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

XM 454 (48-W-01)

Mk 48 Mod 0 Warhead - Cross Section

Timetable of Mk 48 Events

4/28/54	Army expresses interest in development of small low-yield projectile.
5/14/54	Secretary of Defense authorizes study of implosion-type projectile.
4/4/55	Work by the University of California Radiation Laboratory results in request by the Secretary of Defense for a feasibility study of an 8-inch implosion shell.

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

9/20/56	Assistant Secretary of Defense requests United States Atomic Energy Commission to concentrate on atomic artillery shells of 155mm (6.1 inches) diameter.
7/12/57	Assistant Secretary of Defense requests that 155mm atomic implosion projectile be developed.
5/14/58	Developmental guidelines between Atomic Energy Commission and Department of Defense for development of 155mm shell issued.

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

8/4/59	Military characteristics approved by the Military Liaison Committee.
11/6/59	Sandia forwards development program definition to AEC.

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

3/23/60	Military Liaison Committee suspends higher yield requirement.
1/63	Mk 48 Mod 0 Shell design released.
10/26/63	Early production of Mk 48 Mod 0 Shells.
5/64	Final development report approved and published.

RS 3434/29

History of the Mk 48 Shell

The predecessor of the Mk 48 Shell was the Mk 33, an 8-inch-diameter, artillery-fired atomic projectile. While this latter shell was still being designed, the Under Secretary of the Army wrote to the United States Atomic Energy Commission, April 28, 1954, expressing interest in the possibility of developing an even smaller diameter projectile with a very low yield, and a broad study was subsequently authorized by the Secretary of Defense May 14, 1954.

The intent of this study was to investigate the possibility of using implosion techniques in an atomic artillery shell, rather than the gun method used in previous shell designs, but the state of the art was not sufficiently well advanced. Much work was, however, accomplished in the ensuing 12 months by the University of California Radiation Laboratory and resulted in a request from the Secretary of Defense to the Atomic Energy Commission, April 4, 1955, for a feasibility study of an 8-inch shell having advanced nuclear techniques. (b)(1), (b)(3)

(b)(3)

Other components included a corona regulator tube, ceramic spark gap, and an inertial or setback switch. If the tube could not be designed to resist firing shock, other methods of regulation were available that could meet requirements of small size, rugged construction, and dependable operation. An extensive reliability study of the spark gap would have to be made. Due to experience gained on other designs, it was felt that the setback switch would impose no particular problems.[13]

The Army informed Sandia July 16, 1958 that, as the caliber of the implosion shell decreased, the magnitude of the associated engineering problems increased. It was therefore suggested that detailed consideration be limited to the design of a shell with a minimum diameter of 155mm. It was recommended that development engineering be authorized for a shell for the 155mm howitzer and the 175mm gun, but that general small-caliber research be continued.

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

In early 1959, reports were received that the Army was planning to cancel requirements for the XW-48. Subsequently, however, the Division of Military Application, in a letter dated April 16, 1959, noted that the Army had again reviewed the program and decided that development work should continue. The Ordnance Department had been directed to provide the Army portion of the shell by July 1962. It was noted that XW-48 military characteristics were being coordinated and would be released in the near future.[16]

Sandia presented a report on the XW-48 firing set to the May 15, 1959 meeting of the Oak Committee. The design was a ferromagnetic transducer type, and formed a right cylinder 3.5 inches in diameter and 1.7 inches high. Tests had been successful, and most design problems had been solved. (b)(3)

The military characteristics were approved by the Military Liaison Committee August 4, 1959, and forwarded to Albuquerque Operations Office. The Division of Military Application, in the transmittal letter, requested notification if any of the requirements could not be met or were objectionable from the standpoint of sound design engineering. (b)(1), (b)(3)

An estimate was requested of the maximum yield that could be expected if no further nuclear tests were conducted.[18]

At this time the length of the projectile was increased 2 inches to create a higher polar moment of inertia. This provided the shell with improved ballistic characteristics, but increased the weight to 120 pounds and reduced the range to 14,000 meters or about 8.5 miles.[19]

Sandia forwarded the XW-48 development program definition to Albuquerque Operations Office November 6, 1959. (b)(1), (b)(3)

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

Inclusion of mechanical safing would further aggravate the space situation.[21]

The Defense Atomic Support Agency wrote to Sandia January 25, 1960, noting that Report SC4807(TR), Proposed Ordnance Characteristics of the XW-48 Warhead, had been reviewed in coordination with representatives of the Services. The design met all requirements of the approved military characteristics, with certain exceptions. (b)(1), (b)(3)

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

(b)(3)

The higher yield, however, was desired and would be retained in the military characteristics.[23]

The Military Liaison Committee forwarded an amendment to the military characteristics May 2, 1960. This required that the XW-48 be compatible with M1A1 and T258 howitzers.[24] The Lawrence Radiation Laboratory and Sandia had previously informed Picatinny Arsenal that it was not possible, either through calculations or completed tests, to estimate with confidence the ability of the projectile to withstand the T258 environment, as Picatinny had indicated that this new application would subject the shell to angular accelerations 25 percent greater than previously anticipated. However, suitable tests would be conducted.[25]

These tests were subsequently made at the Army's Yuma, Arizona, test station. Linear accelerations of 12,000 g's were recorded, together with angular accelerations of 190,000 radians per second per second, the T258 howitzer environment. No premature firings were experienced, and no damage to shell components resulted. Thus, Sandia notified Albuquerque Operations Office January 15, 1961 that the T258 howitzer and XW-48 Shell were compatible.[26]

The Army informed Sandia November 24, 1961 that nomenclature of the 155mm projectile was changed from T358 to XM454 to prevent unclassified associations indicating the existence of the project for developing the atomic projectile.[27]

An amendment to the military characteristics, approved by the Military Liaison Committee June 26, 1962, deleted surface-burst preclusion. Contact detonation of shell with target was desired.[28] Another amendment was approved by the Military Liaison Committee September 19, 1962. This required that the shell be designed to allow it to be air-dropped in its container and survive impacts causing an 80-g deceleration.[29,30]

Meanwhile, components and complete projectiles had been subjected to laboratory functional and environmental tests simulating operational conditions, and to full-scale howitzer firings in instrumented projectiles. The items were first tested to determine their ability to operate properly as individual components. They were then assembled into subsystems, and finally into complete projectiles, and futher tested to determine their physical and electrical compatibility and their ability to function as a system. These tests were initially conducted under normal laboratory conditions; then under conditions of natural environmental extremes; then under the environments imposed by the application, such as ground handling, howitzer firing, etc.; and finally under the combinations of natural and artificial environments that would be encountered in actual use. All test results indicated that the system was more than adequate.

Production of the first unit, originally scheduled for June 1962, was delayed to October 1962, then to March 1963, and finally to October 1963, with corresponding changes being made to associated program dates. The Mk 48 Mod 0 Shell was given complete engineering release in January 1963, and production of the first projectiles was effected October 26, 1963.[31]

Report SC4871(WD), Final Development Report for the Mk 48 Mod 0 Warhead, was forwarded February 1964 to the Design Review and Acceptance Group, and was

subsequently approved and published in May 1964. (b)(1), (b)(3)

It was integrated with a number of components supplied by the Department of the Army to form the XM454, an artillery-fired atomic projectile designed to be fired from 155mm howitzers equipped with either M1A1 or T258 tubes. The maximum range of the projectile was 14,000 meters, or 8.5 miles. The minimum fuze-setting range was 1650 meters, or about 1 mile, which provided safe distance from nuclear detonation. The projectile was 155mm (6.1 inches) in diameter, 34 inches (5.57 calibers) long, and weighed 120 pounds.

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

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

Glossary of Mk 48 Terms

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, now DASA

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.
(b)(3)

Coordinating Committee on Atomic Energy -- Based on a committee established by the Joint Research and Development Board December 1946. Membership consisted of six members appointed by the Secretaries of War and Navy, and three civilian members appointed by the Chairman of the Research and Development Board. Subsequent to the National Security Act, military members were appointed from the three Services. In June 1953, the functions of this Board were absorbed by the Assistant Secretary of Defense, who established the Research and Development Coordinating Committee on Atomic Energy to continue these responsibilities.

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.

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

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

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.

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)(3)

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.

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.

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~~ shell, 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.

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.

Neutron -- An uncharged particle of slightly greater mass than the proton.

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.

Operation Redwing -- See Redwing.

(b)(3)

(b)(3)

Safing -- Putting a weapon in condition such that it cannot fire.

Self-Destruct Unit -- A device that will destroy the warhead, should the missile miss its target.

Services -- The Department of Defense.

Spark Gap -- An air gap that prevents passage of electrical current. When the gap is ionized, current is conducted.

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.

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

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.

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

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

11. SRD Ltr, RS 8232/5150, Division of Military Application to San Francisco and Albuquerque Operations Offices, dtd 5/23/58, subject, Memorandum of Agreement between the AEC and DOD for the Development of a 155mm Implosion Type Atomic Artillery Shell. SC Central Technical Files, XW-48, 1-7, Livermore.

12. SRD Ltr, RS 3466/69944, Albuquerque Operations Office to Distribution, dtd 6/18/58, subject, Memorandum of Agreement between the AEC and DOD for the Development of a 155mm Implosion Type Atomic Artillery Shell. SC Central Technical Files, 48 Program, 1-3.

13. SRD Ltr, RS 8123/57, Division 8123 to Department 8120, Sandia Corporation, dtd 6/25/58, subject, Investigation Report on the TX-48 Components Proposed by Picatinny. SC Central Technical Files, 48 Program, 1958-1960.

14. (b)(3)

15.

16. CRD Ltr, Division of Military Application to Albuquerque Operations Office, dtd 4/16/59, subject, TX-48 Program. SC Central Technical Files, 1-1, Livermore.

17. (b)(3)

18. SRD Ltr, RS 3466/78825, Division of Military Application to Albuquerque Operations Office, dtd 8/18/59, subject, Military Characteristics for the XW-48. SC Central Technical Files, 48 Program, 1-6.

19. SRD Report, RS 8232-2/1008, Sandia Corporation, Livermore, to Distribution, dtd 5/64, subject, SC4871(WD), Final Development Report for the Mk 48 Mod 0 Warhead. SC Reports Files.

20. (b)(3)

21. SRD Ltr, RS 8000/80, Lawrence Radiation Laboratory and Sandia Corporation, Livermore, to Albuquerque Operations Office, dtd 12/3/59, subject, Military Characteristics of the XW-48 Warhead. SC Central Technical Files, 48 Program, 1-6.

22. (b)(3)

23. TSRD Report, RS LXI-5758, United States Atomic Energy Commission to Distribution, dtd 5/1/60, subject, Weapons Development Status Report. SC Files.

24. SRD Ltr, RS 8100/182, Lawrence Radiation Laboratory and Sandia Corporation, Livermore, to Albuquerque Operations Office, dtd 6/15/60, subject, Military Characteristics of the XW-48 Weapon. SC Central Technical Files, 48 Program, 1-6.

25. CRD Ltr, Lawrence Radiation Laboratory and Sandia Corporation, Livermore, to Picatinny Arsenal, dtd 3/2/60, subject, Reply to ORDBB-TWI-00455. SC Central Technical Files, TX-48, 2-, Livermore.

26. SRD Ltr, RS 8100/214, Sandia Corporation, Livermore, to Albuquerque Operations Office, dtd 1/15/61, subject, Military Characteristics of the XW-48 Warhead. SC Central Technical Files, 48 Program, 1-6.

27. CRD Ltr, Army Ordnance Department to Sandia Corporation, dtd 11/24/61, subject, Change in Nomenclature. SC Central Technical Files, XW-48, 1-8, Livermore.

28. SRD Ltr, RS 3446/53421, Division of Military Application to Albuquerque Operations Office, dtd 7/9/62, subject, Military Characteristics for XW-48. SC Central Technical Files, 48 Program, 1-6.

29. SRD Report, RS 3446/54895, Military Liaison Committee to Distribution, dtd 9/19/62, subject, Military Characteristics for the XW-48. SC Central Technical Files, 48 Program, 1-6.

30. SRD Ltr, RS 3446/54893, Division of Military Application to Albuquerque Operations Office, dtd 10/4/62, subject, Military Characteristics of the XW-48. SC Central Technical Files, 48 Program, 1-6.

31. SRD Report, RS 8000/244, Sandia Corporation to Distribution, dtd 10/25/63, subject, Major Assembly Release, Mk 48 Mod 0. SC Central Technical Files, XW-48, 2-5 to 2-14, Livermore.

32. (b)(3)

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