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Explosives Ordnance Disposal (EOD) of Insensitive Munitions: Challenges and Solutions

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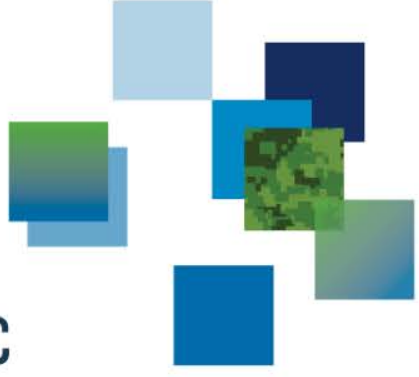

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Outline

- Introduction: The Problem
- Test Method
- Results
- Future Work
- Conclusion

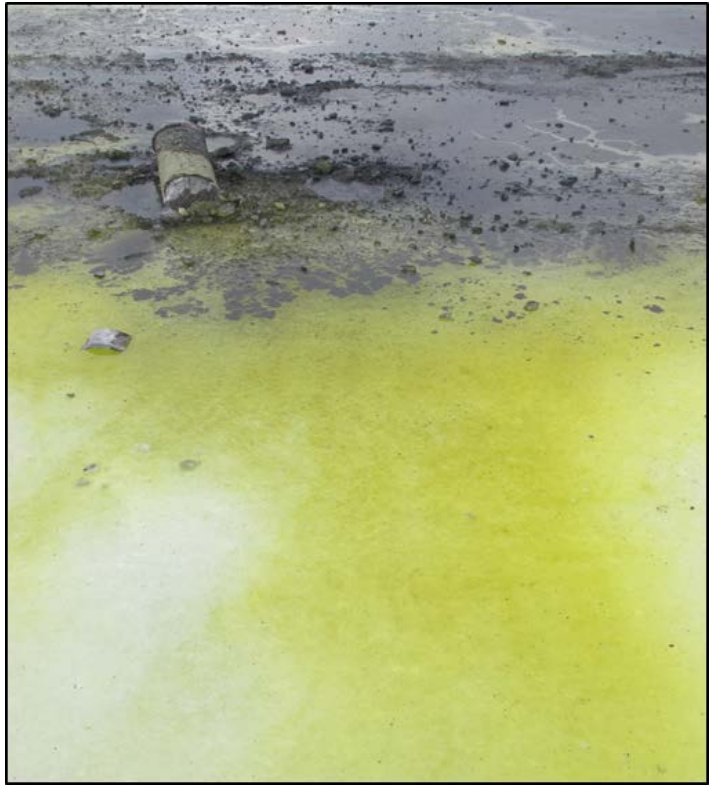
Introduction: The Problem

- Insensitive Munitions were developed to resist external stimuli
  - Such as shock
- Most munitions have a dud rate
  - They require destruction on military training ranges during training
- Traditional methods use plastic explosives on the side of the round
  - Applying shock

- Insensitive Munitions will be more difficult to destroy
  - Obtain partial detonations
  - Material spread on the training ranges

- We want to avoid contamination of the ranges

Introduction: The Problem



We observed that:
Amount of explosives spread ∝ Insensitiveness

We need new EOD methods for IM !

Test Method

- Test EOD methods coupled with Deposition Rate tests
- Tests on snow
- Collect the snow and analyze the residues

Test Method

Test Method

- Army warhead
- Large calibre
  - Generic for this study
  - Method applicable to mortars, artillery and other ammo
- Explosive contains
  - NTO
  - DNAN
  - Nitramine
- The residues post-detonation were analysed for those products

Test Method

- Two parameters defined
  - Deposition rate (of each energetic material)

$$DR\ (\%)\ =\ \frac{Mass\ of\ ingredient\ deposited}{Initial\ mass\ of\ ingredient}\ \text{x}\ 100\%$$

  - Detonation efficiency

$$DE(\%) = 100\ -\ \left(\frac{Mass\ of\ products\ deposited}{Total\ mass\ of\ products}\ \text{x}\ 100\right)$$

Test Method

- We tested different EOD methods
  - Plastic explosives on the side of the round (different configurations)
  - Shaped charges aimed at the side of the round
  - Shaped charges aimed at the booster
  - Shaped charges aimed at the back of the round
- We like shaped charges for EOD
  - Previous project
  - Good results with conventional rounds and small shaped charges
  - Poor results in the past with IM and small shaped charges
  - “There is always a shaped charge large enough”

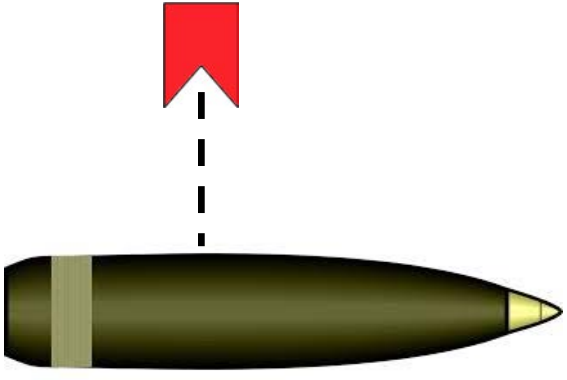
Results

- First tests are normal functioning rounds, in static
  - Our IM round
    - Detonation efficiency = 99.999%
    - Compares well with Composition B in mortar and artillery rounds (literature)
- EOD Method 1: Using plastic explosives
  - 3 different methods
  - All looked full-order
  - The results are lower than EOD of Comp. B filled rounds (60-mm and 81-mm)
    - DE = 99.93% and 99.998%

DE = 72%, 83%, and 97%

Results

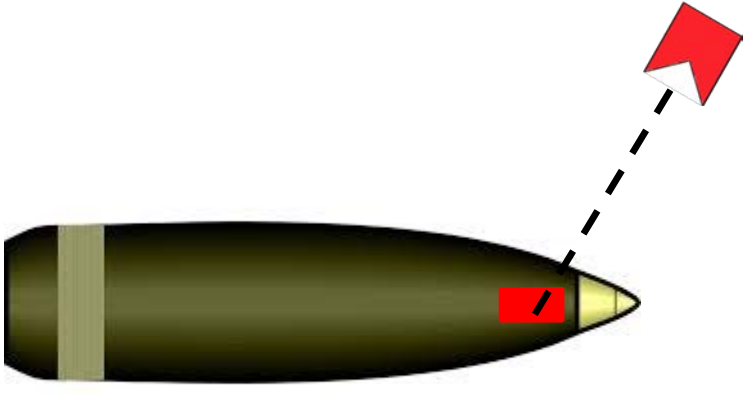
- EOD Method 2: Medium (67-mm) commercial shaped charge on the side
  - Interesting detonation efficiency



DE = 94%

Results

- EOD Method 3: Small (33-mm) and Medium (67-mm) commercial shaped charges aimed at the booster
  - Small shaped charge better than medium shaped charge
    - More precise?



DE = 99.1%, 40.5%

Results

- EOD Method 4: Medium (67-mm) commercial and large (84-mm) military shaped charges aimed at the back of the round
  - Medium shaped charge also gives bad results
  - Large shaped charge performs exceptionally well
    - As good as the EOD of Comp. B

DE = 74.3%, 99.8%

Results

- EOD Method 4: Large (84-mm) military shaped charges aimed at the back of the round
  - Tests repeated
  - Even better results

DE = 99.999%

Results

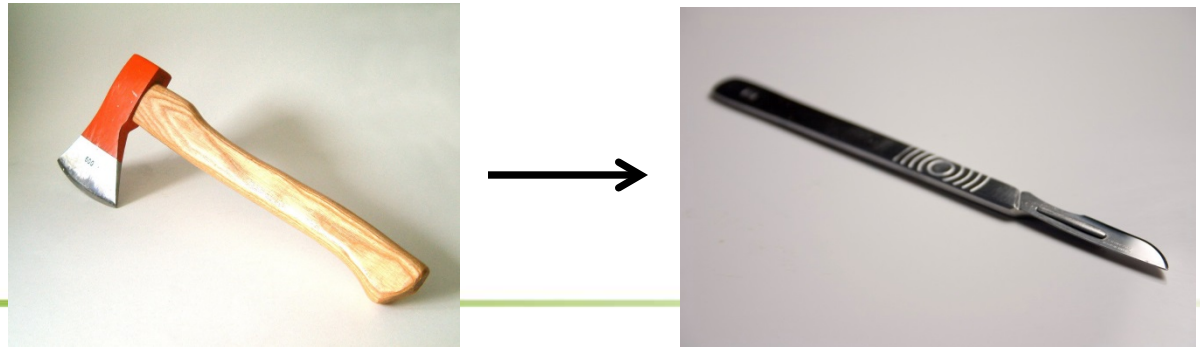
- NTO often gave higher deposition rates than DNAN
  - Counter-intuitive
  - NTO is a good IM ingredient
- NTO results are often variable in those tests on snow
  - High water solubility
  - Disappearance in snow

Future Work

- Alternative EOD methods being tested
  - Shaped charge tailored for EOD operations
  - Cutting charges for very insensitive explosives
  - Thermites to initiate a burning reaction
    - Burning may be cleaner
  - Modifications to the IM formulations to optimize the detonation efficiency
  - High-power lasers

Conclusions

- EOD methods of IM with plastic explosives can be deceiving
  - Low detonation efficiencies
- EOD methods with shaped charges gave variable results
  - On the side, good results
  - At the booster, promising results
  - At the back, some great results with a large shaped charge
- New EOD methods are being tested
- EOD operators may have to be more knowledgeable

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