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# HISTORY OF THE MK 49 WARHEAD (U)

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Weapon Systems

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Information Research Division, 3434

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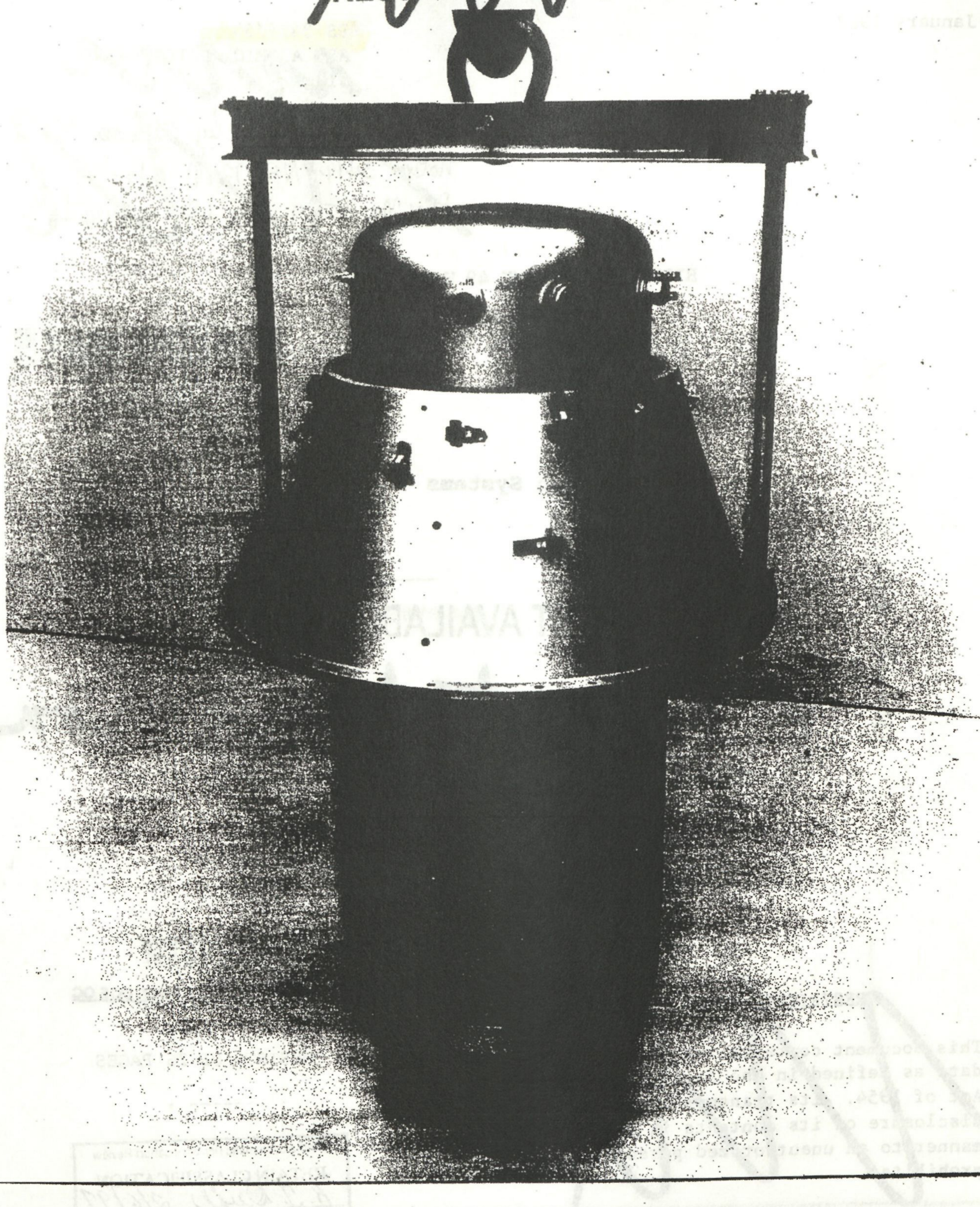

Mk 49 Warhead - Exterior View

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Figure 1. Mk 49 Mod 1 Warhead

Mk 49 Mod 1 Warhead - Cross Section

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MK 49 MOD 3 WARHEAD

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Mk 49 Mod 3 Warhead - Cross Section

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MK 49 MOD 4 WARHEAD

Mk 49 Mod 4 Warhead - Cross Section

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Timetable of Mk 49 Events

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Mk 49 Mod 0

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| | |
|---|---|
| 12/9/57 | Warhead design renamed the XW-49. |
| 3/58 | Mk 49 Mod 0 Warhead design released. |
| 4/23/58 | Design-release report of the Mk 49 Mod 0 Warhead presented to meeting of Special Weapons Development Board. |

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|---|---|
| 7/3/58 | Division of Military Application approves Los Alamos proposal to cancel the XW-35 program in favor of the XW-49. |

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| | |
|---|---|
| 8/29/58 | Mk 49Y1 Mod 0 Warhead released for JUPITER and THOR applications. |
| 9/58 | Mk 49 Mod 0 Warhead enters stockpile. |
| 7/2/59 | Mk 49Y2 Mod 0 Warhead released for ATLAS application. |
| 7/29/59 | Mk 49Y1 Mod 0 Warhead released for ATLAS application. |

Mk 49 Mod 1

| | |
|---|---|
| 5/58 | Design of inertial switch started. |
| 10/21/58 | Military characteristics amended to require installation of inertial switch in Mk 49. |
| 6/59 | Initial release of Mk 49Y1/Y2 Mod 1 Warheads. |
| 10/59 | Early production of Mod 1 Warheads by retrofit of Mod 0 Warheads. |

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Mk 49 Mod 3

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|---|---|
| 1/60 | Mk 49 Mod 3 Warhead design released. |
| 3/11/60 | Mk 49 Mod 3 Warhead authorized for application to THOR and JUPITER missiles. Early production accomplished by retrofit of Mk 49 Mod 1 Warheads. |
| 6/60 | New production of Mk 49 Mod 3 Warheads. |
| 8/16/61 | Final evaluation report of Mk 49 Mod 1/3 Warheads accepted by Military. |

Mk 49 Mod 4

| | |
|---|---|
| 10/3/58 | XW-49-X1 Warhead proposed for use with ablation nose cones. |
| 10/21/59 | Proposed ordnance characteristics of XW-49-X1 presented to Special Weapons Development Board. |

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|---|---|
| 4/26/60 | Mk 49 Mod 4 design released and early production achieved. |
| 10/4/63 | Final development report of Mk 49 Mod 4 accepted by Field Command. |

Mk 49 Mod 5

| | |
|---|---|
| 4/24/62 | Division of Military Application requests Sandia to provide JUPITER warhead with permissive device to prevent unauthorized detonation. |
| 9/25/62 | Mk 49 Mod 5 design released, incorporating coded switch pack. |
| 9/29/62 | Mk 49 Mod 3 Warheads retrofitted to Mod 5. |
| 5/64 | Final evaluation report of Mod 5 published. |

Mk 49 Mod 6

| | |
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| 12/63 | Authorization released to incorporate self-destruct unit into some Mk 49 Mod 3 Warheads. |

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| 3/64 | Initial delivery of Mk 49 Mod 6 Warheads. |
| 7/18/65 | Final evaluation report of Mod 6 accepted by Field Command. |

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History of the Mk 49 Warhead

In mid-1956, Los Alamos Scientific Laboratory and Sandia started to investigate warhead designs that could be used in connection with ATLAS and TITAN intercontinental ballistic missiles and JUPITER and THOR intermediate-range ballistic missiles. These studies culminated in development of the XW-35 and XW-35-X1 Warheads.

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The XW-35-X1 was a new configuration designed to produce a higher yield per pound, and was to follow the XW-35 in development by about one year.

Due to delays in missile availability, it became apparent that the XW-35-X1 would become operational at the same time as the earliest of the above missiles (with exception of JUPITER) and that the XW-35 design could be canceled.

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A decision was then made to cancel the XW-35, use the modified XW-28 for JUPITER, and apply the XW-35-X1 to all four missiles.

(b)(3)

Since THOR and JUPITER squadrons were scheduled for deployment in late 1958 and the XW-35-X1 Warhead would not be available in time, modified Mk 28Y1 Warheads would be supplied for the interim period.[1]

A meeting with General Electric, designers of the nose cone for the ATLAS, TITAN and THOR, was held December 9, 1957, and it was noted that the modified Mk 28Y1 Warhead would be renamed the XW-49.[2] This warhead would contain no internal power, as this would be supplied by the missile adaption kit. It was felt that the XW-49 could be produced in 1958.[3]

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

(b)(1), (b)(3) The warhead would be sealed and pressurized. The firing system would be checked after assembly and subsequently require only continuity and pressure monitoring in field or stockpile. There would be no component replacement permitted and no reason to break the warhead seal after initial assembly.[1]

The Mk 49 Mod 0 Warhead was design released in March 1958,[3] and early units entered stockpile in September 1958.[4] Sandia presented Report SC4161(TR), Description and Status Report at Design Release of the W49-0 Warhead, to the April 23, 1958 meeting of the Special Weapons Development Board.[5] The report noted that the Mk 49 Mod 0 was a thermonuclear warhead designed for early-emergency-capability use in JUPITER and THOR missiles. The warhead was 20 inches in diameter and 54.2 inches in length, exclusive of mounting provisions. (b)(1), (b)(3) Field testing was limited to monitoring the internal warhead pressure every 30 days and checking electrical continuity just before mating the warhead to missile re-entry vehicle.

The report noted that the Mk 49 Mod 0 was the first warhead system to use a rotary chopper inverter/converter to change low-voltage direct current (28 volts) into high-voltage direct current (2200 volts). When proper signals were applied to both chopper and converter, the applied voltage was interrupted, transformed, rectified and used to charge the X-unit capacitor storage bank. To complete arming functions, a low-voltage direct current was applied to boosting-gas reservoir and valve assembly to release deuterium-tritium gas into the sealed pit.

The Mk 49 Mod 0 Warhead could be fired by either one of two signals. The air-burst option applied a 28-volt direct-current signal to a high-turns-ratio, low-impedance pulse transformer. The stepped-up voltage was applied to one probe of a dual-probe spark gap, ionizing the gap and releasing energy stored in the X-unit capacitor bank to the detonators, firing the warhead.

In the contact-burst option, a 250-volt direct-current signal was developed by contact crystals and applied to the grid of a cold-cathode thyratron trigger tube, causing the tube to conduct. This discharged the capacitor in the plate circuit through the primary of the pulse transformer, and voltage generated in the secondary was applied to the second probe of the spark gap. This ionized the gap, the capacitor bank discharged into the detonators, and the warhead detonated.

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

The firing system included X-unit, trigger circuit, rotary choppers, converter, arm/safe switch, and filter package. The boosting-gas reservoir and valve were mounted within the warhead pressure container. This container, composed of warhead case and pressure cover, housed warhead components and protected them from storage and operational environments. A pressure switch and humidity indicator were provided within the container to monitor internal pressure and humidity.

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Based on relative results of these two tests, and the fact that the nuclear testing moratorium was approaching, Los Alamos proposed, June 16, 1958, that the XW-35 program be canceled in favor of the XW-49. This suggestion was approved by the Division of Military Application, July 3, 1958.[7]

The United States Atomic Energy Commission wrote to the Deputy Secretary of Defense, July 8, 1958, reporting the decision to abandon the XW-35 program in favor of the XW-49.

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Sandia notified Albuquerque Operations Office, July 17, 1958, that the Mk 49Y1 Mod 0 Warhead would be delivered to stockpile in the near future. However, it did not appear appropriate to make the release until an acceptable number of successful warhead flights had been completed in various missiles. Schedules called for four THOR systems flights, and three system and two component flights in JUPITER by late 1958; and these would be the bare minimum to support an application release of warhead and missile. However, before the end of 1958, Sandia would issue an emergency-capability release to permit warhead-missile deployment pending availability of adequate flight-test information.[10]

An amended release of the Mk 49Y1 Mod 0 Warhead was made August 29, 1958. It was noted that satisfactory tests of this warhead had been performed in simulated environments typical of JUPITER and THOR, and application release for use in these missiles was authorized.[11]

By April 29, 1959, three warheads had been flight tested on THOR. Flight data indicated that the warhead experienced a relatively mild environment and that the warheads functioned as intended, in both air and contact burst. Six warheads had been tested on JUPITER. Of these, one test was successful, two were unsuccessful due to missile failure, two unsuccessful due to nose-cone failure, and one unsuccessful due to fuzing-system failure. Despite this poor showing, it was noted that these warheads had also experienced a relatively mild environment and that the weapons would have functioned properly if the correct fuzing signal had been given.[12]

The Mk 49Y2 Mod 0 Warhead was released July 2, 1959 for use with the ATLAS missile. One flight had been made, and this also indicated that the warhead could adequately resist the missile environment.[13] The Mk 49Y1 Mod 0 for the ATLAS was released July 29, 1959.[14]

Mk 49 Mod 1 Warhead

Development of a Mk 49 inertial switch was ~~prepared~~ proposed in May 1958. This device would prevent warhead arming until the weapon had experienced a re-entry deceleration environment, and prevent premature detonation caused by tester malfunctions, procedural mistakes, or acts of sabotage.[15]

An amendment to the military characteristics was approved by the Military Liaison Committee October 21, 1958. This requested that a sensing device be built into the Mk 49 Warhead, to be actuated as late in the missile acceleration phase as possible, so as to reduce the possibility of nuclear detonation through accident or sabotage.[16] The Department of Defense had requested that this device be located so that access was difficult and time-consuming, and to protect against fire or other accidents. It was suggested that all existing Mod 0 Warheads be retrofitted with the device, thus resulting in the Mod 1.

Initial release of Mk 49Y1 Mod 1 and Mk 49Y2 Mod 1 Warheads was made in June 1959, and early production was attained in October 1959 by retrofit of Mod 0 Warheads. The Mk 49 Mod 1 was identical in all respects to the Mk 49 Mod 0, with exception of the inertial switch. This switch closed and latched after experiencing a force of 3 to 10 g's, with a total input of 10 g-seconds.

Three 28-volt direct-current inputs were required for arming. These could be received simultaneously, but, if in sequence, the order had to be as follows: (1) Continuous input to the chopper motor, (2) continuous input to the voltage converter, and (3) pulsed or continuous input to the boosting-gas valve.

(b)(3)

Two alternate methods of firing the trigger circuit were provided. The first was 28-volt direct current, and was used only in the air-burst option. The other was a 250-volt direct-current pulse, and could be used for either ground or air-burst.

Fuzing signals varied with the missile. JUPITER issued signals singly, in the above order, for arming, by cam-actuated switches on a safing and arming sequencer. Either a radar-air-burst or a contact-crystal signal was then received. The ATLAS and THOR fuzing system provided arming signals simultaneously and detonated the warhead by means of a baroswitch for air-burst option or piezoelectric crystals in the contact option.[17]

Mk 49 Mod 2 Warhead

The Mk 49 Mod 2 Warhead would have been incorporated in the Mk 3 re-entry vehicle in the ATLAS missile. The design would have been internally initiated, as in Mods 0 and 1. A decision to change to external initiators (see the Mk 49 Mod 3 Warhead) resulted in canceling the Mod 2, prior to production, in favor of the Mk 49 Mod 4.

Mk 49 Mod 3 Warhead

A product change proposal dated November 5, 1959 was designed to conserve reactor products.

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The Mk 49 Mod 3 Warhead was design released in January 1960, and authorization for use of this warhead with JUPITER and THOR missiles was issued March 11, 1960.[19] Early production by retrofit of Mk 49 Mod 1's was accomplished during March 1960, and new production started in June 1960.

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The electrical system consisted of the Mk 28 capacitor bank and trigger circuit with a chopper-converter high-voltage source driven by 28-volt power supplied by the re-entry vehicle.

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

Field Command notified Sandia August 16, 1961 that Report SC4298 (WD), Final Evaluation Report for the Mk 49 Mod 1 and Mod 3 Warheads, had been reviewed in coordination with representatives of the interested Services. This review established that the design met all the requirements of the approved military characteristics and all other known operational, logistic and safety requirements of the Department of Defense.[20] The report was subsequently forwarded to the Division of Military Application.[21]

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Mk 49 Mod 4

Initially, only the JUPITER nose cone was scheduled to use ablation to protect the nose cone against re-entry heat. The nose cone would be covered with nylon-reinforced phenolic that would be eroded, layer by layer, as the nose cone re-entered the earth's atmosphere, and the heat generated would be carried away by the ablation material. The other missiles would use heavy nose-cone metal sinks which would absorb re-entry heat. By late 1958, however, it had been decided to use the ablation principle in all nose cones.[22] This required redesign of the Mk 49 Mod 0 Warhead, this new modification being named the XW-49-X1.[23]

Sandia informed Albuquerque Operations Office, October 3, 1958, that the XW-49-X1 program would provide a warhead suitable for use with ATLAS and TITAN re-entry vehicles. Nuclear components and internal design would be the same as the Mk 49

Mod 0 Warhead, but a new warhead case and pressure cover would be provided. The case would have provisions for mounting nose cap and flare skirt, and the pressure cover would have to withstand the loading created by attachment to the missile. The portion of the warhead case exposed in the re-entry vehicle would be covered with ablation material.[22]

Sandia presented the development program definition of the XW-49-X1 to Albuquerque Operations Office March 16, 1959. Warhead development was directed toward design release in May 1959 and early production in February 1960. The new warhead case would contain modified Mk 49 Mod 0 plastic, same nuclear system, and Mk 49 Mod 1 firing set.[16]

Sandia presented Report SC4293(TR), Proposed Ordnance Characteristics of the XW-49-X1 Warhead, to the October 21, 1959 meeting of the Special Weapons Development Board.[24] The report noted that the warhead was being designed for incorporation in the Mk 3 re-entry vehicle. Carry-over components from the Mk 49 Mod 0 and Mod 1 Warheads would be used wherever possible. Significant changes included major redesign of warhead case section, new interface provisions, and improved sealing features.

(b)(3)

The report was accepted and forwarded to the Division of Military Application.[25]

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

Design release was scheduled for January 1960 and early production for April 1960.

(b)(3)

This change would lengthen the warhead by 2.1 inches. The major diameter would be 20 inches plus ablating material, maximum length 57.9 inches plus electrical connectors, and the weight about 1640 pounds without ablation material and 1732 pounds with ablation material.

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

Albuquerque Operations Office informed Sandia February 1, 1960 that the Air Force had an urgent requirement for some Mk 49Y2 Mod 4 Warheads. These were desired by April 1960, and the program carried a high priority.[27] Release and production of the Mk 49Y2 Mod 4 Warhead were made April 26, 1960.[28]

Report SC4636(WD), Final Development Report for the Mk 49 Mod 4 Warhead, was accepted by Field Command October 4, 1963, and forwarded to the Division of Military Application November 15, 1963.[29,30] This report noted that the XW-49-X1 design was basically the Mk 49Y2 Mod 1 with mounting flange removed; pressure cover extended; and an ablation sleeve, furnished by the Department of Defense, added to the cylindrical portion of the warhead case. The fore and aft ends of the warhead case were extended and threaded to mate with nose and flare sections of the Mk 3 re-entry vehicle.

The report noted that the requirement for TITAN compatibility had been deleted in 1960, only to be reinstated later in the year. All Mk 49 Mod 4 production had been completed by October 1960. Flight tests had been made on the ATLAS to ranges of 7800 nautical miles, and all flight testing was completed by July 1961.

The warhead contained no source of primary power. At missile launch an inertial switch closed, connecting input lines from the missile adaption kit to converter and boosting-gas valve. After re-entry into the atmosphere, electrical signals were provided to the warhead from re-entry vehicle. One signal was 28 volts direct current to chopper motors, converters and boosting-gas valve explosive actuator, and another provided a firing signal to a trigger circuit for air burst. A 250-volt direct-current firing signal was provided to the trigger circuit for contact bursts.[31]

In January 1962, Sandia was requested to re-evaluate the Mk 49 Mod 4 in terms of increased loadings caused by improvements in the ATLAS range.

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Mk 49 Mod 5

On April 24, 1962, the Division of Military Application requested that the JUPITER warhead be provided with a permissive device to prevent unauthorized detonation.[32] Sandia stated that an expedited program could produce retrofit kits by late September 1962. To be compatible with the limited space available in the warhead firing section, separate environmental sensing devices and code switches would be installed.

A joint working group was established and met initially May 11, 1962. It was noted that this change would produce the Mk 49 Mod 5 and would increase the warhead weight by 12 pounds. The design was released September 25, 1962 and, within 4 days, two warheads had been retrofitted.[33,34] The Mod 5's were produced by retrofit of Mod 3's and involved replacing an inertial switch pack with a coded switch pack and substituting a new 2-piece pressure cover.[35]

Report SC4780(WD), Final Evaluation Report for the Mk 49 Mod 5 Warhead, was published in May 1964. This noted that permission had been given to deviate from normal development and production procedures in order to meet the retrofit date. Conversion hardware was produced from development rather than production drawings, the design group was given responsibility for acceptance of components, and all hardware, where possible, was 100-percent tested to establish its functional, electrical, structural and interchangeability characteristics.

The system operation of the Mk 49 Mod 5 was the same as the Mod 3, except that the environmental-sensing-device switches were not cross channeled, and therefore any switch failure would cause failure on one channel. Prior to launch, the coded switches were remotely armed to provide continuity through that part of the system.[36]

Mk 49 Mod 6

In December 1963, authorization was released to incorporate a self-destruct unit into a certain number of Mk 49Y2 Mod 3 Warheads which had been inactivated from the Mk 49/THOR system for this purpose. Those warheads meeting the latest design definition were selected to minimize the amount of component replacement.

(b)(3)

Initial delivery of the Mk 49 Mod 6 to the Military was March 1964, and all such warheads were delivered by June 1964. Report SC-WD-64-661, Final Evaluation Report for the Mk 49 Mod 6 Warhead, was issued in November 1965, after the design had been accepted by Field Command July 18, 1965.[37]

Glossary of Mk 49 Terms

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

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

Capacitor -- A condenser that accumulates and stores electrical energy until time for detonation.

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

Coded Switch -- A switch that cannot be operated until and unless the proper combination is dialed.

Contact Burst -- A weapon burst occurring on contact with target or terrain.

Crash Program -- A weapons program that has been expedited and its schedule speeded up. Generally produces weapons of lower quality or hand-made items that have not been fully tested or certified for use. See Emergency Capability Program.

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

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.

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 detonator.

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.

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

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.

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

Pit -- The hollow metal sphere at the center of an implosion bomb which ~~receives the nuclear capsule when it is inserted.~~ contains the fissile material and the tamper.

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

Radar -- Named 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.

Reactor Products -- Nuclear material, especially uranium and plutonium.

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.

Retrofit -- To modify a weapon, i.e., "retroactively outfit" it with changed material.

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

<u>Thyratron</u> -- A grid-controlled electron tube.

<u>Tritium</u> -- The hydrogen isotope of mass number 3.

<u>Uranium-235</u> -- A radioactive element, an isotope of uranium-238.

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

<u>Warhead</u> -- A weapon carried to the target by missile.

<u>X-Unit</u> -- A device used to provide high voltage to the weapon detonators.

<u>Yield</u> -- The measure of the effect of a nuclear detonation compared to the effect of an explosion of TNT.

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8. (b)(3)

9. (b)(3)

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15. SRD Ltr, RS 1200/3259, Organization 1200 to Organization 1400, Sandia Corporation, dtd 5/27/58, subject, Inertial Switch for the W49. SC Central Technical Files, 49 Program, 1-.

16. SRD Ltr, RS 1000/3329, Sandia Corporation to Albuquerque Operations Office, dtd 3/16/59, subject, Development Program Definition, XW-49-X1. SC Central Technical Files, XW-49-X1, 1-, 2-.

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23.

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24. SRD Minutes, RS SWDB-59-120, Special Weapons Development Board to Distribution, dtd 10/21/59, subject, Minutes of 120th Meeting. SC Archives, Transfer No. 48217.

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26.

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27. SRD TWX, RS 3466/94117, Albuquerque Operations Office to Addressees, dtd 2/1/60. SC Central Technical Files, Mk 49 Mod 4 Warhead, 1-4 thru 5-1.

28. SRD Report, RS 1000/3467, Sandia Corporation to Distribution, dtd 4/26/60, subject, Initial Major Assembly Release, Mk 49Y2 Mod 4 Warhead. SC Central Technical Files, Mk 49 Mod 4 Warhead, 1-4 thru 5-1.

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30. Uncl Ltr, Sandia Corporation to Division of Military Application, dtd 11/15/63, subject, Forwarding Letter for SC4636(WD). SC Central Technical Files, 49 Program, 7-.

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34. SRD Report, RS 1/1393, Sandia Corporation to Distribution, dtd 9/29/62, subject, W49/JUPITER Permissible Arming Link Incorporation. SC Central Technical Files, 49/JUPITER, 1-6.

35. SRD Negative, RS 3446/134428, Sandia Corporation to Distribution, dtd 1/25/63, subject, Weapon Data Sheet, Mk 49 Mod 3 and Mod 5 Warheads. SC Photo Negative Files.

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