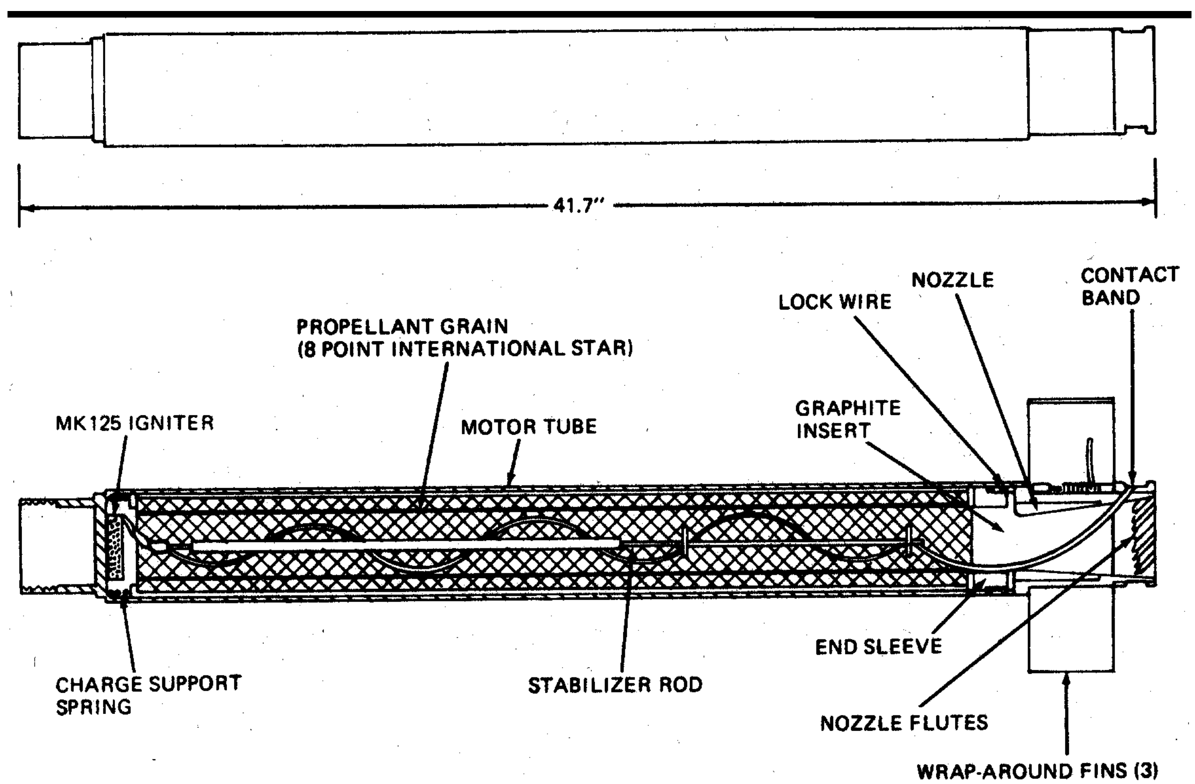
Hydra-70 Rocket System
Integration Information

DESCRIPTIONS

HYDRA-70 Rockets are free flight rockets which mate either unitary or cargo warheads with the MK 66 Rocket Motor. The MK 66 motors use a longer motor tube (than the MK 40/MK 4)



MK66

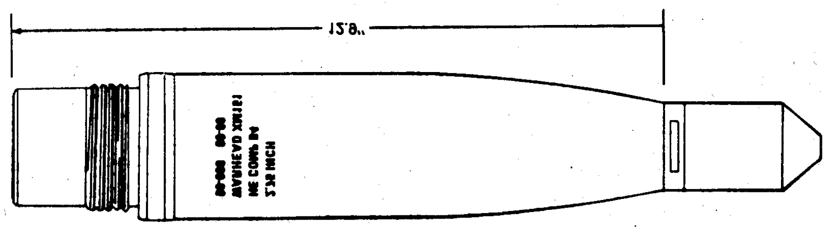
that is of a different aluminum alloy, and is assembled with a new fin and nozzle assembly. The fins are of a spring loaded, wrap-around design and are attached around the circumference of the single nozzle. The propellant grain is longer and of a different formation than for the MK 40/MK 4, however, the stabilizing rod and igniter are essentially the same design. The MK 66 motors have a substantially higher thrust, 1335 lbs, and a longer range. The current generation of the MK 66 in use by U.S. Armed Services are the MK 66 MOD 3 for the Army and the MK 66 MOD 2 for the Air Force, Navy, and Special Operations Force. The MOD 3 incorporates a Hazard of Electromagnetic Radiation to Ordnance (HERO) safe electronic RF filter in the igniter circuit. The RF filter is mounted onto the igniter can and allows the aircraft's direct current firing pulse to pass to the igniter squib, but absorbs and dissipates RF energy. The RF filter does not change the electrical resistance of the firing circuit. Electromagnetic Test Report SR-RD-TE-87-43 dated 8 May 1987 documents the HERO suitability of the MK 66 MOD 3 motor. A brass EMR shield is used over the fin and nozzle to prevent the DC energy produced by electrical arcing encountered when loading motors into launchers in high intensity RF fields from igniting the motor. These shields are furnished with the MOD 3 motor and should be retained for unloading rockets. Due to the shipboard concern of Foreign Object Damage (FOD), the other Armed Services use the MOD 2 motor. The MOD 2 contains a Dahlgren Bridge Assembly (DBA) for a HERO filter. The DBA is a wheatstone bridge designed to prevent the RF of concern from igniting the motor. It consists of two stainless steel wires and two copper core, stainless clad wires of proper resistance crimped together. The alternating current induced by the RF is shunted around the igniter squib. The MOD 2 motor uses a stabilizing rod that is hollow core that acts as a conduit for the igniter wires. The DBA increases the resistance of the motor from 0.7 - 2.0 ohms to 2.3 - 3.0 ohms. This additional resistance can cause the fielded aircraft fire control to err during inventory of available rockets.

The MOD 4 motor is a new design that will become common to all Armed Services and eliminates the undesirable traits of the previous designs. The first deliveries of the MOD 4 motor will be in 1998. The purpose of the MK 66 MOD 4 Rocket Motor is to improve several safety (specifically E^3) deficiencies of the MK 66 MOD 2 Rocket Motor. The MOD 4 motor incorporates a new initiator (MK 26 MOD 0), igniter (MK 311 MOD 0), and E^3 filtering. As a result, the MK 66 MOD 4 Rocket Motor is HERO, 300 KV and 25 KV ESD, and EMP safe. The E^3 filtering includes a capacitor under the nozzle and two low pass filters located on the igniter and in the initiator. Also, a natural spark gap also exists between the contact band and nozzle body. The bare MK 66 MOD 4 Rocket Motor does not function when exposed to 300,000 volts of Electrostatic Discharge (ESD). During testing, as a worst case test, the U.S. Government forced the charge from the 300 KV ESD to hit the rocket motor contact band (firing contact). The filters reliably diverted the ESD pulse away from the initiator. The MK 26 MOD 0 Initiator, the MK 311 MOD 0 Igniter, and the MK 66 MOD 4 Rocket Motor pass 25 KV ESD (human generated electrostatic discharge). The MK 66 MOD 4 Rocket passed HERO testing using the Apache and Blackhawk helicopters as the test platforms. These helicopters are considered to present the worst case for HERO testing. HERO safe certification exists in letter DD/NSWC 8020 F52-RDD dated 13 April, 1995. EMP analyses on the MK 66 MOD 4 Rocket Motor shows it has an EMP factor of safety of over 35 million. This is because the EMP pulse is extremely short (3 microseconds). The short pulse does not provide enough energy to heat the MK 26 MOD 0 Initiator bridgewire.

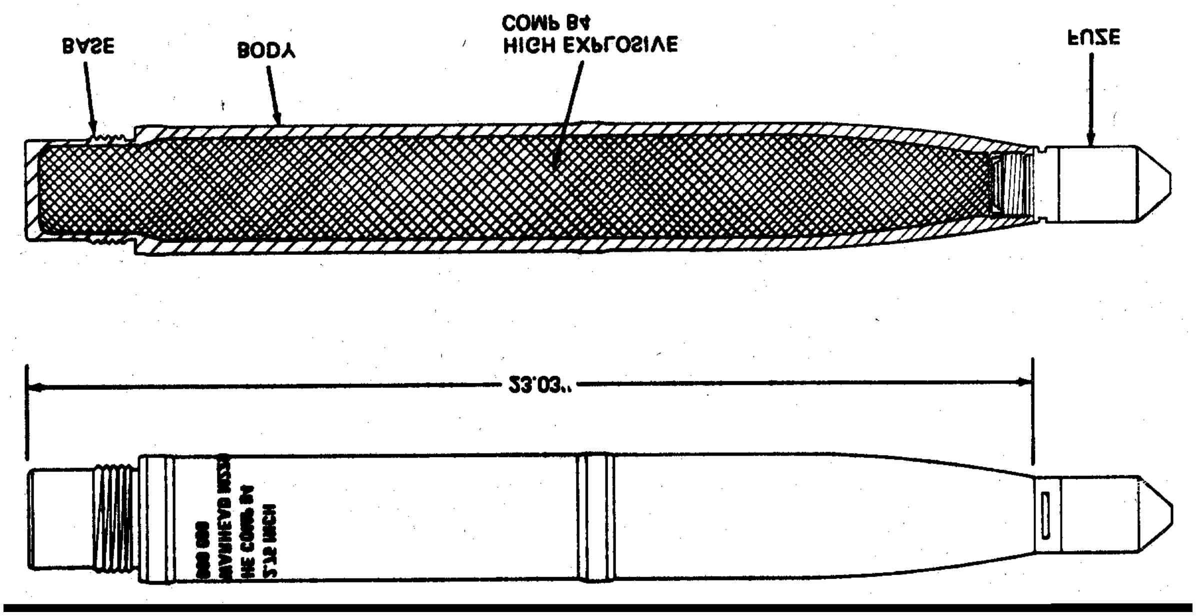
Tabulated data:

Weight, shipped: 13.6 lb
Burn time: 1.05 - 1.10 sec
Average thrust (77 ^oF): 1300 - 1370 lb
Impulse (77 ^oF): 1472 lb/sec
Motor burnout range: 1300 ft (397 m)
Motor burnout velocity: 2425 fps
Launch spin rate: 10 rps
Velocity at launcher exit: 148 fps
Acceleration: 60-70 G (initial),
95-100 G (final)
Range, max @ QE 43^o
w/ MPSM whd: 11,407 yd (10,426 m)

Igniter resistance: 0.7 - 2.0 ohms
Propellant Type: Extruded double base,
ethylcellulose inhibited,
cartridge loaded
Propellant Weight: 7 lb
Propellant Configuration: 8-point internal
burning star
Temperature Limits:
Storage: -65 ^oF to +165 ^oF
(-53.35 ^oC to +73.15 ^oC)
Operation: -50 ^oF to +150 ^oF
(-45 ^oC to +64.9 ^oC)



M151 Warhead



M229 Warhead

Both the M151 and M229 use the M423 Fuze, making them High Explosive Point Detonating (HEPD) warheads. The M151 uses 2.3 pounds of composition B-4 High Explosive. The 10 pound warhead gains lethality from the nose section which is fabricated using nodular, pearlitic malleable, or ferritic malleable cast iron. The 17 pound M229 uses 4.8 pounds of composition B-4 High Explosive. The performance of the M229 is roughly a 50 percent increase in lethal area over the M151. Temperature limits for storage and firing the M151 and M229 are -65 ^{o}F to +150 ^{o}F (-53.35 ^{o}C to +64.9 ^{o}C).

The M423 Fuze consists of four major assemblies: firing pin and body assembly; fuze body; safe and arming (S&A) device; and the booster assembly. The S&A device consists of a rotor housing assembly and unbalanced rotor assembly, an escapement assembly and set-back weight. The unbalanced rotor assembly houses the primer and detonator and is maintained in the unarmed (out-of-line) position. When the rocket motor is fired, sustained acceleration permits the set-back (inertial mass) weight to move rearward, releasing the unbalanced rotor, which in rotating drives the escapement and gear assembly to the armed position. The rotor reaches the armed (in line) position when the rocket has traveled 43 to 93 meters and then is locked into the armed position by a spring-loaded pin. The rotor will return to the unarmed position if the minimum rocket energy (product of acceleration and time) is not sensed throughout the arming distance. Upon impact, the firing pin body walls are crushed between the target and the oncoming fuze body. The firing pin contained in the firing pin body then impacts the oncoming S&A mechanism within the fuze body, initiating the explosive train. The explosive consists of the M104 primer, M85 detonator, lead, booster and warhead explosive which are initiated in sequential order. The M423 is used for launch from low speed aircraft. The M427 is a variation used for launch from high speed aircraft and requires 180 to 426 meters rocket travel to arm. The PD fuzes do not require an umbilical connection to the launcher.

Tabulated data:

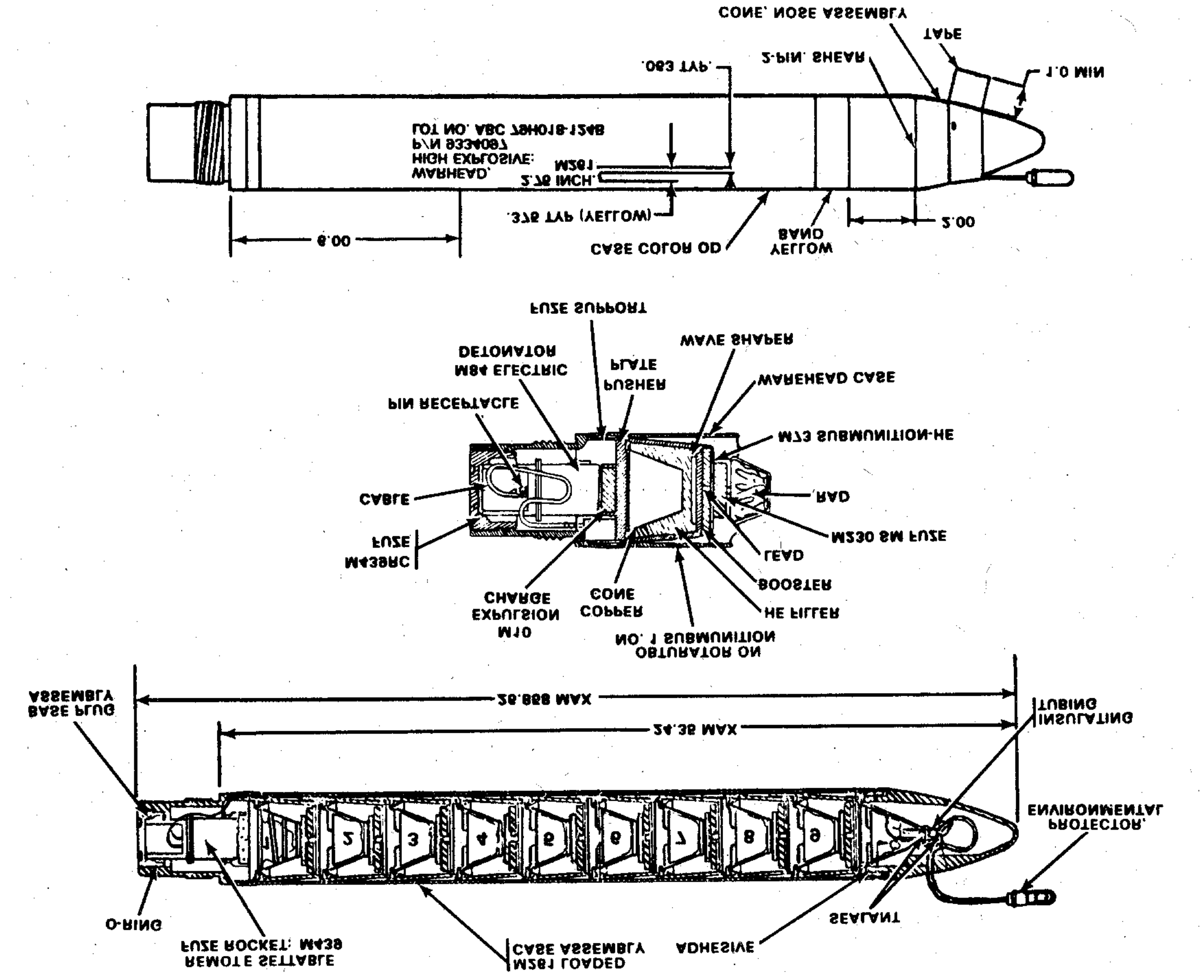
M151 HEPD Rocket w/ MK 66 MOD 3 Motor
NSN:1340-01-269-9123
DODIC: H583
Hazard Classification: Quantity-Distance Class 1.1, Storage Compatibility Group E
UNO Serial No. 0181
DOT Label "Explosive 1.1E", Proper Shipping Name "Rockets"

M151 Warhead w/ M427
NSN: 1340-00-725-8382
DODIC: H842.

M229 HEPD Rocket w/ MK 66 MOD 2 Motor
NSN: 1340-01-309-8300
DODIC: H642
Hazard Classification: Quantity-Distance Class 1.1, Storage Compatibility Group E
UNO Serial No. 0181
DOT Label "Explosive 1.1E", Proper Shipping Name "Rockets with Bursting Charge".

The M261 Warhead is a cargo warhead consisting of a nose cone assembly, a warhead case, an integral fuze, 9 submunitions, and an expulsion charge assembly. The nose cone assembly, a plastic cone bonded to a metal cup-shaped base, is attached to the body by shear pins. The body is a hollow cylinder loaded with 9 full caliber multipurpose submunitions (MPSM). Each submunition has a Ram Air Decelerator (RAD), folded, which nests into the shaped charge cone of the submunition ahead; the 9th (forward) submunition nests into the forward cup which makes up the base of the nose cone. A metal pusher plate is located just aft of the submunition cargo stack and is forward of the expulsion charge assembly. The threaded end of the body is machined internally to accommodate a base detonating, remote settable, variable range fuze. The 9 High Explosive (HE) submunitions are deployed by initiation of a 5.5 gram expulsion charge, consisting of 80% M10 double base propellant and 20% Class 6 black powder. The expulsion charge is initiated by an M84 electric detonator contained in the M439 fuze. A pusher plate then ejects the stack of submunitions through the nose cone.

The primary cargo warhead fuze is the M439 Fuze. It is a resistance-capacitance electronic variable time delay fuze. The time delay is remotely set for the desired functioning distance (time) by charging the circuit from the fire control center, providing a variable range of 0.5 to 7.2 kilometers. The fuze does not have an internal battery; instead energy is supplied from by the aircraft setter at the time of fuze setting. The energy is stored in a capacitor and will operate the electronic timer and fire the M84 electronic detonator. The charging cycle takes place approximately 50 milliseconds prior to rocket motor firing. The fuze begins timing at the first motion of the rocket and will function at the prescribed time if the Safety and Arming (S&A)



device is armed. The S&A mechanism also prevents the fuze from being charged if it is in the partially-armed or fully-armed position. The S&A is a mechanical acceleration integrator with an unbalanced rotor holding the M84 electric detonator and a runaway escapement. An acceleration greater than 27G is necessary to arm the fuze. The M439 Fuze is a base mounted, forward firing fuze. The fuze connector cable extends from the fuze, through the warhead in a lengthwise channel, and exits the ogive for connection to the launcher by an umbilical connector.

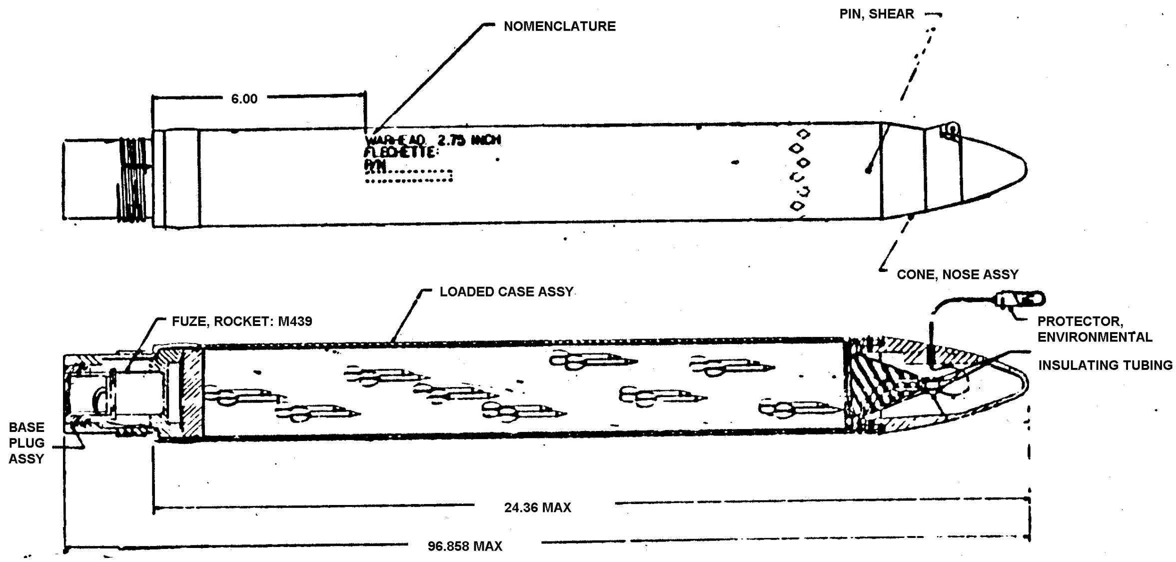
The HE, MPSM M73 Grenade consists of a steel body with a fragmenting wall filled with Composition B explosive incorporating a shaped charge liner, LX14 booster, explosive lead charge, M230 omnidirectional fuze with M55 detonator, wave shaper, and fabric drag device (RAD). The fragmenting body produces 10 grain fragments with a maximum velocity of approximately 5,000 feet per second. The shaped charge sprays lethal fragments nearly horizontal 360 degrees. The submunitions consistently impact within a 40-meter radius of each other. Submunition self destruct has not been a consideration. EOD procedures obviate the need for self destruct. Lethality (penetration) is classified and can be made available through licensed agreement. The performance is roughly a 70 percent (SMCAR-CCH-A Memorandum, 23 Jun 1988) increase in lethal area over the M151.

Tabulated data:

M261 MPSM Rocket w/ MK 66 MOD 3 Motor

NSN: 1340-01-269-1447
DODIC: H165
Hazard Classification: Quantity-Distance Class 1.2, Storage Compatibility Group E
UNO Serial No. 0182
DOT Label "Explosive 1.2E", Proper Shipping Name "Rockets".
Temperature Limits:

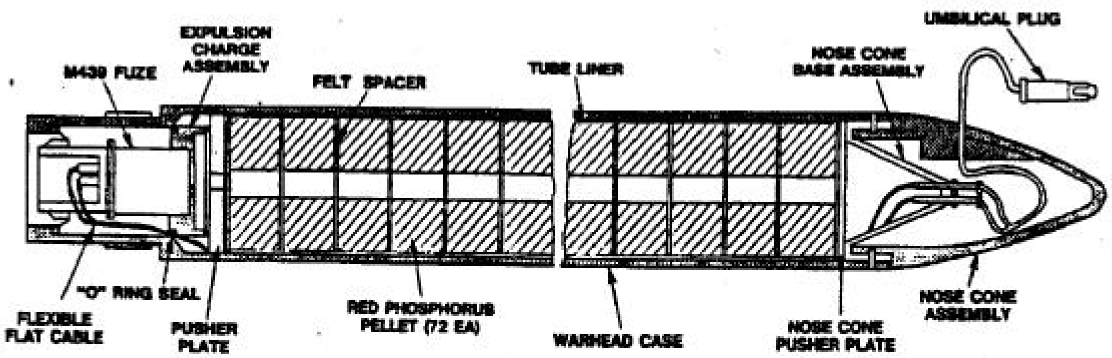
Firing: -50 °F to +150 °F
Storage: -50 °F to +160 °F



The M255A1 Flechette Warhead is intended to be used against light material and personnel targets. The warhead is also a cargo warhead, using the M439 Fuze, and functionally equivalent to the M261 cargo warhead. At expulsion, 1,179 flechettes separate and form a disk-like mass which breaks up with each flechette assuming an independent trajectory, forming a repeatable dispersion pattern. The flechette uses kinetic energy derived from the velocity of the rocket to produce the desired impact and penetration effect on the target.
Tabulated data:

M255A1 Flechette w/ MK 66 MOD 2 Motor
NSN: 1340-01-309-5799
DODIC: H462
Flechette: 60 grain, steel, phosphate coated
Hazard Classification: Quantity-Distance Class 1.4, Storage Compatibility Group G
UNO Serial No. 0191
DOT Label "Explosive 1.4G", Proper Shipping Name Rockets"

The M264 RP Smoke is also a cargo warhead. The warhead is used as a red phosphorus (RP) filled smoke rocket propelled by the MK 66 motor and functions at a remote settable range from 1000 to 6000 meters. Upon functioning, the M439 Fuze ignites the expulsion mix which simultaneously ignites and ejects the 5 pound RP payload through the shear-pinned nose cone. The burning RP drops to the ground producing a voluminous cloud of white smoke. Fourteen M264 rockets will screen a 300-400 meter front with a 5-10 knot wind from the unaided eye for a minimum of 5 minutes. The RP pellet stack assembly consists of 72 RP pellets arranged in 18 rows of 4 each and are separated by felt pieces impregnated with a phosphine gas adsorbent mixture, manganese dioxide/cuprous oxide.

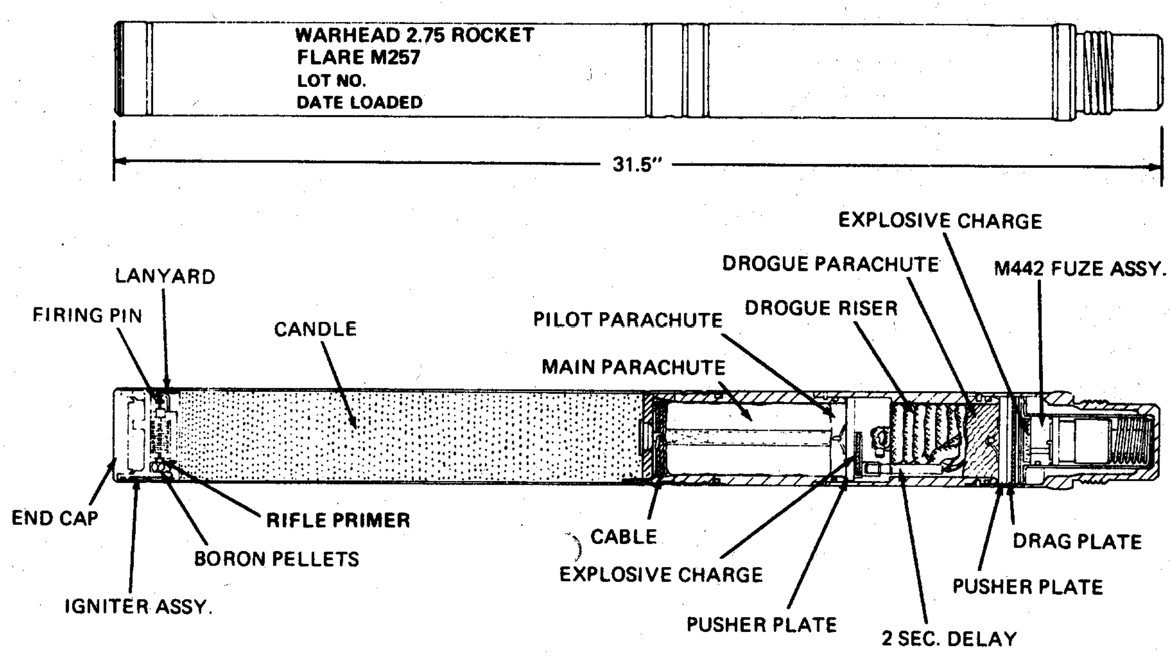


Tabulated data:

M264 RP Smoke w/ MK 66 MOD 3 Motor
NSN: 1340-01-289-4719
DODIC: H184
RP: JXS-10 Smoke Composition Pellets, 0.035 kg/wedge (31.5 gms)
Hazard Classification: Quantity-Distance Class 1.4, Storage Compatibility Group G
UNO Serial No.
DOT Label "Explosive 1.4G", Proper Shipping Name Rockets"

The M257 illuminating warhead consists of an ignition system, flare, main parachute, drogue parachute assembly, and an integral fuze and delay assembly. The warhead is enclosed in an aluminum case. The setback-actuated fixed time integral fuze provides a standoff distance of approximately 3,000 meters. The arming fuze and delay assembly is actuated by motor acceleration. The rocket is fired from the helicopter to attain elevation between 2000 and 4000 feet at 3000 meters downrange. The M257 candle descends at 15 feet per second, burns for approximately 100 seconds with a minimum light output of one million candle power.

Except for the illuminent, the M278 is identical to the M257 warhead. At the aft end of the Separation and Drogue Assembly is the Motor Adapter which is the threaded interface for the launch rocket motor. Inside the adapter is the M442 fuze which initiates the firing sequence for the M278 flare. The fuze must sense an acceleration of at least 17-22 G for about 1 second prior to arming. Upon deceleration of the burnt-out rocket motor the armed fuze fires, directing its output into a 9-second pyrotechnic delay column which in turn ignites a separation charge. The separation charge produces a rapid increase in pressure inside the motor adapter which is reacted by a pusher plate on top of the Drogue Housing. This shears 12 holding pins that are evenly spaced around the circumference of the joint. The pressure also provides an accelerating force for the flare and a decelerating force for the launching rocket motor with the Motor Adapter attached. This ensures positive separation for the flare, and a Deflector plate pulls the expended motor out of the flare flight path. When the Pusher Plate falls into the airstream it pulls the Drogue Chute out of the aft end of the Drogue Housing. Attached to the shroud line bridle of the Drogue Chute is a nylon cord which is attached to the Pull Wire “Quickmatch” of a 2-second



delay “Gas Generator.” The Quickmatch ignites the delay, which in turn fires a Secondary Expulsion charge. This charge functions as the first, producing pressure that shears another set of 12 pins, evenly spaced around the circumference of the flare. Once again the pressure provides an acceleration/deceleration force to the Drogue Housing and the Candle & Parachute Assembly.

Attached to the Pusher Plate is the cord for the Pilot Chute. As the Pilot Chute deploys, it pulls the Main Chute assembly out of its housing (Parachute Insert) for Main Chute deployment. Attached to the Main Chute support cable is a Lanyard that runs through an internal raceway in the Candle and is attached to the Slider assembly in the Igniter assembly. As the main chute is deployed, it pulls the Lanyard with a minimum force of 40 pounds. This force shears a shear pin and moves the slider assembly into the firing position, cocks and releases the firing hammer and fires the ignition primer. During launch of the Rocket, acceleration forces of at least 17 G for duration of approximately one second withdrew the weight assembly of the "Zig-Zag" ignition safe/arm mechanism from its saving position in the slider assembly, allowing Slider movement. The output of the ignition primer is directed into a cavity containing boron pellets. The fire from the boron pellets is directed on the forward face of the flare's illuminant Candle and also on a small propellant wafer which acts as an ignition booster. The Candle produces light in the near IR spectrum for about 180 seconds. The main parachute allows for a descent rate of approximately 13 feet per second.

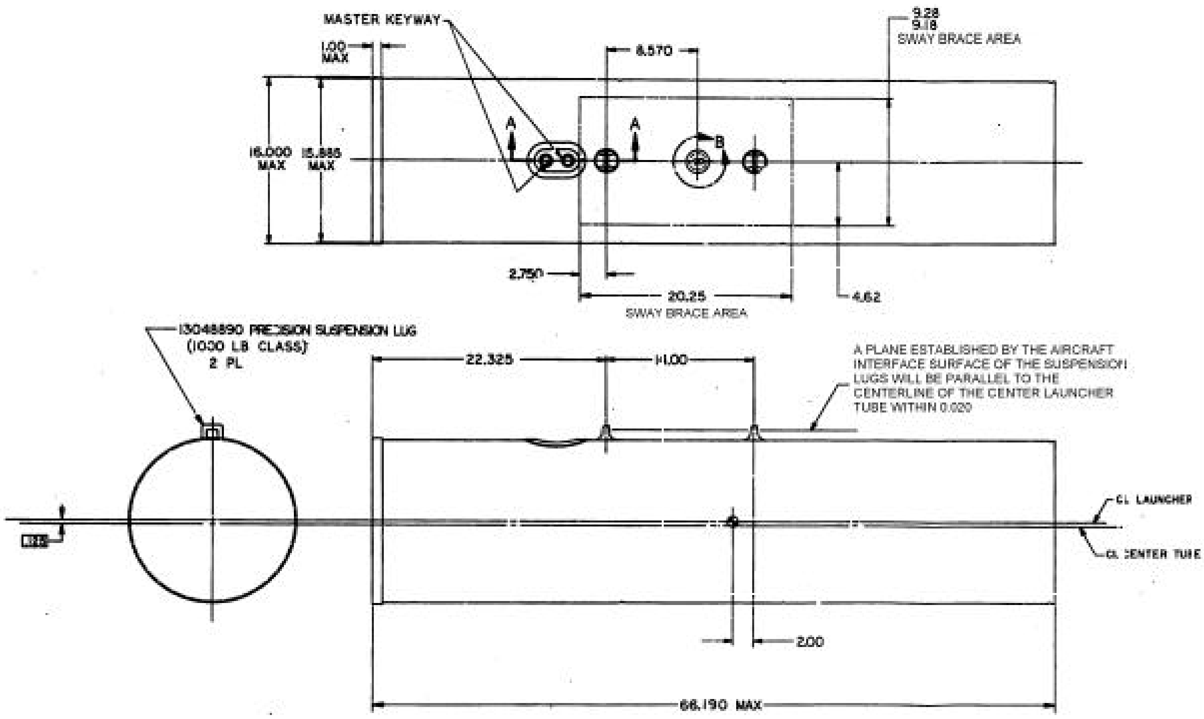
Tabulated data:

M257 Illumination Flare w/ M442 Fuze
Operating temperature limits: -25 ^{o}F to +140 ^{o}F
(-31.35 ^{o}C to +59.40 ^{o}C)
Candle composition: Magnesium Sodium Nitrate
Candle weight: 5.44 lb (2.47 kg)
Illumination intensity, visible: 817.19 CP (avg.)
infrared: 250.02 watts/sr (avg.)
Illumination duration: 197.38 sec (avg.)
Function time: 14.23 sec (avg.)
Shipping and storage data:
Storage class/SCG: 1.2 G
DOT shipping class: A
DOT designation: Rocket Ammunition with Illuminating Projectile
Field Storage: Group D

NSN: 1340-01-268-7175
DODIC: H183
UNO Serial No.

M278 IR Flare w/ M442 Fuze
NSN:
DODIC: H154
UNO Serial No.

The U.S. Army Lightweight Launchers (LWL) are the M260, 7-tube and the M261, 19-tube launchers. The aluminum launchers are inexpensive enough to be disposable, yet durable enough to be reused after as many as 32 firings. The weight savings over the previous Army launchers allows the Army to add other features to the aircraft's rocket system for improved performance. The launcher permits fuze-timing selection from the cockpit and will launch rockets using either the MK 40 or the MK 66 motors. The aft end of each tube in the launcher is fitted with a



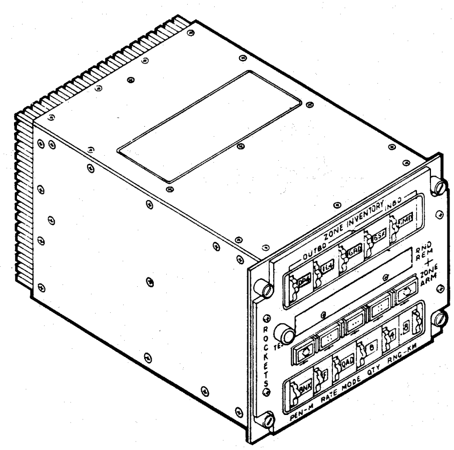
pivoting igniter arm which imparts the ignition current from the firing switch to the rocket motor. A side contact is lowered inside the launch tube for MK 66 ignition with the actuation of the pivoting arm. When the rocket is fired, the igniter arm is pushed back and a mechanical link assists in releasing the rocket from the rocket retainer. However, the primary mode of release is rocket override of the retainer in the launcher. The rocket retention force is specified to be between 170 and 600 pounds, easily overridden by the rocket thrust of over 1300 pounds.

Weight saving was achieved for the LWL design by minimizing the use of rivets, welding and adhesive. Instead, the launchers are assembled using electromagnetic force to swage the aluminum skin and tubes around the four bulkheads. The center two bulkheads are welded to the aluminum strongback. This strongback establishes the rigidity of the launcher and is designed in accordance with MIL-A-8591 for interface with aviation suspension racks and sway braces. The 19-tube launcher has since been redesigned to implement a floating solid bulkhead at the front of the launcher. This solid bulkhead was necessary to minimize the warping from heat built up during ripple launches. All other bulkheads are a laminated stack of plates. The front bulkhead of the 7-tube launcher continues to use a laminated stack.

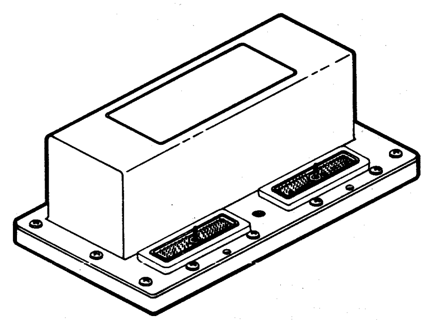
Electrical connectors are referred to as J1 and J2 connectors. The J1 connector (P/N 13048761 is a 26-pin connector for the motor ignition circuit and the J2 (P/N 13048762) is a 23-pin connector for the fuze setting circuit. The firing interval that the launcher normally experiences from the fire control is 0.06 seconds.

Environmental Protection Devices (EPD) have been designed to protect loaded launchers in flight from collecting ice and debris which can cause a rocket to stick in the tube, a condition that can result in a hangfire. The EPDs are molded from an ABS plastic in one piece and mount to the face of the launcher with captive bolts. The EPD effectively protects each tube with a dome cover that is grooved on the surface for fragmentation upon rocket exit. Fragments are designed to not exceed one square inch and can be ingested without event by the turbine engines of the Apache helicopter. A side benefit of the EPD is the thermal protection for the launcher face to prevent warping, which eventually will lead to erosion of the launcher tubes. This also will minimize the heat signature of the launcher after rocket firings.

RMS Display Unit



RMS Operations Unit



The M138 Rocket Management Subsystem (RMS) is a pilot-operated subsystem that interfaces with the wing stores subsystem in the helicopter. The RMS operates from power supplied by the aircraft and consists of one Display Unit and four Operations Units. The RMS enables the aircraft pilot to select and launch MK 40 or MK 66 rocket motors with the desired warhead/fuze combination from two or four 7- or 19-tube launchers mounted under the aircraft stub wings. The RMS automatically senses the quantity and type of launcher installed and automatically sets its firing sequence to agree with the tube numbering of the launcher on board. Should one or more launchers be disabled, the RMS will cause the corresponding launcher on the opposite side of the fuselage to become inactive to maintain in-flight stability by equalizing the load of unfired rockets.

Rockets are loaded according to type (warhead/fuze) in up to five loading zones, and the types loaded in each zone are indicated by manually setting five 12-position thumb wheel switches on the Display Unit panel. The switch positions are marked with two- or three-letter descriptors that represent the available warhead/fuze configurations. When power is applied to the RMS, it automatically inventories the rounds loaded in each zone and provides the pilot with a numeric display of the quantities available for launching from each zone. By setting switches on the face of the Display Unit, the pilot can select the rocket types to be launched, set the fuzes according to the tactical situation, and determine the quantities of rockets to be launched in each volley. Rockets are then launched when the pilot or copilot/gunner squeezes the trigger switch on the cyclic stick. Should the trigger switch be released before the entire volley has been launched, the numeric display on the face of the Display Unit is immediately updated to continuously reflect the quantities of rockets remaining in each loading zone. Refer to TM 9-1090-207-13&P for additional information pertaining to RMS components.

The primary objectives of the remotely settable fuze concept were to use very inexpensive components in the fuze itself, eliminate any battery required to run the electronics during the fuze run time, and accomplish the accuracy goals throughout the total environmental range. The solution was to select a resistance-capacitance technique wherein relatively inexpensive, broad-tolerance (+/- 20 percent) components could be used for high-volume production of relatively inexpensive electronic fuzes. To accurately set the capacitance-charged fuzes for the desired run time throughout the environmental range requires a compensating setter located in the aircraft. The setter, immediately prior to launching a rocket, determines the amount of energy required by the fuze timing capacitor for the component variations existing along with temperature effects to run the fuze timing circuitry for the range selected. The setter then charges the timing capacitor and the storage capacitor used as both the power source to run the electronics and the power source to initiate the pyrotechnic train through initiation of the electric detonator in the fuze safeing and arming device. The setter must be capable of compensating for 20 percent variations in component value and for variations in fuze run time due to temperature effects on individual fuzes. Since each fuze is unique, each fuze must receive a different amount of energy in its timing sequence, whether it be singles, pairs, or quads, fuzes must therefore receive different amounts of energy to accomplish the same set time. Therefore, just prior to firing, the individual fuze and its setter compose an integral subsystem which must perform its function accurately across the entire environmental spectrum, compensating for inherent errors in individual fuzes.

The Display Unit is a cockpit-mounted line-replaceable unit that presents the pilot with controls and displays for inventorying and controlling the launching of aerial rockets. It also contains the power supply and other common circuits necessary for the RMS components to operate as a subsystem. The Display Unit transmits the electrical command signals selected by the pilot to the Operations Units. One Operations Unit is used for each launcher and contains the circuitry that sets the fuzes and the circuitry that provides the rocket motor squib firing pulses for the rockets loaded into the associated launcher.

Additional description of the RMS is contained in enclosure 1. This is an early system description as taken from material used for training (extraneous pages have been extracted) of what eventually became the M138 RMS. It was originally fitted into the AH-1S model of the Cobra helicopter. The weight of the display unit is 6 pounds and of the operations unit is 2 pounds each. The NSN for the M138 RMS is 1090-01-077-8939. A variation of this system known as the Armament Management System was fitted into the AH-1G model of the Cobra helicopter. It uses two zones and was intended as an interim solution for an eventual upgrade to the M138 RMS.

1. **MECHANICAL.**

1.1 & 1.2 Physical Characteristics of the rocket system. The lengths, weights, centers of gravity and moments of inertia of the various rockets (MK 66) as measured are as follows:

The length of the M261 LWL was previously defined as 66.190" (max). The weight, CG and moments for the M261 LWL are as follows:

M261 Lightweight Launcher	**Empty**	**Loaded**
Weight (lbs.)	82	596
CG aft of nose (in.)	35.8	28.3
CG above center line (in.)	0.78	0.14
CG left of center line (in.)	0.033	0.004
Pitch moment (slug-ft^2)	7.12	54.37
Yaw moment (slug-ft^2)	7.28	54.52
Roll moment (slug-ft^2)	0.629	3.37

	Weight, lbs				CG from base		Moments of Inertia, lb-in^2			
		Rocket		Length	(inches)		Live		Fired	
	Warhead	Live	Fired	(inches)	Live	Fired	Axial	Transverse	Axial	Transverse
MK66 Motor only	----	13.65	6.43	41.750	18.89	15.70	15.80	2032	9.30	1371
M151 HE/M423 PD w/ MK66	9.30	22.95	15.73	55.125	29.96	33.55	26.20	6248	19.70	5008
M229 HE/M423 PD w/ MK66	16.87	30.43	23.19	65.240	36.55	41.20	37.60	10479	29.60	7840
M261 MPSM/M439 w/ MK66	13.50	27.15	19.93	66.100	35.26	40.02	29.40	9868	23.30	7595
M255A1/M439 w/ MK66	13.87	27.51	20.34	66.100	35.36	40.00	28.80	9848	22.10	7529
M257/M442 w/ MK66	10.57	24.22	17.00	70.400	34.75	40.04	27.60	10607	21.70	8383
M264/M439 w/ MK66	8.00	21.65	14.43	66.100	30.84	35.11	23.70	7639	17.00	6209

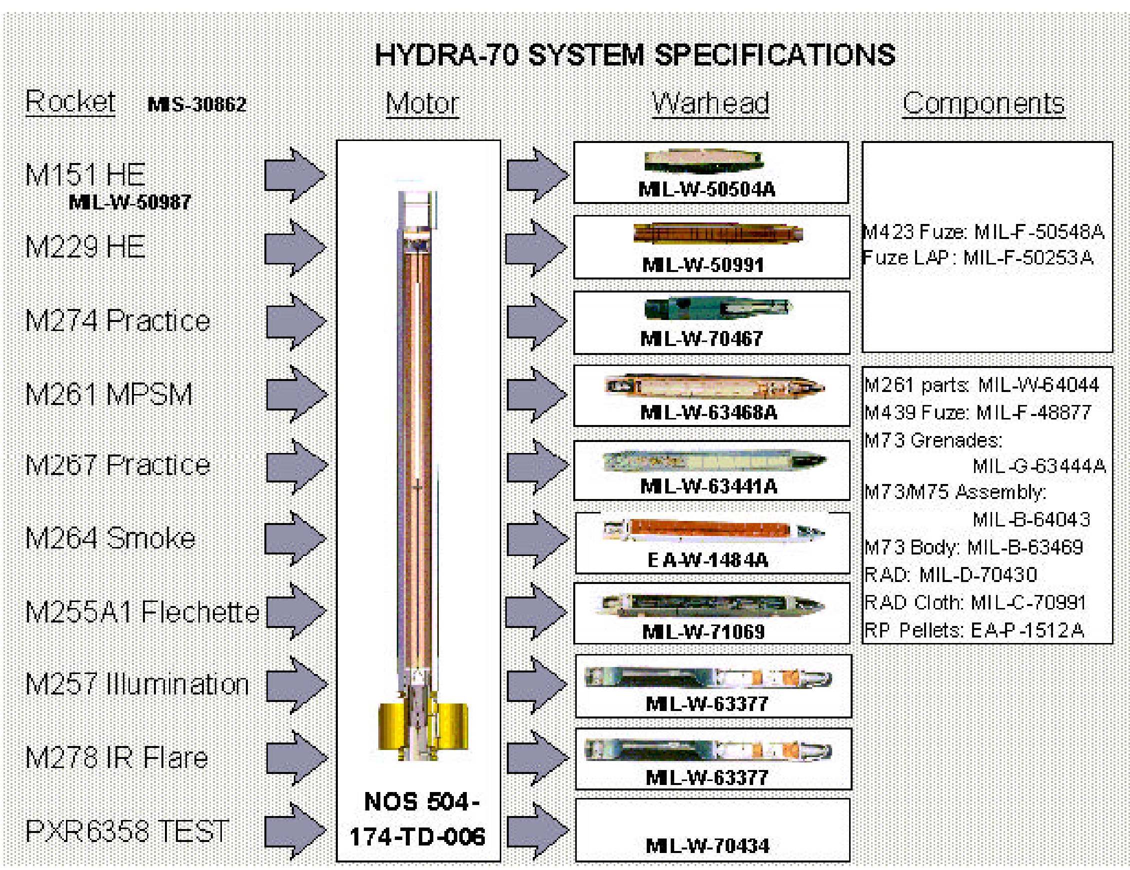
Physical Characteristics of Rockets

The centers of gravity for the M261 LWL when fully loaded with the following rockets are as follows:

Configuration	CG (in. from front)	Weight (lbs.)
Empty	35.8	82.0
M151/M423/MK 66	33.1	518
M229/M423/MK 66	27.2	660
M257/M442/MK 66	29.0	542
M264/M439/MK 66	32.4	493
M261/M439/MK 66	28.5	598
M255A1/M439/MK 66	28.4	604

1.3 Aerodynamic data of the M261. Please refer to excerpts of MIL-A-8591 at enclosure 2 for calculation and modeling methods for aerodynamic loads. An example calculation performed by Hughes Aircraft, the designer of the LWL, is attached at the back of the enclosure. Airflow information would be unique to the aircraft platform and should be available from the U.S. Army Aviation and Troop Support Command (ATCOM).

1.4 Qualification standards. Specifications which control the acceptance of rockets are listed in the chart below. The specification for the LWL is MIS-34583. The RMS is per enclosure 3.



1.5 Environmental influence to the helicopter. The MK 66 motor can eject the ignition wire upon launch. On more rare occasions, the MK 66 MOD 2 motor can eject the stabilizing rod upon launch. Observance of this occurrence indicates that approximately 50 percent are just after the rocket has left the launcher. The MK 66 MOD 4 motor has a more robust design for the stabilizing rod that should preclude ejection.

Chemical and thermal effects are taken from IHSP 89-289. Theoretical combustion products appear in Table IV of this document and is shown below. The exhaust-induced pressure experienced in each launcher tube is 318 psi, measured near the aft end of the launcher.

TABLE IV. EXHAUST PRODUCTS AND TEMPERATURE [a]

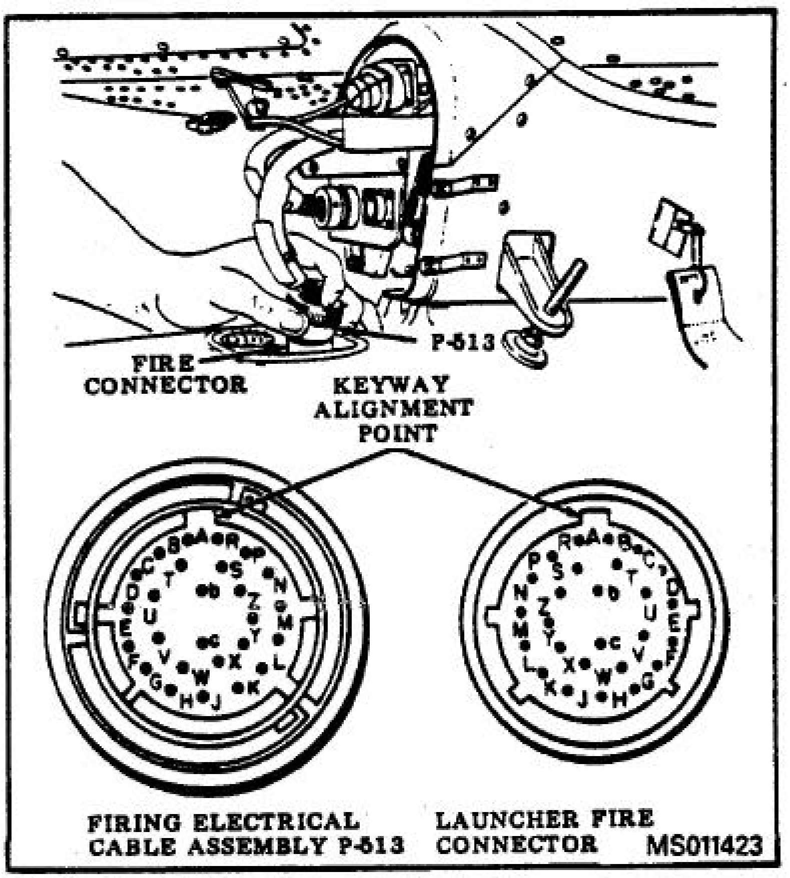
Combustion Components [b]	Chamber Composition (mole fraction)	Exit Composition (mole fraction)
CO_2	0.12953	0.18980
CO	0.38960	0.33007
H_2O	0.24008	0.18146
HCL	0.00001	0.00000
H_2	0.11247	0.17295
N_2	0.12197	0.12218
H	0.00178	0.00000
NH_3	0.00001	0.00000
NO	0.00007	0.00000
O	0.00001	0.00000
OH	0.00094	0.00000
O_2	0.00001	0.00000
Pb	0.00167	0.00177
PbO	0.00010	0.00000
Cu (solid)	0.00000	0.00177
Cu	0.00176	0.00000

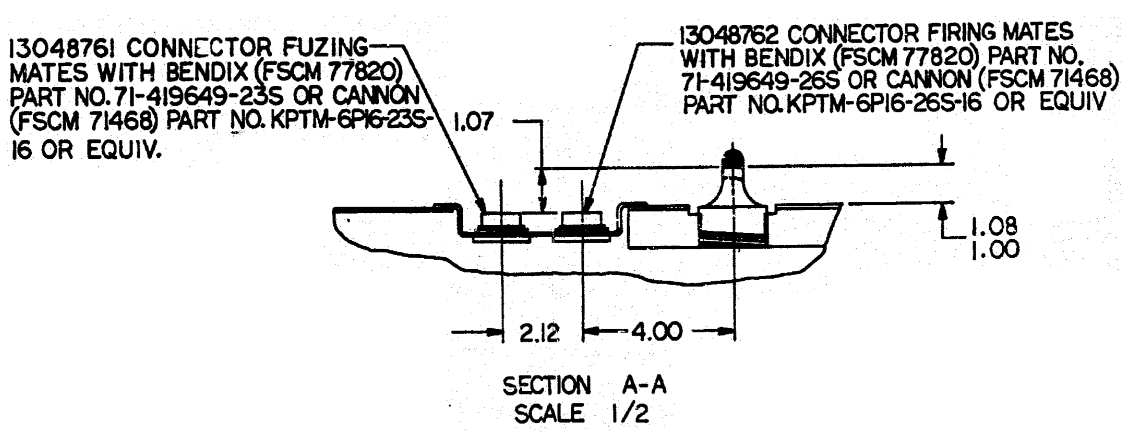
[a] Exhaust flame temperature is 1900° F.

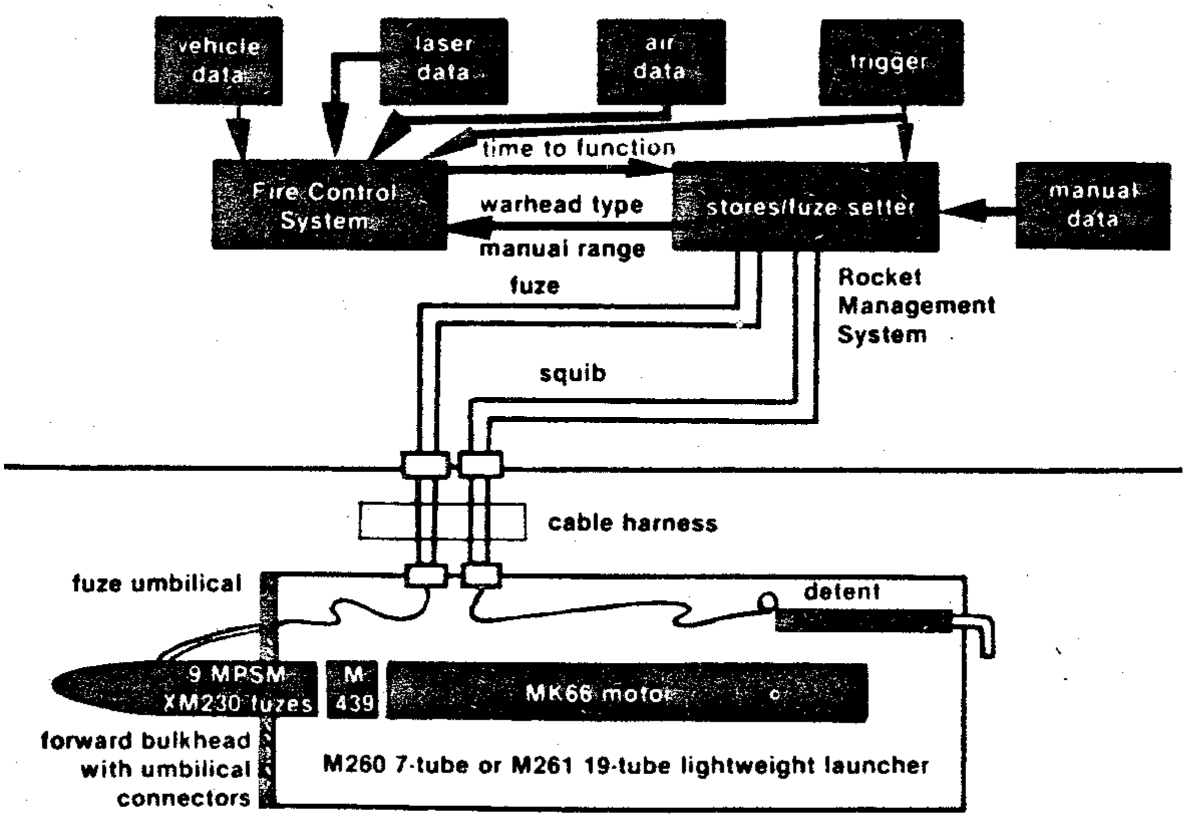
[b] Combustion components are gases unless otherwise indicated.

2. ELECTRICAL.

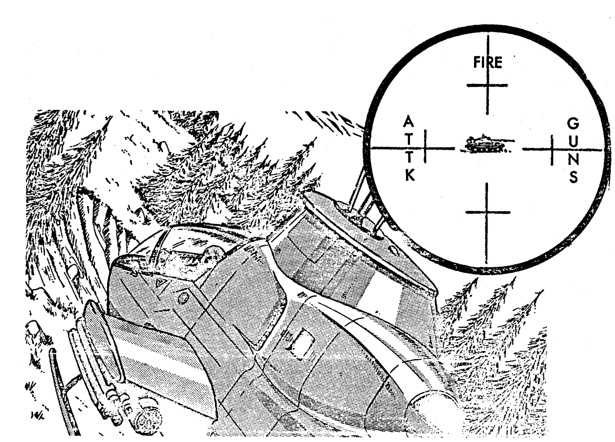
2.1 Electrical Interface. The LWL electrical continuity shall be as specified in drawing 13048860 for the M261 launcher (Type II launcher). When a device that selectively simulates the electrical characteristics of an electrically shorted motor of either the MK 40 or MK 66 type is loaded in a launcher tube, the total circuit resistance from that launch tube connector pin in connector J1 to the ground pin in the J1 connector shall not exceed 1 ohm with an applied current of not less than 1 milliampere or not more than 700 milliamperes. Resistance will be tested with both the MK 40 and MK 66 motors. The resistance of the electrical circuits between J2 and P, and J2 and ground shall not exceed 0.20 ohm with an applied current of not greater than 700 milliamperes. The insulation resistance between isolated circuits and ground shall be equal to or greater than 500,000 ohms at 500 volts direct current (Vdc). With the negative return connected to pin Z of connector P, application of the system fuzing signal from the RMS to pins A through V of connector J2 shall supply fuze set voltage to rockets loaded in tubes 1 through 19 respectively. With the negative return of ignition circuit connected to pin Y and/or Z of connector J1, the application of a fire signal of a minimum of 1 ampere for a minimum of 10 milliseconds from the RMS to pins A through V of connector J1 shall supply ignition voltage to rockets loaded in tubes 1 through 19 respectively.



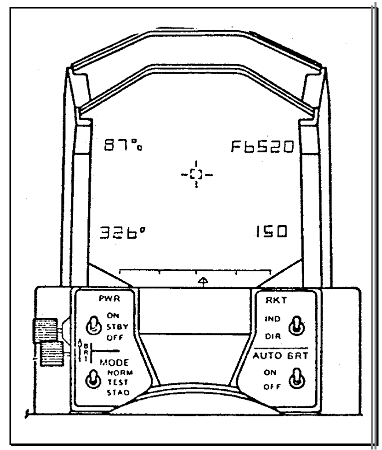




2.2 Description of the functional sequences. The pilot dials in the rocket type and quantity to be fired on the RMS. The RMS designates this data to the Fire Control Computer (FCC) of the aircraft, and the FCC selects the trajectory data from memory. The electronic fuze setter in the RMS will set the fuze when the pilot depresses the firing trigger. The gunner in the front seat of the Cobra sights in on the target through the telescopic sight unit and lases to obtain constantly updated range data. The aircraft FCC processes this data along with aircraft speed, relative wind, temperature and flight characteristics of the rocket, and computes the point at which the fuze must function for the intended target. The computer then presents a solution reticle through the heads up display (HUD) to the pilot in the back seat. The pilot must match the solution reticle to the boresight reticle on the HUD by maneuvering the aircraft and firing the weapon system. The computer continues to constantly update the solutions as the aircraft moves along. The pilot pitches the aircraft up, aligns the boresight reticle with the solution reticle and depresses the firing trigger. The fuze



receives the latest ranging data about 50 milliseconds prior to the rocket motor being fired. The following is a listing of Field Manuals used in the employment of rockets:



Explosives and Demolitions	FM 5-25
Ordnance General and Depot Support Services	FM 9-4
Ordnance Ammunition Service	FM 9-6
Attack Helicopter Gunnery	FM 17-40
Attack Helicopter Operations	FM 17-50

2.3 Power consumption. The rocket management system requires 24-28 VDC.

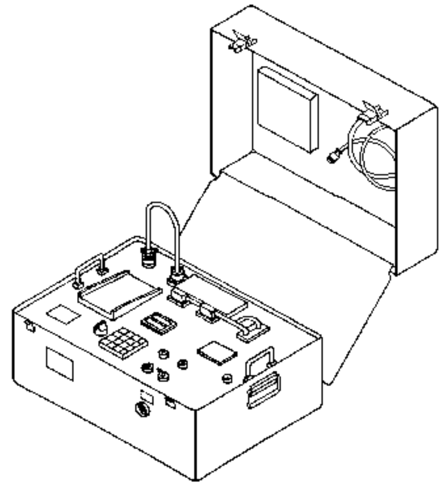
2.4 EMI. Aeronautical Design Standard (ADS) 37, Subject: Electromagnetic Environmental Effects (E^3) Management, Design, and Test Requirements and SARD-DO Memorandum, Subject: Army Acquisition Executive Policy Memorandum 91-3, Army Electromagnetic Environmental Effects (E^3) Program Implementation establish design requirements. As stated previously, the MK 66 MOD 4 Rocket Motor is HERO, 300 KV and 25 KV ESD, and EMP safe. Warheads such as the M278 contain no electronic components and therefore do not present any E^3 concerns. The M255A1 and M264 warheads are recent developments and were evaluated for E^3 because both contain electrical/electronic components, specifically the M439 electronic fuze as well as the M84 electric detonator, and therefore do have the potential to be affected by E^3. Naval Surface Weapons Center (H22-BF/RFM) Letter, dated 22 Jan 87, Subject: Hazards of Electromagnetic Radiation to Ordnance Test Report of the Rocket Management System showed that the M439 Fuze is "HERO SAFE ORDNANCE" and will not be affected by the HERO environment during presence, handling and loading. The M439 Fuze was tested for Electrostatic Discharge (ESD) susceptibility with an inert warhead and found to be sufficiently hardened to personnel-borne ESD. As a result, there are no E^3 concerns associated with either warhead/fuze combination. While documentation does not exist for older designs, similar results can be expected for warheads fuzed with the M439 Fuze. A fact to consider is that the M439 Fuze is inherently shielded by the warhead case and by the motor when mated as a rocket.

3. **Software Modification.** Software modifications are conducted by the host aircraft and may be discussed with the U.S. Army AMCOM. The ballistic tables are established for rounds as they are developed by U.S. Army engineering centers and are submitted to AMCOM. Language and bus interfaces are determined by the developer of the aircraft fire control computer.

4. **Test Equipment.** The Rocket Management Subsystem Test Set, M135 (RMS Test Set), is a manually operated portable test set which automatically tests Line Replaceable Units (LRU) of the RMS, using programmed test routines initiated, as applicable, by the test set operator. The test set is used at the AVIM level to verify equipment failures that were detected by the built-in-test circuits in the RMS LRUs and to isolate troubles in these units to a shop-replaceable assembly. It is also used for verifying the performance of a unit after repair or at any other time. The maintenance manual for the M135 is *"Operator's Aviation Unit, and Intermediate Maintenance*

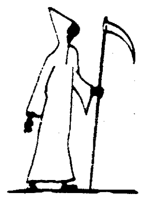
Manual with Repair Parts and Special Tools List for Test Set, Rocket Management Subsystem, M135, TM9-4933-227-13&P."

5. Rocket system electrical checks are performed in accordance with the following procedures.



M135 TEST SET

FIRING CIRCUIT CHECK FOR AH-1 AND AH-64 SERIES AIRCRAFT USING THE
DIGITAL MULTIMETER AN/PSM-45A



WARNING

JETTISON OF LAUNCHERS CAN CAUSE INJURY OR DEATH

(a) INSTALL SAFETY PINS

(b) CHECK TO ENSURE THAT ALL TUBES ARE EMPTY

CAUTION

REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED BEFORE CONNECTING OR DISCONNECTING THE TEST LEADS

(c) MULTIMETER SETUP:

CONNECT RED TEST LEAD TO TERMINAL A

CONNECT BLACK TEST LEAD TO COM TERMINAL

SET FUNCTION SELECTOR ROTARY SWITCH TO DC mA/A

(d) USING THE BLACK ALLIGATOR CLIP, CONNECT BLACK LEAD TO SWAY BRACE BOLT ON ARMAMENT PYLON OR SUITABLE AIRCRAFT GROUND

(e) USING THE RED ALLIGATOR CLIP, CONNECT RED LEAD TO IGNITER HEAD OF TUBE TO BE FIRED

(f) DEPRESS HOLD KEY OF MULTIMETER TO ENGAGE THE HOLD MODE (SEE TM11-6625-3199-14, PAGE 2-22)

(g) TURN ON ALL AIRCRAFT POWER NECESSARY TO FIRE ROCKETS

(h) ACTUATE COCKPIT TRIGGER FOR APPROXIMATELY 1/2 SECOND: MULTIMETER SHOULD READ AT LEAST 3 AMPS FOR THE AH-64 AND AT LEAST

(i) IF READING IS INCORRECT, REFER TO TABLE 3-3 FOR CORRECTIVE ACTION

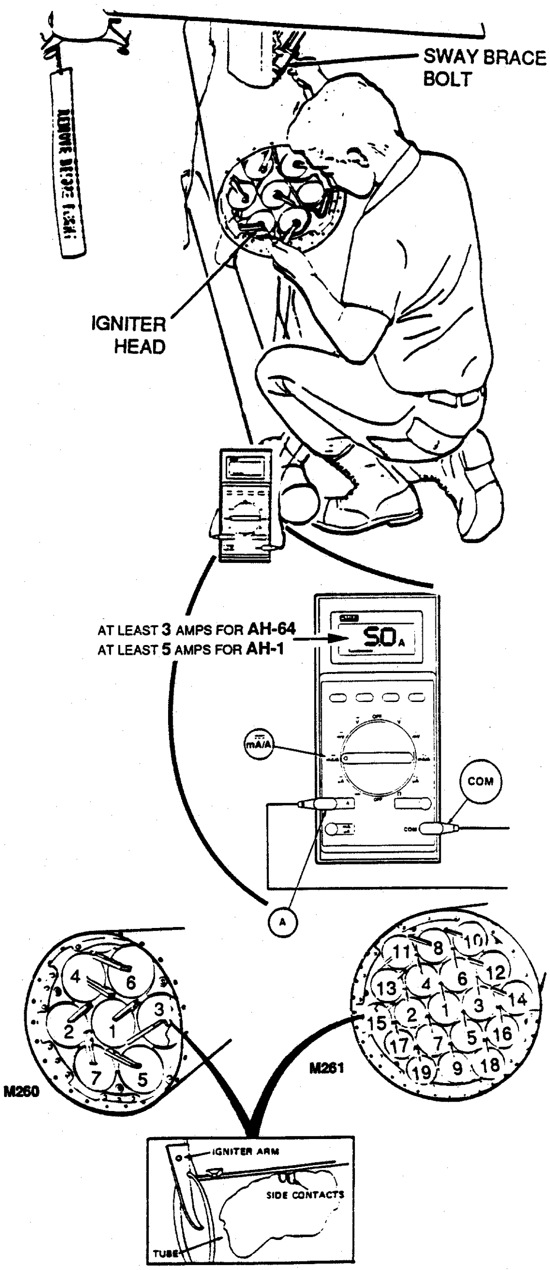
(j) REPEAT STEPS (e) THROUGH (i) FOR EACH TUBE; REFER TO TUBE FIRING ORDER

(k) REPEAT COMPLETE CHECK AT LEAST ONCE EACH OPERATIONAL DAY TO MAKE SURE TUBES ARE OPERATIONAL AND TO IDENTIFY DEFECTIVE TUBES

(l) REMOVE SAFETY PINS

(m) TURN THE MULTIMETER FUNCTION SELECTOR ROTARY SWITCH TO OFF

(n) DISCONNECT METER



TUBE FIRING ORDER (REAR VIEW)

NOTE: TUBE FIRING ORDER IS 19 THROUGH 1, AND 7 THROUGH 1

INSULATION CHECK USING THE **DIGITAL MULTIMETER AN/PSM-45A**
TO PERFORM THE INSULATION CHECK, PROCEED AS FOLLOWS:

NOTE

TWO PEOPLE MAY BE REQUIRED TO PERFORM THIS CHECK

(a) REMOVE ALL POWER FROM AIRCRAFT

(b) REMOVE AIRCRAFT FIRING CABLE FROM LAUNCHER BY DISCONNECTING P2 (AH-1 SERIES HELICOPTERS) OR P513 (AH-64 SERIES HELICOPTERS FROM LAUNCHER FIRE CONNECTOR

(c) MULTIMETER SETUP:

CONNECT RED TEST LEAD TO V/ Ω / DIODE TERMINAL

CONNECT BLACK TEST LEAD TO COM TERMINAL

SET FUNCTION SELECTOR ROTARY SWITCH TO Ω

(d) SHORT THE TEST LEAD TIPS TOGETHER AND MOMENTARILY PRESS THE **REL** KEY.

CAUTION

REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED BEFORE CONNECTING OR DISCONNECTING THE TEST LEADS

(e) CONNECT BLACK LEAD TO PIN a OF FIRE CONNECTOR ON LAUNCHER

(f) CONNECT RED LEAD TO IGNITER HEAD OF TUBE TO BE TESTED. MULTIMETER SHOULD READ AT LEAST 2 MEGOHMS

(g) IF READING IS INCORRECT, REFER TO TABLE 3-3 FOR CORRECTIVE ACTION

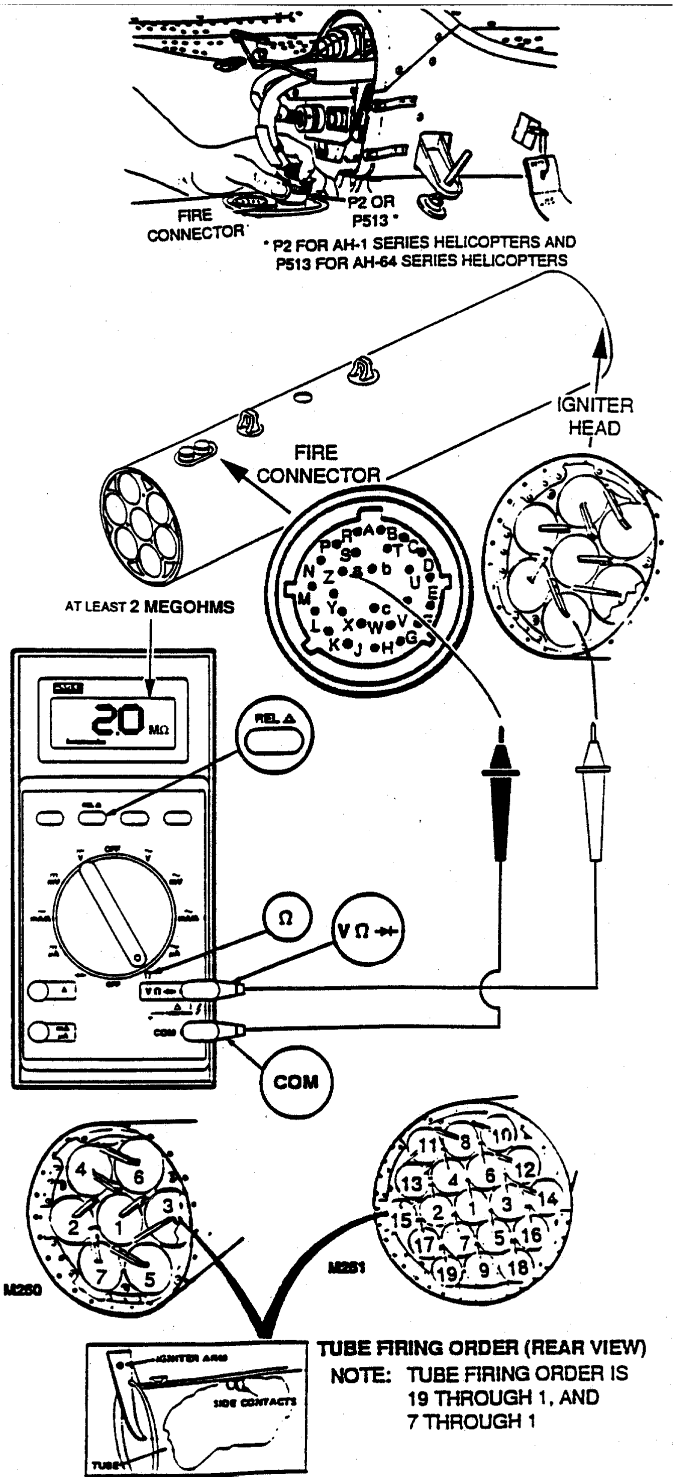
(h) LEAVE BLACK LEAD ON PIN a AND REPEAT STEPS (f) AND (g) FOR EACH TUBE; REFER TO TUBE FIRING ORDER

(i) REPEAT COMPLETE CHECK AT LEAST ONCE EACH OPERATIONAL DAY

(j) TURN THE MULTIMETER FUNCTION SELECTOR ROTARY SWITCH TO OFF.

(k) DISCONNECT METER.

(l) RECONNECT AIRCRAFT FIRING CABLE TO LAUCHER FIRE CONNECTOR



TUBE FIRING ORDER (REAR VIEW)
NOTE: TUBE FIRING ORDER IS 19 THROUGH 1, AND 7 THROUGH 1

STRAY CURRENT CHECK USING THE **DIGITAL MULTIMETER AN/PSM-45A.**
TO PERFORM THE STRAY CURRENT CHECK, PROCEED AS FOLLOWS:

(a) INSTALL SAFETY PINS.

(b) CHECK TO ENSURE THAT ALL TUBES ARE EMPTY.

CAUTION

REMOVE ALL POWER FROM THE CIRCUIT BEING MEASURED BEFORE CONNECTING OR DISCONNECTING THE TEST LEADS.

(c) MULTIMETER SETUP:

CONNECT RED TEST LEAD TO µA / mA TERMINAL.

CONNECT BLACK TEST LEAD TO COM TERMINAL.

SET FUNCTION SELECTOR ROTARY SWITCH TO DC mA/A.

(d) USING THE BLACK ALLIGATOR CLIP, CONNECT BLACK LEAD TO SWAY BRACE BOLT ON ARMAMENT PYLON OR SUITABLE AIRCRAFT GROUND.

(e) USING THE RED ALLIGATOR CLIP, CONNECT THE RED LEAD TO IGNITER HEAD OF TUBE TO BE TESTED.

(f) DEPRESS HOLD KEY OF MULTIMETER TO ENGAGE THE HOLD MODE (SEE TM11-6625-3199-14, PAGE 2-22)

(g) TURN ON ALL AIRCRAFT POWER NECESSARY TO FIRE ROCKETS. MAKE SURE ARMAMENT SWITCHES ARE IN ON POSITION.

(h) MULTIMETER SHOULD READ 30 mA DC. OR LESS

(i) IF READING IS INCORRECT, REFER TO TABLE 3-3 FOR CORRECTIVE ACTIONS.

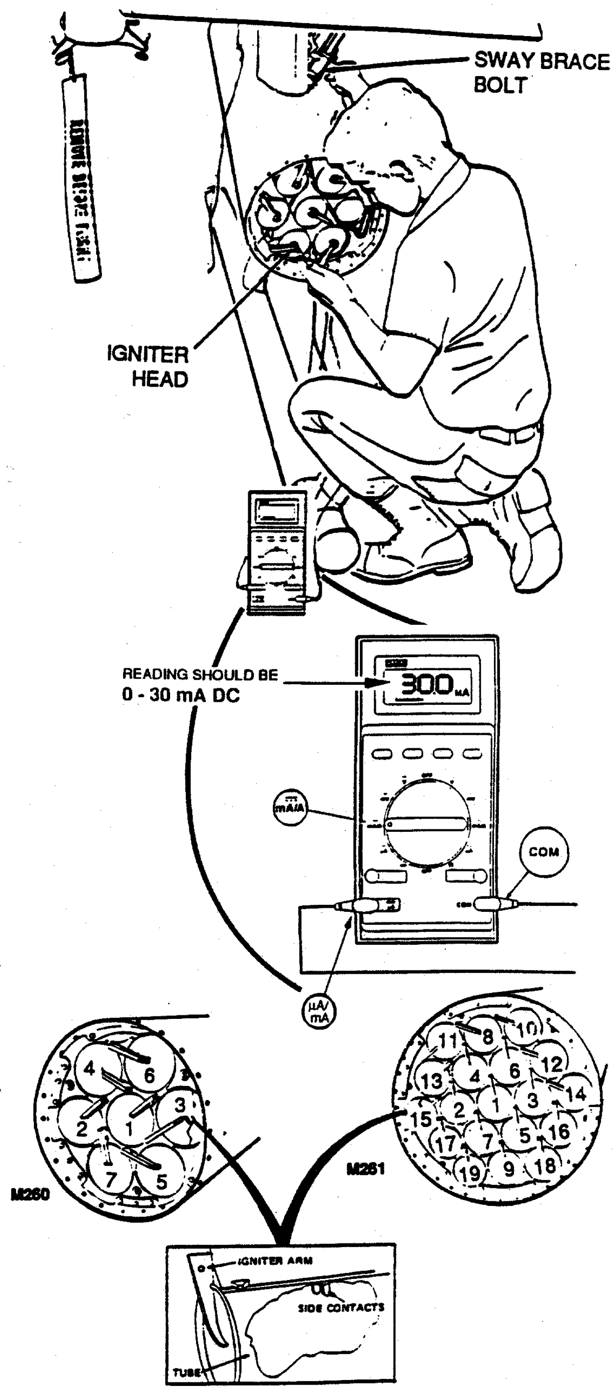
(j) REPEAT STEPS (e) THROUGH (i) FOR EACH TUBE; REFER TO TUBE FIRING ORDER.

(k) REPEAT COMPLETE CHECK AT LEAST ONCE EACH OPERATIONAL DAY AND PRIOR TO EACH LOADING.

(l) REMOVE SAFETY PINS.

(m) TURN THE MULTIMETER FUNCTION SELECTOR ROTARY SWITCH TO OFF.

(n) DISCONNECT METER.



TUBE FIRING ORDER (REAR VIEW)
NOTE: TUBE FIRING ORDER IS 19 THROUGH 1, AND 7 THROUGH 1