Insensitive Propulsion Systems for Large Caliber Ammunition

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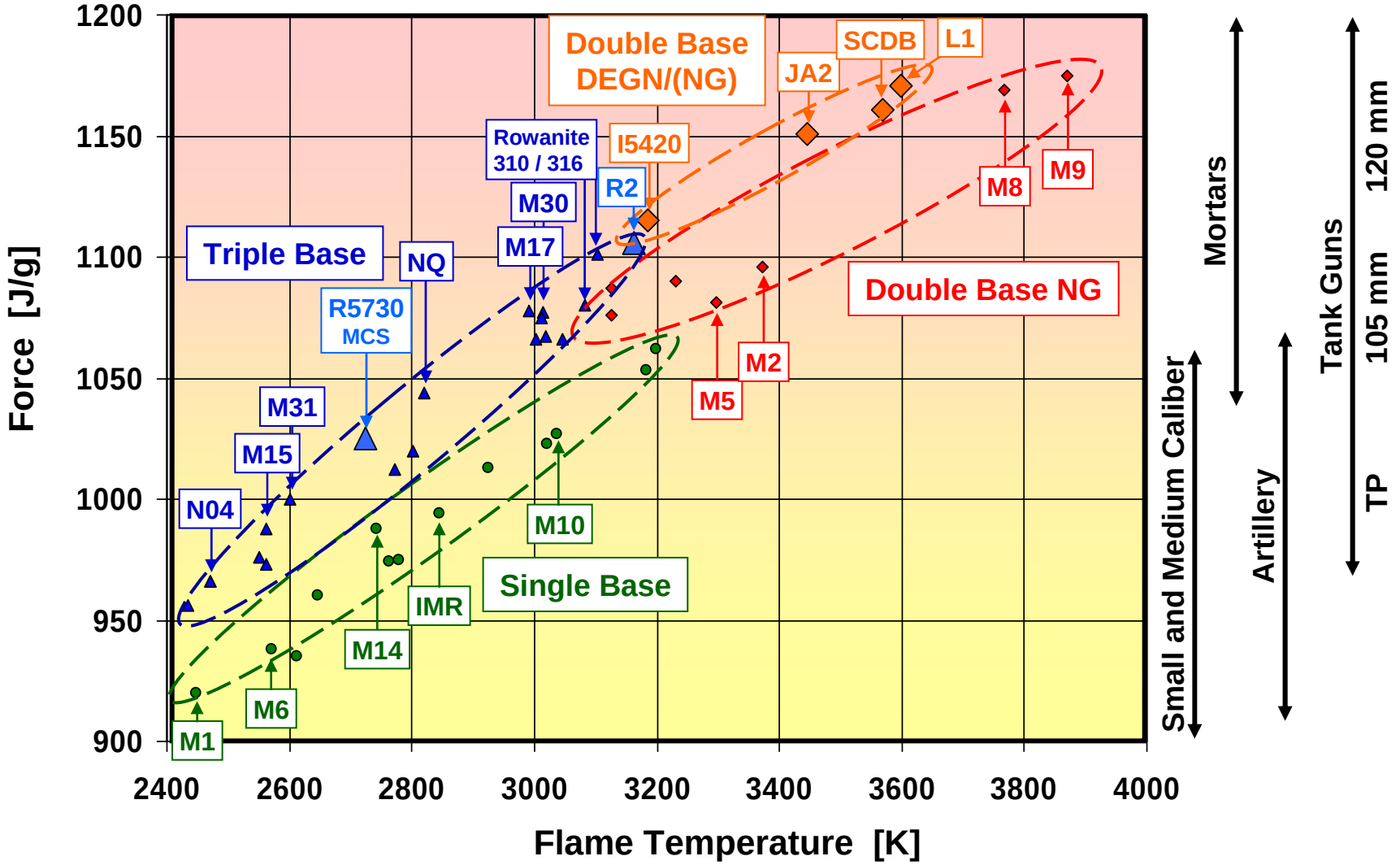
RHEINMETALL NITROCHEMIE

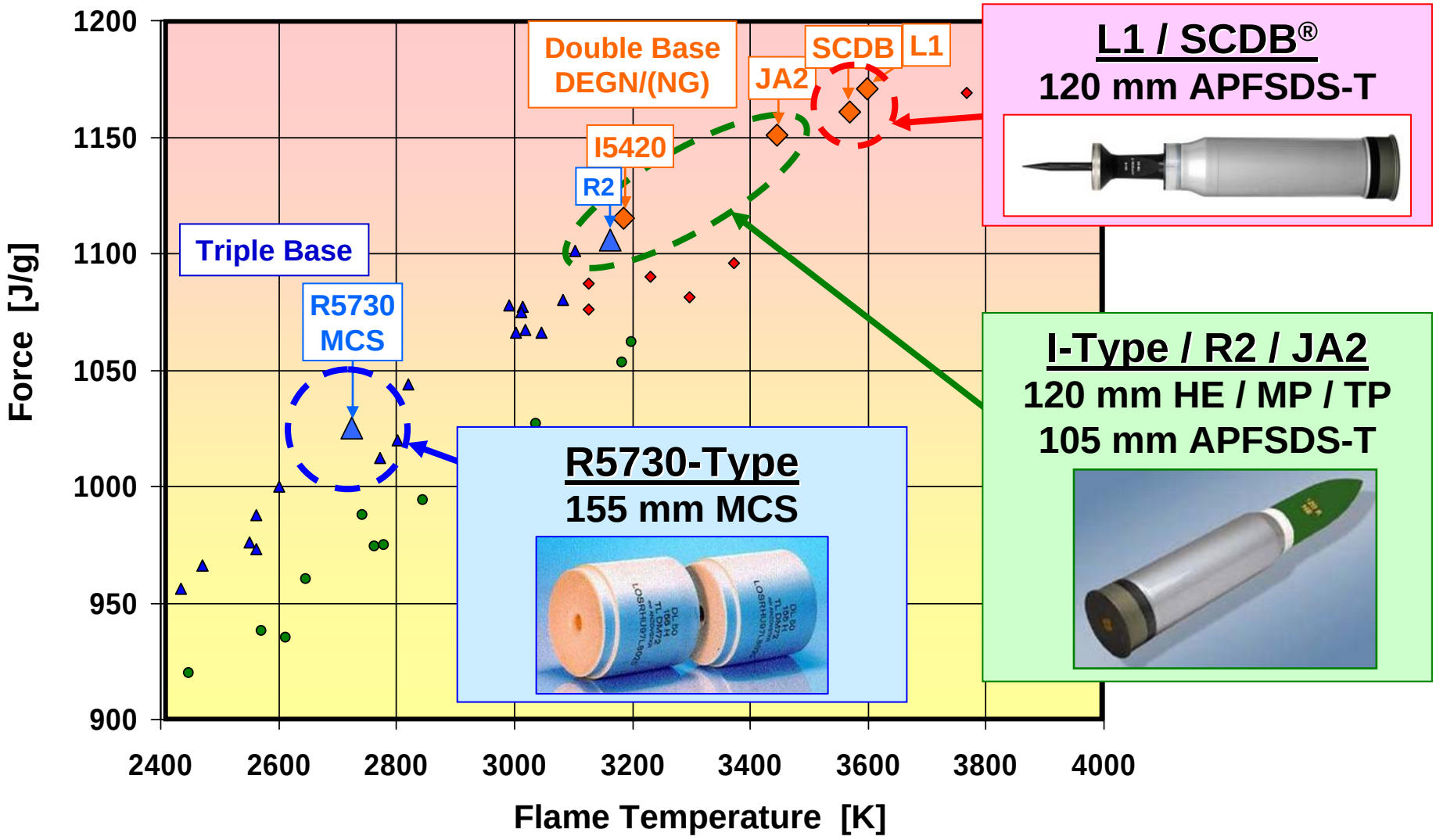
Contents

- Introduction
- Results of IM-Testing for
  - 155 mm Modular Charge System with R-Type Propellant
  - 120 mm APFSDS-T Cartridge DM63 with SCDB® Propellant
  - 120 mm HE and TP-T Cartridges with I- / R-Type Propellants
- Conclusions

Introduction – Overview Gun Propellant Types

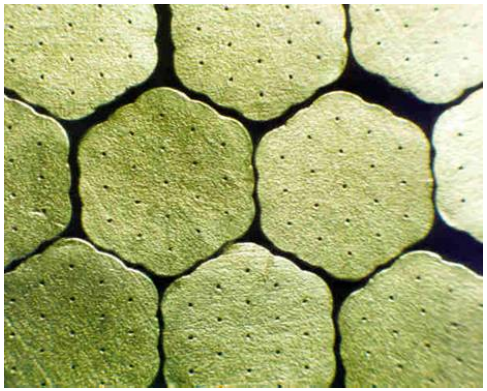


Introduction – NITROCHEMIE's Solvent-Less Gun Propellants



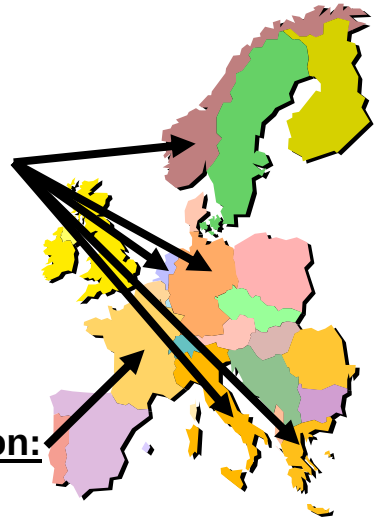
A) 155 mm MCS DM72 / DM92

155 mm Modular Charge System DM 72 / DM 92 with R5730 / R5733 Propellant (Solvent-Less Triple Base Propellant with RDX)



A) 155 mm MCS DM72 / DM92 – Advantages

- **Fully compliant with JBMoU (incl. v_0 = 945 ms at 21°C without exceeding 375 MPa at 63°C)**
- **Increased range to > 40 km (Base Bleed Ammo)**
- **Usability in all NATO standard weapon and ammo configurations (e.g. 39 and 52 barrel), up to 71°C**
- **MCS DM92 is even qualified for C2-A1 climatic zones (-52°C to +71°C) within ERO-ESCP**
- **Low gun barrel wear; barrel life > 2'500 rounds EFC (at 21°C)**
- **Bi-modular charge design for highest possible stow capacity, improved logistics, low price**
- **IM / LOVA requirements met (modules in packaging)**
- **Low toxicity (lead-free charge, no DNT)**
- **Well proven system; qualified and in series production since 1996; introduced in 5 NATO countries; > 1.5 million modules produced and fielded so far**



Introduced:
- Germany
- Norway
- Italy
- Greece
- Netherlands

In Qualification:
- France

A) 155 mm MCS DM72 / DM92 – IM Test Results

Tests performed by Rheinmetall

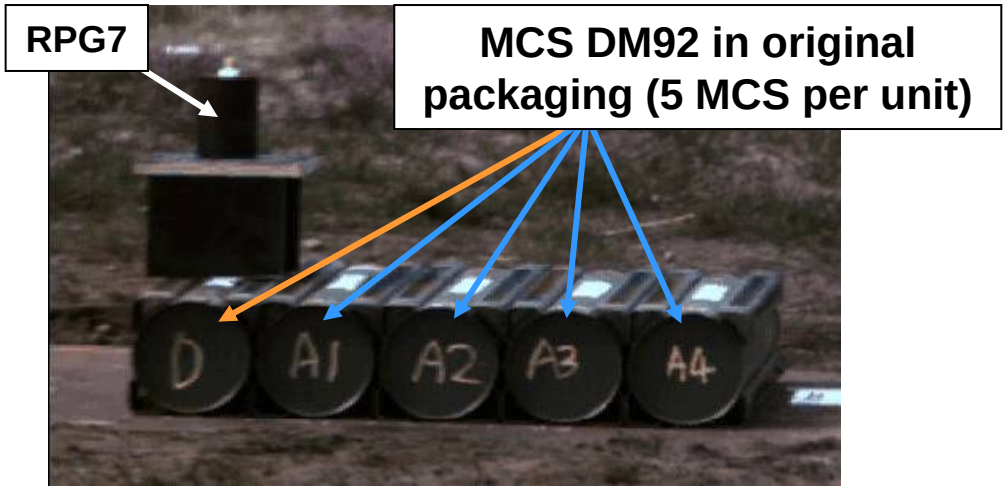
Bullet Impact BI (STANAG 4241)
⇨ **Reaction Type V**
(Rupture of lid, ejection of propellant and combustible cartridge case ccc material, partly burning)

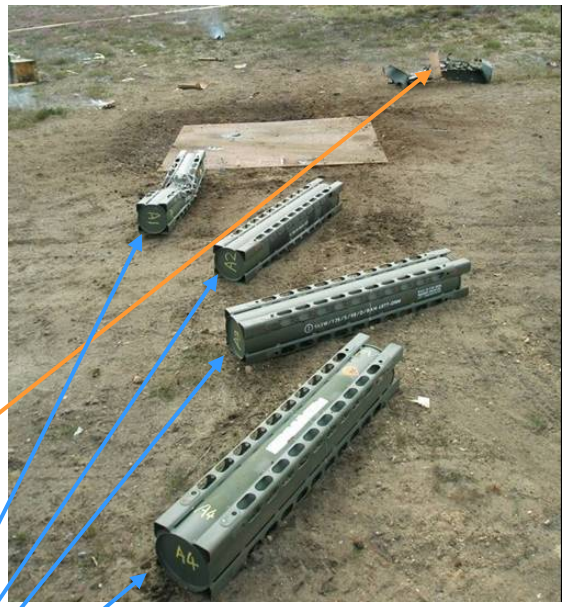
Shaped Charge Jet Impact SCJI (STANAG 4526)
⇨ **Reaction Type IV (RPG7) – V (Bomblet M77)**
(Rupture of packaging, non-violent pressure release, burning and ejection of propellant and ccc material)

Liquid Fuel Fire / Fast Cook-Off FH (STANAG 4240)
⇨ **Reaction Type V**
(Rupture of lid, ejection of propellant and ccc material, partly burning)

Slow Cook-Off Test SH (STANAG 4382)
⇨ **Reaction Type V**
(Burning of propellant and ccc material, ejection of lid, separation of container into 4 parts, no parts beyond 10 m, no fragmentation, blast effect <40 mbar at 5m)

A) 155 mm MCS DM72 / DM92 – Sympathetic Reaction Test





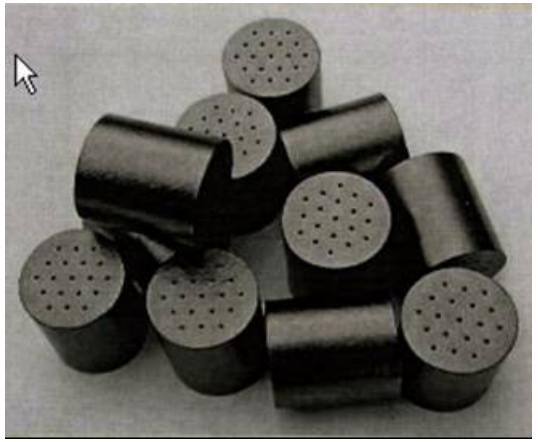
- **RPG7 Shaped Charge Jet Impact** (STANAG 4526)
  - **Type IV Reaction** (Deflagration of Donor)
- **Sympathetic Reaction** (STANAG 4396)
  - **No Reaction**
  - All four MCS acceptors recovered intact within a radius of 5 m – no ignition / no burning
  - Acceptor A1 mechanically damaged (dented)
  - Other acceptors even mechanically undamaged
- **Same Test with conventional artillery propellant**
  → Type I Reaction (Detonation) of Donor

A) 155 mm MCS DM72 / DM92 – Sympathetic Reaction Test

Test performed by Rheinmetall

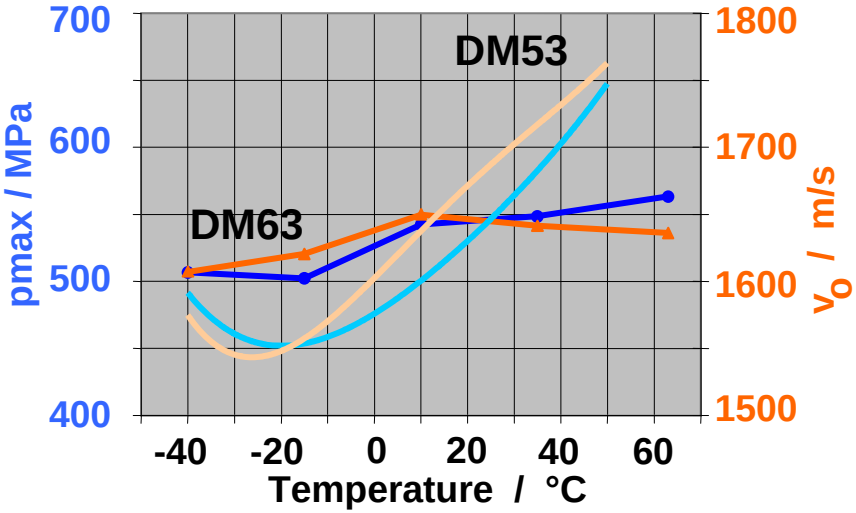
B) 120 mm APFSDS-T DM63

120 mm APFSDS-T Round DM63 with L1 / SCDB® Propellant (Solvent-Less, Surface Coated Double Base Propellant)

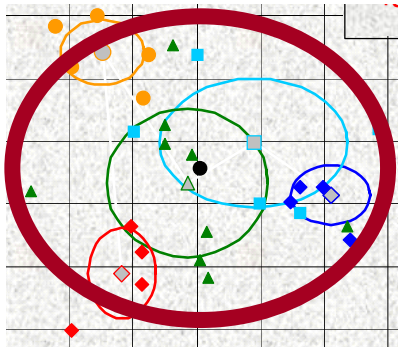


B) 120 mm APFSDS-T DM63 – Advantages

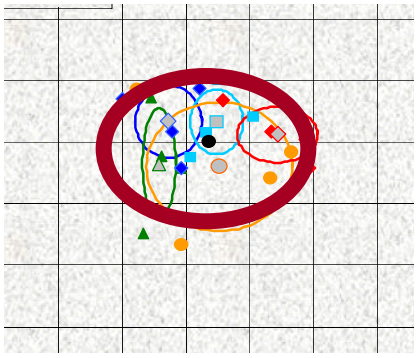
- **Same high performance as predecessor DM53/LKE2**
- **3 times lower gun barrel wear than DM53; barrel life 400 – 600 rounds (such as DM33)**
- **Almost temperature-independent peak pressure, velocity, projectile acceleration, and projectile trajectory**
  - **Suitable for all climatic categories including A1; full function from -46°C to +63°C; save for firing up to +71°C**
  - **lower dispersion / higher hit probability**
- **Reduced peak pressure and recoil impulse**
  - **usable in all in-service smooth bore 120 mm guns**
- **Excellent IM properties due to optimized formulation and surface coating**
- **Qualified and in series production since 2005; introduced in Germany, Netherlands, Finland, Denmark, Austria, Canada, Turkey**



conventional



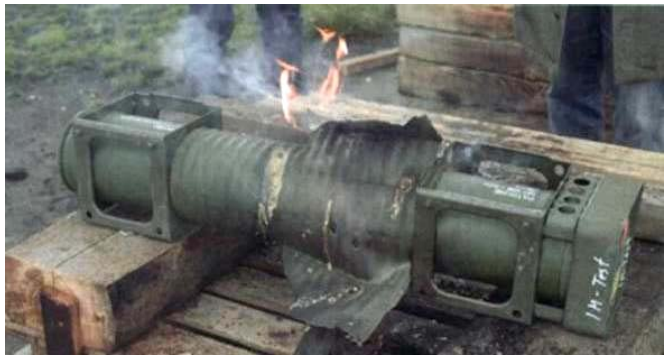
DM 63



B) 120 mm APFSDS-T DM63 – IM Test Results

Tests performed by WTD91

- Tests performed on packed DM63 rounds during DM 63 Qualification

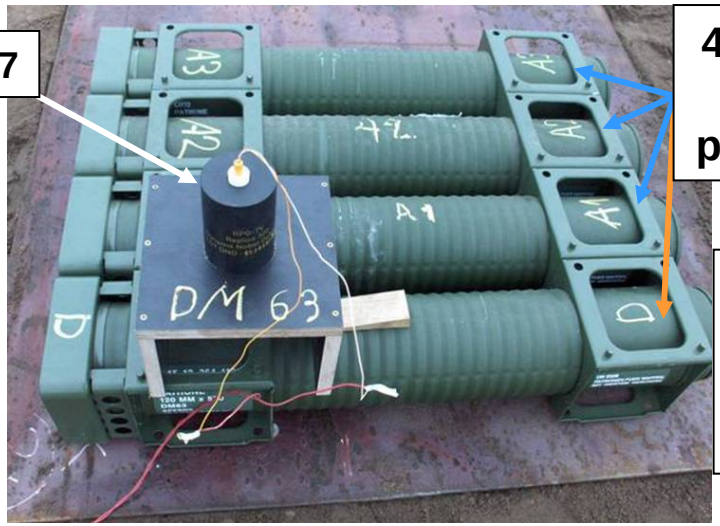


Bullet Impact Test (STANAG 4241)
⇨ **Reaction Type V**
(Rupture of casing in area of bullet exit, burning of propellant and combustible cartridge material, no blast (< 0.09 bar), no fragments, no propulsion of parts)

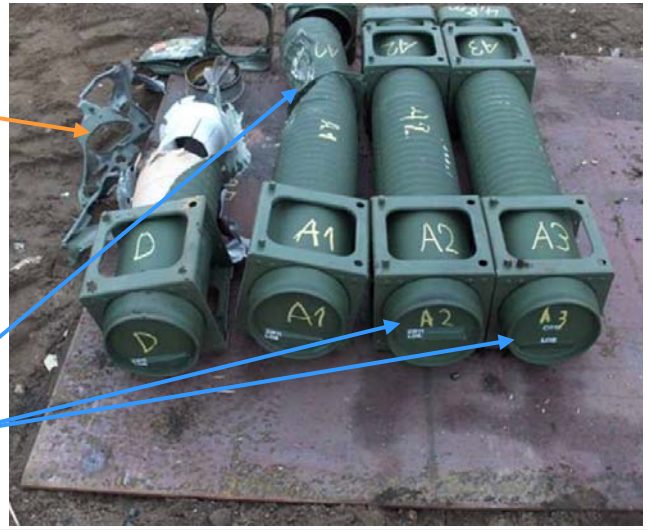
Fast Heating Test (STANAG 4240)
⇨ **Reaction Type V**
(Rupture of lid, burning of propellant and combustible cartridge material, no blast (< 0.09 bar), no fragments, no propulsion of parts >15 m)

Assessment: The 120mm x 570 DM63 round fulfils the level V criteria of STANAG 4439 and can be classified according to UN Code as 1.3 C

B) 120 mm APFSDS-T DM63 – Sympathetic Reaction Test



- **RPG7 Shaped Charge Jet Impact** (STANAG 4526)
  - **Type IV Reaction** (Deflagration of Donor)
- **Sympathetic Reaction** (STANAG 4396)
  - **No Reaction**
  - **All three acceptors recovered intact within a radius of 5 m – no ignition / no burning**
  - **Acceptor A1 mechanically damaged (dented)**
  - **Other acceptors even mechanically undamaged**

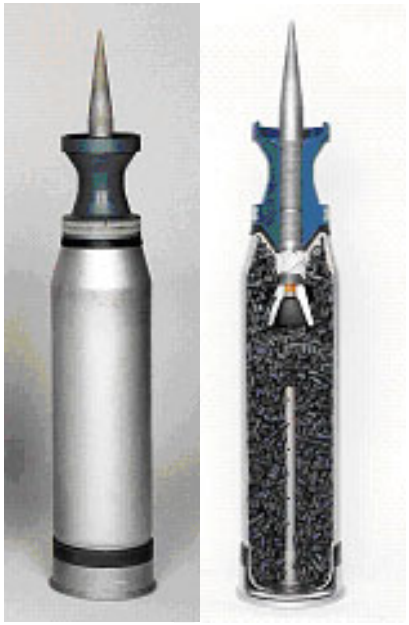


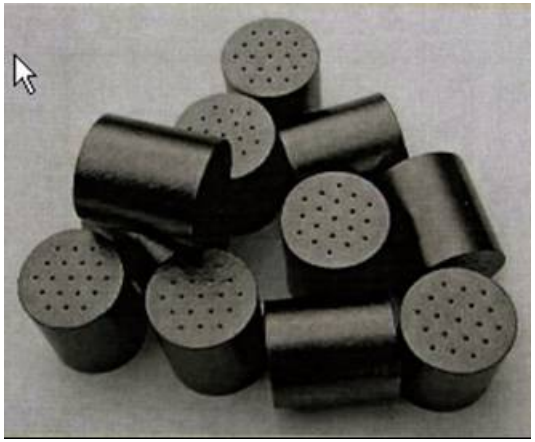
B) 120 mm APFSDS-T DM63 – Sympathetic Reaction Test

Test performed by Rheinmetall

C) 120 mm TPDS-T with I- / R-Type Propellants

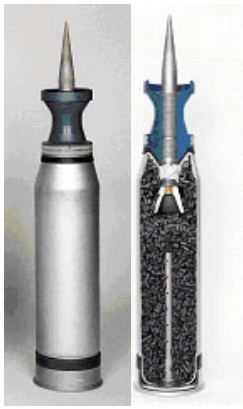
Solvent-Less Produced I-Type and R2 Propellants for 120 mm TP-, HE- and MP- Cartridges and for 105 mm APFSDS-T Applications





C) 120 mm TPDS-T with I- / R-Type Propellants – Advantages

- **The solvent-less produced I-Type and R2 propellants are excellently suited for 120 mm TP-, TPDS-, HE- and MP-cartridges and for 105 mm APFSDS-T applications**
- **Main advantage is that these propellants are much less brittle thus showing better IM properties than the M14, M26 and M30 propellants often used in these applications**
- **<u>I-Type formulation (I5420; double base with DEGN)</u>**
  - **Well established and fielded for 30 years in 120 mm ammunition (MP: DM11; APFSDS-T: DM48)**
  - **Propellant production process was recently optimized regarding IM properties and production costs**
  - **Chosen for the new Rheinmetall 120 mm HE round**
  - **Chosen for the European version of the 120 mm M865 round where the sensitive and toxic M14 propellant is replaced (→ M865C1; qualified, production commencing 2008)**
- **<u>R2 formulation (triple base with RDX/NIGU)</u>**
  - **Recently developed for maximum performance at low erosion level**
  - **Performance and IM properties somewhat better than I-Type propellant**
  - **Slightly more expensive than I-Type propellants**



C) 120 mm TPDS-T M865C1 with I-Type Propellant – Sympathetic Reaction Test

Test performed by Rheinmetall

RPG7

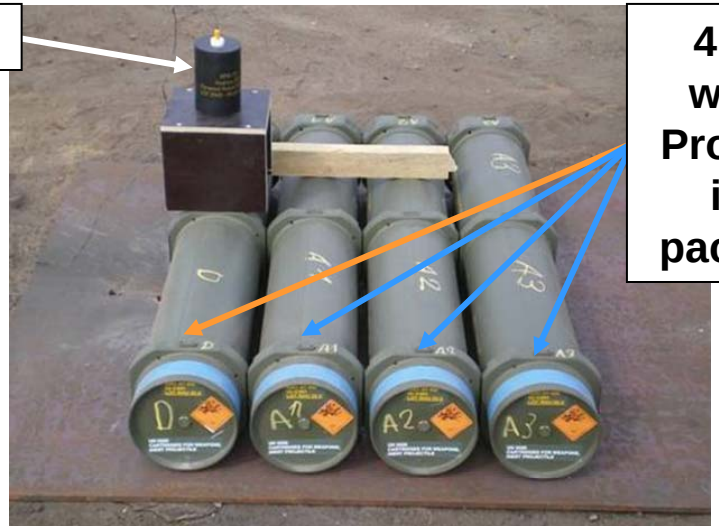
4 M865 with I-Type Propellant in US packaging

- **RPG7 Shaped Charge Jet Impact** (STANAG 4526)
  - **Type IV Reaction** (Deflagration / Propelling of Donor)
- **Sympathetic Reaction** (STANAG 4396)
  - **No Reaction**
  - **Acceptor A1 mechanically damaged**
  - **Acceptor A3 not even damaged**
  - **Acceptor A2 was accidentally hit by RPG7 fragments and was ignited / reacted with burning**

C) 120 mm TPDS-T M865C1 with R2 Propellant – Sympathetic Reaction Test

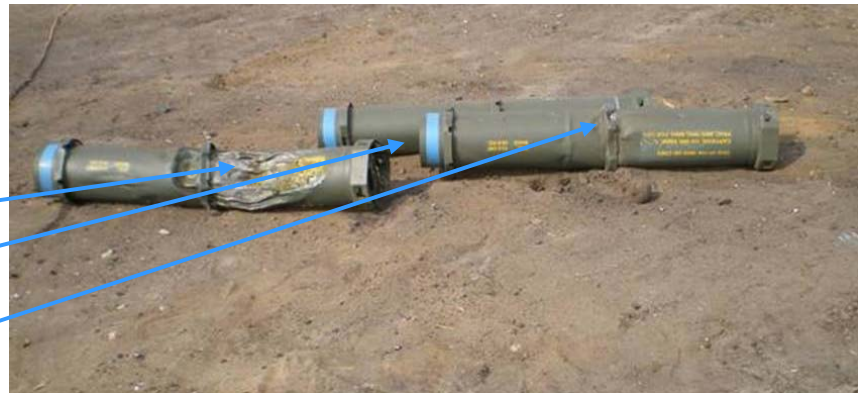
Test performed by Rheinmetall

RPG7



4 M865 with R2 Propellant in US packaging

- **RPG7 Shaped Charge Jet Impact** (STANAG 4526)
  - **Type IV Reaction** (Deflagration / Propelling of Donor)
- **Sympathetic Reaction** (STANAG 4396)
  - **No Reaction**
  - **All 3 Acceptors recovered within 3 m**
  - **Acceptor A1 mechanically damaged**
  - **Acceptor A3 not damaged**
  - **Acceptor A2 (case and ccc) punctured by RPG7 fragments but not ignited**



Conclusions

- The new generation of NITROCHEMIE's large caliber gun propellants combines outstanding performance with excellent IM-properties
- The excellent IM properties are achieved by a combination of
  - optimized formulation,
  - improved and carefully operated solvent-less propellant production process,
  - and, in case of the SCDB© propellant, the addition of the surface coating step
- Upgrade of the solvent-less propellant factory with new and automated equipment assisted IM improvements and reduceds costs
- NITROCHEMIE's strategy to optimize IM properties of nitrocellulose-based propellants rather than searching for exotic polymer-bonded formulations has proven successful again

Last year's winner of the MSIAC Award is not resting on its laurels but searching for further improvements !

Acknowledgement

- Audience: For you Attention
- Rheinmetall: Dr. K.-A. Kratzsch; Mr. W. Stein
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- Co-workers at both company sites