

# **Large Scale HEAT and APERS Munitions Disassembly Safety**

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## **Abstract**

Demilitarization of munitions has primarily involved open detonation and open burning. Due to environmental concerns and public pressure, demilitarization has been making a gradual shift from disposal operations to resource recovery, including recovery of explosives. As the effort to disassemble munitions on a large scale continues, special attention needs to be made to disassembly and explosives safety, which are significantly different from safety concerns for assembly and munitions storage operations.

This paper describes the specific differences in safety for two different munitions types, one a high explosive anti-tank (HEAT) cartridge and the other an anti-personnel (APERS) cartridge. The differences are cataloged through ammunition assembly, including a review of original assembly procedures, ammunition storage procedures, and finally the new safety concerns generated with large scale disassembly operations.

This paper will provide a reference to document the changes and specific safety areas for the three different cycles of munitions life, production, storage, and disassembly.

## **Introduction**

Past demilitarization efforts have included deep sea dumping, open burning/open detonation (OB/OD), and limited disassembly and resource recovery. In most cases, the disassembly efforts were only conducted when a component or group of components were identified to direct reuse or modification and reuse in other munitions items.

In the last few years, the military has undergone significant changes that effect the amount and method of munitions to be demilitarized. The largest impact has been the reduction in the military strength, coupled with a review of the "go to war" weapon systems.

This has placed a tremendous amount of munitions in the demilitarization account, threatening to overwhelm current capacity.

In addition to the increased amount of ammunition requiring demilitarization, increased public focus on the environment has forced traditional methods such as OB/OD to be phased out. In addition, efforts to recycle and recover as much as possible are moving demilitarization operations from disposal to recovery. In an effort to recover as much as possible and still reduce the stockpile awaiting demilitarization, the Army has focused on developing and establishing disassembly and resource recovery locations.

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The Iowa Army Ammunition Plant (IAAP) is a 20,000 acre load/ assemble/pack facility operated by Mason & Hanger-Silas Mason Co., Inc. for the U.S. Army. The primary purpose of this facility is to assemble raw components and sub-components into finished ammunition.

As a natural extension of this mission, we have expanded our operations to include disassembly of ammunition back into their components as part of the Army's demilitarization efforts.

The disassembly takes advantage of the present skills and facilities for disassembly, offering a cost competitive solution to demilitarization.

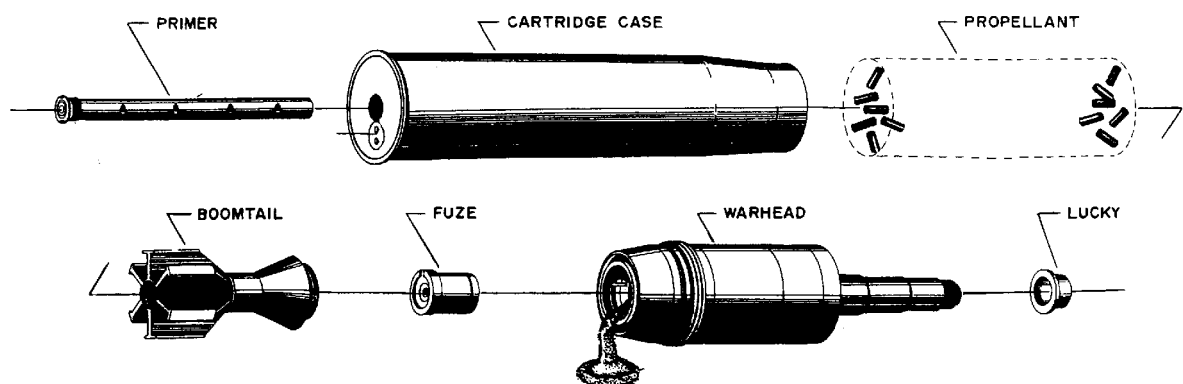
The Iowa Army Ammunition Plant has been designated as the Midwest Area Demilitarization Facility (MADF) and tasked with developing disassembly procedures and methods, in addition to establishing a disassembly facility for high explosive anti-tank (HEAT) and anti-personnel (APERS) cartridges. To date both HEAT and APERS cartridges have been disassembled and demilitarized.

### **Munitions Descriptions**

High explosive anti-tank cartridges are characterized by a shaped charge and either a pressed or cast loaded explosive charge. The charge weights average 1 kg, and normally include a base detonating fuze and switch on a spike. The M431 90mm HEAT-T cartridge used in this paper consists of a warhead loaded into a steel cartridge case.

The warhead consists of a Comp B explosive charge and copper liner, a M509 base detonating fuze, a M13 tracer in the boomtail, and a spike switch. M30 propellant is loaded into the cartridge case.

### **90mm M431 HEAT-T**

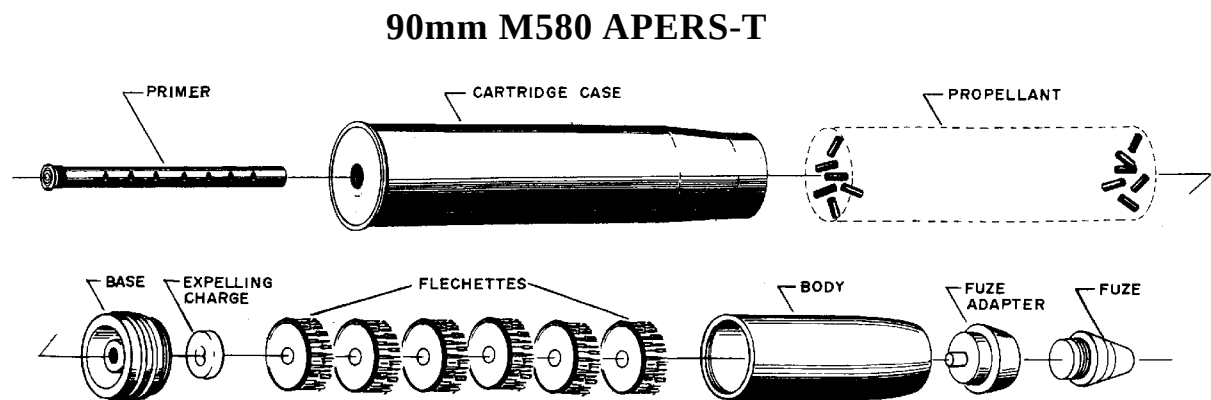


Anti-personnel cartridges are normally loaded with flechettes or fragmenting pellets. Cartridges with fragmenting pellets normally do not contain explosives in the warhead, and

are relatively easy to disassemble. The cartridges containing flechettes are configured to stay intact as they leave the gun tube. A time delay fuze functions an explosive train, forcing the flechettes to disperse and cover the target area. A marking dye is used to spot the location of the time burst to allow the gun crew to adjust the round function if required.

The APERS cartridge used as an example in this paper is the M580, a 90mm APERS-T cartridge.

The warhead is loaded into a steel cartridge case loaded with M6 propellant. The warhead is loaded with multiple bays of flechettes and loose lead chromate dye. A nose fuze is attached. Four radial detonators and a flash tube/base propelling charge spread the flechettes when ignited. A tracer is attached to the base of the warhead.



### Load/Assembly/Pack of the Cartridges

The M431 was originally loaded in the 1960's and 1970's. The first step in the loading process was to receive and inspect the inert warhead body from the metal parts manufacturer. The warhead body was received with the liner already attached.

The second step was to cast load the warhead body with Comp B explosive. The explosive is loaded and cooled to form a cast inside the warhead body. The cast is inspected to ensure it meets quality and safety requirements, and then the loading end (base) is machined so that it will accept a fuze.

The fuze was then tested and assembled into the warhead and the boomtail/tracer assembly was installed around the fuze. The piezoelectric crystal (Lucky) was installed on the spike.

The fourth step was to assemble a percussion primer into the cartridge case. The warhead was

then crimped into the cartridge case.

After crimping, the cartridge case was loaded with propellant through a base loading port and a vibratory feeder.

The final step was to pack the finished cartridge into a fiber tube and two tubes into a packing box. The boxes are palletized and ready for field use.

| <b><u>Process Step</u></b>      | <b><u>Significant Safety Requirements/Notes</u></b>                                             |
|---------------------------------|-------------------------------------------------------------------------------------------------|
| Receive and inspect metal parts |                                                                                                 |
| Cast load the warhead           | Standard melt pour safety requirements                                                          |
| Drill the fuze cavity           | Drilling done remotely                                                                          |
| Fuze testing                    | Remote electrical testing<br>Visual inspection of "safe" condition<br>Grounding plates required |
| Install "Lucky" and test        | Testing done remote<br>Grounding plates                                                         |
| Assemble percussion primer      | Protection of the primer from impact                                                            |
| Crimp cartridge case            |                                                                                                 |
| Load propellant                 | Safety equipment - Gloves, etc.<br>Grounding plates<br>UV fire protection                       |

The M580 APERS was loaded in a very similar fashion. The warhead was received loaded with flechettes from the metal parts vender. The expelling charge was assembled to the warhead with the base. The fuze and fuze adapter (with the four detonators) were then assembled to the warhead. The warhead is assembled to the cartridge case in a similar manner as the M431.

The lead chromate marking dye is loaded by the metal parts vender as part of the loaded warhead body. In some APERS cartridges and bagged lead chromate dye was loaded instead of the lose material as an alternate assembly method.

## **Storage of the Cartridges**

After assembly, the cartridges were delivered to the Army Depot system to be held as war stock. Some of the cartridges may have been used as training ammunition, and some were used during Vietnam. It is probable that some of the ammunition awaiting demilitarization was actually uploaded and downloaded from tanks several times.

During the storage period, periodic inspections of the ammunition happens as part of the standard surveillance program, including propellant stability.

Any discrepancies or safety problems are transmitted through the Ammunition Information Notice (AIN) bulletins.

The cartridges were shipped to the IAAP for demilitarization. Some of the cartridges are field returns sent directly from OCONUS to IAAP for demilitarization.

## **Demilitarization of the Cartridges**

The demilitarization process we have used involves disassembling the round, separating the explosive and hazardous components from the metals to be recycled, and sorting the explosives for commercial resale.

The cartridge is received and unpacked. Packaging is collected and either resold for salvage or land filled as inert trash.

Using Ammunition Peculiar Equipment (APE), the warhead is removed from the cartridge. The propellant is removed from the cartridge and the liner (if present) is removed and separated. The cartridge is left intact with the primer for the next operation. Propellant stability is conducted prior to resale of the propellant for either reuse or blending into commercial explosive mixes.

The cartridge case with primer is then placed into a functioning machine. Using a pneumatic cylinder functioning as a firing pin, the cartridge primer is functioned into a blow tube. The exhaust gases are then filtered and scrubbed using a wet wash system prior to release. An automatic controller is used to control the process. Additionally, an electric welding arc can be used should the primer fail to function using the firing pin.

At this point the demilitarization process between the HEAT and the APERS begins to differ. The HEAT warhead is then sectioned using a vertical lathe to

separate the forward section (inert), the warhead body with the cast load, the boomtail and tracer, and the base detonating fuze. Our process uses two lathe cuts to separate these pieces.

The cast load is then pressed from the warhead body. The tracer is functioned in a chamber using an electric welder and the off gases filtered prior to release. The base detonating fuze is

thermally treated or functioned using an electric welder in a blast chamber.

All metals recovered are thermally treated in the contaminated waste processor prior to release as 5X. The explosive cast (Comp B) is repacked and sold for commercial mining.

The APERS warhead fuze is removed for its first disassembly step. The warhead is then lathed to remove the base and expulsion charge and the fuze adapter. The now inert warhead has the flechette load pushed out inside of a booth to reduce dust. The warhead body and the flechettes are washed to remove the lead chromate dye, with the dye being resold and the metals recycled.

The fuze and fuze adapter are thermally treated, and the expulsion charge incinerated or killed (black powder charges).

### **Safety Concerns with Disassembly**

Several safety concerns are unique to disassembly. As a general rule, the safety concerns and protection required in assembly will also be required in disassembly. Special attention needs to be made that production quality requirements do not get interpreted as safety requirements. Additionally, disassembly will introduce more safety areas than assembly.

Moving through the disassembly process, we identified several special safety concerns with the HEAT and APERS disassembly.

#### Unpacking

The unpacking is routine, except that the lots need to be verified before disassembly and cross checked against known safety problems, such as unstable propellant. Additionally, much of the ammunition to be demilitarized is unknown or mixed lots and often suspended from issue.

During unpacking operations, standard personnel protective equipment is required for cutting banding and for handling palletized loads. It is also important that the process be designed ergonomically correct so that operators are not over exerted handling the 60+ pound cartridges.

Whenever the cartridge cases are handled, either as full up cartridges or after pull apart, protection needs to be in place over the percussion primer to ensure it is not accidentally activated.

#### Pull Apart

The pull apart operation itself is done in a safety tested barricade with internal UV fire protection. After pull apart, the propellant is collected in a hopper with a baffle and internal UV fire protection. Ventilation and grounding plates are provided in this area.

An important step in this operation is to collect samples of the propellant and verify that the stability level is still acceptable. Each lot of propellant is packed and stored separately until a verified stability test is conducted. Additionally, a stability test is conducted early in the disassembly run to limit potential handling of hazardous propellant.

#### Warhead Disassembly, HEAT

The warhead disassembly operation is conducted remotely with the operator controlling the process through a TV camera. The cutting process itself is done vertically with the shaped charge pointed downward. Water is used to both cool the cutting blade and to remove chips as they are generated.

Process controllers monitor and control the speed and feed of the lathe operation. Rotation is limited to 300 rpm. During lathing, the spike and "lucky" are left on the warhead. We conducted impact testing to verify that the "lucky" would not initiate the fuze if dropped or otherwise impacted during the lathe operation.

The HE charge is removed using a hydraulic press after the lathe operation. The pressure of the press is limited to 5,000 pounds of force. We have found that the charge will remain intact during push out operations at this pressure, and that some charges will not come out, but will also remain intact. Cooling the charges will help removal of these charges.

After lathing, the fuze is removed from the warhead by cutting the "lucky" wire and pulling it out of the fuze cavity. The fuze and the boomtail with tracer are then transferred to treatment operations. The metal is collected and flashed to 5X prior to resale.

#### Warhead Disassembly, APERS

The warhead is transferred from the pull apart to the disassembly station. The fuze and fuze adapter are removed behind an operating shield and sent for treatment. The warhead is then placed into a CNC lathe and the base removed from the warhead body. After the base is removed, the expelling charge is removed and incinerated or recycled.

The warhead is then placed into a closed chamber and the flechettes removed. The chamber is sealed to prevent the lead chromate dust from the operator. The flechettes and body are washed to remove the dust and the metal parts drummed for shipment to a metal recycler. The dust is collected and sold for recycling. It is very important that the dust collection systems be both cleanable and protect the operator from the dust.

#### Fuze, Tracer, and Primer Treatment

As RCRA operations, the fuze, tracer, and primer are treated to remove (function) the explosive components. The fuze is functioned either in an APE 1236 incinerator or functioned using an electric welder in a blast chamber. The chamber is controlled using a logic controller to prevent misloading, and the chamber has been explosively tested to verify its blast

resistance.

The tracer and primer function are conducted behind shielding to protect the operator. In both cases a wait cycle is built into the processor to allow for full removal of any fumes prior to reloading the next item to be functioned.

The process is controlled to detect duds and prevent the operator from recycling any duds or removing them from the process prior to a wait time elapsing. Any repeated duds are treated as an EOD disposal item and destroyed using a donor charge.

During tracer function, it is not unusual to have a very short burning tracer. In these cases the detector often records a false dud. In this case visual inspection (remotely) by the operator is able to verify or deny functioning. Also, the time required for the hot tracer to cool is measured and the dud process wait time is based on the cooling period.

We also remove the primer tube from the cartridge case after firing and flash this to ensure that it is 5X. We have found that an unconstrained detonation will often leave traces of unburnt explosive (especially black powder) in the tube and that significant amounts will enter the fume removal system. Our fume system is equipped with inspection ports and a water bath to catch any unburnt black powder.

### **Safety Testing Conducted**

#### **Test**

#### **Frequency**

X-ray of a sample of cartridges to verify fuze safe condition

Start of demil process

Propellant stability

Twice each lot

"Lucky" impact sensitivity

Start of demil process

Tracer cool down time

Start of demil process

Blast testing of the fuze barricade

During fabrication of barricade

## **Special Safety Protection In Place for the Disassembly**

### **Disassembly Step**

### **Special Safety Protection**

Unpacking

Gloves and full face shield for  
banding strap removal

Pull apart

Barricaded with internal UV

Propellant collection

Grounding plates  
UV fire protection

Material handling

Percussion primers protected

Lathe, HEAT

Remote operation  
Limited speed  
Process controller

Warhead disassembly, APERS

Shielded  
Dust enclosure and filters

Tracer function

Operator Shielded  
Process controller with  
"fire-eye" detector

Primer function

Operator shielded  
Sound muffler in ducting  
Hearing protection required  
Process controller with sound  
detector

Fuze function

Barricaded  
Process controller with sound  
and CO2 detector

## **Environmental Safety Concerns**

During all operations, special attention needs to be paid to whether the operations are RCRA treatment operations dealing with hazardous waste or hazardous material handling operations.

Our treatment of the fuze, tracer, and primer are considered RCRA operations, and are permitted by both the State of Iowa and the Federal EPA. All material handling of these components after disassembly and prior to treatment are as hazardous waste, and designated hazardous waste accumulation areas have been established on our production line. Every effort was made to have a dry process so that water treatment and release is limited. On those operations that do use water (lathe and air filter system), water is recirculated and filtered as long as possible.

## **Summary**

Demilitarization and disassembly of munitions can be accomplished safely, environmentally, and cost effectively. During the disassembly, special attention needs to be made to protecting the operator from hazards not seen with munitions assembly. The safety protection needs to consider the changes in environment the ammunition has seen during its service life.

Additionally, special care needs to be applied so that the environment is not damaged during disassembly and that as much material is recovered and reused when practical.