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30 x 173mm TPDS-T Development

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Contents

- Project Objectives/Summary
- Cartridge Concept
- Cartridge Development
- Testing Summary
- Go Forward Plans
**Project Objective:** Develop a 30 x 173mm TPDS-T training cartridge (MK317) that provides a ballistic match to the 30 x 173mm MK258 and MK268 APFSDS-T tactical cartridges. Deliver 1200 rounds to the USMC for qualification testing.

**Project Summary:**
- Evaluate projectile designs for function, ballistic match and producibility
- Evaluate tracer designs for retention, visibility and burn time
- Testing to refine and verify design
- Manufacture and deliver 1200 rounds to the USMC for MK317 qualification testing
30mm TPDS-T Design Requirements

- **Muzzle Velocity**
  1615 \(15\) m/s (+21C)
  SD \(\leq 12\) mps (-54C/+71C)

- **Chamber Pressure**
  \(X\)-bar = 61.4 kpsi (+21C)
  \(X\)-bar + 3SD = 66.6 kpsi (-54C/+71C)

- **Action Time**
  5.3 msec (+21C/+71C)
  7.7 msec (-54C)
  8 msec max individual

- **Trace**
  3.5 sec min (all temps)
  Visible against light background

- **Dispersion**
  0.40 x 0.40 milliradian (+21C @1000 inches)

- **Max Range**
  8000 meters

- **Ballistic match to MK258/MK268 from 1500 to 2000 meter range**

- **Existing qualified ignition train**
30mm TPDS-T Cartridge Concept

• M910E1 (25mm) projectile scaled to 30mm
  – Aluminum pusher
  – Steel sub-projectile core w/tracer
  – Aluminum press-fit nose
  – Plastic molded sabot

• Existing qualified 30x173 ignition system
  – M36A2 primer
  – Flashtube assembly (IB52 pellets)
  – AFP-001 propellant
  – Aluminum cartridge case
**30mm TPDS-T Projectile Baseline Concept**

- **M910E1** steel sub-projectile with aluminum nose and tracer.
- Solid aluminum pusher.
- 4-petal (slot) molded sabot (20% glass filled nylon 6/6).
  - Different rotating band diameters and tapers were evaluated.

**Images:**
- **4-Petal Molded Sabot**
- **M910E1 Steel Sub-Projectile with Tracer**
- **Baseline Pusher**
Alternate Projectile Concepts Considered

- Stress analysis of scalloped 3-petal sabot design said that it would survive in-bore loads and discard but lower risk 4-petal design was incorporated.
- Segmented pusher yielded higher dispersion than solid pusher. This concept may be pursued in follow-on design optimization work.
Preliminary PRODAS model of cartridge as analyzed by Arrow Tech

<table>
<thead>
<tr>
<th></th>
<th>Mass, gm.</th>
<th>Transverse Inertia, gm-cm²</th>
<th>Axial Inertia, gm-cm²</th>
<th>CG from Nose, cm.</th>
<th>Diameter, cm.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projectile</td>
<td>123.5</td>
<td>497.5</td>
<td>93.6</td>
<td>6.06</td>
<td></td>
</tr>
<tr>
<td>Sub-projectile w/tracer</td>
<td>66.3</td>
<td>170.3</td>
<td>21.5</td>
<td>5.24</td>
<td>1.62</td>
</tr>
<tr>
<td>Sub-projectile after burnout</td>
<td>62</td>
<td>157.4</td>
<td>21</td>
<td>5.16</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Physical Properties of M910E1 (TPDS-T) Variant
1600 m/s Velocity Required for Ballistic Match

Vertical Mismatch 30mm TPDS-T at 1600 m/s vs MK258 and MK268 APFSDS-T USMC EFV

Range (m) vs Vertical Mismatch (mils)

-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5

MK268
MK258
• Initial interior ballistic modeling of AFP-001 indicated that design goal of 1600 m/sec should be achievable.

<table>
<thead>
<tr>
<th>Code Used</th>
<th>Projectile Weight Grams</th>
<th>Chamber Pressure Kpsi</th>
<th>Predicted Muzzle Velocity, m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRODAS, Baer-Franke model</td>
<td>128</td>
<td>60.9</td>
<td>1570</td>
</tr>
<tr>
<td>CONRESS</td>
<td>122</td>
<td>58</td>
<td>1600</td>
</tr>
</tbody>
</table>

• Charge establishment testing was only able to achieve a max velocity of 1154 m/sec at 19.6 Kpsi case mouth pressure

• AFP-001 burn rate was too slow to develop adequate pressure with a 122 – 126 gram projectile.
1620 m/sec muzzle velocity provided the best overall ballistic match to 2000 meters.
A higher order interior ballistics analysis was conducted on alternate propellants using IBHVG-2.

Radford RP-910, with tailoring of grain geometries, was recommended as a viable solution based upon the modeling.

<table>
<thead>
<tr>
<th>Charge Weight</th>
<th>Velocity</th>
<th>Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>125 grams</td>
<td>1527 m/s</td>
<td>59.8 Kpsi</td>
</tr>
<tr>
<td>140 grams</td>
<td>1590 m/s</td>
<td>61.5 Kpsi</td>
</tr>
<tr>
<td>150 grams</td>
<td>1624 m/s</td>
<td>61.5 Kpsi</td>
</tr>
</tbody>
</table>

Initial results still had lower velocity than model but pressures were also lower.

Final charge establishment test results met the velocity design requirements with margin.

<table>
<thead>
<tr>
<th>Group No.</th>
<th>Charge Weight, grams</th>
<th>Quantity</th>
<th>Muzzle Velocity, m/s</th>
<th>Pressure, Kpsi</th>
<th>Action Time, msec</th>
<th>Dispersion Dispersion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>145</td>
<td>10</td>
<td>1571</td>
<td>41.2</td>
<td>3.44</td>
<td>0.33</td>
</tr>
<tr>
<td>2</td>
<td>151</td>
<td>10</td>
<td>1619</td>
<td>45.4</td>
<td>3.18</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>157</td>
<td>8</td>
<td>1670</td>
<td>50.3</td>
<td>3.04</td>
<td>0.33</td>
</tr>
</tbody>
</table>
LAT Results for First Deliverables

LAT results for the first sub-lot met most of the design requirements.

- Velocity above target
- Pressure has significant margin
- Trace times were very good at extreme temperatures
- Dispersion slightly exceeded design requirements
- Autogun F&C had no metal parts security issues

<table>
<thead>
<tr>
<th>Temp</th>
<th>Velocity</th>
<th>SD</th>
<th>Pressure</th>
<th>SD</th>
<th>DISP X</th>
<th>DISP Y</th>
<th>Trace Time</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>21C</td>
<td>1630 m/s</td>
<td>6.4</td>
<td>46.6 Kpsi</td>
<td>0.7</td>
<td>0.42</td>
<td>0.55</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-25F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.11 sec</td>
<td>0.59</td>
</tr>
<tr>
<td>-65F</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>7.33 sec</td>
<td>0.58</td>
</tr>
</tbody>
</table>
Final 30mm TPDS-T Cartridge Design

• Cartridge Weight (422 grams)

• Projectile (123 grams)
  – Aluminum pusher
  – Steel sub-projectile core w/tracer
  – Aluminum press-fit nose
  – Plastic molded sabot

• Ignition system
  – M36A2 primer
  – Flashtube assembly (IB52 pellets)
  – RP-910 propellant (151 grams)
  – Aluminum cartridge case
ATK stands ready with our remaining 30mm TPDS-T hardware to support the USMC qualification effort whenever it resumes.
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