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HISTORY OF THE MK 52 WARHEAD (U)

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Weapon Systems

Redacted Version

Information Research Division, 3434

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Mk 52 Warhead - Cross-Sectional View

History of the Mk 52 Warhead

The Mk 52 resulted from the effort to provide the Army SERGEANT rocket with an appropriate nuclear warhead. An early meeting was held September 25, 1953, with representatives of the missile contractor (the Jet Propulsion Laboratory of the California Institute of Technology), the Armed Forces Special Weapons Project and Sandia in attendance. It was noted that the SERGEANT would be 30 inches in diameter, 35 feet long, weigh 10,000 pounds, and be able to carry a 1500-pound warhead to a range of 75 to 100 miles. The SERGEANT was a surface-to-surface, solid-propellant guided rocket, intended as a replacement for the CORPORAL, which carried a Mk 7 Warhead.[1]

The Division of Military Application, in a letter dated November 27, 1953, noted that the SERGEANT had not yet been approved as an atomic weapon carrier, and that Sandia participation should be limited to liaison and interchange of information to assist the Jet Propulsion Laboratory in preparing a system proposal.[2]

Little immediate warhead work was performed, but by late May 1955 Sandia studies indicated that it would be possible to provide a warhead to meet missile requirements of reliability, simplicity, ease of operation, freedom from countermeasures, ruggedness and safety. A thermonuclear design was suggested, since the higher yield and efficiency of such weapon would have size and weight advantages that would aid in achieving missile objectives.[3]

The Assistant Secretary of Defense notified the United States Atomic Energy Commission August 29, 1955 that early production of the SERGEANT missile was scheduled for May 1959. Request was made for participation in a joint feasibility study of suitable warheads for the system, in cooperation with the Army and the Armed Forces Special Weapons Project, and this request was subsequently forwarded to both Santa Fe and San Francisco Operations Offices.[4]

By mid-April 1956, two successful SERGEANT flight tests had taken place. The rocket was inertially guided, and continuous guidance correction during the missile flight

was provided. The range was controlled by extending the drag brakes of the missile for a specified length of time.

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The Army's Picatinny Arsenal had been studying possible fuzing systems and proposed that a radiating-type fuze be used, with options of air burst with contact backup, ground burst, and air burst with contact preclusion. It was felt that either inertial or barometric fuzing would not be sufficiently precise, as it was hoped to develop a burst-height accuracy of ±50 feet.

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A feasibility study group had meanwhile been formed, with representatives from Field Command, Picatinny Arsenal and Sandia. This group reported, July 25, 1956, that it would be about a year and a half before firm atomic-warhead information would be required for the SERGEANT program, and that consideration of warhead designs was premature. It was proposed that warhead selection, as well as completion of the feasibility study, be deferred until after the 1957 nuclear test series.[6]

Picatinny Arsenal requested information on the one-point-detonation characteristics of the nuclear design, so that an adequate safing system could be devised.

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Rocket design continued, with little work being done on the warhead. The feasibility study group again met December 3-4, 1957, and learned that the rocket operational availability date of mid-1962 might be shortened by almost a year.

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Picatinny Arsenal released the feasibility study report December 31. 1957.

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Typical targets were fighter airfields, command posts, headquarters, communication centers, supply and logistic installations, troop units, tanks and artillery.

The rocket was 31 inches in diameter, 31 feet long, and weighed 10,000 pounds at launch. It was composed of four major sections; propulsion, fins, guidance and warhead. The solid-propellant motor had a burning time of 28 seconds and reached a peak longitudinal acceleration of about 10 g's at burnout. The range was controlled by four simultaneously activated drag brakes which extended and retracted three times during the upward leg of the missile trajectory. The time that the brakes remained extended was determined by an internal computer which continuously compared the actual position and velocity of the rocket, as determined by an inertial platform, with the reference trajectory that the missile should be following for that particular range.

Time of flight varied between 120 and 200 seconds. About 22 seconds prior to impact, an arming decision was made, based on establishment of the square or window in space through which the missile would have to pass in order to receive an affirmative arming command. During the final 20 seconds of flight any necessary corrective maneuvers were performed.

The nose section for the warhead would have an overall length of 139 inches, with the base of the section having a diameter of 31 inches and tapering to a point. The warhead installation would be limited to a weight of 1500 pounds, of which 1250 pounds were allocated for the warhead. The warhead itself could have a maximum length of 65 inches.

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Warhead installation flights would start in April 1958, final systems demonstration of

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The Assistant Secretary of Defense notified the United States Atomic Energy Commission, October 10, 1958, that some time had passed since the Joint Chiefs of Staff had established a military requirement for a nuclear warhead for SERGEANT, but that a request for warhead development had been delayed pending a decision on the missile system itself.

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The Army would be the cognizant agent for the Department of Defense portion of the development, with normal Armed Forces Special Weapons Project participation.[13]

A Joint AEC/DOD Warhead Committee for SERGEANT was appointed and held its first meeting November 17, 1958. It was noted that the missile was in an advanced state of development and it appeared likely that the warhead flight-test program could proceed without major interruptions.

It was reported that considerable work had been accomplished on the missile fuzing system, but this had been designed to meet TX-43 requirements and might not be entirely applicable. There would be two options, air burst and contact burst, but no contact backup for the air-burst option. The fuze would be baro-armed and radar-fired in the air-burst option. Both impact crystals and crush switches would be considered for contact fuzing. At an altitude of 18,500 feet above the firing altitude, a baro offset switch would interrogate an arming-decision device to determine whether it was safe to arm the warhead. If trajectory and attitude were within limits, arming and firing signals would be generated in proper sequence.[14]

A SERGEANT meeting was held December 11-12, 1958. There was general agreement by all except Picatinny that a self-destruct feature was not desired. Development time scales were felt reasonable, with the exception of early flight-test dates which might be difficult to meet. The warhead would be design released in May 1960, with early production in May 1961, and would achieve operational capability in August 1961. Sandia proposed that a chopper-converter system be used. This would be a two-channel system, each channel of which would require a separate arming and charging signal. It was felt that a trajectory sensing or goof-proof device should be included, to provide ground handling safety.[15]

Sandia notified Albuquerque Operations Office, January 19, 1959, that it appeared entirely feasible to develop a warhead for the SERGEANT by August 1961, but that no firm commitment would be made until military characteristics had been received and evaluated.

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Military characteristics for the XW-52/SERGEANT were approved by the Military Liaison Committee January 20, 1959.

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Development authorization was released February 27, 1959.[18]

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Sandia forwarded the development program definition of the warhead to Albuquerque Operations Office April 22, 1959.

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~~Power would be supplied~~ by the missile adaption kit. Sandia felt that the military characteristics required certain features that might limit use of the warhead for other applications or might compromise reliability, or were more appropriately adaption-kit requirements, and recommended changes were being discussed.[21]

Sandia wrote to the Division of Military Application April 29, 1959, commenting on the military characteristics. These characteristics had been prepared especially for the SERGEANT warhead, but it was felt that the size, shape and weight of the warhead should be optimized for other possible applications.[22]

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Since the missile system would not arm the warhead until the missile had entered the intended target area, there appeared to be no portion of the trajectory during which the proposed self-destruct system would be useful, and it was suggested that this requirement be deleted.

The option of air burst with contact preclusion was unclear, as both fuze and warhead attributes were involved, and contact-burst preclusion could be accomplished by the fuze. Since the warhead contained no energy source, it would be electrically inert and could be protected against accidental inputs by a handling safety device. This device would interrupt the power line from the adaption kit to the warhead and thus should be part of the Army's adaption kit. The warhead would have inaccessible trajectory-sensing devices, such as integrating accelerometers, and it was felt that caps that could be locked would provide no more safety than the use of caps having safety seals.[23]

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The higher yield weapon would have a maximum length of 65 inches and weigh not over 1200 pounds.[24]

Field Command notified Sandia January 9, 1961 that Report SC4445(WD), Proposed Ordnance Characteristics for the XW-52-X1 Warhead, had been reviewed in coordination with representatives of the interested Services. This review established that the design met all requirements of the military characteristics, with two exceptions. There was no provision for integral shielding against neutron radiation, but this had been accepted by the Army. Capability of monitoring the safe condition of the environmental sensing device would depend on current negotiations with the Army. The report had been accepted by the Design Review and Acceptance Group and was subsequently forwarded to the Division of Military Application.[32,33]

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The first XW-52-X1 Warhead tested was flown at the White Sands Missile Range March 10, 1961. The trajectory was low and the impact point about a kilometer short of the intended target.[35] Following this, three successful flights were staged in May 1961, and the balance of two flights was delayed pending availability of missiles.[36] These two flights were held in October 1961 and were successful.[37,38]

Static and centrifuge tests had meanwhile shown that the warhead design was more than adequate, and structural evaluation noted that the design could successfully withstand all handling and transportation loads, as well as carriage in the SERGEANT missile.[39] Engineering release of the Mk 52 Mod 1/SERGEANT was accomplished June 1961 on schedule, and early production achieved May 1962.

The Mk 52 Mod 2 Warhead was released January 28, 1963. This differed from the Mk 52 Mod 1 in that it incorporated a prescribed-action-link device, and entered production in February 1963.[40]

Sandia forwarded SC4715(WD), Final Report for the Mk 52 Mod 1 Warhead, to the Division of Military Application March 5, 1963. The report had been presented to and accepted by the Design Review and Acceptance Group. The warhead diameter was 24 inches, length 56.72 inches, and weight 925 pounds.

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Glossary of Mk 52 Terms

Accelerometer, Integrating -- A device for measuring acceleration, capable of summing the total acceleration in any given direction.

Adaption Kit -- Those items peculiar to the warhead installation less the warhead; namely, the arming and fuzing systems, power supply, and all hardware, adapters, and the like, required by a particular installation. Adaption-kit components are normally grouped into a complement, radars (if used), and power supply (if required).

Albuquerque Operations Office -- Change of name for the Santa Fe Operations Office, effective April 2, 1956.

Armed Forces Special Weapons Project -- An interdepartmental agency formed to handle military functions related to atomic weapons.

Arming -- The act of arming a weapon, that is, preparing it for firing.

Assistant Secretary of Defense -- Created by Department of Defense Directive, June 30, 1953, as part of DOD reorganization. Handles research and development activities of the DOD.

Barometric Fuze -- Fuze incorporating a baroswitch. A pressure device actuated by increasing air pressure as the weapon descends in its trajectory.

Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase the fission activity.

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Department of Defense -- The Armed Forces, i.e., the Army, Navy and Air Force.

Design Review and Acceptance Group -- A Military committee established to review the design of a specific weapon.

Detonators -- Explosive devices which, when initiated ~~(see bridge wires)~~ by the X-unit, ignite the lens charges of the high-explosive sphere (which see).

Deuterium -- The hydrogen isotope of mass number 2.

Director of Defense Research and Engineering -- Change of name for the Assistant Secretary of Defense.

Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

Environmental Sensing Device -- A device that reacts to a specific environment of the weapon, such as speed, acceleration, altitude, etc.

Field Command -- The local office of the Armed Forces Special Weapons Project, located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Fuze -- A combination of the arming and firing devices of a weapon.

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Hardtack -- A nuclear series of 72 tests. Hardtack I was held at the Pacific Proving Grounds from April 28 to August 18, 1958. The decision to declare a moratorium on testing resulted in Hardtack II, held at the Nevada Test Site between September 12 and October 30, 1958.

High-Explosive Sphere -- The ball of high explosive that surrounds the nuclear primary and is designed to produce the implosion effect when detonated.

Implosion -- The effect created when a sphere of high explosive is detonated on its exterior surface. If suitable lens charges are provided to invert the explosion, the force of the shock wave is directed largely toward the center of the sphere.

Inertial Switch -- A switch containing a small weight and a spring. When subjected to an external force of acceleration or deceleration, the weight compresses the spring. Generally, a metering device is added to measure the length of time the external force is applied.

Joint Chiefs of Staff -- A group composed of the Chiefs of Staff of the Army, Navy and Air Force, to determine policy and develop joint strategic objectives of the Armed Forces.

Kiloton -- A means of measuring the yield of an atomic device by comparing its output with the effect of an explosion of TNT. A 1-kiloton yield is equivalent to the detonation effect of 1000 tons of high explosive.

Los Alamos Scientific Laboratory -- A nuclear design organization located at Los Alamos, New Mexico.

Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

Military Characteristics -- The attributes of a weapon that are desired by the Military.

Military Liaison Committee -- A Department of Defense Committee established by the Atomic Energy Act to advise and consult with the AEC on all matters relating to military applications of atomic energy.

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Radar -- Name for Radio Detecting and Ranging. Radars emit a pulse of high-frequency energy and measure the time lapse from that transmission to receipt of a reflected electrical "echo" from an object. This time measurement determines the distance of the object from the transmitting antenna of the radar.

Reservoir -- As used in this history, a container for deuterium-tritium boosting gas.

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Thermonuclear -- Two-stage reaction, with a fission device exploding and starting a fusion reaction in light elements.

Thyratron -- A grid-controlled electron tube.

Ton (Yield) -- A means of measuring the yield of an atomic bomb by comparing its output with the effect of an explosion of TNT. A 1-ton yield is equivalent to the detonation effect of 2000 pounds of high explosive.

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HISTORY OF THE MK 53 WEAPON (U)

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Weapon Systems

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Timetable of Mk 53 Events

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9/2/58	Division of Military Application requests estimate of operational availability date.
10/15/58	Los Alamos and Sandia submit tentative development schedule.

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6/17/59	Sandia forwards development program definition of TX-53 to the Albuquerque Operations Office.

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10/21/59	Proposed ordnance characteristics of TX-53 accepted by the Special Weapons Development Board.
3/13/60	Study of an XW-53/TITAN Warhead published.
5/17/60	Director of Defense Research and Engineering requests Atomic Energy Commission to participate in feasibility study of warheads for TITAN II missile.
7/12/60	Warhead feasibility study recommends development of an XW-53 Warhead for TITAN.
9/1/60	Director of Defense Research and Engineering requests Atomic Energy Commission to develop XW-53 Warhead.

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History of the Mk 53 Weapon

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This device pointed the way to development of the Mk 53.

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Subsequently, the Division of Military Application wrote to Albuquerque Operations Office, September 2, 1958, requesting that preliminary arrangements be made, but stating that full authorization would not be released until the military characteristics had been issued by the Department of Defense.[4] An estimated operational availability date was requested.[5]

The Los Alamos Scientific Laboratory and Sandia submitted a tentative development schedule October 15, 1958.

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Los Alamos and Sandia held a joint meeting November 13, 1958. The bomb would be carried in B-47 and B-52 aircraft, with possible application to the B-58 Pod and perhaps even to the B-70. However, the high speed of the B-70 would create high bomb-bay temperatures, and it was felt that this might seriously affect such items

as the parachute and the high explosive used in the design.[7] Various cooling methods were considered, including insulation of bomb-bay walls, use of a jettisonable water jacket, or filling the bomb bay with a low-density material blown in after the weapon had been loaded in the strike aircraft. It was noted that the bomb dimensions were limited by the size of the B-47 bomb bay and that redesign or repackaging of some weapon components might be necessary.[8]

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Sandia studied several possible ways of stabilizing the bomb in flight. Fin deployment appeared necessary for a number of reasons. There was an adverse center-of-gravity location, and the aircraft bomb bay limited the fin height. Aerodynamic requirements required stabilization of the bomb shortly after release, and it was felt that a large fin area would be needed. It would be necessary to provide mechanical devices between the fins to make sure that all four fins deployed simultaneously.[10]

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Sandia forwarded the TX-53 development program definition to Albuquerque Operations Office June 17, 1959.

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Delivery methods for the B-58 Two-Component Pod, recently redesignated the BLU-2/B Pod, would include high-altitude free fall and possibly low-level pop-up. Use of the bomb less parachute container and fins as a laydown device in an MB-1-type Pod would also be considered.

The Department of Defense would provide a parachute, and the Atomic Energy Commission would be responsible for nuclear design and the rest of the bomb. Units furnished for the B-58 Pod application would contain complete fuzing and firing systems, with the exception of pressure-sensing and contact-fuzing devices supplied by the Air Force. Sandia would provide the engineering and production specifications for all other fuzing components and materials.

The program schedule would depend on successful development of materials for mitigating high shock, high-strength light materials for secondary nuclear component support, and high-strength aluminum for the weapon case. The aerodynamic shape would have extendible fins to provide proper stability of free-fall bombs released at high altitudes.

The B-70 bomb application would be sufficiently unique to require a field modification kit to provide the required aerodynamic and heat-resistant qualities. This kit would be design released after compatibility had been proven in flights and drops from B-70 aircraft, but it was predicted that such aircraft would not be available until about mid-1962.

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Since the deformation switch used to produce contact firing signals in the complete bomb was different than the corresponding components in the Pod application, a connector was provided on the weapon skin to allow either type of deformation switch to be used.

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On July 15, 1959, the Air Force proposed that Sandia be responsible for providing pressure-sensing and contact-fuzing devices, rather than the Military, and this proposal was subsequently accepted by the Military Liaison Committee.[19]

An amendment to the military characteristics was issued August 4, 1959.

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A ballistic drop test was held September 12, 1959, and indicated need for modification of the low-level deployment sequence.

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The Air Force Special Weapons Center had requested a list of changes that would have to be made to provide a fuzing and firing system compatible with the low-level Special Weapons Emergency Separation System.

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Field Command wrote to the Air Force Special Weapons Center October 5, 1959, proposing that the variable timer for the laydown option be replaced with a single fixed time delay. This change would provide increased reliabiltiy and safety by eliminating the setting mechanism and the human effort involved in making the setting, and environmental protection would be increased, since the case would not have to provide a seal around the rotary shaft of the variable timer.[23] The Center replied October 16, 1959, noting that the Strategic Air Command had been queried, and a preference stated for the variable timer.[20]

Report SC4267(TR), Proposed Ordnance Characteristics of the Basic TX-53 and the TX-53 Bomb, was presented by Sandia to the October 21, 1959 meeting of the Special Weapons Development Board.[24] This noted that the Basic TX-53 would contain a

high-explosive implosion system, nuclear pit, gas-boosting system, secondary, electrical fuzing and firing system, primary case and Basic TX-53 case. The TX-53 Bomb would consist of the Basic TX-53, aft assembly with retardation parachute, extendible fins, shock-mitigating material, and nose assembly with impact switch.[3] The report was accepted and forwarded to the Division of Military Application December 4, 1959.[25]

Sandia had informed the Division of Military Application that the bomb would have to be thermally protected when carried in the B-70 aircraft, to maintain the bomb temperature below 165°F. This protection could be provided by bomb-bay cooling or insulation. Any modification to the bomb to provide the shock-mitigation system, afterbody or parachute with materials which could resist high temperatures would require at least 15 months of effort and would increase the weapon diameter to 52 inches, the length to 164 inches, and the weight to 9300 pounds.[26] Subsequently, December 10, 1959, the Air Force requested that any work toward establishing compatibility of the TX-53 Bomb with B-70 aircraft be halted, due to delays in the latter program.[19]

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Sandia informed the Air Force Special Weapons Center that the TX-53 Bomb experienced severe pitchdown in drop tests made from B-47 aircraft. This caused parachute deployment problems, imposed high aerodynamic loads on the bomb, and increased the

possibility of contact between bomb and aircraft during weapon releases. Separation from B-52 aircraft appeared satisfactory.[30]

The Center replied February 8, 1960, noting that the B-47 bomb bay had caused problems in the past, but that this had not prevented designers from achieving weapon compatibility without modifying the bomb bay. This latter work would require extensive aircraft modification and probably result in performance degradation. It was noted that there appeared to be close correlation between delivery speeds and weapon release characteristics. Since the B-52 was being modified to permit low-level flight at 400 knots, it was requested that separation tests of bomb from B-47 at this speed be conducted.[31]

Sandia notified Field Command February 16, 1960 that the design intent of the TX-53 was to ensure that fuzing-system restrictions on the bomb release altitude were less severe than limitations imposed by safe escape or other criteria. It was felt that, except for a minor altitude restriction for some retarded contact bursts, this design intent appeared to have been met. The fuzing system thus appeared to provide the necessary flexibility for the intended use of the bomb, and formal concurrence in the design was requested.[32] Field Command subsequently replied, noting that the Strategic Air Command stated that the release capabilities of the TX-53 Bomb were acceptable.[33]

Laydown tests demonstrated that the terminal velocity of the TX-53 Bomb was less than anticipated, and a change to the nose design was made which reduced the overall length of the bomb and provided better clearance in the B-47 bomb bay. It now became possible to jettison the parachute and its container in the free-fall option, and this change shifted the weapon center of gravity far enough forward so that aerodynamic stability was attained without deployable fins.[34]

A study of a warhead to be carried by the TITAN missile was reported March 13, 1960. This called for use of a high-yield warhead at ranges up to 5500 nautical miles, and a lighter weight warhead for targets 8500 miles distant. The XW-38 Warhead was being developed for application to the TITAN and ATLAS missiles for the latter usage, and consideration was given to the TX-53 design for the shorter

range, higher yield employment. The warhead could be severely reduced in weight over the bomb application, as the impact-mitigation system would not be needed.[35]

On May 17, 1960 the Director of Defense Research and Engineering requested the Atomic Energy Commission to participate in a feasibility study of warheads to be used with the TITAN II or SM-68B intercontinental ballistic missile system.

(b)(1), (b)(3)

The study report was published July 12, 1960, and recommended development of an XW-53 Warhead.

(b)(1), (b)(3)

The TITAN missile operational date was March 1963 and it was felt that the warhead could be provided at the same time. It was noted that if production authorization were received in the near future, flight tests could be started by November 1961, design release made in the same month, and early production achieved by December 1962.[37]

The Director of Defense Research and Engineering requested the Atomic Energy Commission, September 1, 1960, to proceed with development of the XW-53 Warhead, with the Air Force being designated cognizant agency for the Department of Defense, and normal Defense Atomic Support Agency participation.[38]

The military characteristics for the TITAN warhead were approved by the Military Liaison Committee October 18, 1960. Fuzing options included air burst with contact backup and contact burst.

(b)(1), (b)(3)

Sandia wrote to Albuquerque Operations Office March 10, 1961, discussing the development program definition for the XW-53. Sandia would be responsible for design and production specifications of the warhead, with the exception of explosive and nuclear parts. General Electric would develop the re-entry vehicle, and Glenn L. Martin Company would be in charge of missile development. Warhead design release would be in April 1962 with early production in January 1963.

per second. A disreefed 48-foot, three-parachute cluster replaced a 44-foot cluster.

The Air Force decided to provide the three 48-foot parachutes with a 22-1/2 foot reefing line and a 1-second reefing time. This resulted in an overload on the second parachute stage. To reduce this load and to move some of it to the first stage, the reefing-line length was increased to 25 feet. This design functioned satisfactorily, but the loads extrapolated to an overly high figure for the maximum drop conditions of the bomb. Sandia dropped a unit and found that two of the three parachutes failed completely by breaking the suspension lines.[41]

Sandia notified the Division of Military Application May 12, 1961, that the bomb production date would have to be delayed due to lack of a satisfactory retardation system. The Division of Military Application requested that another program assessment be made after drops scheduled for early June 1961.[42]

A meeting was held June 27, 1961 to discuss the results of the BLU-2/B drop-tower and laydown programs. There had been wide variation in test results, although drop conditions had been kept relatively constant. It appeared that the angle of impact significantly affected impact accelerations, and it was decided that the rest of the drop-tower program would be delayed until enough laydown tests had been completed to determine whether the drop-tower velocities were realistic.[43] Subsequently, Sandia reported, August 8, 1961, that 10 drop tests had been made of a half-scale beer-barrel nose. Results showed that the nose was capable of reducing the longitudinal impact acceleration to less than 100 g's.[44]

The Air Force Special Weapons Center notified Albuquerque Operations Office November 30, 1961, that the parachute was compatible with the TX-53 Bomb as carried in B-47 and B-52 aircraft.

(b)(1), (b)(3)

Field Command notified Sandia January 23, 1962, that Report SC4553(WD), Proposed Ordnance Characteristics for the XW-53 Warhead, had been reviewed in coordination with representatives of the interested Services. The review established that the design met all the requirements of the approved military characteristics, with certain exceptions.

The diameter of 40.5 inches over the mounting flange exceeded the 37.5 inches allowed by the military characteristics, but this was acceptable, as was the warhead length of 103.5 inches rather than the desired 102 inches. It was felt that considerable increase in safety could be realized if the environmental sensing device were upgraded to minimize the possibility of its being inadvertently operated or bypassed in a fire environment, and it was requested that efforts be directed toward such improvement.

(b)(1), (b)(3)

Otherwise, the design was acceptable to the Department of Defense.[46]

Sandia wrote to Albuquerque Operations Office January 31, 1962, noting that a proposed acceleration of the XW-53 Warhead design, with release in October 1962 rather than February 1963, would require issuance of information considered premature even for the later date. Deliveries of development hardware had been delayed and there were progressive slippages in the flight-test program. However, every attempt would be made to provide certified production material by the date requested and, if not, operative components would be made available.[47]

Field Command notified Sandia February 13, 1962, that Report SC4621(WD), Interim Development Report for the TX-53 Basic Assembly and TX-53 Bomb, had been reviewed in coordination with representatives of the interested Services. There were a few deviations from the military characteristics. There was no warhead entity as such, but the basic assembly included the warhead elements, as well as all fuzing and firing components except the impact-fuzing or deformation switch, and this deviation was acceptable.

(b)(1), (b)(3)

Effective length of the TX-53 was 148.75 inches to the rear automatic deployment cover, slightly more than desired, but this length was compatible with designated carriers and was acceptable. The weight was 8850 pounds, slightly more than specified, and this also was acceptable.

(b)(1), (b)(3)

This latter capability would be provided at a later date.

(b)(1), (b)(3)

Sandia subsequently notified Field Command May 10, 1962, that the Mk 53 had three power sources; aircraft monitor and control system, fast-rise thermal batteries, and main-fuzing-system thermal batteries. The electrical system of the bomb had been designed so that the firing-system circuits were physically separated from any circuits likely to receive power in the event of fire. It was thus felt that the bomb provided sufficient fire safety, but thermal fuses would be included in the fuzing-system selector control as an added safeguard.[49]

The Mk 53 Bomb and the Mk 53 Basic Assembly were design-released August 10, 1962. It was noted that the B-47 bomb-bay spoiler doors had to be retracted for both high- and low-altitude releases to prevent adverse bomb pitchdown at release.[50]

(b)(1), (b)(3)

switch had to be manually turned to the ARMED position (either retard or free fall) before takeoff, or a weapon dud would result. The fuzing-system control selector provided choice of air or contact burst. Laydown delayed burst was automatically selected when the bomb was released below its specified altitude, with the aircraft monitor and control selector placed at AIR or GROUND.

When the bomb was released from the carrying aircraft, pullout rods were extracted, and this action activated pulse generators which initiated fast-rise thermal batteries and a set of sequential timers. The batteries supplied power to baroswitch and timers, and activated another set of thermal batteries.

(b)(1), (b)(3)

About one second after weapon release, sequential-timer contacts closed and completed circuits between battery pack and detonators in the automatic parachute deployment system. At the same time, the timer provided a signal that severed the retardation-parachute suspension lines, and the following deployment sequence occurred: The automatic deployment cover was separated from the rear case section by the explosion of a length of mild detonating fuse, the cover deployed a 4-foot-diameter pilot chute, the pilot chute deployed a 16.5-foot ribbon retardation chute permanently reefed to 12 feet, and the retardation chute deployed the laydown parachute system, which consisted of three 48-foot ribbon chutes, each reefed to 22.5 feet for 2 seconds after line stretch.

The laydown parachute system was designed to reduce the rate of fall of the bomb to less than 55 feet per second, and to position the bomb upright at the instant of impact. The energy of impact was absorbed by aluminum honeycomb in the bomb nose. Since strong surface winds might cause the bomb to fall over on its side, similar shock-absorbing material was placed around the bomb components.

As the rotary switch remained in the laydown option in low-altitude releases, main battery power was supplied to the laydown bus after bomb release. Retardation created by the laydown parachute caused an interval timer to operate toward its armed position, applying main battery power to the motor and contacts of the sequential timer.

(b)(1), (b)(3)

At detonation time a third switch closed, activating explosive switches and triggering the spark gap to cause bomb detonation.

(b)(1), (b)(3)

Less than one second after bomb release, the rotary switch turned to the high-level option position. Shortly afterward, the sequential timer completed a circuit between battery pack and detonators in the automatic parachute deployment system. If free-fall option had been selected, closure of contacts in the sequential timer applied power from fast-rise thermal batteries to parachute deployment system and severed the chute attachments, allowing the retardation chute to extract and discard the laydown parachute in its stowage can. If the retarded option had been selected, the sequence was similar to that for free fall, except that the parachute deployment proceeded normally.

Air-burst option could be selected by the aircraft monitor and control system.

(b)(3)

(b)(1), (b)(3)

Less than 1 second after weapon release, the option switch operated to the high-altitude option. Closure of a timer 1 second after release had no effect on Pod operation.

(b)(3)

If contact option had been selected on the Warhead Control Selector Switch before release, the fire baro was bypassed and the Pod contact crush switch was brought into the circuit. The firing pulse transformer circuit was completed by the impact crush switch which closed on impact with the target.[60]

(b)(1), (b)(3)

Report SC-WD-64-574, Final Development Report for the Mk 53 Mod 0 Warhead, was issued by Sandia in December 1965. This noted that the warhead system used a rotary chopper/converter system to change low-voltage direct current at about 28 volts to about 2100 volts direct current. An environment similar to the launch acceleration of the TITAN II missile had to be experienced to complete the converter arming circuit. This acceleration operated the environmental sensing device.

When two independent arming signals were applied to both chopper and converter, the applied voltage was chopped, transformed, rectified and used to charge the X-unit capacitor bank and arm the trigger circuit.

(b)(3)

Detonation of an armed warhead could be accomplished by either a low-voltage (17 volts) or high-voltage (250 volts) method. The output of the trigger circuit was applied to one probe of the dual-probe spark gap. This signal caused ionization of the spark gap, and energy stored in the X-unit capacitor bank was transferred to the detonators, causing detonation of the warhead. Energy from the capacitor bank also triggered an explosive timer on the neutron generators. This timer burned down and detonated the explosive driver which depoled a ceramic crystal. The crystal then supplied a high-voltage pulse to a deuterium-tritium tube which provided neutrons for initiation.[62]

Glossary of Mk 53 Terms

Air Force Special Weapons Center -- That element of the Air Force Systems Command having to do with compatibility testing of nuclear devices with aircraft. Located at Kirtland Air Force Base, Albuquerque, New Mexico.

Albuquerque Operations Office -- The local office of the Atomic Energy Commission (AEC) concerned with the operations of Sandia Corporation.

Armed Forces Special Weapons Project -- An interdepartmental agency formed to handle military functions related to atomic weapons.

Assistant Secretary of Defense -- Created by Department of Defense directive, June 30, 1953, as part of DOD reorganization. Handles research and development of activities of the DOD.

Ballistics -- The science governing motion of projectiles or bombs dropped from aircraft.

Baro -- A pressure-sensitive device used in weapons to actuate circuits. The term is a contraction of "barometric switch," a switch actuated by air pressure, sometimes referred to as "baroswitch."

Boosting -- The technique of increasing the yield of a nuclear device by introducing deuterium-tritium gas into the implosion process to increase fission activity.

(b)(1), (b)(3)

Defense Atomic Support Agency -- An interdepartmental agency formed to handle military functions related to atomic weapons. Originally called the Armed Forces Special Weapons Project.

Department of Defense -- The Armed Forces, i.e., the Army, Navy and Air Force.

Design Review and Acceptance Group -- A Military committee established to review the design of a specific weapon. It absorbed some of the functions of the Special Weapons Development Board.

Detonators -- Explosive devices which, when initiated ~~(see bridge wires)~~ by the X-unit, ignite the lens charges of the high-explosive sphere (which see).

Deuterium -- The hydrogen isotope of mass number 2.

Development Program Definition -- A report that describes the weapon to be designed and the steps that will be taken in its development.

Director of Defense Research and Engineering -- Change of name for the Assistant Secretary of Defense.

Division of Military Application -- An AEC office that functions as liaison between the Military and weapons designers and producers.

(b)(1), (b)(3)

Field Command -- The local office of the Armed Forces Special Weapons Project (Defense Atomic Support Agency), located on Sandia Base, Albuquerque, New Mexico.

Firing System -- The electrical system of the weapon that produces and applies a high-voltage current to the detonators.

Free-Fall Bomb -- A bomb that falls under the forces of gravity and the impetus given at time of release.

(b)(1), (b)(3)

One-Point-Safe Weapon -- A weapon that will not produce a nuclear yield when detonated at one point on the surface of the high explosive.

Operation Hardtack -- See Hardtack.

Reservoir -- As used in this history, a container for deuterium-tritium boosting gas.

Retarded Bomb -- A bomb provided with some means for slowing the rate of descent, generally a parachute.

Ribbon Parachute -- A parachute having a set of ribbons in place of a solid canopy. This type of parachute provides less severe deceleration on deployment.

(b)(1), (b)(3)

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(b)(3)

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(b)(1), (b)(3)

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(b)(1), (b)(3)

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