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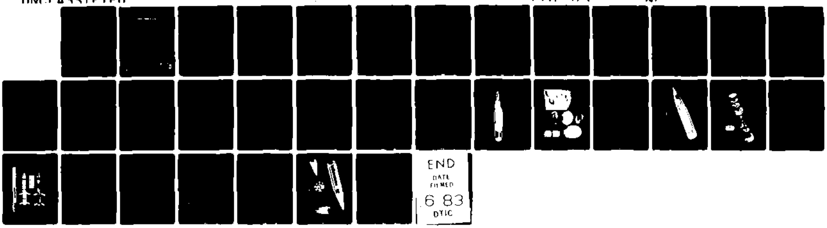

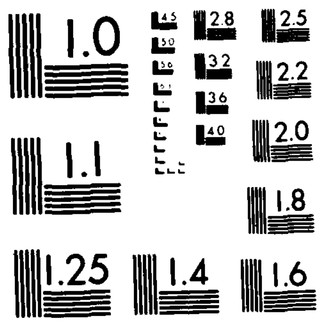

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LEAD TIME STUDY

JULIE CHU

MAY 1982

US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND

REQUIREMENTS AND ANALYSIS OFFICE

SYSTEMS ANALYSIS DIVISION

DOVER, NEW JERSEY

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LEAD TIME STUDY

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BACKGROUND

Lead times for the procurement of ammunition items are usually established during the latter part of the development phase, which is approximately two years before the initial production buy. Typical procurement lead time forecasts have been 15 months for the initial buy and 12 months for reorder. During the last decade ammunition items have greatly increased in sophistication due to the widespread use of electronics technology. As a result, lead times for such items have increased to 18-31 months initial and 15-28 months reorder. Higher authority is concerned with the growth in lead times and is reluctant to change lead times after they appear in budgetary documents such as the 5 Year Defense Plan (FYDP). This results in apparent delivery slippages against the unrealistic lead times which eventually impact subsequent procurements when the delivery backlogs can no longer be tolerated. At this point a decision is made to reduce or eliminate production funds which, in turn, disrupts the flow of hardware metal parts and causes significantly higher unit prices. Because of this problem the Program Management Office, ARRADCOM, requested a Lead Time Study be conducted to examine the validity of current lead time assumptions and means for improving lead times for more sophisticated items.

OBJECTIVE

Determine the validity of 15 month initial order procurement lead time and 12 months reorder procurement lead time in Army materiel planning for complex and high technology items.

Identify factors which determine lead times for complex items and actions which can be taken to minimize their effect.

STUDY PROCEDURE

A literature search of pertinent studies and documents was conducted to obtain background information. Appendix 1 is a listing of the studies and documents reviewed.

Six ammunition items were selected for in-depth study of lead times. The items selected were identified as either complex or simple. "Complex" items are those using electronic components and are more sophisticated in nature. The items selected for study and their designations are as follows:

Projectile, 155mm, M692/731 (ADAM)	-	Complex
Projectile, 155mm, M741/718 (RAAM)	-	Complex
Projectile, 155mm, M712 (Copperhead)	-	Complex
Cartridge, 105mm, M490	-	Simple

Cartridge, 105mm, M724 - Simple

Projectile, 155mm, M483A1 - Simple

Descriptions of the selected items are contained in Appendix 4.

Site visits were made to gather lead time data relating to such elements as raw material, critical and high technology components, suppliers capacity, market behavior and other factors which affect lead times. A listing of visits made is contained in Appendix 2.

The results of these efforts were analyzed and are presented in this report.

DEFINITION OF TERMS

Procurement Lead Time includes Administrative and Production Lead Times and is defined as follows:[1]

> Administrative Lead Time (ALT) - Begins the month in which procurement program authority is received and ends the month contract is awarded.
>
> Production Lead Time (PLT) - Begins the month immediately following end of ALT and ends the month immediately preceding month in which identifiable end items is initially delivered from either contractor production or government fabrication or assembly (excluding prototypes).

The Procurement Lead Time depends on the following variables, most of which are interrelated with each other and not necessarily accumulative:

No. of engineering drawings/specifications/engineering changes.

No. of prime and sub-contractors.

Critical raw material involved.

No. of foreign suppliers.

Industrial base responsiveness.

FINDINGS AND ANALYSIS

LITERATURE SEARCH

A wide variety of literature covering the period 1964 through 1981 was reviewed. Some of the documents reviewed were in depth studies of lead times and associated factors; others dealt with background issues affecting lead times. The review

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[1]Procurement Planning and Policy Guidance, DA, December 1980.

indicated that measurement and control of lead times has not been systemized to the extent necessary for materiel planning. This stems largely from the number of interacting factors which influence lead times and the constantly changing conditions which may easily result in poor forecasts. Other contributing factors include limited resources, critical materiel shortage, decreasing defense supplier base and backlogs in deliveries which have occurred since 1973.

LEAD TIME HISTORY

Table 1 is a compilation of administrative and production lead times for the 6 items.[1] For ADAM, the table indicates an average Production Lead Time of 24 months over the three year period. Examination of actual production deliveries indicates that major electronic components were delivered by the contractor 10-13 months after contract award. It should be noted that, in order to accomplish the 10-13 months deliveries, the contractor (Honeywell) found it necessary to place component orders, at his own risk, 4 months in advance of contract award. The balance of 11-14 months was required to LAP (Load, Assemble and Pack) end items at the Louisiana Ordnance plant. The time required for LAP included a delay caused by a slippage in prior year deliveries. If this delay had not been experienced, the average production lead time would have been reduced by a like amount.

A similar situation occurred with RAAM. In this case, the average PLT was 21 months. Of the total, 10-13 months was required for delivery of major electronic components and 8-11 months for LAP. The LAP time also included a delay due to slippage in prior year deliveries.

Copperhead presented a different problem. Although the initially planned LAP capacity was reduced significantly, it was not the cause for the long lead times, i.e., LAP capacity was not the controlling factor. The problem stemmed more directly from the failure to accomplish a timely initial production build-up which, in turn, reflects the need for longer lead times for items of greater complexity.

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[1] Provided by Production Directorate, ARRCOM and PM/CAWS Office

Table 1

Lead Time in Months

	FY78			FY79 ***			FY80		
	ALT*	PLT*	Total	ALT	PLT	Total	ALT	PLT	Total
ADAM M692/M731	6	23	29	6	25	31	5	24	29
RAAM M718/M744	10	20	30	9	21	30	10	21	31
Copperhead M712				12	27	39	14	16**	30**
M483A1	3	9	12	5	8	13	6	7	13
M490	7	5	12	7	5	12	8	6	14
M724A1	4	4	8	4	7	11	10	4	14

* ALT - Administrative Lead Time

PLT - Production Lead Time

** No delivery has been made by 30 April 1982

*** Note: FY79 was the fourth year buy for ADAM, second year for RAAM and the first year for Copperhead.

ANALYSIS OF LEAD TIME VARIABLES

The major drivers of the long lead time for complex items were found to be electronic components and critical raw material. Other drivers, such as metal parts, forgings, castings, special heat treatment and mill run, which are common to the six selected items did not contribute significantly. Similarly, precision, tolerance limits or fabrication process requirements, which are generally more severe for the complex items, did not contribute serious delays. The following long lead time variables relating to the major drivers were investigated with results as indicated.

Number of Drawings/Specification/Engineering Changes

Table 2 is a compilation of the number of engineering drawings, specifications and engineering changes in the Technical Data Package for each item.

Table 2

	No. of Engr. Drawings	No. of Specs.	No. of Engr. Changes
Copperhead	3975	531	912
ADAM	342	252	117
RAAM	350	247	152
M483	126	171	109
M490	92	146	60
M724	147	153	72

The number of engineering drawings and specifications is a true measure of the complexity of an item. As the complexity increases it can be expected that a larger number of engineering changes will be required during early production and increased delivery time will result. Table 1 reflects the contribution of these three variables. Copperhead, with the largest number of drawings, specifications and engineering changes, has also experienced the longest lead time. ADAM and RAM are similar to each other in each of the three categories and have experienced similar lead time delays. The three "simple items" have smaller numbers in each category and have a better lead time performance record.

Number of Contractors/Subcontractors

Table 3 contains a listing of prime contractors for each of the six items.

Table 3

	Prime Contractors	Electronic Component Subcontractors	Sub-Subcontractors
M712 (Copperhead)	1	7	32*
XM692/731 (ADAM)	4	1	80
M718/741 (RAAM)	2	1	103
M724	6	0	0
M483	10	0	0
M490	8	0	0

* No. shown is for 1 electronic component subcontractor only. Others unknown.

Also listed are the electronic component subcontractors and sub-subcontractors. As noted thereon, a complete listing of sub-subcontractors was not available for the Copperhead projectile, however, the compilation does serve to indicate the need for longer lead times in those cases where a number of electronic component subcontractors and sub-subcontractors are involved. This is evidenced by the fact that the three complex items (Copperhead, ADAM, RAAM) involved 40, 84 and 105 contractors respectively (plus an additional unknown quantity for Copperhead). Since the three simple items (M724, M483 and M490) contained no electronic components, there were no electronic component subcontractors involved. The better performance achieved with the simple items, in terms of production lead time (Table 1), appears to stem in part from the absence of involvement of subcontractors.

Critical Raw Materials

A source of delay in the Copperhead programs stemmed from the use of titanium in the seeker/guidance assembly. The contractor, Martin-Marietta, experienced lead times of 56-66 weeks on titanium forgings and 40-54 weeks on titanium extrusions and these lead times are expected to increase dramatically over the next few years as a result of the B-1 program. Lead time data developed by the Defense Science Board Task force are summarized as follows:

Schedule Trends (Weeks)

	1976	1977	1978	1979	1980
Titanium Sponge	40	46	60	70	104
Titanium Large Forging			70	150	180
Titanium Extrusions			65	95	108

The long lead time for titanium is due to:

Titanium plant capacity - a small number of domestic firms produce titanium sponge. During 1977-1979, the number of titanium fabrications dropped from 16 to 4, primarily because of the sponge shortage and EPA and OSHA requirements.

Non-military sector consumption of titanium sponge, which has increased from 5% to 30% from 1972 to 1979.

U.S. domestic supply cannot meet the U.S. demand.

The trend away from dependence on the military market is encouraging titanium producers to expand. In 1982 the U.S. has added one more plant, the D-H Titanium Company in Texas. Two Japanese sponge producers are expanding their plants and the USSR is planning to expand their titanium sponge capacity by 25 percent. These factors should improve sponge lead time in the future, however, the Army must continue to compete with other services and private industry for the currently limited resources therefore the longer lead times projected for complex items can be expected to continue.

Electronic Components

The increased use of electronic components (semiconductors, integrated circuits, microcircuits, diodes, etc.) in both military and commercial applications has caused an increase in delivery lead times during recent years which is expected to continue in the future. The 1980 Defense Science Board Report contains the following lead time schedule trend for 1978 through 1980:

Lead Time (Weeks)

	1978	1979	1980
Integrated Circuits	25	40	62
Microcircuits	25	40	51
Diodes	25	31	50

Additional data in this regard is provided by Martin-Marietta Aerospace in their Commodity Lead Time and Trend report for the 1st Quarter 1982. The current lead time for integrated circuits is reported to be 48-62 weeks. Martin-Marietta Aerospace has also stated their view that defense electronic lead times will continue to increase even during the commercial slack season, when the market is soft. This is because the industry will close down lines and lay-off workers, therefore, the soft or slow commercial market does not necessarily mean a lead time improvement for the military market.

The increasing commercial market for electronic components has another adverse effect on military procurement. Since the commercial market is increasing at faster rate than the military market, military requirements are becoming a smaller percentage of the total, which places the military in an unfavorable position. Evidence of this trend is contained in the publication Military Electronics/Countermeasures, December, 1979, Page 49 as follows:

	1978	1982	1987
Total Semiconductor Market	$8.4B	$17.3B	$43.1B
Military Semiconductor Market	$563M	$878M	$1.4B
Military as a % of Total	7%	5%	3%

Although the relative size of the military market is perhaps the major factor, other factors exist which influence the ability or desire of industry to satisfy the military market. In general, military items are more complex and impose higher reliability standards. Testing is more severe, time consuming, and requires expensive investment in capital equipment. Such factors in combination with the relatively small market tend to place the military market at a serious disadvantage.

Industrial Base Responsiveness

The shrinking industrial base of DOD subtier contractors is another serious factor which affects the long lead time in complex items. In June, 1980, Texas Instruments conducted a vendor survey on the electronic base. TI contacted their major contractors supplying microwave components, connectors, semi conductors, power supply tubes, rotary components and casting housings. All respondents planned to continue in the military supply business. Most of them intend to modestly invest in equipment but would not make major investments to significantly increase their capacity to produce items for military buys. Resource and capital equipment investment will therefore be conservative and only made to support areas that have high profit potential.

The following is a list of more pertinent survey responses:

Major barriers:

Low production orders.

Low return on investment.

Excessive specifications.

Lack of visibility of total product requirement.

Some small vendors lack personnel and dollars to handle government paperwork and police standard military specifications.

Restriction of supply sources (vendors).

Lack of uniform quality standards.

Action by government or major customer to increase participation:

Standard specifications.

More reasonable lead time.

Adequate time for proposal effort.

More time for new product development.

Allow a fair return on investment.

Multi-year contracts.

Foreign Suppliers

There has been an increasing dependence on foreign suppliers for complex item components. The previously referenced Texas Instruements survey estimates that 80 to 90% of military semi conductors are assembled and tested outside the United States. These facilities are located primarily in the Far East - Taiwan, Korea, Singapore, Malaysia and Hong Kong. In addition, a significant amount of ceramic parts, lead frames and high technology electronic components are supplied by Japan. Other examples of foreign dependency are found in the ADAM and RAAM programs. Filter paper for ADAM is supplied by only one British company, Curten Mathesen. A special glass for the ampoule in the RAAM battery was supplied by a German company for the first two years of production although the glass is now made in the U.S. by the Corning Company. The dependency on foreign sources not only contributes to the lead time problem but also raises a serious question on the source of critical components if, for some reason, foreign sources should no longer be available.

CONCLUSIONS

From the available information on procurement lead time trends, the following conclusions are made:

For the simple items, M483A1, M490 and M724A1, the DA procurement lead time requirements (15 months initial and 12 months reorder) currently in use are reasonable.

The complex items, M712 (Copperhead), M718/M741 (RAAM) and M692/M731 (ADAM), cannot meet the above lead time requirements.

The first year buy is critical to the entire program lead time. A slippage of the first year buy usually causes a corresponding slippage in the following buys.

A special effort is necessary to improve lead time performance.

RECOMMENDATIONS

It is recommended that the following lead time guidelines be applied to complex, high technology items in Army materiel planning:

Initial Administrative Lead Time, 3-9 months

Reorder Administrative Lead Time, 3-6 months

Initial Production Lead Time, 18-21 months

Reorder Production Lead Time, 15-18 months

Recommendations for improving the materiel acquisition are as follows:

Internal actions:

Establish overall management of lead time performance

More effective use of short of award authority

Advanced material buys

External actions:

Establishment of a U.S. military semi-conductor production base to produce critical parts, such as ceramic packages and lead frames, domestically.

Simplify acceptance testing and qualifications for electronic components to the maximum extent possible.

Multi-year contracting to encourage capital investment and provide greater stability to defense contractors.

Authorize advanced material buys

Further studies:

Conduct detailed PERT Analysis of Administrative Lead Time (ALT) and improving program control during this phase.

Perform in-depth analysis of first year buy experience among similar items to identify problems and determine if solutions exist that could improve lead time performance on future programs.

On special projects, such as Copperhead, perform detailed risk analyses for research and development, demonstration and validation, maturation and production phases to obtain early indication of lead time performance and permit more realistic program planning.

APPENDIX 1

LISTING OF STUDIES AND DOCUMENTS REVIEWED

- Procurement Planning and Policy Guidance, DA, Dec 1980.

- Analysis of Critical Parts and Materiels, Air Force Business Research Management Center, Wright-Patterson AFB, Ohio, Dec 1980.

- Report of the Defense Science Board on Industrial Responsiveness, Office of the Under Secretary of Defense for Research & Engineering, Washington, D.C., Jan 1981.

- Procurement Administrative Lead Time Management and Performance Criteria, Army Procurement Research Officer, USA LMAS, Fort Lee, Virginia, Mar 1977.

- The Sub-Contractor and Surge and Mobilization, Briefing at the Conference on Surge and Mobilization, June 4-5, 1981.

- Analysis of Automation VS Lead Time, June 1977.

- Ammunition Production Base Lead Time Study, Stetter Associations, Inc., November 1978.

- Determinations of Distribution of Procurement Lead Times Using the Graphical Evaluations and Review Technique, March 1973.

- JCAP Conventional Ammunition Emergency/Mobilization Lead Time Study, JCAP Procurement & Production Task Group, April 1975.

- An Investigation of Selected Business Indicators as Related to Aerospace Materials Lead Times, Air University, Maxwell Air Force Base, Alabama, July 1975.

- Production Lead Time Forecasting, USA ALMAC, Fort Lee, Virginia, Jan 72.

- Mean Lead Time, ALRAND Report 44, U.S. Naval Supply Depot, Mechanicsburg, PA, July 1-64.

- Purchasing Magazines.

APPENDIX 2

LISTING OF VISITS

In order to obtain first hand information related to current long lead time problems of projectiles, the following trips to both the Government procurement agencies and private industries have been made:

- Rock Island Arsenal, 14-16 October 1981. Visited Production Directorate and Cost Analysis Office in ARRCOM to obtain lead time data on transitioned items and discuss the lead time study approaches.

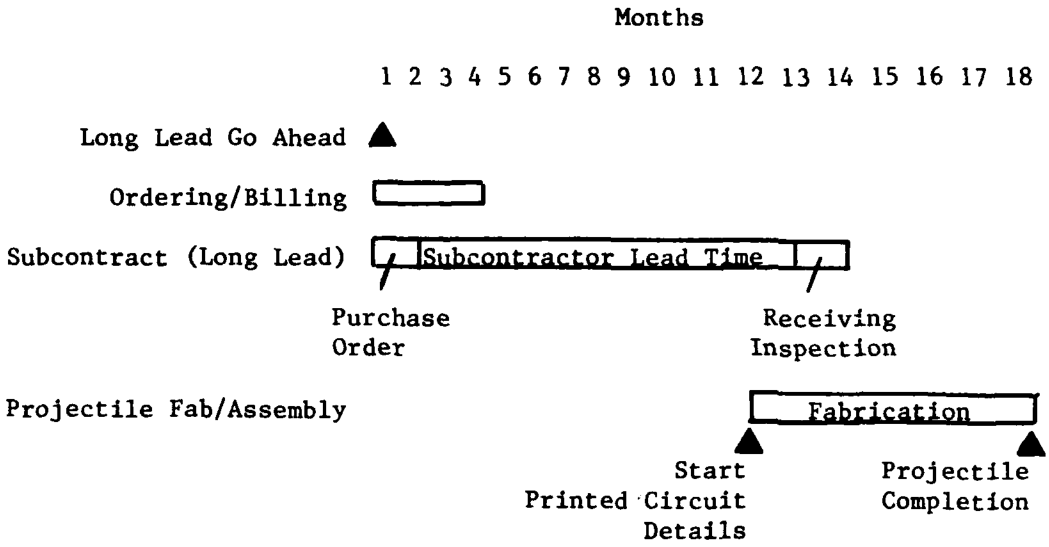
- Martin-Marietta Aerospace 1-2 April 1982. Visited their Orlando Plant to discuss the affecting factors of Copperhead lead time and tour the febrication process line.

- Honeywell Inc., 8-9 April 1982. Visited their New Brighton Plant to discuss critical components, critical raw materiel, vendor supply capability and fabrication process which have great impact to the extended lead times noted in this study. Also toured the ADAM and RAAM fabrication lines.

- Aberdeen Proving Ground, 12-13 April 1982. Visited the Field Liasion Logistic and Readiness Division, AMSAA, to keep each other informed on the on-going lead time trends, studies and analysis.

APPENDIX 3

COPPERHEAD LEAD TIME SCHEDULE - FY82 BUY



Source: Planning Management Office, Martin Marietta Aerospace

APPENDIX 4

System Descriptions *

Proj., 155 MM, HE, M692/M735 (ADAM)

Purpose - ADAM is a special round used to deliver submissiled anti-personnel mines fired from a 155 MM howitzer.

Description - The 155 MM, HE, M692 and M731 ADAM projectiles are mine munitions, each containing 36 AP mines, arranged in four layers of four mines per layer and four layers of five mines per layer. The projectile is comparable in length, weight, and external configuration to the 155 MM, M483A1 projectile. The projectiles will utilize standard propelling charges and will be fuzed with the M577, MT, SQ fuze. The fuze action ignites the expulsion charge (M10 propellant) contained in a cup in the ogive section, ejecting the 36 mines from the base of the projectile over a large, nearly circular area. Setback when fired and the spin of the projectile while in flight enables the safe and arming device of the mine to arm upon ejection and simultaneously the power source is activated, beginning the time function. Upon ground impact and after a short time delay, seven sensor trip lines are deployed. After another short time delay, to allow the munition to return to rest, the electronics are enabled, causing the mine to completely arm. Disturbance of a tripline or disturbance of the mine itself triggers an electronic firing circuit. A thin layer of liquid propellant which surrounds the lower half of the kill mechanism is initiated, shattering the plastic munition body, and projecting the kill mechanism vertically upward. A delay detonator contained within the kill mechanism is forced in line and ignited by this action. At a position 2 to 8 feet above the ground, the kill mechanism, which is a spheroid embossed with a fragmentation pattern and loaded with Comp A-5, detonates, projecting approximately 600 1-½ grain fragments in all directions.

If the mine is not functioned within the desired lifetime, the self-destruct mechanism is activated, initiating the mine as described above. The self-destruct time for the mine differs from the M692 projectile and with the M731 projectile.

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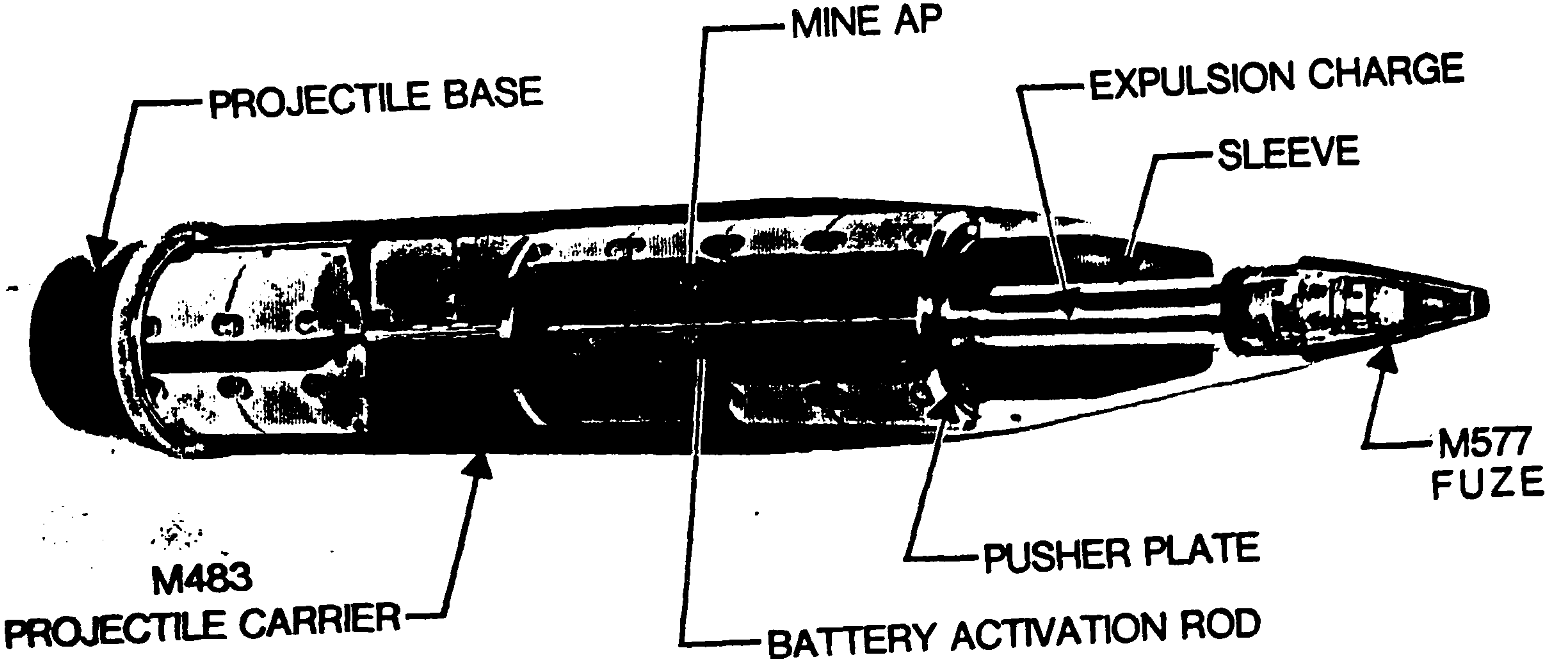
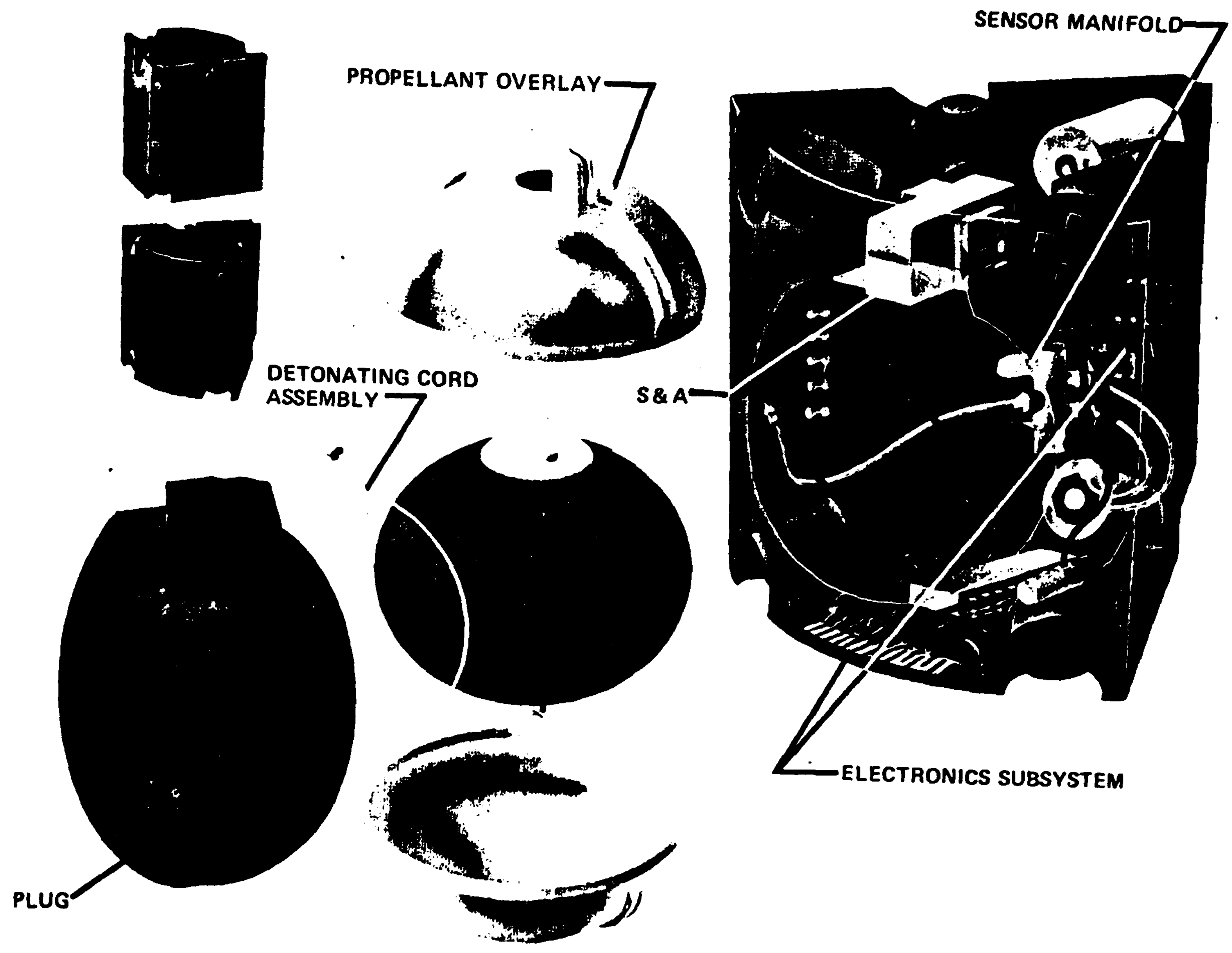
* Source: 155mm Artillery Weapon System Reference Data Book, May 1980, Large Caliber Weapon System Lab, US ARRADCOM.



PROJECTILE, 155MM, HE, M692 / M731 (ADAM)



MINE FOR M692/M731 (ADAM)

Proj., 155 MM, M741/M718 (RAAM)

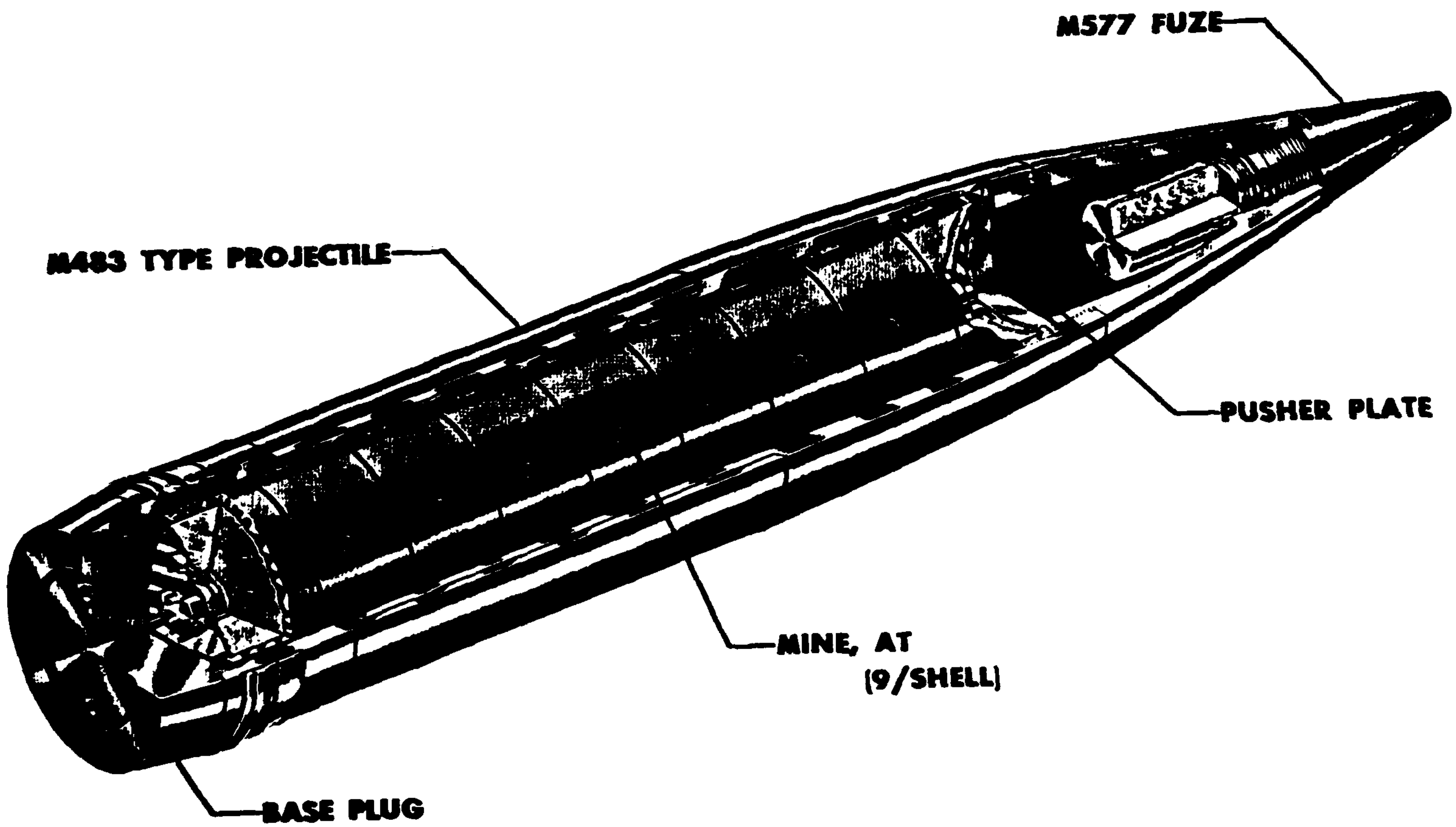
Purpose - RAAM are used to deliver anti-tank mines in front of enemy armored forces to deny/delay access to a particular area for a specific time period.

Description - The projectiles contain a payload of anti-tank mines which are ejected during projectile flight by an expulsion charge activated by the M577 Fuze. The mines are armed soon after ground impact and upon sensing the proximity of tanks or other armor the mines initiate. If the mines are not initiated during their intended life span, a circuit is activated causing the mines to self destruct. A percentage of mines in each projectile have anti-disturbance mechanisms to discourage attempts at mine field clearing.

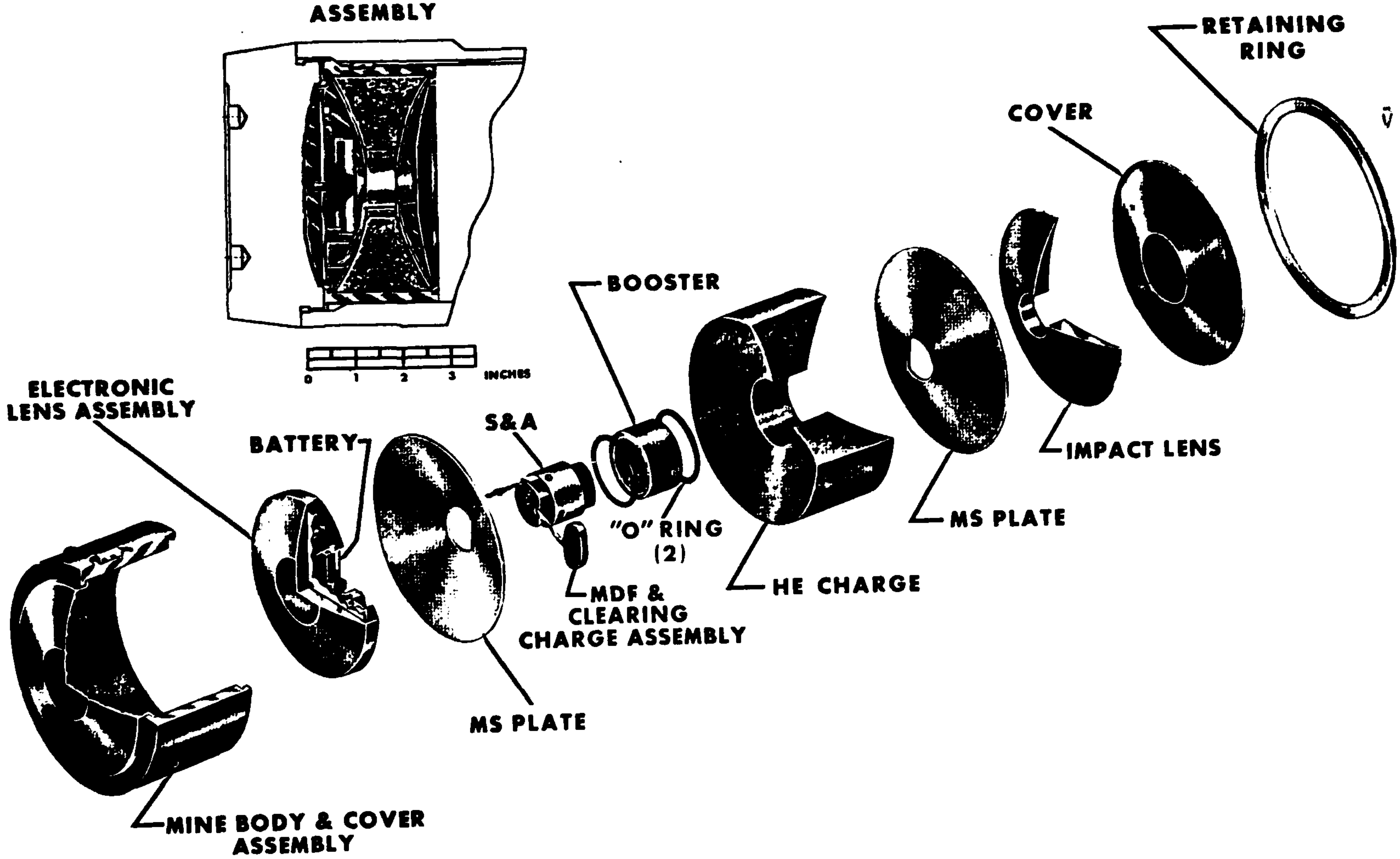
The projectiles are the separate loading type, fuzes, propelling charges and primers being handled separately in sequence. Projectiles are issued eight each to a pallet, with fusible lifting plugs which are replaced prior to firing with M577 MTSQ Fuzes. The 155 MM, HE, AT M718/M741 Projectiles are mine munitions, each containing nine anti-armor mines. They are comparable in length, weight and external configuration to the 155 MM M483A1 Projectile. Standard propelling charges and the M577 Fuze are utilized. The mines are cylindrical in shape measuring five inches in diameter, 2.4 inches in height and weighs five pounds. The fuze action ignites the expulsion charge (M10 Propellant) contained in a cup in the ogive section of the projectile. The propellant gasses, acting against the pusher plate, eject the anti-armor mine submunitions from the base of the shell over the selected area. On ejection, set forward force and projectile spin action enables the safe and arming device of the mine, to start timing functions and aligns the explosive elements. After delay, during which time the mine impacts the ground and mine motion stops, the sensor (magnotometer) is enabled electronically and target direction is possible. Upon sensing the target and localizing the firing in the vehicles most vulnerable area, the mine fuze firing train is initiated with explosive action, removing the electronic lens. The second explosive action is initiated by a delay detonator, the booster and the main charge, which then accelerates the Miznay Shardin (MS) Plate, at hypervelocity, through the belly armor of the vehicle. The large number of fragments, produced beyond the armor, are capable of producing high kill probability.

If the mines are not functioned within their factory set life, the timing circuit of each mine will activate the fuze explosive train, as described above, and the mine will self destruct. The self destruct time for the mine differs from the M718 projectile and the M731 projectile.

PROJECTILE, 155MM, AT, M718/741



MINE FOR M718/M741 (RAAMS)



Proj., 155 MM, CLGP, M712 (Copperhead)

Purpose - The M712 is a laser guided indirect fired cannon launched projectile which provides the Field Artillery with the ability to engage both stationary and moving hard point targets with a high degree of first round kill probability. Designed to be fired from the M109 self-propelled and the M198 and M114 towed howitzers, Copperhead can also be fired from many other 155 MM weapons, including NATO howitzers; FH 70, SP 70 and 155 GCT. It uses standard propellant charges and can be loaded and fired interchangeably with conventional rounds.

Description - Copperhead is a terminally guided system launched from conventional howitzers into a ballistic trajectory. During flight, the target is illuminated by a forward observer with a laser designator. An onboard computer continuously refines the terminal trajectory and provides guidance to the control surfaces, causing the round to home in on the target.

Copperhead has three mechanically separable sections: Guidance, warhead, and stabilization and control. The configuration is aerodynamically controlled by cruciform in in-line wings and tail fins that provide roll stabilization and lateral maneuverability sufficient to provide an impact footprint capable of defeating maneuvering armored targets.

The guidance section consists of the seeker and electronic assemblies which are housed within the nose dome and steel housing. The seeker employs folded body-fixed optics with a spin stabilized gimbaled mirror (seeker gyro). The seeker gyro is mechanically spun and is sustained and torqued electrically.

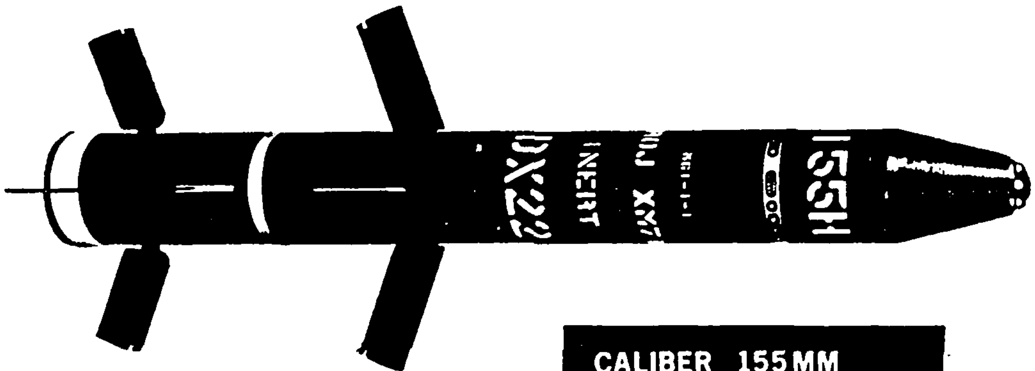
The warhead section includes a high explosive shaped charge warhead in a steel structure and a fuze module. The fuze module houses the dual channel Safing and Arming Mechanism and the firing circuit train. The fuzing subsystem also includes a direct impact sensor mounted in the nose dome, six shock wave sensors in the guidance section, the four second environment (tube exit velocity) sensors in the stabilization and control section housing.

The stabilization and control section includes the deployable aero-dynamic surfaces and associated actuator mechanisms. The control actuator is a cold gas, three axis system. Pitch control is provided by the two connected fins while yaw and roll control are obtained by independently operating the other two fins. In addition to the gas supply and control electronics, this section contains the launch activated thermal battery for all on-board electrical power. The stabilization assembly consists of the control section structural housing, obturator, aft closure, wing assembly, and four fins which attach to the control actuator.

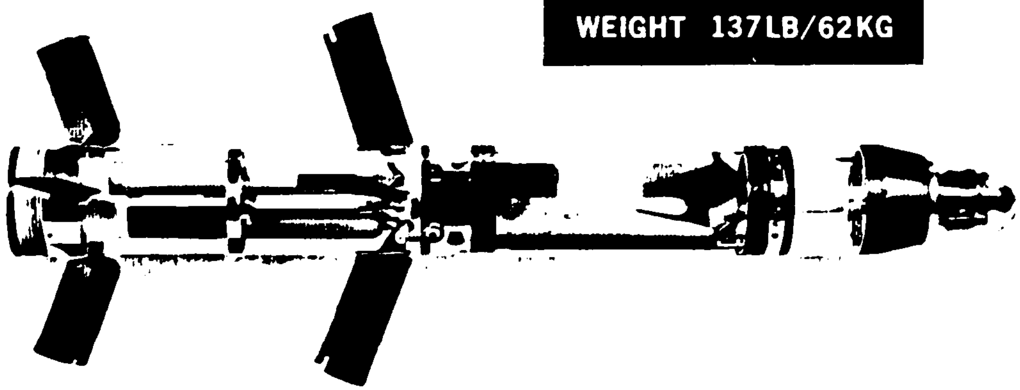
Tail fins are attached to the hubs of the control actuator and retained within the housing by a latch mechanism. The fin locks are released by launched acceleration and the fins are deployed by centrifugal force immediately after the projectile leaves the gun barrel and locked in place.

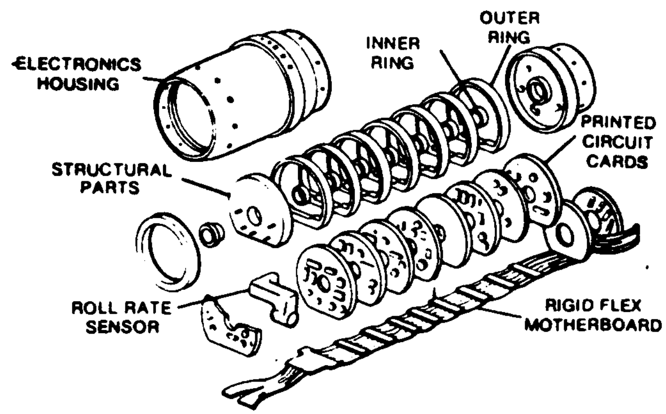
PROJECTILE, 155MM, GUIDED, M712

COPPERHEAD

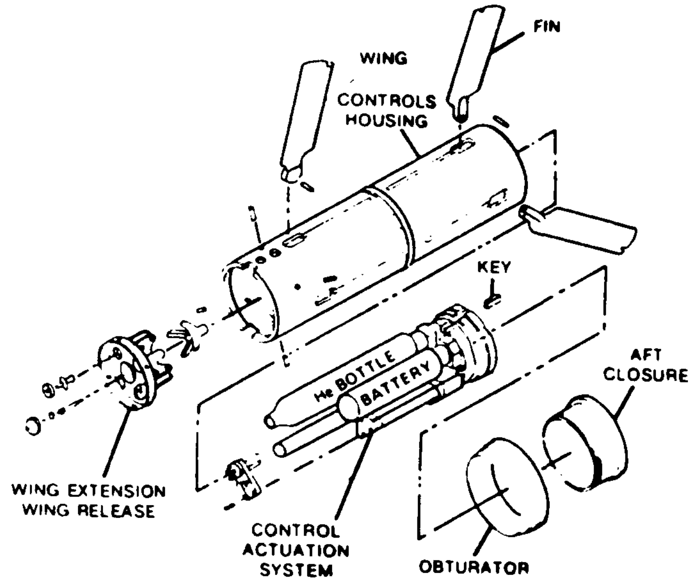


CALIBER 155MM
LENGTH 54IN/137CM
WEIGHT 137LB/62KG

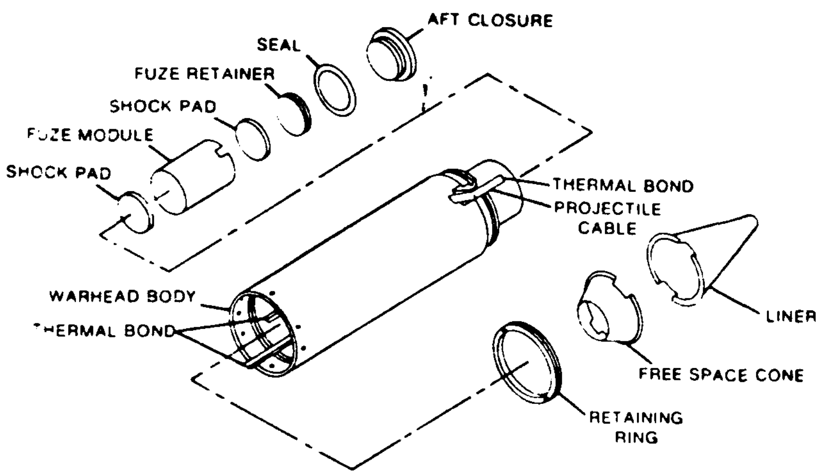




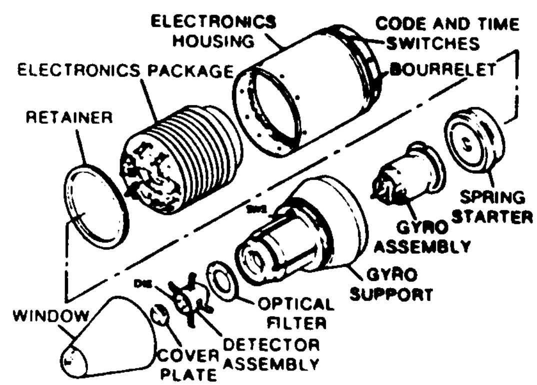
GUIDANCE SECTION (ELECTRONICS ASSEMBLIES)



STABILIZATION AND CONTROL SECTION



WARHEAD SECTION



GUIDANCE SECTION (SEEKER)

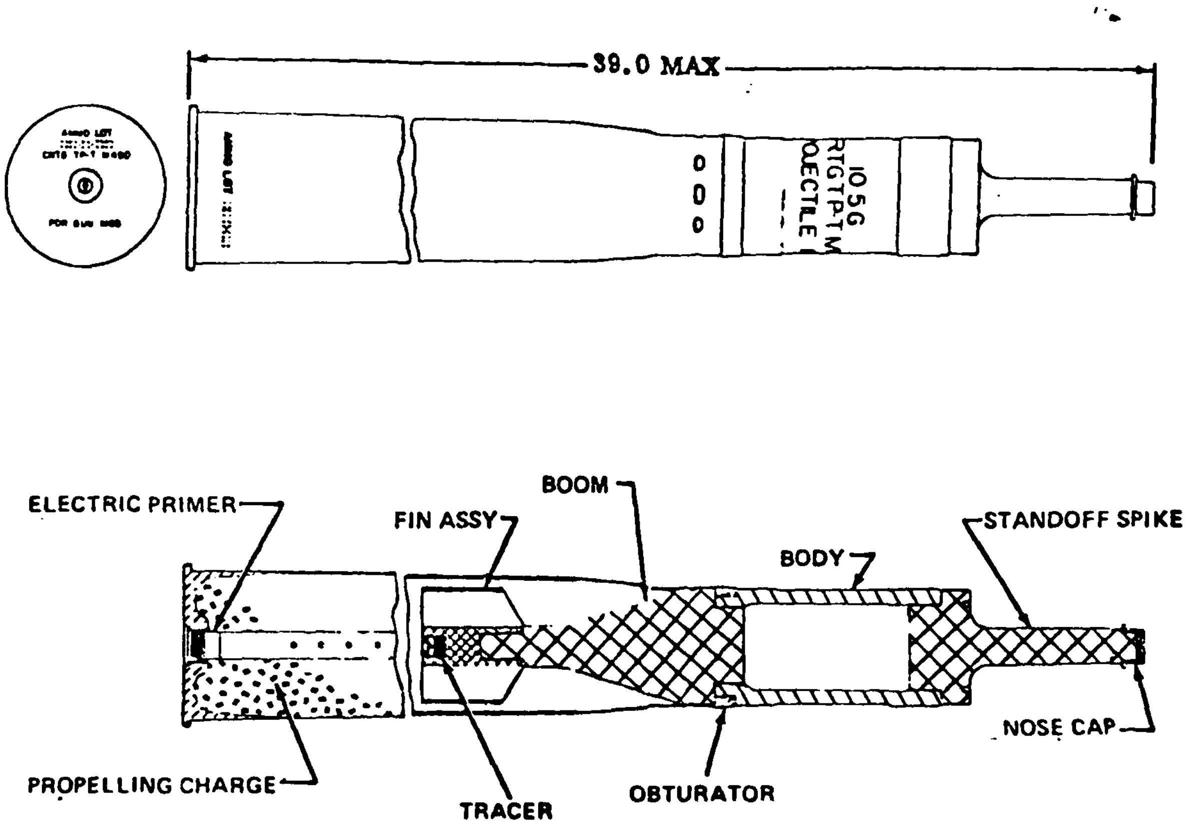
PROJECTILE, 155 MM, GUIDED, M712, MAJOR SECTIONS

CTG, 105 MM, M490

Purpose - The cartridge is for use in 105 MM gun cannons for training in markmanship.

Description - The cartridge is similar in external appearance and ballistically similar to HWAT-T Cartridge M456 series. The projectile consists of a steel body, an aluminum standoff spike, and a boom and fin assembly with tracer. The cartridge case is filled with loosely packed propellant and is fitted with an electric primer.

The electrically initiated primer ignites the propelling charge. Gases produced by the burning propellant propel the projectile from the gun and ignite the tracer which burns for a minimum of 2.5 seconds.



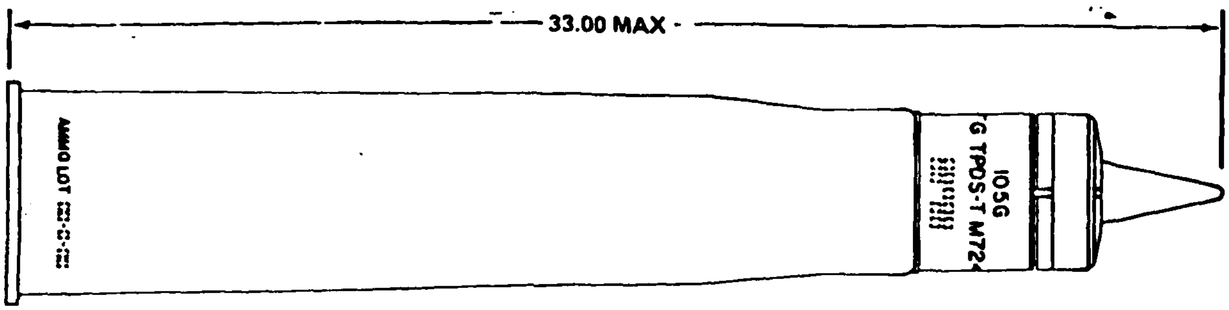
CARTRIDGE 105 MILLIMETER: TP-T, M490

CTG, 105 MM, M724

Purpose - This cartridge is used for gunnery training in tank-mounted 105 MM gun cannons.

Description - This discarding sabot round is similar in external appearance and is ballistically similar to 2000 meters with the APDS-T Cartridge M392A2. There is a tracer located in the base of the projectile. A plastic band encircles the sabot at the forward end. A fiber rotating band and rubber obturating band are mounted toward the base of the sabot. The igniter tube of the electric primer extends almost the entire length of the propellant packed loosely in the cartridge case.

The electrically initiated primer ignites the propelling charge and tracer. Gasses produced by the burning propellant propel the projectile from the gun. The tracer burns for a minimum of 2.5 seconds. The sabot is discarded after leaving the muzzle of the weapon, as a result of setback, centrifugal, and air pressure forces. The solid core of the projectile continues to the target. Since it is a practice round, the projectile lacks the penetrating capability of a service round.



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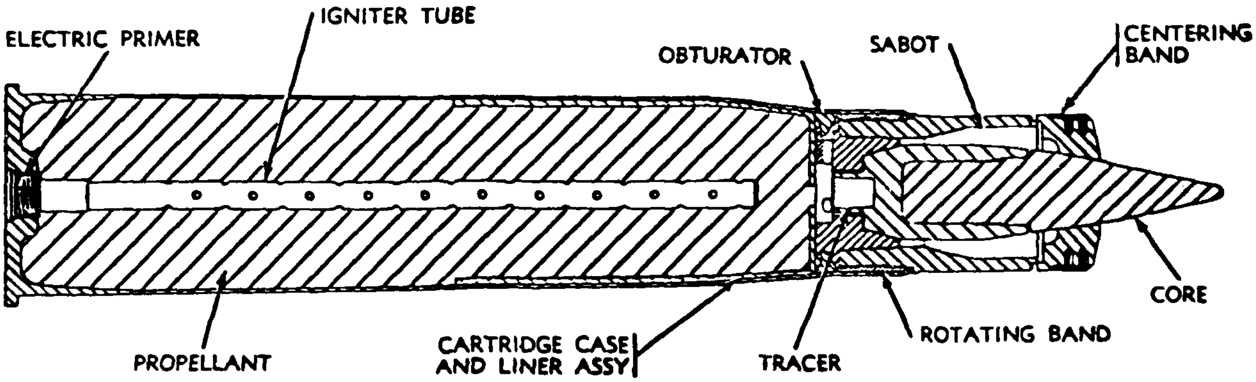


CARTRIDGE, 105 MILLIMETER: TPDS-T, M724A1 AND M724

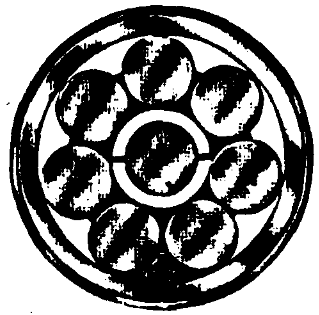
Proj., 155 MM, M483A1

Purpose - This projectile is used to deliver a cargo of submissile dual purpose armor defeating and anti-personnel grenades.

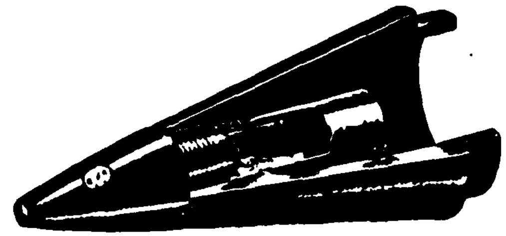
Description - The M483A1 is an ICM projectile containing a total of 88 dual-purpose grenades (64-M42 and 24-M46) each capable of penetrating in excess of 2 ½ inches RHAP armor and fragmentation for incapacitating personnel. The M42 grenade is embossed on the inside wall surface to provide controlled fragmentation effects. The M46 grenade has a stronger unembossed body which is able to withstand the greater load seen at the rear of the shell due to setback upon firing. An M577 Mechanical Time Fuze, or an M724 Electronic Time Fuze, assembled to the projectile, is preset to function over the target area, and initiate the expulsion charge assembly which is contained in a cavity in the ogive of the projectile. The force of this charge, acting upon the pusher plate, is transmitted through the grenades to the base plug, shearing the threads which secure the plug in the shell, and expelling the grenades from the aft end of the projectile. The projectile spin desperses the grenades in a circular pattern. Upon expulsion from the projectile, the nylon ribbon stabilizer, attached to the arming screw in each grenade, deploys and orients the grenade. As the grenade spins about its axis, the ribbon retards the arming screw relative to the rotation of the grenade assembly. This causes the screw to rotate and withdraw from the slide allowing the slide to move into the armed position by action of the slider spring and centrifugal force. On impact, the inertia of the arming screw/weight assembly drives the point of the screw into an M55 detonator initiating the firing train. A shaped-charge jet is directed downward to penetrate armor plate while the grenade body bursts into a large number of small fragments to provide the anti-personnel effects. When required, the expulsion charge is replaced by a shaped charge which will initiate a high order detonation of the entire projectile (with no prior expulsion of the grenades) to provide a spotting capability. The projectile is issued with a fusible lifting plug threaded into the fuze cavity. This is replaced by a fuze prior to loading the projectile into the weapon.

PROJECTILE, 155MM, HE, M483A1

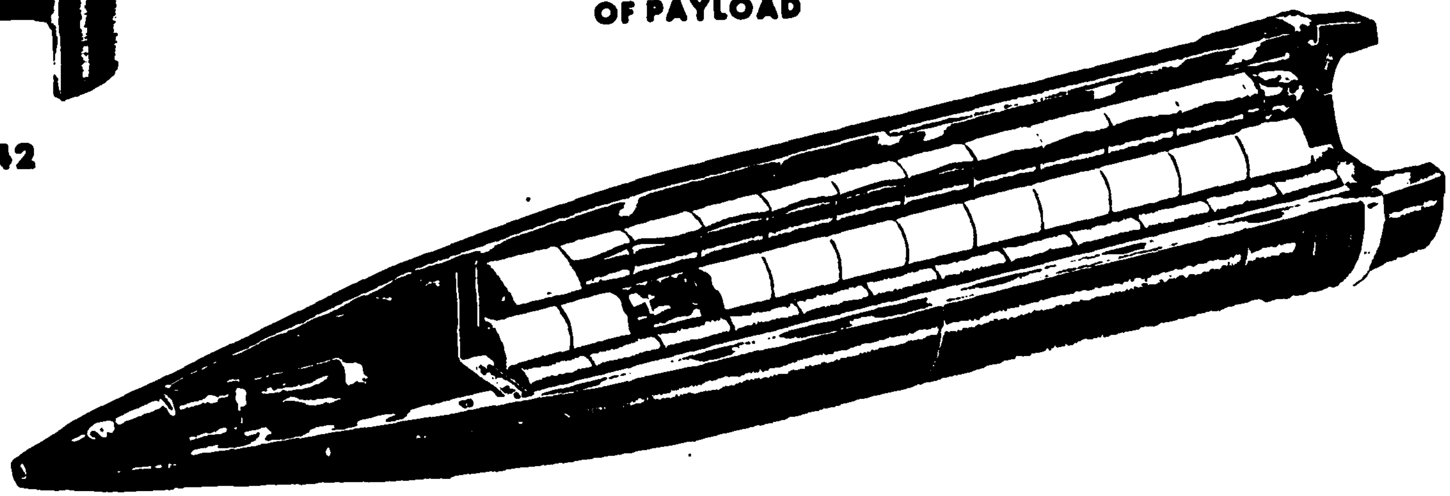
M42



CROSS SECTION
OF PAYLOAD



OGIVE WITH SELF
REGISTRATION ASSEMBLY



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