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DEVCOM ARMY RESEARCH LABORATORY

Final Preparation and Assembly of 120-mm Kinetic Energy Cartridge Prior to Loading of Propellant

by Damian Krzeminski, Ryan Chronister, and Randall Maglaughlin

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14. ABSTRACT
This technical note describes the procedures to install a 120-mm projectile into an assembled 120-mm cartridge case and verify its fit into a 120-mm gun chamber. These procedures may also be used for 120-mm kinetic energy (KE) anti-tank projectile research as well as test and evaluation of 120-mm KE anti-tank cartridges.

An assembled 120-mm base and seal, combustible case, and case adapter are predrilled for piezoelectric pressure ports as necessary, and a larger hole is drilled in the adapter cap to allow for adding or removing propellant.

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120-mm combustible case, case adapter, base and seal assembly, chamber gauge, ring gauge, sabot petal orientation

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Contents

List of Figures

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1. Introduction

This technical note describes the procedures to install a 120-mm projectile into an assembled 120-mm combustible cartridge case and verify its fit into a 120-mm gun chamber. These procedures may also be used for 120-mm kinetic energy (KE) anti-tank projectile research as well as test and evaluation of 120-mm KE anti-tank cartridges.

An assembled 120-mm base and seal, combustible case, and case adapter are predrilled for piezoelectric pressure ports as necessary, and a larger hole is drilled in the adapter cap to allow for adding or removing propellant.

The orientation of the projectile into the case assembly will determine how the sabot petals fly off at discard. This is critical to allow an unobstructed view of the sub-projectile in flight. The orientation of the cartridge case in the gun chamber is also critical to obtaining non-obstructed pressure time traces with the piezoelectric gauges. The gauge locations are marked by using a template to determine where portholes should be drilled.

The cartridge case, projectile, and assembled cartridge are inspected at various times with a variety of gauges described herein.

The equipment used is a preassembled combustible cartridge case with adapter and stub base with predrilled ports for pressure gauges and one larger port/loading hole for loading propellant.

The procedures outlined herein consist of the following:

1. Marking the external diameter of the case to assist with aligning port holes with gauges and verify proper orientation of sabot petals to ensure a discard that allows the cameras to see the flight projectile.
2. Pressing the ready-to-fire projectile into the adapter and ensuring sabot petal splits are aligned with the markings on the case.
3. Checking for proper fit into the cannon using a ring gauge, a composite chamber gauge, and a chamber gauge that mimics the profile of the M256 cannon.

This technical note is provided to enable a better understanding of how a 120-mm cartridge should be assembled and inspected; it is not a substitute for any Standing Operating Procedure (SOP) or Internal Operating Procedure (IOP). It is important that SOPs and IOPs always be followed.

2. Characteristics of 120-mm KE Anti-Tank Cartridges

The 120-mm armor-piercing fin-stabilized discarding sabot with tracer (APFSDS-T) projectile typically consists of either four-petal (90° arc segments) (Fig. 1) or three-petal (120° arc segments) (Fig. 2) sabots encasing a high-density metal penetrator. The orientation of these petals in a gun tube can be critical to protecting down-range equipment or data collection media.

Four-petal sabot: splits at 12 o'clock, 9 o'clock, 6 o'clock, and 3 o'clock orientations will have the petals discard at the 10:30 o'clock, 7:30 o'clock, 4:30 o'clock, and 1:30 o'clock orientations; splits at 10:30 o'clock, 7:30 o'clock, 4:30 o'clock, and 1:30 o'clock orientations will have the petals discard at the 12 o'clock, 9 o'clock, 6 o'clock, and 3 o'clock orientations.

Three-petal sabot: one split at 6 o'clock will have the petals discard at the 12 o'clock, 8 o'clock, and 4 o'clock orientations; one split at 12 o'clock will have the petals discard at the 6 o'clock, 10 o'clock, and 2 o'clock orientations.

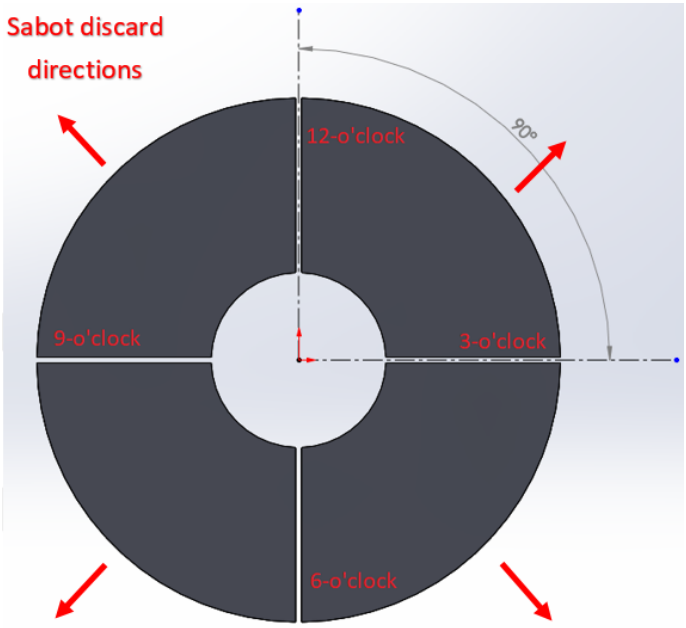

Fig. 1 Four-petal sabot orientation and discard. (Note this figure is a basic visual representation, not an engineering drawing.)

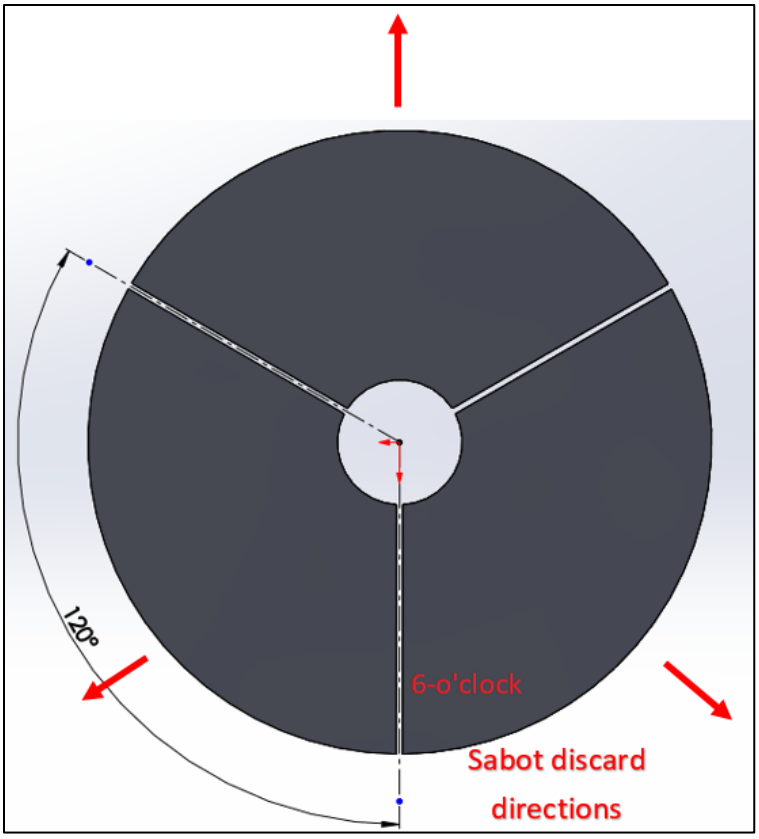

Fig. 2 Three-petal sabot split with 6 o'clock orientation and discard. (Note this figure is a basic visual representation, not an engineering drawing.) A sabot split may also be oriented with the split at 12 o'clock depending on how the user wants the sabot petals to discard.

3. 120-mm Combustible Case, Case Adapter, Stub Base Assembly

A 120-mm KE cartridge consists of a projectile, a combustible case, a pressed fiber adapter to connect the projectile to the cartridge case, and a base and seal assembly (Fig. 3), which accepts the primer used to initiate the propellant when fired.

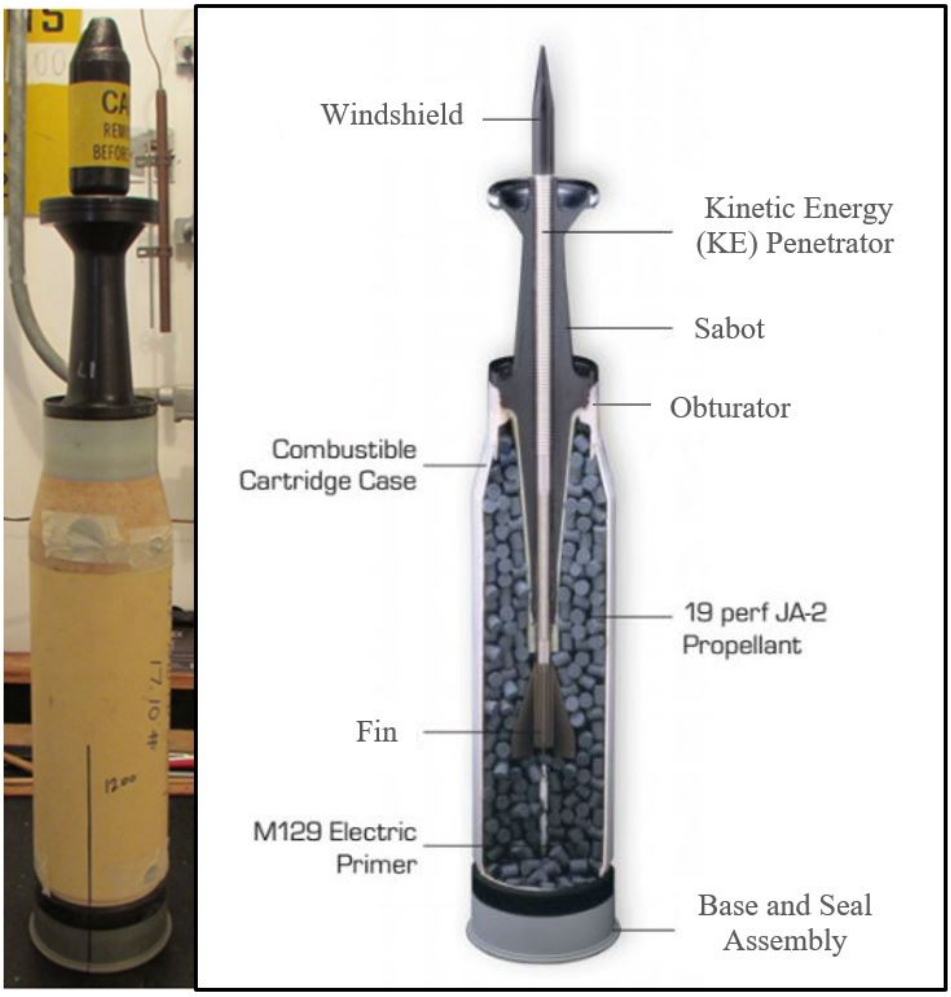

Fig. 3 120-mm KE cartridge and cutaway view

The 120-mm combustible ammunition (nitrocellulose) case is designed to be consumed during the firing of a 120-mm cartridge from the M256 cannon. Post-firing, the only materiel remaining is the stub base and expended primer. The adapter cap (pressed fiber) is consumable but not combustible.

Piezo-electric pressure-time histories may be recorded when the gun tube has been ported and gauges have been installed. It is important to drill portholes through the case and adapter cap to ensure that continuous data may read by the gauges. If the case blocks a gauge, it will delay the pressure reading for that gauge and not be able to provide the initial build-up of pressure on the trace. The cases readily accept marker ink, which is useful for marking the projectile orientation for sabot discard (Fig. 4) and using a template (Fig. 5) to locate the pressure portholes. This aids in properly orienting the cartridge in the gun tube to provide the desired sabot petal's discard orientation and to line up pre-drilled holes with the piezo-electric pressure gauges when utilized.

Fig. 4 12 o'clock sabot split markings on combustible case and stub base

Fig. 5 Gage portholes template over cartridge case

The 6 o'clock sabot split orientation (Fig. 6) for a three-petal sabot ensures no petal discards directly downward along the line of flight (protects down-bore camera).

Fig. 6 6 o'clock sabot split alignment markings on combustible case and case adapter

4. Arbor Press Operations

The arbor press operation for installing a 120-mm projectile (Fig. 7) into a 120-mm cartridge case is detailed in Figs. 8–11.

Fig. 7 120-mm KE projectile

During the press operation, align the bottom edge of the obturator horizontally to the case adapter (Fig. 8). This will allow an even assembly of the projectile into the case adapter without cracking the case adapter.

Fig. 8 Horizontal alignment of the obturator with the split of two sabot petals aligned with the 6 o'clock split line on the case adapter

Use proper spacers (Fig. 9) to allow clearance around the penetrator and the sabot petals. DO NOT use excessive force to seat the projectile into the case adapter. This could cause stress cracks, breaks, and deep scratch markings on the sabot petals, windshield, and the penetrator, or distort the cartridge case. Continue to gently press down on the arbor press wheel without major force until the obturator base snaps

into the case adapter. Figure 10 shows the desired result, and Fig. 11 provides an overall view of a properly assembled projectile into a cartridge case.

Fig. 9 Arbor press for seating projectile fully into cartridge case. Spacers indicated by top arrow, projectile by bottom arrow.

Fig. 10 Shown here is the proper result of an even assembly of the obturator and the case adapter, with no damage to the case adapter

Fig. 11 Complete assembly of the projectile into the case adapter

Pressure portholes are required when operations call for tracking the pressures within the gun tube with piezo-electric pressure gauges during the firing operation. Figure 12 shows the three drilled 7/8-inch pressure portholes and the 1-1/2-inch propellant loading hole/pressure porthole. Two portholes are near the top on the case adapter, and two portholes are near the bottom of the combustible case.

Fig. 12 Locations of pressure portholes

The round assembly is now complete (Fig. 13) and ready to be chambered in a chamber gauge, to check for a proper fit prior to loading with propellant.

Fig. 13 Completely assembled 120-mm KE rounds are now ready for priming and loading operations

5. 120-mm Chamber Gauge Operation

A chamber gauge proves proper fit of the 120-mm rounds. Checking the fit of a cartridge prior to chambering it in a weapon is a prudent step. It can save a significant amount of time and help ensure a safe test. All rounds should be chambered prior to delivery to the range facility. This allows the range facility to fire without any concerns as to the round fitting properly at the gun.

Without proper chamber gauging, there is the possibility of a round being forced into the gun or the round not chambering properly at the gun. Properly chambered rounds allow everyone to operate safely and within the safety rules of the operations.

There are various gauges that can be used to chamber fit a round. Three are detailed in the following sections.

5.1 120-mm Chamber Gauge with Sliding Breech Door

Figure 14 shows a chamber gauge with a sliding breech door. This gauge was built to the specifications of a M256 gun chamber. The sliding door ensures that the round will be fully seated into the gun chamber when loaded.

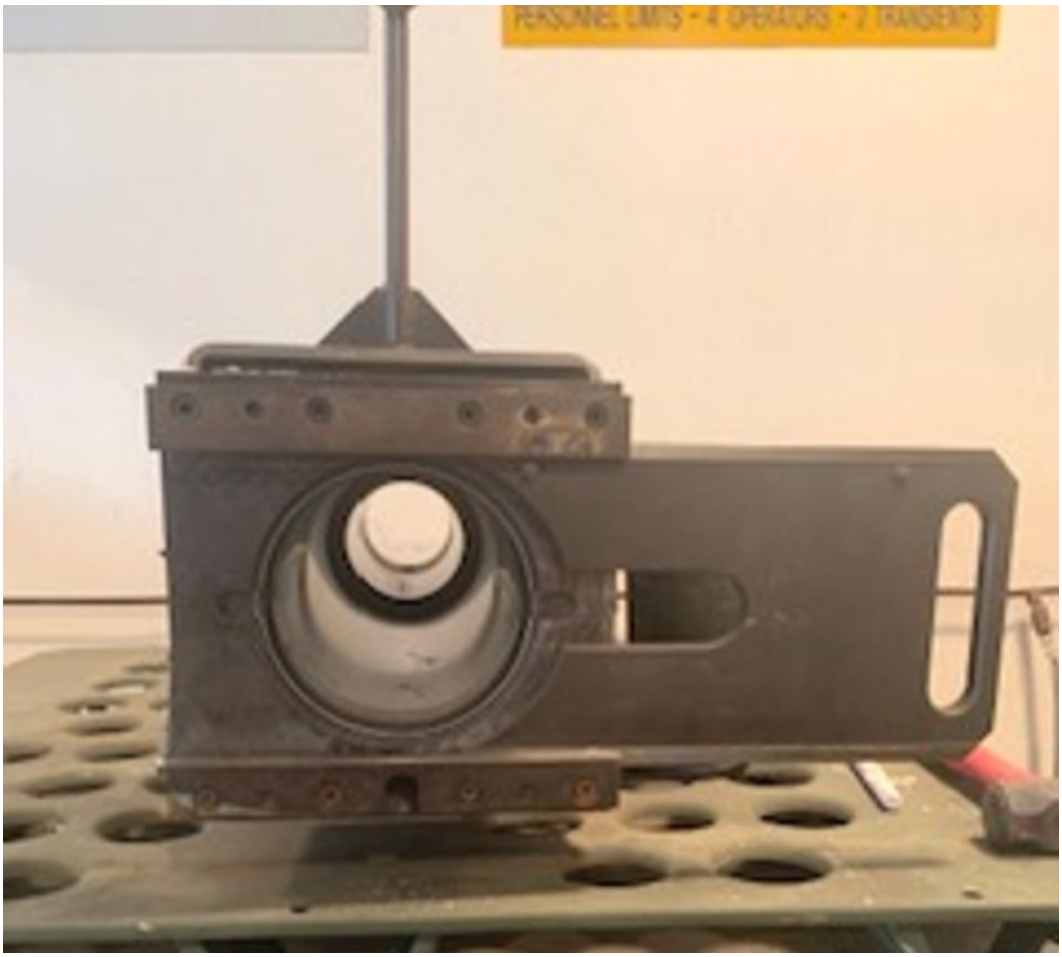

Fig. 14 120-mm chamber gauge with sliding breech door

5.2 Composite Chamber Gauge

The composite chamber gauge (Fig. 15) is a portable, lightweight tool that allows verification of proper case and adapter assembly and verifies that the cartridge assembly properly fits the 120-mm gun chamber.

Fig. 15 120-mm composite chamber gauge

5.3 Aluminum Ring Gauge

The front and rear bore-riding diameters of a projectile may be checked with an aluminum ring gauge (Fig. 16). Perform the check after the turn-down process to check the sabot bell and obturator turn-down.

Fig. 16 120-mm aluminum ring gauge

6. Chamber Fit Operation

Step 1: Insert the 120-mm cartridge case into the chamber gauge (Fig. 17), oriented with 12 o'clock pointing up on the stub base.

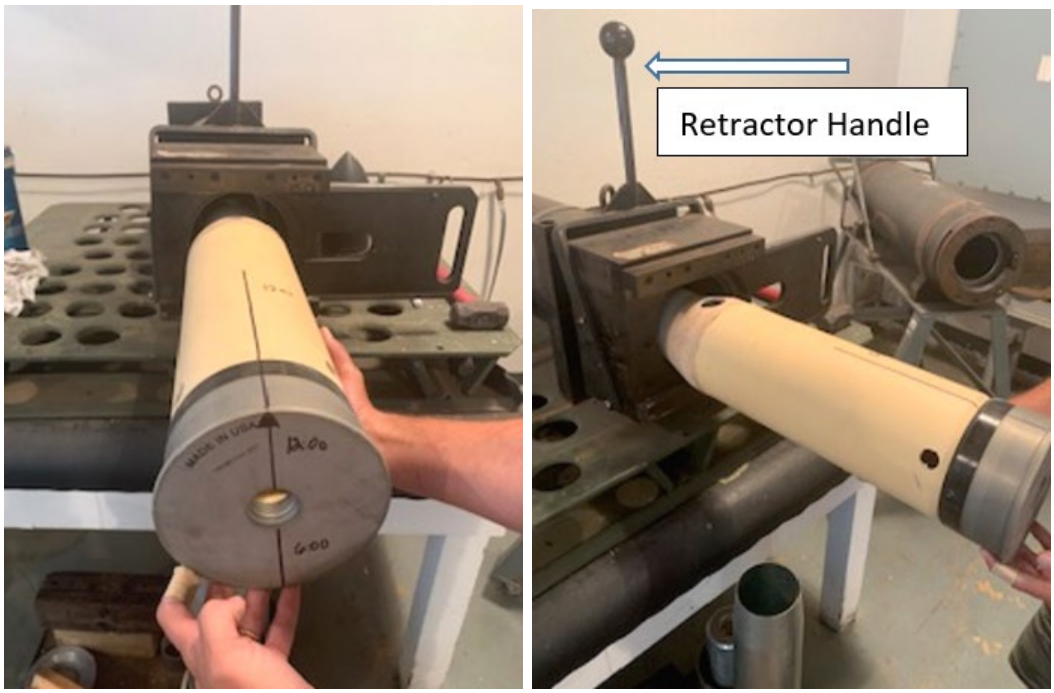

Fig. 17 Inserting cartridge into the chamber gauge

Step 2: Fully insert the cartridge case into the chamber gauge, gently sliding the round all the way forward until the stub base is even with the gauge (Fig. 18) and breech door.

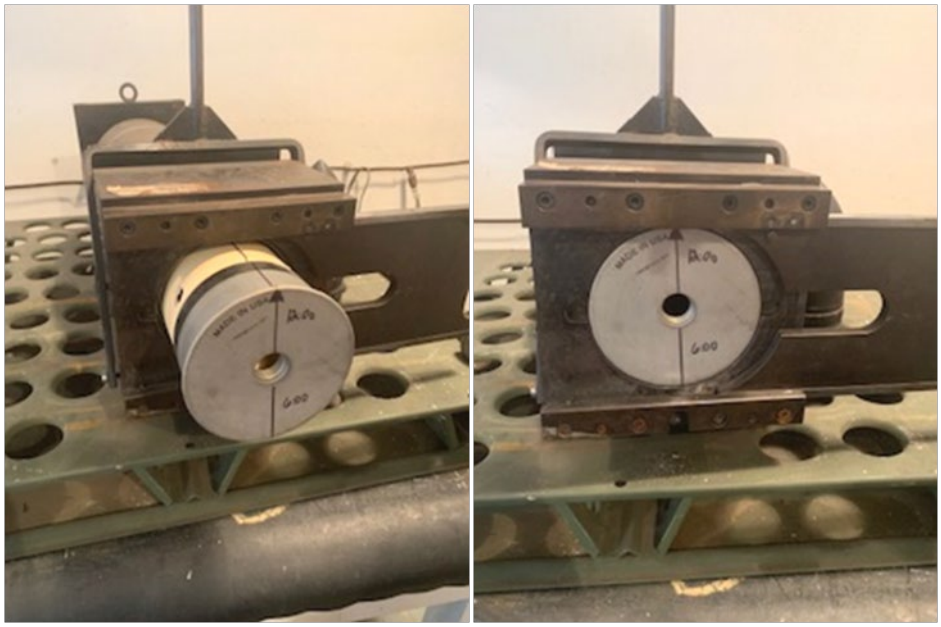

Fig. 18 Seating cartridge case in the chamber gauge

Step 3: Use the retractor handle (Fig. 17) to retract the cartridge from the gauge and rotate the cartridge 180° to make sure the cartridge fully fits at two orientations.

Step 4: Close the breech door by sliding it over the stub base to ensure the breech door fully covers the stub base (Fig. 19). Once the sliding breech door covers the cartridge, a successful fit at the gun is ensured.

Gauging may be performed after the cartridge case is assembled to the base and seal assembly, after the projectile is assembled into the cartridge case, and after the cartridge is loaded with propellant. The slot in the sliding door on the chamber gauge ensures the primer is not engaged by the door.

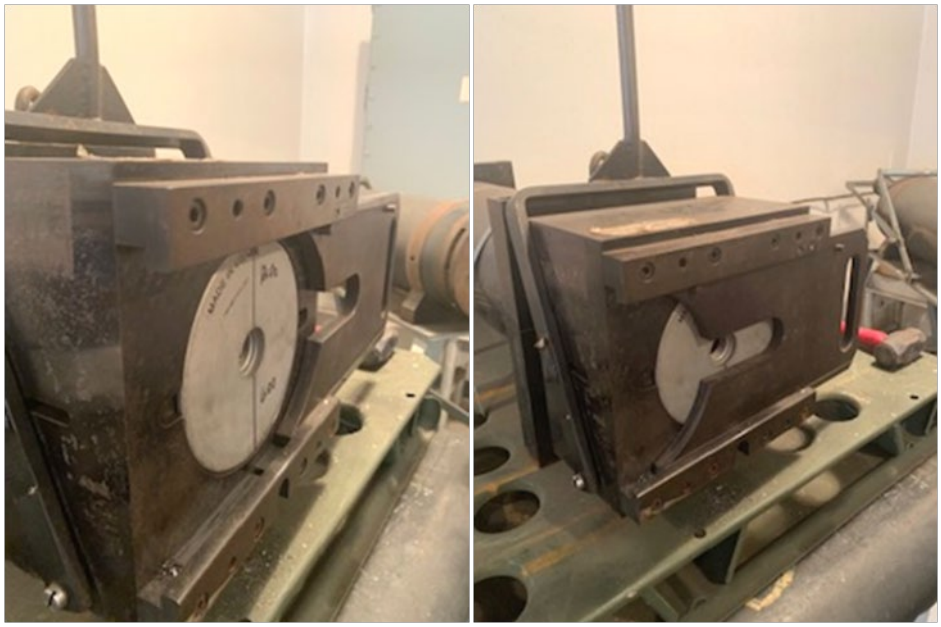

Fig. 19 Fully seated cartridge case in the chamber gauge

7. Summary

This document details the proper steps for assembling 120-mm cartridge cases and KE projectiles in preparation for propellant loading. These steps provide a safe and efficient means to prevent ammunition issues while loading the gun.

List of Symbols, Abbreviations, and Acronyms

APFSDS-T	armor-piercing fin-stabilized discarding sabot with tracer
ARL	Army Research Laboratory
DEVCOM	US Army Combat Capabilities Development Command
KE	kinetic energy

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