Caseless Ammunition Small Arms. The Good, The Bad, and The Ugly.

Presented by

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during the

2012 NDIA Joint Armaments Conference
Seattle, Washington

Purpose

- Discuss the common misperceptions and "perceived" merits of caseless ammunition for use in rapid-fire military small arms.
- Learn from past experiences in numerous US and foreign efforts to "crack the caseless ammunition nut".
- Escape the "10% Bridge Too Far" trap. (1)

(1) Ref. LSAT Briefing, NDIA May 2010 Page 10, 12 (CL = 50%, CTA = 41%)

Caveats

- The contents and opinions expressed in this presentation are those of the presenter and are based on available information and actual hands on experience.

- Applicable organizations were contacted for input. That input was considered and is included as received.

About the Presenter

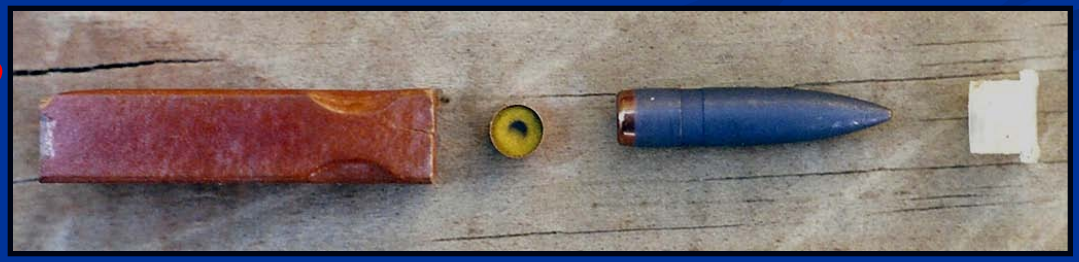
- Life long student in modern small arms and ammunition technology.
- 35 years in the international small arms arena serving in numerous capacities from user and trainer to developer and provider.
- Caseless Technology PM and Contractor Trainer for the Caseless Ammunition G11 Rifle during the "successful" US Advanced Combat Rifle (ACR) program. 3+ years "living with" caseless ammo.

What is Small Arms Caseless Ammunition?

- Ammunition missing *THE* most important cartridge component – the **Exoskeleton Pressure Vessel (EPV)**
- Having a fully combustible propellant body

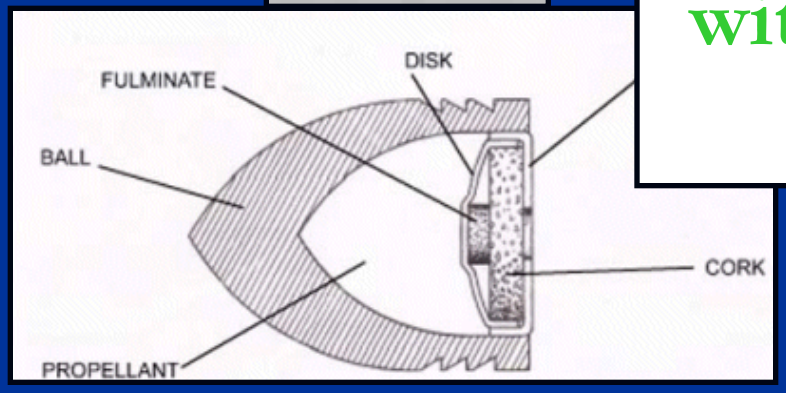
"I can hold my gas and naughty bits together with little help!"
(Cased Round)

"I got nothing!"
(Caseless Round)



Not to be confused with…

"Semi-Caseless" or "Rocket"



.41 Smith & Wesson Volcanic
(USA - 1860)

a.k.a.
"Self-propelled"

Propellant located within a hollow projectile

Gyrojet
(USA - 1965)

Caseless Ammo = Teddy

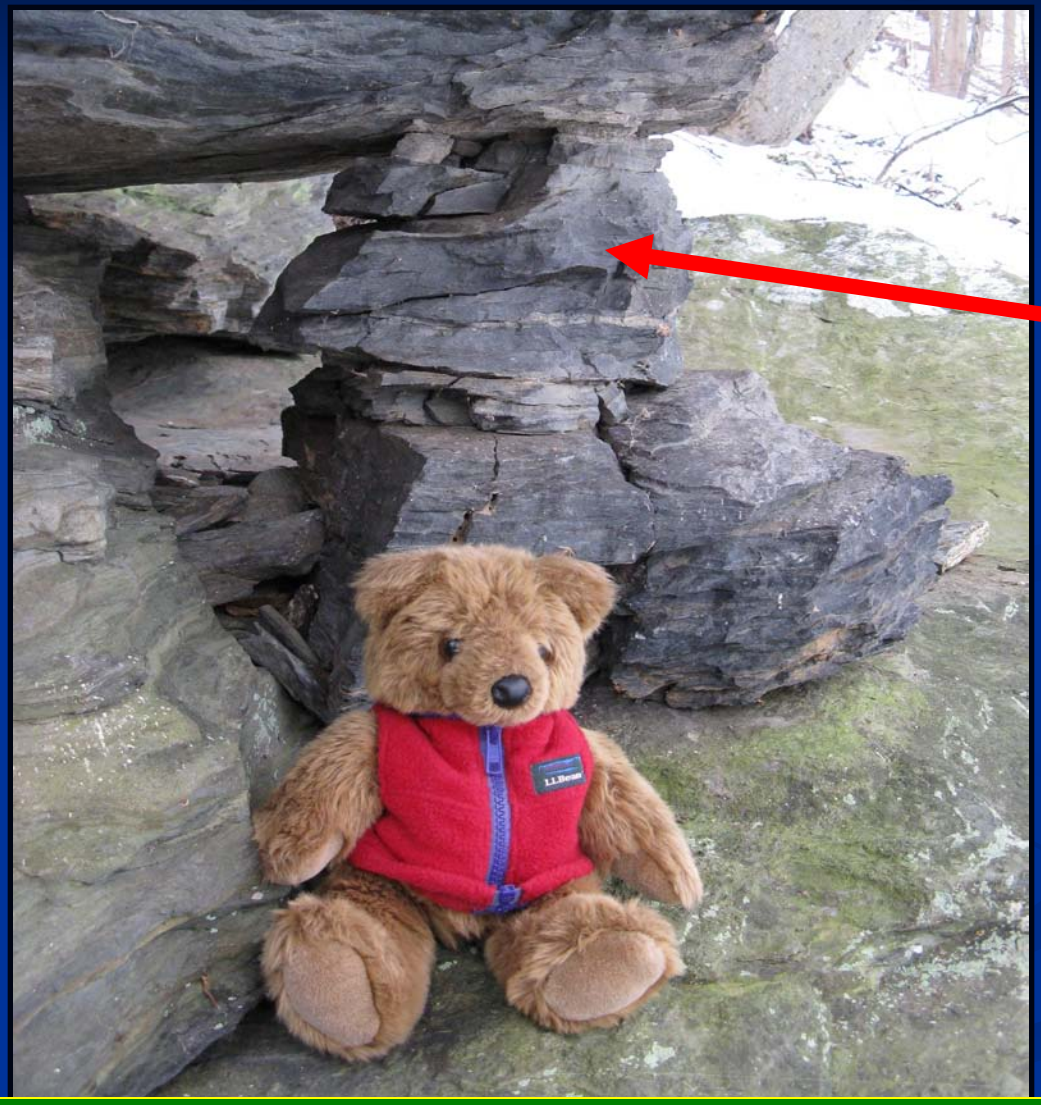
=

Caseless Ammo

"Teddy" on Vacation

No stuffed animals were hurt during the compilation of this presentation

Things are good…while all goes well



Beware of hidden dangers!

No stuffed animals were hurt during the compilation of this presentation

But if the foundation is weak,

bad things can happen (to Teddy!)

No stuffed animals were hurt during the compilation of this presentation

And things go bad…and fast!

OKAY, stuffed animals WERE hurt during the compilation of this presentation

Why should I covet my EPV?

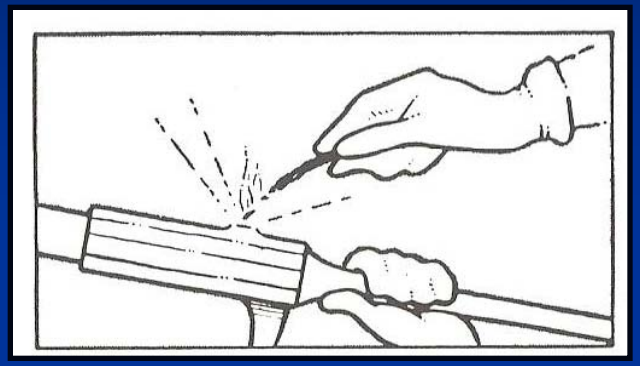
- Because it –

1. Holds all your components together in one solid piece that is easily transportable and "discardable".
2. Is not readily or easily influenced by chamber heat, solvents or rough handling.
3. Can be pull versus push-through extracted.
4. Contains its own initial pressure irrespective to the weapon mechanism around it.
5. Prevents a degree of spark/flame propagation between rounds if struck by incoming fire.

It is a strong and the key foundation for complete "system" integrity, safety and reliability!

Brief Caseless Ammo History

- 1346 - First "hand cannon" – fired "caseless" ammo



- 1570 – 1st "cartridge" (paper case) – *BIG NEWS!*
- 1830 – 1st "metallic cartridge" – *BIGGER NEWS!*
- WWII – Germans experiment with caseless ammunition – Formed Nitrocellulose (NC) employed to save "strategic materials" (brass)

Lesson Learned: Steel cases were used instead.

Caseless Ammo History (cont.)

- Various commercial caseless firearms developed

-Daisy VL .22 Caseless Ammunition Rifle (1967-1969)

ATF-forced "demise"

NC "pellet" ignited by compressed air. Novelty.

- Russian VAG-73 Semi-Caseless Ammo Pistol (1973)

High Capacity

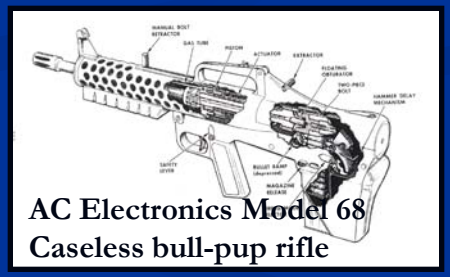
48 round dual column (front, rear) magazine

7.62mm Semi-caseless VAG-73 rounds

Caseless Ammo History (cont.)

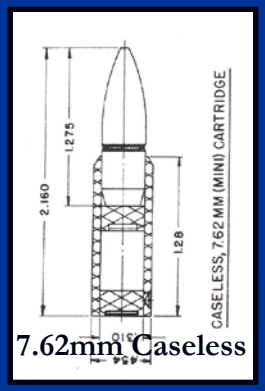
- 1959-1975 - US Ordnance Department
  - -Ground-breaking efforts to develop 5.56mm, 7.62mm and 25mm caseless ammunition (and weaponry) to reduce:
    1. Ammo weight (50%) and volume (30%)
    2. Critical case material reliance
  - -Involved AAI, AC Electronics, GE, GM, Hercules, Hughes Tool Co., others.
  - -Formed NC, HITP, even caseless flechette rounds were developed and tested.

Same technical challenges:
-Sealing
-Cook-off
-Propagation



AC Electronics Model 68 Caseless bull-pup rifle

Hughes 5.56mm Caseless LMG

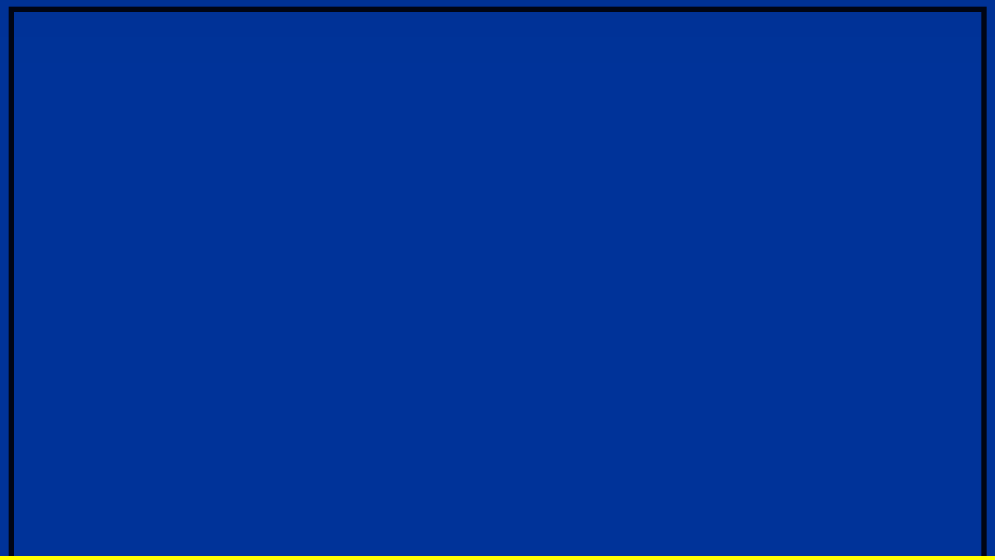


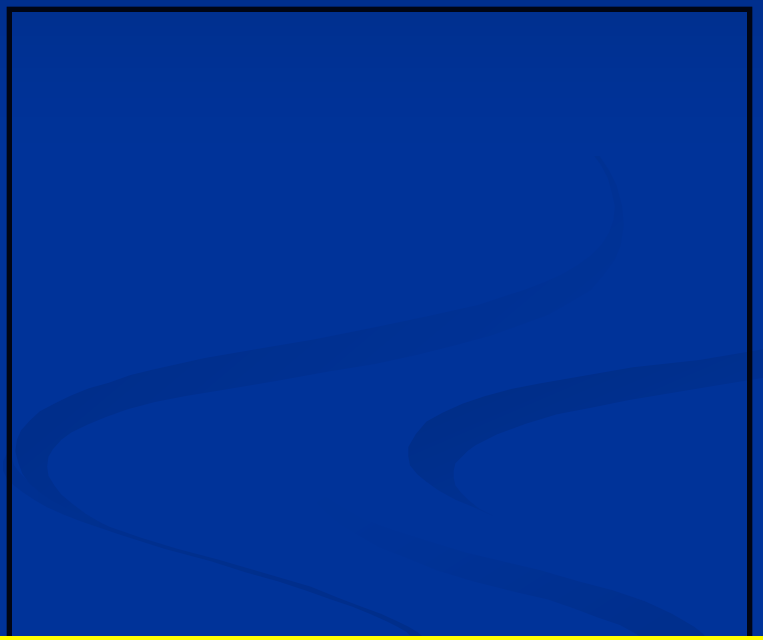
7.62mm Caseless

5.56x30mm Telescoped Caseless Rounds Developed by Hercules, Inc. @ 1969

Caseless Ammo History (cont.)

- 1970-1990 – German 4.92x34mm Caseless G11/US ACR, LSW, PDW developed at the cost of 100M's of $ and DM's. HITP





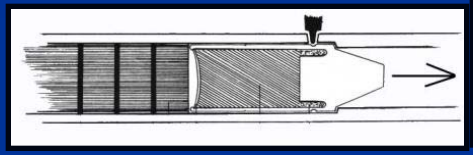
90K rds fired through 20 prototype weapons in 18 months by US troops - all weapons "survived"
BUT only under close supervision!

Increased pH through "Salvo Launch" of multiple projectiles

Caseless Ammo History (cont.)

- Various commercial caseless firearms (cont.)
  - Benelli Armi CB-M2 SMG (1980's)

9x25mm AUPO "semi-caseless" round



NC "stacked" ammunition. Improved reliability.

- Austrian Voere VEC91 hunting rifle and 5.7mm and 6mm NC caseless ammunition (1994)

Electrically-fired to reduce lock-time.

Improved accuracy.

Caseless Ammo History (cont.)

- 2000's – US LSAT LMG and Carbine under development in polymer CTA and Caseless Ammunition variants. Employs reformulated DNAG-developed HITP caseless propellant (of the German G11/ACR) in a cylindrical profile.

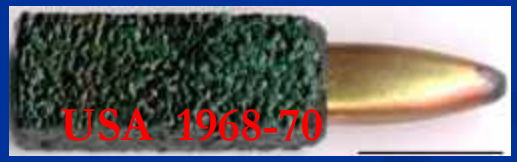

LSAT Carbine

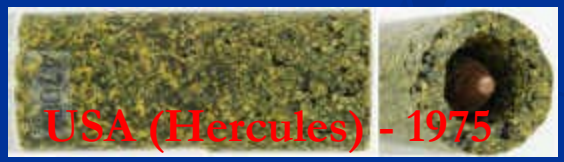

LSAT LMG


LSAT Caseless Ammo

Reduction of combat load

"Failed"(1) Caseless Attempts





(1) – Not fielded in an auto-loading weapon.

1869 through 2012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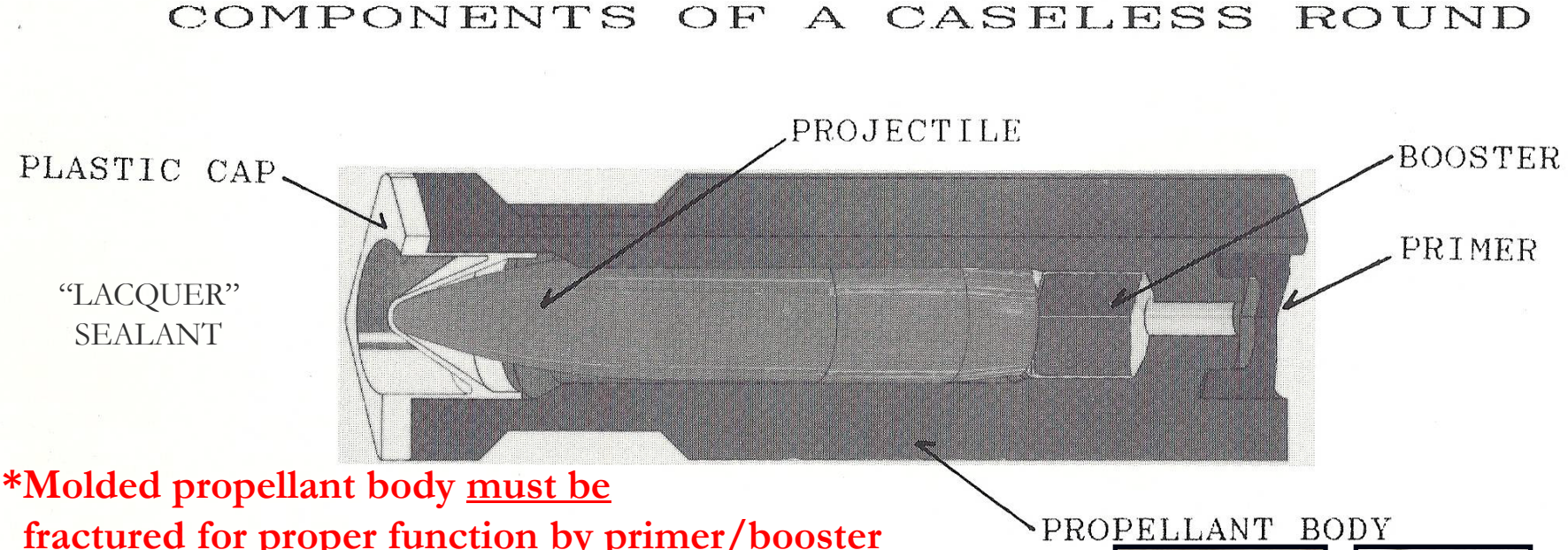
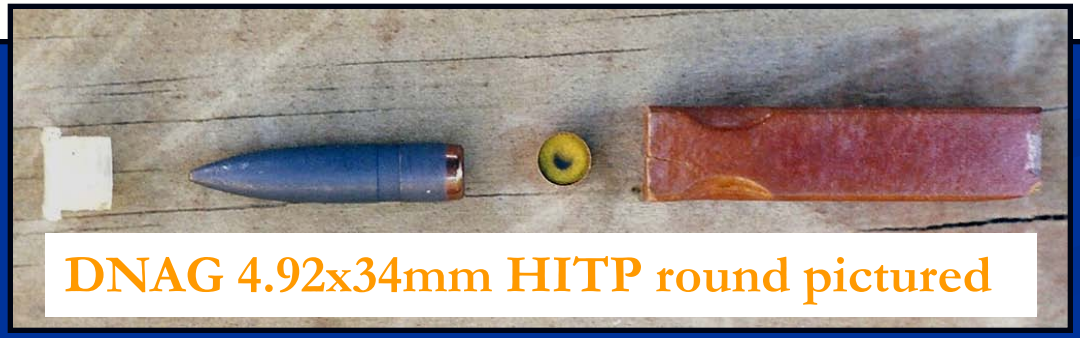
THE GOOD

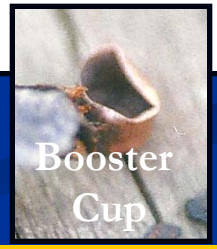
Principle of Operation
HITP Caseless Round



***Molded propellant body must be fractured for proper function by primer/booster**



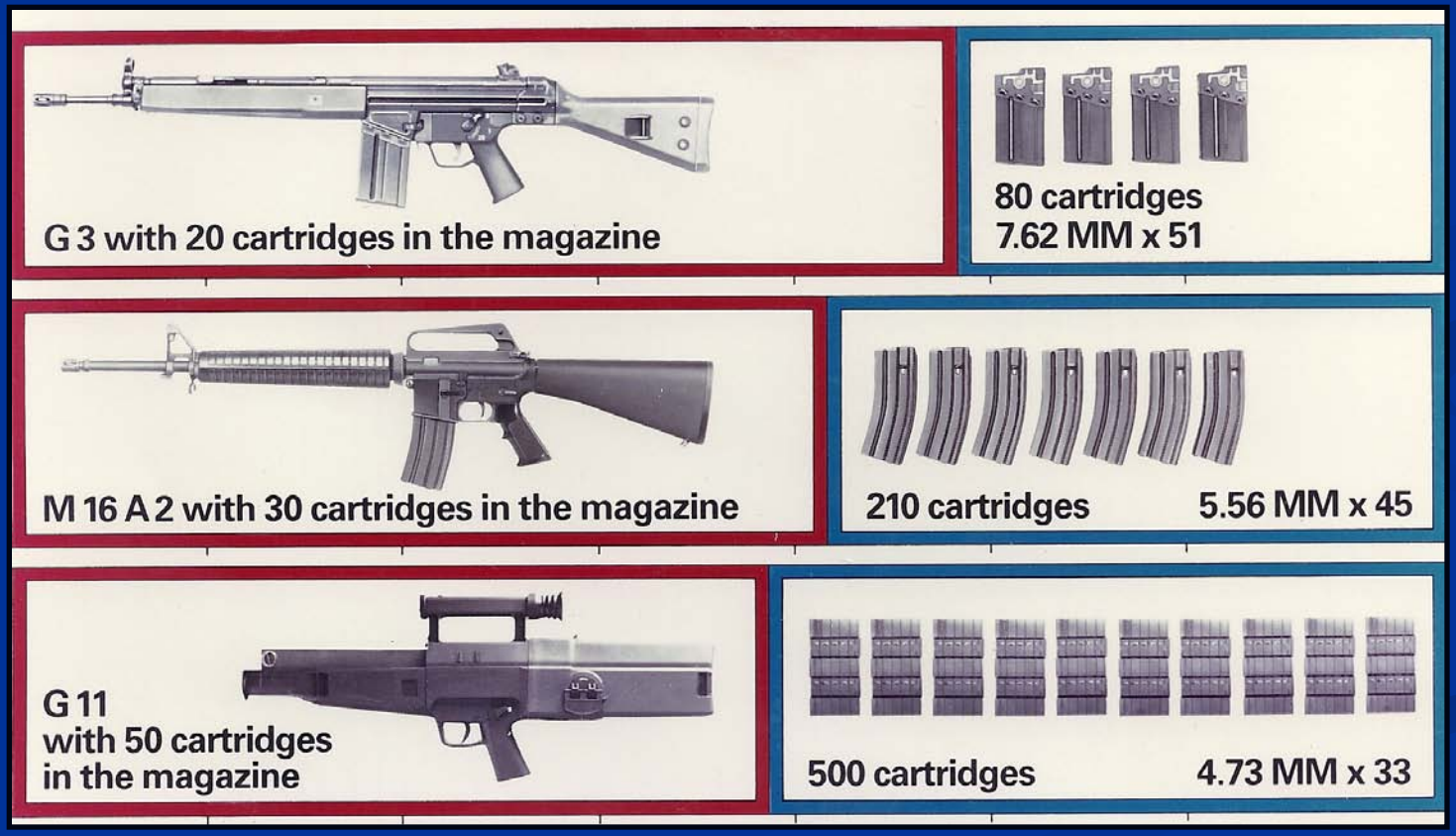
DNAG 4.92x34mm HITP round pictured



Remnants - Unique "Battlefield Spores"

THE GOOD
Weight Reduction

- **Demonstrated Reduction:**
  -Cartridge Weight > 50% vs. M855 (vs. 41% poly CTA) (2)



+ 525 %

+ 138 %

(2) Ref. LSAT Briefing, NDIA May 2010 Page 10, 12 (CL = 50%, CTA = 41%)

THE GOOD

Reduced Bulk

-Bulk: 37% < M855 ■■■■■ ●●●●●

* Smaller packaging, storage.
* Less expensive to transport ($1K-3K/pallet)
* Square round cross section allows more stowed rounds in a given space.

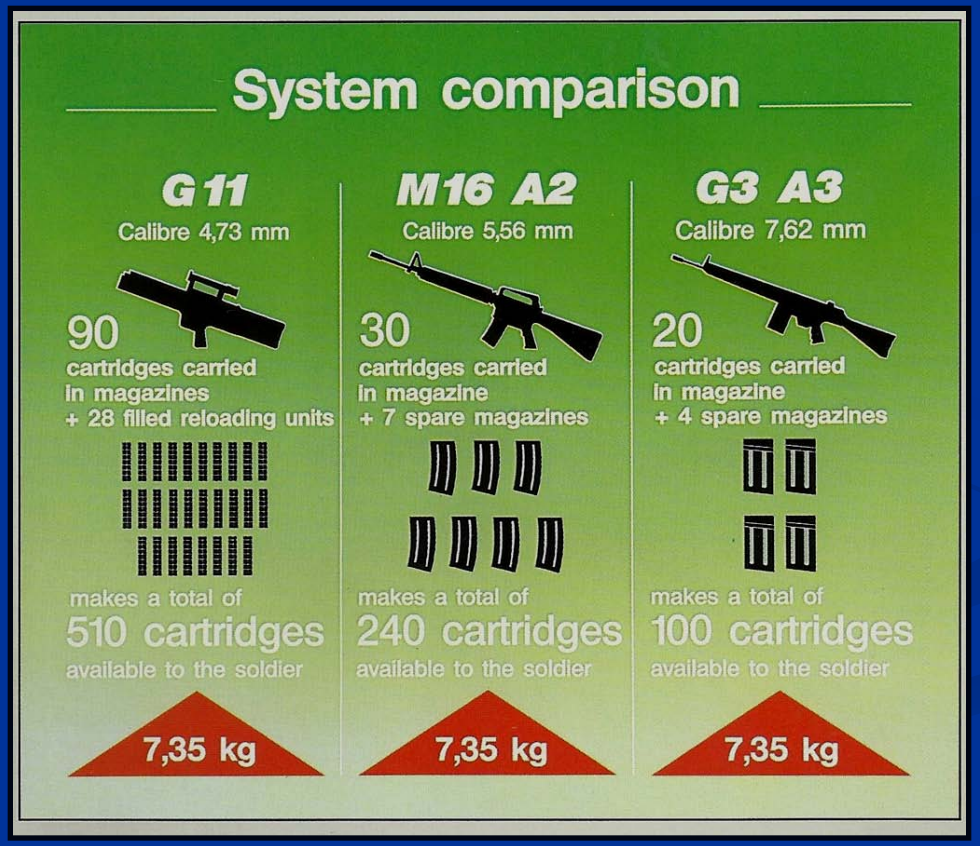
7.62x51mm, 5.56x45mm, 4.92x34mm

*More stowed round on/in weapon. Caseless LMG shown with 300 round "box" of ammunition inside stock.

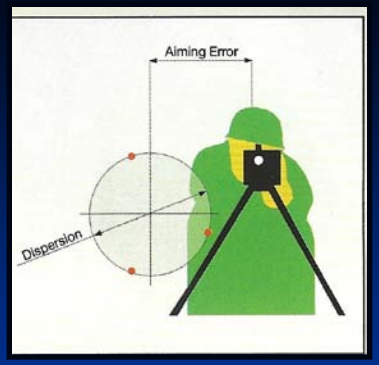
16,000 rds M855 (L), 4.92mm Caseless (R) 4,000 cu. ft. vs. 2,533 cu. ft.

THE GOOD
Increased Combat Load

- On Soldier - 510 rounds versus 240 rounds
- On Weapon – 135+ rounds versus 30 rounds



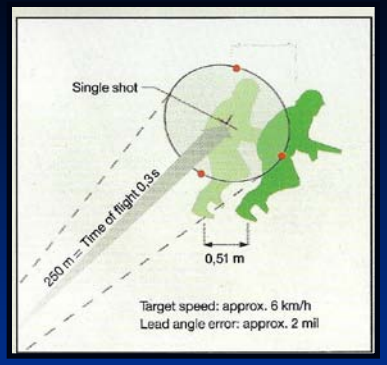
7.35 kg = 16.2 lbs.



THE GOOD

Increased Rate of Fire (Higher pH, BA Defeat)

A Double Edged Sword!



- Elimination of Extraction and Ejection steps (25% less) allows for higher rates of fire (> 2,200 rpm) **BUT requires novel, high risk mechanisms** with a poorly demonstrated down-range pH and body armor defeat benefits.

Conventional Cased Ammunition
Russian AN-94 Assault Rifle
"Shifted Pulse" mechanism

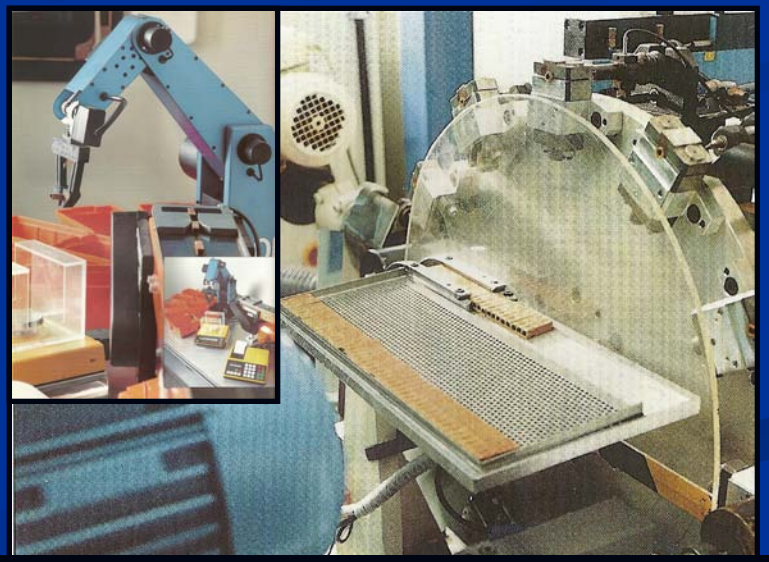
HITP Caseless Ammunition firing G11/ACR "Interior Operating Floating System" (IOFS) mechanism

"Hyper Burst" - Worth the complexity?

THE GOOD

Use of "Non-strategic" materials to lower cost

- Can caseless propellant, production and assembly procedures (mixing, molding, milling) compare with the cost of cased ammunition manufacturing?
  Especially if compared to inexpensive polymer cases?
- Requires all new machinery and processes, which would make the cost of a caliber switch seem cheap by comparison!
- No cases to be recycled.



Caseless ammunition production machinery

THE GOOD
Reduced Operator Cleaning

- Caseless HITP propellant creates almost zero fouling BUT enough exists that can inhibit high-tolerance sealing component function.


2-part "expanding" G11 chamber

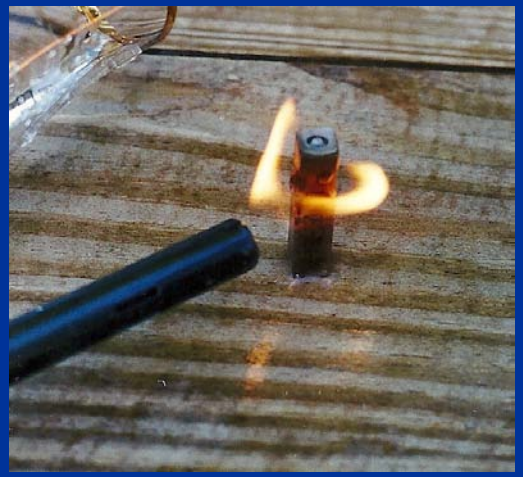
- No brass to police up, control, dispose of.
  -Firing "remnants" are however created and must be expelled during operation and represent unique battlefield "spores" left behind.


Post-misfire remnants of an HITP caseless round

THE GOOD

Reduced Fire Hazard

- The absence of the EPV (case) reduces the risk of secondary missiles and eliminates hazardous case fragments as a result of fire.



Propellant body burns, booster pops, launches projectile @ 18" up. Lands within 10" of "launch site". No fragments.

However round to round propagation is still a serious concern.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THE BAD

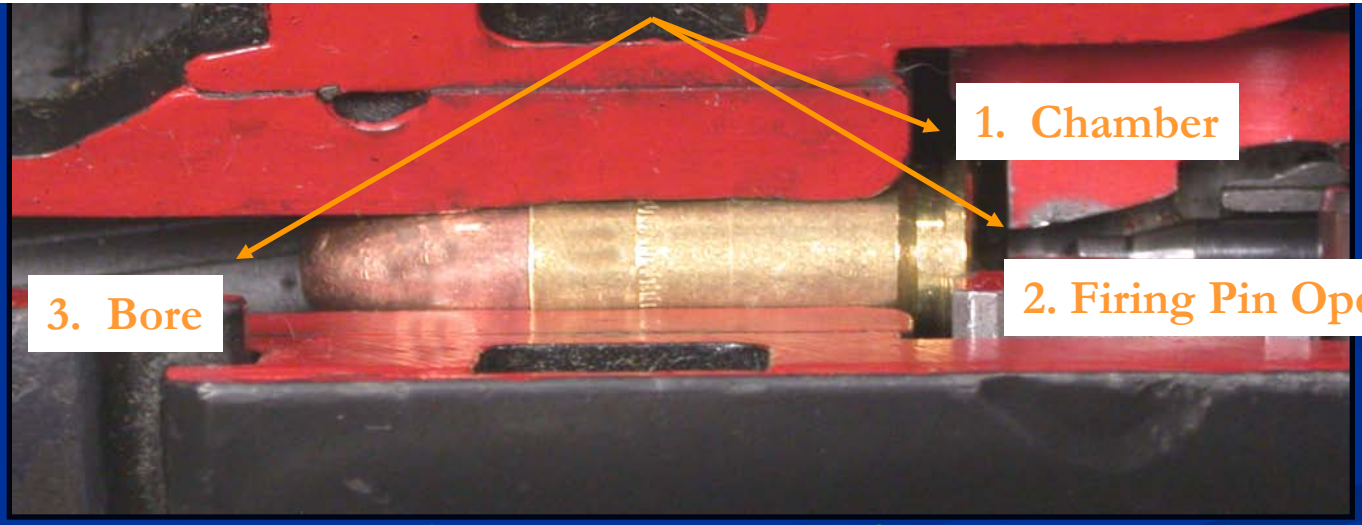
THE BAD

Obturation a.k.a Chamber Sealing

The caseless ammunition "bogeyman!"

It is very likely an insurmountable technical obstacle to successful military fielding.

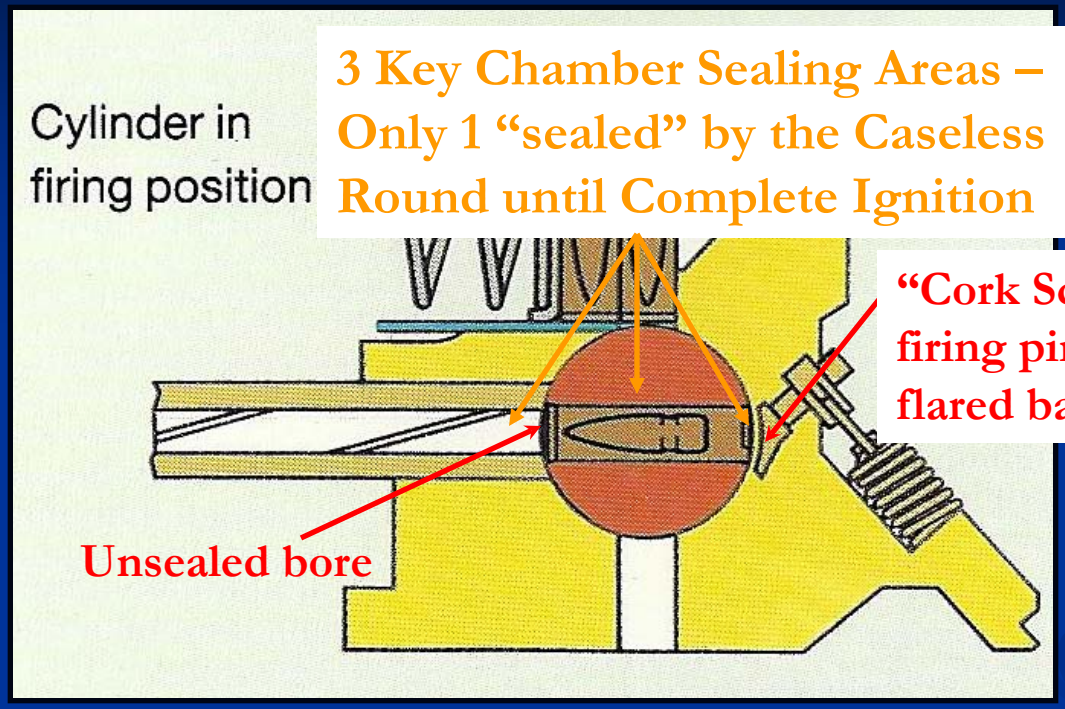
3 Key Chamber Sealing Areas – All "sealed" by the Cased Round



Gas Jet cutting can be game over for the mechanism!

Cased Ammunition

THE BAD
Chamber Sealing (cont.)



1. 2-part Expanding Chamber

Seals chamber front, rear

2. Rotary "corkscrew" Firing Pin

Seals firing pin opening

3. Plastic "Shoot thru" Cap

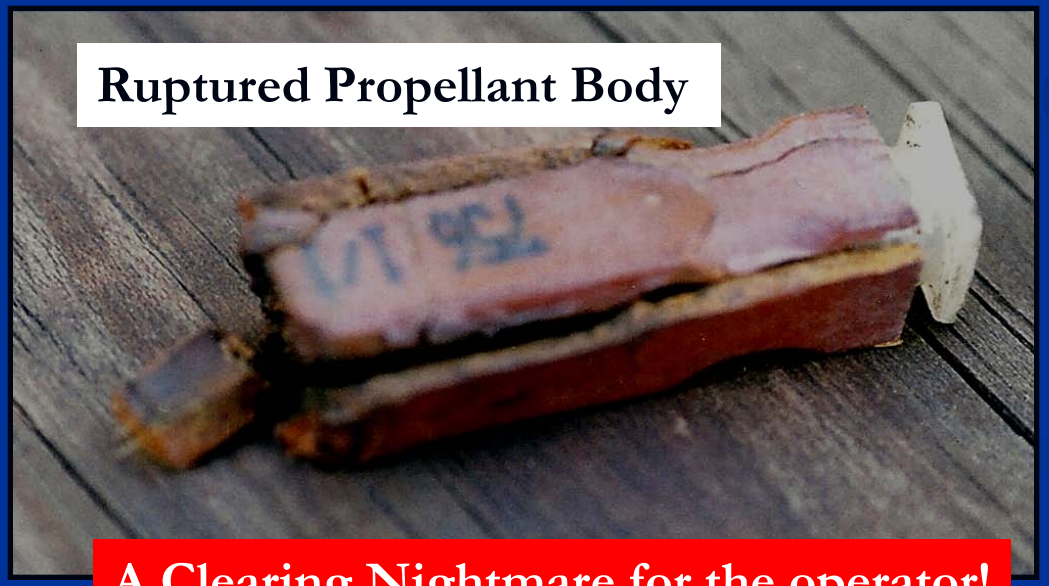
Projectile Seals Bore after "Launch"

Just one example of sealing methods illustrated here

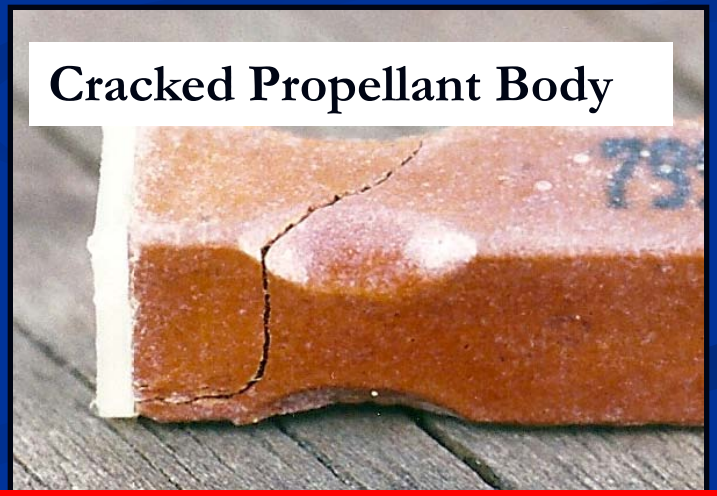
Caseless Ammunition

THE BAD
Fragile Propellant Body

- Not for use in legacy weapon mechanisms.
- Cannot easily/effectively be pull-extracted.
- **Fragments are difficult to clear from weapon!**
- Rough handling must be avoided.



A Clearing Nightmare for the operator!



Can inhibit transport/clearing.

THE BAD
Cook Off

- No expendable cartridge case "heat sink" (@ 10%) to eject from the weapon

5.56x45mm, 4.92x34mm

- 210 rounds – Maximum cook off rate from a single-chamber mechanism. Multiple-chamber mechanism required for high sustained rate of fire employment (LMG's, AR's).

THE BAD
Miscellaneous

- Correct weapon function and cartridge ballistics fully dependant on propellant body weight and the presence of all propellant at ignition.
- Propellant charge variances (i.e. custom loads) difficult to make. No user hand-loading.
- Interoperability within NATO.
- Operator field sustainability is questionable.
- Regulatory controls (ATF and the Daisy VL) and cartridge case "micro-stamping".

THE UGLY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Caseless Ammunition Failures

- Unlike anything you have seen before!
- Many are unique to Caseless Ammunition!
- Remember why we love that case (EPV)?!

Broken propellants pieces make great field chow warmers though!

Caseless Ammunition Failures (cont.)

SCRAPPED LACQUER COATING

Scrapped by slide during unloading procedure on hot weapon. Ok to fire.

Cause: Rough Handling

Class I Stoppage

Clearable by operator in less than 10 seconds

NOTE: Failures shown are weapon, ammo dependent.

Caseless Ammunition Failures (cont.)

Class I Stoppage

Clearable by operator in less than 10 seconds

NOTE: Failures shown are weapon, ammo dependent.

Caseless Ammunition Failures (cont.)

Cause: Mechanism Failure

Missing in the photo are the propellant fragments that cause stoppages.

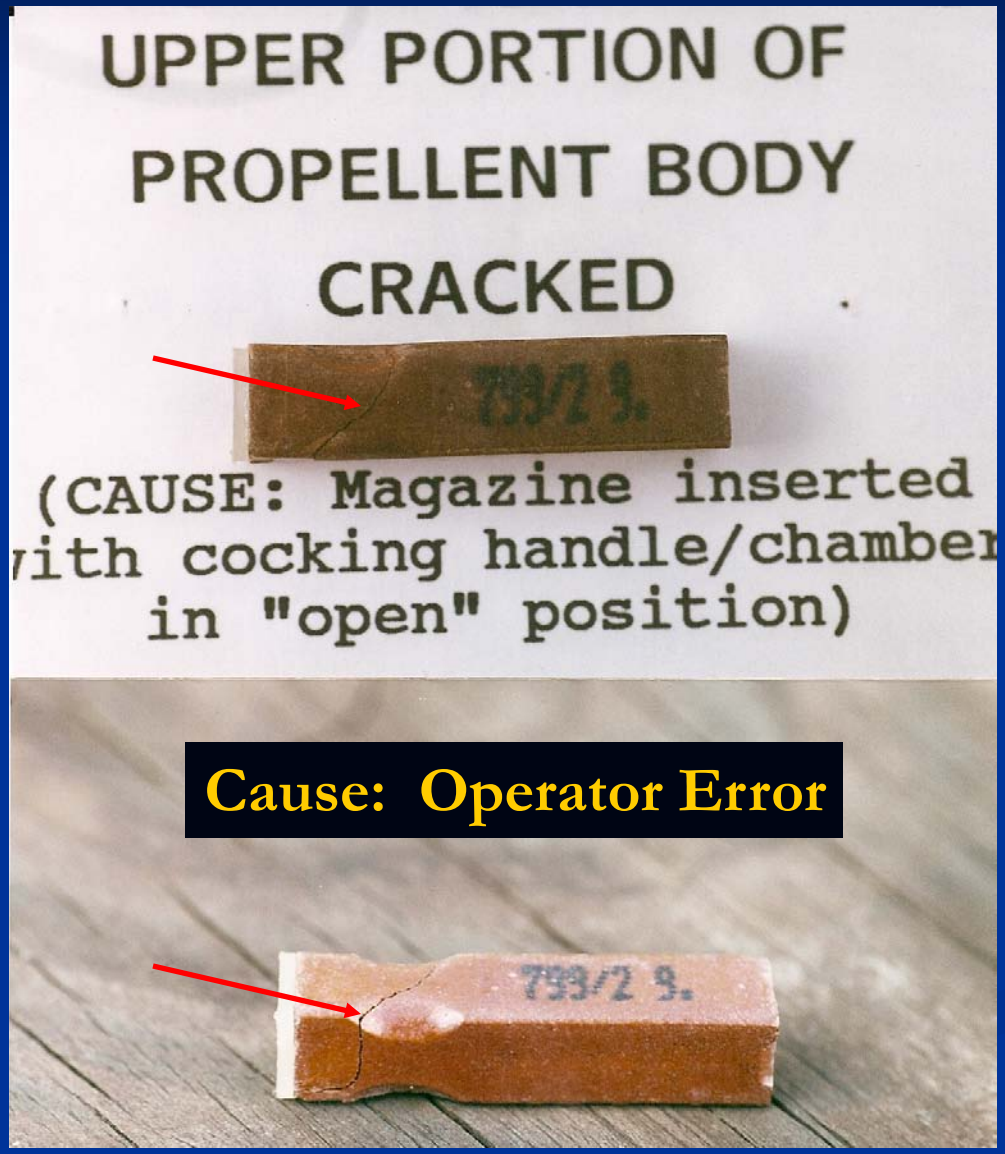
Class I Stoppage

Clearable by operator in less than 10 seconds

NOTE: Failures shown are weapon, ammo dependent.

Why pull-type extractors don't work on caseless rounds.

Caseless Ammunition Failures (cont.)



Class I Stoppage

Clearable by operator in less than 10 seconds

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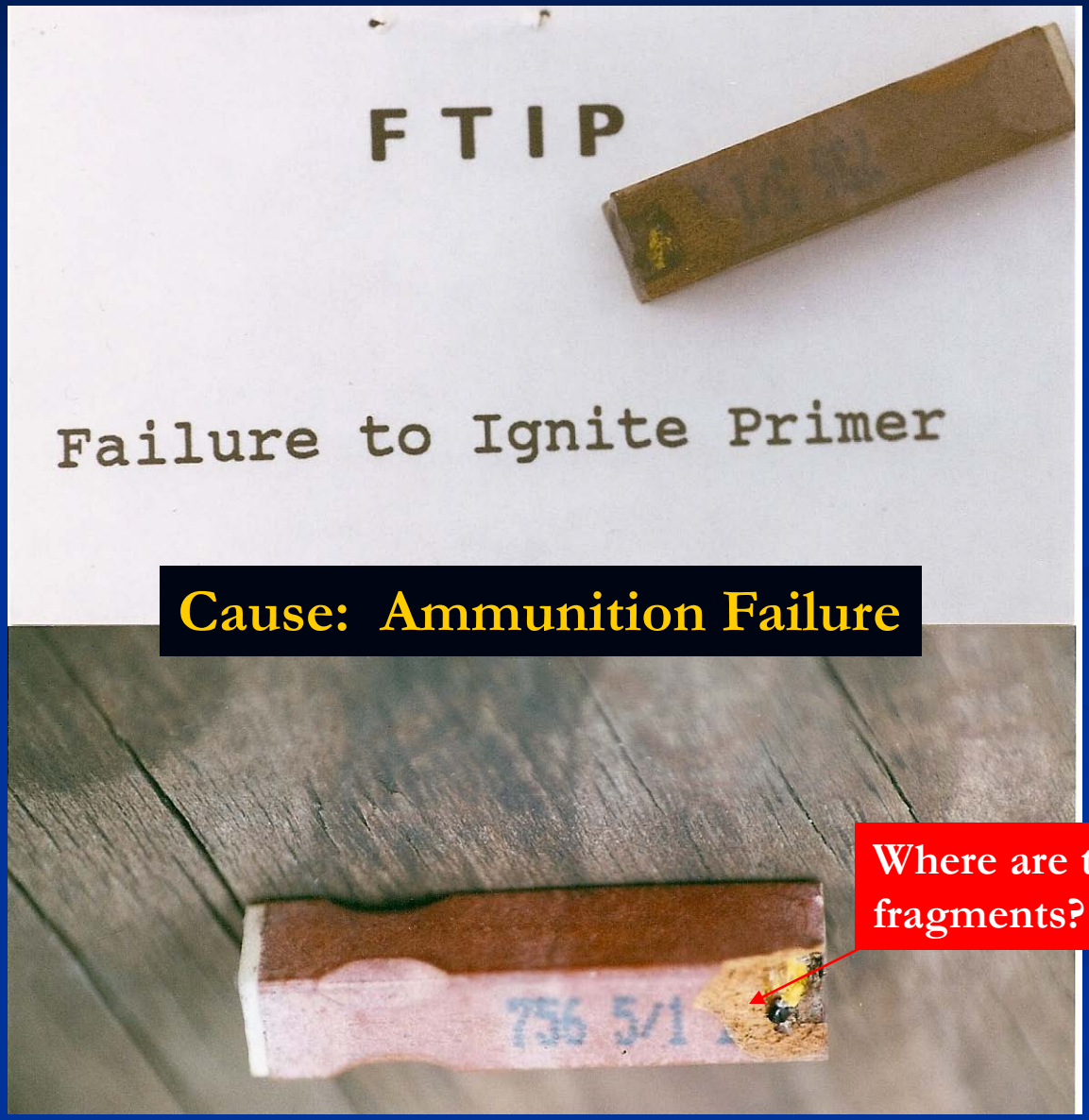
Caseless Ammunition Failures (cont.)



Class I Stoppage

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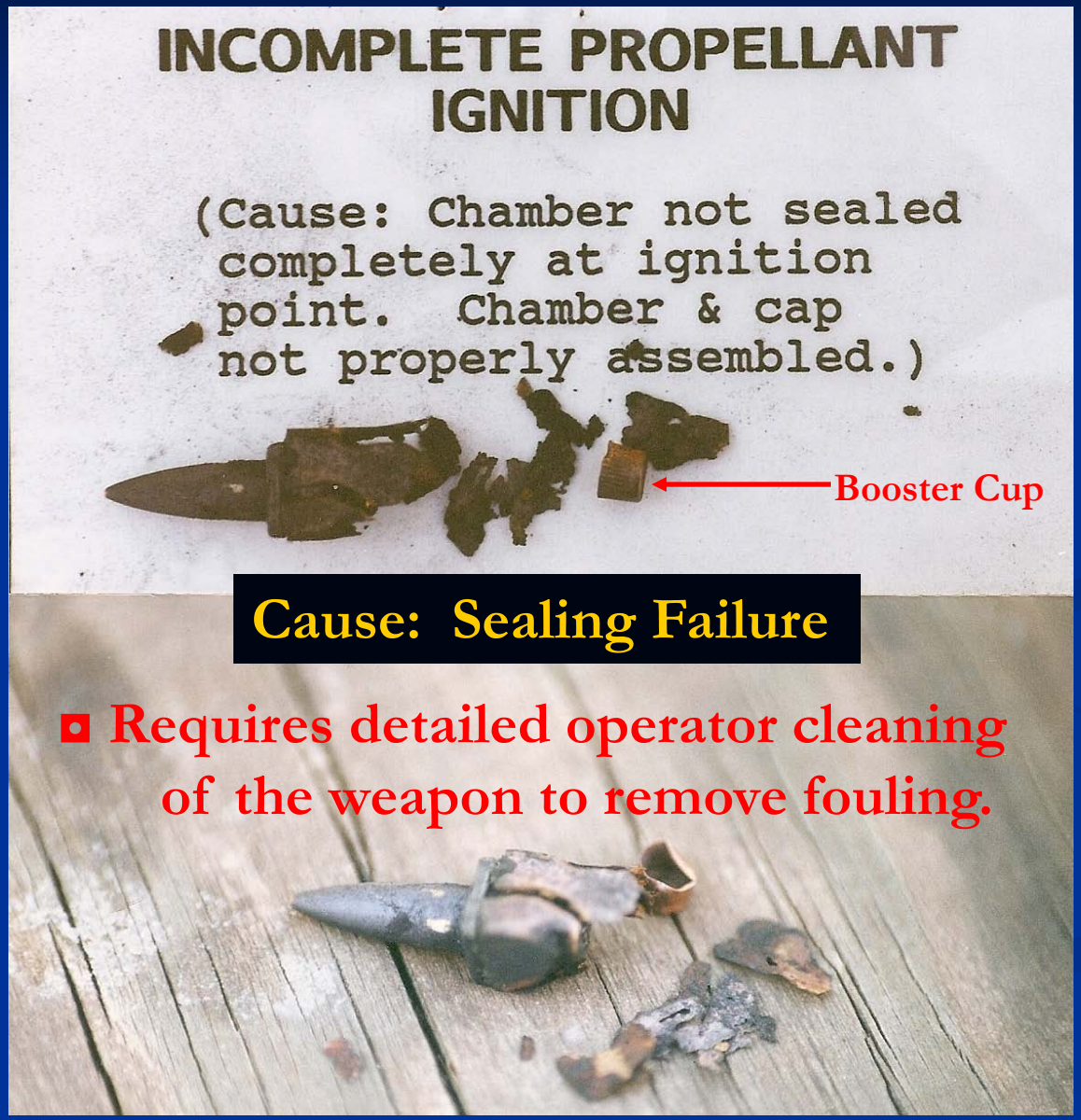
NOTE: Failures shown are weapon, ammo dependent.

Caseless Ammunition Failures (cont.)



Cause: Sealing Failure

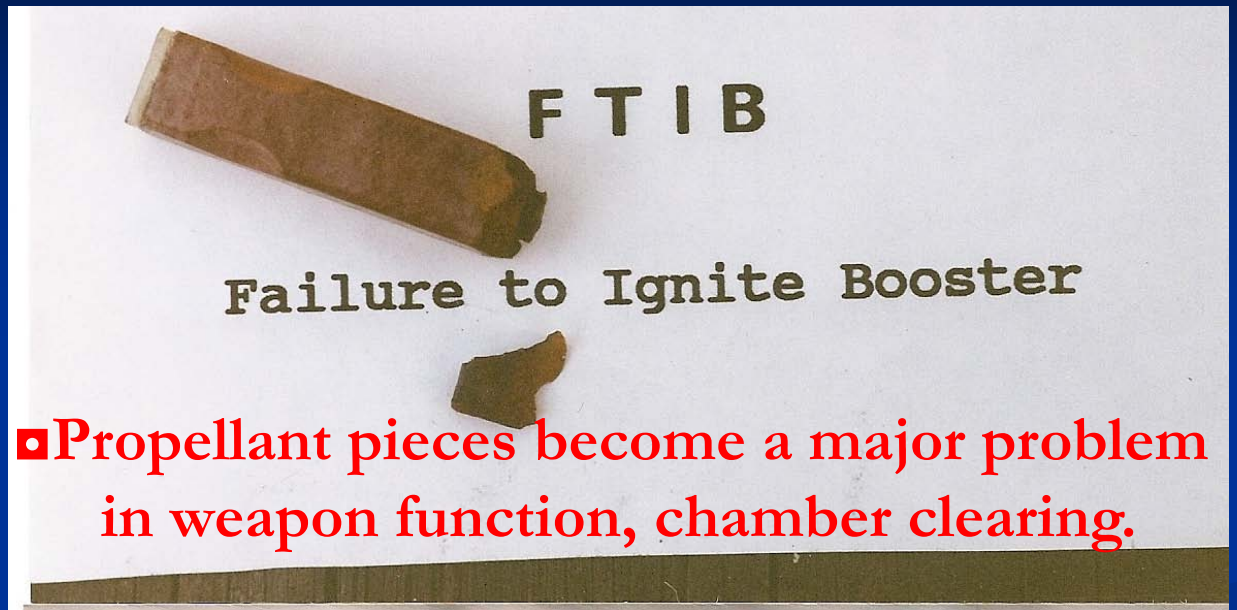
- Requires detailed operator cleaning of the weapon to remove fouling.

Class II Stoppage

Clearable by operator in less than 10 minutes

NOTE: Failures shown are weapon, ammo dependent.

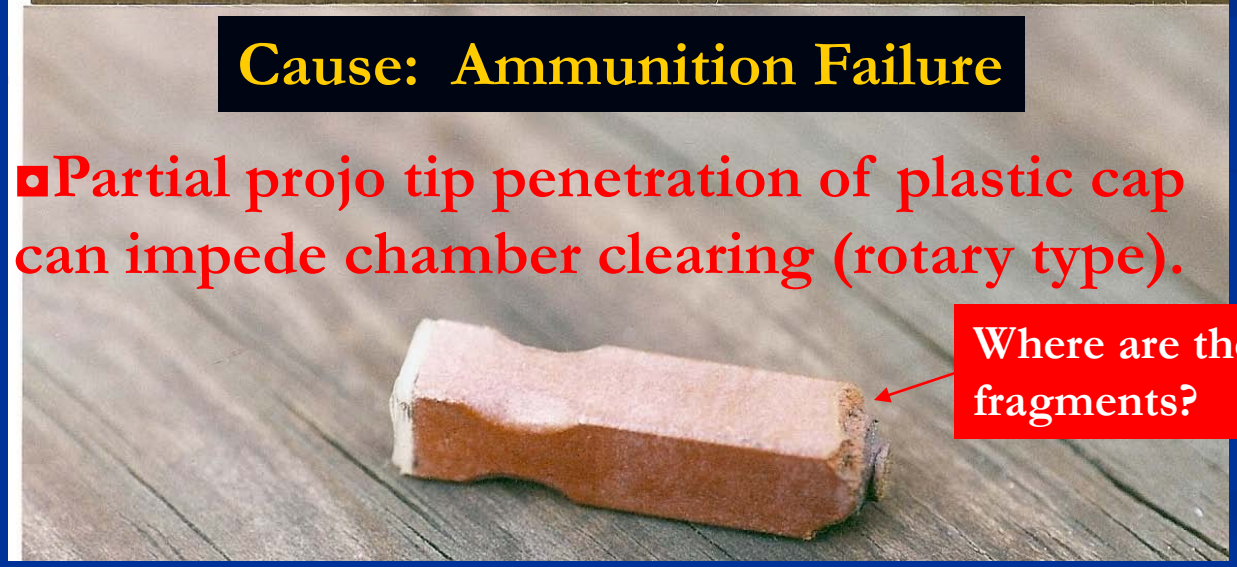
Caseless Ammunition Failures (cont.)



- Propellant pieces become a major problem in weapon function, chamber clearing.

Cause: Ammunition Failure

- Partial projo tip penetration of plastic cap can impede chamber clearing (rotary type).

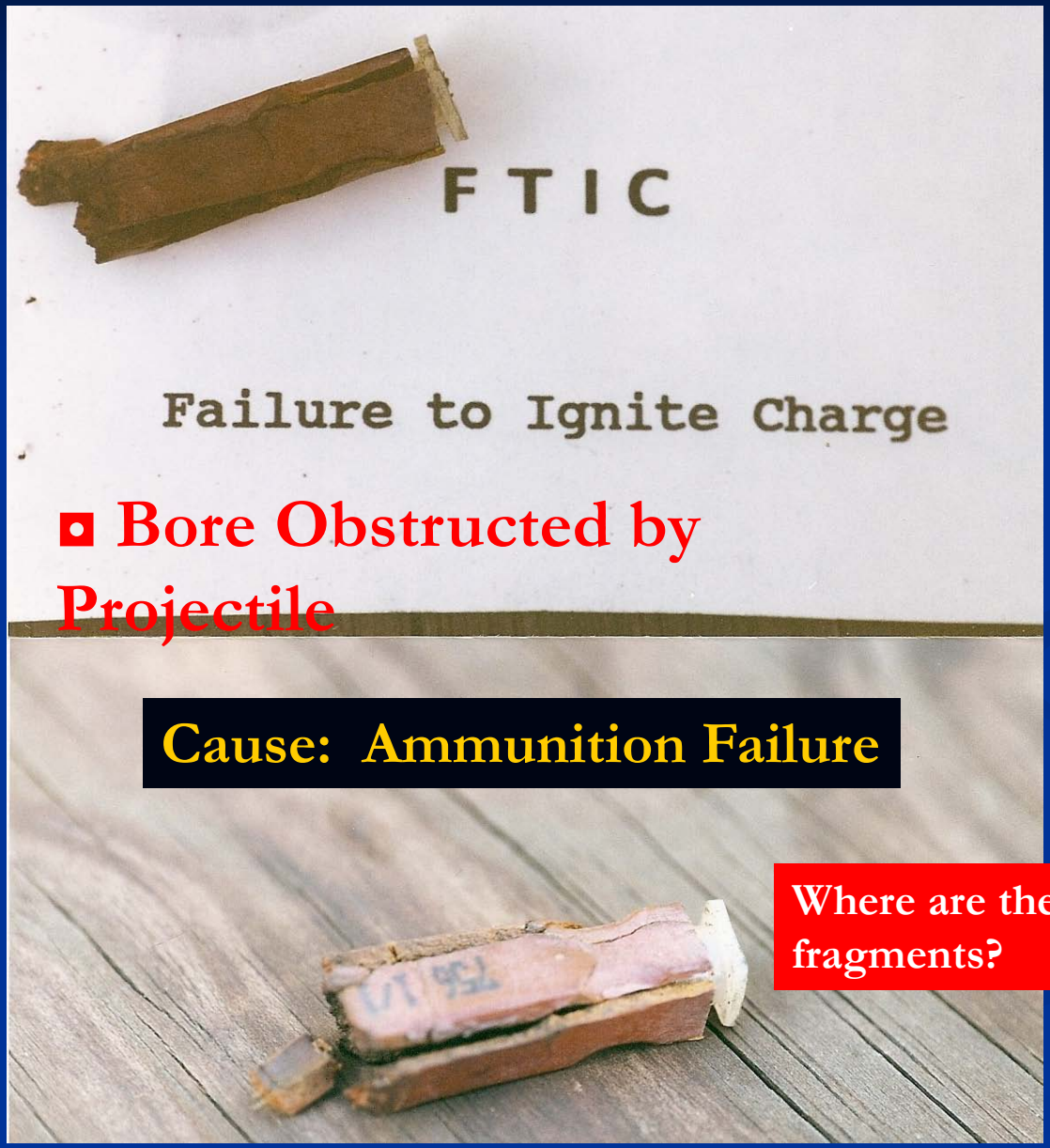


Class II Stoppage

Clearable by operator in less than 10 minutes

NOTE: Failures shown are weapon, ammo dependent.

Caseless Ammunition Failures (cont.)

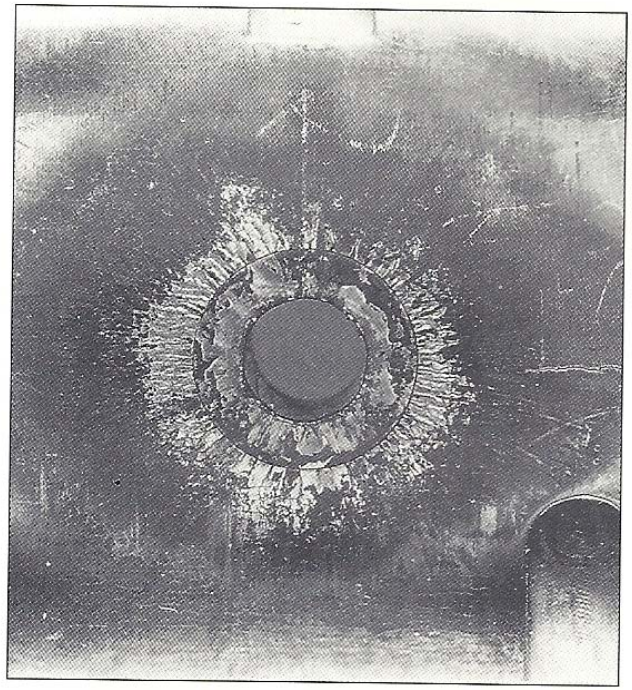


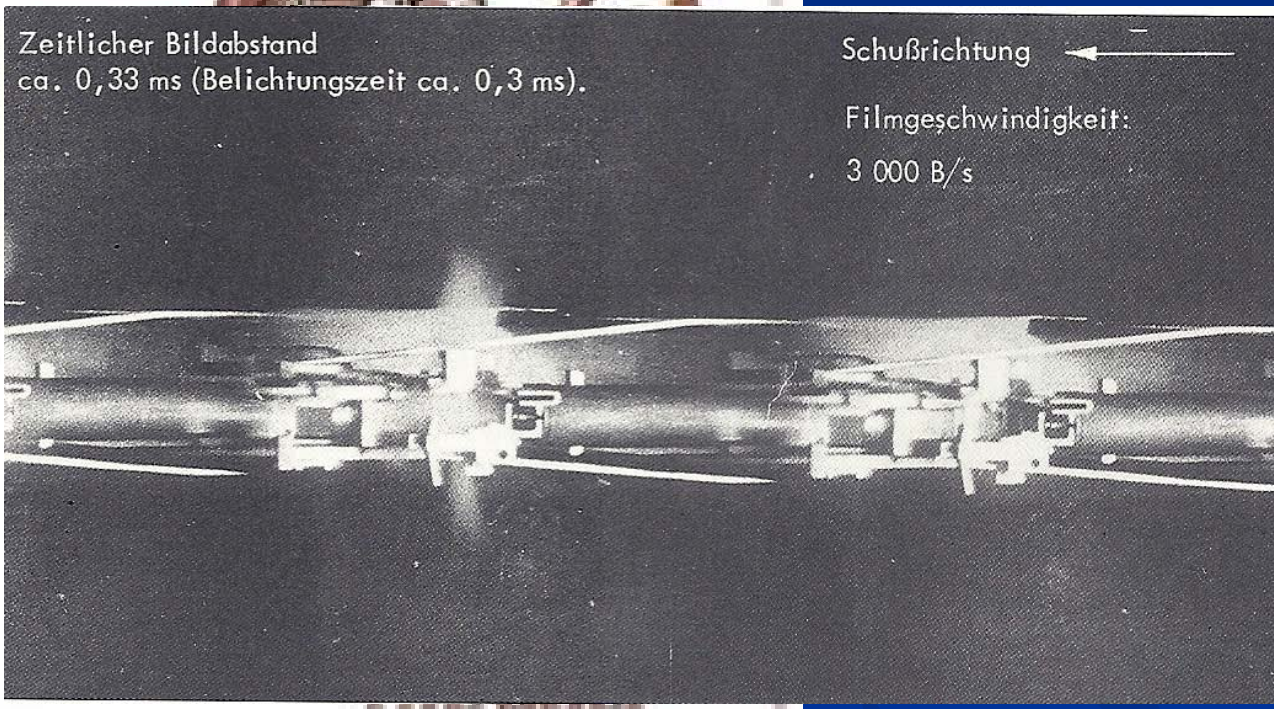
Class III Stoppage

Not clearable by operator.

NOTE: Failures shown are weapon, ammo dependent.

THE END





"Blue Smoke" incident. Sealing failure of chamber.
Gas jet destroys the weapons' breech.
The weapon is inoperable (FUBAR).

Note: Images are of a caseless G11 rifle mechanism.

Summary

- **"10% Bridge Too Far" – is the cartridge weight savings of 50% versus 40%[3] worth:**

-Unavoidable additional weapon complexity, weight[4] and sealing challenges?

-Unique ammunition failures/stoppages?

-Complete retooling cost for caseless ammo production?

-The demise of poor Teddy!

(3) Ref. LSAT Briefing, NDIA May 2010 Page 10, 12 (CL = 50%, CTA = 41%)
(4) Ref. LSAT Briefing, NDIA May 2010 Page 6 (LMG: CL 9.9 lbs., CTA 9.2 lbs)

Questions?

Contact Information
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Thank you for your time and interest!