



Lightweight Small Arms Technologies



Lightweight Small Arms Technologies (LSAT)



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Lightweight Small Arms Technologies

Top 5 Soldier Weight Contributors



Lightweight Small Arms Technologies (LSAT)

For Automatic Rifleman:

1. M249 Squad Automatic Weapon w/200 rds Ammo
2. 5.56mm Ammunition (400 rounds)
3. Body Armor & Helmet
4. Communication Equipment
5. Canteen/Water



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Lightweight Small Arms Technologies Goals



Lightweight Small Arms Technologies (LSAT)

Goals:

- 35% weapon weight reduction
- 40% ammunition weight reduction
- Reduced training & maintenance
- Maintain cost of current systems



Approach:

- “Clean Slate” design
- Reduced weight as the priority
- In depth trade studies
- Extensive modeling & simulation



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Lightweight Small Arms Technologies Program Approach

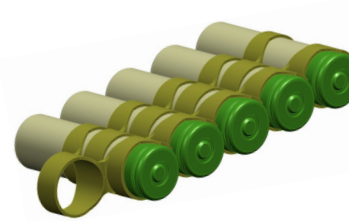


Lightweight Small Arms Technologies (LSAT)

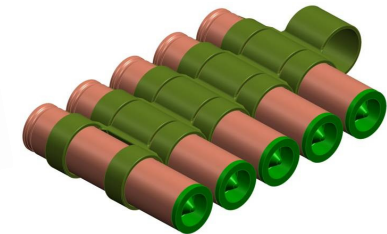
Light Machine Gun Demonstrator



5.56mm Telescoped Ammunition



Cased



Caseless

- Achieve 50% overall weight reduction
- Pursue parallel Cased Telescoped and Caseless Ammunition design approaches
- High commonality of design and function, some action component differences
- Focus is development of technologies- not specific weapon system
- Demo via Light Machine Gun with 5.56mm ammunition
- Spiral development approach



Lightweight Small Arms Technologies Goals vs. Status



Lightweight Small Arms Technologies (LSAT)

Capability	Current (M249)	Current LSAT Program		
		Threshold	Current Status	Objective
Weapon Weight	17.5 lbs	13.1 lbs (25%)	✓CT 9.6 lbs (45%) ✓CL 9.9 lbs (43%)	11.4 lbs (35%)
Ammo Weight 600 rds Pkgd	20.4 lbs	15.3 lbs (25%)	CT 13.6 lbs (33%) ✓CL 9.8 lbs (51%)	12.2lbs (40%)
Affordability	Gun \$3600 Ammo \$262	Gun \$3600 Ammo \$262	TBD TBD	Gun \$3600 Ammo \$262
TRL	N/A	5	✓CT TRL 5 CL TRL 4	5
Effectiveness	Baseline	Maintain Baseline	Potential Improvement	Improve Baseline

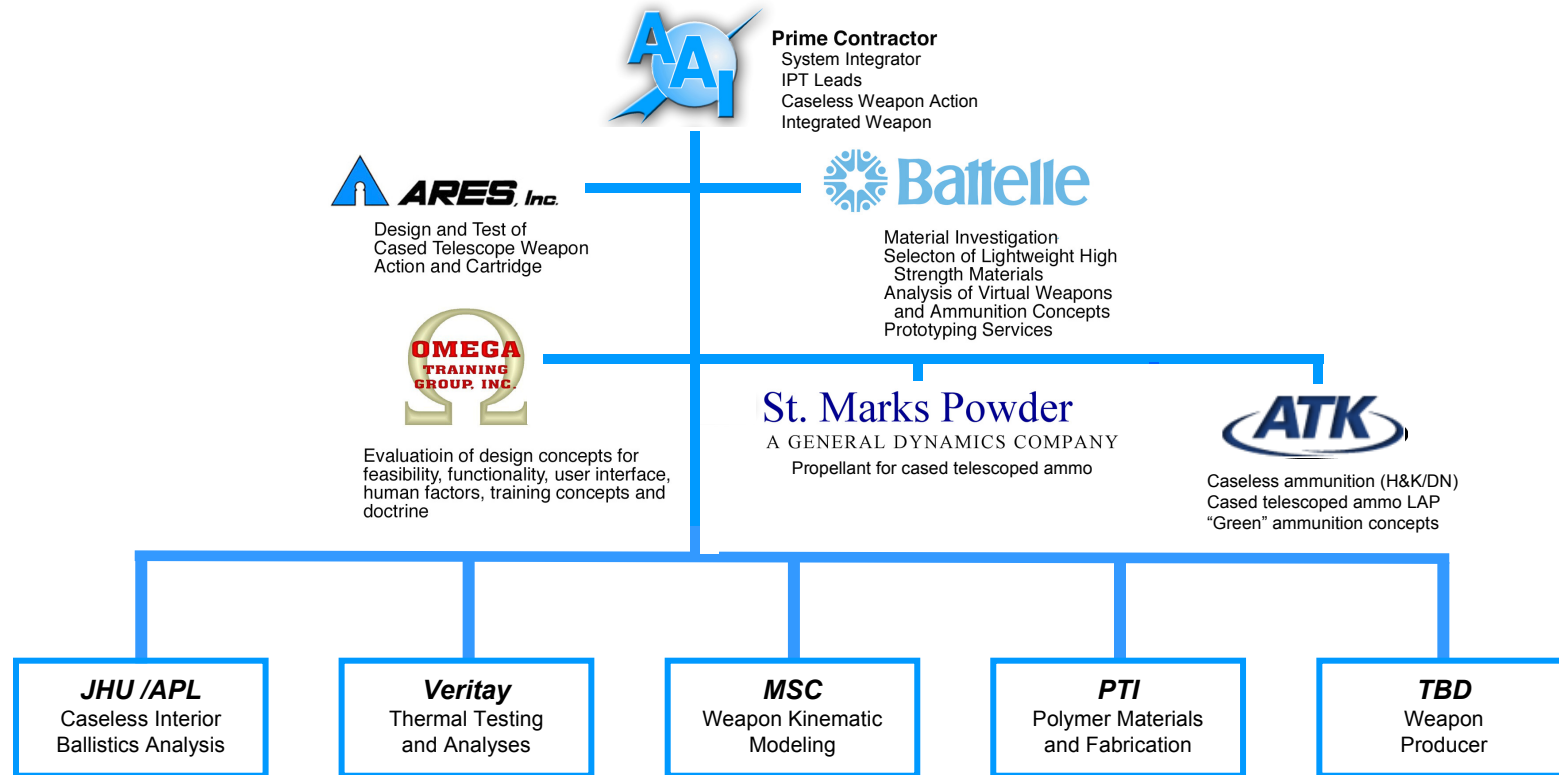


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AAI Contractor Team Members



Lightweight Small Arms Technologies (LSAT)





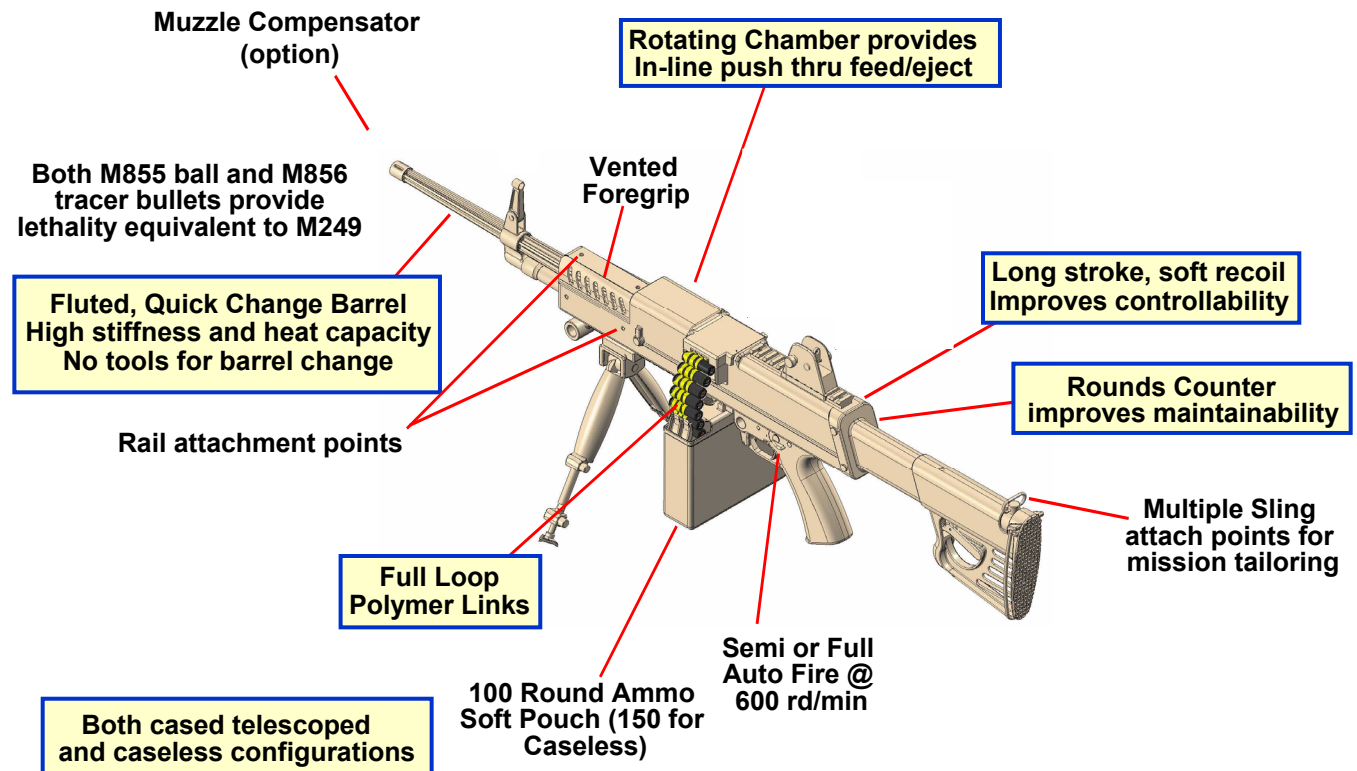
Lightweight Small Arms Technologies Weapon Design and Performance Features



Lightweight Small Arms Technologies (LSAT)

Key technologies

- Use of telescoped ammo-cased and caseless
- Lightweight materials & structural configuration
- Thermal management for weight reduction
 - Barrel
 - Caseless chamber components
- Caseless chamber sealing
- Human factors- firing controllability
- Integration of electronics





Lightweight Small Arms Technologies

Ammunition Design Features



Lightweight Small Arms Technologies (LSAT)



	M855	LSAT CT	LSAT CL
Weight 600 linked pkg'd rnds	20.8 lbs	14.0 lbs <i>33% reduction</i>	10.2 lbs <i>51% reduction</i>
Muzzle velocity (78 ft)	3,020 ft/sec	3,020 ft/sec	3,020 ft/sec
Length	2.25 inches	1.6 inches	1.6 inches
Diameter	0.38 inches	0.45 inches	0.35 inches
Primer	Percussion	Percussion	Percussion

Key Technologies

- Telescoped cartridge
- Cased Ammunition
 - Polymer cartridge case and endcap
 - Compacted/consolidated propellant
- Caseless Ammunition
 - High Ignition Temperature Propellant
 - Booster assisted interior ballistics
- Demonstrate in 5.56mm
 - Address producibility
 - Consider scalability



Lightweight Small Arms Technologies (LSAT)

Cased and Caseless Telescoped Ammunition

Design and Development Status



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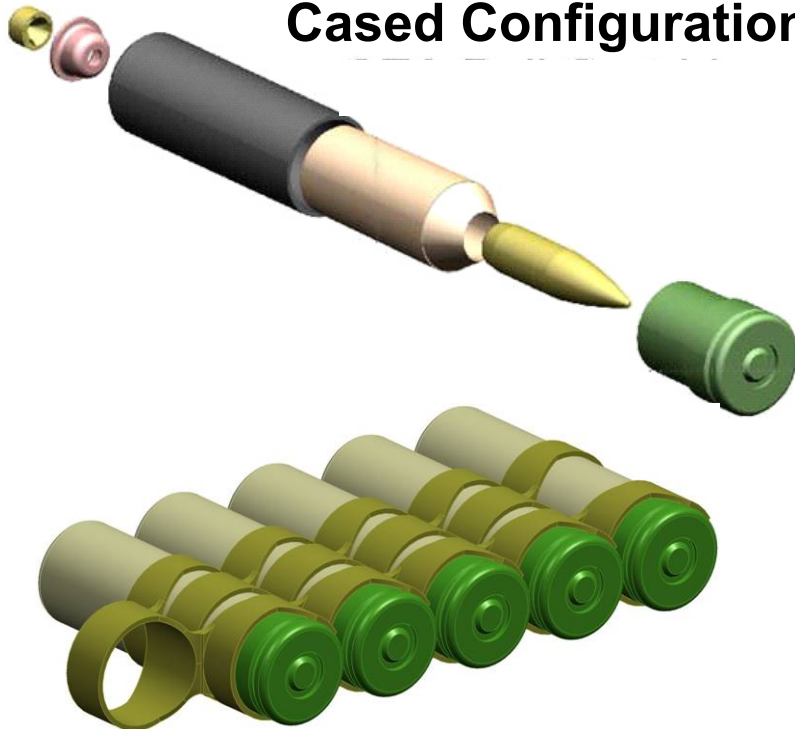


Lightweight Small Arms Technologies Ammunition Features



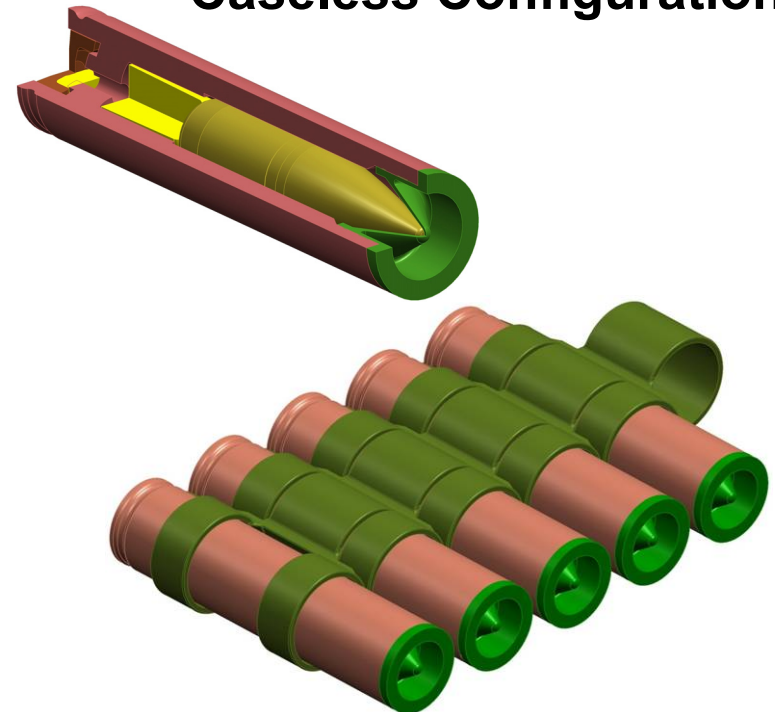
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Cased Configuration



- Conventional technology in telescoped configuration
- Significant weight reduction
- Lower Risk

Caseless Configuration



- High Ignition Temperature Propellant Technology
- Higher Weight Reduction
- Higher Risk



Lightweight Small Arms Technologies

Cased Telescoped Ammunition Status (1)



Lightweight Small Arms Technologies (LSAT)

- *Completed Activities*
 - Developed optimized Spiral 2 cartridge
 - Reduced size and weight from original CT design
 - Attachment methodology for end cap and projectile
 - Optimized propellant for use in CT cartridge
- *Over 4,000 rounds fired*
 - Both Mann Barrel and Weapons
 - Temperatures ranging from -65F to +145F
 - Continued evaluation of alternate case materials





Lightweight Small Arms Technologies Cased Telescoped Ammunition Status (2)

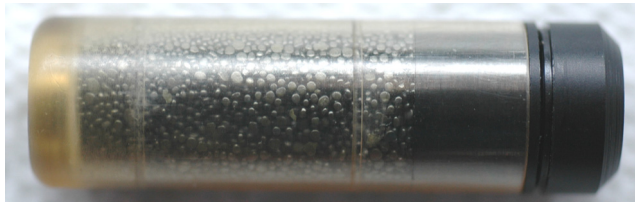


Lightweight Small Arms Technologies (LSAT)

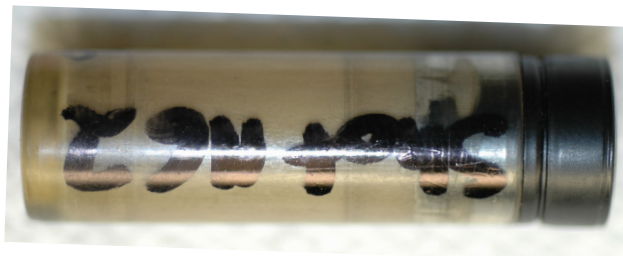
- *Ballistics testing status*
 - Preliminary accuracy and dispersion testing conducted
 - Achieved ballistic efficiency and performance equivalent to M855 baseline
 - Demonstrated TRL5
- *Fabricating in quantity to support weapon testing*
- *Beginning Spiral 3 development*

Spiral 2 Cartridge

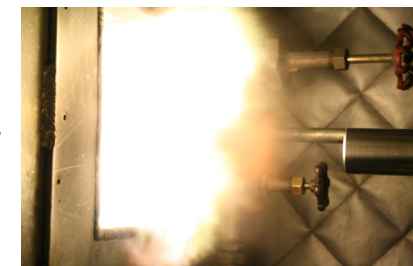
Unfired



Fired



Standard



LSAT



Reduced Flash Powder



Lightweight Small Arms Technologies Caseless Ammunition Status (1)



Lightweight Small Arms Technologies (LSAT)

- *Completed Activities- HITP Materials & Process Development*
 - Characterized chemical and physical characteristics of High Ignition Temperature Propellant (HITP)
 - Replicated HITP to match ballistic and mechanical properties of ACR ammunition
 - Demonstrated HITP production feasibility
 - Developed propellant mixing & fabrication process
 - Developed process simplification
 - Demonstrated process control
 - Conducted “Design of Experiment” studies to assess impact on combustion and physical characteristics
 - Constituent percentages, particle sizes
 - Solvent percentage, mix time, cure time
 - Molding pressure, temperature, cavity design





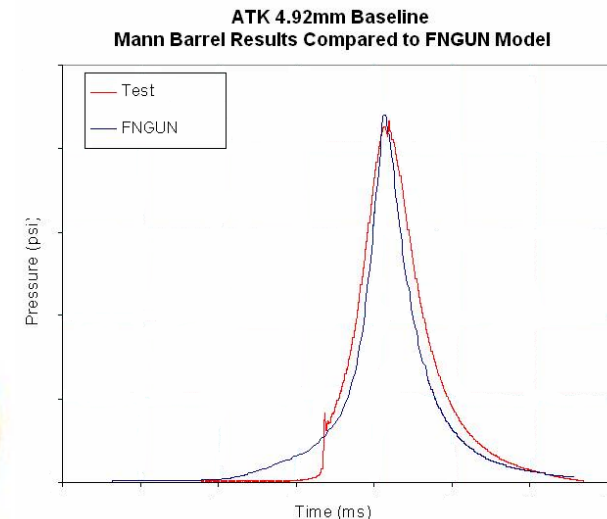
Lightweight Small Arms Technologies

Caseless Ammunition Status (2)



Lightweight Small Arms Technologies (LSAT)

- *Completed Activities- Integrated Cartridge*
 - Primer- Molded HTP primer cup, replicated primer mix, conducted sensitivity tests
 - Booster- replicated booster mix, conducted ballistic testing
 - Demonstrated integrated cartridge performance with 4.92mm ACR configuration in Mann barrel
 - Developed initial FNGUN interior ballistics model





Lightweight Small Arms Technologies Caseless Ammunition Status (3)



Lightweight Small Arms Technologies (LSAT)

- *Completed Activities- Developed 5.56mm Spiral 1 cartridge configuration*
 - Utilized improved fabrication process
 - Demonstrated good dimensional control
 - Conducted ballistic testing in Mann barrel
 - Verifying interior ballistics model with test data





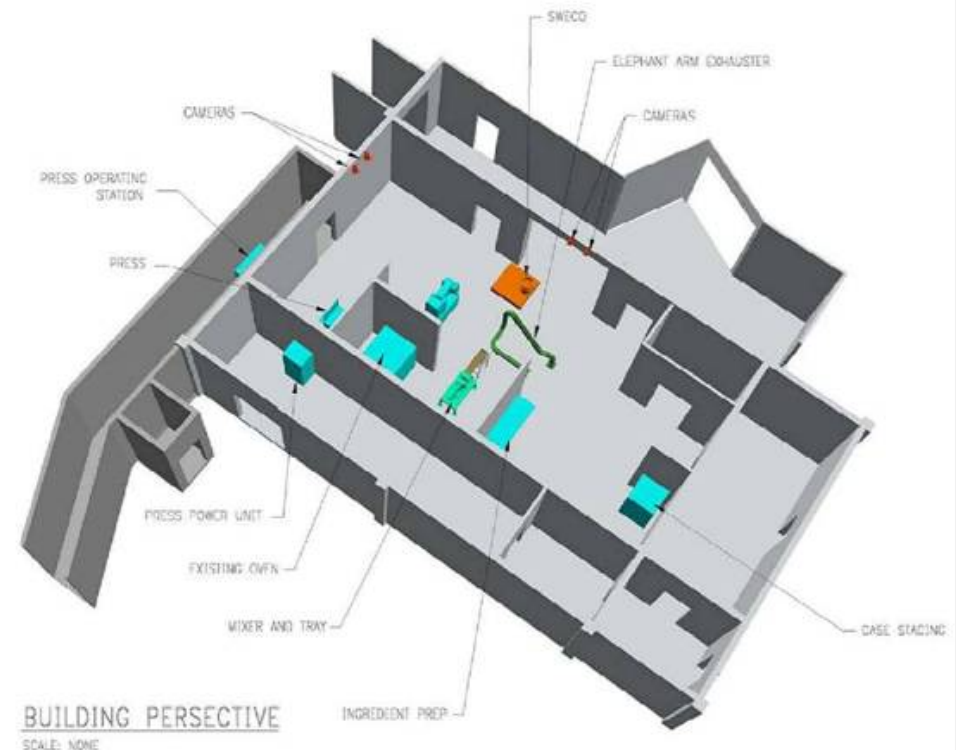
Lightweight Small Arms Technologies

Caseless Ammunition Status (4)



Lightweight Small Arms Technologies (LSAT)

- *Process scale-up facility nearing completion*
 - Located at ATK Launch Systems (Utah)
 - Equipment includes
 - 50 ton transfer mold
 - Dry material feed and handling
 - Solvent processing
 - Horizontal mixer
 - Start-up date mid-May





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Caseless Ammunition Summary



Lightweight Small Arms Technologies (LSAT)

- *Caseless ammunition provides 50% weight reduction and 40% volume reduction vs. standard ammunition*
- *Accomplishments*
 - Demonstrated ability to replicate HTP
 - Demonstrated molding fabrication process
 - Demonstrated integrated cartridge performance
- *Upcoming Milestones*
 - Validation of interior ballistic model vs. cartridge performance
 - Bring process scale-up facility on-line
 - Test caseless ammo in weapon action
 - Optimization of charge weight and dimensions (Spiral 2)
 - Incorporate improvements- thermal and environmental (Spiral 3)





Lightweight Small Arms Technologies (LSAT)

Cased and Caseless Weapon

Design and Development Status



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Lightweight Small Arms Technologies

Weapon Kinematic Model (1)



Lightweight Small Arms Technologies (LSAT)

- *Weapon Kinematic Modeling Approach*
 - MSC ADAMS software
 - Model developed by MSC
 - All geometry derived from weapon and ammo 3D solid models
 - All functional parts modeled- size, weight, stiffness, contacts
- *Purpose of Model*
 - Verify geometric clearances and component ranges of motion
 - Provide full kinematic characterization of weapon and ammo
 - Develop component loads for FEA analysis
 - Identify potential issues/solutions during design process
 - Validate based on test data, then support diagnosis/correction of problems identified during firings
 - Support integrated weapon analyses- drop, vibration etc





Lightweight Small Arms Technologies Weapon Kinematic Model (2)



Lightweight Small Arms Technologies (LSAT)

- *Completed Kinematic Modeling Activities*
 - Transitioned CT model from Spiral 1 to Spiral 2 ammunition configuration
 - Supported weapon conversion to Spiral 2 cartridge, re-validated
 - Expanded and refined model
 - Added full belt dynamics and canister model
 - Conducted belt pull powering study- weapon orientations, feed cam profiles, full belt simulation for test set-up
 - Developed CL weapon kinematic model
 - Based on CL 3D design data and characteristics
 - Incorporated CL unique design features- firing pin operation, chamber, feed cam
 - Significant focus on cartridge/weapon interface loads

Model continues to provide significant reduction in weapon development time and test requirements





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Cased Telescoped Weapon Status (1)



Lightweight Small Arms Technologies (LSAT)

Serial Number CT SN1

- Fired approx 3,000 rds to date
- Converted weapon from Spiral 1 to Spiral 2 ammunition
- Resolved weapon issues using modeling and testing
- Shootability assessment conducted
- TRL 5 achieved!



Serial Number CT SN2

- Incorporates design mods based on CT SN1 experience
- Weapon Action in testing, approx 750 rds fired
- Integrated weapon fit up and testing beginning in June





Lightweight Small Arms Technologies

Cased Telescoped Weapon Status (2)



Lightweight Small Arms Technologies (LSAT)

- TRL 5 Assessment- Successful
 - Spiral 1 and Spiral 2 ammunition- approximately 850 rds
 - Army DTC limited Safety Release for manned fire
 - Flex stand and shoulder fire
 - Demonstrated Successful Function for:
 - Ammunition Temperature Extremes
 - Left and right side weapon orientations
 - Semi and full-auto firing modes
 - Feed from pouch and free belt
 - Bipod, Tripod, Standing firing positions
- Collected shootability data vs M249 and M16
 - 5 test series with 6 shooters
 - Representative scenarios to compare vs M249 and M16
 - Positive feedback on performance, weight benefit, recoil mitigation
 - Identified areas for improvement





Lightweight Small Arms Technologies

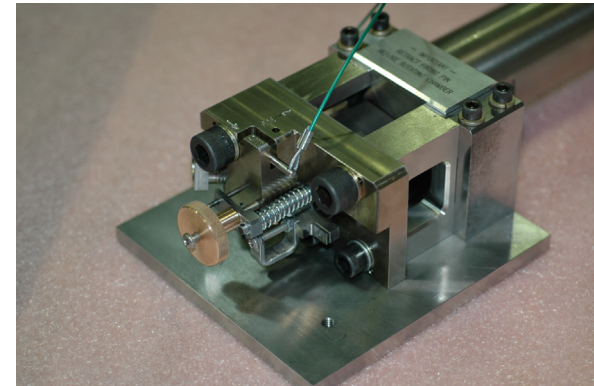
Caseless Weapon Activities



Lightweight Small Arms Technologies (LSAT)

- ***Completed Activities***

- Completed detailed design- 3D CAD, structural analyses, kinematic analyses
- Conducted free volume ballistic assessment w/variable volume test fixture
- Developed subsystem test fixtures to evaluate key weapon/ammunition subsystem interface conditions
 - Ammunition belt and feed loads-nearing completion
 - Mann barrel which replicates chamber sealing and firing pin interfaces-currently in use



- Subsystem tests to be complete and weapon action testing to be initiated within next quarter



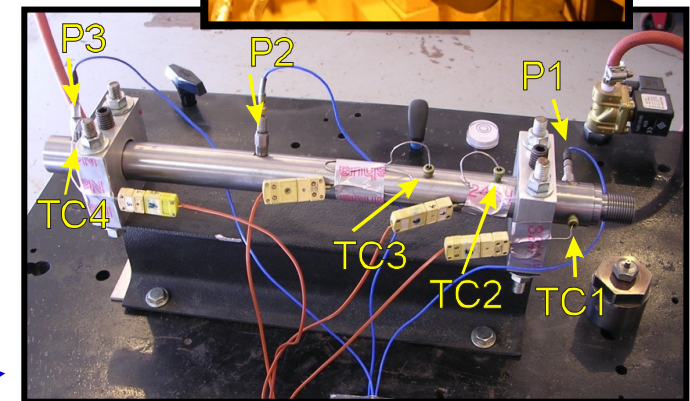
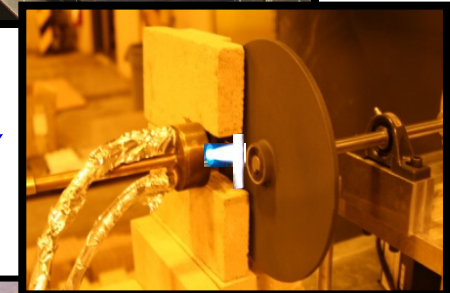
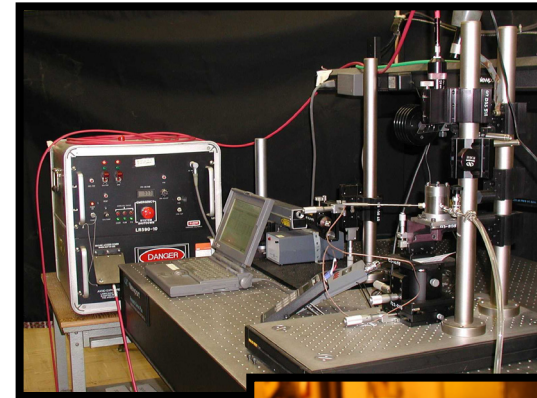


Lightweight Small Arms Technologies Weapon Thermal Management (1)



Lightweight Small Arms Technologies (LSAT)

- **Objective- Develop thermal mgt technologies applicable to caseless action and CT/CL barrels. Focus:**
 - High heat capacity materials
 - Insulating coatings/materials
 - Combustion thermal input reductions
- **Completed Activities**
 - Conducted heat capacity tests, selected materials currently in use in firing fixtures
 - Developed 3 step insulating material thermal characterization/screening approach
 - Laser pulse heating (Benet Labs) to replicate thermal shock environment
 - Rapid intermittent heating fixture (ATK) to simulate burst fire heat inputs
 - Ballistic fixture (Veritay) to produce single shot structural and thermal loads





Lightweight Small Arms Technologies Weapon Thermal Management (2)



Lightweight Small Arms Technologies (LSAT)

- *Current Activities*
 - Screened approx 10 CL chamber insulating material candidates using test fixtures
 - Various constituents, application methods
 - Obtained up to 75% temperature reduction.
 - Several eliminated, tests on-going
 - Barrel thermal analysis and testing
 - Measured downbore temperature profiles for M249, MK46 barrels. Validated thermal model.
 - Developed cartridge ablator concepts
 - CL initial tests complete, demonstrated up to 30% heat reduction at origin of rifling
 - CT design complete, initial cartridges prepared for testing





Lightweight Small Arms Technologies Supportability Activities



Lightweight Small Arms Technologies (LSAT)

- *Supportability Focus*
 - Evaluate technology implementation considerations
 - Fully integrated with development effort
- *Key Activities Currently Underway*
 - Logistics Support Analysis- Level of Repair analysis (COMPASS), Life Cycle Cost analysis (ACEIT), O&M task identification (new Army maintenance concept)
 - Reliability, Availability, Maintainability- Failure modes, effects, and criticality analysis, reliability tracking, mean time to repair
 - Training analysis and materials- Training concept, training task analysis
 - Human System Integration- Human factors design support, system safety evaluations, fightability assessments (2 complete), shootability assessment (1 complete)





Lightweight Small Arms Technologies Summary



Lightweight Small Arms Technologies (LSAT)

- System design meets all program requirements:
 - Exceeds weight reduction goals
 - Improves lethality
 - Improves logistics
 - Improves ergonomics
- Maintaining parallel, synergistic Cased Telescoped and Caseless development plan
 - Emphasizes commonality
 - Reduces program risk
- Scalable design provides significant modularity and commonality
- Cohesive Government/industry team ensures success in development, user acceptance, and production

Comments/Questions?

