GENERAL DYNAMICS
Ordnance and Tactical Systems–Canada

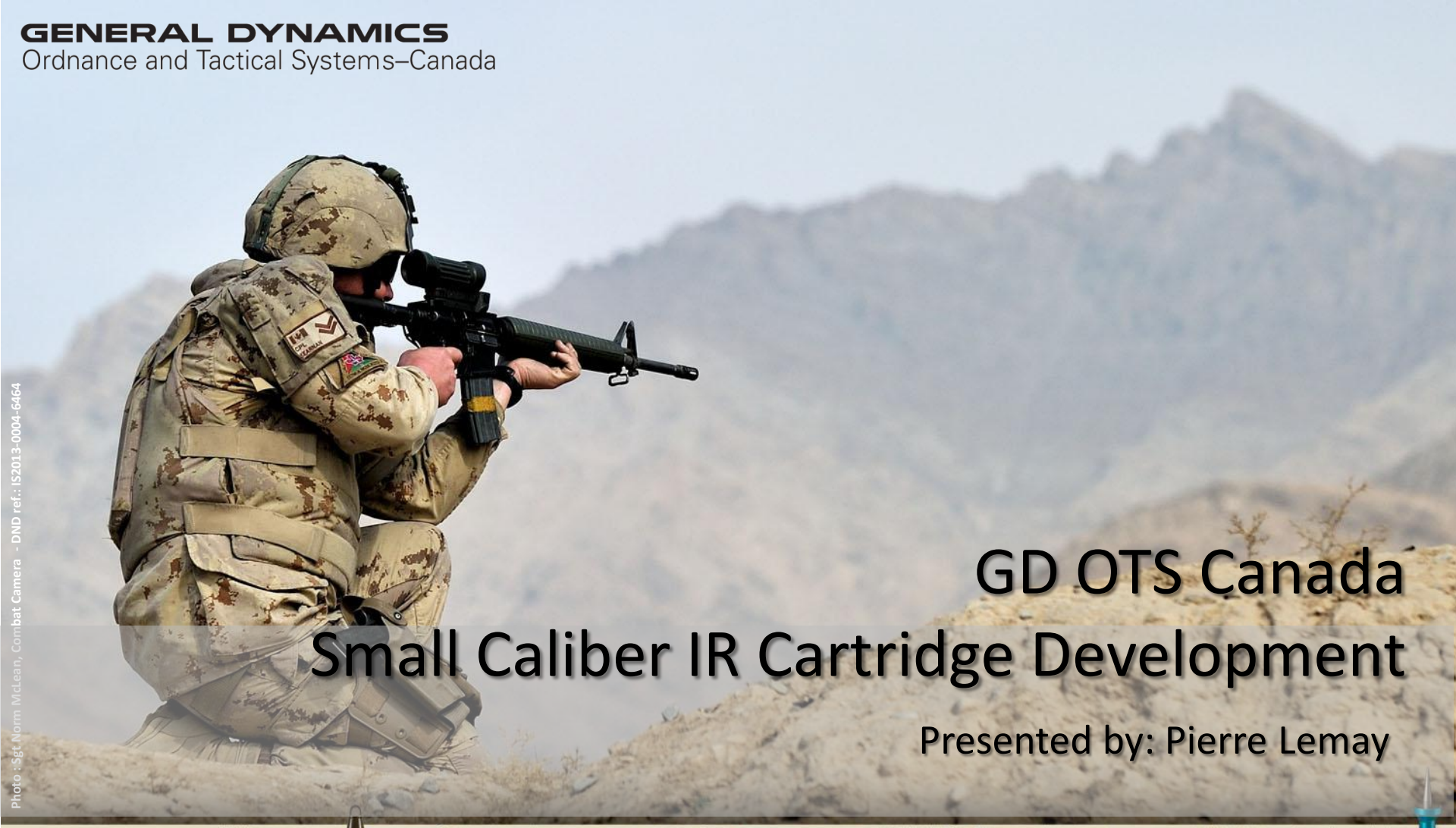

Photo : Sgt Norm McLean, Combat Camera - DND ref.: IS2013-0004-6464

GD OTS Canada
Small Caliber IR Cartridge Development

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Prepared by:
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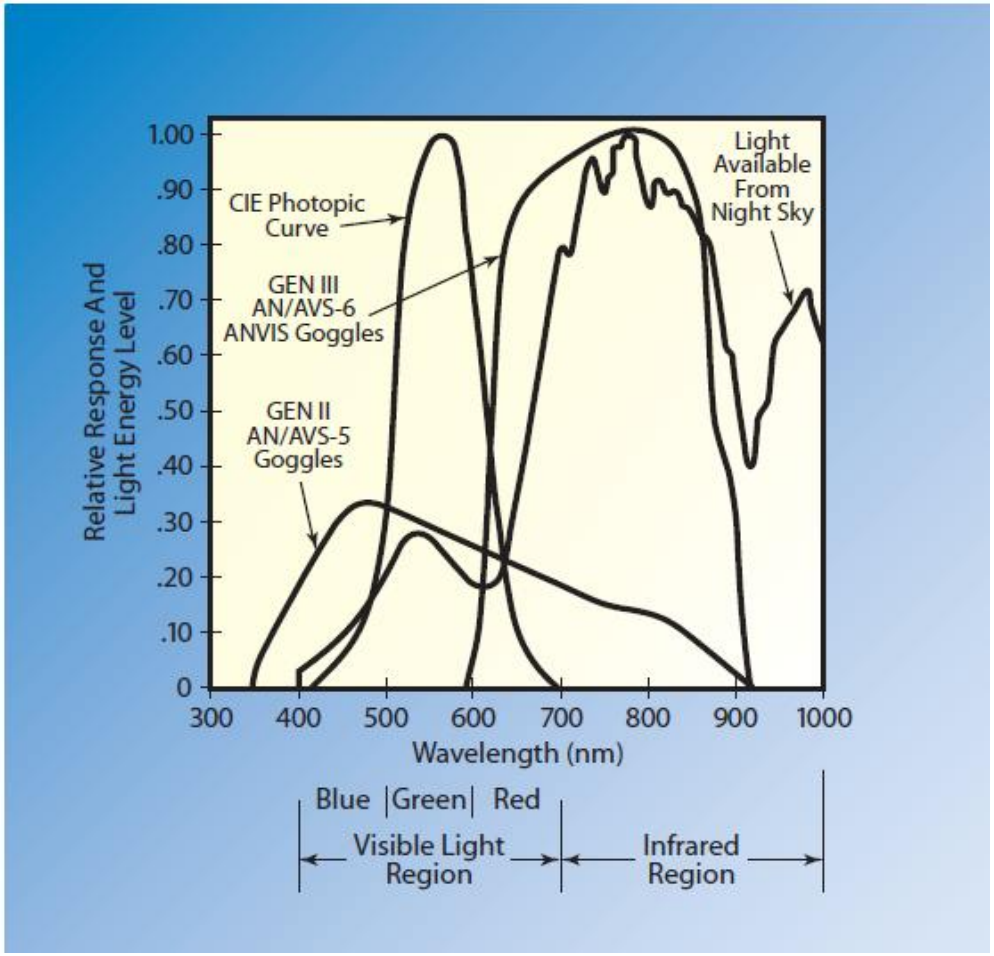
NDIA May 2014

Outline

- Project Objectives
- Development Methodology
- Design of Experiment (DOE)
- Spectrum Analysis
- Live Fire Test Results
- Flame Temperature
- High Rate Production Process
- Conclusion

Project Objectives

- Develop a family of small caliber infrared (IR) cartridges in 5.56mm, 7.62mm and 12.7mm calibers.
- Develop tracer and igniter compositions visible predominantly through Gen II NVG (Night Vision Goggles).



Source: Gamma Scientific www.gamma-sci.com

Project Objectives

- Define, for each caliber:
  - Design parameters
  - Process parameters
- Use same projectile jacket and cores of visual tracers
- Use same machinery and tooling as visual tracers
- Meet NATO standard trace distances and testing protocols, but in IR.
- Use GD OTS Canada patented IR Tracer Mix.

IR Tracer Patent

Non-toxic boron-containing IR tracer compositions and IR tracer projectiles containing the same for generating a dim visibility IR trace

US 8066833 B2

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Type of publication	Granting
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Inventors	Louise Guindon , Carol Jalbert , Daniel Lepage
Original Assignee	General Dynamics Ordnance And Tactical Systems-Canada Inc.
Export citation	BiBTeX , EndNote , RefMan

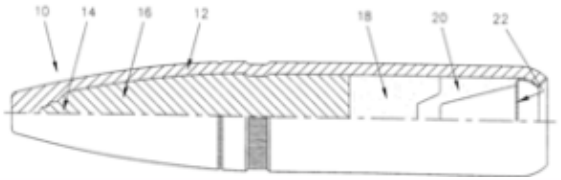
Patent citations (4) Classifications (18) Legal Events (1)

External Links: USPTO , USPTO Assignment , Espacenet

SUMMARY

A novel non-toxic IR tracer composition is provided herein which, when incorporated into an IR tracer projectile which is then fired, generates a dim visibility IR trace. Such IR tracer composition is a non-toxic, boron-containing, IR tracer composition comprising: from about 20 to about 30% by weight, or from about 45 to about 60% by weight, of potassium perchlorate; from about 5 to about 16% by weight of a metallic fuel which consists of boron; from about 20 to about 25% by weight, or from about 40 to about 50% by weight, of a non-metallic fuel which consists of sodium salicylate; from about 5 to about 10% by weight of a retardant which consists either of iron carbonate or magnesium carbonate; and an effective amount of binder, wherein the total percentage of such ingredients add up to 100%. A novel IR tracer projectile containing such IR tracer composition for generating a dim visibility IR trace is also provided.

IMAGES (2)



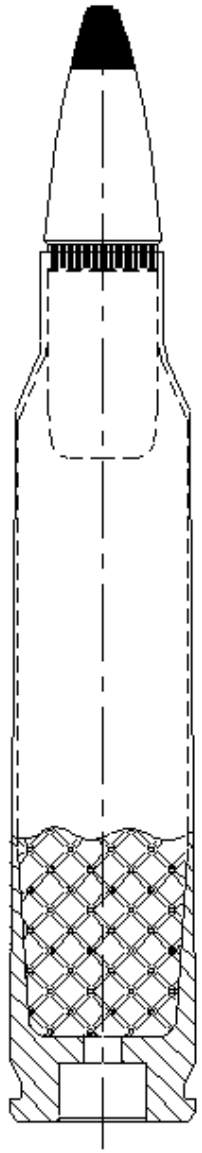
Development Methodology

Using « Lean Design for Six Sigma » methodology:

1. Preselection of formulation
2. Characterisation of ingredients/formulation:
   - Particle size distribution
   - Heat of combustion
   - Sensitivity to friction and static
3. Combined Design of Experiment (DOE):
   - Ingredients
   - Process parameters
4. Static firing & Spectrum Analysis
5. Long Range, Live Fire Testing
6. High Rate Production Testing

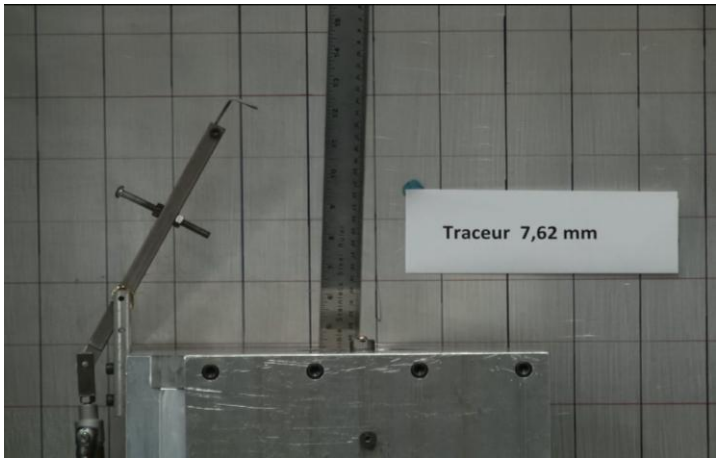
Design Of Experiment (DOE)

- 20 formulations
- 16 projectile assembly process parameters
- 320 Static test series:
  - Spectrum analysis
    - Light Intensity
    - Wavelength distribution
  - Burning duration
- Downselect to:
  - 4 original formulations
  - 2 optimized formulations, based on DOE Model
- Long range live fire night testing
- Choice of optimal formulation



Spectrum Analysis – Lab Setup

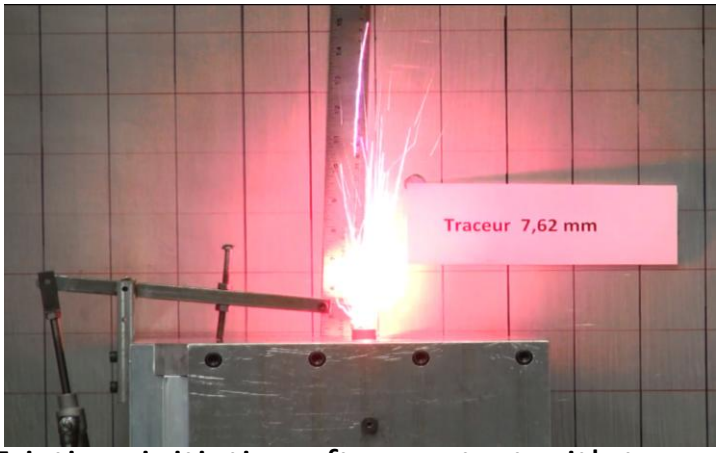
- Tracer mix placed on high speed router shaft
- Initiation of trace through friction between rotating igniter pellet and steel nail upon contact
- Spectrum recorded through Spectrophotometer



Friction initiation device, before contact

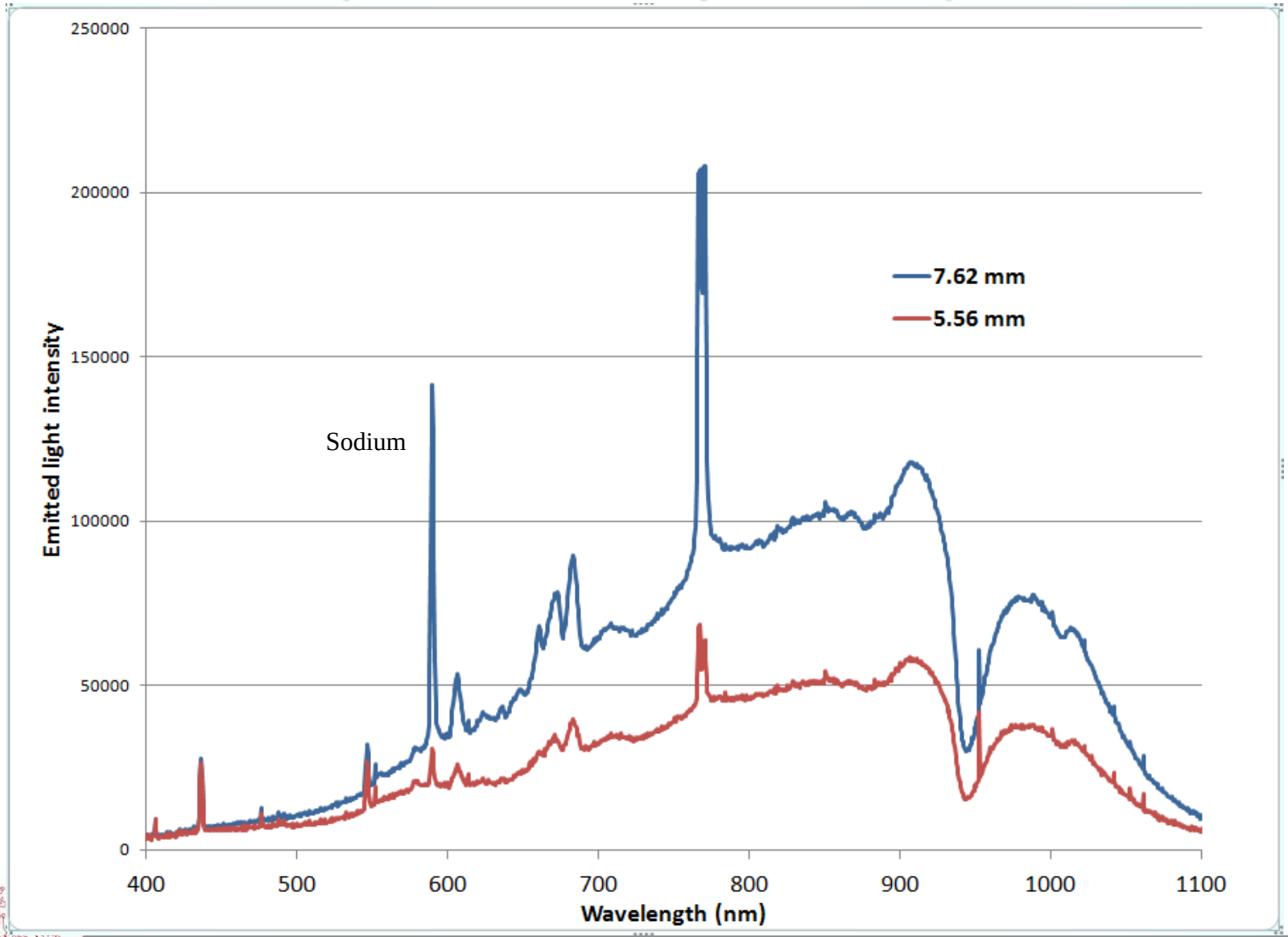
Tracer Lighting Aparatus.mpg

Spectrophotometer



Friction initiation after contact with tracer

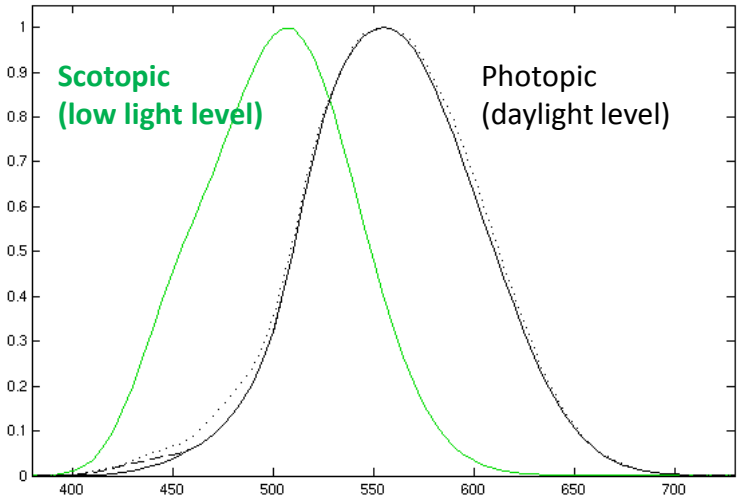
Spectrum Analysis Example



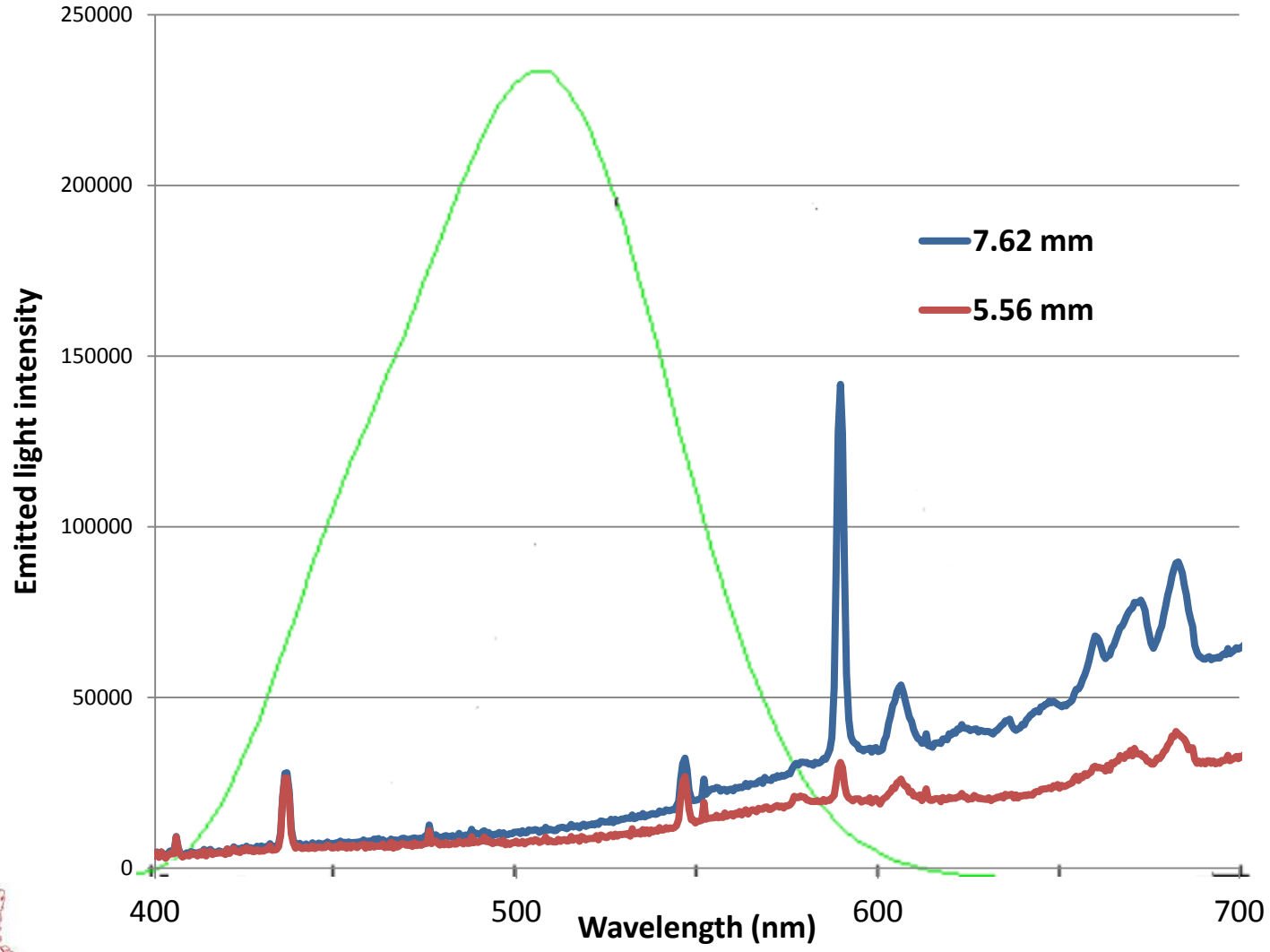
Live Fire Test Results

- Tests done with cartridges conditionned at -52°C, 21°C and +54°C
- Minimum IR Trace distance:
  - 5.56mm: 100% met 600 m objective (average = 650 m)
  - 7.62mm: 100% met 775 m objective (average >1,000 m)
- IR Trace very bright to side observers through Gen II NVG
  - 95% + visibility all along the path
- IR Trace invisible to naked eye side observer

- IR Trace faintly visible to naked eye from firing position because:
  - Low light level eye response shifted to shorter wavelenghts at night (scotopic vision) due to rod receptors
  - IR trace spectrum indicates some low light emissions in the 500 nm area



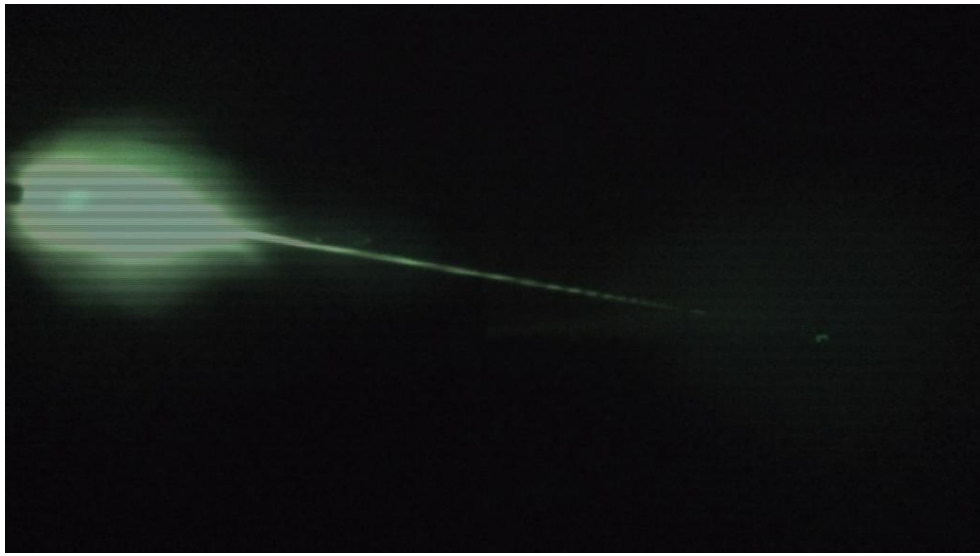
Unaided Night Vision



Live Fire Testing Results

Conventional 12.7 mm Igniter
1/30 s View through Image Intensifier

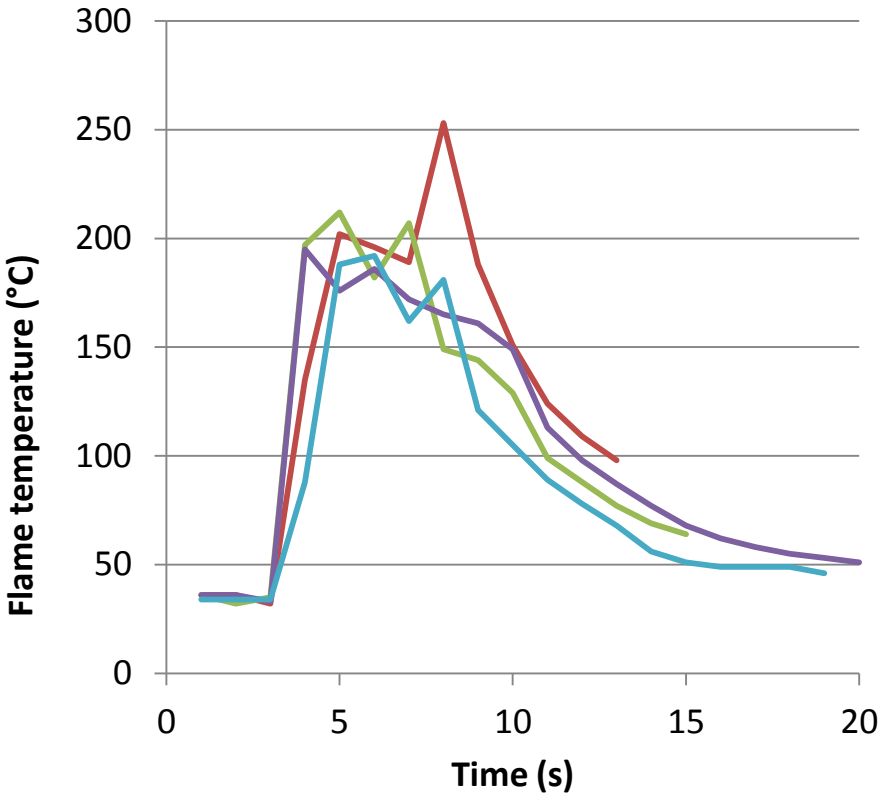
Dim Trace 12.7mm Igniter
1/30 s view through Image Intensifier



Flame Temperature

- Visual tracer measured flame temperatures : >1350 °C
- Maximum measured flame temperature of IR formulation:

  200°C to 250 °C



High Rate Production Process Qualification

- High Rate projectile tracer loading was developped for the Manurhin MCH 240 Tracer Loading equipment.
- Same tooling as for conventional tracer was used.
- Dry ignitor and tracer mix were adjusted to ensure homogeneous flow in hoppers and feeders.

Manurhin MCH 240 tracer loading machine

Conclusion

- Satisfactory 5.56mm and 7.62mm IR Trace formulation, clearly visible with Gen II NVG was developped
- New formulation may be used on conventional tracer loading machinery
- IR trace invisible to enemy combatants on receiving end with or without Gen II NVG
- Final qualification process to be undertaken shortly
- Samples available

Contact Information

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