Ballistic Test Facilities and Systems Modernization at the Lake City Army Ammunition Plant

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US Army, ARDEC
Picatinny Arsenal

Approved # OSR 09S-1471
Indoor & Outdoor Ballistic Test Ranges

2400 Yard Outdoor Ballistic Test Range

- 22 Firing Bays
- 4 Down Range Firing Houses

Indoor Ballistic Test Range

- 14 Velocity & Pressure Bays
- 14 Function & Casualty Bays
- 2 Sub-Ranges 200 Yards
Where We Were In The 1940’s
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After A Few Upgrades 1970-1980’s

- Testing Only The Ammunition
- MSDOS Based Oehler System
- Labor Intensive Paper Targets
- Personnel In Line of Fire
- Subjective Determination
- Single Point Of Failure
- At Maximum Testing Capacity
- No Flexibility
- Redundant Data Entry
- Long Test Cycle Times
Where We Are Going: 2008 and Beyond

- Systematic Approach
- Automation
- Real Time Data
- Quantitative Analysis
- State Of The Art Technology
- Increased Testing Capacity
- Eliminate Need For Data Entry
- Eliminate Single Point Failures
- No Downrange Personnel
Replace the obsolete data collection and analysis systems currently used in the indoor and outdoor ballistic acceptance testing facilities, with a modern system that is compatible with current industry and government standards. Implement key projects as identified in the Ballistics QFD analysis. Automate the test range measurement systems to increase the availability of the ballistics testing functions, and to enhance efficiency, accuracy, and consistency.

### 16 Total Projects

<table>
<thead>
<tr>
<th>Automation</th>
<th>Upgrade/Rehab</th>
<th>Facility/Infrastructure</th>
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</thead>
<tbody>
<tr>
<td>• Trace Performance</td>
<td>• EPVAT</td>
<td>• Hand Loading</td>
</tr>
<tr>
<td>• Accuracy</td>
<td>• Bullet Pull</td>
<td>• Accuracy Mount</td>
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<tr>
<td>• Function &amp; Casualty</td>
<td>• Linker</td>
<td>• Mercury Lab</td>
</tr>
<tr>
<td>• Range Conditions</td>
<td>• Velocity Screen</td>
<td>• Communications</td>
</tr>
<tr>
<td>• Water “Proofness”</td>
<td>• Transducer Calibration</td>
<td>• Gun Air Cooling</td>
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<tr>
<td></td>
<td></td>
<td>• Observation Houses</td>
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</table>
Legacy Trace Performance Testing Not Ideal!
Objectives

- Eliminate Downrange Observers
- Automate Pass/Fail Determination
- Retain Video
- Make Test Data Immediately Available
- Process Data In Real Time

Tracer Spectral Characteristics Measured

Composite Image
Video From 7.62mm Trace Testing
TOES Challenges

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Challenges

- Make Real Time Processing Possible
- Eliminate False Triggers
- Capture Blind Tracer Events

Step One (Vo5 Algorithm)
- Measures Structure

Step Two (Hough Transform)
- Discriminates Linear Events
How To See A “Blind”

Benefits
- Fully Automated
- No Downrange Observers
- Real Time Data
- Quantitative Analysis
- Increased Test Capacity

Acoustic Trigger

Camera 1

Camera 2
Legacy Accuracy Testing Not Ideal!

- Operator staples target to wood frame
- Gunner tries to locate center of target
- Gunner fires through target
- Target cut down
- Operator digitizes target
- Clerk enters data into spreadsheet
Range Accuracy Target System (RATS)

1. Projectile passes through target area
2. Wave is induced on aluminum rod
3. AE sensors receive signals
4. XY coordinate recorded
5. Calculation of dispersion characteristics
6. Data automatically entered
## RATS Results

### Horizontal SD

<table>
<thead>
<tr>
<th>5.56mm</th>
<th>Mean</th>
<th>StD</th>
<th>P-Value</th>
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</thead>
<tbody>
<tr>
<td>Paper</td>
<td>1.326</td>
<td>0.302</td>
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<tr>
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### Vertical SD

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<tr>
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<tr>
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### Mean Radius

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<th>7.62mm</th>
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<tbody>
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<tr>
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<table>
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<th>50 Caliber</th>
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<tr>
<td>RATS</td>
<td>5.198</td>
<td>1.048</td>
<td>0.612</td>
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### Paper System
- Rotational Error
- Wave Error
- Target Movement Error
- Digitizing Error
- Personnel In Line Of Fire

### RATS
- Gunner Centered Easily
- Spec Requirement
- Actual (x,y) Coordinates
- No Personnel Downrange
- Est. Accurate To 0.1” At 600 Yards

**Greater Accuracy, Greater Precision**
Accuracy Sub-Sonic

- Screen Type Material As A Target
- Camera Takes Images Of Fired Shots
- Coordinate Recorded, Dispersion Characteristics Calculated
- Data Is Transmitted To Server And Display Application
- Target Is Mechanically Indexed By Gunner From Firing Location
Legacy Function & Casualty

- Acoustic Sensor Adjacent Bay Cross Talk
- Blank Rounds Measured
- Water Trap Causes Wet Environment
- Various Weapon Systems
- MSDOS Based Oehler System
- Cadence Controlled By Operator
- Excessive Manual Gain Adjustment

Legacy Cyclic Rate Testing Not Ideal!

Not Designed For Gun Blast
Cyclic Rate Calculator (CRaC)

- Senses Pressure Blast
- Up To 1500 RPM
- +/- 2% Of True Rate Of Fire
- Functional Weapons
- Cadence Controlled
Impact

• Systematic Approach
• Reduction In Test Cycle Time
• Quantitative Analysis
• Reduction In Personnel
• Increased Testing Capacity
• Improved Efficiency
• Significant Reduction In Data Entry
• Elimination Of Single Point Failures
• Elimination Of Downrange Personnel