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REPORT ON A STUDY OF THE SAFETY ASPECTS OF UHA AND VHA' FOR OPERATION HARDTACK

Prepared by the

SAFETY WORKING GROUP

under Joint Direction of:

Chief, Armed Forces Special Weapons Project.
Chief of Research and Development, Dept of The Army
Director, Division of Military Application, USAEC

October 21, 1957

[redacted]

REPORT ON A STUDY OF THE SAFETY ASPECTS OF UHA AND VHA' FOR OPERATION HARDTACK (U)

21 October 1957

Prepared by the Safety Working Group
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Chief, Armed Forces Special Weapons Project
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FOREWORD

This report has been prepared by the Safety Working Group at the request of the Chariman of the Eniwetok Planning Board and of the Commander, Joint Task Force Seven.

The Safety Working Group is a joint study group, representing the Armed Forces Special Weapons Project, the Department of the Army, and the Division of Military Application, US Atomic Energy Commission.*

The Mission of the group is to study the safety aspects of the UHA and VHA' events proposed for Operation HARDTACK (Shots TEAK and ORANGE, respectively), and to submit a formal report thereon, with particular emphasis on nuclear safety.

* The following references designate members of the group:

1 - Ltr, Hq AFSWP File SWPWT/976, dtd 13 Aug 57 to Chief of R&D, D/A Subj: Safety Working Group, HARDTACK (U), and 1st Ind thereto from Office, Chief R&D to Chief AFSWP dtd 28 Aug 57.

2 - Ltr, Hq AFSWP File SWPWT/976,5 (UHA) dtd 19 Aug 57 to Dir, Division of Military Application, USAEC.

3 - Ltr, Asst Mgr for Advance Planning ALO, AEC, Albuquerque, NM, Symbol: ALP:ECS dtd 11 Sep 57, Subj: Appointment of AEC Representatives to Working Group for UHA and VHA Prime shots.

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SUMMARY

The Safety Working Group has considered the safety aspects of the UHA and VHA' events for Operation HARDTACK, with particular emphasis on nuclear safety, and concludes that these experiments can be conducted within acceptable safety limits.

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ACKNOWLEDGEMENT

A large number of people in all interested agencies have been of major assistance in the preparation of this report. The Safety Working Group wishes to express particular appreciation to Mr. Dieter Grau and Mr. James Farrior of ABMA, Mr. James G. Drake of Picatinny Arsenal, and Mr. D. M. Olson and Mr. John Hungate of Sandia Corp.

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ILLUSTRATIONS

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I. OPERATIONAL CONCEPT AND ASSUMPTIONS

The Department of Defense intends to launch two Redstone Missiles from Bikini Atoll early in operation HARDTACK. [redacted] (An extreme upper limit for Bikini Island) Selection of the burst point for TEAK (UHA) was made essentially without regard to thermal effect, since the altitude alone was sufficient to provide the required protection of ground installations. In both cases, the aiming azimuth was selected so as to provide a reasonable assurance of deep-water impact in the event of a dud. The missiles will be fired from a launching site on Bikini Island, after an extensive check-out procedure by the Army Ballistic Missile Agency's Missile Firing Laboratory. Check-out procedures on the launching pad will assure that all components are fuctioning properly prior to launch. Concurrent checks by personnel of Picatinny Arsenal and Sandia Corporation will assure that the S&A components and the warhead are safe and in ready condition. During this entire period the warhead will remain "nuclear safe" until installation of the "key" at a time still to be determined.

DOE 6.1(a)

For experimental reasons the firings are scheduled during hours of darkness, as early in the evening as is operationally feasible. It is anticipated that Bikini Atoll will have been evacuated approximately two hours prior to the primary shot time, and that only those personnel will remain in the Bikini Area whose presence is essential to accomplishment of the mission. Those personnel who do remain in the area will be in protected locations either in the firing bunker on HOW (Bikini) Island or in the Control Center on NAN (Enyu). The total number of such personnel is currently estimated at fifty (50).

Preparation of the missiles and warheads will be a joint undertaking of personnel of the Army Ballistic Missile Agency, the Sandia Corporation, and Picatinny Arsenal, all under direction of CTG 7.1. The Actual missile firing will be conducted by and under direction of the ABMA Missile Firing laboratory, subject to operational control of CTG 7.1. To provide certain command safety features, limited control of the inflight missile can be exercised from the ground. This control will rest in a range safety officer appointed by the Commander, Joint Task Force Seven, and will be the only command contact with the missile after take off.

Although only two missiles are scheduled to be fired, three complete assemblies including warheads will be transported to the proving ground. Scheduling will be so arranged that there will at all times be a complete and ready missile available on Parry Island to be transported to Bikini immediately in the event of damage, malfunction or failure of one of the primary missiles. Firing dates are tentatively scheduled as 23 April and 6 May, with some hope that these dates may be advanced a few days after the attainment of intermediate ready dates is evaluated.

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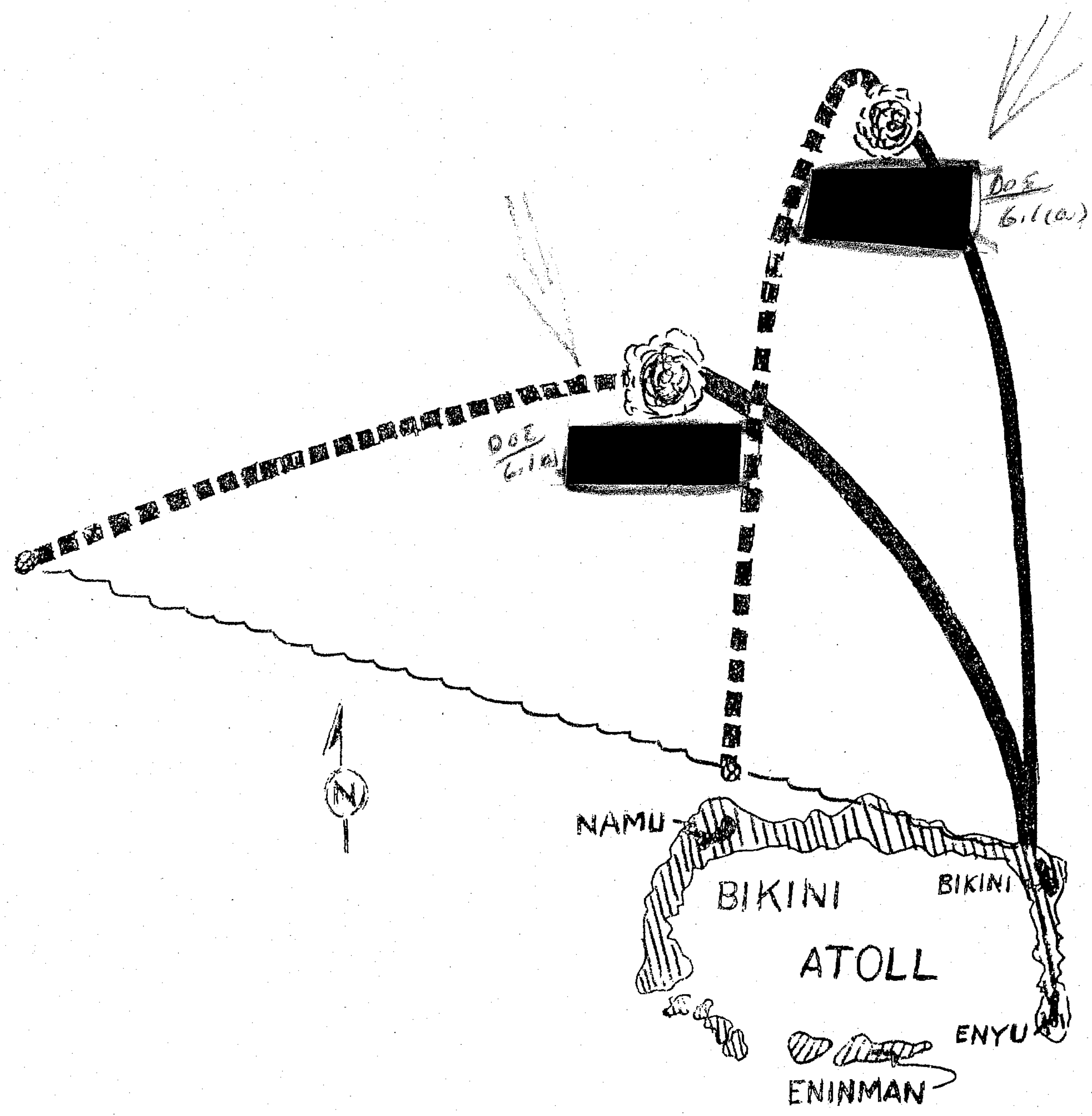

APPROXIMATE HORIZONTAL DISTANCES

[redacted] DOE 6.1(a)

TRAJECTORY AZIMUTH: 305° T.

[redacted] DOE 6.1(a)

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II. THE MISSILE SYSTEM

A. DESCRIPTION

1. The HARDTACK missiles will be of the tactical Redstone configuration, with suitable modifications to provide the short base-line trajectories and the high air-burst capabilities which are required for the operation. The guidance function will be utilized for the initiation of a properly timed cut-off signal for the rocket motor and the provision of the intelligence required by the arming system.* This differs from the tactical missile in which the range guidance function is utilized for terminal guidance (during and following reentry). Lateral guidance will be retained as in the tactical configuration. Certain additional signals are provided to the Arming system, as outlined in Section III.

2. Two new trajectories are being developed to allow the detonations to occur in the near vicinity of Bikini Atoll. Standard trajectories attain the required altitudes, but at distances from the launch point which would be excessive for the HARDTACK application. [redacted]

DOE 6.1(a)

3. The missiles will be completely assembled (including inert warheads) and ground tested at ABMA, Huntsville, Alabama, prior to air-lifting to the Eniwetok Proving Ground. This assembly will include interference testing of all components and handling equipment, and it is expected that it will duplicate as nearly as possible the procedures to be followed in the forward area.

B. MISSILE (NON-NUCLEAR) SAFETY

With the exception of the normal industrial safety hazards associated with this type of operation, the Redstone missile launchings present two hazards which are somewhat unique in character. These are offered, first,

* There is one additional function assigned to the guidance system, in connection with the instrumentation for the firings. However, this function is in no way related to the behavior of the missile, and hence is unrelated to safety.

[redacted]

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by the large quantity of fuel and oxidizer which is at all times a potential source of a fire of conflagration proportions, and second, by the possibility that an erratic missile has the capability of direct impact on either the firing bunker or the control center, both of which are manned. With regard to fire, a number of precautions are appropriate. These precautions are standard practice at AFMTC and elsewhere, and have successfully prevented serious accident throughout the history of the program. Facilities for isolating and controlling fire are being incorporated in the design of the launching facility, and protection of personnel is adequately afforded by the shelters which are a part of that facility.

Impact of a missile on the launch bunker is a clear possibility, especially during the early stages of flight. Aside from the geographical improbability of impact at any specific point, a degree of control of this situation is provided to the safety officer by the instantaneous visual presentations of missile behavior, and by the command system for flight termination. The flight safety officer is thereby enabled to sense a developing unsafe condition, and to command engine cut-off and separation of the missile into its two major components. At the discretion of the Commander, JTF-7, he may also be enabled to command fuel dispersion, which has the effect of tearing open the propellant tanks so that burning of most of the propellants will occur before impact.

Although it is difficult to assign numerical values to probabilities of the occurrences discussed above, it is noted that the risks involved are not unique to the HARDTACK program, and in fact are regularly accepted on behalf of civilian residents of the communities surrounding the AFMTC and other missile firing installations in the continental United States.

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III. NUCLEAR SAFETY

A. DESCRIPTION OF THE SYSTEM

1. Warhead:

[redacted]

DOE 6.1(a)

An additional safing arrangement will be provided in the warhead used for the Hardtack tests. In order to allow one-man control of nuclear safety at all times up until shortly before launch, the high voltage cabling between the thermal battery and the X-unit capacitor bank is interrupted and the ends terminated in receptacles which are accessible through doors in the fully erected missile. A jumper cable to complete the circuit will be kept in possession of the arming party until a short time prior to launch. [redacted] Possession of this "key" will provide means for the arming party to control nuclear safety until the evacuations have been completed, regardless of any circumstances which might occur.

DOE 6.1(a)

With the above features, positive warhead safety is assured until the "key" is installed, and after that the safety is dependent upon whether or not signals reach the warhead.

* SRD LASL Report, Ref. Sym: LA-2018.

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FIGURE 2- ARMING & FIRING BLOCK DIAGRAM

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2. Arming and Fuzing Components

This portion of the system supplies power for warhead actuation signals, generates these signals at the proper times, and prevents these signals from reaching the warhead unless certain conditions of missile flight are achieved.

[redacted]

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[redacted]

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3. Missile Functions

The launch relay in the missile supplies a signal to the arming and fuzing section which unlocks the timers in the safing and arming device and in the arming-fuzing timer assembly. The launch relay is energized at the time of launch and is de-energized by the physical separation of the missile from the launch pad; the signal is supplied to the arming and fuzing section through normally-closed contacts as the relay falls out. Fallout of the relay also starts the program device. The launch relay is interlocked electrically with other missile functions so that the launching sequence is discontinued if the relay drops out prematurely, prior to the start of thrust buildup.

The missile program device is a timer which utilizes a tape recording to deliver signals at predetermined intervals to various missile and arming and fuzing components. A signal is generated by the guidance computer for the ejection of an instrumented pod shortly before cutoff. Ejection of this pod then starts a timer which provides the cutoff signal to the rocket motor, and initiates the guidance check interval, during which missile velocities and displacement in certain planes must be correct in order to release one of the detents in the safing and arming device. Another signal is supplied 15 seconds after cutoff which releases the fourth detent in the safing and arming device, allowing it to close arming switches. This same signal activates the 28-volt batteries and starts the fuzing timers in the arming and fuzing section.

Ground Equipment

The T-4007 Control and Monitor Panel is used in the bunker to control and/or monitor the warhead electrical system, the safing and arming device, and the arming and fuzing timer. This panel monitors the continuity circuits in these three areas and operates the warhead arm/safe switch. In normal sequence of operation, the safe conditon of the warhead arm/safe switch is monitored first; the continuity circuits in the safing, arming, and fuzing areas are monitored; and then the continuity circuit in the warhead is monitored. The warhead arm/safe switch is then armed. Electrical interlocks prevent arming of this switch unless the continuity circuits are satisfactory. In addition, resistors in the T-4007 limit the monitor current to 28 milliamps nominal. This value is below the threshold operating level for all of the components in the areas being monitored, thereby preventing any serious consequences in the event of a short cirucit between a continuity circuit and an active circuit.

[redacted]

B. ASSUMPTIONS

Certain assumptions have been made in this study regarding safety criteria and the procedures to be followed in the operations prior to launch. These are:

1. The T-107 safing and arming devices will be opened and visually inspected after arrival in the launch area in order to determine that all components are correctly reset. The monitor circuits in these devices check only that the switches have not operated and that timers are reset; they do not insure that all detents are in the proper position and that accelerometer weights are latched.

2. The T-107 devices will not be installed until after missile erection, in order that the above visual inspection is not invalidated by any shocks the devices may have experienced in handling.

3. The arming and fuzing timer assembly will be opened and visually inspected after arrival in the launch area to determine that the cams are reset to the correct initial position. The electrical monitor circuit does not insure that cams are reset properly; only that solenoids have been reset.

4. The high voltage jumper cable in the warhead will be installed approximately 15 to 30 minutes prior to launch, or later. The jumper plug which connects the arming and fuzing section to the missile circuits will be installed at the same time.

5. The warhead arm/safe switch will be armed by the T-4007 control and monitor panel at approximately one minute prior to launch.

6. In the event of a fire occurring while the missile is on the launcher, all external power to the missile will be immediately disconnected.

7. Nuclear detonations occurring 90,000 feet or more (slant range) from any inhabited area are not hazardous.

8. The means available for ground control of the missile after launch are command cutoff and separation. Command fuel-tank rupture by means of primacords may also be provided subject to a pending decision of Commander, JTF.7.

9. Assuming faulty guidance, the maximum possible range of the missile with the fuel load carried is approximately 175 nautical miles.

10. The only personnel on Bikini Atoll at the time of detonation are on How and Nan Islands.

[redacted] RESTRICTED DATA ATOMIC ENERGY ACT 1954

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C. DISCUSSION OF VARIOUS SITUATIONS

Various situations which might occur are described below, along with the estimated probability of detonation in each case. In each situation malfunction of certain parts of the system is assumed and the probabilities estimated for failures of the remaining devices which could result in a hazardous detonation. A detailed explanation showing the basis of the estimates for each situation is given in the appendix.

Numerical estimates are made for probabilities of specific types of component failure and these quantities are combined to arrive at a combined figure for the probability that detonation will occur in a certain situation. there is no statistical data to support these estimates; they are based only on judgment as to what should be expected of the component reliability. It is believed that the resulting probabilities of premature are small enough so that a wide margin of error in the individual estimates would not affect any conclusions which may be drawn from this report.

1. Handling operations up until the time of installation of the high voltage jumper cable "key".

[redacted] DOE 6,1(a)

Prior to the installation of the "key" there is no way in which a firing voltage can reach the capacitor bank, so the probability of a premature detonation is essentially zero. This includes the effects of fire, since a fire could contribute no probability of establishing a high voltage path from the battery to the capacitor bank when the "key" is not installed.

2. After installation of the key and prior to launch.

At this time a nuclear detonation can occur if signals are supplied to the warhead. These signals will be supplied in the proper sequence by the arming and fuzing timer if it receives unlock and start signals, provided the signals can get through the T-107 safing and arming device. Certain signals from the missile system are required in order that solenoid-operated detents in the T-107 are released; these same signals would actuate the arming and fuzing timers and battery. The probability of premature, therefore, is the probability that the missile system will supply these signals and that certain mechanical actions will occur in the T-107. It is estimated that the probability of detonation in this period is about 10^{-12}, excluding fire. In the event of fire the probability is estimated to be about 10^{-9}.

3. Launching occurs and missile moves from the pad, but not far enough so that the electrical system is destroyed on impact after thrust is terminated.

[redacted] ~~RESTRICTED DATA~~ ATOMIC ENERGY ACT 1954

In this situation thrust buildup is initiated normally and some movement away from the pad occurs. This movement causes the launch relay to drop out, and the program timer is started and the flight sequence initiated. However, the thrust is of insufficient magnitude or duration to move the missile more than a few feet above the launch pad. The missile consequently is not destroyed as it falls back at the termination of thrust, and the electrical system continues to function. Detonation can occur when timed signals are delivered to the warhead, provided they can pass through the T-107 safing and arming device. The T-107 must malfunction in such a manner that the guidance check function is bypassed and that the g-weight assumes a position such that the detent associated with it is released. The effects of fire in this situation are negligible, since the portions of the system most likely to be affected by fire would have already operated normally. The probability of a detonation in these circumstances is estimated to be about 5×10^{-9}.

4. Launching occurs and missile moves from the pad far enough so that after thrust is terminated the electrical system will be destroyed on impact.

In this situation, the safety of the system is primarily a time function. If the missile impacts before the weapon has had time to arm, the impact forces will destroy the nuclear capability. If the missile flight lasts long enough to guarantee a safe slant range from the launch point at intended firing time, the explosion can occur without danger to launch personnel. However, if the missile flight time falls between these limits, a dangerous condition can exist. [redacted] These figures show the approximate slant range for bursts at the intended time plotted against cutoff time. The safe cutoff time region on the left of each curve represents the times for which the missile will impact before arming, assuming normal thrust or less to cutoff. The safe region on the right of each curve represents the times for which the missile will be at a safe slant range at the intended burst time, assuming normal thrust or more to cutoff. DOE 6.1(a)

For the unsafe region between these two safe regions, and for the situation of subnormal thrust in the right hand region, the program timer and the arming and fuzing timer will operate normally. Detonation can occur when signals are delivered to the warhead provided these signals can pass through the T-107 safing and arming device. The T-107 must malfunction in such a manner that the guidance check function is by-passed. In addition, the g-weight must assume a position such that the detent associated with it is released. The g-weight will assume this position normally if cutoff occurs after 70 seconds. Prior to 70 seconds, it will occur only as the result of a failure.

[redacted] DOE 6.1(a)

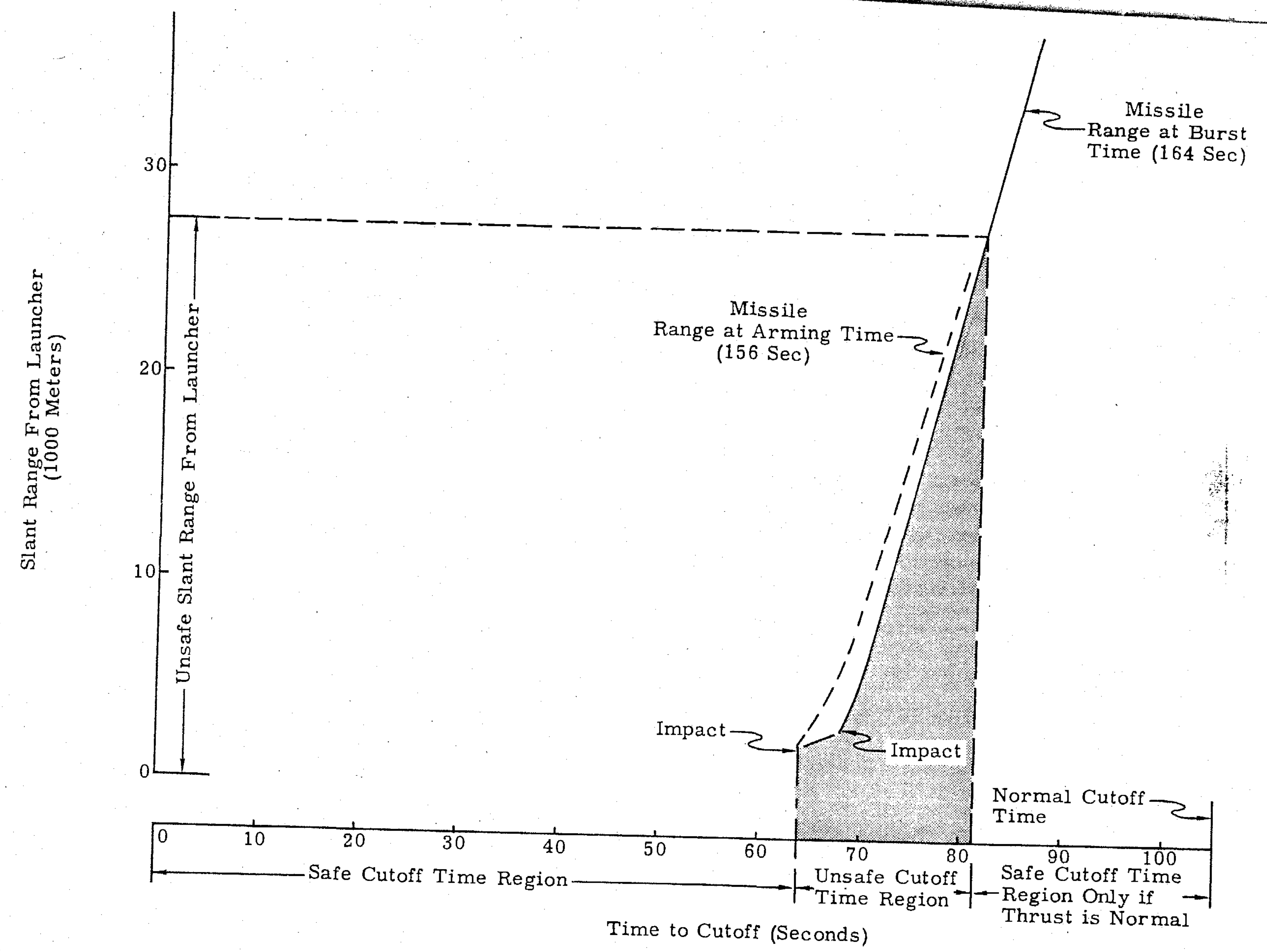

FIGURE 3-UNSAFE CUTOFF-UHA

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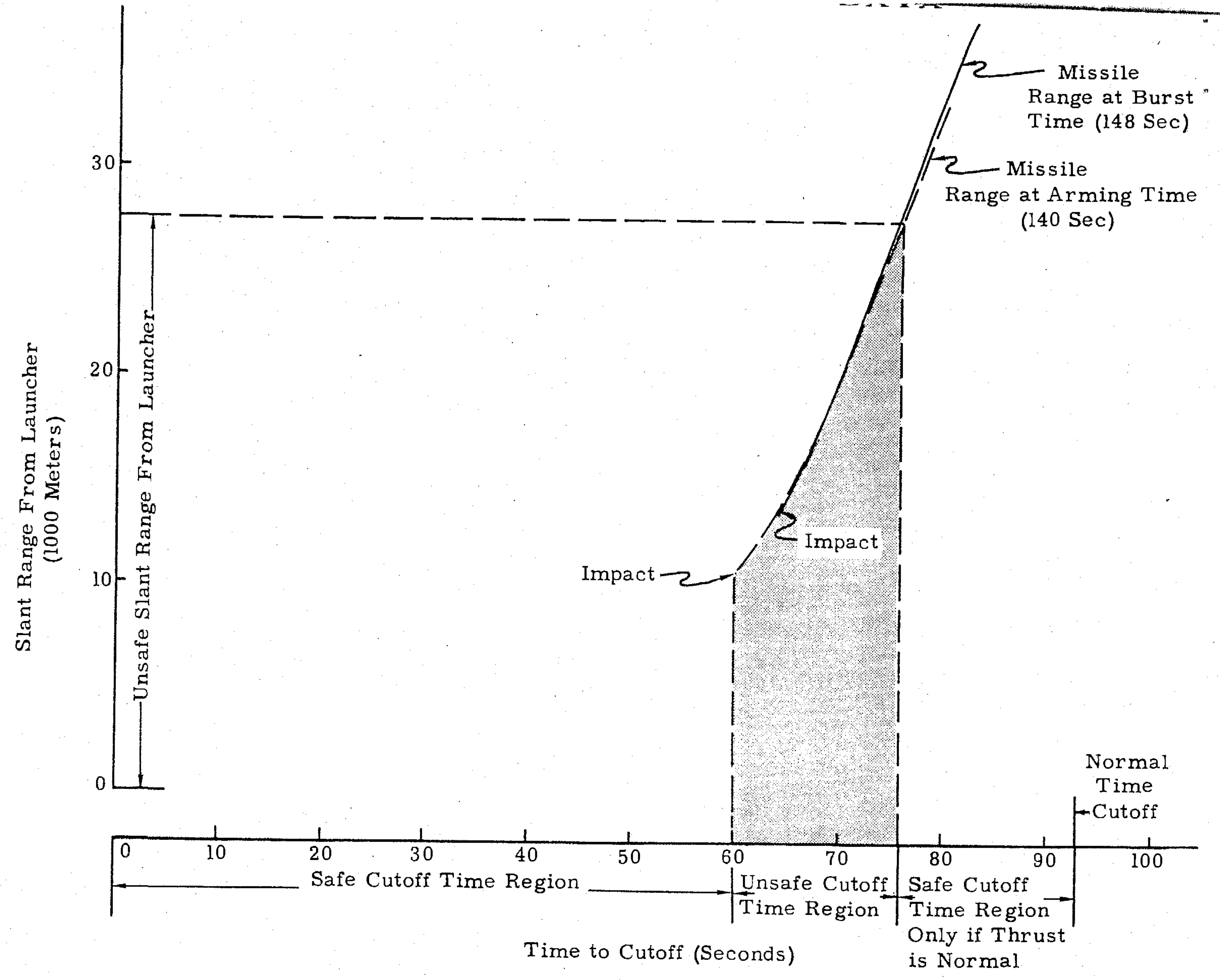

FIGURE 4-UNSAFE CUTOFF-VHA'

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5. Launching occurs normally and all missile functions are normal, xcept pitch programming, which fails completely.

In this situation the missile will travel essentially vertically nd return to earth in the vicinity of How and Nan Island. All normal ignals from the missile will be received by the safing and arming devices xcept the guidance check. [redacted] DOE 6.1(a)

A dangerous detonation can occur if the warhead arms normally, ails to fire, and fails to disarm when the disarm signal is supplied from ne re-entry deceleration.

[redacted] DOE 6.1(a)

6. Launching occurs normally and all missile functions are normal xcept pitch programming, which operates erratically.

In this situation, the missile will travel normally in the azimuth rection, but pitch will be programmed erratically, hence impact with the rth may occur anywhere along a line through How Island extending in both rections along the intended trajectory azimuth. [redacted] DOE 6.1(a)

In this as well as in the following situation the assumption is de that, with thrust and cutoff normal, the limits of operation of control d guidance are such that with any possible degree of pitch the missile ll still be at an altitude greater than 90,000 feet at the time set for tonation. [redacted] DOE 6.1(a)

In addition, the differences in horizontal position would be very small and difficult to detect by ground control during the period when command cutoff would be effective.

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Although the probability of detonation in a specific area is greater the nearer the area is to the launch point (excluding the predicted impact area, which will be considered separately), this distribution is ignored. It is considered that the estimates are sufficiently broad to cover the entire area, and thatthe probabilities in any parts of the areas do not exceed the figures quoted.

The conditions which can lead to a detonation at impact in this situation are the same as those in situation 5 for the VHA' shot except for the probability of the situation occurring and the probability that the ground control equipment will successfully detect the situation and prevent a detonation by fuel cutoff.

[redacted]

DoE 6.1(a)

7. All missile functions occur normally, but both the azimuth and range guidance functions are erratic.

In this situation the missile can travel on any trajectory within the limits of the control system, assuming normal thrust and cutoff, and will impact anywhere within a radius of 180km for the UHA shot and 100km for the VHA' shot.

This situation is the same as the previous one with the addition of failure of the azimuth guidance, and the increased likelihood that ground control will be able to interrupt the arming sequence by effecting early cutoff. [redacted]

DoE 6.1(a)

8. There is a possibility that a detonation can occur outside the region described in situation 7 above, within a radius of the order of 175 nautical miles from the launch point (the maximum range permitted by the fuel load), but this requires additional component failures and is several orders of magnitude less likely to occur.

9. All missile functions are normal and warhead arms but fails to fire.

This situation may result in a detonation in the predicted impact area, and is similar to several of the previous situations but without any failure of missile or arming components.

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DoE 6.1(a)

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IV. FLIGHT SAFETY

A. GENERAL

Flight Safety will be a function of JTF-7, exercised for the Task Force Commander by a Flight Safety Officer appointed by him. Many of the details of this function are as yet not decided, but the fundamentals can be clearly stated. The Flight Safety Officer shall have exclusive responsibility for exercising control over the missile from the instant of launch until the flight is terminated. This control will be exercised thru a radio link to the Command Destruct Receiver in the missile. The information provided to the Flight Safety Officer will include a number of meter indications of missile condition and behavior (telemetered) and the BEAT-BEAT presentation, an entirely independent information link which is described in detail below.

The Redstone flight safety problem is basically simplified in the HARDTACK application. This is true because the area surrounding the launching area is uninhabited except for two locations, and because the only ships in the nearby area will be subject to the absolute control of the Task Force Commander. The normal flight safety function which is carried over into HARDTACK is that of preventing impact on the launch bunker and the control center (Station 70). This function will be exercised in the same fashion as at AFMTC. The unusual function is related to the nuclear capability which is discussed in Section III and in Section VII (Recommendations).

B. THE BEAT-BEAT SYSTEM

The Beat-Beat system will be used to determine whether the missile is following the anticipated trajectory. This system is designed to present in real time the azimuth angle of a missile in flight to an accuracy of better than 1/100 of 1°. It also indicates whether the missile is following the pre-computed trajectory or program. To measure the azimuth angle two modified dovap receiver stations are placed symmetrically about the desired zero line. As long as the missile in flight remains on the desired zero line the doppler beat frequency at each station is exactly the same. When the missile deviates to the left or right one beat frequency will increase and the other decrease, the difference between these two Beats or the Beat-Beat is an indication of the lateral velocity. The total number of cycles of the difference is an indication of the lateral angular displacement. This displacement is indicated visually to the flight safety official on a Brown recorder. Two symmetrically placed receiver stations are used to indicate the program of the missile into its precomputed trajectory with visual presentation in real time.

For each set of two Beat-Beat receivers one Brown recorder instrument is provided at the safety control point, i.e., one instrument for program, one for azimuth presentation. For azimuth presentation the recorder will read center scale when the missile is in the zero plane or following the

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prescribed azimuth. In the case of program presentation the Brown recorder shows the missile as following the pre-inked line on the chart. Preliminary safe limit lines will be drawn on the charts so that the safety official can determine instantaneously during the missile flight whether the missile is within the prescribed safety limits. The Beat-Beat System will be provided with complete redundancy.

[redacted]

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V. ADDITIONAL CONSIDERATIONS

A. MISSILE PERFORMANCE.

1. To date 30 Redstone missiles have been fired.* These firings have afforded function and component testing as follows:

Guidance System	13 Missiles
Control System	29 Missiles
Separation and Expulsion	27 Missiles
Structure	29 Missiles
Engine and Accessories	18 Missiles

(12 of the 30 flights were with a now discontinued engine)

2. Based on the above firings, the Army Ballistic Missile Agency has evaluated the performance probabilities of the HARDTACK missiles. In making this evaluation certain assumptions have been made which are not recounted here in detail, but are incorporated in the Operational Plans. Further, the evaluation has considered each of the missiles fired as if it had been fired on the HARDTACK mission. The latter condition means that component or function failures during the terminal guidance phase have been ignored.

3. Evaluation of this small test lot of missiles utilizing the binomial probability distribution curve results in the following estimates:

a. The probability of the missile leaving the ground and following the precalculated trajectory up to the moment of burst within prescribed limits is 80%.

b. Assuming a successful flight to propulsion cutoff, the probability of success of the missile up to the moment of burst is 92%.

c. Assuming a successful flight up to and including booster separation, the probability of success of the missile up to the moment of burst is 99.99%.

d. In the event of an unsuccessful flight, the operational reliability of the Command Receiver System is 99.99%.

4. With regard to 3d, above, the Command Destruct receiver has never failed in laboratory tests, and there have been no known failures during flight. In a series of test firings pulses were sent to the missile and

* One additional firing completed while this report was being prepared is not utilized in this summary.

[redacted] RESTRICTED DATA ATOMIC ENERGY ACT 1954 279 relayed back to the ground by telemetry during the entire trajectory of about 150 nautical miles, and with a summit altitude exceeding that of UHA. The telemetry data indicated that the receiver properly received the signals in all cases.

B. <u>FUZING SYSTEM AND WARHEAD EVALUATION</u>.

1. On a Redstone Missile firing at AFMTC (missile number 41) in November 1957, two safing and Arming devices will be evaluated as HARDTACK fuzing components.

2. In addition it is planned that the HARDTACK fuzing system and warhead will be evaluated on missiles (No.42 and No.46) to be fired in December 1957 and February 1958. An additional warhead electrical system will be included inside the warhead for tactical system evaluation. Warhead operation of both systems will be telemetered.

C. <u>FIRING PERSONNEL AND EQUIPMENT</u>.

Of final significance, but not subject to numerical evaluation is one of the fundamental decisions which will be adhered to throughout the operation. It is an established matter of policy that the persons who conduct the inspection checkout and actual launching shall be selected from among the most experienced in the Army Ballistic Missile Agency. Techniques will be borrowed from those which have become accepted at the AFMTC and have repeatedly been proven under firing conditions. Check-out and firing equipment will be a combination of that which has been used extensively in Research and Development firings, augmented by tactical equipment which has been designed, tested, and accepted for field use.

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VI. CONCLUSION

A. NUCLEAR

It is concluded that the plan for HARDTACK Redstone firings has been conceived so as to maximize personnel safety. The probability of a nuclear detonation which would be hazardous to any point on the earth's surface is conservatively estimated not to exceed one in ten million - this probability existing only within the immediate area of Bikini Atoll. Figure 5 shows the geographical distribution of this probability in other areas.

B. NON-NUCLEAR

It is concluded that from the standpoint of other than nuclear safety the hazards associated with the preparation and launching of the Redstone missiles are neither unusual nor lacking in precedent.

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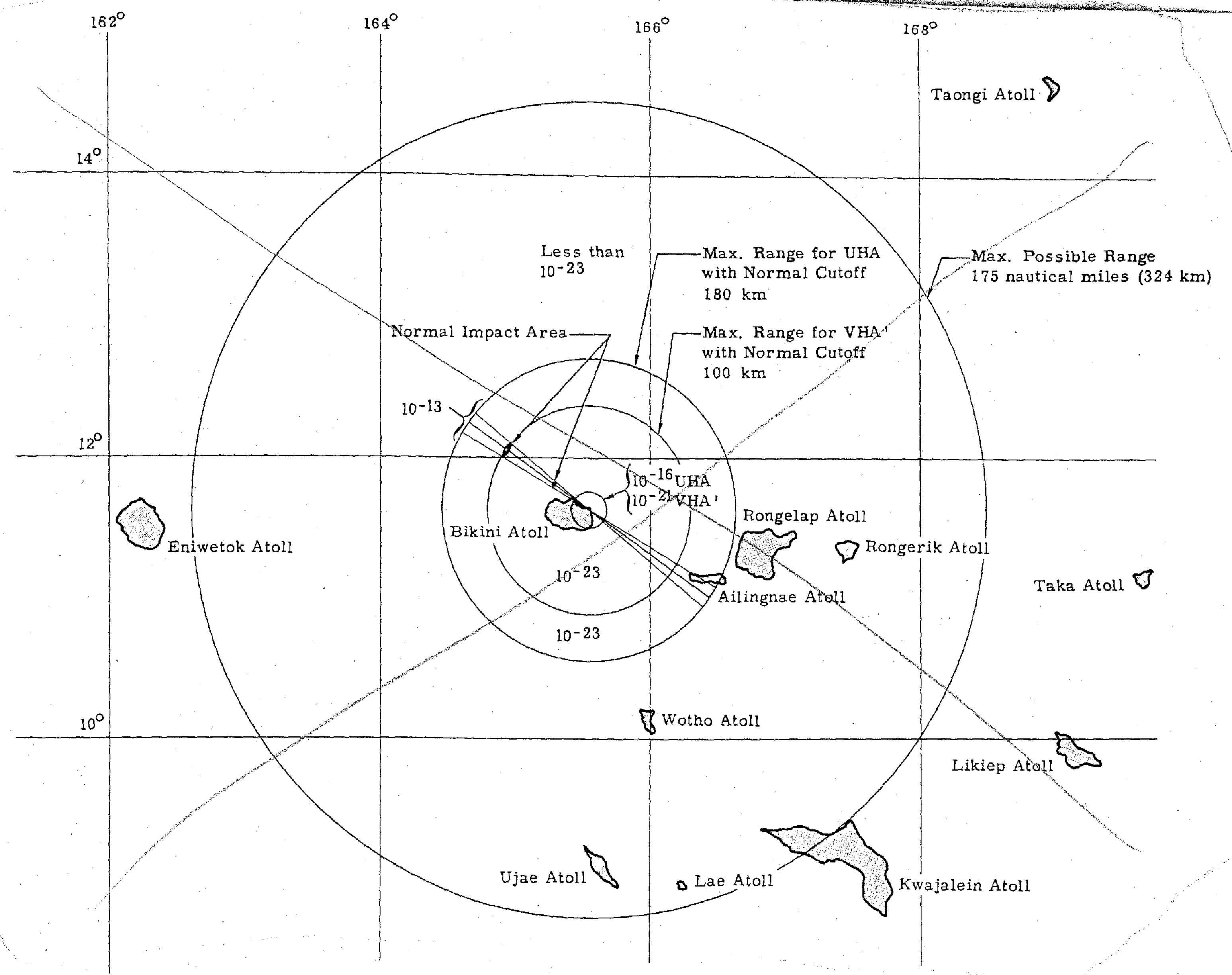

FIGURE 5 - GEOGRAPHIC DISTRIBUTION OF DETONATION PROBABILITY Sk(1216) 89671

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VII. RECOMMENDATIONS

A. It is recommended that from the standpoint of safety the subject firings be approved for inclusion in the HARDTACK program.

B. It is recommended that the Commander, Joint Task Force SEVEN, on the advice especially of ABMA and AFMTC, give detailed consideration to the flight safety requirements and determine:

1 - the functions which are to be subject to Safety Officer control.

2 - any overriding or disabling functions which are to be included in the system.

3 - the manner of decision to be employed by the Safety Officer.

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APPENDIX

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DOE 6.1(a)

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3. Launching occurs and missile moves from the pad, but not far enough so that the electrical system is destroyed on impact after thrust is terminated.

[redacted]

DOE 6.1(a)

4. Launching occurs and missile moves from the pad far enough so that after thrust is terminated the electrical system will be destroyed on impact.

[redacted]

DOE 6.1(a)

[redacted] ~~RESTRICTED DATA~~

[redacted]

[redacted]

5. Launching occurs normally and all missile functions are normal except pitch programming which fails completely.

DOE 6.1a

The probabilities of detonations endangering How and Nan Islands are:

For the UHA test

[redacted]

DOE 6.1(a)

For the VHA' test

[redacted]

DOE 6.1(a)

[redacted]

RESTRICTED DATA
ATOMIC ENERGY ACT 1954

784

[redacted]

DOE 6.1(a)

DOE 6.1(a)

[redacted]

~~RESTRICTED DATA~~
ATOMIC ENERGY ACT 1954

[redacted]

[redacted]

DOE
6.1(a)

[redacted]

RESTRICTED DATA
ATOMIC ENERGY ACT 1954

[redacted]

[redacted]

DOE
6.1(a)

[redacted]

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