47th NDIA Annual Fuze Conference

April 2003

communications

BT Fuze Products Division
An Empirical Study of the M739A1 S&A Device Operational Range

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Purpose

• Extend the arming distance of the MOFA S&A to meet the US Navy EX437 Multi Option Fuze requirement
  • 400 feet no arm
  • 900 feet all arm
• MOFA requirements (155 mm)
  • 400 caliber
  • $400 \times \frac{155}{304.8} = 203$ feet
M739 S&A History

- Gearless S&A
  - No hob
  - Cast components
  - Unusual tooth design and pressure angles
  - Unusual design location
  - Dry film lubrication
Functional Description

- S&A rotor contains M55
- Rotor held safe by setback pin and spin detents
- Setback removes pin
- Spin releases detents
- Spin drives rotor through escapement
  - Essentially a turns to arm arrangement
Considerations for Increasing Arming Time

- Rotor Gear
  - 9 tooth sector gear, snap to arm
- Rotor mass
  - Zinc cast, eccentric mass
- Pallet
  - Brass stamping, oscillation rate
Rotor Assembly
<table>
<thead>
<tr>
<th>Rotor Material</th>
<th>Mass</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zinc Die-Cast</td>
<td>3.95 grams</td>
</tr>
<tr>
<td>Aluminum</td>
<td>1.73 grams</td>
</tr>
</tbody>
</table>
Pallet
# Pallet

<table>
<thead>
<tr>
<th>Pallet Configuration</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard</td>
<td>0.2762 grams</td>
</tr>
<tr>
<td>Modified 1-A</td>
<td>0.3335 grams</td>
</tr>
<tr>
<td>Modified 1-B</td>
<td>0.3294 grams</td>
</tr>
<tr>
<td>Modified 2</td>
<td>0.4469 grams</td>
</tr>
</tbody>
</table>
Arming Distance Estimate

• M782 S&A – 24 turns to arm (TTA)
  • Arm distance = TTA * Rifling * Bore dia.
• M102
  • 24*20*105/304.8 = 165 feet
• Mk45
  • 24*25*5/12 = 250 feet
Test Performed on Modified S&A

- Arming Spin test @ 1700 RPM
  - S&A with Aluminum rotor (56% decrease in mass) yielded 32% increase in arm time
Test Performed on Modified S&A

Rotor Material Comparison

Configuration

MOFA

AI/9T

Time (seconds)

0

0.2

0.4

0.6

0.8

1

1.2

1.4

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Test Performed on Modified S&A

- Arming Spin test @ 1700 RPM (cont.)
  - S&A with modified pallet (61% increased mass) yielded 40% increase in arm time
Test Performed on Modified S&A

Performance Comparison

Time (seconds)

<table>
<thead>
<tr>
<th>Configuration</th>
<th>MOFA</th>
<th>Pal. 1A</th>
<th>Pal. 1B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.84</td>
<td>0.86</td>
<td>0.89</td>
</tr>
</tbody>
</table>
Test Performed on Modified S&A

- Arming Spin test @ 1700 RPM (cont.)
  - Combined effect
  - 85% increase in arming distance
Resulting Increase in Arm Time

- M782 arm time at 1700 RPM
  - 850 ms
  - $850\text{ ms} \times 1.85 = 1.57\text{ seconds}$
- MOFN application
  - $1.57\times\frac{1700}{60}\times25\times5\times\frac{1}{12} = 463\text{ feet (min arm)}$
- Meets minimum arm with some margin
Continued Test Efforts

- Efforts not completed in time for presentation
  - Detonation propagation tests with Aluminum rotor
  - Out of Line Safety
Energetic Test Results

- Out-of-line safety
  - Progressive arming
- Explosive propagation
  - Gap test (5 mil Mylar)