this study to the next ten years. During the period 1945 to 1955 it is probable that at the beginning of any war, bombs will still be delivered by the conventional airplane. It is also obvious that during this period Russia and the United States will be the outstanding military powers. For the purpose of this study the destruction of the Russian capability to wage war has therefore been used as a basis upon which to predicate the United States atomic bomb requirements. It is to be noted also from a geographical aspect alone, Russia is in the most favorable strategic position of any major power. An investigation of the Russian strategic vulnerability prepared by MIS, WDGS, is presented as TAB "A".

7. It is to be emphasized that reliable information on any phase of Russian economy, industry, population and transportation is extremely scarce and that conditions are in a continual state of flux. All statistics presented in TAB "A" are the best estimates available, but must be accepted only insofar as they provide a basis for the present study.

8. As a foundation, a list was compiled of all Russian cities having any major strategic importance. These 66 cities were plotted on the map shown as Appendix "A" to TAB "A". This list is quite comprehensive. The following percentages of total Russian production are accomplished in these cities: Aircraft 95%, tanks 97%, guns 73%, trucks 88%, steel 45%, oil refining 95%, aluminum 100%, lead 48%, nickel 60%, zinc 44%. In addition, the majority of all ball-bearing, synthetic rubber, and machine tools are manufactured in these areas. It is to be noted that the above statistics mainly include basic and heavy industry which is normally more remotely located than those industries engaged in the manufacture of the end products. It is therefore logical to assume that an even greater proportion of Russian total manufacturing is concentrated in these 66 cities, which include all of Russia's large population and industrial concentrations.

Twenty-one cities in Manchuria were also investigated but were not considered in the final computations because Manchuria is not an integral part of the USSR. Manchurian industrial potential is less than 10 percent of that of the USSR and does not exceed 15 percent in any major item.

9. From the basic list, a group of 15 first priority cities and a group of 25 first and second priority cities were selected. The bar-charts on the bottom of the same map, Appendix A to TAB "A", give the percentages of major industries contained in the cities of each of the three categories. From these charts, it is readily apparent that the bulk of all major industries upon which statistics are available is concentrated in the fifteen first priority targets. Only in aluminum and oil refining is there any significant increase in percentage produced between the first priority cities and the total list of cities.

The primary objective for the application of the atomic bomb is manifestly the simultaneous destruction of these fifteen first priority targets. Based on

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our experience with the bombs dropped to date, three well-placed bombs would throw a modern city of any size into chaos and definitely incapacitate it for an appreciable period of time. Four of these cities would require only two bombs and one city only one bomb to completely destroy them. Adding these individual requirements gives a total of 39 bombs as a minimum.

10. It is obvious that the immediate destruction of the complete list of 66 cities would have an even more devastating effect on Russia. Therefore, an optimum requirement for atomic bomb stocks would be the number necessary to obliterate all of these cities. As deduced in TAB "B", the destructive area of each bomb is approximately 4 square miles.

Tab "C" is an individual tabulation of the bomb requirements to destroy each of the entire 66 cities. In assessing the necessary number of bombs, the cities were classified by size. For this purpose it was estimated that six bombs would be sufficient for the largest city. The total requirement under this system is 204 bombs as an optimum.

11. An important function of the Army Air Force is the protection of the United States. This could be greatly insured by the neutralization of any enemy bases of possible counter-attack. The atomic bomb is an ideal weapon for this purpose.

The radius of any known operationally proven long-range bomber is 2000 miles for the B-29. Appendix "C" to Tab "A" illustrates the fact that an arc subtended 2000 miles from any area of strategic importance in the United States falls upon areas under our control or that of nations friendly to ourselves. Hence, any antagonist must set up and establish these bases within range of our air forces. It is improbable that an enemy would be capable of establishing simultaneously more than 10 such bases. One bomb should effectively neutralize any such installation. Therefore, an additional requirement of ten bombs has been estimated for this purpose.

It is to be noted that should the present range capabilities be doubled or suicide tactics (one-way trip) be used, strategic areas of either Russia or the United States would be within range of bases located in the other country. A situation under these conditions would become a mammoth slug-fest.

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in which the United States would attempt to defend her own vital installations while launching a knock-out blow at the enemy as it would obviously be impossible to neutralize all enemy launching bases in his own country. Therefore, no estimate of bombs needed for this purpose has been attempted.

12. The role of the atomic bomb in tactically aiding the emplacing of the forces to carry out this visualized program of destruction, has not been neglected. However, the complexity of the problem makes detailed analysis extremely nebulous. The destruction of the enemy air force has been discussed above. Experimentation with the atomic bombs in direct support of ground force has not progressed to a point where it is possible to determine their use. It is evident that they cannot be presently used in close support. The principal tactical role would thus be in isolation of the battlefield. This tactical application would probably be limited inasmuch as all transportation centers in the USSR proper have already been considered in the list of strategic cities. Communications in other countries, which might be over-run by the enemy, would probably be interdicted initially by pin-point application of the conventional bomb. There are a few natural terrain features such as the Dardanelles, Kiel Canal, and the Suez Canal, which are exceptions. An allotment of 10 bombs has been reserved for this purpose.

13. There are no operational experience factors available which closely parallel the conditions under which this bomb would be employed. However, from an analysis of B-29 operational and training bombing statistics, including radar drops, it appears safe to assume a probability that over 75% of all bombs will fall within one-half of the destructive radius of the bomb (3500'). Probable losses are also difficult to assess. Unless caught completely unawares the enemy would tenaciously resist these attacks by every means within his power including suicide tactics. Our operations would be carried out under the most difficult conditions of weather, vast distances, and fanatical opposition. Without delving closely into operational details it may be assumed that the United States would employ this weapon in such a manner as to insure the greatest possible chance of the bombs being delivered. This must probably include diversions, supporting bombers and fighters, plus any known counter-measures to enemy defenses. However, our difficulties must be expected to

exceed those encountered by the Eighth Air Force in the early days of the European air offensive. Here the greatest percentage loss on any one mission was 28% on the mission to Kassel and Oschersleben of 28 July 1943. A calculated loss rate of 35% has been assumed for initial attacks until a degree of air superiority has been obtained. Integrating losses and bombing inaccuracies it is computed that 48% of all bombs airborne will be effectively delivered.

14. Appendix "B" to Tab "A" shows the range coverage of the USSR by B-29's and B-36's from the bases presently in our possession, from those currently proposed, and from possible airbases peripheral to the USSR which might possibly be available. It can readily be seen that the B-36, with a radius of 5000 miles, can reach any portion of the USSR from bases in Alaska, but that the B-29 can only reach the important Russian strategic centers from bases in Europe and Asia. This points out the necessity of retaining bases in Europe and Asia until the B-36 becomes operational and the desirability of retaining them longer.

15. It is to be noted that authoritative opinion believes the present bomb to be an experimental model. Vast improvements will undoubtedly be made which will render the current model obsolescent. Practical planning would therefore dictate only a limited dependence on the weapon in its present form -- especially in view of the tremendous expenses involved. However, even if future developments do antiquate our present type of bomb, it will still be more potent than anything yet devised, and it will still have the same destructive capabilities it now contains.

16. It is believed that the storage distribution of the atomic bomb is not a critical factor in the determination of requirements. Necessary security, special storage requirements, and expense dictate that most of the bombs should be centrally stored in the United States and dispatched to the staging bases immediately prior to their employment. Special consideration must be given to the need for having on hand for immediate use at such a base as the Azores, a small quantity of these bombs.

17. There appears to be no requirement for a stock-pile of atomic bombs of lesser destructive power. The destructive agent composes only a negligible proportion of the weight and volume of the present bomb. Benefits derived from

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the use of a small explosive charge would not be realized in ease of delivery, but in more efficient utilization of the available quantities of the basic explosive. Hence, it is desirable that research be continued with a view to the development of a cheaper atomic bomb for employment during a prolonged struggle against limited targets such as naval vessels, individual factories, bridges, and other isolated targets.

18. In summary, it is computed that the United States requirements for stocks of atomic bombs are as follows:

<u>Minimum</u>	<u>Optimum</u>
For incapacitation of 15 first priority targets -	39
For neutralization of possible enemy bases in the Western Hemisphere -	10
For Strategic isolation of the battlefield -	10
Total	59
Probable effectiveness factor -	48%
Minimum requirement = $59 \div .48$ or	Optimum requirement = $224 \div .48$ or
<u>123</u> bombs	<u>466</u> bombs
Total	224
Probable effectiveness factor -	48%

#### CONCLUSIONS

19. It is concluded that the United States has a requirement for a minimum M-Day stock of 123 atomic bombs and an optimum stock of 466 atomic bombs.

#### RECOMMENDATIONS

20. It is recommended that:

- (1) The above requirement be presented to Major General Groves, the director of the atomic bomb project, and that his comments be obtained.
- (2) The basic study, with the comments of General Groves, be forwarded to the Joint Chiefs of Staff for use in the determination of a production program for the atomic bomb.
- (3) The minimum requirement derived in the basic study be accepted as the initial basis for estimating the scope of the Army Air Force atomic bombing program.

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WAR DEPARTMENT  
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WASHINGTON, D. C.



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26 September 1945

MEMORANDUM FOR MAJOR GENERAL LAURIS NORSTAD:

1. Answering your memorandum of 15 September 1945 on the subject "Atomic Bomb Production", the following general comments are submitted:

2. The number of bombs for the minimum M-Day stock and the optimum stock are high because of the following factors:

a. The estimates are based on an area of total destruction and amounted to four square miles with an outer bomb damage of 6,000 to 7,000 feet. An area at least twice that should be used. While the damaged area of Nagasaki was considerably less than that of Hiroshima it was because the target was not suitable in size or shape for the maximum effectiveness of the bomb.

b. It is not essential to get total destruction of a city in order to destroy its effectiveness. Hiroshima no longer exists as a city even though the area of total destruction is considerably less than total.

c. While at Hiroshima the frames of a number of reinforced concrete buildings remained intact the windows were blown out and the interiors were gutted. While the buildings could be rebuilt they were made unusable for a considerable period. The Nagasaki bomb did more damage to reinforced concrete buildings. While our studies are not completed it is believed the final results will show a greater radius of destruction for such buildings than is indicated in the report.

3. In the limited time available no detailed analysis has been made of the report but my general conclusion would be that the number of bombs indicated as required, is excessive.

CLASSIFICATION CANCELLED

DATE 9/25/75  
For the U. S. Energy Research

and Development Administration

JOHN K. HARTSOCK JKV

Division of Classification

L. R. GROVES,  
Major General, U. S. A.

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