

28 February 1948

DNA1.940930.052

MEMORANDUM FOR GENERAL OMAR N. BRADLEY

SUBJECT: Atomic Bomb Casualties.

In accordance with my promise I am inclosing a study on the nature of the casualties resulting from the atomic bombing of the two Japanese cities, Hiroshima and Nagasaki, and of the possible effects against large American cities.

L. R. GROVES,
Lt. General, USA.

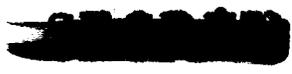
Inclosure:
Study - Atomic Bomb Casualties

Declassified by DNA, Chief, ISTS

Robert H. Ryan
Date: 8 / 19 / 94

Statement A
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* WITH ENCL. *[Signature]*

HRE-0751



EFFECTS OF ATOMIC BOMB

CASUALTIES

Nature of Casualties

1. The explosion of a 20,000 ton (TNT equivalent) atomic bomb, the power used against Japan, at the proper altitude is characterized by:

a. A blast wave of high peak pressure and long duration which produces a downward thrust on structures directly under the point of detonation and a severe distorting push on those farther away. The duration of the blast wave is sixteen times as great as the wave from a five ton TNT explosion. This increases greatly the damaging effect.

b. An emission from the ball of fire of heat radiation ranging from infra-red to ultra-violet which causes fires in structures and flash burns on personnel.

c. An emission of gamma rays, alpha and beta particles, and neutrons, from the nuclear fission process and from the resulting fission products, which can cause death or sickness to personnel.

2. Casualties are produced among personnel by three principal distinct phenomena:

a. Burns. The majority of casualties caused by the bomb will result from burns. The heat radiation travels with the speed of light and possible victims are thus easily caught. The burns are of two types: flash burns caused by the direct, instantaneous heat radiation from the explosion, particularly the ultra-violet, and flame or secondary burns suffered by persons caught in buildings set afire by heat radiation or by overturned stoves, broken gas mains or damaged electrical systems. Personnel trapped in damaged buildings though uninjured are very likely to receive flame burns. Flash burn is a type of injury found on a major scale only with the atomic bomb. It is similar to but much more severe than a bad sunburn. The burn casualties are fairly evenly divided into the two classes.

b. Mechanical injuries. These include broken bones, cuts, bruises, smothering, and the like. Injuries result from structural damage to buildings, from falling and flying debris and flying glass often thrown considerable distances by the blast wave. These are similar to mechanical injuries from any other cause. Contrary to what might be expected, injuries from direct blast pressure such as ruptured eardrums or internal hemorrhages, are rare, since the human body can stand as much as 250 pounds per square inch pressure, while only two or three pounds pressure may collapse a large building. The high

altitude of burst of the most effective explosions such as those over Hiroshima and Nagasaki, prevents very high blast pressures from reaching the ground.

c. Radiation disease. This effect is peculiar to atomic explosions. In a relatively high air burst, only the instantaneous (first few seconds) emission of rays and particles from the explosion is effective. When the bomb is exploded well up in the air, the radioactive fission products and bomb material fragments are so widely scattered that they are not deposited on the ground in dangerous concentrations; nor is the induced secondary radioactivity significant. The direct gamma radiation is the most important since it is very penetrating and is emitted in great quantity. Gamma rays and neutrons penetrate the skin without producing an immediately apparent effect. Severely irradiated personnel showed characteristic symptoms, nausea, vomiting and fever within twenty-four hours and lasting for about one day. In the most severe cases, these symptoms are followed by bloody diarrhea, inflammation of throat and mouth and continued vomiting and fever and death within a week. In less severe cases, typical symptoms to a much lesser degree than in the most severe cases, appear, together with skin hemorrhages and general discomfort while partial or complete loss of hair begins in about ten days. In Japan in about 50% of the severe cases, death resulted in about thirty days. Mild cases suffered minor effects of the typical symptoms but usually recovered within sixty days. Clinical observations of the Japanese suffering from radiation sickness revealed that the most insidious and lethal effects of radioactivity are caused by the attacking of the blood producing cells in the bone marrow. The degree of decrease of the white blood count is one of the most accurate indices of the amount of radiation a person has received.

Hiroshima

3. Hiroshima was an essentially flat city typified in the United States by a city such as Detroit. Its area was about twenty-six square miles and its peak wartime population about 350,000. The main center of the city was about seven square miles and its population, 245,000 at the time of the bombing. The Japanese had already started their evacuation of unbombed cities by this time.

4. The bomb was detonated at the desired altitude, and it was effective against structures and personnel in all directions from the center of blast. The bomb blast caused severe structural damage to all except heavy reinforced concrete buildings, within a one mile ground radius. The usefulness of these buildings was destroyed by the gutting by fire and other interior damage. Diminishing moderate structural damage was suffered to distances up to three miles depending on the strength of buildings. Fires, caused by heat radiation from the bomb or indirectly by damage to heating or electrical systems, produced additional damage generally to distances of one and one-half miles and sometimes to several miles. In general the usefulness of the entire seven square mile built-up area of Hiroshima was destroyed.

5. Many conflicting reports developed on the numbers of casualties caused by the bomb. The best estimate is that about 80,000 people were killed, about 10,000 were missing and that about 80,000 were injured. 50-60% of the deaths were from burns, about evenly divided between flash burn and flame burn. Mechanical injuries, lacerations, fractures, contusions and abrasions, from falling and flying debris caused 30-40% of the deaths. Only a small percentage, probably well under 10% of the deaths were caused solely by radioactivity.

6. There are two principal difficulties in attempting to assign exact proportions to the types of injury causing fatalities:

a. Close to the blast, say within one-half mile, people were subject to several types of injury any of which might have been fatal - in general it can be assumed that burns and mechanical injuries were about equally effective - radioactivity, being a slower killer, would not have had time to be effective before the casualty succumbed to other injuries.

b. Probably as many as 10% of the injured who died could have been saved had a proper rescue service been operating and had adequate American-type medical treatment been available. Approximately 90% of the hospital facilities and medical personnel were rendered ineffective by the bomb and the surviving population was completely distraught and ineffective. In addition, the blow had such a stunning effect that medical help which might have come from outside was considerably delayed.

7. Of the injured who did not die, a great percentage of the casualties suffered from burns of either the flame or flash type. Again, multiple injuries complicate the problem of assigning percentages to types of injury. Among the surviving injured, radiation sickness of varying degrees was quite prevalent.

Nagasaki

8. The second atomic bomb was used against Nagasaki on 9 August 1945. This bomb was detonated well above one rather isolated section of the city. It was a finger of about four miles long in a valley less than one mile wide, between two ridges. At one end it joined on to the main section of the city. There was an important war factory towards each end of the finger. A similar typical American city, which is much larger however, is Pittsburg. The total area of Nagasaki was roughly thirty-five square miles and its population about 260,000 of which 100,000 were exposed to the direct effects of the bomb in the three and one-half square miles of built-up area in the industrial valley. There were many open spaces and many less domiciles than in other sections of the city.

9. Since the effects of the bomb were confined, the overall effect on the city as a whole was less shattering than at Hiroshima. Nagasaki had suffered several small scale attacks of conventional bombs, but the city was comparatively

intact on 9 August 1945. The bomb fell midway between the two large industrial war plants; these were between 30% and 75% destroyed. Typical steel frame structures were nearly destroyed, reinforced concrete buildings were damaged internally and although machinery was not all destroyed it was knocked out of line and covered with debris. Buildings within one mile were destroyed and those up to three miles suffered moderate to light damage. In Nagasaki, too, fires caused great damage. About three and one-half square miles, the main built-up industrial area, were rendered useless.

10. The number of persons killed was about 39,000 and about the same number were injured. As has been pointed out, the lesser number of casualties at Nagasaki was because of the lesser number of persons present within range of the bomb's effects. About 75% of the dead at Nagasaki died from burns, 15% from mechanical injuries and 10% from other causes including radioactivity. The greater number of deaths from burns is undoubtedly due to the fact that there were fewer people near the center of the explosion; mechanical injuries kill a greater proportion of people near the center than at greater distances and burns are fatal at greater distances than are mechanical injuries. Hospital facilities and medical personnel were hard hit but were able to operate more effectively than at Hiroshima, since parts of the city had been completely shielded from the blast. Possibly 5-10% of those wounded who died eventually might have been saved had adequate American-type medical service been available.

11. A comparison of certain statistics in the two cities reveals the true effectiveness of the bombs used:

	<u>Effective Maximum Radius</u>	
	<u>Hiroshima</u>	<u>Nagasaki</u>
Multi-story brick buildings destroyed	4,400 feet	5,300 feet
Steel frame buildings destroyed	4,200 feet	4,800 feet
Typical Japanese homes seriously damaged	6,500 feet	8,000 feet
Flash burns - personnel	7,500 feet	13,000 feet
Lacerations - personnel	10,600 feet	12,200 feet

General Considerations

12. The currently available atomic bomb, of about 20,000 tons TNT equivalent, will effectively destroy about three and one-half square miles (about one mile radius) in any city, except that heavy reinforced concrete buildings will not be flattened. They will be severely damaged internally and will probably not be usable. Severe damage to houses and other light buildings will extend to one and one-half miles radius. Light damage will occur in about twenty-five square miles of area.

13. Underground structures and shelters will be well protected as will be underground utilities. Transportation systems will not be vulnerable but equipment for them will be. Above ground railway switches and telephone, telegraph and power lines will be susceptible to severe damage within one mile radius.

14. Flash burn will cause casualties out to two and one-half miles. Practically any type of shielding including clothing, particularly white, will be effective against flash burn at distances of one-half mile or more. Severe burns on exposed skin will occur out to one and one-half miles. All except minor mechanical injuries will be limited to the radius of moderate structural damage or about two miles. Radiation will kill otherwise unharmed personnel at one-half mile. An exposed person will have a 50% chance of survival at three-fourths of a mile. Slightly over one mile will be the limit of radiation disease although mild cases may occur at distances as great as two miles. Beyond one-half mile, concrete walls of varying thickness depending on the distance will shield personnel against the effects of radiation. About 90% of personnel not specially sheltered within one-half mile of the blast, 50% from one-half mile to one mile and 10% from one mile to two miles will be killed.

Vulnerability of American and British Cities

15. The British Mission which investigated the bombed areas of Hiroshima and Nagasaki computed what might happen to a typical British city under atomic bomb attack. Surprisingly enough, even though assumptions have been made that the damage in Japan was so severe due to the poor quality of Japanese construction, their estimates of the damage to British houses and other buildings approximate what were the actual facts at Hiroshima and Nagasaki. Assuming a population density of about 29,000 per square mile (about equal to Hiroshima) which is average for cities in the United Kingdom (as well as for the centers of large American cities), the estimated casualties would be 60,000 dead and 50-100,000 injured in varying degrees.

16. In large American cities, the bulk of the buildings will generally be subject to damage on about the same scale as those in Hiroshima and Nagasaki. Not so many fires will be started, but other damage may be greater due to the higher buildings and the use of facing material in office buildings. It is a reasonable assumption that except for special areas (lower Manhattan for instance), the atomic bomb would have effects against American cities similar to those in Japan. For example, four square miles of central Washington including the business district and the Federal triangle would probably have a population during working hours of about 250,000. Even though the buildings in this area may provide considerable protection, at least 65,000 people in this area would be killed and between 65,000 and 100,000 would be injured.

17. Lower Manhattan, during working hours has a population density of about 140,000 per square mile. Probably about 25% of the personnel within four square miles would be killed; the figure, 140,000 dead, staggers the imagination but it may well be a low estimate. The varying effects which might be achieved from a

lower air burst or ground level burst, or from an underwater burst where sufficient depth of water is available cannot be easily calculated but there is no question but that the effects of radioactivity would be considerably greater. Lower air bursts would, in general, destroy structurally stronger buildings over a smaller area. A ground level burst would produce blast damage over a relatively small area, but the deposited radioactivity would provide a major problem. Although most effective radiologically, an underwater burst in New York harbor would cause little or no blast damage in the city. The pressure transmitted through the water would sink ships within 500 yards of the detonation point and would cause considerable damage to ships and to dockside facilities within one mile. The most destructive feature of this type of attack, under proper wind conditions, would be the spreading of a radioactive mist over five to ten square miles of lower Manhattan. This would deposit enough radioactive material to deliver lethal doses of radiation to a great proportion of the population in the area and to render that portion of the city uninhabitable for weeks, and possibly months. The safe evacuation of the population from the area would present a most difficult problem as would later entry for the re-establishment of necessary civic functions.

SNPEX

7 July 1948

SUBJECT: Studies Being Made on Survivors of the Atomic Bombings in Japan.

TO: SUPREME COMMANDER ALLIED POWERS IN JAPAN
APO 500 c/o Postmaster
San Francisco, California

1. Recently the National Research Council requested the Joint Chiefs of Staff to reaffirm the interest of the National Defense Establishment in the studies being made by the Atomic Bomb Casualty Commission on the survivors of the atomic bombings in Japan and requested further that this expression of interest be transmitted to the Commander in Chief Far East for his information.

2. The Joint Chiefs of Staff referred this request to the Armed Forces Special Weapons Project for reply. A copy of this reply, ~~which has the concurrence of the Joint Chiefs of Staff,~~ is forwarded herewith for your information.

FOR THE CHIEF, AFSWP

S. V. HASBROUCK
Colonel, FA
Chief of Staff

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cy ltr Hasbrouck to
Nat'l Res Coun, 25 Jun 48

Statement A
Approved for public release;
Distribution unlimited 29 Jul 48

319.1 Medical Operations 41. + 21.

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7 July 1948

Dr. Lewis H. Weed
Chairman, National Research Council
2101 Constitution Avenue
Washington 25, D.C.

Dear Dr. Weed:

In accordance with your request of 29 June 1948, we have forwarded to the Supreme Commander Allied Powers in Japan a copy of our letter of 25 June in which we reaffirm the interest of the National Military Establishment in the studies being made on the survivors of the Atomic Bombings in Japan.

Sincerely yours,

S. V. HASBROUCK
Colonel, FA
Chief of Staff

Statement A
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NATIONAL RESEARCH COUNCIL

2101 CONSTITUTION AVENUE, WASHINGTON 25, D. C.

Established in 1916 by the National Academy of Sciences under its Congressional
Charter and organized with the cooperation of the National Scientific
and Technical Societies of the United States

DIVISION OF MEDICAL SCIENCES

29 June 1948

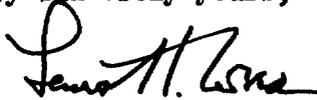
The Chief, Armed Forces
Special Weapons Project
P. O. Box 2610
Washington, D. C.

Dear Sir:

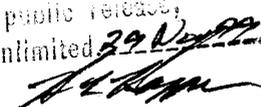
This will acknowledge receipt of your letter of 25 June 1948, reaffirming the interest of the National Military Establishment in the work of the Atomic Bomb Casualty Commission as requested in our letter of 13 May 1948 addressed to the Joint Chiefs of Staff.

The National Research Council is gratified with this expression of interest and respectfully requests that, if there is no military objection, you forward a copy of your letter of 25 June to the Supreme Commander Allied Powers in Japan for his information.

Very sincerely yours,



Lewis H. Weed, M. D.
Chairman

Statement is
Approved for public release,
Distribution unlimited 29 June 1948


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25 June 1948

National Research Council
2101 Constitution Avenue
Washington 25, D.C.

Gentlemen:

Your letter of 13 May 1948 to the Joint Chiefs of Staff, in which you request that the National Defense Establishment reaffirm its interest in the studies being made on the survivors of the atomic bombings in Japan by the Atomic Bomb Casualty Commission, has been forwarded to this office for reply.

The Armed Forces Special Weapons Project is in full accord with the follow-up study on the survivors of the atomic bombings in Japan. Data obtained therefrom will provide this Project with information vital to certain studies which it is carrying on. It is urgently recommended that these follow-up studies be continued and that the Atomic Bomb Casualty Commission be given every opportunity to complete the work already started.

Sincerely yours,

S. V. HASHBROCK
Colonel, FA
Chief of Staff

cc/JCS
(Attn: Capt. Stephens) e

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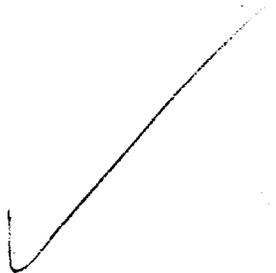
29 Nov 99
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NATIONAL MILITARY ESTABLISHMENT
ARMED FORCES SPECIAL WEAPONS PROJECT
P. O. BOX 2610
WASHINGTON, D. C.

ADDRESS REPLY TO:
THE CHIEF, ARMED FORCES
SPECIAL WEAPONS PROJECT

16 June 1948



MEMORANDUM FOR THE JOINT CHIEFS OF STAFF

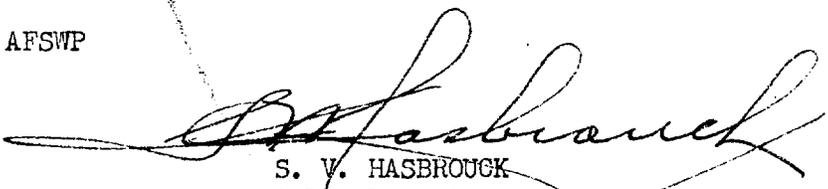
SUBJECT: Studies Being Made on Survivors of the Atomic Bombings
in Japan.

1. The Armed Forces Special Weapons Project is in full accord with the follow-up study on the survivors of the atomic bombings of Japan. The data obtained therefrom will give this Project certain information vital to its present study of Radiological Warfare; specifically, it will provide information concerning casualties to be expected from the offensive use of radioactive contaminants as well as the practical aspects of the treatment of casualties over a long period of time.

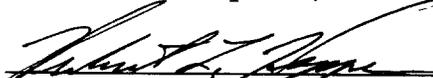
2. In order to evaluate fully the effects of the atomic bombs it will probably be necessary to follow a group of individuals through at least one complete generation to determine what, if any, genetic effects the bombing may have produced. The complete life span of the survivors will need to be correlated with those not so exposed to determine fully if there are unpredicted after-effects.

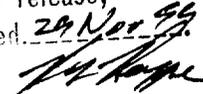
3. It is recommended that these follow-up studies be continued and that the Atomic Bomb Casualty Commission be given every opportunity to complete the work already started.

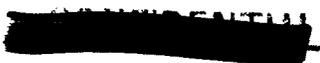
FOR THE CHIEF, AFSWP


S. V. HASBROUCK
Colonel, FA
Chief of Staff

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Date: 8/19/94

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NATIONAL MILITARY ESTABLISHMENT

ARMED FORCES SPECIAL WEAPONS PROJECT

P. O. BOX 2610
WASHINGTON, D. C.ADDRESS REPLY TO:
THE CHIEF, ARMED FORCES
SPECIAL WEAPONS PROJECT

16 June 1948

MEMORANDUM FOR THE JOINT CHIEFS OF STAFF

SUBJECT: Studies Being Made on Survivors of the Atomic Bombings
in Japan.

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FOR THE CHIEF, AFSWP

S. V. HASBROUCK
Colonel, FA
Chief of Staff

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