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"HISTORY OF THE MK 38 WARHEAD (U)"

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Weapon Systems

Redacted Version

Sandia Systematic Declassification Review
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Information Research Division, 3434

Classified By: Richard B. Craner
Classification Analyst, Org 4225
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Mk 38 Mod 0 Cross Section

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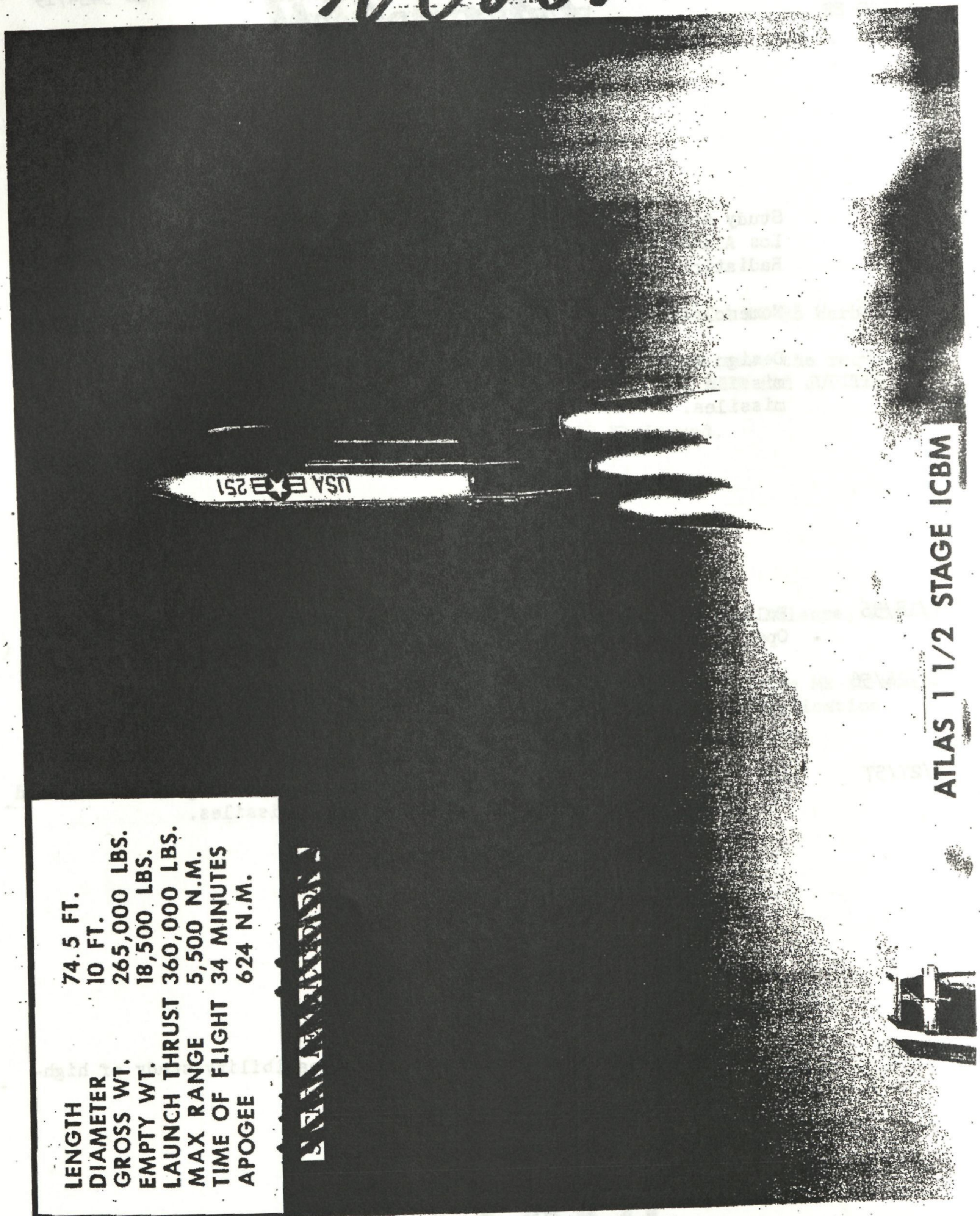

ATLAS Missile

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Timetable of Mk 38 Events

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7/55 Study shows that design is feasible. Authorization issued to Los Alamos Scientific Laboratory and University of California Radiation Laboratory to proceed with parallel designs.

1/19/56 Nomenclature of XW-38 assigned to the Radiation Laboratory design.

3/56 Design expanded to include the TITAN intercontinental ballistic missile and the THOR and JUPITER intermediate-range ballistic missiles.

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7/18/56 Full-scale development of XW-38 Warhead authorized by Albuquerque Operations Office.

11/26/56 Division of Military Application changes design of XW-38 to a 3000-pound warhead, to be provided on a low-priority basis as a follow-on to the Los Alamos XW-35.

5/27/57 Assistant Secretary of Defense requests study of high-yield warhead for carriage by intercontinental ballistic missiles.

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5/7/58 Assistant Secretary of Defense requests feasibility study of high-yield warhead ~~of~~ for ATLAS and TITAN.

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3/11/59	Designation of XW-35-X1 assigned to high-yield XW-38 Warhead.
5/13/59	Amendment to the military characteristics deletes the requirement for compatibility of the XW-38-X1 with the THOR and JUPITER missiles.
11/59	Production authorization for XW-38-X1 issued.

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5/61	First unit of Mk 38 Warhead produced.
8/18/61	Report SC4825(WD), Mk 38 Mod 0 Status at Design Release, forwarded to the Division of Military Application.
6/63	Report SC48~~25~~42(WD), Final Development Report for the Mk 38 Mod 0 Warhead, forwarded to the Division of Military Application.
Mid-1965	Mk 38 Warheads retired.

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The study was completed July 1955 and showed that the design was feasible, and parallel authorization for design was given to both Los Alamos Scientific Laboratory and the University of California Radiation Laboratory.[2]

On January 13, 1956, Santa Fe Operations Office assigned development nomenclature of XW-38 to the design being considered by the Radiation Laboratory.[3] The project was expanded to include the TITAN intercontinental ballistic missile and the THOR and JUPITER intermediate-range ballistic missiles in March 1956, when the Department of Defense and the Atomic Energy Commission agreed that it would be desirable to develop a single warhead for all four missiles.[2]

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The Radiation Laboratory noted that the XW-38 would be operational by June 1960. The design would be heavier than the parallel XW-35 Warhead being developed by Los Alamos, as the extra 18 months in the XW-38 development schedule, as compared to the XW-35, would undoubtedly result in missile design advancement.[7]

Subsequently, a decision was made to place emphasis on the XW-35 Warhead, and the Division of Military Application instructed the Radiation Laboratory November 26, 1956, to change the XW-38 to a 3000-pound design, to be provided as a low-priority follow-on to the XW-35.[8,9]

The Assistant Secretary of Defense wrote to the Atomic Energy Commission May 27, 1957, noting that a high-yield warhead was needed for intercontinental-ballistic-missile attack of certain targets. It was requested that a feasibility study of a warhead weighing 2600 pounds, and having the maximum yield obtainable in this weight, be undertaken in cooperation with the Air Force, and this request was forwarded to both Los Alamos and the Radiation Laboratory.[10,11]

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The Assistant Secretary of Defense wrote to the Atomic Energy Commission, May 7, 1958, noting that the Joint Chiefs of Staff had approved an operational requirement for a high-yield warhead to be carried by intercontinental ballistic missiles. This weapon was to attack targets that required heavier payloads than the XW-35. The warhead would be designed for the ATLAS and TITAN, and it was hoped that it would be compatible with intermediate-range ballistic missiles. The warhead could weigh as much as 3500 pounds, have maximum yield for this weight, and was operationally desired by 1962.[13]

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The fuzing and firing components, ~~parachute and afterbody~~ would be contained in a cylindrical space 34 inches in diameter and 24 inches long.

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Thus, the Department of Defense had authorized the development of such a weapon for application to the ATLAS, TITAN, THOR and JUPITER missiles. The warhead would be operationally available in mid-1961, and the Air Force was designated cognizant agent for the Department of Defense portion of the program, with normal Armed Forces Special Weapons Project participation.[15]

A set of military characteristics was approved by the Military Liaison Committee January 20, 1959.[16]

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The warhead would be capable of becoming electrically armed within 5 seconds of receipt of the arming signal and remaining in this condition for at least 90 seconds, and would fire upon receipt of either air-burst or contact-burst signals. If, when armed, electrical energy was stored in the warhead awaiting the firing signal, a device would be incorporated to safely dissipate the electrical energy in the shortest time possible, not to exceed 10 minutes and not to interfere with the normal arming-firing sequence.

The warhead would not contain any primary source of energy. No final assembly procedures would be necessary after delivery of the warhead to the Military. Assembly of warhead to missile re-entry body would be as simple, quick and safe as possible," and require a minimum amount of specialized equipment and personnel.

At least one arming device, which would also serve as a safety device, was required to sense the unique environment of the missile after launch and before warhead operation. This device would be installed in a manner to minimize the possibility of nuclear detonation through sabotage. The design priorities emphasized safety from nuclear disaster to friendly installations, weapon reliability, operational simplicity, and ease of maintenance.[17]

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Sandia would have full responsibility for warhead design, except for nuclear materials and components.[18] A designation of XW-38-X1 was assigned to the program to distinguish it from the initial aims of the XW-38 project.[19]

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(b)(3) A production date of May 1961 would be required to meet the June 1961 operational availability date. These dates would require expediting the program to the utmost, and no delays could be tolerated in the missile flight-test program.[20]

The Department of Defense agency responsible for the missile systems was the Air Force Ballistic Missile Division. Systems contractor for the Military was the Space Technology Laboratory, Inglewood, California. The Research and Advanced Development Division of Avco Manufacturing Corporation, Wilmington, Massachusetts, was the subcontractor for re-entry vehicle design and development. Avco would also provide arming and fuzing system design.

Warhead responsibility was divided between Lawrence Radiation Laboratory and Sandia's Livermore Laboratory. Lawrence was responsible for the nuclear functioning of the warhead and the design and production specifications of all nuclear components and materials. Sandia had responsibility for the design and production specifications of the remaining warhead components and materials.

Flight tests aboard TITAN were scheduled to start in March 1960, and a total of 16 flights were required to obtain necessary warhead environmental and systems operational data. A minimum of three successful warhead flight tests on the ATLAS missile were desired. Design release of the warhead was scheduled for August 1960.

There were three basic firing systems under consideration. One included explosive ferroelectric external initiators, an explosive ferromagnetic X-unit, and acceleration-sensing handling-safety devices. Another proposal featured an electronic external initiator, capacitor-type X-unit, chopper-converter system, trigger circuit, and acceleration-sensing handling safety devices. The third scheme had a Jonah initiation system, explosive ferromagnetic X-unit, and acceleration-sensing handling safety devices. The warhead would be sealed and require only continuity monitoring in stockpile or field.

The ATLAS was a 1-1/2-stage intercontinental ballistic missile 10 feet in diameter and 80 feet long. It was classed as a 1-1/2-stage missile because the two booster engines drew their fuel from the main missile tanks; the engines separated at the end of the boost phase, but the tanks remained with the missile to supply fuel for the sustainer engine. The ATLAS weighed 269,000 pounds at takeoff, of which about 252,000 pounds was liquid oxygen and fuel for the rocket motors. The maximum range of the ATLAS was in excess of 5500 nautical miles, and it attained a speed of 23,500 feet per second (16,000 miles per hour). The booster engines each developed 165,000 pounds of thrust, and the sustainer engine 67,000 pounds. Final position and velocity adjustments for the missile were made by two small vernier rockets. After these vernier rockets stopped firing, the re-entry vehicle separated from the missile and followed a ballistic trajectory to the target.

The TITAN was a 2-stage intercontinental ballistic missile with a maximum range in excess of 5500 nautical miles. It was 10 feet in diameter, 97 feet long, and weighed 221,000 pounds at takeoff, of which about 200,000 pounds was liquid oxygen and fuel. The first-stage booster, which developed 300,000 pounds of thrust, separated from the rest of the missile at booster-engine cutoff, carrying with it all associated tankage, plumbing and controls. The second stage, or sustainer, then fired, developing 80,000 pounds of thrust. At sustainer-engine cutoff, vernier rockets made a final velocity correction. The re-entry vehicle then separated from the missile and followed a ballistic path to the target.

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An amendment to the military characteristics was approved by the Military Liaison Committee May 13, 1959. This amendment deleted the requirement for compatibility of the XW-38-X1 Warhead with the THOR and JUPITER intermediate range ballistic missiles.[2]

Sandia wrote to Albuquerque Operations Office September 29, 1959, recommending that XW-38-X1 production units be identified as Mk 38 Mod 0 Warheads. Since advance ordering information was being provided to meet the accelerated production schedule, it was felt that production nomenclature should be assigned, and this suggestion was subsequently accepted.[22,23] Production authorization for the warhead was issued in November 1959.

[redacted]

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

The Division of Military Application, in a teletype of June 10, 1960, suggested that the XW-38-X1 be assigned a high priority, in an effort to retain the early production date of May 1961.[25] Sandia and Lawrence issued a joint reply, June 30, 1960, stating that the program status did not warrant release of material for operational use.[26] Despite this, however, the project was authorized use of extra funds, and calculated risks in early assembly were taken.

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[redacted] Early production units of the Mk 38 Warhead began to flow from the assembly lines in May 1961.

Report SC4825(WD), Mk 38 Mod 0 Status at Design Release, was issued August 1961.[27] The report noted that the warhead was partially integrated with and formed the center section of the re-entry vehicle for the ATLAS and TITAN intercontinental ballistic missiles. The nose cap, which contained the adaption kit, was of magnesium, and included an ablative heat shield. An explosively actuated separation mechanism tied the re-entry vehicle to the missile with a 60,000-pound compressive preload. Operation of the separation mechanism and the release of this preload imparted a differential velocity to the re-entry vehicle, separating it from the missile.

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With heat shield installed, it had a diameter of 33.24 inches and a weight of 3309 pounds.

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The ablative heat shield was constructed of fiberglass covered with oblique tape-wound fibrous quartz.

An integrating inertial switch was provided, with two sets of normally open contacts, which interrupted input lines from the adaption kit to the warhead arming components. This switch prevented arming until the warhead experienced an acceleration environment of powered flight. The switch contacts closed when the warhead had undergone a minimum acceleration of 3.5 g's and an acceleration-time product of at least 15 g-seconds. The switch would not operate under an acceleration of 2 g's or less, regardless of how long this acceleration was applied. Accelerations greater than 10 g's were clipped, ensuring that momentary applications of very high accelerations would not close the switch.

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The firing set contained a dual-channel chopper-converter, a single-channel capacitor X-unit, and a tack switch. This assembly received 28 volts direct current from the adaption kit and converted this to alternating current, which was transformed into two higher voltages, rectified separately and supplied to the X-unit capacitor and neutron-generator capacitors. Upon receipt of a firing signal, the tack switch discharged the X-unit capacitor, firing the warhead detonators and triggering the neutron generators.

The X-unit stored energy to fire the detonators and trigger the neutron generators. The X-unit consisted of an oil-filled 1-microfarad storage capacitor and an explosively operated switch. There was a bleeder resistance in parallel with the capacitor and, if the signal to the chopper-converter was removed before the capacitor discharged, the bleeder resistance, in less than 30 seconds, reduced the capacitor energy to a level insufficient to fire the warhead detonators.

The tack switch consisted of four squib-driven tacks and two electrodes (input and output), all potted in a plastic dielectric. Upon receipt of a firing signal, squibs drove metal tacks through the dielectric and bridged a gap between two electrodes. Two squibs were connected to the air-burst circuit and two to the ground-burst circuit. Actuation of any tack completed a circuit from the X-unit capacitor to the warhead detonators and the neutron-generator trigger circuits.

The neutron generators, one in each channel, consisted of a storage capacitor, timing circuit, triggering network, and neutron source tube.

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The system operated as follows: Before launching, but not necessarily before or during countdown, the adaption-kit air-burst switch was set for the planned detonation altitude, and air-burst or ground-burst option selected by operation of the adaption-kit air-ground relay. After the missile was launched, the adaption-kit lockout switch closed, after sensing the sustained acceleration of a normal flight. The warhead environmental sensing devices also closed under this acceleration.

When the missile attained the position and velocity necessary for the re-entry vehicle to reach its target, a guidance prearm signal from the missile passed through a lockout switch.

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A separation signal from the missile then passed through the lockout switch and operated the missile/re-entry vehicle separation mechanism. The re-entry vehicle separated from the missile and followed a ballistic path to the target.

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When the re-entry vehicle entered the atmosphere, it righted itself and started to decelerate. This deceleration activated the arming-firing battery in the adaption kit. When this battery came up to voltage, it supplied power through environmental sensing devices to the chopper-converter motors.

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If air burst had been selected, the air-burst switch operated at the selected altitude, sending a firing signal through the air-ground relay to the tack switch. This switch transferred energy from the X-unit capacitor to the warhead detonators and triggered the neutron generators. If ground burst had been selected, or if the air-burst switch failed, impact detectors in the nose of the re-entry vehicle were actuated by the ground impact. These detectors triggered a signal that fired the tack switch.

The design-release report was presented to the Design Review and Acceptance Group of Field Command. It was noted that the design met all requirements of the approved military characteristics, with the following exceptions: The warhead length had been increased to 82.45 inches, but this was at the request of the using Service for convenience in adapting the warhead to the re-entry vehicle, and was acceptable.

An increase in weight to 3080 pounds was acceptable in view of a mutually agreed-upon upper limit of 3130 pounds.

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The overall design was thus felt to be acceptable to the Department of Defense, and Report SC4825(WD) was forwarded to the Division of Military Application August 18, 1961.[28]

Report SC4842(WD), Final Development Report for the Mk 38 Mod 0 Warhead, was released in June 1963.[29] Flight testing had been initially delayed to incorporate components fully representative of War Reserve items and again postponed due to nonavailability of missiles. Thus the flight tests, which had been originally scheduled for completion in early 1961, were not finished until December 1962.

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Albuquerque Operations Office issued notice December 11, 1964, that the Division of Military Application had decided to retire the Mk 38 Warhead by mid-1965. Sandia was requested to cancel any further design changes.[30]

Glossary of Mk 38 Terms

<u>Adaption Kit</u> -- 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).

<u>Air Force Ballistic Missile Division</u> -- A division of the Air Force concerned with the design and production of ballistic missiles.

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

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

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

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

<u>Ballistic Missile</u> -- Long-range missile given a high initial velocity and which travels on a ballistic course to the target.

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

<u>Capacitor</u> -- A condenser that accumulates and stores electrical energy until time for detonation.

<u>Chopper-Converter</u> -- A device for transforming steady direct current into chopped pulses of energy.

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

<u>Depleted Uranium</u> -- Natural uranium from which most of the uranium-235 has been removed, leaving the uranium-238.

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

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

<u>Deuterium</u> -- The hydrogen isotope of mass number 2.

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

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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.

Fuzing System -- The system that arms the weapon at the appropriate time and provides a firing signal to the firing system at the selected burst height.

g -- Force equal to one unit gravity.

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

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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.

Initiator -- A source of neutrons.

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.

Kilogram -- A metric weight approximating 2.2 pounds.

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.

Lawrence Radiation Laboratory -- A change of name for the University of California Radiation Laboratory (which see), effective October 1958.

Lenses -- As applied to nuclear weapons, lenses are elements of the high-explosive sphere, which are designed to produce an implosion. The lens charge is composed of high explosives of different burning rates and is so constructed and shaped as to change the explosion initiated by the detonators into an implosive force which converges smoothly on the nuclear materials.

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.

Microsecond -- One millionth of a second.

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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Operation Hardtack -- See Hardtack.

Operation Plumbbob -- See Plumbbob.

Operation Redwing -- See Redwing.

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Pit -- The hollow metal sphere at the center of an implosion bomb which receives the nuclear capsule when it is inserted.

Plumbbob -- A less-than-full-scale test series held at the Nevada Test Site. Series of 29 tests, starting May 28 and ending October 7, 1957.

Primary -- A fission bomb that acts as the source of energy to start the secondary or thermonuclear reaction of a two-stage device.

Proton -- The nucleus of the atom of the light isotope of hydrogen. It has a unit positive charge of electricity.

Redwing -- A full-scale nuclear series of 17 tests held at the Pacific Proving Grounds from May 4 to July 21, 1956.

Re-entry Vehicle -- That part of a ballistic missile that forms the nose of the missile, generally contains the warhead, and is detached from the missile during the trajectory to re-enter the earth's atmosphere and follow a ballistic trajectory toward the target.

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

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

Secondary -- The thermonuclear portion of a two-stage weapon.

Services -- The Department of Defense.

Squib -- A device containing a small powder charge. When detonated, the resulting gas pressure closes a switch or performs a similar action. A light, quick-acting, one-shot device.

Thermal Battery -- A battery whose electrolyte is in a solid state while inactive. To activate, heat is applied to this electrolyte, melting it and putting the battery into active output condition.

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

Ton (Yield) -- A means of measuring the yield of an atomic device 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.

Tritium -- The hydrogen isotope of mass number 3.

Two-Stage -- Combination of fission and fusion action in a weapon.

University of California Radiation Laboratory -- A laboratory established at Livermore, California. Initially founded for work on the thermonuclear designs.

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Uranium-235 -- A radioactive element, an isotope of uranium-238.

Uranium-238 -- A radioactive element, atomic number 92. Natural uranium contains about 99.3-percent uranium-238; the rest is uranium-235.

Warhead -- A weapon carried to the target by missile.

X-Unit -- A device used to provide high voltage to the weapon detonators.

References

1.

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2. SRD Report, RS 8233/1151, Sandia Corporation to Distribution, dtd 4/60, subject, Report SCDR-57-59, Development Record of the XW-38-X1 Warhead. SC Reports Files.

3. SRD Case, RS 7221/577, Sandia Corporation to Distribution, dtd 8/9/57, subject, Design and Development of the XW-38 Warhead. SC Central Technical Files, XW-38, 1.1, Authorization.

4.

5.

(b)(3)

6.

7. SRD Ltr, University of California Radiation Laboratory to Distribution, dtd 9/19/56, subject, UCRL Participation in Warhead Development for ICBM/IRBM. AEC Files, MRA-5, XW-35 to 38, 7/56.

8. SRD Minutes, RS 3466/82348, Special Weapons Development Board to Distribution, dtd 12/12/56, subject, Minutes of the 104th Meeting, Part II. SC Archives, Transfer No. 48217.

9. SRD Ltr, RS 3466/82672, Albuquerque Operations Office to Distribution, dtd 3/5/57, subject, XW-38 Warhead. SC Central Technical Files, 38 Program, 2-, 1956-63.

10. SRD Ltr, Assistant Secretary of Defense to U. S. Atomic Energy Commission, dtd 5/27/57. AEC Files, MRA-5, Warhead, 7/56-6/57.

11. SRD Ltr, Division of Military Application to San Francisco and Albuquerque Operations Offices, dtd 6/12/57, subject, Feasibility Study of 2600 Pound ICBM Warhead. AEC Files, MRA-5, Warhead, 7/56-6/57.

12.

(b)(3)

13. SRD Ltr, Assistant Secretary of Defense to U. S. Atomic Energy Commission, dtd 5/7/58. AEC Files, MRA-5, 7/57-6/58.

14. (b)(3)

15. SRD Ltr, RS 3466/73901, Assistant Secretary of Defense to U. S. Atomic Energy Commission, dtd 11/25/58. SC Central Technical Files, 49 Program, 1-6.

16. SRD Report, RS 3466/74323, Military Liaison Committee to Distribution, dtd 1/20/59, subject, Military Characteristics for a 3000 Pound Warhead for the ATLAS. SC Central Technical Files, 49 Program, 1-6.

17. SRD Report, Military Liaison Committee to Distribution, dtd 10/13/59, subject, Amended Military Characteristics for a 3000 Pound Warhead for the ATLAS and TITAN. Forms part of Reference 2.

18. SRD Ltr, RS 8140/14, Department 8140 to Division 4171, Sandia Corporation, dtd 3/10/59, subject, Research and Development Case 806.00 Fiscal Year 1959. SC Central Technical Files, Livermore, XW-38, 1.1.

19. SRD Ltr, RS 1000/3353, Sandia Corporation to Albuquerque Operations Office, dtd 3/11/59, subject, Weapon Development Program Designator Assignment. SC Central Technical Files, 38 Program, 1-, 1956-62.

20. SRD Ltr, RS 8232/509, U. S. Air Force to Distribution, dtd 3/17/59, subject, XW-38 (3000 Pound) ICBM Warhead Diameter. SC Central Technical Files, Livermore, XW-38, 1.7 Meetings.

21. (b)(3)

22. CRD Ltr, RS 1000/3423, Sandia Corporation to Albuquerque Operations Office, dtd 9/29/59, subject, Production Nomenclature, XW-38-X1 Program. SC Central Technical Files, 38 Program, 1-, 1956-62.

23. CRD Ltr, RS 4424/1801, Sandia Corporation Nomenclature Committee to Distribution, dtd 11/19/59, subject, Production Nomenclature, XW-38-X1. SC Central Technical Files, 38 Program, 1-, 1956-62.

24. (b)(3)

25. SRD TWX, RS 3466/140131, Albuquerque Operations Office to Distribution, dtd 6/15/60. SC Central Technical Files, 38 Program, 2-, 1956-63.

26. SRD Ltr, RS 1/1286, Sandia Corporation to Albuquerque Operations Office, dtd 6/30/60, subject, SRD ALOO Teletype NR 1379-5. SC Central Technical Files, 38 Program, 1-, 1956-62.

27.

(b)(3)

28. CRD Ltr, RS 8000/9833, Sandia Corporation to Division of Military Application, dtd 8/18/61, subject, Forwarding Letter for SC4825(WD). SC Central Technical Files, 38 Program, 6-.

29. SRD Report, RS 8233/16582, Sandia Corporation to Distribution, dtd 6/63, subject, Report SC4842(WD), Final Development Report for the Mk 38 Mod 0 Warhead. SC Reports Files.

30. SRD Ltr, RS 3427/54409, Albuquerque Operations Office to Distribution, dtd 12/11/64, subject, Mk 38 Warhead Retirement. SC Central Technical Files, 38 Program, 6-9.