

"The Evaluation of the Atomic Bomb as a Military Weapon", June 30, 1947. President's Secretary's File, Truman Papers.

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ENCLOSURE "A"

THE EVALUATION of the ATOMIC BOMB

AS A

MILITARY WEAPON

The Final Report
of the
Joint Chiefs of Staff
Evaluation Board
For
Operation Crossroads

30 June 1947

DECLASSIFIED
E.O. 13526, Sec. 1.4(C) and 1.4(D) or (2)
OSD memo, April 12, 1974
By MLT *[Signature]*, NARS Date *[Signature]*

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Explanatory Note

The following pages contain the salient portions of the final report of the Joint Chiefs of Staff Evaluation Board. The Board has seen fit, in the national interest, to delete certain paragraphs. Other deletions have been made by competent authority in accordance with the provisions of the ATOMIC ENERGY ACT. The Joint Chiefs of Staff have made further deletions in the interest of security of military data derived from the Crossroads tests, (or otherwise in the national interest at the request of higher authority).*

* This clause to be added, or some suitable equivalent, in case the President wishes the bracketed paragraphs to be deleted.

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* If "Five - Atomic Warfare Policy" is deleted, page numbers must be corrected accordingly.

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Acknowledgments

In the preparation of this report the Board availed itself of the services of Rear Admiral W. S. Parsons, USN, Chairman, JOINT CROSSROADS COMMITTEE and found his advice and assistance of great value. In addition, members of the Operations Evaluation Group, Office of the Chief of Naval Operations, were of service to the Board. Its members are especially indebted to Dr. Edward S. Gilfillan, Jr., Technical Director of JOINT CROSSROADS COMMITTEE; to Dr. Arthur Brown, of the OEG; and Commander Roger Rovello, USN, Oceanographic Assistant to the Director of Ship Material and Co-ordinator for Oceanography to the JOINT CROSSROADS COMMITTEE, for material especially prepared for this report. Rear Admiral T. A. Solberg, USN, Director of Ship Material and Capt. P. X. Forrest, USN, Bureau of Ships, were generous in their assistance. Col. Stafford L. Warren, USA (MC), Radiological Safety Advisor, OPERATION CROSSROADS, was of great assistance to the Board in his field. Credit for material taken from the reports of others is contained in the text of this report.



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This report was prepared under the direction of the Board by Mr. Russ Symontowne, Expert-Consultant to the Civilian Members of the Board and Chief of its Secretariat. Mr. Symontowne had the assistance of Dr. Thornton Page, Col. Robert G. Butler, Jr., USA, and Maj. Glen W. Clerk, USA, Technical Aids and Consultants to the Military and Naval Members of the Board.

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PART I -- Letter of Transmittal

The Joint Chiefs of Staff
Washington
D. C.

Subject: Final Report, JCS Evaluation Board

Gentlemen:

Your Board, appointed to evaluate the Bikini Atoll Atomic Bomb tests, has the honor to transmit to you its final report.

In accordance with our Directive this report is classified as a TOP SECRET. In order that the Joint Chiefs of Staff may make this report public, the Board has prepared a revision from which certain matter has been deleted. Prior to the publication of this revision it will be necessary that classified factual material be deleted by the Joint Chiefs of Staff.

We regret the death of Gen. Joseph W. Stilwell, an original member of the Board, who took an active part in its early deliberations. His duties have been capably discharged by Lieut. Gen. A. C. Wedemeyer, whom you appointed to succeed him.

Respectfully yours,

Lt. Gen. L. H. Brecken, USA
Bradley Dewey
Thomas F. Farrell
Vice Adm. John H. Hoover, USN

Rear Adm. Ralph A. O'Rourke, USN
Lt. Gen. A. C. Wedemeyer, USA
Karl T. Compton, Chairman

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PART II - The Board's Participation in the Tests

1. Under date of 27 February 1946, William D. Leahy, Fleet Admiral, United States Navy, Chief of Staff to the Commander in Chief of the Army and Navy transmitted a memorandum for the Chairman, Evaluation Board, Atomic Bomb Tests with the subject: "Instructions to Evaluation Board, for the Atomic Bomb Tests".

This memorandum charged the Board with "two broad functions":

"a. To be available for advice to the Task Force Commander during the preparations for the tests.

"b. To examine and evaluate for the Joint Chiefs of Staff the results of the tests."

2. There followed instructions for the preparation of two preliminary, public reports, one to be submitted immediately upon the conclusion of each test.

3. Concerning its final report this memorandum informed the Board that it should include "pertinent comments on strategy, tactics, and technical information valuable to the national interests of the United States".

4. The memorandum further read: "The Evaluation Board will be guided exclusively by its own judgment in its evaluations based on the results of the tests. Particular attention will be paid in the final evaluation to the strategic implications of the results as well as the factual damage incurred by naval vessels and other material".

5. The Chairman, acting on behalf of the Board and with its subsequent approval, offered 2 April 1946 several suggestions to the Commander, Joint Task Force One, with respect to the oil, gasoline and ammunition loadings of certain target vessels as well as to instrumentation for the tests. The Chairman's observations, together with the reply of the Task Force Commander have been presented previously.

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6. The Board held three meetings in Washington, prior to the tests, these being on 23 February, 26 March and 29 April. Its members and staff left Washington for Bikini Atoll 23 June and, after witnessing the tests, returned 1 August. Numerous meetings and consultations with the Task Force Commander, members of his staff and civilian experts were held during the tests. The Board members were afforded every facility for the performance of their duties and enjoyed every courtesy from all with whom they came in contact.

7. Following the tests, the Board held three meetings in Washington for the preparation of this report. These meetings took place 13 and 14 January 1947, 11 February and 23 April. The Board held its final meeting in Cambridge, Mass., 24 June.

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PART III -- Conclusions and Recommendations

Section One - CONCLUSIONS

Note: Several paragraphs have been deleted and the paragraph numbers adjusted accordingly.

1. The Board has reached the following major conclusions:

(1) If used in numbers, atomic bombs not only can nullify any nation's military effort, but can demolish its social and economic structures and prevent their reestablishment for long periods of time. With such weapons, especially if employed in conjunction with other weapons of mass destruction as, for example, pathogenic bacteria, it is quite possible to depopulate vast areas of the earth's surface, leaving only vestigial remnants of man's material works.)

(2) The threat of the uncontrolled use of the atomic bomb and of other weapons of mass destruction is a threat to mankind and to civilization. Only the outlawing of all war and the setting up of an adequate international control of weapons of mass destruction can lift this threat from the peoples of the world.

(3) In the absence of absolute guarantees of abiding peace, the United States has no alternative but to continue the manufacture and stockpiling of weapons of nuclear fission and to carry on continuous research and development for their improvement and improvement in the means of their delivery.

(4) The value of surprise in attack has increased with every increase in the potency of weapons. With the advent of the atomic bomb, surprise has achieved supreme value so that an aggressor, striking suddenly and unexpectedly with a number of atomic bombs might, in the first assault upon his vital targets, achieve such an order of advantage as would insure the ultimate defeat of an initially stronger adversary.

(5) There must be national recognition of the probability of surprise attack and a consequential revision of our traditional attitudes toward what constitute acts of aggression so that our armed forces may plan and operate in accordance

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with the realities of atomic warfare. Our policy of national defense must provide for the employment of every practical means to prevent surprise attack. Offensive measures will be the only generally effective means of defense, and the United States must be prepared to employ them before a potential enemy can inflict significant damage upon us.

(6) National defense requirements of the future are only those of the past; any aggressor must be overcome with superior force. But, where in the past, the duty of the President, as the Commander in Chief has been restricted (before formal declaration of war) to action only after the loss of American lives and treasure, it must be made his duty in the future to defend the country against imminent or incipient atomic weapon attack.

(7) What constitutes an "aggressive act" or "imminent" or "incipient" attack it is the responsibility of the Congress to define and to redefine, from time to time, so that it may draft suitable standing orders to the Commander in Chief for prompt and effective atomic bomb retaliation should another nation ready an atomic weapon attack against us.

(8) No weapon can be more effective than the means used to bring it into action against the enemy; hence the necessity for the coordinated development of atomic weapons and weapon-carriers and their integration into a series of devices, each with a tactical or strategic purpose. In the category of weapon-carrier may be included any means of ultimate delivery such as aircraft, guided missiles, rockets, torpedoes and mines of all types.

(9) Inseparable from the development of bombs and bomb-carriers, should be the planning of naval surface and submarine vessels from which atomic bomb-carriers may be launched or discharged, as well as of land launching devices, stationary or mobile, and the acquisition and maintenance of land and air bases.

(10) Any target study must include a critical consideration of the vulnerability of this country to atomic bomb attack and should lead to the study of ways and means of reducing this vulnerability, not only by physical dispositions and military measures, but by suitable training and indoctrination of military personnel and civilian population.

(11) No specific defense against the bomb exists nor, in the current opinion of science, is any likely to be devised. Such passive defense measures as concealment, or massive shielding, or below-ground construction may well serve in the case of vital military facilities, but these measures are impracticable for the defense of a city and its inhabitants.

(12) For defense against atomic weapons, chief reliance must be upon the prevention or frustration of an enemy attack, or upon immediate retaliatory measures which will overwhelm an enemy and result in the destruction of his power and ability to make war.

(13) Essential to any plan of defense will be (a) knowledge as to whether potential enemies are in possession of the means to produce weapons of nuclear fission and (b) knowledge of their readiness for an attack. To gain this knowledge there will be required an intelligence service with a far greater effectiveness than any such service this country has had in peace or war.

(14) A correlation of the Bikini test data with other data, indicates that ships at sea and bodies of troops are, in general, unlikely to be regarded as primary atomic bomb targets, although in special circumstances they would undoubtedly invite such attack.

(15) The advent of the atomic bomb has not eliminated the need for ground, sea and air forces, although it may affect their composition in sizable degree.

(16) No result of the Bikini tests indicates the wisdom of any departure from the principle that naval ship design should be based upon tactical function. Neither did the tests

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indicate that the design requirements of ships, as dictated by tactical function, should be compromised by emphasis upon additional protection from atomic weapons beyond that degree appropriate to the type.

(17) Dominance in the ability to wage atomic warfare, the loss of which might be fatal to our national life, can be retained only by unflagging effort to hold that leadership in science and engineering which made the atomic bomb possible. A vital part of the national defense must be not only a program of scientific and engineering research and development in every field involved in bomb production and tactical use, but in basic science as well. Such a program requires periodic tests of atomic weapons.

(18) A peace enforced through fear is a poor substitute for a peace maintained through international cooperation based upon agreement and understanding. But until such a peace is brought about, this nation can hope only that an effective deterrent to global war will be a universal fear of the atomic bomb as the ultimate horror in war.

Section Two - RECOMMENDATIONS

Note: Several recommendations have been deleted and the paragraph numbers adjusted accordingly.

1. The Board recommends:

(1) That, since the abolition of war is the only absolute protection humanity can have against possible annihilation of its civilization by atomic and other weapons of mass destruction, the Joint Chiefs of Staff continue to give every proper support to plans for the achievement of an acceptable guaranty of international peace.

(2) That so long as the world lacks such acceptable guaranties of permanent peace, the manufacture and stockpiling of atomic weapons and fissionable materials be continued by the United States in such quantities and at such a rate of production as will give to it the ability to overwhelm swiftly any potential enemy.

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(3) That a constant program of research and development be carried on looking to the improvement of atomic weapons.

(4) That legislation be enacted by the Congress establishing new definitions of acts of aggression and incipient attack, including the readying of atomic weapons against us. This legislation should make it the duty of the President of the United States, as Commander in Chief of its Armed Forces, after consultation with the Cabinet, to order atomic bomb retaliation when such retaliation is necessary to prevent or frustrate an atomic weapon attack upon us.

(5) That the development of atomic weapons and weapon-carriers be so coordinated as to integrate them into a series of devices of specific tactical use and widest military effectiveness.

(6) That the conclusion be accepted that passive defense (dispersion, concealment, and above- or below-ground protection) practical for relatively small facilities is impracticable for urban and industrial areas.

(7) That studies be undertaken to determine to what extent and in what manner military and other targets of high importance can be given adequate protection.

(8) That studies be undertaken to determine measures (a) for the immediate relief of survivors of atomic bomb attacks, (b) for the reduction of mortality by medical techniques, (c) for the suitable advance training of military and civilian personnel in radiological safety techniques, including methods of decontamination, and, (d) for the development of instruments and equipment necessary to the foregoing.

(9) That, it being evident that early knowledge of a potential enemy's production of fissionable material in war quantity and of his readying of atomic weapons for use is of essential value to our defense, we maintain an intelligence service with a far greater effectiveness than any such service this country has had heretofore in peace or war.

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(10) That tests of atomic weapons be held whenever necessary in the research and development of such weapons or the tactics of their use or the training of personnel.

(11) That the Atomic Energy Commission be requested to reclassify as soon as possible Bikini test results now classified either in a military sense or under the Atomic Energy Act, so that (a) certain data will be available to military schools and (b) other data will be unrestricted.

(12) That the Congress review, in the light of new considerations and in the interests of the long-term effectiveness of the national defense, the statement of policy upon which the Atomic Energy Act is based.



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PART IV -- Text of the Report

Section One--operation CROSSROADS

1. The Board finds from available figures that operation CROSSROADS, in the conduct of atomic bomb tests, ABLE and BAKER, held at Bikini Atoll, 1 July and 25 July 1946, respectively, cost the Government an extra expense approximating \$50,000,000.

2. The tests fully accomplished two major purposes:

(1) They provided data essential to future military planning, giving bases for the calculation of the conditions under which the maximum destructive effects of an atomic explosion will be obtained against various types of land and water targets and against living organisms. Some estimate of the amount of this material may be gained from the statement that the Technical Historian's summary report alone consists of 32 chapters while more than 30,000 pages of detailed technical reports have been written with others in preparation.

(2) The tests gave to those upon whom falls the responsibility of various phases of atomic warfare planning, the incalculable benefit of a first-hand knowledge of the bomb in action, an advantage theretofore possessed by very few persons.

3. The tests furnished a vast amount of data of importance in wide and varied military, scientific, engineering and technological fields. Many of these data remain classified, either in a military sense, or as restricted data under the Atomic Energy Act. Of especial peacetime value are the data relating to nuclear physics, medical phases of radiation, including military aspects of radiological safety, and those relating to oceanography, meteorology, and marine and island biology and geology.

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4. The tests had further value in again demonstrating the ability of personnel of all branches of the armed services and civilian personnel to work in efficient harmony, setting a pattern for such cooperation in the future.

5. We feel that the conclusion expressed as to Test ABLE in our Preliminary Report 5 July 1946 may now be stated as a fact as to both tests, that is, that "the conditions were well chosen and that the highest skill and ingenuity have been used to obtain a maximum amount of data in an unbiased, scientific manner". The Board feels that the tests were valid and the Summary Reports therefrom honest and competent.

6. In a supplement to our first Preliminary Report which was made a part of our Second Preliminary Report we called attention to the fact that the ABLE bomb did not burst at the planned explosion point.

7. Only four ships and craft instead of ten as planned were within relatively close range of the projected point of burst and only 18 ships and craft instead of 25 as planned were within medium range.

8. The tests focussed the attention of the world upon the atomic bomb. They were held in the presence of a large number of correspondents (Test ABLE, 175; Test BAKER, 75) representing various media of public information. Approximately 2,417,500 words (in five languages) were transmitted by radio to newspapers and magazines; 615 radio broadcasts and 401 radiophotos were transmitted.

9. Certain pertinent comments and criticisms on the functioning of the public information plan have been submitted.

10. As a result of carefully planned operating procedures and radiological safety measures, no casualties resulted from explosion or radiation during, or after, either test and casualties from other causes were remarkably few.

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Section Two--GENERAL PHENOMENA

1. As the Board indicated in its preliminary reports on Tests ABLE and BAKER, the phenomena attending the explosions of both bombs, followed to a remarkable degree the predictions made by civilian and service experts.

2. Data on these phenomena are now in process of analysis and will be available to the Joint Chiefs of Staff.

3. One phenomenon of great importance, the base surge which appeared after the explosion of BAKER bomb, was not predicted.

Section Three--EFFECTS ON SHIPS

One--Damage Results

1. For the following brief summary of ship damage resulting from the bursts of Test ABLE and Test BAKER, the Board has drawn upon a large accumulation of data.

2. It is to be noted that the target array at Bikini did not, in either of the tests, represent any ordinary pattern of ship anchorage used by the Navy except in the case of surplus naval and merchant vessels anchored in close proximity in dead storage. Rather, the ships were arranged in accordance with the CROSSROADS directive to insure graded damage from sinking to negligible, and with the hope that a majority would remain afloat, so that data and instruments might be recovered.

TEST ABLE

3. As a result of the air burst in Test ABLE there was sunk a total of five target vessels in the array of 80 ships and small craft. They consisted of two destroyers, two transports, and the Japanese cruiser SAKAMA.

4. In addition six (non-sunk) vessels were immobilized. These included two battleships, two cruisers, a destroyer and a light carrier. Ships' top hamper, exposed electronic equipment and instruments were damaged.

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5. Submarines, both surfaced and submerged, proved less vulnerable than other types of vessels.

6. Although most of the damage was due to blast, small fires were started on a total of 25 ships. The exact cause of these fires is not clear in every case; in general they were minor, and because no damage control measures were immediately possible, fire damage exceeded that which might have been expected had the ships been ranned.

7. Except for that caused by the minor fires at long range, there was little damage to some types of materials exposed on the decks of target ships.

8. There was induced radioactivity in the sodium and phosphorus contained in small stores such as soap and matches. This effect was of negligible importance and fell off rapidly within 24 hours. The lethal effects of radiation are discussed in Section Four.

TEST BAKER

9. The damage produced by the underwater burst of Test BAKER was caused largely by the underwater shock wave. Surface waves also caused heavy damage, and some damage resulted from an air blast.

10. Of the US ships and small craft exposed in Test BAKER, the burst sank or capsized a total of nine vessels. Five (non-sunk) vessels were immobilized. Three other vessels suffered, at least temporary, serious loss of military efficiency.

(The ship figures above include the Japanese battleship NAGATO which sank five days after the explosion, but not the German cruiser PRINZ EUGEN which sank near Kwajalein Atoll about

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five months later. On both these ships the hazards due to radioactive contamination prevented control of slow leaks. In the case of the HAGATO, these hazards prevented inspection of damage by boarding parties.)

BOTH TESTS

11. Correlating the general effects of the two bomb bursts on ships and material, it can be stated:

(1) Little or no underwater damage was done by the air burst while severe underwater shock and wave motion accompanying the BAKER burst did heavy damage to ships' structure and equipment below the waterline.

(2) The air blast of Bomb-A caused extensive damage to superstructures, stacks and exposed decks. An air blast of lesser magnitude accompanied the detonation of BAKER bomb. Extensive damage to above-water portions of ships was caused (a) by this blast and (b) by breaking waves which engulfed ships with masses of water.

(3) Fires were set by the explosion of Bomb-A; no fires resulted from the second burst.

Two--Naval Design and Training

1. No result of the Bikini tests indicates the wisdom of a deviation from the principle that ship design should be based upon tactical function. Neither did the tests indicate that the design requirements of ships, as dictated by tactical function, should be compromised by emphasis upon additional protection from atomic weapons beyond that degree appropriate to the type.

2. The foregoing considerations should not deter study of (a) measures to minimize the bomb's explosive effects upon

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structure and personnel, (b) its radiation effects upon the latter, (c) routines (organization bills) for ships' personnel, the development of instruments to determine the radiation dosage received by personnel exposed to such radiation, and the extent and degree of contamination of structures.

3. An impressive result of MAKER was the contamination of ships by fission fragments. Efforts to decontaminate these ships have thus far emphasized the difficulties of the problem and the necessity for further experiment with Bikini target vessels. Techniques developed for ships will apply to the decontamination of other structures.

Section Four--EFFECTS UPON THE HUMAN ORGANISM

1. From a military viewpoint, the atomic bomb's ability to kill human beings or to impair, through injury, their ability to make war is of paramount importance.

2. Thus the over-all result of a bomb's explosion upon the crew of a ship or the inhabitants of a city is of greater interest here than an analysis of the physiological causes of these results.

3. Instrumental data and the results of animal experimentation at Bikini sustained the reports of Nagasaki and Hiroshima observers that the effects of an atomic explosion upon living organisms may be several fold:

- (1) They may be burned by the flash heat of the bomb.
- (2) They may suffer organic impairment by external radiation at the instant of blast.
- (3) They may suffer impairment by radiation after the blast from contaminated surfaces or by the entrance into the body of fission fragments and unfissioned material.

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(4) They may be subjected to the air blast of the explosion and also to the mechanical effects of falling and flying debris and to secondary fires.

4. Since it is estimated 92 per cent of those within a radius of 660 yards from the projected ground point of the air burst at Nagasaki were killed by one or more of the bomb's effects, a discussion of separate effects within this range is academic.

5. Beyond this range, the British Mission to Japan found that the probable order of the causes of death was (1) burns, (2) mechanical injury, and (3) gamma radiation.

6. Of the utmost significance, analysis of the Japanese data reveals that, had the bomb's effects been solely radiological, the mortality would have been substantially the same.

7. The British Mission found that at a range of 1660 yards, the mortality rate was 49 per cent, while nearly a third of those present within a radius of 2000 yards were killed. Even at 2300 yards the mortality rate was 12.5 per cent and a few were killed at the extreme range of 3000 yards.

8. Flash burn, a matter of importance in the detonation of modern explosives, occurred at an extreme range of 4600 yards at Nagasaki and it is reported that 95 per cent of those surviving the Nagasaki blast and seeking medical attention suffered from burns. (Explosion of a comparable amount of T.N.T., i.e., 20,000 tons, could be expected to produce comparable flash burn results.) It was demonstrated in the Japanese bomb drops and confirmed by the Bikini tests that so brief was the duration of the thermal radiation, that shielding even of the most unsubstantial sort (sheets of paper or thin cloth) was sufficient to protect adequately against flash burn, even within short range of the detonation.

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9. The menace of nuclear radiation is present at the instant of explosion and residual radioactivity may persist for a considerable length of time thereafter in the immediate vicinity and at greater distance for diminished lengths of time.

10. Within one second of the explosion of a bomb in air, gamma radiation and neutron emission, it has been estimated, are sufficient to destroy human life at distances exceeding 1000 yards, and casualties may result at 2000 yards.

11. In the case of a burst at the land surface or at very low altitude, there is a deposition of fission products over an area of several hundred yards' radius, sufficient to be dangerous for several years. Neutron emission at the instant of burst results in induced radioactivity in various elements, notably sodium. This hazard, while it may be great for a brief period, is secondary in importance to radioactivity from other sources.

12. When a bomb is exploded underwater, lethal residual radioactivity assumes an importance greater than the physical damage caused by the explosion. Vast quantities of water falling from the explosion column and traveling outward in the base surge and, also falling as "rain" from the cauliflower cloud, carry, not only highly radioactive fission products, but unfissioned material as well.

13. Massive shielding is the only known protection against external nuclear radiation. No treatment to nullify the effects of radiation upon living organisms exists, nor is there reason to hope that means of prophylaxis (immunization or the like) can be found. (So-called "supportive measures" may be effective in prolonging life in certain "border line" cases and, it has been suggested, would reduce mortality in exposures of less than 400 roentgens.)

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14. This report recognizes the importance of, but does not discuss the mechanical effects of, atomic explosion upon human beings. These effects of the atomic bomb are those common to the explosion of conventional bombs except that in the former case deaths appear to occur at lower peak pressures, perhaps because of the character of the pressure wave.

Section Five--THE USE OF THE BOMB IN WAR.

One--General Defense Considerations

1. The tremendous destructive (explosive) power of the atomic bomb and the great range of its lethal (radiation and residual radioactivity) effects, combined with the fact that no specific means of defense or of prophylaxis against it exists, or is likely to be devised, make it a weapon capable of decisive importance in war.

2. It is apparent that potential enemies of the United States will seek to arm themselves with this weapon and the means to deliver it. The speed with which they will possess atomic weapons will be conditioned largely by their scientific, technological and industrial ability to solve the problems involved. It is common knowledge that research in nuclear fission is in progress throughout the world.

3. Therefore, unless there is permanent peace - guaranteeing national security through international control of all means of war - immediate and continuous preparation for the contingencies of atomic warfare is the part of prudence.

4. In the absence of special means of defense against atomic weapons, there are the considerations (a) of conventional passive defense (interception of attacking forces and the dispersion, concealment or massive protection of targets) and (b) of the positive defense of attack.

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5. Conventional defense measures cannot be neglected, but there are severe limitations to their effectiveness. A fighter air force in being, radar networks, ample anti-aircraft weapons and proximity-fused missiles, might well prove of high value in event of an attack preceded by sufficient warning. However, the great expense of this country and the vast number of targets it presents make its adequate defense by such means impracticable.

6. The passive defense of dispersion, concealment, and massive or underground protection is feasible for relatively small facilities of high military value, but could not be employed for extensive installations or cities.

7. An adequate program of defense, therefore, must have as a goal, the possession of a superior striking power and the ability to explode at will, with greatest effectiveness, such a number of suitable designed atomic weapons as will:

a. Deter a potential enemy from attack, or,

*b. If he prepares an attack, overwhelm him and destroy his will and ability to make war before he can inflict significant damage upon us.

8. The effective military use of atomic weapons is conditioned by the possession:

- a. Of atomic weapons in adequate numbers
- b. Of suitable means for their delivery
- c. Of plans for their strategic use
- d. Of bases within range of enemy targets.

Two--Research, Development and Stockpiling

1. No weapon can be more effective in war than the means used to bring it into action against the enemy. Thus, it follows that emphasis should be placed upon the coordinated development of atomic weapons and weapon-carriers and their integration into a series of devices each with a tactical or strategic purpose.

* Substitute "attacks" for "prepares an attack" and include this paragraph if its present form is disapproved.

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2. Progress reports of agencies engaged in the research of guided missiles and aircraft for travel at trans- and supersonic speeds indicate that in the foreseeable future, chief reliance for aerial bomb delivery at ranges greater than 400 miles must be upon conventional aircraft. Hence, national security will require unremitting effort to develop present types of aircraft capable of operating at great range, under all weather conditions and in spite of enemy opposition.

3. Inseparable from the development of the bomb and bomb-carriers is the development of methods of bomb launching from naval vessels, both surface borne and underwater, and the acquisition of land air bases which will best insure bomb delivery to targets distant from continental United States.

4. The only means of insuring that we may be in possession of a sufficient number of bombs to overwhelm an enemy intent upon attacking us is the stockpiling of bombs and fissionable materials.

5. In the present state of science, the processing of these materials is complicated and time-consuming. It is the lesson of history that new inventions may at any time vastly accelerate presently known methods and thus make it possible for a potential enemy of the United States, starting late, to outstrip us quickly in atomic weapon production.

6. The United States cannot retain dominance in atomic warfare - the loss of which might be fatal to our national life - unless by unflagging effort it retains the leadership in nuclear physics, chemistry and engineering, which made the bomb possible. Hence, a vital part of our national defense must be a program of research and development in every field involved in bomb production.

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7. No development of any weapon or skill in its use can be achieved without periodic tests. The phenomenon of nuclear fission precludes the explosion of an atomic weapon of less than critical mass, and hence all tests must be "full scale".

Three--Measures of Active Defense

1. For so long as the United States retains exclusive possession of atomic weapons, it will be a matter of our choice, based upon political and military considerations of the moment, whether they should be employed in the event any country has the temerity to attack us.

2. Situations can be envisaged in which an aggressor, with or without the atomic weapon, relying upon various factors of war favorable to him and, making difficult our successful delivery of atomic bombs to targets vital to his military effort, might undertake an attack upon us.

3. An enemy, geographically remote, in possession of only a few atomic bombs, might contrive to deliver them in merchant vessels to our chief seaports and, without declaration of war, to discharge them in our bays and harbors and so cripple us as to permit him to proceed with an act of aggression against a third power whose integrity we desired unimpaired.

4. The advent of the atomic bomb has not eliminated our need for ground, naval and air forces. Nor has it lessened the need for overseas bases from which they can operate effectively. The relationship of the atomic weapon to other weapons and means of war in the nation's defensive armament, should be the subject of constant scrutiny in the light of changing conditions and new knowledge.

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5. The length of time before potential enemies will arm themselves with weapons of nuclear fission has been variously estimated by experts, many of whom have expressed little faith in the accuracy of their predictions, but who are virtually unanimous in the belief that the development of those weapons by others is inevitable.

6. To deliver an immediately paralyzing blow, an aggressor striking against a country armed with atomic weapons, will have to rely upon the highest order of surprise and striking power. He must overwhelm his adversary with such suddenness that retaliation cannot be undertaken or, if attempted, will be unsuccessful. There will be little solace in ultimate victory if retaliation has brought national ruin to the victor. Thus, in such warfare, the element of surprise will be an essential, the possession of which will be the only assurance of success and whose lack may be catastrophic.

7. Offense, recognized in the past as the best means of defense, in atomic warfare will be the only general means of defense. Even a nation capable of retaining the will and ability to fight a victorious war after losses far greater than those of the Pearl Harbor surprise attack, can be seriously crippled, perhaps defeated, by a well planned and executed atomic bomb surprise attack. This may hold true no matter how great the damage inflicted by belated counter-attack.

8. Basic to a defense against weapons of nuclear fission will be, first, protection against surprise and, second, the ability to attack with overwhelming force before an enemy can strike a significant blow.

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Four--Intelligence

1. Protection against the catastrophic consequences of an atomic bomb surprise attack will require an intelligence service with a far greater effectiveness than any such agency that this country has ever had in peace or war. Such an agency, charged with the duty of constant, world-wide scrutiny to determine whether atomic weapons (or other weapons of mass destruction) are being manufactured or readied for use, must be the first bulwark of our national defense.

2. An effective intelligence agency must have the duty of (a) supplying early intelligence of the manufacture, by any nation, of fissionable material in war quantity, and (b) providing prompt warning should a potential enemy ready atomic weapons for use.

3. An effective intelligence service will require a coordination of the effort of existing agencies, as well as the employment of suitably trained physicists, chemists and other scientists.

Five--Atomic Warfare Policy

1. Traditionally, the policy of the United States is one of non-aggression and, as a result, in the past we have awaited attack before employing military force. Because such forbearance in the future will court catastrophe, if not national annihilation, it is necessary that, while adhering in the future to our historic policy of non-aggression, we revise past definitions of what constitutes aggression calling for military action.

2. Article 1, Section 8, paragraph 11 of the Constitution of the United States gives to the Congress the sole power to make war, and neither restricts this power nor offers instruction in its use. So long as the people of the United States adhere

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to the democratic form of government, this power must reside in the Congress and can never be delegated.

3. Article II, Section 2, Paragraph 1 of the Constitution declares that the "President shall be Commander-in-Chief of the Army and Navy of the United States".

4. Under these ample provisions the United States has successfully defended itself in the past and we can find no reason to believe that the emergence of the atomic bomb requires any alteration of the organic law for our future defense. The security demands of the future are those of the past; any aggressor must be overcome with superior force.

5. Presently the duty of the Commander-in-Chief (before a declaration of war by the Congress) is confined to action only after the loss of American lives or treasure. In the future it must be made his duty to defend the country against incipient attack by atomic weapons whenever another nation is readying an atomic attack upon us.

6. What constitutes incipient attack it is the responsibility of the Congress to explore and define so that it may draft suitable orders to the Commander-in-Chief for the prompt and effective utilization of our armed forces should we be under the menace of an atomic weapon attack.

7. The processing and stockpiling of fissionable material in a certain quantity by a certain nation at a certain time may not constitute an aggressive act (incipient attack) while the same acts by another nation at another time may, upon their discovery, call for swift action in the national defense.

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8. Therefore, necessarily, the Congress must, from time to time, reconsider its definitions of aggressive act and incipient attack so that it may alter and change its standing orders to the Commander-in-Chief as to the state of facts upon which it becomes his duty to defend the United States against attack by atomic weapons.

9. It will be the duty and the responsibility of the Congress to decide whether these definitions and its directions to the Commander-in-Chief be published to the world or be held secret.

10. Article II, Section 2, Paragraph 1 of the Constitution of the United States provides that the President (Commander-in-Chief) "may require the opinion in writing of the principal officer in each of the executive departments upon any subject relating to the duties of their respective offices. . . ."

11. Whatever may be the legal effect (or mandatory force) of the foregoing provision, it would seem clear that American tradition would require the Commander-in-Chief to receive the advice of Cabinet members before deciding that a dictate of the Congress requiring military action had come into force.

Six--Consideration of Targets

1. The selection of targets for attack by atomic weapons must take account of the number of such weapons available in the predictable future. Thus selection and priority of targets become of prime importance in the employment of the weapon.

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2. The correlation of the results of the explosions of atomic bombs over Japanese cities and against naval vessels, at Bikini, gives ample evidence that the bomb is pre-eminently a weapon for use against human life and activities in large urban and industrial areas, as well as seaports.

3. Against structures, ashore or afloat, from a military standpoint, the blast effects of the bomb are those of a conventional explosive except for their greater magnitude. Thus, against structures, the bomb has two advantages over other explosives: (a) it can accomplish damage over a much greater area, and (b) the demands for accuracy in delivery of a single bomb to produce a given result are far less than for bombs loaded with conventional explosives.

4. The atomic bomb will therefore have value in the demolition of structures whenever military judgment dictates that the importance of such demolition warrants its use despite the risks and difficulties involved. Here the importance of the target combines with the value of the bomb to emphasize the importance of means of certain delivery.

5. Dams, ship canals, naval bases, immobilized naval and merchant fleets concentrated in storage areas, air fields, troops engaged in amphibious landings or concentrated in staging areas, may be cited as targets justifying the use of the atomic bomb should special circumstances give them sufficient value.

6. It would appear axiomatic that whenever a target comparable to the foregoing has such high value as to invite atomic bomb attack, it will be strongly defended. Where dispersion, concealment and massive shielding are impracticable, then air defenses may be calculated to increase greatly the risk of the delivery of the bomb to such targets by conventional aircraft.

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7. In the case of naval vessels, the Bikini tests would strongly suggest that ships under way will rarely constitute suitable targets for atomic bomb attack. Ships engaged in amphibious operations, or carriers, or groups of carriers, able to launch atomic weapons, and ships at anchorage and in harbors, will constitute exceptions.

8. For the defense, in particular cases, of Navy, Army and Air Force land facilities, as well as other installations (dams, canals, atomic bomb dumps, industrial plants) reliance must be placed in air defense measures and in dispersion, concealment, massive shielding or underground construction.

9. An air defense which would make the delivery cost of bombs prohibitive would certainly be an effective defense, as would the protection of a key facility deep underground. An intensive and energetic study would reveal the value and practicality of passive defense for specific targets.

Seven--Effectiveness of the Bomb against Cities

1. However feasible passive means of defense may prove for small vital installations, such protection will be inadequate for a city. Its structures and inhabitants, except as interception measures at a distance are effective, are fully vulnerable to atomic bomb attack.

2. Conventional methods of fire control, emergency policing, care of the wounded and the restoration of essential services would certainly mitigate the results no matter how extensive. But the personnel for these services would have to be recruited from outside the area and where radioactive contamination existed could enter it only with extreme difficulty and after some lapse of time.

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3. TEST BAKER gave evidence that the detonation of a bomb in a body of water contiguous to a city would vastly enhance its radiation effects by the creation of a base surge whose mist, contaminated with fission products, and dispersed by wind over great areas, would have not only an immediately lethal effect, but would establish a long term hazard through the contamination of structures by the deposition of radioactive particles.

4. We can form no adequate mental picture of the multiple disaster which would befall a modern city, blasted by one or more atomic bombs and enveloped by radioactive mists. Of the survivors in contaminated areas, some would be doomed to die of radiation sickness in hours, some in days, and others in years. But, these areas, irregular in size and shape, as wind and topography might form them, would have no visible boundaries. No survivor could be certain he was not among the doomed and so, added to every terror of the moment, thousands would be stricken with a fear of death and the uncertainty of the time of its arrival.

5. Rescue parties could not enter any part of the city, except at the hazard of life, until the contaminated areas had been established and delimited. When this had been done, relief might be brought to those remaining in lightly contaminated areas, but the dead would remain unburied and the wounded uncared for in the areas of heaviest contamination where certain death would lurk for many days and, in which, for many years to come, continuous habitation would be unsafe.

6. Thousands, perhaps millions, of refugees would rush from the city in panic, breaking down remaining transportation facilities, congesting highways, and creating in their flight new hazards to life. Among these fugitives, for the moment unidentifiable from the rest, would be numbers whose contaminated

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clothing and any goods they carried could establish in others the fear of dangerous radioactivity, thus creating a unique psychological hazard.

7. It cannot be assumed that in a future war, a participant, with a range of choice, will rely altogether upon a single weapon of mass destruction. Driven by the necessity of overwhelming his adversary, lest he himself be overwhelmed, a combatant might well choose to compound the horror of an atomic bomb attack with the simultaneous delivery of pathogenic agents which would insure that frightened fugitives would spread, not only their panic, but epidemic disease as well.

Eight--Psychological Atomic Warfare

1. In the foregoing division, an attempt has been made to extrapolate from available data a statement of the gross dislocations of urban life which may be expected to result from the explosion of atomic bombs against heavily populated areas. But largely absent from this statement are speculations as to the specific psychological phenomena which such a burst will induce, and which must constitute an element of paramount importance in the selection of atomic bomb targets.

2. In the body of knowledge of human behavior, there are no data directly useful to a discussion of these phenomena as they might occur in a modern Occidental city because there have been no observations of conduct under conditions fully approximating those described above.

3. A study of the population behavior in Nagasaki and Hiroshima (Manhattan Engineer District and U.S. Strategic Bombing Survey Reports) offers little help to an understanding of what may be expected in the future, in the cases either of air or underwater bursts. Prior knowledge of the bomb's effects was not possessed

by inhabitants of the Japanese cities and made no contribution to their behavior patterns. Similarly, the inhabitants of Japan, as a whole, even after the fact, had little or no knowledge of nuclear phenomena and hence, no opportunity to exhibit anticipatory panic. Then, too, the mental makeup peculiar to the Japanese is probably at greater variance with that of Occidental peoples than the mental makeup of these peoples is, one from another. This would, of course, complicate evaluation.

4. On each of the two occasions the atomic weapon was employed in Japan, a single bomb only was burst in air over a single city on a single mission, providing no picture of the national situation which might have resulted had tens or hundreds of bombs been discharged, within a brief period of time, over several cities.

5. Moreover, there are lacking from an air burst many of the important psychic stimuli which would be present after an underwater explosion.

6. In the face of these negative findings, and of the bomb's demonstrated power to deliver death to tens of thousands, of primary military concern will be the bomb's potentiality to break the will of nations and of peoples by the stimulation of man's primordial fears, those of the unknown, the invisible, the mysterious. We may deduce from a wide variety of established facts that the effective exploitation of the bomb's psychological implications will take precedence over the application of its destructive and lethal effects in deciding the issue of war.

7. A thorough study of the many-faceted psychological problem will doubtless reveal a wide variation in the psychological military value of cities as targets.

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8. There are countries where because communication facilities are so limited, large areas might be depopulated with little or no effect upon the morale of the country at large. There are cities of especial sentimental significance whose loss to a country might have a more profound effect upon the national will than the destruction of areas more important intrinsically.

9. There are cities symbolic of national greatness beyond their conventional military importance. There are capital cities vital to the national unity necessary to the prosecution of war; the loss of other capitals might scarcely disturb their nation's military tempo.

10. Of as wide variation and of equal importance it will probably be found, are national temperaments, ways of life and levels of education. Paradoxically, it would seem that, within some limits, the greater the knowledge of nuclear fission phenomena, the greater the fear it engenders. Dwellers of a city who are aware of the nature of the calamities being afflicted upon their fellow countrymen of another city, will identify themselves with these calamities and may, the more easily, translate early fear into ultimate alarm and panic. Less likely are persons largely ignorant of the manifold deadliness of an atomic bomb to make these psychological adjustments.

11. With the question of a given group's reaction to the discharge of an atomic bomb (as compared to the reactions of other groups) is raised the consideration of propaganda as a means of enhancing the bomb's military utility. Coupled with this are considerations of the communication facilities of a given country and of the extent of the free exchange of information.

12. Even a cursory examination of the characteristics of the American people and of the cultural and material fabric of their national life invites the conclusion that this nation is much more

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vulnerable to the psychological effects of the bomb than certain other nations. A study of the factors involved should not only assist us in determining the vulnerabilities of other nations, but, also, should lead to the development of measures to lessen the effects of these phenomena should we be attacked.

Nine--Continuous Review of Targets

1. The selection of atomic bomb targets will be seen to involve problems far more numerous and complex than those involved in the selection of targets for conventional weapons. To be fully effective, the survey of potential targets will have to be continuous so that the relative importance, as well as the accessibility, of a given target may be known at all times.

2. Exactly as the atomic weapon and weapon-carrier must be regarded as an integrated weapon and the development of each coordinated with the development of the other, so the consideration of suitable targets is inseparable from consideration of the combined potential of weapon and weapon-carrier to give a desired result.

Ten--Concluding Observations

1. The effort to appreciate the implications of atomic energy is taxing the apperceptive powers of the most unfettered minds in every field of thought. Its use, as an implement of war, poses a wider variety of new and complex problems than have ever before confronted military planners. Not merely the overcoming of the inertia of conservatism is here required, but a revolutionary change in military mental attitudes.

2. It is not always the nation first introducing a new weapon which develops its highest utility. England invented the tank, but Germany developed the tactics which made it a major weapon. Germany first employed lethal gas in battle, but her failure to

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develop quickly a suitable technique of use may have cost her victory in the first World War. The possible penalty of a failure to retain dominance in the development of the atomic bomb and of the strategy and tactics of its use is so great that it must serve as a constant incentive to the best thought and effort of our military planners.

3. In conclusion the Board reverts to the ATOMIC ENERGY ACT and its basic provisions. In our opinion, these basic provisions, however justified at the moment of the ACT's passage, should be reviewed from time to time in the light of changing events.

4. The Board offers no criticism of the ATOMIC ENERGY COMMISSION. In a friendly and cooperative spirit and with long-term effectiveness of the national defense in mind, the Board recommends a reconsideration by proper authorities of the questions: Whether the Services should (a) have representation on the ATOMIC ENERGY COMMISSION, (b) own, have title to, and be charged with the control of atomic weapons after fabrication, (c) participate in the work of the design and testing of atomic weapons, and (d) control all information relating entirely to the military utilization of the weapons, as distinguished from design and development information.



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