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Mks 21, 22, 26 and 36

SC-M-67-662

Weapon Systems

SC-M-67-662
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Information Research Division, 3434

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Sandia Systematic Declassification Review
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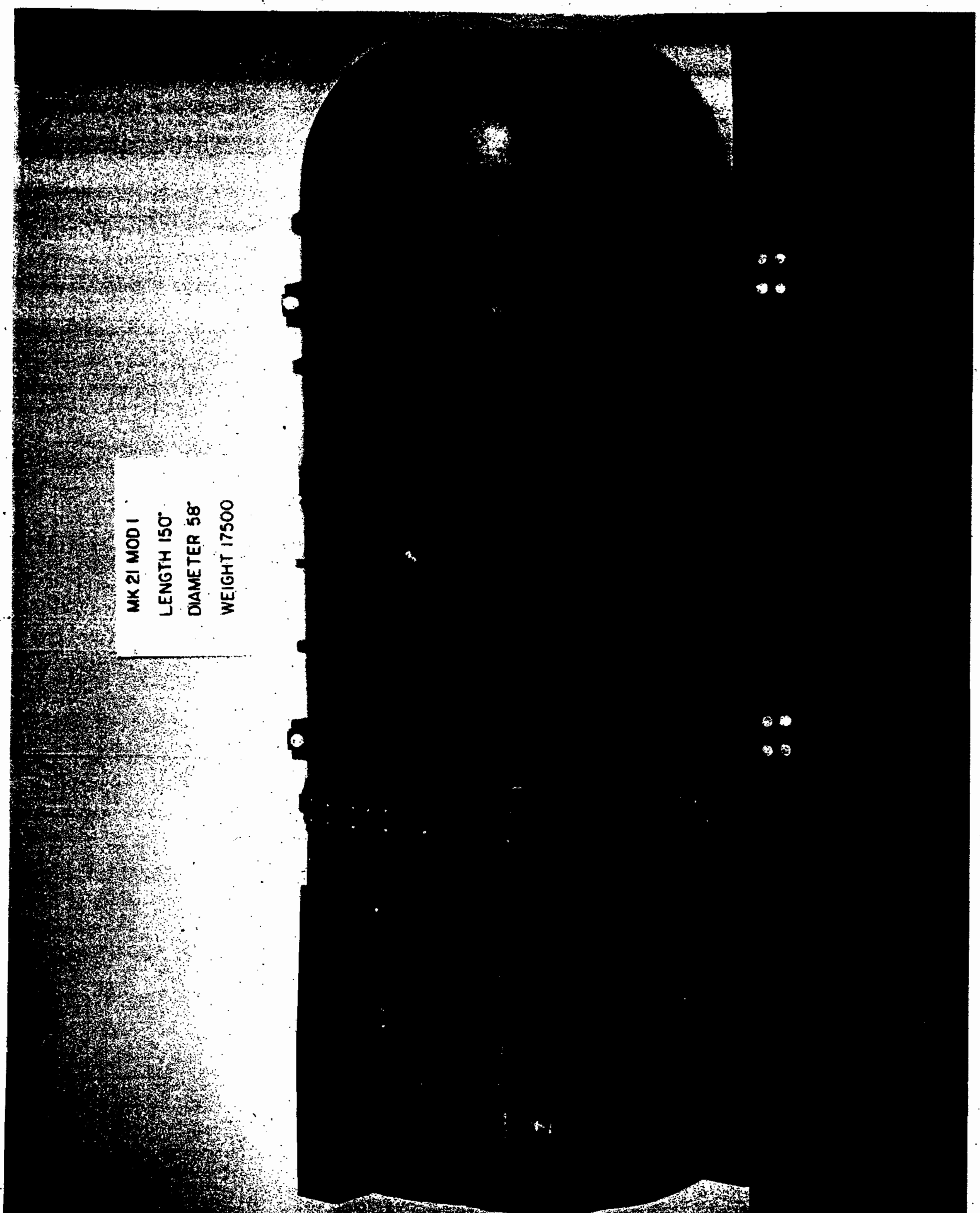

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Mk 21 Exterior View

~~SECRET~~

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

Timetable of Mk 21/26 Events

1/15/54	TX-Theta Committee meets. (b)(1), (b)(3) TX-21 nomenclature assigned.
	(b)(1), (b)(3)
3/26/54	Weight reduction of TX-21 proposed.
4/15/54	Military characteristics released. (b)(1), (b)(3)
6/4/54	TX-Theta Committee proposes expedited schedule.
6/7/54	Santa Fe Operations Office issues go-ahead on TX-21 design.
7/1/54	Military Liaison Committee approves expedited schedule for TX-21.
7/23/54	Results of wind-tunnel tests reported.
9/1/54	Contact fuze proposed. (b)(1), (b)(3)
9/29/54	Proposed ordnance characteristics of TX-21 reviewed.
12/15/54	Air Force Special Weapons Center requests weight reduction.
1/6/55	(b)(1), (b)(3)
5/9/55	Aerodynamics report on TX-21 ballistic shape issued.
6/1/55	Design of Mk 21/26 reviewed by Special Weapons Development Board.
7/15/55	(b)(1), (b)(3) Parachute provided for retarded deliveries.
12/55	Mk 21 Mod 0 Bombs stockpiled.
6/27/56	Mk 21 Mod 1 with contact fuze design-released. TX-26 design subsequently deleted from program.
6/57	Stockpiled Mk 21 Bombs converted to Mk 36Y1 Mod 1.
11/57	Conversion program completed.

Sandia meanwhile had started scale studies of the TX-21 shape and, by early March 1954, had determined that it would require at least one spoiler band on the nose and another on the afterbody to produce adequate free-fall stability. It was thought that a flat area on the nose might eliminate the need for a nose band, and appropriate tests were scheduled. It was estimated that external dimensions could be definitely fixed by mid-1954; fuzing, firing and ballistic drop tests held in early 1955; design release effected in mid-1955; and early Mark production by January 1956.[5]

The weight of the bomb was discussed in the March 26, 1954 meeting of the TX-Theta Committee.

(b)(3)

This would allow the weapon to be delivered by the B-58 or Hustler bomber, then being designed. Los Alamos stated that any weight-reduction study would delay the overall program, and noted that bombers could refuel in the air after takeoff. There would thus be little difference in bomber range due to weapon weight.

After discussion, the Committee decided that an attempt would be made to trim the weight to 15,000 pounds. Sandia would test wind-tunnel models representing diameters between 48 and 54.5 inches, and would study the component space problems created by such diameters. It was requested that this investigation delay the program not more than one month.[6]

The military characteristics for a two-stage weapon in the 23,000-pound maximum weight class were released April 15, 1954.

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

It was stated that more than one ballistic shape might be required for these various applications, but that the number of such shapes should be held to a minimum.

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

The two weapons would have a near-contact burst as the primary option, achieved by a network of proximity fuzes, and these units would provide backup for the secondary air-burst option. The fuzing and firing systems in both options would be armed by a barometric switch. A true contact fuze for thermonuclear applications was being developed, but this design would require extensive testing.

Work was progressing on improved types of power sources, which would meet military requirements of minimum preparation time and long storage life; but nickel-cadmium batteries would be used in the early stockpiled weapons. A retarded trajectory was desired, due to the large yield of the weapon, and would be provided by a 24-foot-diameter parachute, reefed to provide a down-time of 75 seconds, as compared to an unreefed time-of-fall of 108 seconds. Use of this parachute would be controlled by equipment installed in the aircraft.

It was noted that the diameter of the bomb over the spoiler bands was 58.47 inches, the overall length was 148.37 inches, and the weight was 17,600 pounds.[20] The outer case was an aluminum-alloy shell which formed the main structural member of the bomb.

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

The afterbody was a cylindrical extension of the warhead case, having the same diameter and being attached to it by an external bolting flange which also served as an aerodynamic spoiler band. Access doors were provided for battery installation, safety switch, and interconnecting box. All fuzing and firing components, with the exception of X-unit and pullout switch, were mounted on a plate readily accessible through the tail of the bomb after the parachute container was removed.

The bomb had four fins, with a 6- to 14-degree double-wedge shape, a 39-1/2-inch chord length, and an 80.9-inch span. The forward half of each fin was of sheet metal and the remainder of polyester-glass laminate. A proximity-fuze antenna was installed in the plastic portion of each fin.

Deployment of the 24-foot-diameter parachute could be selected at any time prior to weapon release. Fuzing and firing system components were the same as the TX-15 Bomb, with the exception of X-unit and cabling. A remote-setting baroswitch provided a detonation signal for air bursts, and a network of four proximity fuzes provided the signal for near-contact bursts, as well as cleanup for air-burst failures. Safe separation was provided by a baroswitch that was set prior to takeoff of the strike bomber.[21]

The Division of Military Application notified the Military Liaison Committee October 25, 1954, that the TX-21 would be design-released in March 1955, with stockpile entry in August 1955. To meet this schedule, it had been necessary to assign the highest priority to the development.

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

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

It was hoped that a contact fuze could be introduced into the Mk 21/26 stockpile by mid-1956.[22]

Some concern was felt about the firing-switch contact buttons. These buttons were made of molybdenum and, during humidity testing, developed an insulating layer of oxide. The contacts were plated with palladium, which resisted oxide formation, but the necessary plating thickness and uniformity could not be secured, and firing tests showed that the film of molybdenum oxide would not prevent proper switch operation. Consequently, the palladium plating requirements were deleted in late October 1954.[23]

The Air Force Special Weapons Center wrote to Sandia December 15, 1954, noting that the weapon weight would be acceptable, but that efforts should be made to reduce this to the desired 15,000 pounds. A question was raised whether proximity fuzes would satisfy the military requirements for near-surface bursts, and it was recommended that a true contact fuze be developed. In this connection, it was suggested that an extendible probe-type impact device be studied.

(b)(3)

Sandia had made a study of contact fuzing and reported to the January 12, 1955 meeting of the Special Weapons Development Board. Sled and drop tests had indicated that the crystals developed for the Mk 17 Bomb would also be satisfactory for the TX-21. Also being considered was a double-shell contact device, having a false nose which contained two conductors separated by a plastic insulating layer.[25]

Report SC3608(TR), Design and Description Report at Design Release of the Mk 21/26 Mod 0 Bomb, was reviewed in the June 1, 1955 meeting of the Special Weapons Development Board. The bomb was 58.48 inches in diameter over the spoiler bands, and 149.6 inches long. (b)(1), (b)(3) Either free-fall or parachute-retarded deliveries were possible. A 16-foot parachute furnished a 75-second time-of-fall.

The drop-test program was still under way, with nine ballistic and three fuzing and firing drops completed. Ballistic performance was satisfactory, but some parachute oscillations had been noted, and this problem was being solved as the test program progressed.

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

This required an increased aircraft escape time of 100 seconds, and Wright Air Development Center was requested to develop a 24-foot-diameter parachute. It was felt that a two-stage deployment system would have to be used to mitigate the opening shock of the larger canopy.[33]

Report SC3694(TR), Engineering Evaluation of the Mk 21 Mod 0 Weapon, was presented to the December 14, 1955 meeting of the Special Weapons Development Board. Environmental resistance had been determined by component testing to performance standards, as well as overall weapon testing in arctic, tropic and desert environments. Models had been subjected to thermal tests; tests simulating loads involved in flights of B-47 and P6M aircraft; railroad humping tests; and rain, sand, dust, salt spray and sunshine tests. A total of 42 units had been drop-tested, including ballistic free-fall units, ballistic parachute units with proximity fuzes, ballistic parachute units with contact fuzes, and fuzing and firing units.

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

after the safe-separation interval (determined by the setting of the arm baroswitch), the X-unit started to charge and the proximity fuzes were armed. A 3-second delay was provided by a timing device to prevent firing before the X-unit attained its normal charge.

As the bomb reached the desired burst altitude, the firing baroswitch closed, actuating the firing switch in the X-unit, discharging the capacitor bank into the detonator bridge wires, and initiating the explosive and nuclear sequence. If the system malfunctioned, the proximity fuze detonated the bomb. The parachute was deployed after release from the aircraft, if the retarded option had been selected. If a near-surface burst was selected, the barometric fuze was set at -3000 feet and the proximity fuze detonated the weapon.

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

The Mk 21 Mod 0 first appeared in stockpile December 1955, and final deliveries were made in July 1956.

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

The TX-26 was never authorized for production.[38]

Meanwhile, work had been proceeding on the design of a true contact fuze.[39] Report SC3606(TR), Proposed Electrical Characteristics for the Fuzing and Warhead Systems for the TX-15-X1 and the TX-21/26-X1 Weapons, was presented to the April 27, 1955 meeting of the Special Weapons Development Board.

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

(b)(1), (b)(3) Drops had not as yet been made with parachute retardation, since the parachute design had not stabilized to the point where the test would be meaningful.

(b)(1), (b)(3) Due to the marginality of the data obtained, it was felt necessary to refine the test devices for an exact simulation of the weapon.[41]

The program was further discussed in the February 29, 1956 meeting of the Special Weapons Development Board.

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

Sandia presented Report SC3826(TR), Design and Description at Design Release of the Mk 21/26 Mod 1 Bomb, to the June 27, 1956 meeting of the Special Weapons development Board. It was noted that the nose of this design was the same as the Mod 0 except for the impact crystal installation, and that the parachute and afterbody were identical. New contact crystals and a baroswitch were provided. The new crystals gave more consistent performance and were installed in a less critical area. The baroswitch contained four elements, ganged to make up the firing baroswitch, and these could be manually set to the desired burst altitude. Other elements in the baroswitch acted as the arming device, and these were automatically set 4000 feet higher than the firing altitude.[43] The Mk 21 Mod 1 was never produced.

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

TX-22 Cross-Section

Timetable of TX-22 Events

9/18/53 (b)(1), (b)(3)

10/29/53 Santa Fe Operations Office authorizes Sandia to assist in the above design.

2/2/54

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

4/30/54

TX-22

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

Sandia was requested to develop preliminary ballistic configurations, as well as requisite parachute ~~and~~ and fuzing and firing components.[48]

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

The Santa Fe Operations Office requested Sandia, October 29, 1953, to assist the Radiation Laboratory in work on the aerodynamic case. Sandia would also design the fuzing and firing system, and conduct flight tests for both ballistics and systems prove-out.[49]

A review of a prospective drop-test program was held November 19, 1953. The devices would be released from a B-36 bomber flying at an altitude of 40,000 feet.

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

The question of parachute retardation was raised, and was subsequently referred to the Air Force Special Weapons Center. (b)(1), (b)(3)

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

However, these calculations assumed that no clouds were present in the burst area to reflect thermal radiation onto the bomber and crew.

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

By mid-January 1954, work on the ballistic design had progressed to the point where it was obvious that a modified TX-13 case could not be used, and the Division of Military Application authorized development of a special design.[52, 53]

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

Plans were now made for test-firing.

(b)(3)

Sandia wrote to the Air Force Special Weapons Center February 15, 1954, requesting the support of the Center and the 4925th Special Weapons Group in the TX-22 ballistics test program, which would start in August 1954. Refinement of weapon parameters noted that the cylindrical case would have a diameter of 51 inches, fin box dimension of 56 inches, length (including parachute) of 145 inches, and maximum weight of 18,000 pounds. Several units would be dropped free-fall, but the majority would be parachute-retarded. The fuzing and firing signals would be provided by baroswitches, with a proximity fuze as backup.

The carrier would be the B-47 aircraft, using a reinforced TX-15 sling and rack. Both B-36 and B-52 aircraft would later be used. Plans were made for 30 tests, with early drops for ballistic and parachute study, and fuzing and firing tests starting in late 1954.[55]

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

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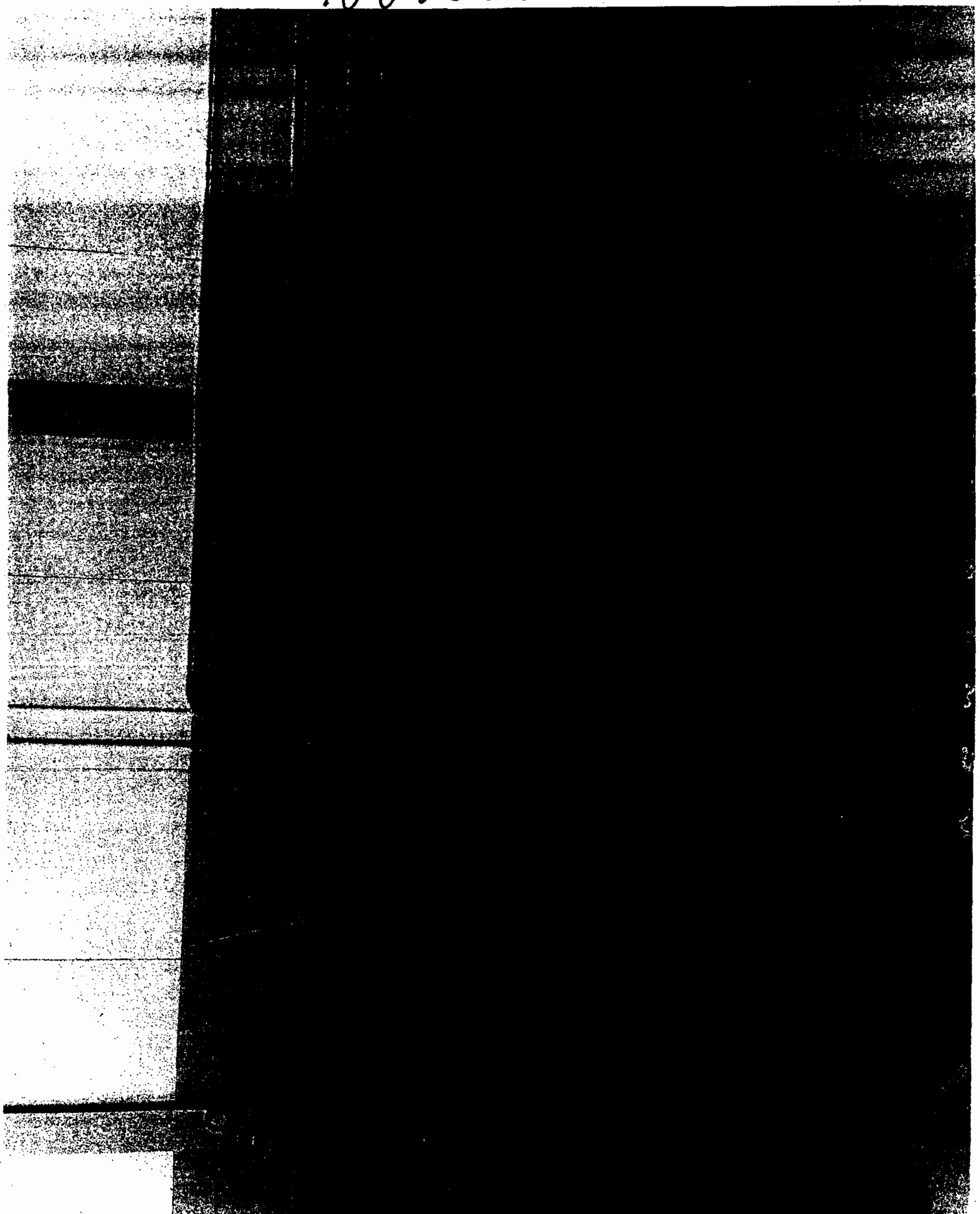

Mk 36Y1 Mod 2 Exterior View

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

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Mk 36 Y2 Mod 1 Cutaway

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

Mk 36Y1 Mod 2 Cutaway

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Timetable of Mk 36 Events

11/22/55	(b)(1), (b)(3)
1/3/56	TX-36-X1 design released.
4/56	Mk 36 Mod 0 enters stockpile.
5/56	Mk 21/36 Mod 1 Bomb design released.
7/13/56	TX-36-X2 program authorized for development.
9/24/56	(b)(1), (b)(3)
10/24/56	Proposed ordnance characteristics of TX-36-X2 Bomb reviewed by Special Weapons Development Board.
10/56	Mk 21/36 Mod 1 Bomb enters stockpile.
11/15/56	(b)(1), (b)(3)
4/12/57	TX-36-X2 program suspended.
4/22/57	(b)(1), (b)(3)
7/11/57	Resumption of work on TX-36-X2 authorized.
7/57	(b)(1), (b)(3)
4/23/58	TX-36-X2 design released.
1/9/59	Albuquerque Operations Office cancels Mk 36 program.

Mk 36

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

The TX-21-X1 program was subsequently canceled, but the TX-36-X1 was design-released January 3, 1956, and became, in production, the Mk 36 Mod 0.[63, 64] The weapon entered stockpile in April 1956 with a proximity fuze and internal initiator.[38]

Meanwhile, other improvements in the Mk 21 design had been suggested, principally in the fuzing and firing system. This work had begun in early 1955 in connection with the Mk 15 and Mk 39 programs, and the proposed design would provide options of either air burst or true contact firing. The weapon would be armed and fired by barometric switches, and the contact crystals would act either as primary fuze or as backup to the air-burst system. Thermal batteries would replace the nickel-cadmium units and would supply both low-voltage power for the fuzing system and high-voltage power for charging the X-unit.

Report SC3826(TR), Design and Description Report at Design Release of the Mk 21/36 Mod 1 Bomb, was released May 1956. This noted that the yield, weight, and physical configuration of the Mod 1 was essentially identical with the Mod 0, with the exception of the fuzing and firing system. The Mod 1 would be employed in a high-altitude level release, using either a free-fall or retarded trajectory.

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

Baroswitch settings were made on the ground prior to aircraft takeoff by a single dial setting. This setting was computed by comparing the intended height of burst with the target elevation above sea level and including a 300-foot offset correction. Prior to bomb release from the strike aircraft, the selector switch was placed at either air- or ground-burst position, the nuclear capsule inserted, the safing switch placed in the armed position, and the option switch placed at either the open or closed position, depending on whether ground or air burst had been selected.

The release of the bomb from the aircraft closed a pullout switch in the high-voltage-battery firing circuits, and operated magneto generators which furnished electrical pulses to ignite the low-voltage batteries. Power from these batteries was applied to the open contacts of the arm baroswitch. When the arm baroswitch closed, at the appropriate point in the weapon trajectory, low-voltage power was applied through the closed pullout switch and safing switch to the activating circuits of the high-voltage batteries, placing these latter devices in operating condition. The 2500 volts provided by these batteries charged the X-unit and supplied plate voltage to the trigger circuit.

If air-burst option had been selected, closure of the firing baroswitch applied a signal from the low-voltage batteries to the trigger circuit, thus detonating the bomb. If ground-burst option had been selected, the option switch held the firing circuit open, allowing the weapon to fall to the ground, where the contact fuze supplied the detonation signal.[65]

The Mk 21 Mod 1 Bomb was never produced, but the Mk 36 Mod 1 design entered stockpile in October 1956.

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

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

/The TX-36-X2 would be design-released in June 1957 with early production scheduled for July 1958 and operational availability in the fall of 1958.[69]

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

On July 11, 1957, the Albuquerque Operations Office sent a teletype to Sandia, authorizing resumption of development and production activities on the TX-36-X2 program and requesting revised schedule dates, hopefully including an early production Mod-kit date of September 1958. Sandia replied, August 9, 1957, that a product definition was being prepared, and that it was hoped that the design could be released by October 1957.[81]

Report SC4113(TR), Design and Description Report at Design Release of the Mk 36Y2 Mod 1 Bomb. was issued July 1957.

(b)(3)

The TX-36-X2 became the Mk 36 Mod 2 and retrofit to this modification was planned for about half the Mk 36 Mod 1 Bombs in the stockpile. The Mod 2 incorporated a trajectory baroswitch-controlled, high-voltage safing switch to prevent inadvertent charging of the X-unit. The system also included a manually set baroswitch, desirable from reliability and operational standpoints.[83]

Sandia suggested to the Albuquerque Operations Office January 22, 1958, that Mk 36 Mod 1 Bombs which were not to be retrofitted to Mod 2 status be fitted with the safing switch.

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

It was also felt that consideration should be given to the replacement of the remotely set baroswitch with a manually controlled design, since the first switch required aircraft equipment for baroswitch setting.

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

It was recommended that the above changes to the Mod 1 and Mod 2 Bombs be authorized for production and that the designs be identified as the TX-36-Y1-X3 and TX-36-Y2-X3 programs. Since present planning envisaged retirement of the Mk 36 Mod 1 stockpile by mid-1960, this proposed modification would match the retirement program.[84]

(b)(3)

Report SC4222(TR), Final Evaluation of the Mk 36Y2 Mod 1 Bomb, was presented to the December 17, 1958, meeting of the Special Weapons Development Board.

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

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

Dynamic drop tests to ultimate loads, railroad humping tests, extreme temperature tests, and a simulated 6-month tropic storage test had been conducted, and these demonstrated the ability of the weapon to withstand these environments.[89]

At the above Board meeting, Report SC4188(TR), Final Evaluation of the Mk 36Y1 Mod 2 Bomb, was also presented.

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

About half the existing stockpile of Mk 36Y1 Mod 1 Bombs would be converted to this new design, which had been called in development the TX-36-X2.

(b)(3)

The program included environmental, drop and neutron-generator compatibility tests, and demonstrated that the weapon was more than adequate to withstand the stockpile-to-target sequence. Both land and water targets had been included in the drop-test program, with release altitudes between 20,000 and 50,000 feet.[89]

On January 9, 1959, Albuquerque Operations Office canceled the Mk 36 program. The Mk 36 Mod 1 Bombs scheduled for updating would remain in current status until retirement in mid-1959.[90] This retirement program was later deferred to mid-1961.

Drogue Parachute -- A parachute that slows the rate of fall of a bomb.

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

Field Command -- The local office of the Armed Forces Special Weapons Project, 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 ~~signals the start of high-voltage charging of the firing system.~~ 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 the fission activity.

High-Explosive Sphere -- The ball of high explosive that surrounds the nuclear pit and capsule and is designed to ~~primary assembly and~~ produce the implosion effect when detonated.

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

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.

Knot -- A naval unit of speed, equivalent to 1 nautical mile or 6076 feet per hour.

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

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

Mach -- A measure of speed. Mach 1.0 is the speed of sound, or 738 miles per hour at sea level.

Megaton -- A measure of yield of a large weapon. One megaton is the equivalent of 1,000,000 tons of high explosive.

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.

Mod Kit -- A kit of parts which can be applied to a weapon to change the Mod number of the weapon.

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 Castle -- See Castle.

Operation Redwing -- See Redwing.

Oralloy -- A code term for enriched uranium. The two initial letters stand for Oak Ridge *(where Orally was first made in quantity), added to* alloy *from* Tube Alloys, Ltd. (the name of the British wartime atomic-energy project).

(b)(3)

(b)(3)

<u>Thermal Battery</u> -- 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.

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

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

<u>Two-Stage</u> -- Combination of fission and fusion action in a weapon.

<u>TX Committee</u> -- A joint committee of Los Alamos and Sandia members, established to guide the development of implosion-type weapons.

<u>TX-Theta Committee</u> -- A committee established to guide the development of thermonuclear weapons.

<u>University of California Radiation Laboratory</u> -- A laboratory established under the guidance of the University of California to work on thermonuclear designs, and located at Livermore, California.

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

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(b)(3)

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(b)(3)

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(b)(3)

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(b)(3)

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26.

(b)(3)

27.

(b)(3)

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