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HISTORY OF THE MK 39 WEAPON (U)

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Weapon Systems

Redacted Version

Information Research Division, 3434

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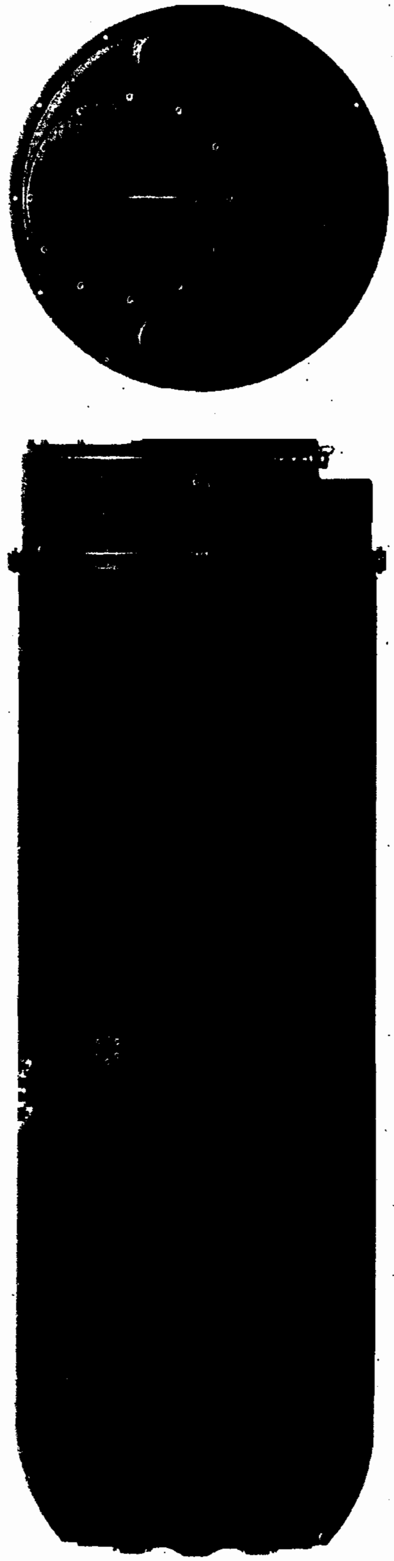
MK 39 MOD 1 BOMB

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

Mk 39 Mod 1 Bomb - Cross Section

RS 3434/20



CARRIERS
1 B-58 POD
2 SM-62 SNARK
3 REDSTONE

MK 39 MOD 1 WARHEAD

LENGTH 104.5 IN.
DIAM. 34.5 IN.
WEIGHT 6230 LBS.

Mk 39 Mod 1 Warhead

Timetable of Mk 39 Events

Mk 39 Mod 0 Bomb

11/22/55 Military Liaison Committee requests that new weapon designation be assigned to modification of the Mk 15 and TX-29.

4/25/56 Sandia presents status at design release of the Mk 39 Mod 0 to meeting of Special Weapons Development Board.

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

3/20/57 Sandia presents final engineering evaluation report of the Mk 39 Mod 0 Bomb to meeting of Special Weapons Development Board.

Mk 39 Mod 1 Weapon

1/16/56 TX/XW-15-X3 modification redesignated TX/XW-39-X1 program, with new primary and reduced weapon weight.

2/29/56 Sandia presents proposed ordnance characteristics of new design to meeting of Special Weapons Development Board.

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

3/57 Sandia releases status at design release of the TX/XW-39-X1.

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

8/20/58 Sandia presents final evaluation of Mk 39 Mod 1 Bomb/Warhead to meeting of Special Weapons Development Board.

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

Mk 39 Mod 2 Bomb

9/17/56 Field Command requests Sandia to study feasibility of a laydown Mk 39 Bomb.

11/18/57 Air Force notifies Division of Military Application that Strategic Air Command has urgent requirement for a low-altitude laydown Mk 39. Design named the Big Tail.

3/5/58 Military Liaison Committee requests United States Atomic Energy Commission to develop an advanced Big Tail design.

10/21/59 Sandia presents final evaluation of the Mk 39Y1 Mod 2 Bomb to meeting of Special Weapons Development Board.

Mk 39 Missile Applications

NAVAHO:

3/8/56 Air Force notifies Division of Military Application that NAVAHO program has been accelerated.

4/27/56 Sandia states that accelerated NAVAHO program can be supported with Mk 39 Warhead.

7/31/57 Military Liaison Committee cancels Mk 39/NAVAHO application.

REDSTONE:

8/1/56 Joint Committee on REDSTONE missile requests application of Mk 39 Mod 1 Warhead.

9/19/56 Assistant Secretary of Defense requests Atomic Energy Commission to apply low-yield Mk 39 Warhead to REDSTONE missile.

10/30/56 Mk 39/REDSTONE flight tests started.

7/8/59 Mk 39 Mod 1 REDSTONE warhead application released.

10/21/59 Sandia presents final evaluation report of the Mk 39Y1 and Y2 Mod 1 REDSTONE to meeting of Special Weapons Development Board.

SNARK:

6/20/57 Mk 39/SNARK flight tests started.

5/31/60 Sandia presents final evaluation report of the Mk 39 Y1 Mod 1 SNARK to meeting of Special Weapons Development Board.

B-58 POD:

9/19/56 Albuquerque Operations Office requests Sandia to consider application of Mk 39 Warhead to B-58 Pod.

5/8/62 Sandia forwards final evaluation report of the Mk 39 Mod 1 application to the B-58 MB-1 Pod to the Division of Military Application.

5/11/62 Sandia forwards final evaluation report of the Mk 39 Mod 1 application to the B-58 BLU-2/B Pod to the Division of Military Application.

AIR position. This moved a solenoid-operated safing switch in the bomb to the armed position, inserted the capsule, and placed another solenoid-operated switch in the weapon to the open or closed position, depending on whether ground- or air-burst option had been selected.

When the bomb was released from the aircraft, pulse generators supplied electrical pulses and activated the low-voltage battery in the bomb. The release action also closed switches in the high-voltage activation circuits. When the arming baro contacts closed, after the bomb had fallen to the predetermined altitude, power was applied through the closed contacts of the pullout switch and safing switch to the pulse-transformer primary of the high-voltage battery, placing the battery in an activated condition. The battery voltage of 2500 volts charged the X-unit and supplied plate voltage to the trigger circuit. If air-burst option had been selected, closure of the firing-baro contacts applied a signal from the low-voltage battery 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. The contact fuzing system then supplied a separate voltage pulse to the trigger circuit and detonated the bomb.[9]

Mk 39 Mod 1 Weapon

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

and determine the ballistic performance of the design. There would be some 14 such tests, both parachute retarded and free fall, and the program would start in June 1956 and be completed in early 1957. The aircraft involved would be the B-36, B-47 and B-52, with a few flights being made on the B-66 and A3D.[15]

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

Meanwhile, design and production problems were developing on external initiators, differential-pressure switches, and boosting-gas reservoirs, and Sandia notified Albuquerque Operations Office, October 5, 1956, that a 3-month production delay was inevitable. The design-release date was scheduled for April 1957 and early production in October 1957.[16]

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

Report SC3897(TR), Status at Design Release of the TX-39-X1 (and TX-15-X4) Bombs and the XW-39-X1 Warhead. was dated March 1957.

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

This was gas boosted, eliminated the inflight insertion mechanism, and was internally initiated. A new fuzing and firing system had been designed, which featured simplification of individual fuzing and firing components, reduction of field testing and maintenance work, and a preflight test that minimized weapon preparation time.

(b)(3) The TX-39-X1 could be produced by reworking the Mk 39 Mod 0. The bomb could be converted to a warhead by removing the bomb nose cap and rear assembly, and installing warhead protective covers. The parachute for the bomb had been released as a Mark-Mod entity and would be stored separately. Bombs would be produced, and bomb-to-warhead conversion components would be provided.[18] The bomb was design-released in May 1957, and was called the Mk 39 Mod 1.

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

Meanwhile, a request had been made for a reduced-yield Mk 39 Warhead for the REDSTONE missile.[19]

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

This nomenclature was accepted, and designs with this nomenclature were released in early 1958.[21]

Report SC4114(TR), Final Evaluation of the (Mk 15 Mod 2 and) Mk 39 Mod 1 Bombs and the Mk 39 Mod 1 Warhead, was presented to the August 20, 1958 meeting of the Special Weapons Development Board.[22]

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

A Mk 2 Mod 0 parachute configuration was provided, and this was compatible with all delivery aircraft tested, although tests with the P6M aircraft had not yet been conducted.

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

The fuzing system incorporated a trajectory arm switch, which functioned as a safety device to prevent accidental disaster when handling the weapon on the ground and during loading operations. However, this device would not provide proper safety in the event the weapon was accidentally dropped in water of sufficient depth (17 inches or over) to operate the pressure differential switch. The arm and fire baroswitch was an 8-element, fixed offset component manually set before the strike mission. The firing system had a safing switch that prevented high voltage from reaching the X-unit until a continuous signal had been supplied by closure of the trajectory arm switch. One set of contacts kept the X-unit electrically grounded until the switch operated.

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

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

When the bomb fell a sufficient distance, the pressure switch closed. When open, this switch isolated the low-voltage power supply from the coils of the high-voltage safing switch. When closed, power from the low-voltage battery pack operated the high-voltage safing switch, completing the circuit between the high-voltage power supply and the X-unit. At arming altitude, the arming baroswitch closed and connected the 28-volt power supply, through two fuses, to the primaries of two high-voltage thermal-battery ignition transformers. The pulse from the transformer secondaries activated the high-voltage power supply and the two fuses blew in approximately 100 milliseconds and removed this high current load from the low-voltage power supply. The high-voltage power supply charged the X-unit to 2500 volts and supplied this voltage to the trigger circuit.

At air-burst firing altitude, the baroswitch closed, connecting the 28-volt power supply, through two fuses, to saturable transformers in the trigger circuit. The two fuses blew in approximately 100 milliseconds and removed this high current load from the power supply. In the air-burst option, the saturable transformers passed the fire signal, firing the trigger circuit, X-unit, and the weapon. In the contact option, the saturable transformers blocked the fire signal, and the weapon was detonated by a signal from the contact fuzing system.[23]

The drop-test program for the bomb consisted of 28 drops, 8 of which were ballistic and 20 were fuzing and firing tests. These proved compatibility with the bomb, parachute system, and carriers. The fuzing and firing drops covered a wide range of speeds and altitudes, with about half the drops being free fall and the other half retarded.

Mk 39 Mod 2 Bomb

Meanwhile, some consideration had been given to the design of a Mk 39 Bomb with a low-level release capability. Field Command requested Sandia, in a letter dated September 17, 1956, to conduct a feasibility study of a laydown bomb that would detonate some time after the weapon struck the target and came to rest.[24] Not much work was done for some time and, November 18, 1957, the Air Force notified the Division of Military Application that there was an urgent requirement for the capability of releasing a small number of Mk 39 Bombs from B-47 and B-52 aircraft at low altitudes.[25] This capability had been requested by the Strategic Air Command for attacking certain important targets in the War Plan, and Sandia was requested to assist the Air Force in this task.[26]

Wright Air Development Center subsequently designed a parachute system consisting of pilot, ribbon and solid-canopy chutes. This was quite bulky, and Sandia designed a new enclosing tail.

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

The parachute system did not slow the bomb sufficiently to produce the required time of fall, and it was replaced by a reefed two-chute system, using a 24-foot ribbon and a 100-foot solid-canopy chute. Each chute had one reefed and one unreefed stage, and the Sandia-designed afterbody for the three-stage chute could be used.[27] This was named the Mk 39 Mod 1 Big Tail.

The Big Tail test program started in mid-December 1957 and by early 1958 successful drops were being made.[28] Since the contact crystals did not operate satisfactorily under the relatively low impact speed, the design was changed to a deformation switch. A nose cap was machined to a thickness of 0.08 inch, and a contact plate bearing sharp metal spikes was placed behind this cap, with a separation of about 1/8 inch. The nose cap was crushed when the bomb impacted the target, forcing the spikes in contact with the cap, completing an electrical circuit and causing weapon detonation. Since this

foot-diameter ribbon first-stage chute. In the second stage, a 64-inch-diameter octagonal chute stabilized a 100-foot-diameter solid flat-canopy chute.

Prior to release of the bomb, the aircraft monitor and control was turned ON, and the selector switch placed at either armed position. This operated the arming/safing electrical switch to the armed position and placed the saturable-core transformers of the trigger circuit so that they would pass a fire signal.

At release of the bomb, extraction of the arming rods actuated the pulse generator, thus pulsing the squibs in the thermal battery pack, activating the batteries, and starting a sequential timer. Also at release, two plugs were pulled from the afterbody, opening 2.5-inch-diameter holes in the afterbody to supply pressure sensing for the differential pressure switch. The valves in the pressure switch and valve assembly were closed by cables attached to the pullout plugs.

(b)(3)

This same output was also applied to the open contacts of the timer, the fixed differential pressure switch, and, through fuses, to the saturable-core transformers. The bomb nose switch, previously described, was open to the ground side of the transformers.

When the bomb fell a distance to provide sufficient differential pressure to close the differential-pressure-switch contacts, the circuit was completed through the arming/safing switch to the energizing coils of the safing rotary switch. This latter switch then moved to the armed position, the ground was removed from the X-unit, and the circuit from the high-voltage thermal battery pack to the X-unit was completed.

The timer completed its run 42 seconds after release of the bomb from the aircraft, and the 28-volt output of the low-voltage battery was applied, through fuses in the electrical fuse pack, to the primary of the pulse transformers in the high-voltage battery pack, activating the high-voltage batteries.

This 2500-volt output was applied directly to the trigger circuit and, through the closed contacts of the safing rotary switch, to the capacitor bank of the X-unit.

When the bomb struck the target, the outer surface of the nose cap was crushed against the switch contacts inside the cap, thus supplying a firing signal to the trigger circuit. The resulting signal from the trigger circuit caused the spark-gap switch to break down, discharging the X-unit into the detonator bridge wires and initiating the high-explosive system.

The release altitude range for retarded delivery was from 3500 to 5700 feet above target elevation. These limits were established by aircraft escape time and thermal-battery life, respectively. Free-fall delivery was the same as that for retarded delivery. The minimum release altitude for free-fall delivery was 35,000 feet above the target, dictated by timer setting and X-unit charging time.[35]

Mk 39 Missile Applications

NAVAHO -- Meanwhile, work had been proceeding on application of the Mk 39 to various missiles such as the NAVAHO, REDSTONE and SNARK. Since time scales of the Mk 39 Mod 1 appeared to be compatible with these missiles, there was no reason for considering a Mk 39 Mod 0 Warhead design.

The Air Force notified the Division of Military Application March 8, 1956, that the NAVAHO program had been recently accelerated, with its operational date being shortened from October 1962 to October 1960. Flight tests of the XW-39-X1 Warhead installation were scheduled to start in October 1959, and warhead production would have to commence by April 1960, probably before all warhead testing could be completed. It was recognized that this program entailed some risk, but the Air Force was accepting an even greater risk by committing the missile to a production go-ahead.[36]

Sandia notified Albuquerque Operations Office April 27, 1956 that an accelerated NAVAHO program could be supported. Design release would be scheduled

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

Release of the Mk 39 Mod 1 Warhead for application to REDSTONE was made July 8, 1959. Sandia had participated in 15 REDSTONE flights, 9 of which had been successful.[43]

Report SC4314(TR), Final Evaluation of the Mk 39Y1 and Y2 Mod 1 REDSTONE Warhead, was presented to the October 21, 1959 meeting of the Special Weapons Development Board.[34]

(b)(3)

Initial effort had been directed toward use of the Mk 39 Mod 0 Warhead but, with the advent of the Mk 39 Mod 1 sealed-pit design, attention was diverted to this warhead. Physical compatibility tests were completed in April 1956 with the development warhead, and in November 1957 with the production warhead.

The report noted that the REDSTONE was a single-stage, liquid-propelled, surface-to-surface ballistic missile. Guidance was all-inertial and was based on a gyrostabilized, gyro-supervised stable platform. The missile could be fired to ranges between 50 and 175 nautical miles and was to be used against troop concentrations, supply and transportation centers, and mechanized forces. The missile had a maximum diameter of 70.2 inches, length of 67 feet, and launch weight of 57,000 pounds. The adaption kit was provided by the Army's Picatinny Arsenal, and the radar fuze by the Diamond Ordnance Fuze Laboratories. (b)(1), (b)(3)

Before launch, the desired type of burst (air or contact) was selected and the arming/safing switch electrically placed to the armed position. Before the arming signal was applied, the continuity loops in the warhead and the fuzing system were checked. At missile launch, the safing and arming devices unlocked. These devices measured accelerations at various times and failed safe if the missile did not reach the correct position and velocity on the

August 16, 1957. The missile traveled downrange for approximately 107 minutes to the vicinity of Puerto Rico. Here the missile executed a hard left rudder, then a right bank. The elevons then began to operate erratically and the missile broke up. The flight covered about 990 nautical miles.[46]

A third flight took place September 19, 1957. The missile flight was good, but the Sandia telemetering equipment did not transmit properly and about half the warhead environmental data were lost. However, a gap firing signal was received about 5 seconds prior to warhead impact.[47] Another flight test was held October 31, 1957, from Cape Canaveral, Florida. The launch was normal and the flight was conducted in accordance with the missile flight plan and flown under complete on-board guidance, with the exception of several left-heading commands that were required to calibrate the system headings due to unpredictable crosswinds. The total flight time was 8 hours 16 minutes and the flight covered about 4450 nautical miles. The nose impacted within the target area.[48] Subsequent flight tests followed.

Report SC4374(WD), Final Evaluation of the Mk 39Y1 Mod 1 SM-62A (SNARK) Warhead Application, was presented to the Design Review and Acceptance Group of Field Command and accepted for forwarding to Washington, May 31, 1960.[49] The report noted that structural compatibility between the Mk 39Y1 Mod 1 Warhead and the SNARK had been demonstrated by analytical ~~analysis~~ method and flight tests. No formal laboratory tests of the warhead-missile electrical system were conducted, but electrical compatibility was demonstrated by tests of components, a functional ground-system test, and flight tests. The flight-test program included 18 warhead flight tests; the program was started in June 1957 and completed in May 1959. Release of the warhead for use in the SNARK was issued September 15, 1959.

The SNARK was a high subsonic, surface-to-surface, pilotless bomber produced by Norair (a division of Northrop Corporation) and designed for bombardment of strategic targets. The missile had a basic diameter of 5 feet, length of 68.84 feet, and wingspan of 42.25 feet. The weight of the missile, including boosters, was 60,000 pounds. The missile was launched by rocket assist from

production authorization for the XW-39-X1/B-58/MB-1 Pod application had been released by the Atomic Energy Commission in a letter dated January 18, 1956. At this time, three warheads were under consideration, the XW-27, XW-39, and XW-41. On June 21, 1957, Sandia was requested to discontinue application to the XW-27 and XW-41.

The warhead compartment of the Pod had a double wall around the warhead, with fuel carried between the walls. Flight testing of the system started in April 1959 and continued until November 1960. A release of the Mk 39Y1 Mod 1 Warhead for use with the B-58 MB-1 Pod was issued July 15, 1960.

The weapon had a free-fall capability only. Either air-burst or contact-burst option was selected before release of the Pod from the carrying aircraft. Two arming functions were performed at this point. The pilot placed the arming control switch to ARM, thus providing aircraft power to drive the ready-safe switch to the READY position, and the navigator-bombardier turned on the DCU-9A and selected either air burst or ground burst. Operation of the DCU-9A armed the arming-safing switch and, if ground option had been selected, applied a voltage to set the air-burst transformer in the trigger circuit to the blocked position.

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.

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 fission activity.

Ground Burst -- Detonation at or very close to the surface of the ground or target.

(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.

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

Los Alamos Scientific Laboratory -- A nuclear design organization located at Los Alamos, New Mexico.

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.

Millisecond -- One thousandth of a second.

Nautical Mile -- A naval measurement of length. One nautical mile is equivalent to 6076.1033 feet, or the length of 1 minute of arc (1/21,600) of a great circle of the earth.

Nuclear Insertion -- Insertion of the nuclear capsule when the weapon is ready to be armed for detonation. An atomic weapon with a retracted capsule is relatively safe, and will only produce a yield equivalent to the amount of high explosive in the weapon if the arming and fuzing sequence were initiated and went to completion.

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

Picatinny Arsenal -- An arsenal of the Army, responsible for design of nuclear weapons for the Army.

Piezoelectric Crystals -- Crystals that possess the property of generation of an electrical current when squeezed or struck.

Pit -- The hollow metal sphere at the center of an implosion bomb which receives the nuclear capsule when it is inserted.

Plumbbob -- A less-than-full-scale test series held at the Nevada Test Site. Series of 29 tests, starting May 28 and ending October 7, 1957.

Plutonium-239 -- A radioactive heavy element, atomic number 94.

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

Proximity Fuze -- A fuze that detonates the weapon as soon as it comes within a certain specified distance of the ground or target.

Pullout Switch -- A switch whose contacts are kept separated by insertion of some nonconducting material. Release of the bomb from an aircraft results in closure of the switch contacts.

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.

Redwing -- A full-scale nuclear series of 17 tests held at the Pacific Proving Grounds from May 4 to July 21, 1956.

Reservoir -- As used in this history, a container for deuterium-tritium boosting gas.

Retarded Bomb -- A bomb provided with some means for slowing the rate of descent, generally a parachute.

Ribbon Parachute -- A parachute having a set of ribbons in place of a solid canopy. This type of parachute provides less severe deceleration on deployment.

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

Telemetry -- The transmission of signals from a moving or distant object.

Thermal Battery -- 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.

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

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.

<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.

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37.

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