



GREEN BULLET PROGRAM



Presented by:
Mr. Arthur R. Pizza
SR. Project Engineer
Non-Toxic Projectile

Committed to Excellence

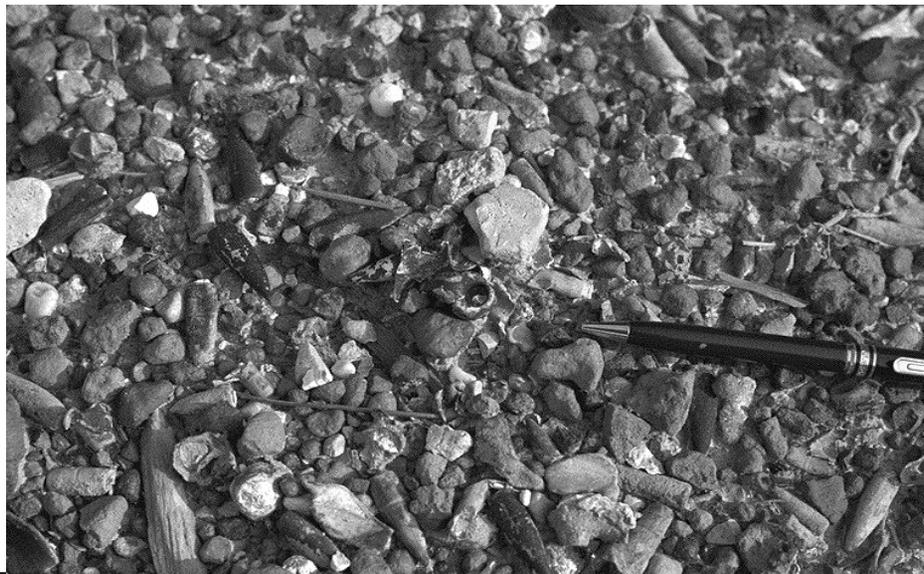


Environmental Problem Statement



Problem: Use of small arms ammunition has resulted in the contamination and suspension of training ranges due to high lead levels in the soil and surrounding areas.

Technical Objective: Eliminate use of lead-antimony in projectile cores. To develop lead-free projectile cores that do not degrade performance and are non-toxic.





Principal Performers



•Investigators:

John Middleton

US Army Armaments RD&E Center

Rick O'Donnell (Range XXI)

James Heffinger (Green Ammo)

US Army Environmental Center

•Performers:

Arthur R. Pizza

US Army ARDEC

Rick Lowden

Oak Ridge National Laboratory

Charles Buxton

Naval Surface Warfare Center

Mike Richard

Operational Support Command

Charles Gersitz

US Army ARDEC-RIA



History



- Contracts (Awarded 6-11-99)
 - Ideas to Market, LP (I2M), TX
 - GenCorp, Aerojet Ordnance, TN
- 1 Million cores with 3 million option
- I2M delivered 1 million slugs/option
 - LAPed at Lake City
 - Passed Cartridge Test
 - In Inventory
 - Fielded to Mass. Nat. Guard
- Aerojet is in Process

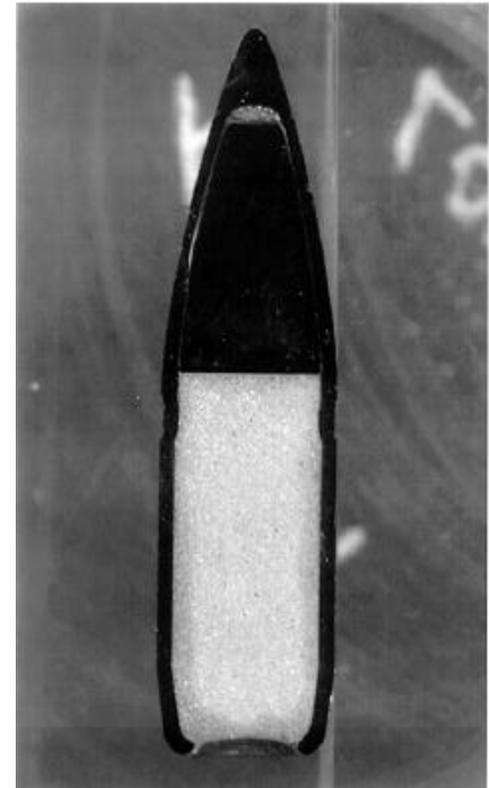




Projectile Core Replacement Efforts



- ➔ 5.56mm M855 Ball cartridge completed
 - Two candidates qualified
 - Field Tested - Stewart River, Alaska
 - MMR, Camp Edwards
 - Currently procuring 7M cores for FY00
 - 1M+ cartridges available to field in Dec 99
- ➔ Caliber .50 lead replacement completed
- ➔ 5.56mm companion tracer, 7.62mm and 9mm replacement efforts underway

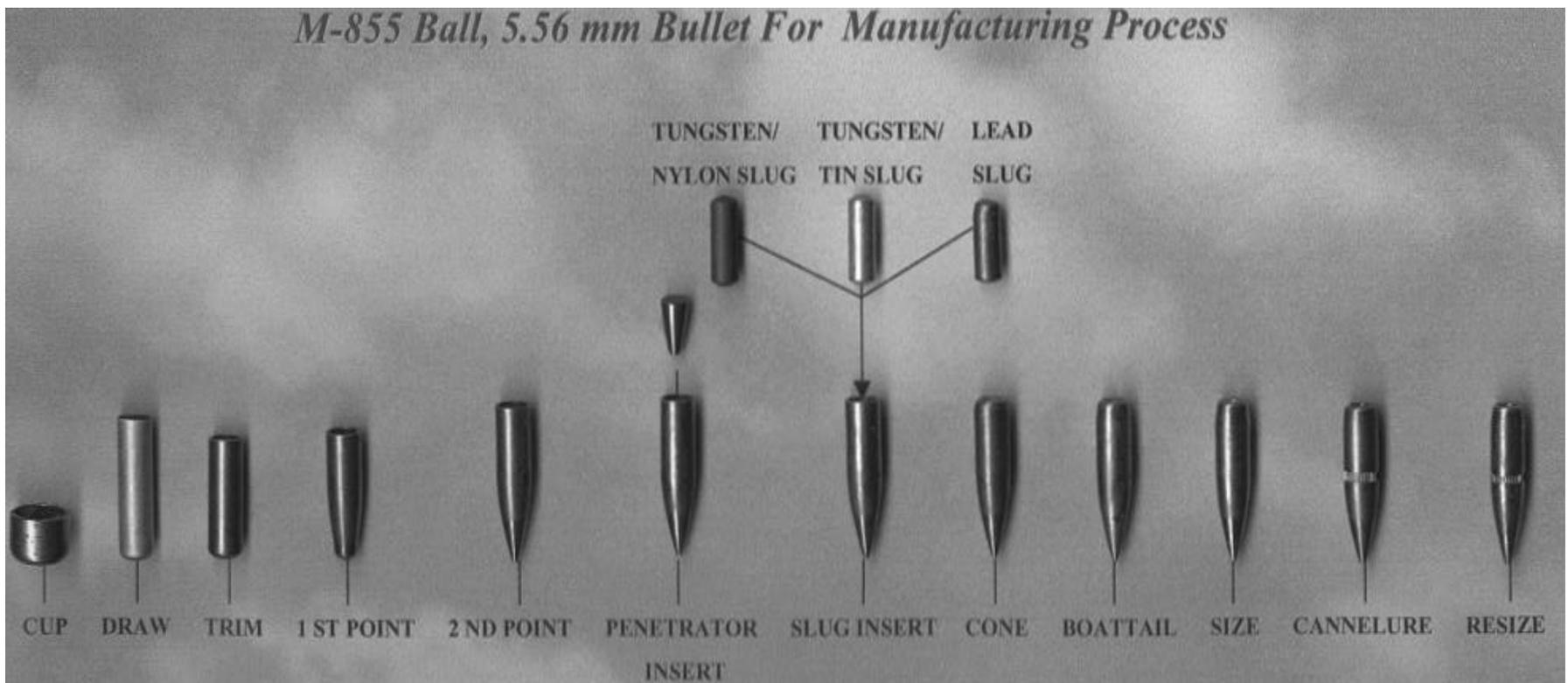




LAKE CITY ARMY AMMUNITION PLANT



- **Lake City Army Ammunition Plant manufactures 5.56mm - Cal..50 ammunition for the Army.**
- **Operated by Alliant Techsystems (ATK)**





Projectile Core Replacement Efforts

Stewart River, Alaska



→ Field Test at Stewart River, Alaska - Aug '98

→ Conducted by the 1st Battalion, 297 Infantry

→ New Range Facility in Pristine area.

→ Riflemen were shooting for qualification

→ 5,200 rds fired by 72 riflemen for Qualification



“Green Ammunition had no adverse impact on qualifying soldiers”
MAJ Garry W. Curtiss



Projectile Core Replacement Efforts *Massachusetts Military Reservation*



First Firing of Production Green Bullet M855, October '99

Massachusetts Military
Reservation (Camp Edwards)

Training had been suspended
for 2 years.

211th And 972nd Military
Police Battalion

Riflemen were shooting for
qualification

58 Riflemen Qualified (one
perfect score)



AEROJET

LEAD-FREE 5.56mm AMMUNITION

***Mark R. Mabry
Program Manager
Aerojet Ordnance Tennessee***

***2000 NDIA
Joint Services Small Arms Symposium
Session VII - Ammunition and the Environment
August 30, 2000***

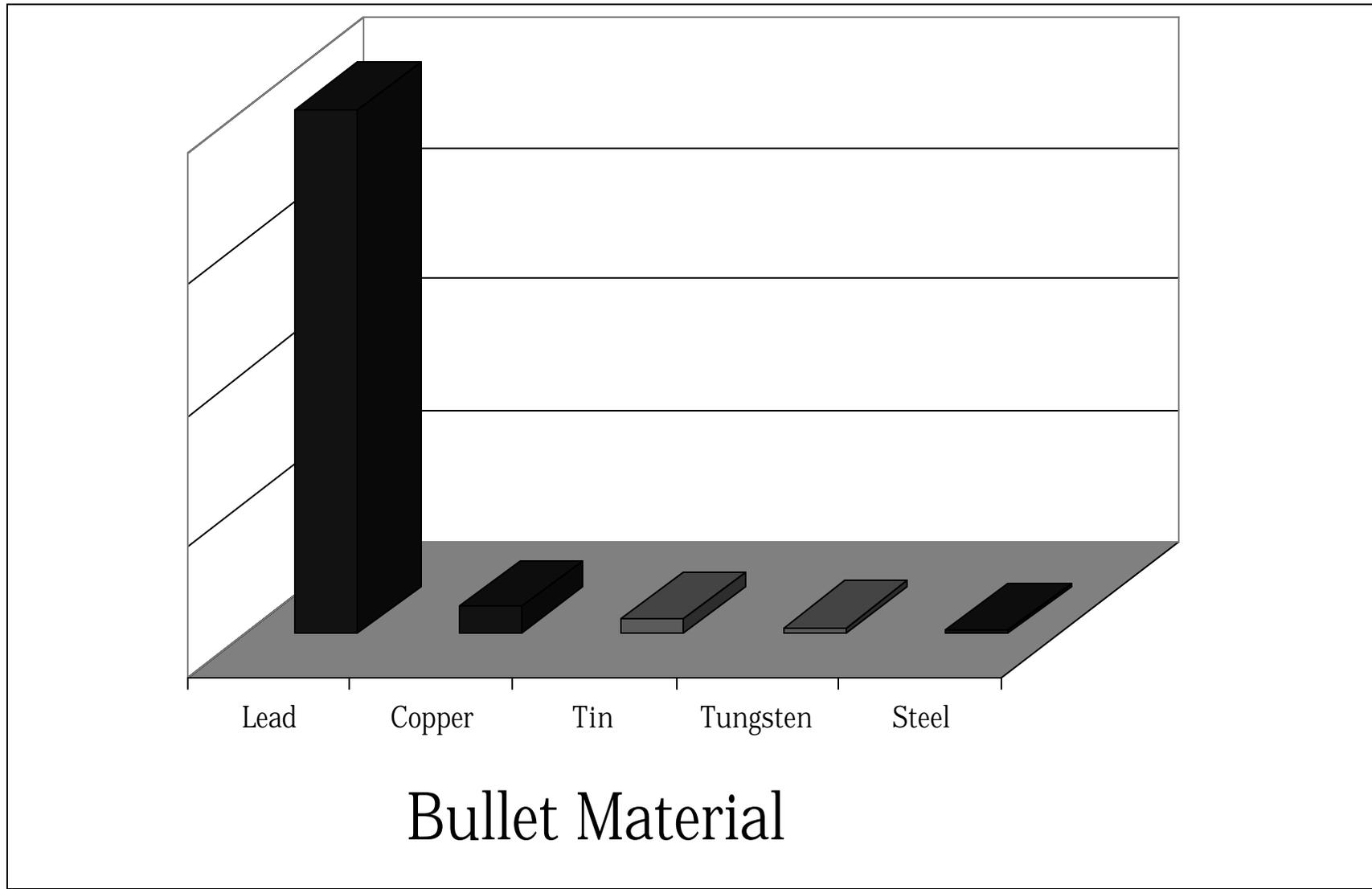
Email: info@aerojet.com

Objective

- *Eliminate the use of Lead in the 5.56mm M855 Projectiles.*
- *Transition the W-Tin Core Technology into high rate production.*

Relative Toxicity of 5.56mm Bullet Materials

AEROJET



Ref: OSHA Reg. (Permissible Exposure Limits) - 29CFR 1910.1000

Email: info@aerojet.com

- **W-Tin Material Offers:**
 - **“Drop-in” Replacement for Lead**
 - *Equivalent Density & Volume*
 - **Most Cost Effective Lead Replacement Material to Date**
 - **Flexibility in Future Designs**
 - *Easily change density by altering the W-Tin blend composition*
 - *Net Shape formed core*
 - *Mechanical Properties can be tailored to meet application*
 - **Process is conducive to High-Rate Production**

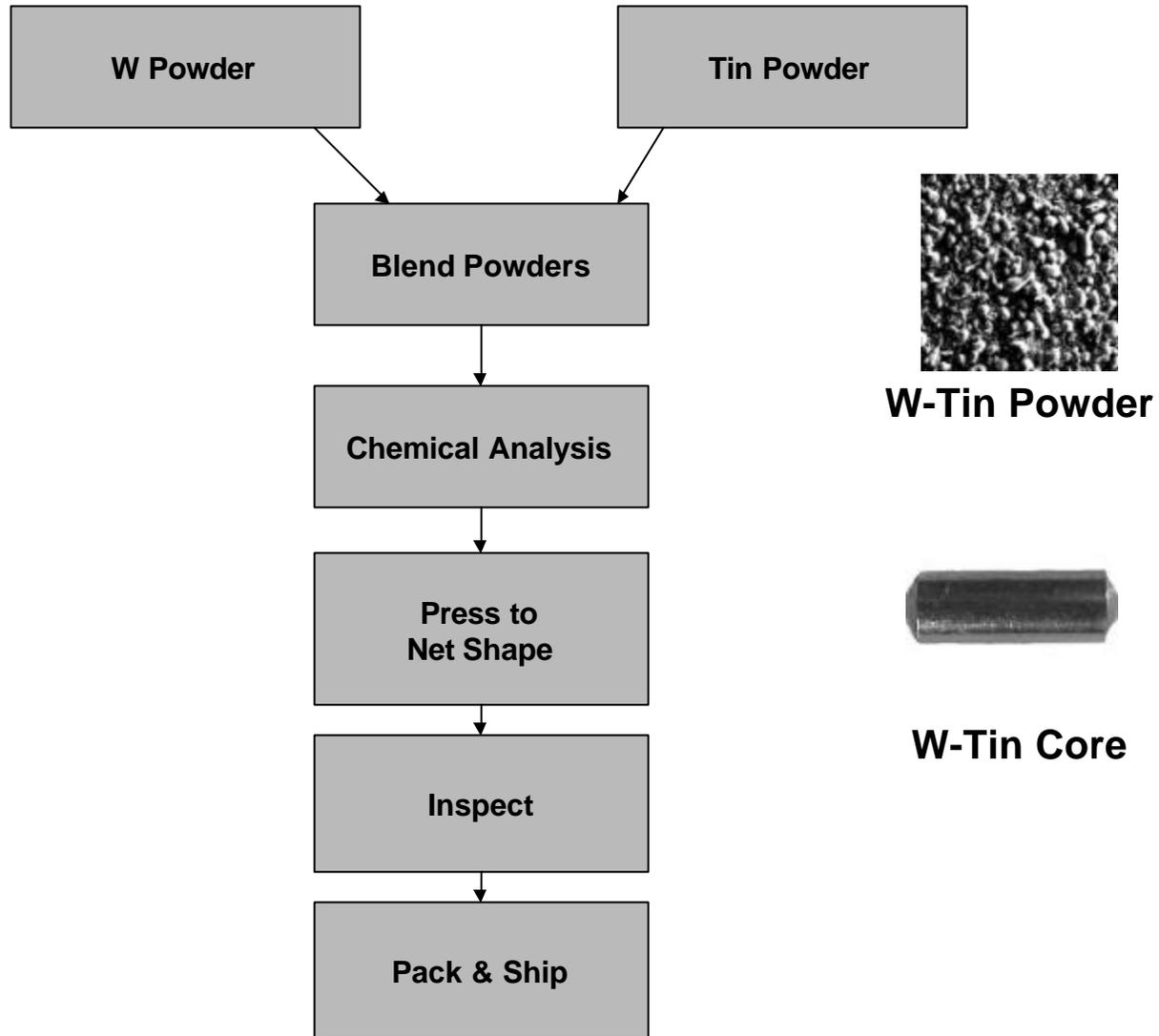


Tungsten-Tin



Lead

W-Tin Process Flow



Conclusion

AEROJET

- *W-Tin is a Viable Replacement Material for Lead in Small Caliber*
 - *Non-Toxic Alloy*
 - *Cost Competitive to Alternate Materials*
 - *“Drop-In” to 5.56mm Bullet has been Demonstrated.*

Ecomass[®] Compounds

*Development of Lead-Free 5.56mm
Ammunition*

Robert R. Durkee, III

President

IDEAS TO MARKET, LP

2000 NDIA

Joint Services Small Arms Symposium

Exhibition & Firing Demonstration

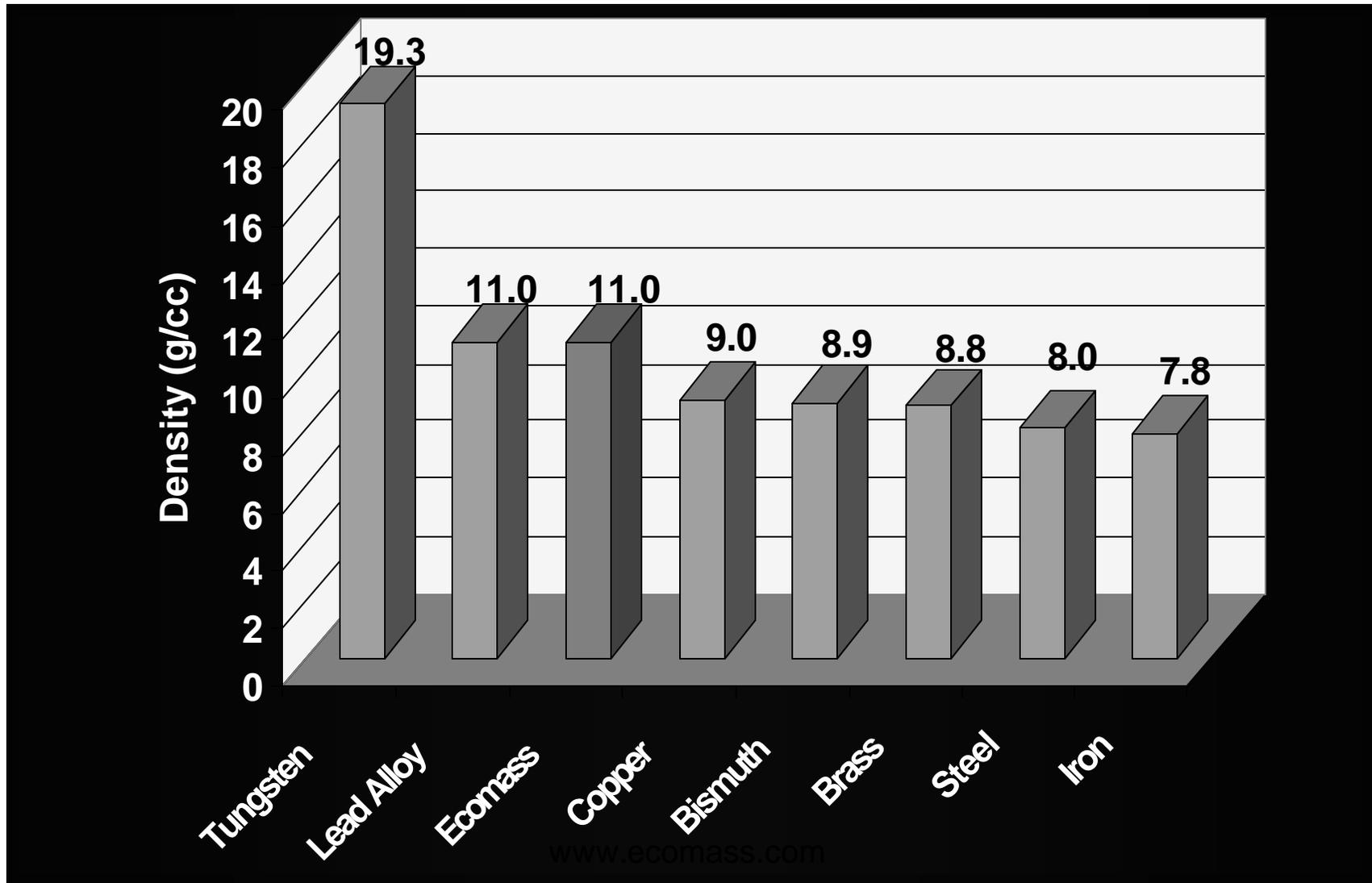
www.ecomass.com

- **New Composite Material Technology**
 - Primary Development Objectives:
 - Nontoxic Material (DoD, EPA)
 - Achieve Key Characteristics of Lead
 - Density of 11.0 g/cc
 - Ease of Processing
 - Achieve Same Level of Ballistic Performance as Lead Projectile Cores
 - Development of Tungsten / Nylon Thermoplastic Composite Material

- **Polymers and Fillers**

- Base Polymer - (Nylon, PE, PPS, PEEK, TPE)
- Fillers - Type & Load Levels
 - Tungsten (W)
 - Inert Metal Powder
 - Melting Point: 3,400° C
 - Density: 19.3 g/cc
- Performance Attributes / Properties
 - Density
 - Tensile Strength
 - Impact Strength

Properties - Density Comparison



Ecomass[®] Compounds

Properties - Ecomass[®] Compounds

Property (Test)	Units	NJ-84TP	NJ-90TP	NJ-94TP	NJ-96TP
Filler	%	84	90	94	96
Density	g/cc	5.0	7.0	9.0	11.0
Flexural Modulus	MPa	3,000	3,100	4,310	8,410
Tensile Strength	MPa	50	50	52	52
Ultimate Elongation	%	4.5	3.0	2.0	<1.0
Notched Izod Impact	J/m	58.8	58.8	69.5	77.5
Deflection Temp. 1.8 MPa	°C	147	149	155	155
Linear Mold Shrinkage	mm/mm	0.254	0.229	0.155	0.155

Ecomass® Compounds

➤ Applications

➤ Military Ammunition

➤ 5.56mm ball (M855) and tracer (M856)

➤ 7.62mm ball (M80) and tracer (M62)

➤ 9mm

➤ Law Enforcement

➤ Civilian Ammunition

➤ Shotgun Shot



- **Conclusions**

- New Line of Composite Materials
 - Nontoxic
 - Thermoplastic Based
 - Wide Range of Binder Options
 - Injection Moldable
 - Increased Part Design Flexibility
 - Performance Parameters Similar to Lead
- Lead Replacement for Various Applications
 - Projectiles and Shot
 - Radiation Shielding