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

Presented by
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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”

a.k.a. “Self-propelled”
Propellant located within a hollow projectile

.41 Smith & Wesson Volcanic (USA - 1860)

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!)

Beware of hidden dangers!
Caused by a poor foundation

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)
    - 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

ATF-forced “demise”
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

Hughes 5.56mm Caseless LMG

AC Electronics Model 68 Caseless bull-pup rifle

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

NC “stacked” ammunition. Improved reliability.

Electrically-fired to reduce lock-time. Improved accuracy.
Caseless Ammo History (cont.)

“Failed” (1) Caseless Attempts

1869 through 2012

- Austria-Swiss 1983
- Austria 1994
- France 1980-86
- France
- Belgium 1987
- USA 1869
- USA 1969
- USA 1963
- USA 1968-70
- USA (Hercules) - 1975
- USA mid-1960's
- Germany 1975-78
- Germany 1973-78
- Germany 1974-78
- Germany/USA 1989-90
- Unknown
- Italy
- Spain

(1) – Not fielded in an auto-loading weapon.
Principle of Operation
HITP Caseless Round

COMPONENTS OF A CASELESS ROUND

PLASTIC CAP
“LACQUER” SEALANT

PROJECTILE

BOOSTER
PRIMER

PROPELLANT BODY

*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)

G 3 with 20 cartridges in the magazine
80 cartridges
7.62 MM x 51

M 16 A 2 with 30 cartridges in the magazine
210 cartridges
5.56 MM x 45

G 11 with 50 cartridges in the magazine
500 cartridges
4.73 MM x 33

(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.

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

7.62x51mm, 5.56x45mm, 4.92x34mm

16,000 rounds 4.92mm Caseless
(3.8) 20x20x20 inch boxes

16,000 rounds 5.56mm M855
(6) 20x20x20 inch boxes

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.
The Good
Reduced Operator Cleaning

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

- 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.
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.
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
1. 2-part Expanding Chamber

3 Key Chamber Sealing Areas – Only 1 “sealed” by the Caseless Round until Complete Ignition

“Cork Screw” firing pin with flared base seal

2. Rotary “corkscrew” Firing Pin

Seals chamber front, rear

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.

Ruptured Propellant Body

A Clearing Nightmare for the operator!

Cracked Propellant Body

Can inhibit transport/clearing.
THE BAD
Cook Off

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

- 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).

5.56x45mm, 4.92x34mm
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
**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!**
Class I
Stoppage

Clearable by operator in less than 10 seconds

SCRAPPED LACQUER COATING

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

Cause: Rough Handling

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.

Cause: High Weapon Temperature

DEFORMED PLASTIC CAP AND BLISTERED LACQUER

(Cause: Prolonged exposure to Hot Chamber)
Caseless Ammunition Failures (cont.)

Class I
Stoppages

Clearable by operator in less than 10 seconds

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

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

NOTE: Failures shown are weapon, ammo dependent.
Caseless Ammunition Failures (cont.)

Class I Stoppage

Clearable by operator in less than 10 seconds

Cause: Operator Error

NOTE: Failures shown are weapon, ammo dependent.
Caseless Ammunition Failures (cont.)

Class I

Stoppage

Clearable by operator in less than 10 seconds

Cause: Ammunition Failure

Failure to Ignite Primer

NOTE: Failures shown are weapon, ammo dependent.

Where are the fragments?
Caseless Ammunition Failures (cont.)

**INCOMPLETE PROPELLANT IGNITION**

(Cause: Chamber not sealed completely at ignition point. Chamber & cap not properly assembled.)

- **Class II Stoppage**
  - Clearable by operator in less than 10 minutes

**Cause: Sealing Failure**

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

NOTE: Failures shown are weapon, ammo dependent.
Caseless Ammunition Failures (cont.)

Class II
Stoppage

Clearable by operator in less than 10 minutes

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

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

Where are the fragments?

NOTE: Failures shown are weapon, ammo dependent.
Caseless Ammunition Failures (cont.)

Class III
Stoppage

Not
clearable by
operator.

Failure to Ignite Charge

♢ Bore Obstructed by Projectile

Cause: Ammunition Failure

Where are the fragments?

NOTE: Failures shown are weapon, ammo dependent.
“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?

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Thank you for your time and interest!