

Public Release Picatinny Arsenal
PAO-375-11 dtd 6 Apr 11



GD-OTS/RWM NON-TOXIC LESS INCENDIARY SMOKE PROJECTILE



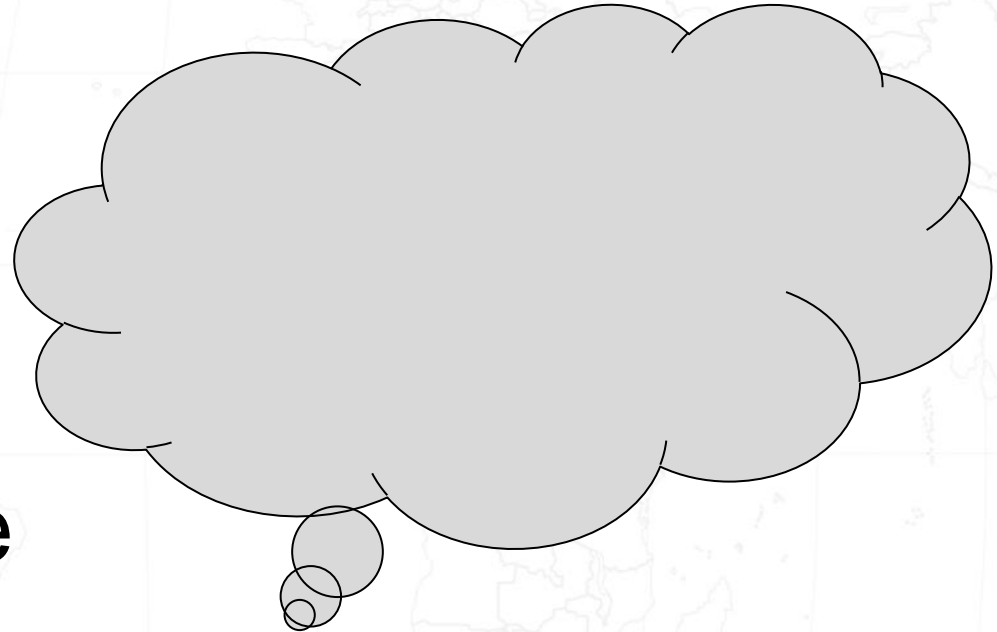
Guns & Missiles
Conference
April 12, 2010



GENERAL DYNAMICS
Ordnance and Tactical Systems

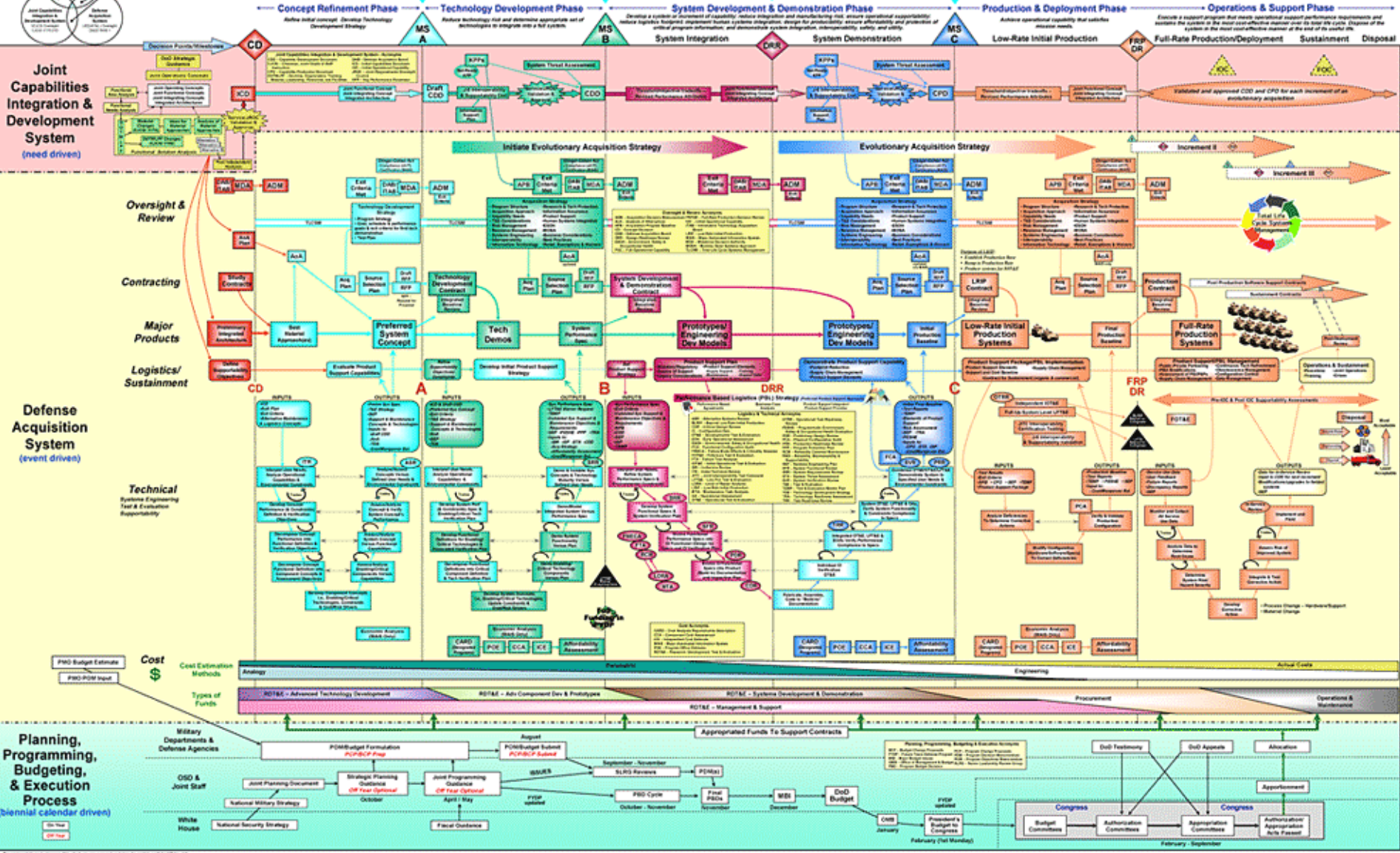
Obscuration

- What is the purpose of Obscuration?
 - To Hide
 - To Mask
 - To Delay
 - To Confuse



What better way to do that than inflicting our adversaries with.....

THE DEFENSE ACQUISITION SYSTEM



Bottom Line Up Front

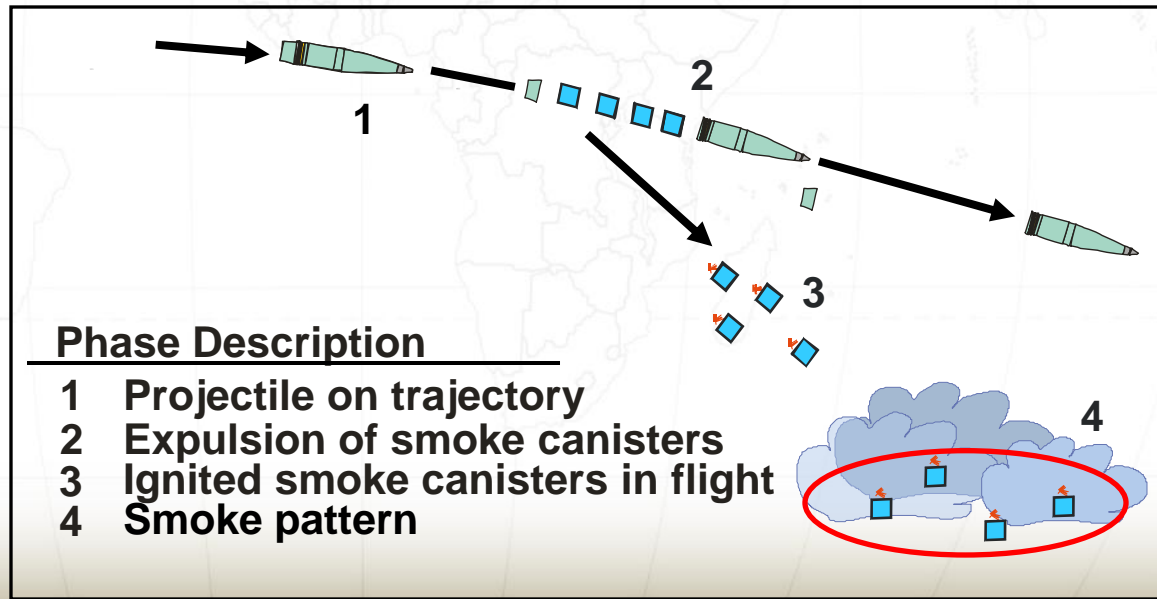
General Dynamics – Ordnance and Tactical Systems (GD-OTS), partnered with Rheinmetall Waffe Munitions (RWM), offers a unique solution that re-uses existing M483 DPICM projectiles (after demilitarization, recovery, and refurbishment) as a carrier for the deployment of non-toxic, very-low incendiary canister technologies with the DM1560 smoke canisters.

M483-Based Smoke Projectile

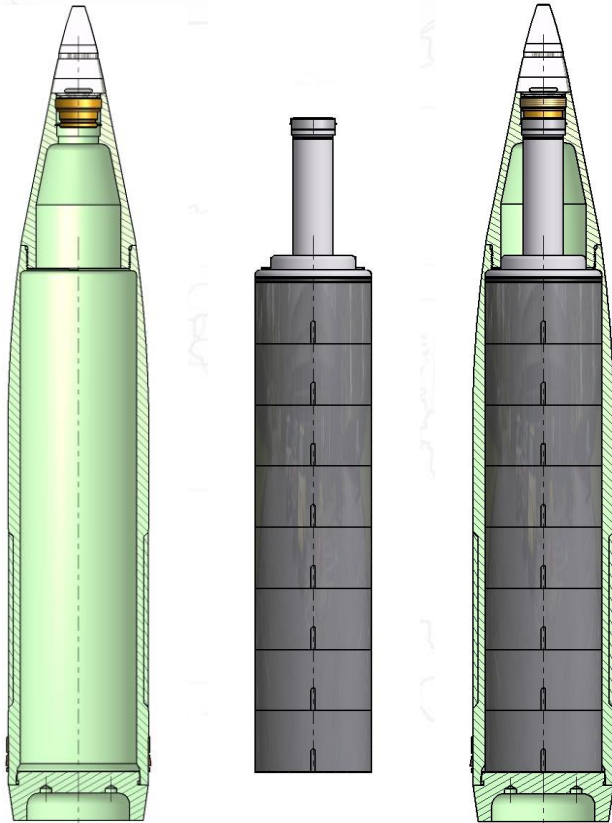
8 ea DM1560 Smoke Canisters

Expulsion System

Reutilized M483
Carrier



M483-Based Smoke Projectile



- Diameter and height of the smoke canister payload stack are designed to fit into the M483A1 shell with minimum modification
- Weight of the smoke canisters is designed to replicate the current M42/M46 DPICM grenade payload
- Payload will interface with the current keyway in the body to insure a firm lock into the carrier to prevent any relative payload motion during flight
- Expulsion/pusher plate system will be used to ensure both proper ignition of the smoke canisters and complete cargo expulsion

DM1560 Smoke Canister



- **Burning time in excess of 3.5 min**

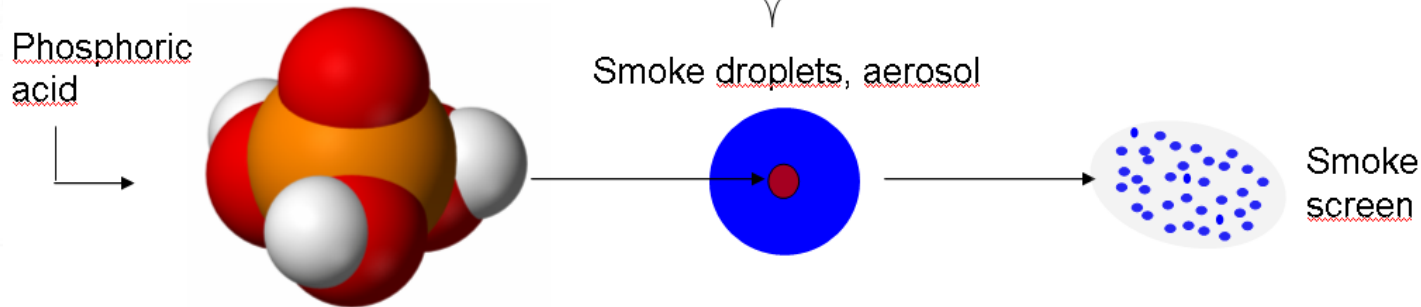
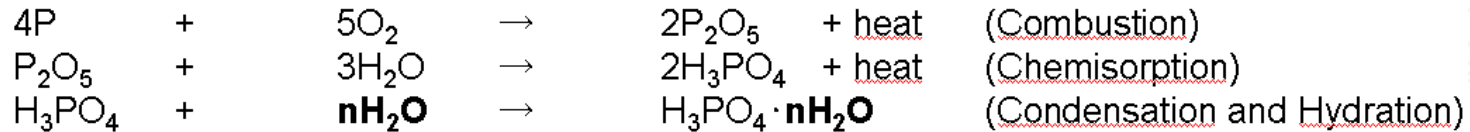
Features

- The M483 projectile is currently being demilitarized by the US Army
- The RWM DM1560 is a NATO-qualified canister currently employed in the DM125 projectile
- RWM smoke compound based on Micro-Encapsulated Red Phosphorous offers significantly reduced phosphine split rates over conventional RP
- Low incendiary risk due to contained combustion
- No toxic effects on environment and human beings in compliance with STANAG 4588



Red Phosphorous Smoke Design

Reaction:



- Burning of Red Phosphorous generates H_3PO_4 which is phosphoric acid.
- The phosphoric acid is highly hygroscopic and adds water from the ambient air.
- Together with H_2O the H_3PO_4 forms droplets which can be seen as smoke in the visual band. The smoke is also IR-effective.

Red Phosphorous Smoke Design

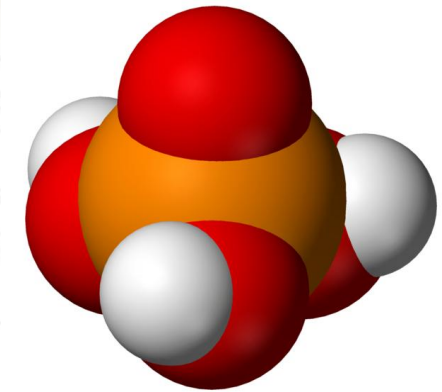
Mass extinction coefficients are such that RP has the same demonstrated IR masking capabilities as WP, better than HC

$$\tau(\lambda) = e^{(-\alpha c x)}$$

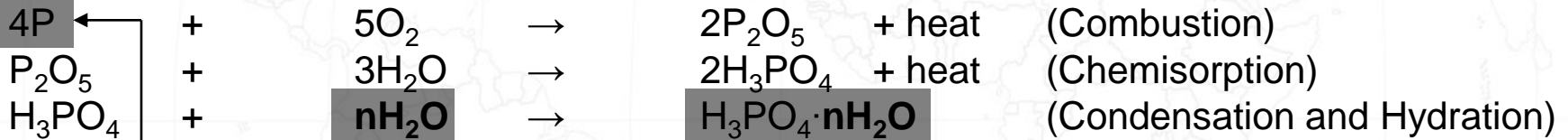
- $\tau(\lambda)$ = Transmission
- α = Mass extinction coefficient
- c = Aerosol concentration
- x = optical length through smoke

Material	visual 0.4 - 0.7 μm [m ² /g]	near IR 1.06 μm [m ² /g]	mid IR 3 - 5 μm [m ² /g]	far IR 8 - 14 μm [m ² /g]
WP	2.9	1.4	0.27	0.32
RP	2.9	1.4	0.27	0.32
HC	2.1	0.7	0.18	0.18

Red Phosphorous Smoke Design



Reaction:



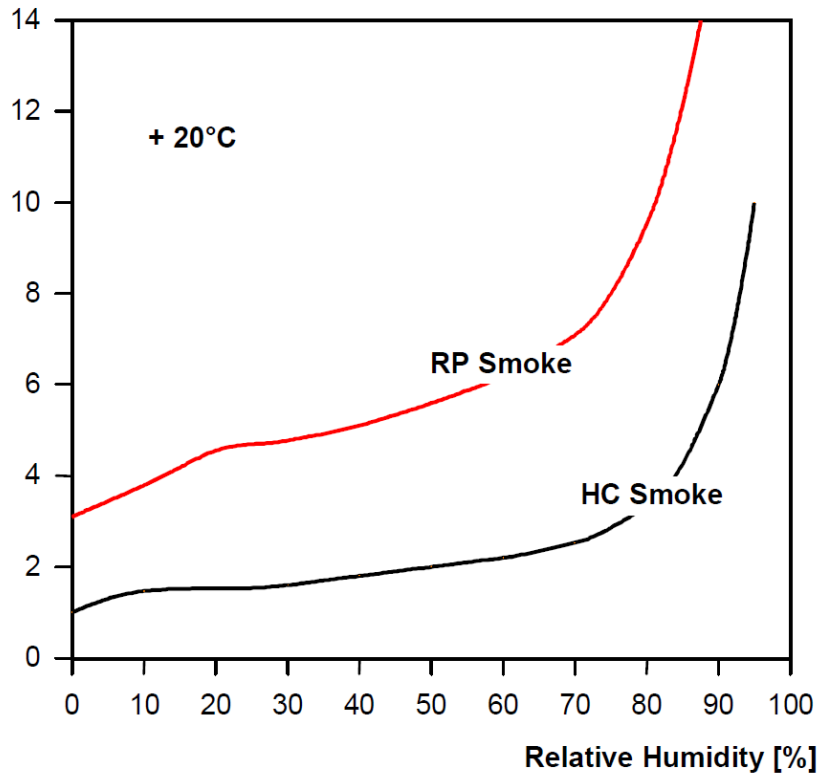
Yield-Factor:

$$Y_F = \frac{m_{Aerosol}}{m_{RP}}$$

The ratio of burned smoke compound to generated smoke aerosol mass by the water add is called Yield Factor.

DM1560 Red Phosphorous Smoke

Yield Factor



$$\tau(\lambda) = e^{(-\alpha c x)}$$

$$C = \frac{m_{\text{Aerosol}}}{V}$$

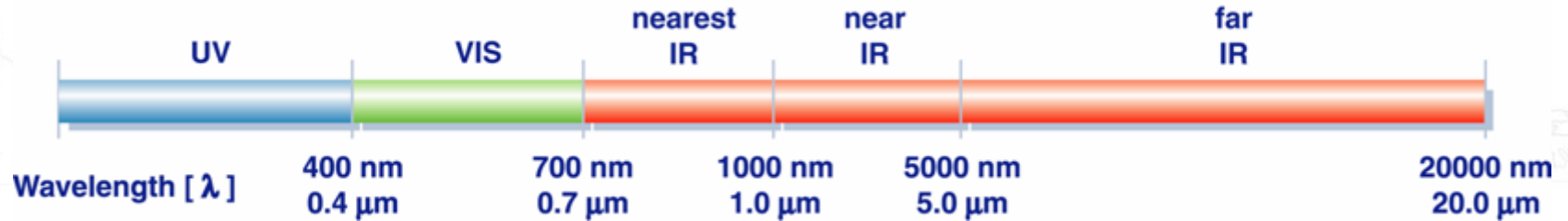
$$C = \frac{m_{\text{RP}} \cdot \text{Y.F.}}{V}$$

$$\text{Y.F.} = \frac{m_{\text{Aerosol}}}{m_{\text{RP}}}$$

$\tau(\lambda)$ = Transmission
 α = Mass extinction coefficient
 c = Aerosol concentration
 x = optical length through smoke

- Smoke Performance is dependent on humidity & temperature

Multi Spectral



- The output of the DM1560 is such that sufficient obscuration can be produced to cover the VIS and IR spectrum.
- Effective against all electro-optical equipment like Thermal Imagers, Laser Range Finders, and Laser Designators

Red Phosphorous Smoke Design

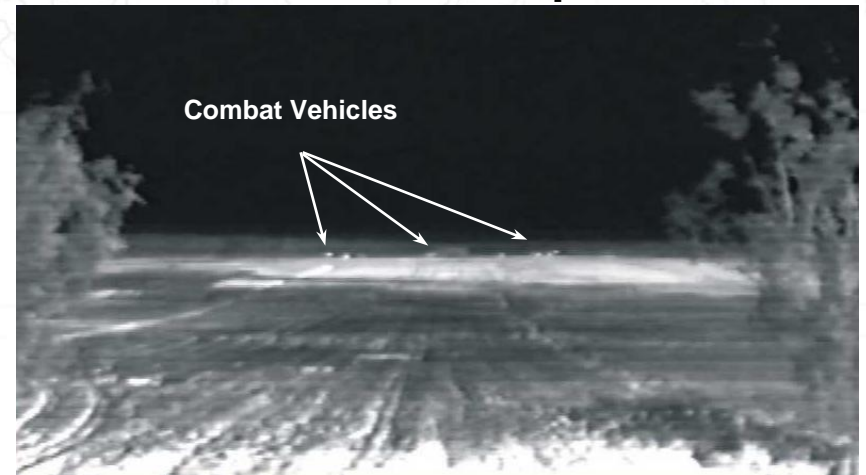
Current Rheinmetall Smoke Round

Target View without smoke

Visual



Infrared 8 - 12 μm



Red Phosphorous Smoke Design

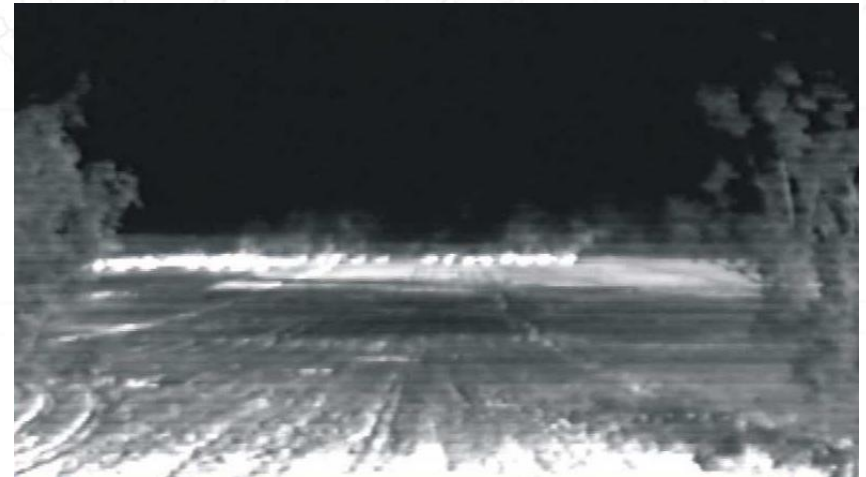
Current Rheinmetall Smoke Round

Target View with 3 Rounds (24 canisters)

Visual



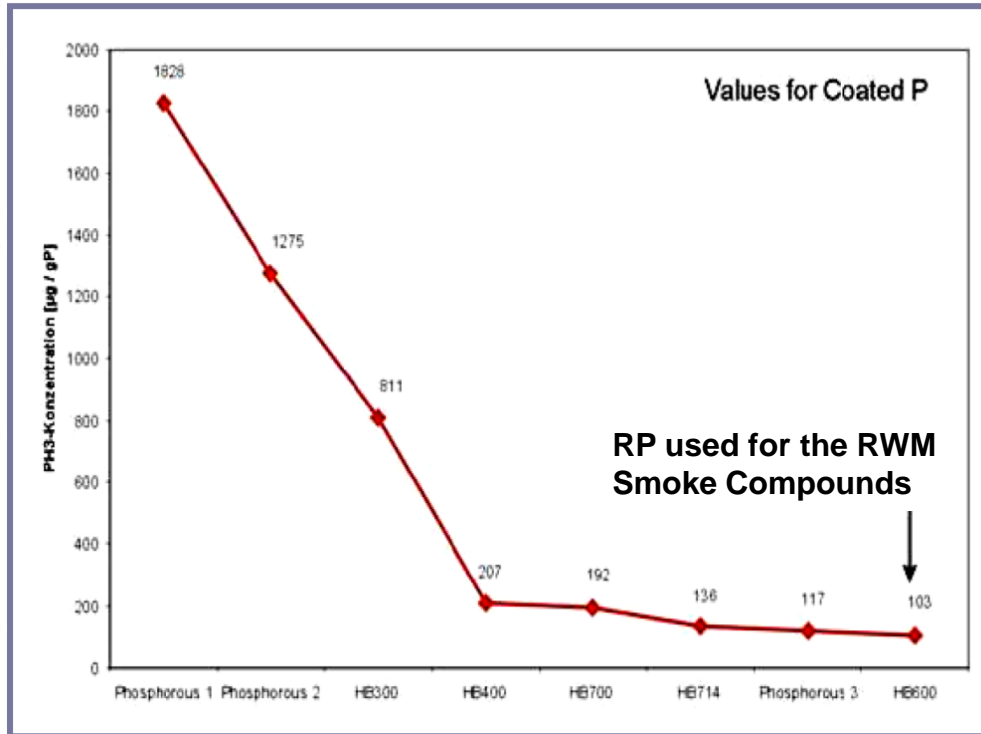
Infrared 8 - 12 μ m



Toxicity

- RWM has developed a Hexachloroethane (HC) – free, non-toxic obscurant
- RWM RP is more compatible than existing smoke compositions for environmental and human toxicology
- The RWM RP smoke compound was successfully tested in accordance with STANAG 4588
- Toxicologically harmless to humans and the environment
- Does not exceed pollution limits when used in training
- No restrictions for use in training or tactical missions
- No restrictions in storage and shipping

Stability



Split rates of RWM RP, development on the last 20 years on RP coating

- Phosphine split rate reduced by a factor of 1:100,000 compared to uncoated RP
- Production is environmental eco-friendly by using water based binders
- Storage life of 10 years minimum
- No toxic effects from Phosphine PH₃ during storage
- No auto-ignition based on PH₃ – split (no disproportion reaction $2 P_4 + 12 H_2O \rightarrow 5 PH_3 + 3 H_3PO_4$)
- Long-term stability of RP in the smoke compound is supported by a smooth and water based production process at RWM branch

Conclusions

- Low cost re-use of existing payload hardware after demilitarization, recovery and refurbishment.
- Concept exists for replacing the original DPICM grenade cargo with a low-incendiary, non-toxic, RP obscurant.
- DM1560 canisters currently undergoing US smoke characterization trials.
- Partnership to fully utilize US manufacturing base.

Points of Contact

GD-OTS

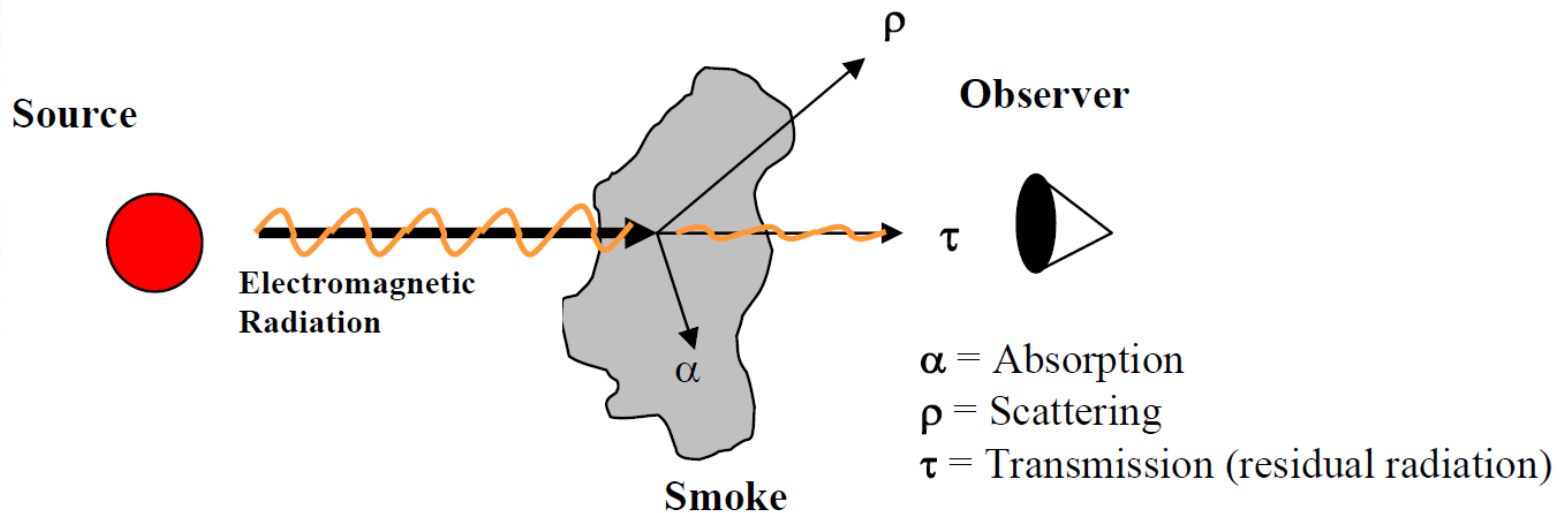
George R. Kurzik
Director – Programs
200 East High Street
Red Lion, PA 17356
+1-717-246-8263
george.kurzik@gd-ots.com

RWM

Joerg Schlobach
Program Manager
Heinrich-Erhardt-Str. 2
D-29345 Unterlues
+49-5827-80-6295
joerg.schlobach@rheinmetall.com

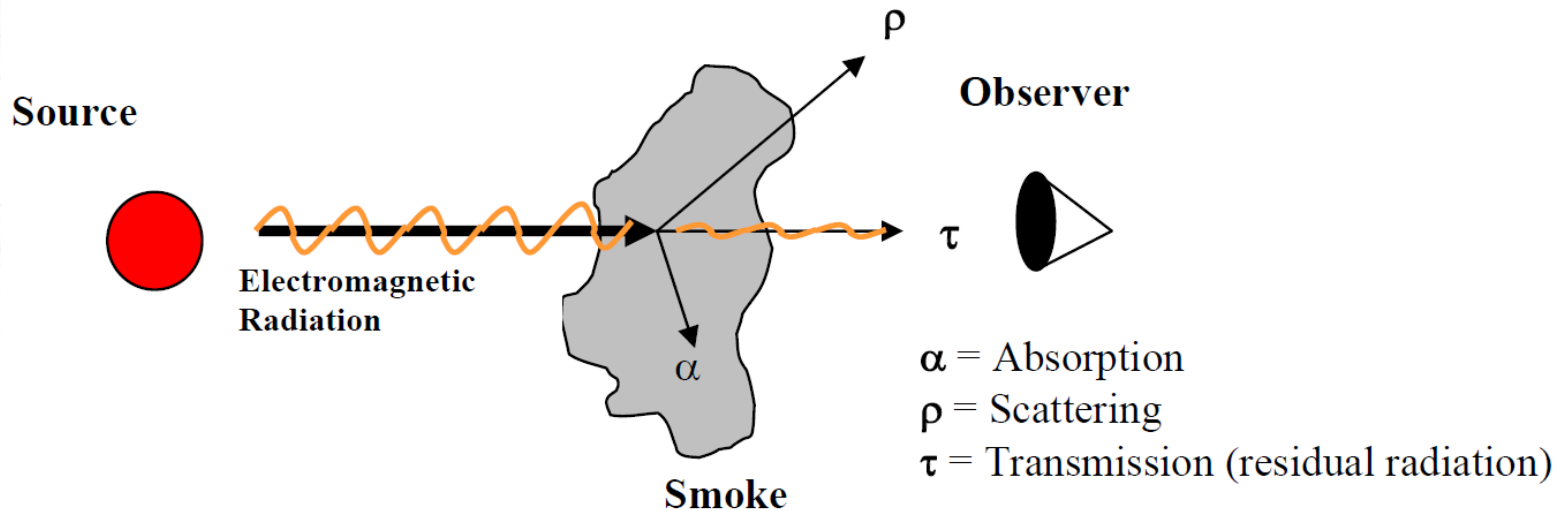
BACKUP SLIDES

Red Phosphorous Smoke Design



- The droplets in the smoke screen have the size in the order of the wavelength of visual and IR wavelength, so that absorption and scattering effects occur in the smoke cloud.

Red Phosphorous Smoke Design



Law of Lambert and Beer:

$$\tau(\lambda) = e^{(-\alpha c x)}$$

$\tau(\lambda)$ = Transmission
 α = Mass extinction coefficient
 c = Aerosol concentration
 x = optical length through smoke

- The intensity of transmitted light can be described by the law of Lambert and Beer.

Red Phosphorous Smoke Design

Mass extinction coefficients

$$\tau(\lambda) = e^{(-\alpha c x)}$$

$\tau(\lambda)$	= Transmission
α	= Mass extinction coefficient
c	= Aerosol concentration
x	= optical length through smoke

- The mass extinction coefficient in $[m^2/g]$ defines the amount of mass which is able to be efficient in the observed wavelength. Mass extinction coefficients are material specific values.

This means effectiveness in a defined wave length is depending on:

- The chosen smoke compound material.
- The concentration of smoke compound in the target area.

Toxicity

Toxicological Evaluation

- The toxicological and ecotoxicological evaluation according STANAG 4588 were performed by independent german institutes:
 - Fraunhoferinstitut für Umwelt und Chemische Technologien, Schmallenberg
 - Fraunhoferinstitut für Toxikologie und Aerosole, Hannover
- The final assessment was carried out by:
 - Bundeswehr Research Institute for Protective Technologies and NBC Protection (WIS)

Toxicity

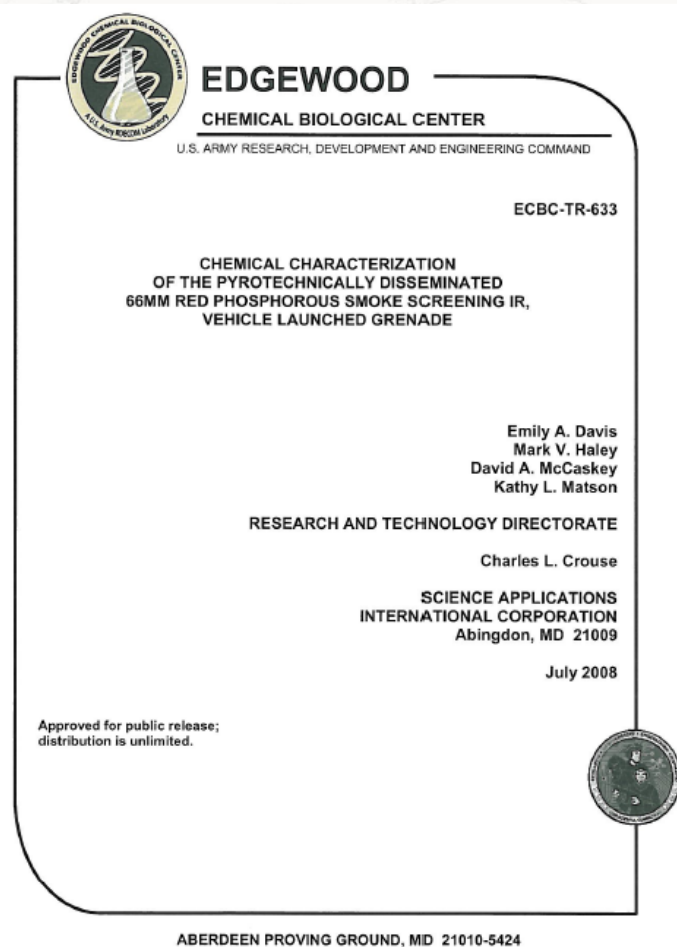
Humantoxicological results

- No relevant toxicological findings.
- The RP Aerosol showed no genotoxic effects.
- In “28 Days Inhalation Toxicity Study“ there were found typical symptoms for phosphoric acid / phosphorus oxide with 1 mg/m^3 (“Reversible Irritation Effect”)

Ecotoxicological results:

- RP Smoke compound showed no toxicological effects.
- RP Aerosol showed no soil toxicity (no negative influence to soil due to dilution and buffer effects). Only a slight aquatic toxicity due to a slight pH-displacement was observed. Consequently no negative results for environment were expected.
- Burning Residues showed moderate aquatic toxicity and no toxicity as far as soil is concerned (no negative results for environment when dumping of substances is prevented)

RP Technology already qualified in the US



With the qualification of the **Grenade, 66 mm, Smoke Screening IR, Vehicle Launched, MK1 mod.0** the RWM RP smoke compound is fully qualified in the US.

The RP composition is the same as DM125, only slight % changes of ingredients.

