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AEC ATOMIC WEAPON DATA
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HISTORY OF THE MK 44 WARHEAD

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Information Research Division, 3434

Weapon Systems

Redacted Version

Sandia Systematic Declassification Review
RETAIN CLASSIFICATION
A. T. Duff 2/11/97
Reviewer Date

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MK-44 MOD O

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Mk 44 Mod 0 Warhead - Cutaway View

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7/16/58 Military Liaison Committee issues military characteristics of the XW-44 Warhead.

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10/59 XW-44-X1 design released.

11/59 Proposed ordnance characteristics of XW-44-X1 Warhead for ASROC application presented to the Special Weapons Development Board and accepted.

4/18/60 Status at design release of XW-44-X1 reviewed by Design Review and Acceptance Group and accepted.

5/61 Early production of Mk 44 Mod 0 Warhead achieved.

2/13/62 Final development report of the Mk 44 Mod 0 Warhead reviewed by Design Review and Acceptance Group and accepted.

The Assistant Secretary of Defense requested the United States Atomic Energy Commission, November 1, 1954, to collaborate with the Navy Bureau of Ordnance in a study to determine the feasibility of developing a rocket-propelled atomic depth charge for attack of fast, deep-diving submarines. Recent improvements in submarine detection equipment had been made, and the Bureau of Ordnance wished to consider application of a nuclear weapon.[1]

The Division of Military Application forwarded the above request to the Santa Fe Operations Office, but pointed out that the scope of the study was quite broad and general, and that, until a particular weapon system had been selected, AEC participation should be confined to informal discussions. Time scales for the study had not been specified, and it was felt that a deliberate and unhurried examination should be conducted.[2]

Some months later, June 29, 1955, the Assistant Secretary of Defense requested a study of the feasibility of producing 10- to 12-inch implosion warheads.[3]

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Longitudinal accelerations of 100 g's for antiaircraft missiles and about 2000 g's for antisubmarine-warfare weapons were prescribed, and it was pointed out that the higher figure was appropriate for those weapons that would have to withstand water entry.

The attendees at the Board meeting felt that it would be possible to produce warheads of the desired size by 1959, in view of effort currently being expended on the XW-25 and XW-30 designs.

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It was felt that the system could be made rugged enough for use as a depth charge.

Sandia reported that existing pulse transformers for external initiators were fairly bulky, and it was not apparent that their size and weight could be materially reduced. It was hoped that capacitors could be made smaller, and work was in progress on a toroidal design using a single winding, rather than the several individual capacitors used in existing components. However, costs would be high and reliability questionable for some time to come.

It was felt that completion of weapon development on schedule would depend largely on Sandia's work, and it was hoped that one design would be compatible with all carriers. Since NIKE and TERRIER were already available, the study would be based largely on these two missiles. One requirement, however, would be the high g-loading created by water entry, and it was suggested that shock-resistant designs be investigated.[4]

Field Command issued a study report November 1, 1955, which stated that an implosion weapon with an outside diameter of 11.75 inches and maximum length of 24 inches could be developed for use in several weapon delivery systems, including that of an ASROC (or antisubmarine rocket).

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The warhead would require no external power other than short pulses of 28 volts.[5]

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It was requested that both Operations Offices establish a joint AEC-DOD ASROC Coordinating Committee, and each weapons laboratory was authorized to proceed with any study efforts necessary for early development.[10]

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Since the weapon would not be operational for another 3 years, it was felt that there would be plenty of time for detail design work after test results had been received.[11]

The Chief of Naval Operations wrote to the Atomic Energy Commission March 20, 1956, referring to the Navy feasibility report, the Field Command study, and the January 27, 1956 authorization from the Assistant Secretary of Defense.

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It was felt that the weapon should have a diameter no greater than 14 inches, to facilitate handling and stowage aboard destroyers, and to provide for possible adaptation of the ASROC to a family of weapons, including air-defense missiles and rocket-assisted high-explosive torpedoes. Recent rapid growth of a Soviet submarine threat required that development time scales of an ASROC weapon system be accelerated to the utmost and, accordingly, a target date of April 1958 was established for operational availability.[7]

The above was supplemented by a letter from the Assistant Secretary of Defense, March 23, 1956, to the Division of Military Application, designating the Navy as the cognizant agency for the ASROC system. The AEC was requested to collaborate with the Navy in design and development of a weapon which would combine a 10- to 12-inch implosion warhead with ASROC.[12]

A fixed delay of 3 seconds after water impact would be established to allow for complete warhead electrical arming, during which time the adaption kit would not issue a firing signal. This signal would be initiated when the ASROC payload was at optimum burst depth or at bottom contact. If the ocean bottom defeated the bottom-sensing elements, the firing signal would occur at a time-interval after water entry.[15]

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The Bureau of Ordnance discussed the XW-44 Warhead design in a letter to the Chief of Naval Operations September 6, 1956.

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Authorization to proceed with development engineering of the ASROC warhead was released by the Division of Military Application November 1, 1956.

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The Assistant Secretary of Defense wrote to the Atomic Energy Commission November 30, 1956, noting that the Army had canceled the requirements for a warhead for NIKE I and that this adaptation should be suspended.[20]

The proposed military characteristics for the ASROC warhead were forwarded by the Military Liaison Committee to the Atomic Energy Commission in early December 1956.

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The ASROC weapon system was described in a report issued by the Naval Ordnance Test Station January 28, 1957. The system had been designed to provide surface ships with a weapon for long-range attack of fast, deep-diving submarines. The system would be able to deliver either an atomic depth charge or an acoustic homing torpedo, and both payloads would use the same fire-control launcher, motor-thrust termination and airframe. The atomic ASROC would have a range from 3,500 yards (2 miles), which was the minimum safe range for launching-ship safety, to 10,000 yards (5-3/4 miles).

Warhead electrical arming would be initiated at water impact when, and only if, minimum safe range had been assured. A fixed time delay of 2 seconds after water impact would be provided to allow for complete warhead arming. Shallow-water hydrostats would assure that the depth charge had entered a water environment. The power source for the high-voltage system for warhead detonation could be removed or reinstalled with the weapon in place on the launcher.

The arming and fuzing functions would be divided into three main phases: Pre-launch, airflight, and underwater operation. Prior to launch, the arm/safe switch would be manually operated to the ARM position. When the rocket motor was ignited at launch, the weapon low-voltage power supply would be activated by the fire-control signal and the range determined by terminating the rocket thrust at the correct velocity to achieve proper range. This termination signal would be furnished by a range control device containing an integrating accelerometer and

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Sandia notified Los Alamos February 5, 1957 that preliminary investigations of the XW-44 Warhead had made it apparent that components external to the high-explosive system would occupy a larger portion of the warhead weight and space than in previous programs.

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Sandia would continue efforts to miniaturize the warhead system, but requested that Los Alamos reduce the size of the initiating system.[24]

The Military had suggested that designs for XW-44 and XW-45 were similar, and should be combined into a single program. Sandia sent a teletype to the Division of Military Application March 18, 1957, stating that it would be better to develop separate warheads. It was felt that this action provided a significant reduction in time over that required if one weapon laboratory were to develop a single warhead to satisfy all applications. It was noted that time was of major importance in both programs.

Early production of both XW-44 and XW-45 had been originally planned for June 1959, but the XW-44 had now been delayed to September 1959. The XW-44 design would probably satisfy all applications, since the ASROC environment was the most severe of the XW-44 and XW-45 environments.

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There was some question whether a ruggedized XW-45 could meet the 150-pound weight limit required by the military characteristics.[25]

Subsequently, the Atomic Energy Commission wrote to the Military Liaison Committee March 26, 1957, noting that proving out the XW-44 for three different missile environments would greatly complicate the test program and delay the

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A meeting was held July 29, 1958 to determine whether the design-release date of the XW-44 should be delayed. The test program used components not representative of production, and the amount of test data secured was somewhat meager. Production-type components were becoming available, but drop tests had been delayed until September 1958, and these test results could not be analyzed before the scheduled design-release date of the warhead.

It was pointed out that the weapon case, originally a two-piece welded design, had lacked adequate strength as shown by water-impact and air-gun tests. A redesigned one-piece case was apparently satisfactory, but it was noted that the flight-test program had been performed on prototype items, and that results were not truly indicative.

However, it was felt that a delay of 1 to 2 months, to include the results of the next series of drop tests, would not be too helpful. The meeting attendees decided that the design-release date should be left as scheduled, but that risks were involved, and remedial action and production changes might later be required.[37]

Los Alamos wrote to the Division of Military Application August 8, 1958, noting that a primary requirement of the XW-44/ASROC Warhead was one-point safety.

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It was felt that inflight and underwater trajectory characteristics would be essentially unaltered, and that no serious launcher compatibility problems would be created. This proposal would be discussed at the next meeting of the ASROC Joint Coordinating Committee.[42]

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In each test, the vehicle was launched from a prototype ASROC launcher to a range of 10,000 yards and impacted into at least 100 feet of water. The fuze and missile system operated successfully, and the Los Alamos and Sandia items survived the test environment and functioned properly. It was concluded that the warhead case and all major components were structurally adequate to survive the ASROC water-entry environment.[43]

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Bureau of Ordnance attendees felt that they could not approve this proposed change. Expenditure of funds for a feasibility study could not be justified, and it was estimated that the Navy would require 6 months for the study and almost 18 months for development. Under these conditions, operational capability of the XW-44 would slip from the spring of 1960 to the spring of 1961, and this delay was unacceptable.[44]

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Early production could be achieved by March 1960, a date compatible with the availability of ASROC-equipped ships. Los Alamos, however, seriously questioned the advisability of carrying out this program.

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Additionally, the extra burden placed on Los Alamos and Sandia in production of interim warheads and training materials would be substantial.

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It was requested that this study consider, to the maximum practical extent, the feasibility of developing this warhead to be compatible with ASROC and similar weapon systems in conceptual or feasibility-study stages. The study would be completed June 1, 1959.[48]

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An operational availability date of July 1960 was requested and was later confirmed by Albuquerque Operations Office, which stated that the designator XW-44-X1 would be assigned to the program during design.[51]

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The environment experienced by the neutron generator and the firing set was somewhat more severe than in previous tests, and it was determined that components and warhead case were adequate.[52]

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In production, the weapon would be called the Mk 44 Mod 0 Warhead.[53]

The development-program definition for the XW-44-X1 was outlined in a letter from Sandia to Albuquerque Operations Office July 21, 1959.

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The warhead was electrically inert and would have a chopper-converter system which received power from the adaption kit. The safety-swtich pack was a new design and would require maximum effort in order to meet schedules.

Insofar as practical, and where requirements were known, the warhead would be designed to satisfy the slapdown forces of the LITTLE LULU (lightweight multipurpose bomb) and the high rotational speeds and launching acceleration of the

design did not adversely affect the operational performance of the system.

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Thus, the design met all the requirements of the Department of Defense, and the report was accepted by the Design Review and Acceptance Group.[60]

Field Command wrote to Sandia February 13, 1962, noting that Report SC4619(WD), Final Development Report of the Mk 44 Mod 0 Warhead (ASROC Application), had been reviewed in coordination with representatives of the three Services. This review paralleled that of the Status at Complete Design Release report.[61] The report was accepted by the Design Review and Acceptance Group and was forwarded to the Division of Military Application April 6, 1962.[62]

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Glossary of Mk 44 Terms

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

Acoustic Homing Torpedo -- A torpedo that "homes in" on a source of noise, such as a ship or submarine power plant.

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.

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.

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

Bureau of Ordnance -- That part of the Navy Department having to do with design and procurement of ordnance.

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

Hydrostat -- A pressure switch which closes at a prescribed water depth.

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.

Inverter -- A device for converting direct current into alternating current.

Ionizing -- To render a device conductive by formation of ions or electrically charged atoms.

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.

Laydown Device -- A bomb capable of being dropped on a relatively hard target or surface and surviving in a condition to later detonate.

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

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.

Millisecond -- One thousandth of a second.

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

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

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