Firing US 120mm Tank Ammunition in the Leopard 2 Main Battle Tank

NDIA Guns and Missiles Conference
Harlan Huls
22 April 2008
1. Overview of tanks and ammunition
   • Interoperability of the weapon and ammunition
2. Objectives of the test conducted in Denmark
3. Results of the firings in Leopard 2 with L44 and L55 weapon system
4. Conclusions
Description of US Tank Ammunition

US 120mm Tank Ammunition Types

Several US ammunition types with interoperability maintained through International JCB by controlling interface features (ICD)
Abrams and Leopard 2 MBT With 120mm Smoothbore Cannon

An advanced weapon and space systems company

Abrams Tanks

M1A1 Abrams
(M256 ~ L44 Weapon)

M1A2 Abrams
(M256 ~ L44 Weapon)

Leopard 2 Tanks

Leo2A6
L55 Weapon
(Dutch)

Leo2A5
L44 Weapon
(Danish)

Leo2A4
L44 Weapon

Several MBT configurations with 120mm weapon. Interoperability is maintained through international JCB by controlling interface features (ICD)
<table>
<thead>
<tr>
<th>Platform Picture</th>
<th>Type and Country</th>
<th>Caliber</th>
<th>Basic Load</th>
<th>Tactical Rounds</th>
<th>Training Rounds</th>
<th>Comments</th>
</tr>
</thead>
</table>
| ![M1A1 Abrams](image) | **M1A1 Abrams**  
USA, Australia, Kuwait, Egypt | 44      | 40 rounds  | M829A3, M829A2, M829A1, M830, M830A1, M1028, KEW, KEWA1, KEWA2 | M865, M831A1, M1002 | Training and Tactical designed for 120mm Compatible Weapon systems |
| ![M1A2 Abrams](image) | **M1A2 Abrams**  
USA, Saudi Arabia | 44      | 42 rounds  | DM33, DM53, DM63, DM12A1, DM11, DM31 | DM48, DM18 | Training and Tactical designed for 120mm Compatible Weapon systems |
| ![Leopard 2 A4 or A5](image) | **Leopard 2 A4 or A5**  
Germany, Austria, Chile, Denmark, Norway, Finland, Switzerland, Sweden, Greece | 44      | 42 rounds  | DM33, DM53, DM63, DM12A1, DM11, DM31 | DM38/A1-5, DM48, DM18, M865, M865C1 | Training and Tactical designed for 120mm Compatible Weapon systems |
| ![Leopard 2 A6](image) | **Leopard 2 A6**  
Germany, Canada, Netherlands, Spain, Greece | 55      | 42 rounds  | DM33, DM53, DM63, DM12A2 | DM38/A1-5, DM48, DM18, M865, M865C1 | Training and Tactical designed for 120mm Compatible Weapon systems |
1. Ammunition meets the requirements of NATO STANAG 4385
   – Designed, tested and manufactured to this standard from beginning.
   – Interoperability is maintained by the Interface Control Document (ICD)
   – ICD is maintained by International Joint Configuration Board

2. Ammunition interoperability is demonstrated when fired from the compatible platform.
## Where US Tank Ammunition has been fired

<table>
<thead>
<tr>
<th>Ammunition Type</th>
<th>L44 (M256)</th>
<th>L55</th>
<th>Countries that have fired the ammunition</th>
</tr>
</thead>
<tbody>
<tr>
<td>M830 HEAT-MP-T</td>
<td>✔️</td>
<td></td>
<td>USA, Egypt, Kuwait, Saudi Arabia</td>
</tr>
<tr>
<td>M830A1 HEAT-MP-T</td>
<td>✔️</td>
<td>✔️</td>
<td>USA, Australia, Denmark, The Netherlands</td>
</tr>
<tr>
<td>M831A1 TP-T</td>
<td>✔️</td>
<td></td>
<td>USA, Australia, Austria, Denmark, Egypt, Finland, Kuwait, Saudi Arabia</td>
</tr>
<tr>
<td>M865 TPCSDDS-T</td>
<td>✔️</td>
<td>✔️</td>
<td>USA, Australia, Austria, Denmark, Egypt, Finland, Kuwait, Norway, The Netherlands</td>
</tr>
<tr>
<td>M908 HE-OR-T</td>
<td>✔️</td>
<td></td>
<td>USA</td>
</tr>
<tr>
<td>M1002 TPMP-T</td>
<td>✔️</td>
<td>✔️</td>
<td>USA, Denmark, The Netherlands</td>
</tr>
<tr>
<td>M1028 Canister</td>
<td>✔️</td>
<td>✔️</td>
<td>USA, Australia, Denmark, The Netherlands</td>
</tr>
<tr>
<td>KEWA1 APFSDS-T</td>
<td>✔️</td>
<td></td>
<td>USA, Egypt, Kuwait, Saudi Arabia</td>
</tr>
<tr>
<td>KEWA2 APFSDS-T</td>
<td>✔️</td>
<td>✔️</td>
<td>USA, Australia, Egypt, Kuwait, Denmark, The Netherlands</td>
</tr>
</tbody>
</table>
Purpose of test firing

1. Support NATO Allies for deployment in Afghanistan
2. Demonstrate the interoperability of US ammunition in the Leopard 2 tank with L44 and L55 weapon system
   - M865 and M831A1 training ammunition is already used by countries with Leopard 2 tanks
3. Check ammunition performance across temperature and distance using the existing Leopard 2 firing control
4. Demonstrate functional performance against targets when fired from the L44 and L55 weapon system
How We Arranged the Demonstration Test

• The Danish Army hosted the event in Oksboel Training Center
  – Provided the test range, targets, Leopard 2/A5 MBT, test crew and instrumentation, facilities and transportation on site, and focal point for logistics.

• The Dutch Army provided the Leopard 2/A6 MBT, test crew and instrumentation, and assisted in coordination and logistics

• The ammunition producers, ATK and GD-OTS, provided the ammunition and assisted in logistics and support.

• US Army provided on site support at the test

The Demonstration Test took several months of planning. As cooperation and enthusiasm grew we decided to invite other 120 user nations to witness the test. 12 Countries were able to attend the test.
Demonstration Test Firing in Oksboel, Denmark

Test fired 4 types of US ammunition across temperatures in the
• Danish Leopard 2/A5 with L44 weapon system
• Dutch Leopard 2/A6 with L55 weapon system (longer gun)
Test Fired 20 rounds to verify fire control across temperatures:

- 6 from each tank at temperature -32C, +21C, +50C tracking projectile to tank fire control
- 4 from each tank using the existing Leopard 2 tank Ballistic setting, A2 of fire control system, at +21C for zeroing on a target at 1,000m measured for precision
- Results (H X V mils) $L_{44} = 0.14 \times 0.22$, $L_{55} = 0.20 \times 0.03$

Results showed ammunition works well in Leopard 2 Tank System
M1002 Training Round Velocity Data

Velocity versus temperature in L44 and L55 Weapon.

TPMP M1002

$y = 0.8398x + 1398$

$R^2 = 0.9911$

$y = 0.8975x + 1350.1$

$R^2 = 0.9956$
• 14 rounds fired across temperatures
• 7 rounds in each tank across temperatures at 1700 meters
  – 2 at -32°C, 3 at +21°C, 2 at +50°C

Used existing Leopard 2 tank Ballistic setting A2 of fire control system
Velocity versus temperature in L44 and L55 Weapon.

KEWA2™ Velocity Data

An advanced weapon and space systems company

Linear (NL): $y = 1.9322x + 1724.4$, $R^2 = 0.9785$

Linear (DK): $y = 2.2929x + 1646$, $R^2 = 0.9761$
• 2 rounds fired from Danish Leopard 2/A5 Tank at +21°C for effect on target
• Target is Leopard 1A5 Main Battle Tank at ~1,000 meters

Accurate and effective

1\textsuperscript{st} shot through turret

2\textsuperscript{nd} shot through front armor
KEWA2™ Effect on Target

Front of vehicle
Entrance holes

Rear of vehicle
Exit holes

An advanced weapon and space systems company

GENERAL DYNAMICS
Ordnance and Tactical Systems
KEWA2™ Firing on Tank Target, Gunner Sight

2006-09-13 12:45:21 GUNNER

no valid data
• Fired to verify fire solution across temperatures
• 7 rounds from each tank across temperatures at 1700 meters
  – 2 at -32C, 3 at +21C, 2 at +50C

Use existing Leopard 2 tank Ballistic setting A2 of fire control system
Velocity versus temperature in L44 and L55 Weapon.

HEAT MP-T M830 A1

Velocity versus temperature in L44 and L55 Weapon.
M830A1 Multi-Purpose High Explosive Air Burst

- Fired for airburst effect on target
  - Target is Simulated Helicopter at ~1,000 meters

Before

After
M830A1 Fired on Simulated Air Target
M830A1 Multi-Purpose Ground Mode

• Fired for effect on ground target
  ➢ Target is Main Battle Tank at ~1,000 meters

Impact point on tank
- Test Fired to establish aim point and check firing across temperatures
- 3 from Danish Leopard 2/A5 Tank
- 1 from Dutch Leopard 2/A6 Tank

Combined fire for effect and analysis on targets
- 1\textsuperscript{st} Target is razor wire entanglement
- 2\textsuperscript{nd} Target is wood plates to demonstrate dispersion of tungsten balls
- 3\textsuperscript{rd} Target is a civilian vehicle at \textasciitilde100 meters
Direction of fire
M1028 Canister Fired on Vehicle

An advanced weapon and space systems company
M1028 Canister on Simulated Suicide Vehicle

An advanced weapon and space systems company

GENERAL DYNAMICS
Ordnance and Tactical Systems
Results  Conclusions

- Ammunition is interoperable and safe to fire in Leopard 2 Tanks (L44 / L55)
- Demonstration showed interoperable use of these products.
- Demonstration in cooperation and partnering to meet common objectives
Final Comments

• Thanks to Danish, Dutch, and US Army for supporting this Test
• Members from 12 countries attended
• Demonstration in cooperation and partnering to meet common objectives