
# Revolutionary Insensitive, Green and Healthier Training Technology with Reduced Adverse Contamination Project (RIGHTTRAC Project)

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# Acknowlegments

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# Outline

- RIGHTTRAC Objective and Concept
- Background
- Current Work
- Summary

# RIGHTTRAC

- Technology Demonstration Project
  - 5 years
- Objective: To demonstrate
  - that green and IM munitions have better properties than current munitions.
  - that it is feasible to implement a solution that would ease the environmental pressures on the Canadian Forces ranges and training areas.

# RIGHTTRAC Concept

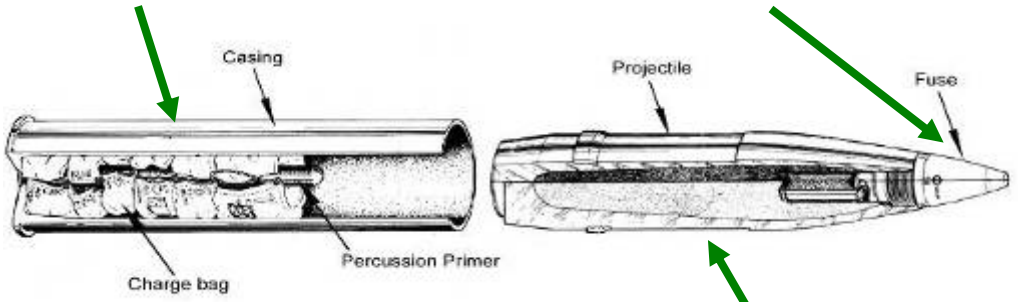
- Test vehicle : 105-mm M1 artillery round
  - Scalable to other weapons

Decrease the production of UXOs

Avoid using toxic and carcinogenic ingredients in gun propellants

Green/IM propellant

More reliable fuzing system with self destruct mechanism




Avoid RDX

Green/IM explosive

# Important Considerations

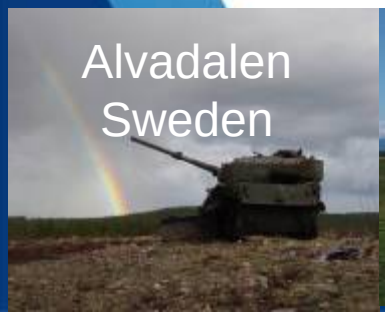
- Military readiness is imperative
- Most munitions fired in training areas
  - Around 95% before Afghanistan
- Increased personnel in Land Forces
- Increased foreign training

Prevention is essential to keep our (rather large) ranges and training areas in operational conditions

# RIGHTTRAC Background

- > 15 years of R&D on environmental impacts of munitions (> 30 M$ in research funds)

  - Site characterization
    - Guidelines at http://www.em-guidelines.org/
  - Complex environmental fate of explosives
  - Mechanisms involved in the contamination
- Large international efforts with USA, Sweden, the Netherlands, U.K. and Australia





# Background – Reduce the UXOs

- Probable sources of munitions residues in target areas
  - Low-order detonations of various ordnance items
  - UXO blow-in-place operations (BIPs)
  - Corrosion of surface and subsurface UXO
  - Rupture of UXO items from nearby detonations

Environmental Impacts

Safety Hazards

# Background – Reduce the UXOs

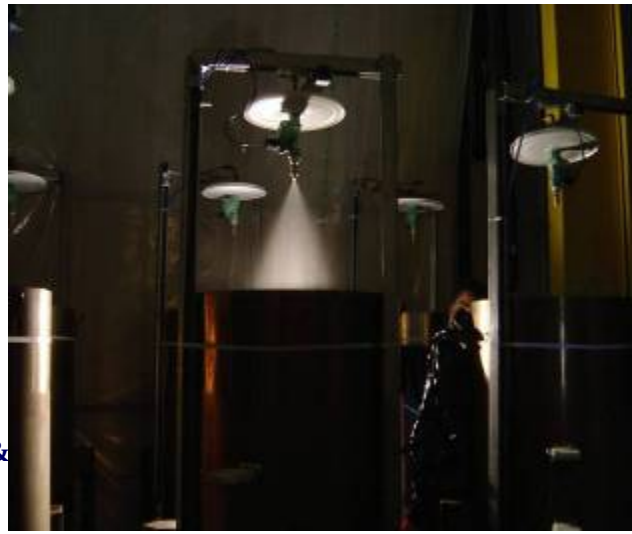
- 81-mm mortar cracked by the detonation of another incoming round
- One round can potentially contaminate a large amount of underground water in one rain season

Cracked shell

Production

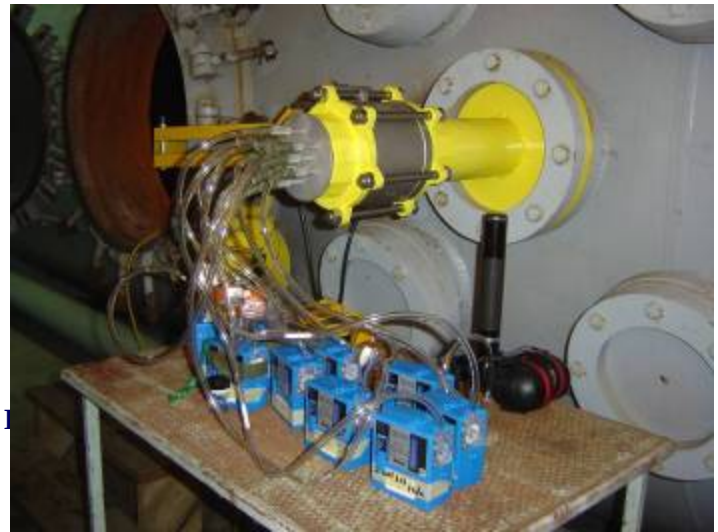
Result

Simulated rain in columns

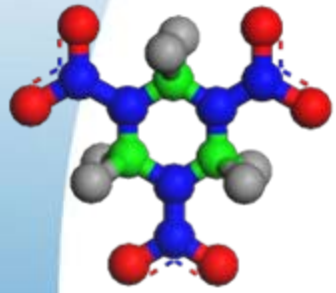


# Background – Replace Gun Propellant Ingredients

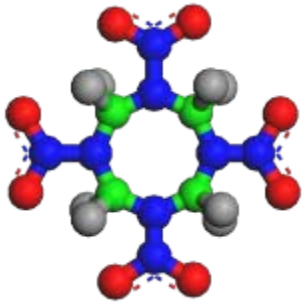
- Significant amounts of propellant residues were detected at firing positions
  - Incomplete combustion of propellants
  - Open burning of excess propellant
- Some constituents may be **toxic** or **carcinogenic**
  - DNT, NG, phtalate derivatives, heavy metals, etc.



# Background – Avoid RDX



- RDX
  - One of the explosives that is used the most
  - The most mobile through the soil profile
  - Migrates to groundwater and contaminates surrounding areas
  - It is considered rather toxic
- Our solution: HMX
  - Performs better than RDX (more expensive)
  - Almost a drop-in replacement in many applications



# Background – Avoid RDX

| Water solubility (mg/L) | |
|---|---|
| RDX | HMX |
| 42 | 5.0 |

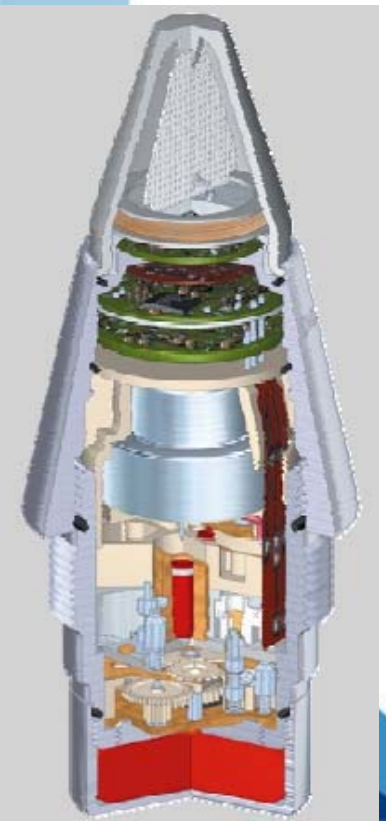
| EPA Lifetime Health Advisory for Drinking Water (μg/L) | |
|---|---|
| RDX | HMX |
| 2 | 400 |

- HMX is less soluble than RDX
- HMX is less toxic than RDX
- Factor of 1000 !
- Other energetic solids could also be appropriate but at this point in time, HMX is our best bet!

http://www.clu-in.org/char/technologies/exp.cfm
http://www.epa.gov/waterscience/criteria/drinking/dwstandards.pdf

# RIGHTTRAC – Current Work

- Fuze
  - Development of a self-destruct capability to current artillery fuzing systems in case of a failure of the primary fuze
    - operator handling
    - soft impacts
    - age-related failures
  - Implementation in an existing fuze
  - Reduce the actual live fire dud rate from approximately 1-5% overall to less than 1%



# RIGHTTRAC – Current Work


- Gun Propellant
  - 4 candidates studied for performance
    - "Green" M1 propellant
      (DNT, DBP and DPA free)
      ***Green compliance** = **High;** **IM compliance** = **Low***
    - Modified triple base propellant
      ***Green compliance** = **High;** **IM compliance** = **High***
    - Modified HELOVA
      (HMX-based propellant with ETPE (Energetic ThermoPlastic Elastomer) and energetic plasticizer)
      ***Green compliance** = **Medium;** **IM compliance** = **Very High***
    - Propellant combining nitrocellulose and ETPE
      ***Green compliance** = **High;** **IM compliance** = **Very High***

# RIGHTTRAC – Current Work

Performance of the gun propellants

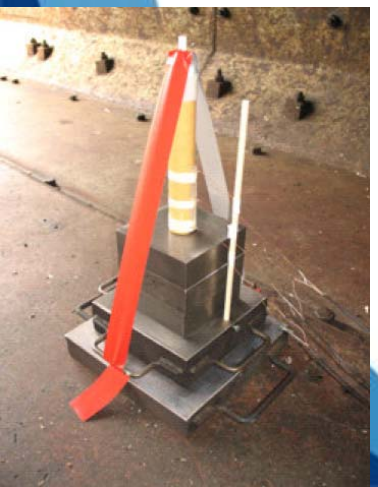
| | Relative Force |
|---|---|
| Current M1 gun propellant | 100 |
| “Green” M1 propellant (DNT, DBP and DPA free) | 112 |
| Modified triple-base propellant | 109 |
| Modified HELOVA (HMX-based propellant with ETPE) | 138 |
| Propellant combining nitrocellulose and ETPE | 81 |

# RIGHTTRAC – Current Work

- Explosive charge
  - Option 1. Green/IM Explosive (GIM)
    - Mix of melt-cast explosives with an Energetic Thermoplastic Elastomer (ETPE) patented by DRDC Valcartier
      - TNT/HMX/ETPE
    - Conventional melt-cast apparatus can be used without modifications
    - Recyclable products for remilitarization

  - Option 2. Plastic-Bonded Explosive (HMX-based)
    - High mechanical strength, good explosive properties, excellent chemical stability, insensitivity

# RIGHTTRAC – Current Work

Performance of the explosives

| | Comp. B | GIM (TNT/HMX/ETPE) | PBX (HMX/HTPB/DOA) |
|---|---|---|---|
| Density (g/cm3) | 1.69 | 1.69 | 1.62 |
| VoD (m/s) | 7885 | 7708 | 8197 |
| $P_{CJ} = ¼ \rho D^2$ (GPa) | 26.3 | 25.1 | 27.2 |
| Plate dent (cm) | 0.782 | 0.799 | - |

# RIGHTTRAC – Current Work

- NOL Large Scale Gap Test
  - Comp. B 216 cards
  - GIM (TNT/HMX/ETPE) 182-184 cards

- DREV Gap Test
  - Comp. B 1.14 cm
  - PBX (HMX/HTPB/DOA) 0.79 cm

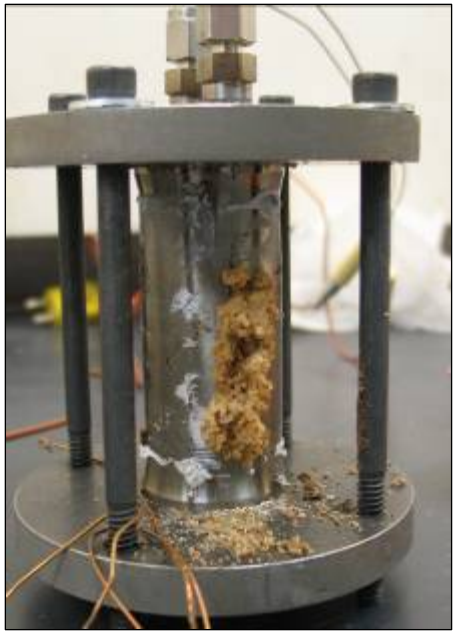
# RIGHTTRAC – IM Tests

- Bullet Impact on 105mm M1 projectiles
  - GIM (TNT/HMX/ETPE)
    - Burning and No reaction
  - PBX (HMX/HTPB/DOA)
    - Burning reaction



# RIGHTTRAC – Small-Scale IM Tests

- Variable Confinement Cook-off Test (VCCT)
  - GIM (TNT/HMX/ETPE)
    - Deflagration and overpressure reactions
    - 183 °C
  - PBX (HMX/HTPB/DOA)
    - Overpressure
    - 203-207 °C



# RIGHTTRAC – Current Work

## Toxicity studies (BRI-NRC)

- Formulations under study: GIM, PBX, gun propellants (2), reference formulations (M1 propellant and Comp B)
- Solubility and dissolution kinetics
- Abiotic degradability in water and in soil
- Transformation of DPA and NQ
- Transport in batch soil assays and in soil columns
- Ecotoxicity assays
  - Effects of the above munitions formulations, their individual components and the reference compounds in soil and sediment
- Bioavailability
  - For selected soil organisms receptors using chemical (extracts), toxicological (toxicity tests) in different soil conditions

# Conclusions

- We are trying to demonstrate that green and IM munitions have better properties
- We are trying to ease the environmental pressures on the Canadian Forces ranges and training areas
- Our demonstrator is an artillery 105-mm round
- We are working on:
  - the fuze (to reach a near-zero dud rate)
  - the gun propellant (to eliminate potentially toxic components and incorporate IM ingredients)
  - the explosive (to replace RDX – move to HMX, add a binder to reduce bioavailability and make it IM)
- Not many projects integrate both IM and green characteristics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