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Roll 1

Target 4

File 3 - Stockpile, Storage, and Military Characteristics

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NATIONAL ARCHIVES MICROFILM PUBLICATIONS

SAVE

~~TOP SECRET~~

WAR DEPARTMENT
P. O. Box 2610
WASHINGTON, D. C.

FOR VICTORY BUY UNITED STATES WAR BONDS AND STAMPS

REFER TO FILE No. _____

THIS DOCUMENT CONSISTS OF ....3. PAGE(S)
NO ...3.. OF .4.... COPIES, SERIES .A...

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 JKH
Division of Classification

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

WA B

~~TOP SECRET~~

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

~~TOP SECRET~~
LIMITED

2048

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.

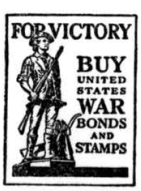
2. This paper is still on the working level. Prior to concluding this study and forwarding it to the CG, AAF, your comments are requested.

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

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

THE DIVISION OF CLASSIFICATION, U.S. ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION, HAS DETERMINED THAT THIS DOCUMENT CONTAINS NO RESTRICTED DATA OR FORMERLY RESTRICTED DATA. ERDA HAS NO OBJECTION TO ITS DECLASSIFICATION.

John K. Hartzler 9/25/75
REVIEWED BY DATE



(B)

~~TOP SECRET~~
LIMITED

LIMITED

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.

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 shownas 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

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

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 tenatiously 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

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:

Minimum		Optimum	
For incapacitation of 15 first priority targets -	39	For destruction of 66 cities of strategic importance -	204
For neutralization of possible enemy bases in the Western Hemisphere -	10	For neutralization of possible enemy bases in the Western Hemisphere -	10
For Strategic isolation of the battlefield -	10	For Strategic isolation of the battlefield -	10
Total	59	Total	224
Probable effectiveness factor -	48%	Probable effectiveness factor -	48%
Minimum requirement = 59 ÷ .48 or		Optimum requirement = 224 ÷ .48 or	
123 bombs		466 bombs	

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.

~~TOP SECRET~~

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By authority A. C. of S., G-2

Date 31 Aug 45 (TAP)

Initials

INTELLIGENCE RESEARCH PROJECT

PROJECT NO. 2532 DATE 30 Aug 45

A STRATEGIC CHART OF CERTAIN RUSSIAN

AND MANCHURIAN URBAN AREAS

COPY NO. 5

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REVIEWED BY John Woodcock DATE 9/25/75

MILITARY INTELLIGENCE SERVICE

WDGS

~~TOP SECRET~~

TITLE	PROJ NO.
A STRATEGIC CHART OF CERTAIN RUSSIAN AND MANCHURIAN URBAN AREAS	2532
	DATE: 30 Aug 45

ORIGINATOR	SUBMITTED BY
Air Plans Section - OPD Thru Russian Specialist - MIS	Political Branch

PREPARED BY (NAME, RANK OR GRADE, BRANCH)	HOURS
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Freund, Max, 1st Lt.	4
Hawley, R. S., Capt.	1
King, M. E., P-1	2
Kullgren, John, P-5	5
Markham, Esther, P-3	38
Nichols, Wade H., 1st Lt.	1
O'Connell, Mary, P-3	12
Pardee, H. B., P-3	12
Polyzoides, T. Achilles, Lt. Col.	3
Raymond, Ellsworth, P-5	46
Rossbach, Richard M., Major	10
TOTAL MAN HOURS	146

Military Branch (Carto.) is submitting separate man hour report.

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Lt. Col. Polyzoides Major Rossbach Lt. Nichols		12	15

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A STRATEGIC CHART OF CERTAIN RUSSIAN

AND MANCHURIAN URBAN AREAS

[redacted]

Project No. 2532

Date 30 Aug 45

A STRATEGIC CHART OF CERTAIN RUSSIAN AND MANCHURIAN URBAN AREAS

1. Explanation of Data.

a. Russian Area. In preparing the statistical data for the U.S.S.R. upon which the project is based, certain problems had to be overcome. These arose chiefly from the fact that in many instances completely up-to-date figures are lacking, which has made it necessary to base calculations upon pre-war reports. In this connection, it is impossible to assign relative industrial importance to cities destroyed in the course of the war and currently in the process of rebuilding or to determine how large a proportion of their previously evacuated populations have returned. It is also difficult to approximate size of industrial communities which have mushroomed during the course of the war and where, in many cases, major installations are outside the city proper. Industrial output itself is subject to estimate as to current breakdown by community, while no census has been taken since 1939, and only scattered reports on population shifts have been received.

In order to present as complete and accurate a picture as possible it has been necessary to accept certain measurement standards. Population figures given are based upon the 1939 census amended to incorporate all known changes. Industrial importance is based upon estimated 1945 production, although it is recognized that, using this method, full weight cannot be given to former industrial communities in areas overrun by the Germans and now in process of rebuilding. Communication centers and oil producing areas are rated on the basis of latest available information. Community areas are shown mainly by computation of 1939 atlas information corrected with any positive knowledge of subsequent changes or in cases where 1927 area data only was obtainable by adjusting size proportionately to population increase.

The cities selected for this project represent a major portion of Soviet economic installations. Based upon evidence at hand they include: 95 percent of airplane output, 97 percent of tank output, 73 percent of guns, 88 percent of trucks, over 67 percent of crude oil, 45 percent of steel, almost 100 percent of aluminum, 60 percent of nickel, 48 percent of lead, 44 percent of zinc and 95 percent of oil refining capacity. In addition they include the majority of machine building and ball bearing plants, the majority of synthetic rubber factories, the main river and seaports and most of the main railway junctions.

b. Manchuria Area. In the absence of up-to-date, reliable information, population and area figures for Manchurian cities are based largely on the official Japanese census of 1940. The area included within a municipality does not necessarily comprise only built-up portions but may also embrace outlying sections. Since Japanese occupation of Manchuria many cities have been considerably developed through industrial

expansion and inclusion of adjoining areas to the municipality. The Japanese have from time to time announced municipal developments through Domei. Recent figures released gave Mukden a population of 2,880,000, Hsinking 770,000 and Dairen 850,000. Only the latter figure has been used as reflecting a reasonable increase. Cities without listed populations are estimated to be under 50,000; while area figures are not currently available for some of the smaller communities.

c. Communist China Area. The situation in China is currently so fluid as to preclude any accurate account of Chinese Communist areas. However, it is known that the Communists' war-time base areas contain not a single large city; their industrial establishments are very insignificant. Some of the large cities in North China which are within the zone occupied by the Japanese are, on the other hand, under a potential threat of being taken by the Chinese Communists during the process of the surrender of Japanese troops. The two largest of these cities are Peiping and Tientsin with populations considerably above 1,000,000, the latter city being an important manufacturing center. Other larger cities in North China with populations of 500,000 or less include Kueisui, Ta-t'ung and Kalgan (Wan-ch'üan) in Inner Mongolia, Taiyuan (Yangchü), capitol of Shansi Province, Ch'ing-yuan (Paoting) in Hopeh Province, Ch'in-huang-tao and Shan-hai-kuan, important port cities in Hopeh Province, Tsinan and Tsingtao in Shantung Province, and Kaifeng in Honan Province. Chinese Communist troops operate in the vicinity of all of these cities.

2. LIST OF CITIES ON SOVIET TERRITORY

City	Estimated Population	Approx. Area (sq mi)	Priority Ind.	Oil	Tr	Industrial Strategic Importance*
Moscow	4,000,000	110.0	1	3	1	13% of plane output, 43% of truck output, 2% of steel output, 15% of copper output, machinebuilding, oil refinery, ballbearing plant.
Leningrad	1,250,000	40.4	2	-	1	Gun manufacture, shipbuilding, machinebuilding.
Tashkent	850,000	28.9	3	-	-	2% of plane output, machinebuilding, textile mills.
Baku	809,000	7.0	3	1	2	61% of crude oil output, 49% of oil refining, 1% of steel output, machinebuilding.
Novosibirsk	750,000	22.0	1	-	1	11% of plane output, machinebuilding, optical goods manufacture.
Gorki	644,000	13.5	1	3	2	11% of plane output, 24% of tank output, 45% of gun output, 43% of truck output, oil refinery, machinebuilding.
Sverdlovsk	600,000	20.2	1	-	1	9% of tank output, 11% of gun output, 1% of steel output, machinebuilding, tire plant, ballbearing plant.
Chelyabinsk	550,000	11.5	1	-	1	13% of tank output, 44% of zinc output, ferroalloy smelting, machinebuilding.
Tbilisi	519,000	12.7	3	-	2	3% of plane output.
Omsk	514,000	6.6	2	-	1	5% of plane output, 9% of tank output, tire plant, machinebuilding.
Kuibyshev	500,000	12.6	1	3	3	22% of plane output, gun manufacture, oil refinery, ballbearing plant, machinebuilding.

(* Percentages are of U.S.S.R. production)

City	Estimated Population	Approx. Area (sq mi)	Priority Ind.	Oil	Tr	Industrial Strategic Importance
Kiev	425,000	64.4	3	-	2	Machinebuilding.
Lvov	420,000	20.0	3	2	2	Oil refineries.
Kazan	402,000	20.0	1	-	2	13% of plane output.
Alma Ata	400,000	13.1	3	-	-	Ammunition manufacture.
Kharkov	400,000	30.1	3	-	2	Tractor factory, Machinebuilding.
Riga	393,000	40.0	3	-	2	Machinebuilding.
Saratov	376,000	8.8	2	3	3	8% of plane output, oil refinery, ballbearing plant, machinebuilding.
Koenigsberg	370,000	37.8	3	-	2	Shipbuilding.
Odessa	300,000	28.7	3	-	3	Machinebuilding.
Rostov-on-Don	300,000	14.4	3	-	3	Machinebuilding.
Dnepropetrovsk	300,000	9.2	3	-	2	Steel Mill.
Stalino	300,000	7.1	3	-	2	Steel Mill.
Yaroslavl	298,000	14.0	2	3	2	2% of truck output, 2% of oil refining, synthetic rubber plants.
Ivanovo	285,000	16.2	3	-	3	Textile mills.
Archangel	281,000	11.0	3	-	2	Lumber mills.
Khabarovsk	275,000	10.0	3	2	2	1% of oil refining, machinebuilding.
Tula	272,000	8.1	3	-	3	Small arms manufacture.
Molotov	255,000	5.7	1	3	3	17% of gun output, oil refinery.
Astrakhan	254,000	4.8	3	-	2	Shipbuilding.
Magnitogorsk	250,000	10.0**	1	-	-	17% of steel output, shellcase manufacture.
Vladivostok	250,000	10.0	3	-	1	Shipbuilding, machinebuilding.

** Estimate based upon no data.

City	Estimated Population	Approx. Area (sq mi)	Priority Ind.	Oil	Tr	Industrial Strategic Importance
Stalingrad	250,000	20.3	3	-	2	Tractor factory, steel mill, machinebuilding.
Ufa	246,000	10.8	3	2	2	5% of oil refining, machinebuilding.
Irkutsk	243,000	11.5	2	-	3	3% of plane output, gun manufacture, steel manufacture.
Vilna	208,000	20.0	3	-	3	Light industries.
Voronezh	200,000	17.0	3	-	3	Machinebuilding.
Izhevsk	176,000	7.5	3	-	-	Gun manufacture, machinebuilding.
Chkalov	173,000	10.2	3	-	3	2% of plane output.
Grozny	172,000	1.3	3	1	-	11% of oil refining, 6% of crude oil output, machinebuilding.
Stalinsk	169,000	10.8	1	-	-	16% of steel output, 25% of aluminum output, gun manufacture.
Nizhni Tagil	160,000	17.3	1	-	3	31% of tank output, 5% of steel output, machinebuilding.
Penza	157,000	5.8	3	-	3	Gun manufacture.
Minsk	150,000	4.2	3	-	3	Machinebuilding.
Kirov	143,000	5.3	2	-	3	11% of tank output.
Tallinn	138,000	16.0	3	-	2	Machinebuilding.
Kemerovo	133,000	5.0**	2	-	-	Gun manufacture, giant nitrogen plant.
Ulan Ude	129,000	22.3	3	-	2	Machinebuilding.
Komsomolsk	127,000	5.0**	2	3	3	2% of plane output, 1% of steel output, oil refinery, shipbuilding, machinebuilding.
Murmansk	117,000	4.0	3	-	1	Shipbuilding.

** Estimate based upon no data.

City	Estimated Population	Approx. Area (sq mi)	Priority Ind.	Oil	Tr	Industrial Strategic Importance
Belostok	110,000	6.0	3	-	3	Textile mills.
Vitebsk	100,000	3.9	3	-	3	Machinebuilding.
Zlatoust	99,000	5.6	3	-	-	2% of steel output, gun manufacture, machine-building.
Makhach Kala	87,000	1.8	3	2	2	3% of oil refining.
Syzran	77,700	5.4	3	3	2	Oil refinery.
Chimkent	74,000	13.4	2	-	-	48% of lead output.
Batum	71,000	3.9	3	2	2	10% of oil refining.
Kovrov	67,000	1.8	3	-	3	Gun manufacture.
Orsk	66,000	4.8	2	2	3	7% of oil refining, 60% of nickel output.
Kamensk	50,900	4.0**	1	-	3	75% of alumimum output.
Brest Litovsk	50,000	4.5	3	-	2	Rail center.
Gurev	33,000	4.0**	-	3	3	Oil refinery.
Sterlitamak	26,000	3.1	-	3	-	3% of oil refining.
Ishimbaevo	-	4.0**	-	3	-	2% of oil refining.
Neftedag	-	4.0**	-	3	3	1% of oil refining.
Ukhta	-	4.0**	-	3	3	1% of oil refining.

Total population of cities: 21,784,600
Total area of cities: 901.3 square miles

** Estimate based upon no data.

3. LIST OF 15 KEY SOVIET CITIES

1. Names

Moscow	Kazan
Baku	Saratov
Novosibirsk	Molotov
Gorki	Magnitogorsk
Sverdlovsk	Grozny
Chelyabinsk	Stalinsk
Omsk	Nizhni Tagil
Kuibyshev	

2. Size

Total population: 10,151,000
Total area: 277.3 square miles

3. Combined Share of Soviet Industrial Output

83% of airplanes	60% of oil refining
86% of tanks	25% of aluminum
73% of guns	15% of copper
86% of trucks	44% of zinc
42% of steel	over 50% of ballbearings
67% of crude oil	

4. Transport Importance

1st priority - 5 cities
2nd priority - 3 cities
3rd priority - 4 cities

TOP SECRET

4. LIST OF 25 LEADING SOVIET CITIES

1. Names

Moscow	Kuibyshev	Magnitogorsk
Leningrad	Kazan	Irkutsk
Tashkent	Kharkov	Grozny
Baku	Saratov	Stalinsk
Novosibirsk	Odessa	Nizhni Tagil
Gorki	Yaroslavl	Kirov
Sverdlovsk	Khabarovsk	Komsomolsk
Chelyabinsk	Molotov	Orsk
Omsk		

2. Size

Total population: 14,103,000
Total area: 456 square miles

3. Combined Share of Soviet Industrial Output

90% of airplanes	25% of aluminum
97% of tanks	15% of copper
73% of guns	60% of nickel
88% of trucks	44% of zinc
43% of steel	majority of ballbearings
67% of crude oil	majority of synthetic rubber
70% of oil refining	

4. Transport Importance

1st priority - 6 cities
2nd priority - 6 cities
3rd priority - 9 cities

5. MANCHURIA AREA

City	Population	Area Sq. Km.	Target Priority Ind.	Oil	Tpn.	Remarks
Mukden	1,200,000	(262.0) 101 sq. mi.	1		1	100% of aircraft output; chief production center for aircraft engines and components; 40% of locomotive and rolling stock; production center for automobiles, tanks, machine tools, machinery, special steel and chemicals, guns and ammunition.
Dairen	850,000	1 58 sq. mi.			1	40% of locomotive and rolling stock output; chief shipbuilding center; chemical plant; small steel plant; 12% cement output; oil refinery.
Harbin	660,000	(803.8) 310 sq. mi.			1	
Hsinking	600,000	(437.7) 169 sq. mi.			1	
An-tung	315,000	(303.6) 117 sq. mi.	2		2	12% cement output; production of trucks, automobile engines, explosives and chemicals.
Fu-shun	270,000	(91.2) 35 sq. mi.	1	1	2	100% aluminum output; 7% cement output; country's largest coal mines; sulphuric acid plant; 1 hydrogenation plant and 3 shale oil plants with annual capacity of 3,932,400 barrels of refined products.
An-shan	215,000	(123.2) 48 sq. mi.	1		2	80% iron and steel output. 33% lead smelting output.
Mu-tan-chiang	180,000	(362.7) 140 sq. mi.			2	
Kirin	175,000	(16.6)	3	2	3	10% cement output; synthetic rubber plant; calcium carbide plant; Synthetic plants with annual capacity of 378,000 barrels of refined products.
Chin-hsien	140,000	(114.8) 44 sq. mi.		3	3	Synthetic oil plant with annual capacity of 249,600 barrels of refined products.
Tsitsihar	135,000	(66.9) 26 sq. mi.			3	
Chia-mu-ssu	130,000	(113.5) 44 sq. mi.			3	

City	Population	Area Sq. Km.	Target Priority Ind.	Oil	Tpn.	Remarks
Pen-hsi-hu	100,000	(34.9) 13 sq. mi.	1			12% iron and steel output; 10% cement output.
T'ung-hua	80,000		2			Iron manufacturing center.
Ssu-p'ing-kai	70,000	(29.4) 11 sq. mi.		3	2	Synthetic oil plant with estimated annual capacity of 150,000 barrels of refined products.
T'u-men	50,000				3	
Kung-Yüan	50,000 est.	(70.0) est. 27 sq. mi.			2	
Su-chia-tun					1	
Chin-hsi				3		Synthetic oil plant with annual capacity of 150,000 barrels of refined products.
Pai-ch'eng-tzu	20,000				3	
Hu-lu-tao	5,000 est.		3			33% lead smelting output; 90% zinc smelting output.

Total size

Total population: 5,245,000
Total area: 1310 square miles

Combined Share of Manchurian Industrial Output

100% of aircraft
80% of railroad locomotives and cars
100% of iron and steel
100% of aluminum
66% of lead
100% of zinc
51% of cement
100% of oil refining
Majority of tanks, automobiles, trucks
Majority of chemicals
Majority of ammunition and weapons

LIST OF SOURCES

Documents in Political Branch files. (Top Secret)

Economics of Socialist Industry, Moscow, 1941. (Unclassified)

Soviet Information Bulletin, Washington, 4 Jul 44. (Unclassified)

Pravda, 30 Dec 44. (Unclassified)

SD, Moscow, Cable 2337, 30 Jun, MIS J1 29 of 4 July. (Confidential)

Moscow Radio, 15 Jul. (Unclassified)

SD, Moscow, Cable 2630, 19 Jul, MIS J1 119 of 24 Jul. (Confidential)

SD, Moscow, Report 643, 3 Jul 44, MIS 35778. (Secret)

MIS, Soviet Aircraft Production, 1 May 44. (Secret)

SD, Kuibyshev, Report 251, 15 Feb 43. (Confidential)

SD, Moscow, Airmail 20, 28 Jun, MIS 189828. (Confidential)

Bureau of Mines, Mining Industries of the Soviet Union, Aug 44. (Secret)

SD, Moscow, Report 3, 29 Jan, MIS 159225. (Restricted)

SD, Moscow, Report 1501, 23 Feb, MIS 160734. (Confidential)

Izvestia, 5 Jul. (Unclassified)

SD, Moscow, Report 1384, 11 Jan, MIS 119106. (Restricted)

Tikhookeanskaya Zvezda, 22 Jun 44. (Unclassified)

Trud, 6 Jul. (Unclassified)

SD, Moscow, Cable 1793, 29 May, MIS J1 151 of 31 May. (Confidential)

SD, Moscow, Cable 260, 27 Jan, MIS J1 144 of 1 Feb. (Confidential)

OSS, R&A 2094.3, 1 Feb, MIS 123408. (Confidential)

Great Soviet Atlas, Vol. II, Moscow, 1939. (Unclassified)

Socialist Construction of the U.S.S.R., Moscow, 1939. (Unclassified)

Russian Economic Notes, No. 14-1, 30 Jul 39. (Unclassified)

Janis 73, Joint Army and Navy Intelligence Study of Southeastern Siberia, Feb 45, MIS 118036. (Secret)

OSS, R&A 2750.4, 1 Jan, MIS 117569. (Confidential)

U.S. Embassy Report, Moscow, 1 Sep 44, MIS 87575. (Confidential)

U.S. Embassy Report, Moscow, 4 Dec 44, MIS 100417. (Confidential)

SD, Moscow, Report 7, 24 Sep 43. (Secret)

Official Map of the People's Commissariat for Transport, 1940. (Unclassified)

Pocket Atlas of the U.S.S.R., Moscow, 1941. (Unclassified)

Economics of Transport, Moscow, 1941. (Unclassified)

NA, Vladivostok, Report 13-44, 8 Jun 44, MIS 58410. (Secret)

SD, Moscow, Cable 2632, 19 Jul, MIS J1 228 of 25 Jul. (Confidential)

ALUSNA, Moscow, 16 Jun 44, MIS J1 78 of 20 Jun 44. (Secret)

SD, Moscow, Cable 2970, 20 Aug, MIS J1 7 of 23 Aug. (Secret)

MM, Moscow, Cable M 25387, 22 Aug, MIS J1 206 of 22 Aug. (Secret)

ONI, Serial No. 73-44, 10 Jun 44, MIS 44847. (Secret)

The Far East Year Book 1941.

Manchuria - China Travel Year Book, 1944.

Japan's Position in Liquid Fuels and Lubricants (estimate by Joint Far East Oil Committee and Report prepared by MIS under the direction of the Joint Far East Oil Committee) 10 August 1945. (Secret)

The Equipment and Capacity of the Iron and Steel Industry under Japanese Control, Foreign Economic Administration, January 1945. (Confidential)

Japanese Controlled Cement Industry, Foreign Economic Administration, August 1944. (Confidential)

Committee of Operations Analysts Study on Non-Ferrous Metals, November, 1943. (Secret)

Target Study Southern Manchuria, Headquarters Allied Air Forces, S.W.P.A., 15 July 1945. (Confidential)

Manchuria, 1931-1945, Ministry of Economic Warfare, January 1945. (Secret)

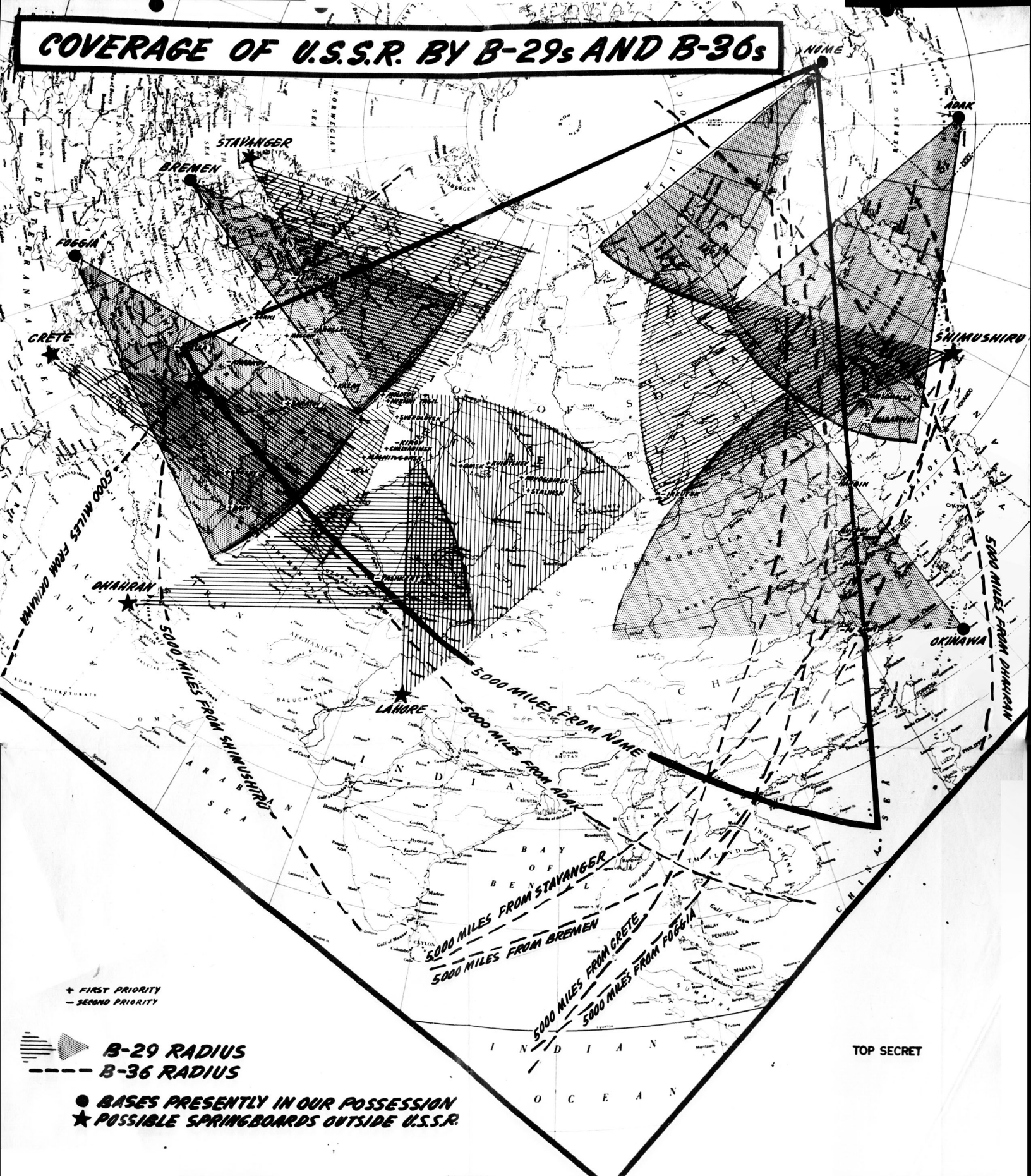
Map of Japanese and Chinese Held Areas in China, 1:2,000,000 (overlay on Transportation Map, AMS 5201, sheets NE and SE) March 1945 (Confidential)

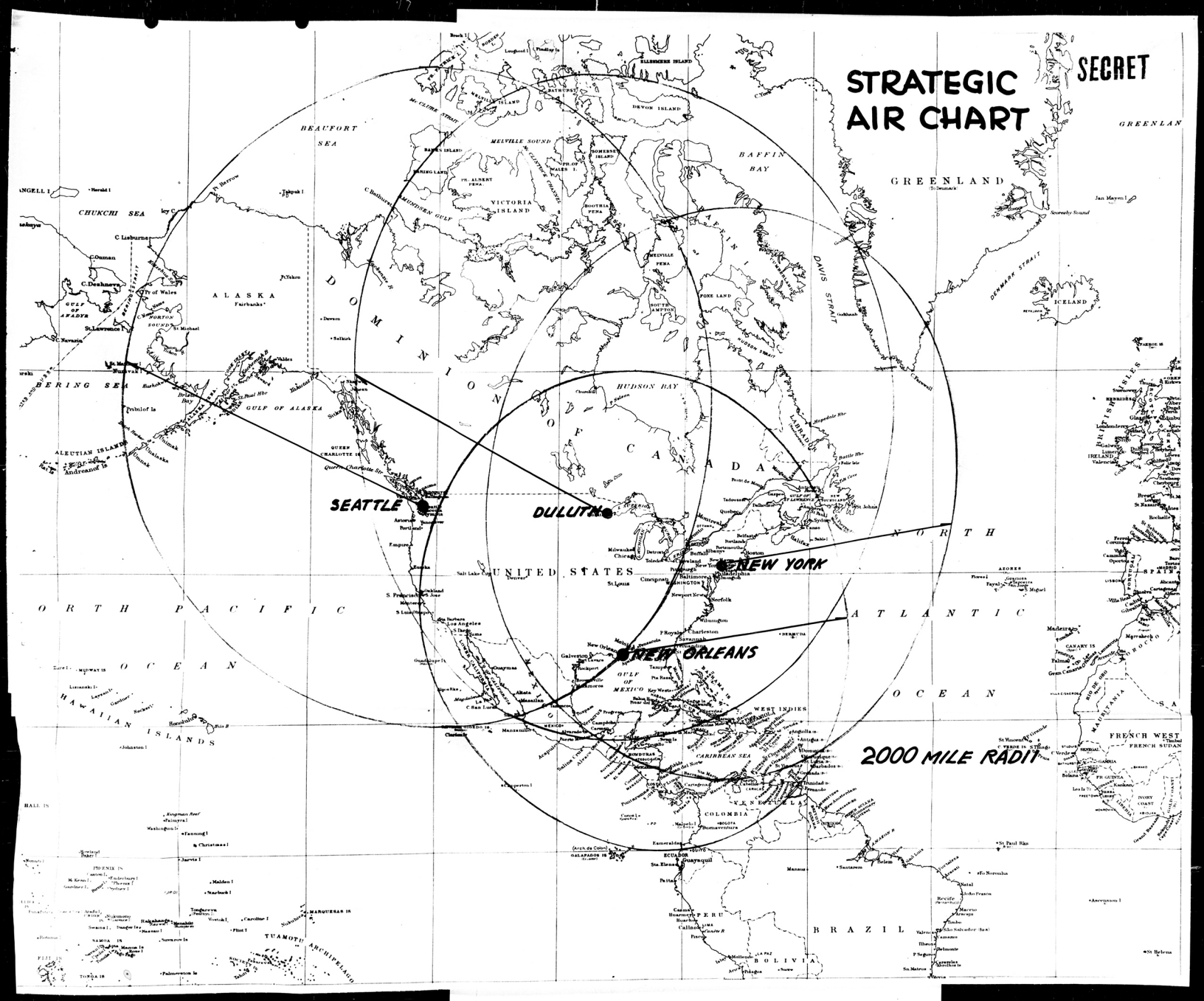
Annex "A" to Tab "A"

RUSSIAN & MANCHURIAN STRATEGIC URBAN AREAS

NORWEGIAN SEA
ARCTIC OCEAN
BARENTS SEA
LAPTEV SEA
EAST SIBERIAN SEA
SEA OF OKHOTSK
NORWAY
SWEDEN
FINLAND
GREAT NORTH BRITAIN SEA
BALTIC SEA
GERMANY
POLAND
HUNGARY
ROMANIA
BULGARIA
BLACK SEA
TURKEY
LATAKIA
LEBANON
IRAN
AFGHANISTAN
INDIA
TIBET
CHINA
SINKIANG
OUTER MONGOLIA
INNER MONGOLIA
MANCHURIA
KOREA
HONSHU
HOKKAIDO
SHIKOKU
KYUSHU
KURILE IS.
KARAFUTO
SEA OF JAPAN
UNION OF SOVIET SOCIALIST REPUBLICS
MOSCOW
Leningrad
Kuibyshev
Gorki
Sverdlovsk
Chelyabinsk
Omsk
Novosibirsk
Stalinsk
Irkutsk
Ulan-Ude
Khabarovsk
Komsomolsk
Vladivostok
Harbin
Changchun (Hsinking)
Mukden
Antung
Dairen
Port Arthur
Kirin
Tsitsihar
Hailar
Chiamussu
Kwangchow (Kirin)
Fushun
Anshan
Penhsihu
Yingkow
Shenyang (Mukden)
Chinchow
Jehol
Peiping
Tientsin
Tsinan
Tsingtao
Hankow
Nanking
Shanghai
Hangchow
Wuhan
Chungking
Sian
Lanchow
Urumchi
Alma Ata
Chimkent
Tashkent
Frunze
Stalinabad
Ashkhabad
Mashhad
Tabriz
Baku
Tiflis
Batum
Erivan
Kuibyshev
Saratov
Stalingrad
Rostov
Voronezh
Kursk
Kharkov
Kiev
Dnepropetrovsk
Stalino
Odessa
Minsk
Smolensk
Gorki
Yaroslavl
Kalinin
Kirov
Molotov
Sverdlovsk
Chelyabinsk
Magnitogorsk
Ufa
Kazan
Saratov
Stalingrad
Rostov

COVERAGE OF U.S.S.R. BY B-29s AND B-36s




STRATEGIC AIR CHART
SECRET
SEATTLE
DULUTH
NEW YORK
NEW ORLEANS
2000 MILE RADII
GREENLAND
BAFFIN BAY
DAVIS STRAIT
DENMARK STRAIT
ICELAND
BEAUFORT SEA
CHUKCHI SEA
BERING SEA
ALASKA
GULF OF ALASKA
ALEUTIAN ISLANDS
DOMINION OF CANADA
HUDSON BAY
UNITED STATES
NORTH PACIFIC OCEAN
NORTH ATLANTIC OCEAN
HAWAIIAN ISLANDS
GULF OF MEXICO
CARIBBEAN SEA
WEST INDIES
COLOMBIA
VENEZUELA
PERU
BRAZIL
BOLIVIA
FRENCH WEST
FRENCH SUDAN
TUAMOTU ARCHIPELAGO

Annex "C" to Tab "A"

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1 September 1945

TAB B

JOINT TARGET GROUP
PHYSICAL VULNERABILITY SECTION
SPECIAL PROJECT PV-P82

PHYSICAL DAMAGE TO HIROSHIMA FROM THE ATOMIC BOMB -- A PRELIMINARY ANALYSIS

1. Summary

This report is an analysis of the physical effects of the atomic bomb on Hiroshima. The analysis of the damage is based solely on twenty-four (24) inch post-attack photographic cover (3PR/5M391 -- 7 August 1945) and so this is a preliminary report subject to revision when additional information is made available from ground surveys or other photographic cover. The principal conclusions are as follows:

(a) The area damaged consists of a compact region of virtually total destruction amounting to 112.5 million sq. ft. (4.0 sq. mi.) whose outer boundary lies between 6000 ft. and 7000 ft. from the estimated center of impact, and in addition an outlying region of scattered damage whose exact extent cannot be accurately determined from the available post-attack photography. The best available estimate of the damage is given in Table 1 below:

Table 1

Percent of Building Plan Area Damaged within Various Annular Rings

Distance from Estimated Center of Impact	Percent of Building Plan Area Damaged
0 to 6000 ft.	100 percent
6000 to 8000 ft.	69
8000 to 10,000 ft.	56
10,000 to 12,000 ft.	31
12,000 to 14,000 ft.	12
14,000 to 16,000 ft.	3

(b) The type of damage out to 7000 ft. is a combination of blast and fire, and beyond this distance is predominately blast.

(c) The analysis of damage by type of building construction reveals one fact of major significance: nearly all concrete buildings remained apparently intact. Of forty-eight (48) such buildings within the area of virtually total destruction, two were completely destroyed and three partially destroyed. Beyond 7000 ft. two concrete buildings were observed in pre-attack photography, and neither of these appears to be damaged.

(d) The Mean Area of Effectiveness (MAE) of the bomb computed for structural and superficial damage to average industrial buildings (excluding those of concrete construction) is 3000 million sq. ft. (10.7 sq. mi.). A comparable MAE for the 2000 lb. G. P. bomb is 0.03 million sq. ft., which is 1/10,000 of that of the atomic bomb.

CLASSIFICATION CANCELLED
DATE 9/17/75
For the U.S. Energy Research and Development Administration
JOHN E. HARTSOCK
Division of Classification

THE DIVISION OF CLASSIFICATION ... RESEARCH AND ... DETERMINED THAT ... RESTRICTED DATA ... ERDA HAS NO OBJECTION TO ITS DECLASSIFICATION.
John K. Hartsock 9/17/75
REVIEWED BY DATE

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2. Area Damaged.

In determining the ratio of destruction to districts, circles with 1000 ft. and 2000 ft. radii were used. The center of these circles is at the estimated center of impact. In the absence of a crater and in the absence of strike photographs from which the bomb's trajectory could be computed, this center was located by an examination of the damage. Its position is probably correct to within 500 ft.

This tabulation, however, does not give a complete picture of the extent of damage; for there is much scattered damage beyond the area of virtually total destruction. The qulaity of the post-attack photography does not permit a detailed examination of the damage to each building in these outlying regions. The best that can be done is to assess the damage to the larger buildings in the more important industrial, military, and public installations. The percent of these buildings damaged at a given distance from the center of impact may then be taken as an estimate of the percent of damage to all buildings at that distance. In support of this method of estimation, it should be noted that although the larger buildings present a larger area to the blast wave and hence might be expected to receive more damage than the small buildings, on the other hand the larger buildings are stronger and less vulnerable to damage than the smaller buildings which are chiefly residences. In the opinion of experienced damage analysts, these two effects largely cancel each other. A study of the damage to these larger buildings is presented in Appendix C, and the results have been summarized in Table 1 above.

3. Type of Damage.

Within the area of virtually total destruction the damage is due to a combination of blast and fire. There is little evidence of fire damage outside this area except in a few cases where fires were probably started by secondary explosions (such as that of the gas works) rather than by the bomb itself. The predominant cause of damage beyond 7000 ft. is blast.

4. Damage by Type of Building Construction.

Variations in the type of building construction are found principally in the industrial, military, and public installations of the city. The vulnerability characteristics of these installations determined from an examination of all available pre-attack photography are set forth in Appendix B. The classifications used are those adopted by the Joint Target Group for the conventional weapons. These are explained in Appendix A.

There was no damage to V1 and V2 buildings except in the portion of Target 54 which is nearest to the point of impact of the bomb. Destruction of V3 and V4 buildings was complete out to the 6000 ft. ring, and from then on there was scattered damage which showed no pronounced difference between the categories. There is no apparent relationship between the combustibility of the buildings and the amount of damage to them.

In Appendix C part of the data from Appendix B has been rearranged to show the dependence of the amount of damage, by vulnerability category, upon the distance of the target from the point of impact. V3 and V4 are combined and no reference is made to the combustibility categories. This information is used in section 5 below to calculate the Mean Area of Effectiveness of the bomb.

An exceptional and remarkable feature of the damage is the large number of concrete buildings which remained apparently intact after the explosion.

Whether or not there is internal damage to these buildings must be determined by a ground survey. The number, location, and damage sustained by these buildings is shown in Table 2.

Table 2.

Damage to Concrete Buildings

Distance from Center of impact	Total No. of Buildings	Number partially Destroyed	No. Completely Destroyed
0 to 1000 ft.	10	1	1
1000 to 2000 ft.	13	1	0
2000 to 3000 ft.	5	0	0
3000 to 4000 ft.	7	0	0
4000 to 5000 ft.	3	0	0
5000 to 6000 ft.	10	1	1
6000 to 7000 ft.	0	0	0
7000 to 8000 ft.	0	0	0
8000 to 9000 ft.	1	0	0
9000 to 10,000 ft.	0	0	0
10,000 to 11,000 ft.	1	0	0
beyond 11,000 ft.	0	0	0
Total	50	3	2

5. Mean Area of Effectiveness.

The mean area of effectiveness of the atomic bomb for structural and superficial damage to V3 and V4 buildings (which are average multi-story and single story industrial buildings respectively) was computed to be 300 million sq. ft. or 10.7 sq. mi. This should be interpreted to mean that if a target of unlimited extent were completely builtup with buildings of this type, the damage would have been 10.7 sq. mi. This, of course, is in excess of the 4.0 sq. mi. of damage stated for the area of virtually complete destruction. The figure of 4.0 sq. mi. does not include additional scattered damage, much of which could not be measured on the available photography, nor does it take into account outlying regions which were within reach of the effects of the bomb but which were in fact not builtup.

The computation was performed by the "annular ring method". In this method the percent of building plan area damaged within successive 2000 ft. annular rings was determined. The sum of the ground areas of each respective ring multiplied by the applicable percentage gives the Mean Area of Effectiveness. The percentages used are given in Table 1 which is based upon the data listed in Appendix C.

6. Damage by Urban Area Zones.

In the Joint Target Group analyses of incendiary attacks on urban areas, it has been customary to break down the damage by urban area zones such as Residential, Manufacturing, Storage, Transportation, etc. This zoning served two purposes: (1) it made possible a study of the relative vulnerability of the several zones to incendiary attacks, and (2) it contributed to the economic assessment of the damage. In the case of the atomic bomb attack on Hiroshima all of the zones appear to have been equally vulnerable to the explosion. As an aid to the economic assessment of the damage the following breakdown has been made of the distribution of

the area of total destruction among the several zones. It should be recalled that this includes only the central area of damage and does not take into account the outlying scattered damage. For an explanation of the notation used see Appendix A.

Table 3

Damage Resulting from Atomic Attack - Hiroshima Urban Area

	Pre-attack area*			Post Attack			
Zone	Ground	% Builtup	Roof	Ground area Damage		Roof Area Damage	
Residential							
R_1	76.6	42	32.2	59.5	or 78%	26.8	or 83%
R_2	127.4	27	34.4	41.3	32%	11.0	32%
R_3	77.7	12	9.3	3.5	5%	0.4	4%
50% X	1.9	22	.4	1.3	68%	0.4	99%
Total	283.6		76.3	105.6	37%	38.6	51%
Industrial							
M	48.1	30	14.4	3.3	7%	1.5	10%
S	29.8	19	5.7	1.4	5%	0.3	5%
T	6.3	14	0.9	0.9	14%	0.2	22%
50% X	1.9	22	0.4	1.3	68%	0.4	99%
Total	86.1		21.4	6.9	25%	2.4	11%

* All areas are given in millions of square feet.

APPENDIX A

Explanation of Notations Used

HE Vulnerability Classes

The symbols V1, V2, V3, V4, and V5 denote the relative vulnerabilities of buildings to damage from HE bombs. V1 is the least vulnerable and V5 is the most vulnerable. A detailed discussion of the structural types comprising these classes is given in Joint Target Group Memorandum 8. The following brief description, however, is adequate for most purposes:

V1 Reinforced concrete, multi-story, earthquake resistant structures.

V2 Inudstrial structures containing travelling cranes.

V3 Typical multi-story industrial buildings, not specially resistant to earthquakes.

V4 Typical single story, shed-type industrial structures; also all small buildings.

V5 Arched hanger type buildings.

IB Vulnerability Classes

R - Fire resistive: Buildings which have no significant amount of combustible material in the structure and which will withstand all but the most intense fire without structural damage.

N - Noncombustible: Buildings which have no significant amount of combustible material in the structure, but whose structure is susceptible to damage by fire in the contents.

C - Combustible: Buildings whose roof and/or walls are constructed of combustible material. The floors, except the ground floor, are required to be of similar construction.

Urban Area Zones

R_1 - Residential (fully builtup, 40 percent and over).

R_2 - Residential (moderately builtup, 20 to 40 percent).

R_3 - Residential (sparsely builtup, 5 to 20 percent).

M - Manufacturing.

X - Mixed industrial and residential.

T - Transportation.

S - Storage.

Special Notations.

N.C. (appearing in Appendices B and C) mean "No cover". Where it appears in these tables, either there was no damage cover of a particular installation or the available cover was cloud covered or of such poor quality that no damage assessment could be made.

? - Unknown.

[redacted] Table 7

Building Construction Analysis of Annotated Targets

Annotation No.	AAF Target No.	Name	Site Area 1000 sq. ft.	Built-up-ness %	Estimated Roof Area 1000 sq. ft.	Radius from Center of Impact 1000 ft.	NE Vulnerability V1 %	V2 %	V3 %	V4 %	V5 %	Special %	IB Vulnerability R %	N %	C %	Damage % (Superficial plus structural)
3	--	Asahi Engineering Works	7400	10%	740	15.6	--	20%	--	80%	--	--	--	70%	30%	3%
4	--	Mitsui Small Arms Plant	760	30%	230	12.3	--	--	10%	90%	--	--	--	40%	60%	1%
5	--	Unidentified Industry	110	40%	40	10.9	--	40%	--	60%	--	--	--	80%	20%	15%
6	--	Hiroshima-Mitsubishi Shipyard	5120	10%	510	15.5	--	20%	10%	70%	--	--	--	30%	70%	1%
7	--	Military Storage	1270	10%	130	12.3	5%	--	--	95%	--	--	5%	--	95%	95%
8	--	Army Supply H. Q.	580	20%	120	10.2	10%	--	--	90%	--	--	10%	30%	60%	12%
9	--	Nippon Chemical Industry	370	20%	70	9.2	--	--	--	100%	--	--	--	20%	80%	80%
10	--	Rubber Products Factory	310	30%	90	8.1	--	--	20%	80%	--	--	--	40%	60%	90%
11	--	Toda Chemical Plant	130	20%	30	7.6	--	--	--	100%	--	--	--	40%	60%	100%
12	--	Lumber Mills	280	10%	30	5.7	--	--	--	100%	--	--	--	--	100%	100%
13	--	Unidentified Industry	120	40%	50	6.5	--	--	--	100%	--	--	--	50%	50%	100%
14	--	Sanyo Textile Mill	70	50%	40	4.3	--	--	60%	40%	--	--	--	--	100%	100%
15	2627 & 2617	Hiroshima Airfield & Seaplane Station	11400	1%	110	10.7	--	--	--	50%	50%	--	--	--	100%	65%
16	--	Kureshiki Aircraft Industry	150	50%	75	8.6	--	--	20%	80%	--	--	--	--	100%	85%
16A	--	Unidentified Industry	260	30%	80	8.4	--	--	10%	90%	--	--	--	20%	80%	95%
17	--	Woodworking Plant	170	10%	20	7.9	--	--	--	100%	--	--	--	--	100%	100%
18	--	Toho Synthetic Chemical Ind.	150	20%	30	7.4	--	--	--	100%	--	--	--	30%	70%	100%
19	--	Chugoku Paint Co.	170	30%	50	7.1	--	--	--	100%	--	--	--	--	100%	100%
20	--	Chugoku Paper Co.	340	20%	70	6.0	--	--	30%	70%	--	--	--	40%	60%	100%
21	--	Cardboard Plant	70	30%	20	5.5	--	--	40%	60%	--	--	--	--	100%	100%

[redacted]

APPENDIX B

~~CONFIDENTIAL~~

~~Table 3 contd.~~

Building Construction Analysis of Annotated Targets

Annotation No.	AAF Target No.	Name	Site Area 1000 sq. ft.	Built-up-ness %	Estimated Roof Area 1000 sq. ft.	Radius from Center of impact 1000 ft.	HE Vulnerability V1 %	V2 %	V3 %	V4 %	V5 %	Special %	IB Vulnerability R %	N %	C %	Damage % (Superficial plus structural)
22	--	Unidentified Industry	120	60%	70	5.6	--	--	70%	30%	--	--	--	--	100%	99%
23	--	Imperial Rayon Co.	300	50%	150	8.3	--	--	30%	70%	--	--	--	40%	60%	15%
24	--	Hiroshima Car Barns	220	20%	40	6.3	--	10%	10%	80%	--	--	--	30%	70%	70%
25	735	Army Transport Base	22200	10%	2220	(13)	--	--	10%	90%	--	--	--	30%	70%	10%
25A		Daiwa Textile Co.	2200	35%	770	13.5	10%	--	--	90%	--	--	10%	60%	30%	5%
26	--	Unidentified Textile Co.	150	10%	20	10.9	--	--	--	100%	--	--	--	--	100%	100%
27	737	Army Food Depot	520	30%	160	9.5	--	--	40%	60%	--	--	--	30%	70%	10%
28	--	Unidentified Industry	930	30%	280	6.8	--	--	40%	60%	--	--	--	40 %	60%	35%
29	--	Hiroshima Gas Works	200	20%	40	6.2	--	--	--	80%	--	Gasholders 20%	--	80%	20%	100%
30	--	Communications Div. Post	1410	5%	70	6.8	--	--	70%	30%	--	--	--	--	100%	70%
31	738	Army Clothing Depot	1730	20%	350	8.1	--	--	40%	60%	--	--	--	--	100%	60%
32	736	Army Ordnance Depot	2520	20%	500	8.3	--	--	30%	70%	--	--	--	20%	80%	N.C.
31A	--	Foundry & Machine Shop	410	10%	40	7.8	--	--	20%	80%	--	--	--	--	100%	20%
33	1889	Ujina Shipbuilding Co.	580	20%	120	18.7	--	--	10%	90%	--	--	--	--	100%	?
34	--	Printing Plant	180	20%	40	10.3	--	--	40%	60%	--	--	--	20%	80%	100%
35	--	Koi RR Station	220	4%	10	9.0	--	--	--	100%	--	--	--	--	100%	10%
36	--	Sanyo Paper Co.	140	50%	70	8.3	--	--	20%	80%	--	--	--	20%	80%	95%
37	--	Slaughter House	310	10%	30	7.3	--	--	10%	90%	--	--	--	10%	90%	100%
38	--	Leather Factory	200	10%	20	7.9	--	--	30%	70%	--	--	--	30%	70%	15%
39	--	Cannery	130	60%	80	6.3	--	--	20%	80%	--	--	--	--	100%	100%

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APPENDIX B (CONTD)

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Table 3 cont'd.

Building Construction Analysis of Annotated Targets

HE Vulnerability

IB Vulnerability

Annotation No.	AAF Target No.	Name	Site Area 1000 sq. ft.	Built-up-ness %	Estimated Roof Area 1000 sq. ft.	Radius from Center of Impact 1000 ft.	V1 %	V2 %	V3 %	V4 %	V5 %	Special %	R %	N %	C %	Damage % (Superficial plus structural)
40	--	Meiji Clothing Co.	80	40%	30	5.4	--	--	10%	90%	--	--	--	--	100%	100%
41	--	Toyo Can Co.	170	30%	50	5.8	--	--	10%	90%	--	--	--	20%	80%	100%
41A	--	Needle Factory	70	50%	30	5.5	--	--	--	100%	--	--	--	--	100%	100%
42	--	Can Factory	80	70%	50	4.9	--	--	50%	50%	--	--	--	--	100%	100%
43	--	Marine Engine Works	90	60%	50	5.2	--	--	10%	90%	--	--	--	10%	90%	100%
44	--	Rubber Footwear Factory	170	60%	100	3.6	--	--	--	100%	--	--	--	--	100%	100%
45	--	East Asia Machine Tool Co.	180	40%	70	4.2	--	--	20%	80%	--	--	--	40%	60%	100%
46	--	Needle Factory	100	40%	40	4.7	--	--	40%	60%	--	--	--	20%	80%	100%
47	--	Yokogawa Electric Mfg. Co. Hiroshima Plant	150	30%	45	5.5	--	--	--	100%	--	--	--	60%	40%	100%
48	--	Yokogawa RR Station	360	10%	40	5.9	--	--	20%	80%	--	--	--	--	100%	98%
49	--	Tamura Rubber Co.	70	40%	28	5.8	--	--	--	100%	--	--	--	--	100%	100%
50	--	Hiroshima Dye Plant	130	30%	39	5.8	--	--	--	100%	--	--	--	--	100%	100%
50A	2178	Otamagawa RR Bridge	100	100%	100	4.9	--	--	--	--	--	RR Bridge 100%	--	100%	--	0%
50B	--	Rubber Factory	50	40%	20	5.5	--	--	20%	80%	--	--	--	70%	30%	100%
51	--	Unidentified Factory	120	40%	50	11.6	--	--	--	100%	--	--	--	30%	70%	0%
52	--	Unidentified Factory	430	30%	130	15.7	--	--	--	100%	--	--	--	80%	20%	N.G.
52A	--	Radio Station JCFK	160	10%	20	15.1	--	--	90%	10%	--	--	90%	--	10%	0% ?
53	1885	Mitsubishi Electric Mfg. Co.	2050	20%	410	17.2	--	--	15%	85%	--	--	--	75%	25%	N.G.
54	748	Army Div. Headquarters	13500	10%	1350	2.1	3%	--	35%	62%	--	--	5%	--	95%	98%
55	--	Army Engineering School	500	10%	50	6.6	--	--	80%	20%	--	--	--	--	100%	N.G.

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APPENDIX B (CONTD)

[redacted] Table 3 cont'd.

Building Construction Analysis of Annotated Targets

Annotation No.	AAF Target No.	Name	Site Area 1000 sq. ft	Built-up-ness %	Estimated Roof Area 1000 sq. ft.	Radius from Center of Impact 1000 ft.	HE Vulnerability V1 %	V2 %	V3 %	V4 %	V5 %	Special %	IB Vulnerability H %	M %	C %	Damage % (superficial plus structural)
56	--	Military Storage	420	30%	130	7.7	--	--	30%	70%	--	--	--	--	100%	N.C.
57	--	Hiroshima Waterworks	1270	60%	760	8.7	--	--	--	5%	--	Filtering Beds 95%	95%	5%	--	0%
58	--	Unidentified Industry	80	70%	60	5.6	--	--	--	100%	--	--	--	90%	10%	100%
59	--	Unidentified Industry	50	60%	30	5.0	--	--	--	100%	--	--	--	10%	90%	100%
60	--	Storage Sheds	130	50%	60	5.5	--	--	--	100%	--	--	--	--	100%	100%
61	--	Toyo Textile Mill	130	80%	100	6.3	--	--	90%	10%	--	--	--	90%	10%	N.C.
62	749	East Hiroshima RR Station	4040	2%	80	6.2	--	10%	10%	80%	--	--	--	20%	80%	N.C.

[redacted]

APPENDIX B (CONTD)

Damage Analysis of Annotated Targets

Distance from Center of Impact	Annotation No.	Distance 1000 ft.	Roof Area 1000 sq ft	Total Damage %	V1 % Present	V1 % Damage	V2 % Present	V2 % Damage	V3 and V4 % Present	V3 and V4 % Damage	Other % Present	Other % Damage	Remarks
Less than 2000'			No cases										
Between 2000' and 4000'	44	2.1	1350	.488%	3%	2%	--	--	97%	96%	--	--	Two cement bldgs. survived, another has one wing gutted.
	44	3.6	100	100%	--	--	--	--	100%	100%	--	--	
Between 4000' and 6000'	45	4.2	70	100%	--	--	--	--	100%	100%	--	--	
	14	4.3	40	100%	--	--	--	--	100%	100%	--	--	
	46	4.7	40	100%	--	--	--	--	100%	100%	--	--	
	50A	4.9	100	0%	--	--	--	--	--	--	RR Bridge 100%	0%	
	42	4.9	50	100%	--	--	--	--	100%	100%	--	--	
	59	5.0	30	100%	--	--	--	--	100%	100%	--	--	
	43	5.2	50	100%	--	--	--	--	100%	100%	--	--	Blast (not fire and blast)
	40	5.4	30	100%	--	--	--	--	100%	100%	--	--	
	21	5.5	20	100%	--	--	--	--	100%	100%	--	--	
	41A	5.5	30	100%	--	--	--	--	100%	100%	--	--	
	50B	5.5	20	100%	--	--	--	--	100%	100%	--	--	
	60	5.5	60	100%	--	--	--	--	100%	100%	--	--	
	47	5.5	45	100%	--	--	--	--	100%	100%	--	--	
	22	5.6	70	99%	--	--	--	--	100%	99%	--	--	
	58	5.6	60	100%	--	--	--	--	100%	100%	--	--	
	12	5.7	30	100%	--	--	--	--	100%	100%	--	--	
	41	5.8	50	100%	--	--	--	--	100%	100%	--	--	
	49	5.8	28	100%	--	--	--	--	100%	100%	--	--	
	50	5.8	39	100%	--	--	--	--	100%	100%	--	--	
	48	5.9	40	98%	--	--	--	--	100%	98%	--	--	
Between 6000' and 8000'	29	6.2	40	100%	--	--	--	--	80%	80%	Gasholders 20%	20%	Gas generators still standing
	62	6.2	80	N.C.	--	--	10%	?	90%	?	--	--	
	20	6.0	70	100%	--	--	--	--	100%	100%	--	--	
	39	6.3	80	100%	--	--	--	--	100%	100%	--	--	
	24	6.3	40	70%	--	--	10%	--	90%	70%	--	--	Fire
	61	6.3	100	N.C.	--	--	--	--	100%	?	--	--	
	13	6.5	50	100%	--	--	--	--	100%	100%			
	55	6.6	50	N.C.	--	--	--	--	100%	?	--	--	
	30	6.8	70	70%	--	--	--	--	100%	70%	--	--	
	28	6.8	280	35%	--	--	--	--	100%	35%	--	--	
	19	7.1	50	100%	--	--	--	--	100%	100%	--	--	
	37	7.3	30	100%	--	--	--	--	100%	100%	--	--	Combination of blast and fire
	18	7.4	30	100%	--	--	--	--	100%	100%	--	--	
	11	7.6	30	100%	--	--	--	--	100%	100%	--	--	Blast
	56	7.7	130	N.C.	--	--	--	--	100%	?	--	--	
	31A	7.8	40	20%	--	--	--	--	100%	20%	--	--	
	38	7.9	20	15%	--	--	--	--	100%	15%	--	--	Roof damage
	17	7.9	20	100%	--	--	--	--	100%	100%	--	--	

APPENDIX C

Damage Analysis of Annotated Targets

Distance from Center of Impact	Annotation No.	Distance 1000 ft.	Roof Area 1000 sq ft	Total Damage %	V1 % Present	V1 % Damage	V2 % Present	V2 % Damage	V3 and V4 % Present	V3 and V4 % Damage	Other % Present	Other % Damage	Remarks
Between 8000' and 10,000'	10	8.1	90	90%	--	--	--	--	100%	90%	--	--	Blast
	31	8.1	350	60%	--	--	--	--	100%	60%	--	--	
	32	8.3	500	N.C.	--	--	--	--	100%	?	--	--	
	23	8.3	150	15%	--	--	--	--	100%	15%	--	--	
	36	8.3	70	95%	--	--	--	--	100%	95%	--	--	Blast
	16A	8.4	80	95%	--	--	--	--	100%	95%	--	--	Fire and blast
	16	8.6	75	85%	--	--	--	--	100%	85%	--	--	Blast
	57	8.7	760	0%	--	--	--	--	5%	0%	Filtering beds 95%	0%	
	35	9.0	10	10%	--	--	--	--	100%	10%	--	--	
	9	9.?	70	80%	--	--	--	--	100%	80%	--	--	
	27	9.5	160	10%	--	--	--	--	100%	10%	--	--	
Between 10,000' and 12,000'	8	10.2	120	12%	10%	0%	--	--	90%	12%	--	--	Blast
	34	10.3	40	100%	--	--	--	--	100%	100%	--	--	Roof of large bldg. stripped. Smaller bldgs. crushed by blast
	15	10.7	110	65%	--	--	--	--	50%	15%	50%	50%	Some removal
	5	10.9	40	15%	--	--	40%	0%	60%	15%	--	--	
	26	10.9	20	100%	--	--	--	--	100%	100%	--	--	
	51	11.6	50	0%	--	--	--	--	100%	0%	--	--	
Between 12,000' and 14,000'	4	12.3	230	1%	--	--	--	--	100%	1%	--	--	Possible removal
	7	12.3	130	95%	5%	--	--	--	95%	95%	--	--	Possible removal-blast damage, perhaps some fires
	25	(13)	2220	10%	--	--	--	--	100%	10%	--	--	
	25A	13.5	770	5%	10%	0%	--	--	90%	5%	--	--	
Above 14,000'	52A	15.1	20	0%?	--	--	--	--	100%	0%?	--	--	
	6	15.5	510	1%	--	--	20%	--	80%	1%	--	--	
	3	15.6	740	3%	--	--	20%	--	80%	3%	--	--	Blast to minor bldgs.
	52	15.7	130	N.C.	--	--	--	--	100%	?	--	--	
	53	17.2	410	N.C.	--	--	--	--	100%	?	--	--	
	33	18.7	120	0%	--	--	--	--	100%	0%	--	--	Possible removal

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TAB "C"

ESTIMATED BOMB REQUIREMENTS FOR DESTRUCTION OF

RUSSIAN STRATEGIC AREAS

CITY	AREA OF CITY IN SQ. MILES	NO. OF BOMBS
Moscow	110.0	6
Leningrad	40.4	6
Tashkent	28.9	6
Baku	7.0	2
Novosibirsk	22.0	6
Gorki	13.5	4
Sverdlovsk	20.2	5
Chelyabinsk	11.5	3
Tbilisi	12.7	3
Omsk	6.6	2
Kuibyshev	12.6	3
Kiev	64.4	6
Lvov	20.0	5
Kazan	20.0	5
Alma Ata	13.1	4
Kharkov	30.1	6
Riga	40.0	6
Saratov	8.8	2
Koenigsberg	37.8	6
Odessa	28.7	6
Rostov-on-Don	14.4	4
Dnepropetrovsk	9.2	3
Stalino	7.1	2
Yaroslavl	14.0	4
Ivanovo	16.2	4
Archangel	11.0	3
Khabarovsk	10.0	3
Tula	8.1	2

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REVIEWED BY [signature] DATE 9/25/75

CITY	AREA OF CITY IN SQ.MILES	NO. OF BOMBS
Molotov	5.7	2
Astrakhan	4.8	1
Magnitogorsk	10.0	3
Vladivostok	10.0	3
Stalingrad	20.3	5
Ufa	10.8	3
Irkutsk	11.5	3
Vilna	20.0	5
Voronezh	17.0	5
Izhevsk	7.5	2
Chkalov	10.2	3
Grozny	1.3	1
Stalinsk	10.8	3
Nizhni Tagil	17.3	5
Penza	5.8	2
Minsk	4.2	1
Kirov	5.3	2
Tallinn	16.0	4
Kemerovo	5.0	2
Ulan Ude	22.3	6
Komsomolsk	5.0	2
Murmansk	4.0	1
Belostok	6.0	2
Vitebsk	3.9	1
Zlatoust	5.6	2
Makhach Kala	1.8	1
Syzran	5.4	2
Chimkent	13.4	4
Batum	3.9	1
Kovrov	1.8	1
Orsk	4.8	2
Kamensk	4.0	1

CITY	AREA OF CITY IN SQ.MILES	NO. OF BOMBS
Brest Litovsk	4.5	1
Gurev	4.0	1
Sterlitamak	3.1	1
Ishimbaevo	4.0	1
Neftedag	4.0	1
Ukhta	4.0	1
TOTAL - 66 Cities	901.3	204