A NEW COMMERCIAL FUZE FAMILY FULFILLING MODERN SAFETY AND RELIABILITY REQUIREMENTS FOR 40MM GRENADES

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Agenda

1. Short Company Presentation
2. Background – Modern ammunition requirements
3. The Rheinmetall 40mm Family
4. Reliability and Safety
5. Summary and Forecast
Business Unit Weapon & Munition
Product Division Fuzes

Development

Production

Proving Grounds

Testing

Tank Fuzes

Shoulder launched

Infantry Grenades

MORTAR and Artillery

Medium Caliber
Product Division Fuzes

- Rheinmetall Defence has increased activities in the fuze business continuously since 2007

- 5 fuze qualifications ran in the last 3 years successfully

- Rheinmetall is self funding new fuze projects

- Rheinmetall is investigating into potential locations for fuze development, production, and approaches for international cooperation

- Rheinmetall’s target is to become a leader in the fuze business
Background – modern ammunition requirements

- Latest MOPs have shown additional ammunition requirements in the field of infantry weapons
  - The main issues are shown in the following diagram:
Background

modern ammunition requirements

- dismounted troops after leaving burning vehicle after IED attack
- sheltered aggressor (< at 600m )
- (un)sheltered aggressor (at 600m )
- In case of HV firing at limit of range (e.g. downhills)
- 1800m
Background – modern ammunition requirements

**Resulting is the need for:**
- Variability in range (>> LV)
- Variability in target effectiveness/target engagement
- High efficiency of ABM munition (CEP and hit probability)

**Additional customer specific requirements:**
- High requirements from customer regarding safety & functionality („Fennek test“, or high angle sensitivity)
- High reliability (less UXO effort) reg. duds and functionality

Rheinmetall conducted improvement programs on the 40mm family for several years
How did we achieve this?

- One key element is the self destruct (SD) feature

  We have created a design with the capability to achieve the greatest possible functionality and reliability.

- Another key element is having great flexibility regarding customer requests

  We have created design concepts where most design elements can be easily interchanged.
Creating an SD function in a 40mm fuze

| Pyro-delay element: | Reliability issue at high temps | - |
|                    | difficult to achieve long times (>30s) | - |
| Mechanical:        | Issue of extremely dangerous duds! | - |
| Electronically:    | can be completely discharged | + |
|                    | highly reliable | + |
|                    | long delay time | + |
|                    | Requires electrical energy | - |
|                    | enables other features | + |

- **Mechanical impact** (percussion detonator)
- **Electrical self destruct** (electrical detonator) → **up to 33s delay time**
- Enables new functions if energy problem is solved
Modular features for any fuze design

The following functions were created and can be applied to each design based on customer requirements

- Implementation of a double bold system to resist higher drops (e.g. parachute drops) without pre-arming
- A second parallel spin lock to increase safety (due to special customer requests)
- Spin drop detection
- Special material selection (plastics, coatings and finish) to achieve high resistance in according to customer specific environmental requirements (like transport vibration testing)
Technical Data Range

With this modular SAD system we cover the full range of fuze applications (LV-HV) – „One size fits all“!

<table>
<thead>
<tr>
<th>LV Systems</th>
<th>Muzzle velocity : $V_0 =$ 78m/s</th>
<th>range 400m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>max. acceleration: $a =$ 6.000g</td>
<td>max. spin: $D =$ 3.800 Upm</td>
</tr>
<tr>
<td>LR (LV+)</td>
<td>Muzzle velocity : $V_0 =$ 100m/s</td>
<td>range 650m</td>
</tr>
<tr>
<td></td>
<td>max. acceleration: $a =$ 12.000g</td>
<td>max. spin: $D =$ 4.950 Upm</td>
</tr>
<tr>
<td>MV Systems</td>
<td>Muzzle velocity : $V_0 =$ 135m/s</td>
<td>range 800m</td>
</tr>
<tr>
<td></td>
<td>max. acceleration: $a =$ 25.000g</td>
<td>max. spin: $D =$ 6.700 Upm (under development)</td>
</tr>
<tr>
<td>HV Systems</td>
<td>Muzzle velocity : $V_0 =$ 245m/s</td>
<td>range &gt;2000 m</td>
</tr>
<tr>
<td></td>
<td>max. acceleration : $a =$ 55.000g</td>
<td>max. spin : $D =$ 12.500 Upm</td>
</tr>
</tbody>
</table>
### Example: Technical data HV

<table>
<thead>
<tr>
<th><strong>New HV concept:</strong></th>
<th>Point Detonating Fuze with Electric Self-Destruct</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Arming:</strong></td>
<td>Setback ~ 550,000m/s², Spin ~12,400min⁻¹</td>
</tr>
<tr>
<td><strong>Muzzle Safety:</strong></td>
<td>No arm 18m, All arm 40m, mechanical safe and arm device</td>
</tr>
<tr>
<td><strong>El. Self-Destruct:</strong></td>
<td>electronic Time ~33s or spin drop below 4,000min⁻¹</td>
</tr>
<tr>
<td><strong>Reliability:</strong></td>
<td>PD-Function 98% and due to SD-function the dud rate is less than 0.7%</td>
</tr>
<tr>
<td><strong>Compliance:</strong></td>
<td>Full compliance with STANAG 4187 „Fuzing–Safety Design“</td>
</tr>
<tr>
<td><strong>Energy supply:</strong></td>
<td>Setback generator (qualified by German Armed Forces)</td>
</tr>
</tbody>
</table>

- **Enhanced / extension of functionality** ➔ Airburst function! ➔ qualified in Germany in 2014
- **Adaptation to MV** ➔ currently under testing
40mm x 53 Fuse family – HV options – PD and ABM

The modular design of the fuzes uses different housings (with or without diodes) and different PCBs only:

**PD versions**

**ABM version**

*Fuze in-flight programming*
RWM 40mm Concept:

**ABM is the highest performing effector**

Airburst infantry ammunition’s most obvious advantage is effectiveness against targets behind shelters, – which cannot be reached by classical ammunition.

But there are more benefit!

This schematic is property of the Rheinmetall Defence AG.
RWM 40mm Concept:

**ABM is the highest performing effector**

**Benefit of air burst ammunition versus PD-ammunition:**

- No shaddowing due to ground effects → higher efficiency

*This schematic is property of the Rheinmetall Defence AG*
ABM capability offers higher efficiency by reduced CEP!

**Benefit of air burst ammunition to PD-ammunition:**
- Higher precision, higher effect, less logistical burden!

*Natural circular dispersion of incoming ammunition (no vo effects!)*

*Small CEP*

*Large CEP*

*with ABM:*
- Detonation after programmed time: compact effect volume!

*w.o. ABM:*
- At ground impact natural dispersion is projected to an ellipsis!
Reliability & Safety: Production Quality

- Quality assured by 100% control of critical parts
- Arming time is measured, stored and documented for each fuze in production
- Very stable process (about 4-Sigma distance from USL & LSL), additional reliability is achieved by selection
- Swiss watchmaking technology and engineering

→ >98% reliability and less then 0.7% dud rate
# Reliability & Safety: Simulated Transport

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
<th>Frequency</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airplane</td>
<td>„Propeller Aircraft“ / annex C1</td>
<td>68 Hz</td>
<td>120 minutes</td>
</tr>
<tr>
<td>Helicopter</td>
<td>„Helicopter Cargo“ / annex D1</td>
<td>11.25 Hz</td>
<td>120 minutes</td>
</tr>
<tr>
<td>Ship 1</td>
<td>„Shipborne Vibration Test Description“ / annex E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ship 2</td>
<td>„Shipborne Vibration Test Description“ / annex E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Train</td>
<td>Railroad Cargo Test Description“ / annex E1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheeled Vehicle</td>
<td>DAF YA 4442 [9b]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheeled Vehicle</td>
<td>„Tactical Wheeled Vehicle – All Terrain“ / annex A2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>tracked Vehicle</td>
<td>„Heavy Vehicle – Material on Spnson or installed in Hull“ / annex B3</td>
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**History:** Past failure at qualification for USMC due to strong vibration requirements:

Special care in the design, specific material selection and quality procedure enable the Rheinmetall fuzes to fulfil specific customer requirements like increased and harder vibration loads.

(Here: NL vibration requirements including helicopter noise)
Reliability & Safety:
High low angle sensitivity

Full fuze performance is achievable up until very high impact angles,

Even at 70° Nato angle:
100% functionality achieved!

( @ 2mm Alu plate and 20 mm steel plate!)

Test results on angle sensitivity on different material

Our Fuze design performs at specifically high customer requirements for slanted angle sensitivity!
Conclusion

Rheinmetal Defence offers a highly modern, efficient and reliable Infantry systems for HV, LV and MV

New fuze functions like airburst capability allow high effectiveness, high efficiency and less logistical burden due to munition saving

**Systems are fielded/in charge:** Nato qualified systems available for LV and HV since 2013:

- Customer: Canada, Qualific. (2011)
- Customer: NL, Qualific., (2013)
- Customer: Austria (2013)
- Customer: Denmark (2013)
- Customer: Italy (2014)

System for MV currently under testing

Specific customer requests can be easily realized by modular fuze concepts
Rheinmetall offers full 40mm portfolio

→ *Rheinmetall is your system provider for 40 mm solutions!*
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