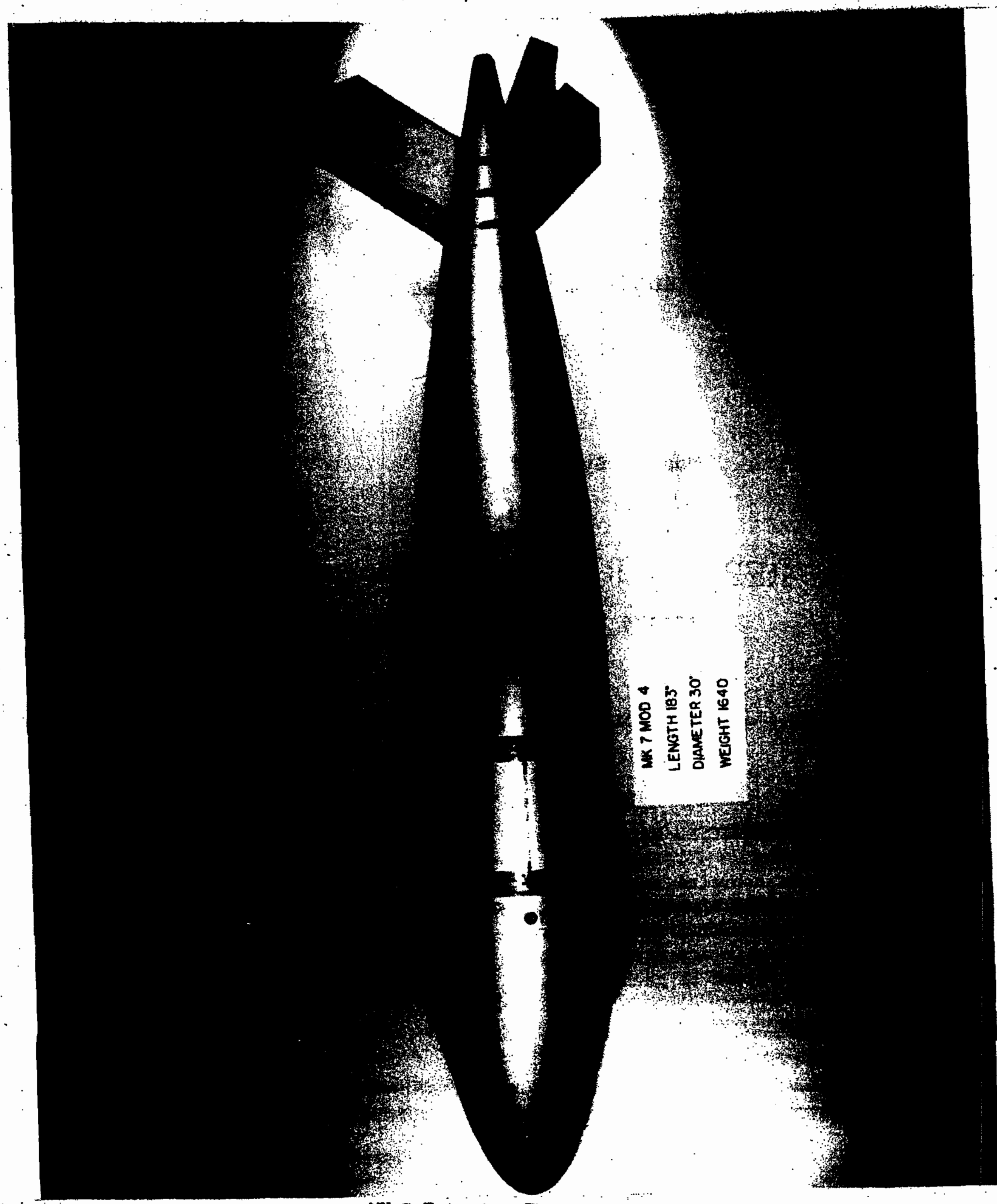

MK 7 Exterior Photo

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

History of the Mk 7 Weapon

The Mk 7 weapon had its beginning in studies made by Group W-4 of the Los Alamos Scientific Laboratory in late 1949 and early 1950. Results of these researches were presented to the May 26, 1950, meeting of the TX-5 Steering Committee by W-4, who noted that the Group was interested in the development of small-diameter bombs for tactical military use.

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A weight of 1900 pounds (compared to 3300 for the Mk 5) was predicted, and a maximum outer bomb diameter of 32 inches.[1]

Detail studies were then started. While these were in progress, the conflict in Korea deepened and resulted in a July 11, 1950, teletype from the Division of Military Application which stated:

(b)(3)

Submission of your plan is requested in part or in whole as it is received.[2]

(b)(3)

A TX-5 Steering Committee meeting was held July 17, 1950, followed by a joint meeting August 2, 1950, with the Sandia Weapons Development Board.[4]

(b)(3)

(b)(3) The streamlined shape of the bomb suggested the practicality of external carriage, but this required a complicated nuclear insertion system and made it difficult to retain the nuclear components in the event the bomb had to be jettisoned. Due to the radical change in shape from previous atomic bombs, the ballistics problem required attention, both from the standpoint of external carriage and the release trajectory of the bomb. Aircraft compatibility would entail a major effort, as a variety of tactical airplanes were being designed and produced.[7] It had been proposed that the external case be developed by an aircraft company, and Sandia had already conferred with several West Coast manufacturers. Of these, Douglas Aircraft Company appeared a logical choice, with both space and cleared personnel available, and a contract was subsequently awarded.[8]

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Inflight insertion problems required study.[9] The purpose of inflight insertion was to prevent nuclear detonation from occurring during take-off or landing, reduce nuclear contamination in the event of accident, and allow salvage of nuclear material. Sandia prepared both forward and rear insertion proposals.

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This second type resulted in a considerable shift of the bomb center of gravity during insertion, and the initial decision was to use the forward insertion design. Later, it was decided to place the relatively heavy cartridge at the forward face of the sphere assembly and a horizontally operating insertion mechanism aft of the sphere. Controls were installed in the cockpit of the carrying aircraft, so that insertion or retraction of the capsule could be remotely accomplished in flight.

It was felt that the fuzing system might require attention, but not until information was received from the Military concerning the method of bomb combat use. The firing system would be similar to that used in the TX-5. It was proposed that the bomb length be about six times the diameter and it was predicted that this shape would attain a speed of Mach 1.2 to 1.5 during the bomb drop.

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Closer estimation of the weight placed this figure at 1680 pounds.

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An August 9, 1950, memorandum from the Military Liaison Committee to the Division of Military Application stated that the Joint Chiefs of Staff had established a requirement for air-burst atomic bombs sufficiently light in weight and small in cross section to be carried by high-speed tactical planes.

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The weapon was to be used by fighter or light bombardment aircraft in attacking tactical targets, with the bomb normally being carried externally.

(b)(3)

The bomb was not to exceed 2000 pounds in weight nor 33 inches in diameter and was to have a configuration which would reduce aerodynamic drag to a minimum. Exterior ballistics should allow reproducible trajectories, and the bomb was to be aerodynamically stable. The fuzing system was to permit freedom to select alternate targets at varying altitudes while en route, be relatively nonsusceptible to enemy countermeasures, and allow both air burst and an approximately zero height of burst. However, this last requirement was not to delay the early availability of the bomb.

The bomb was to have a means of nuclear safing, such as remotely controlled inflight insertion and extraction, require only simple adjustment or monitoring, and be capable of release at subsonic and supersonic speeds. It was to be designed for ease of assembly in forward-base areas or on board ship, and be capable of storage for periods up to 6 months in these locations. The bomb was to be able to withstand stresses created by carriage on fighter-aircraft wing pylons and bomb racks. Normal operation was to be possible under icing conditions and throughout a temperature range from -65°F to +165°F.[12]

(b)(3)

Two types of bomb suspension were considered, a three-hook rack with one lug forward and two lugs aft, and a two-lug design.[13]

A 14-percent scale model was built and tested at the Cooperative Wind Tunnel at the California Institute of Technology. A drag coefficient of less than 0.042 was reported, as compared to 0.54 for the Mk 4. This indicated the general superiority of the long, thin shape, and it was proposed that the bomb length be increased to 192 inches, the maximum possible without the bomb striking the runway on takeoff or landing. To provide more ground clearance, it was decided to use three fins instead of four, and to make the lower fin retractable. Later, the bomb was shortened to about its originally proposed length, or 183 inches, to permit carriage of the weapon on certain Navy aircraft.[14]

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Douglas Aircraft Company reported development of a family of shapes that appeared satisfactory from below sonic speed up to Mach 1.2. Meetings with Air Force representatives underscored the emerging need for tactical nuclear weapons, and orders were issued for early modification of a group of Tactical Air Command F-84E airplanes to carry the TX-7.

Completion of wind-tunnel model tests at speeds up to Mach 1.2 demonstrated that the shapes possessed adequate stability, and full-scale drops were started. The first such drop at the Salton Sea Test Base resulted in the bomb's going into gyrations of 45 degrees and shedding its tail assembly, while another drop produced severe pitching action. Immediate and intensive investigation was undertaken, and it was found that fin misalignment caused circular wobbling of the tail, and that this instability was augmented when the misalignment was enough to cause

coupling if roll & pitch frequencies

the bomb body to rotate at the same rate as its natural pitching frequency. The problem was solved by holding the fin alignment to ±1/2 degree, and by stiffening the fixed fins by base angles and the retractable fin by guide rollers.[16] Spin tabs were added to generate a roll rate which would always be greater than the natural pitch frequency.

Terminal velocity during full-scale drops was found to be about Mach 1.0, in an unstable or buffeting region, and it was felt necessary to reduce this speed. A drogue-chute design was proposed that incorporated six small fins to which were attached risers of a 36-inch-diameter parachute. Experimentation, however, showed that operation was strongly affected by relatively minor changes in wind, air density, airspeed, and release altitude.

Dive brakes were tested and proved satisfactory. The first such design had an area of 87 square inches, causing too much drag, and the area was reduced to 70 square inches. The length of the fin, initially 26 inches, was increased to 30-1/2 inches for improved stability. This was found to provide insufficient clearance with carrying aircraft, and the length was eventually established at 29 inches.

The foregoing studies were interwoven with the problem of providing an accurate barometric pressure-sensing system for bomb altitude determination. Nose probes were tested, but could not be made long enough to reach unaffected pressure regions ahead of the falling bomb. Trailing probes were subjected to excessive whipping in flight and to freezing of the mechanism. Eventually, the problem was alleviated by the reduced speed of fall resulting from the use of dive brakes. Studies conducted at the Salton Sea Test Base resulted in locating the pressure ports on the bomb case 125 inches aft of the nose.

Flight tests were conducted on the F-84 aircraft at Muroc Dry Lake, California. The TX-7 store was installed on the right wing pylon and a

(b)(3)

This order was amended September 4, 1951, to require production-quality fuzes. Sandia noted that this second program would continue to divert engineering effort, already severely affected by the 7N work, and delay regular Mk 7 production.[28] Sandia was subsequently relieved of work in connection with this second 7N program,[29] but later was requested to inspect and certify some of the 7N components used in the program.[30]

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Sandia pointed out that regular Mk 7 Bombs would be available soon after this date, and this third program was canceled.[31]

The Mk 7 Mod 1 Bomb resulted from a request from the Armed Forces Special Weapons Project that external power be supplied to battery and radar heaters to create proper operating temperatures in cold weather.[32] Stockpile production of this modification started November 1952.

It was felt that the Mk 7 Nose, which formed a radome for the radars, might ice up during external carriage of the bomb. Several methods were studied, including use of a pulsating rubber boot or deicing fluid. Tests showed that a neoprene-coated radome would do the job and at the same time reduce rain erosion damage, and this change was adopted. The carriage of the Mk 7 on many types of aircraft resulted in a requirement for different fin positions, and the design was accordingly amended so

Fuze B was subsequently designed with a timer that could be used to arm the radars (providing safe-separation time) or as a primary fuze by itself. Radar air burst was retained and a contact fuze added which could be used as cleanup or as a primary fuze. An externally accessible remote-setting device permitted preflight selection of safe-separation times coupled with radar ranges.

Tests had shown that boat-tail fins produced increased stability with little or no increase in drag, and this fin design was adopted.[37] Other methods of retarding the speed of bomb drop had been studied, such as parachutes or rotochutes (freely rotating vanes), but these latter designs did not prove entirely satisfactory from the standpoint of bombing accuracy and effectiveness of retardation.

The Mk 7 Mod 3 Bomb entered production June 1953 with the new fuze design and improved ballistic characteristics. The fins were made nonretractable, but could be removed for storage. A visual port was provided in the body of the bomb so that the position of the safety switch (which isolated the battery from the bomb circuits) could be checked. In previous bomb modifications, this check had been made from the cockpit of the carrying aircraft, using a special tester. Weight was reduced slightly, to 1620 pounds.

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This change was incorporated in the Mk 7 Mod 4 Bomb, which also provided a universal warhead that could be used for both bombs and missiles, and which possessed a quick-disconnect radome. The Mod 4 was design-released in March and stockpiled December 1954

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

It was found that ejector forces exerted by the Aero 7A Bomb Rack created shock loads which affected timers and radars. Shock-absorption pads were installed to protect the radars, and new shock mounts were designed for the timers. These changes were released October 1956 and the resulting units were stockpiled June 1957 as the Mk 7 Mod 5 Bomb.

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

Sandia suggested, February 15, 1960, that additional safing be provided for Mk 7 Bombs being maintained in alert status. Charging of the X-unit would be prevented until the weapon had experienced a normal trajectory. Sandia was requested to provide such design January 25, 1961, and it was suggested that components being produced for the Mk 43 Bomb be used for this purpose.

Wind-tunnel tests of the design gave satisfactory results, but flyaround tests resulted in erratic operation on one type of aircraft. The pressure-switch setting was slightly altered, and the use of a higher spoiler in front of the pressure-switch port produced good results. The change entered production in July 1961 as the Mk 7 Mod 7 Bomb.

Permissive Arming Link devices were released for use in the Mods 5 and 7 Bombs, with production being initiated in February 1963. The Mk 7 Mod 5 became the Mk 7 Mod 8, and the Mk 7 Mod 7 became the Mk 7 Mod 9.

Glossary of Mk 7 Bomb Terms

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

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

Barometric Fuzing -- Use of a pressure switch actuated by increasing air pressure as the weapon falls in its trajectory to institute weapon fuzing.

Buffeting -- Excessive vibration of a falling bomb caused by weapon instability. Also vibration of a bomb carried externally on aircraft.

Buster-Jangle -- Tests of atomic devices at the Nevada Test Site. Series of seven shots, starting October 22 and ending November 29, 1951.

Capsule -- The nuclear ~~assembly~~ element of an atomic weapon which, when subjected to compression in the implosion process, becomes supercritical and produces a nuclear reaction.

Capsule Retention -- A method of retaining the nuclear capsule while allowing jettisoning of the weapon; of prime importance in the early days of nuclear weaponry, due to scarcity of nuclear material.

Cartridge -- An assembly, generally containing fuzing and firing system elements, which can be inserted and removed from an atomic weapon in the manner of a cartridge being inserted or removed from the chamber of a rifle.

Compatibility Tests -- Tests to prove whether or not the weapon can be easily installed, tested and released from its specified carriers.

Contact Fuze -- A fuze that detonates the weapon by contact with the ground or the target.

Core -- See Capsule.

Detonators -- Explosive devices which when initiated by the x-unit ignite the lens charge of the high explosive sphere. ~~Devices containing bridge wires which, when subjected to an electrical current, burn rapidly and act as a match to apply a flame to various points on the outer surface of the high explosive~~ sphere.

Dive Brakes -- ~~Projecting~~ plates, generally at the tail of a weapon, which, when released, ~~to~~ slow its fall through the air. Purpose is to reduce the rate of fall (velocity) to well below the speed of Mach 1.0, which was a highly unstable speed region for the early bombs.

12. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 8/17/50, subject, Lightweight Air Burst Bomb. SC Archives, microfilm reel MF-SF-SC-1447.

13. SRD Minutes, RS 3466/67992, Sandia Weapons Development Board to Distribution, dtd 8/16/50, subject, Minutes of the 43rd Meeting. SC Archives, Transfer No. 48217.

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15.

16. SRD Ltr, RS 1000/377, Sandia Corporation to Sandia Weapons Development Board, dtd 5/19/51, subject, Dropping Limitations on the Aerodynamic Performance of the TX-7 Bomb. SC Archives, microfilm reel MF-SF-SC-1440.

17. SRD Minutes, RS 3466/67993, Sandia Weapons Development Board to Distribution, dtd 11/22/50, subject, Minutes of the 46th Meeting. SC Archives, Transfer No. 48217.

18. SRD Ltr, RS 1240/30, E. H. Draper, SC, to R. W. Henderson, SC, dtd 12/2/50, subject, Proposed Fuzing and Firing Systems for the TX-5/TX-7. SC Archives, microfilm reel MF-SF-SC-28.

19. SRD Ltr, Santa Fe Operations Office to Division of Military Application, dtd 12/18/50, subject, Scheduling of TX-7. SC Archives, microfilm reel MF-SF-SC-28.

20. SRD Ltr, Division of Military Application to Santa Fe Operations Office, dtd 1/5/51, subject, Implosion Type Weapon Program. Forms Appendix 1 to the 22nd Meeting of the TX-N Steering Committee. SC Archives, microfilm reel MF-SF-SC-68.

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22. SRD Ltr, TX-N Steering Committee to Los Alamos Scientific Laboratory and Sandia Corporation, dtd 1/24/51, subject, Re-Examination of TX-7 Production Schedule. SC Archives, microfilm reel MF-SF-SC-107.

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