Change in view point: Application of the Dual Recoil System to Light Weight Towed Artillery

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Role of Artillery

• Support maneuver elements
  – Provide timely, accurate and effective fires
  – Both in direct and general support

• Tube artillery has a place with rocket/missile and mortar systems
  – Range capability
  – Accuracy
  – Responsiveness
System Limiting Factors

• Strategic Mobility
  – Limited assets
  – Competition for space

• Tactical Mobility
  – C-130
  – Helicopter performance
  – Prime mover performance
Current Light Cannon Artillery
M119A2 105mm Towed Howitzer

- Max Range/Precision (M913)
  - 19.5 km / 32 m CEP
  - 20 km / 35 m CEP (Battlefield Emergency)
- Weight - 4270 lb
- Prime Mover – M1097 HMMWV
Weapon Weight Reduction

• Limited by recoil reaction
• Recoil reaction reduction dependant upon system utilized
• Structural Life
Fire-In-Battery
Single Recoil System

For a given weapon impulse and recoiling mass, the weapon load is inversely proportional to the recoiling mass and the distance it is allowed to translate.
Implications of Increasing Recoil Distance

- Tipping center of gravity shifts
- Recoil mechanism and cradle structure increases
- Loading more difficult complicated
- Recoil cycle time impacted
Implications of Increasing Recoil Distance

Tipping Moment vs Primary Recoil Length (in)

Quadrant Elevation (mils)

Moment (in-lbf)

0 10000 20000 30000 40000 50000 60000 70000 80000 90000

0 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

15 20 25 30 39 47
Fire-Out-of-Battery
Single Recoil System

• Recoil impulse partially countered by inducing forward momentum prior to weapon firing

• Performance affected by temperature, forward velocity, and position along orifice control
Fire-In-Battery
Dual Recoil System

Recoil system between cannon and cradle and recoil mechanism between the top and bottom carriages
Dual Recoil Historical Application

• Very heavy artillery systems from World War I into the 1950’s
  – Railway guns
  – Very heavy mobile siege guns and howitzers

• Dual recoil system required to handle:
  – Huge recoil forces (projectile weights/ranges)
  – Within reasonable physical and logistic limits
US M59 280mm Towed Gun

System Weight – 47 tons
Projectile Weight – 550 lb.
Charge Weight – 150 lb.
Range – 27 km
Recent Weight Reduction Efforts Towed Cannon Artillery

- M777 155mm Towed Howitzer
  - Increased recoil length of single recoil FIB
  - Titanium

- Giat LG1 Mk II 105mm Towed Howitzer
# Draft Requirements for Forcible Entry Weapon (FEW)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Threshold</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>3,300 lbs</td>
<td>3,000 lbs</td>
</tr>
<tr>
<td>Max. Range</td>
<td>19.5 km with M913</td>
<td>20 km with CCF/BB</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21 km without CCF</td>
</tr>
<tr>
<td>Rate-of-Fire</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Shift Fire Azimuth</td>
<td>6400 mils</td>
<td>6400 mils</td>
</tr>
<tr>
<td>Emplacement/Displacement</td>
<td>60 sec.</td>
<td>30 sec.</td>
</tr>
</tbody>
</table>
Concept System Utilizing Dual Recoil System
Concept System Characteristics

• **Weight**
  - Recoiling (primary) - 1710 lb.
  - Recoiling (secondary) - 915 lb.
  - System – 3230 lb.

• **Max. rate of fire**
  10 rounds per minute

• **Ammunition – All compatible with M119A2 howitzer**

• **Range**
  - M760 Ballistic-14.5km
  - M913 RAP Ballistic-21km
  - M913 RAP CCF-20km

• **Recoil cycle time – 2.3 seconds**
Concept System Dual Recoil

Concept Peak Loading

Force (lbf) vs QE (mils)

K(lbf)
Vertical Reaction (lbf)
Rearward Reaction (lbf)
M119 Z8 K
M119 Z8 Vertical Reaction
M119 Z8 Rearward Reaction
# Dual Concept Compared to M119A2 Howitzer

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Concept</th>
<th>M119A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Weight (lb)</td>
<td>3230</td>
<td>4270</td>
</tr>
<tr>
<td>Max. Range - M760 (km)</td>
<td>14.5</td>
<td>14</td>
</tr>
<tr>
<td>Max. Range – M913 (km)</td>
<td>21</td>
<td>19.5</td>
</tr>
<tr>
<td>Max. Rate of Fire (rounds per minute)</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Trail Configuration</td>
<td>Split</td>
<td>Wish bone</td>
</tr>
<tr>
<td>Muzzle Brake</td>
<td>None</td>
<td>Single Baffle, Med.</td>
</tr>
<tr>
<td>Peak Recoil Load, Primary @ 800 mils (lbf)</td>
<td>30000</td>
<td>38600</td>
</tr>
<tr>
<td>Peak Lateral Ground Reaction Load @ 0 mils (lbf)</td>
<td>16000</td>
<td>(22100 est.)</td>
</tr>
</tbody>
</table>
Dual Concept Compared to M119A2 Howitzer
Blast Overpressure