GENERAL DYNAMICS
Ordnance and Tactical Systems–Canada

Development of Infrared Tracers

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Outline

- Objectives
- Features and Benefits
- Development Steps
- Formulation Selection
- Tracer Composition Process
- Tracer Assembly Process
- Ballistic Performances
- Conclusions

Objectives

- The objectives are the following:
  - Develop a complete family of small caliber infrared (IR) cartridges (main objective) using the ‘’Lean Design for Six Sigma’’ methodology. The selected calibers are 5.56, 7.62, and 12.7 mm.
  - Develop tracer and igniter compositions that are invisible to the naked eye and visible with night vision goggles.
    - Different tracer compositions for each caliber because the trace distance requirement is not the same; the burning rate should be different.
  - Define design and process parameters of the IR tracers for each caliber.
  - Develop IR cartridges meeting NATO standards.

Features and Benefits

- Use the same projectile, jacket, core and propelling system (primer and propellant) as the conventional tracer cartridges.
- Only igniter and tracer compositions are modified.
- Same match and ballistic as conventional cartridges because only pyrotechnic compositions change.
- Reduce small arms firing signature with IR tracers.
- Increase safety by reducing the risk of detection by enemy force.

Development Steps

- Development of tracer compositions (5.56 mm and 7.62 mm):
  - Preliminary development is completed.
    - Gun firing performed in both calibers using different formulations. Formulation was selected and needs to be optimized for each caliber.
  - Advanced development is on-going:
    - Small scale test developed to analyze IR tracers.
    - DOE (Design of Experiment) to optimize tracer formulations and key assembly parameters, and then verify tolerances.
    - Demonstration in an operational environment and at extreme temperatures (-54°C, +52°C).

Development Steps

- Development of tracer compositions (12.7mm):
  - A new tracer composition has to be developed which has not yet however begun but will be completed once development for the other calibers is completed.
- Development of igniter compositions is completed for all 3 calibers.

Formulations Selection

- Ingredient selection based up on purity, hygroscopicity, and grain size.
- Igniter composition:
  - Ignition temperature, heat of combustion, and ability to ignite the tracer composition.
- Tracer composition:
  - Oxidizer:
    - Easiness of ignition and increase intensity in IR region.
  - Fuel:
    - Easiness of ignition and increase intensity in IR region.
  - Binder:
    - Low melting point, humidity barrier, covering ability, and easiness of flow.

Tracer Composition Process

- Investigation performed to determine:
  - Mixing time of every steps
  - Drying time
  - Final granulation
  - Humidity content
- Characterization of tracer composition:
  - Grain size distribution
  - Calorimetric heat
  - Ease of flow
  - Friction sensitivity
  - Light intensity in visible and IR spectrum

Tracer Assembly Process

- Parameters studied:
  - Tracer composition weight
  - Igniter composition weight
  - Consolidation pressure
  - Number of increments
  - Pressure gradient
  - Punch shape
  - Air gap between closing disc and composition
- All of these parameters vary from caliber 5.56 mm, 7.62 mm and 12.7 mm.
- Some parameters had less influence while others will need to be optimized.

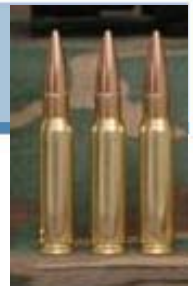
Ballistic Performances

- Performance evaluation during preliminary development
  - Ignition at -54°C, +21°C and at +52°C
  - Trace distance
  - Day and night visibility (naked eye vs night vision goggles)
  - Light intensity at desired wavelength
  - Pulse, projection and other visible defects
- Gun firing performances:
  - First test
    - Standard 90° observation angle
  - Optimization
    - Various observation angles (90°, 45°, 12° and 0°)
    - Modified assembly parameters in 7.62 mm

Ballistic Performances in 5.56 mm

- First test using conventional 90°observation angle:
  - Tracers were invisible to naked eye from gun mouth up to 600m.
  - Tracers were invisible at gun muzzle and ignited at 140m (in IR).
  - Only 20% of the tracers were visible in IR at 600m.
  - Tracers projected ashes.
- Optimization using modified observation angles:
  - Invisible to naked eye except some projections at 550m (37%).
  - Visibility and intensity increase in IR when
    - distance from the shooter increases (140m vs 300m)
    - observation angle is reduced from 90° to 45° to 12° and even behind the shooter.
- Therefore for IR tracers, the best observation point is at 300m with a 12° observation angle.

Ballistic Performances in 7.62 mm



- First test using conventional 90°observation angle:
  - Tracers were invisible to naked eye at 13m.
  - Tracers were invisible at 13m and ignited at 140m (in IR).
  - 32% were slightly visible in the visible band during the trajectory.
  - 94% of the tracers met the trace distance requirement of 775m.
  - Tracers projected ashes.
- Optimization using modified observation angles and assembly parameters:
  - Invisible to naked eye except projections at 550m (94%).
  - Same observations as in 5.56 mm for visibility and intensity in IR.
- Therefore for IR tracers, the best observation point is at 300m with a 12° observation angle.

Ballistic Performances in 12.7 mm

- Feasibility tests results are:
  - Some ignition problems
  - Visible to the naked eyes (igniter and tracer)
  - Excellent trace quality in IR
  - Acceptable trace distance
  - Projections were observed

Conclusions

- 12.7 mm to be developed
- Optimization required for 5,56 and 7,62 mm
- 5.56 mm, 7.62 mm and 12.7 mm infrared tracer cartridges with the following features :
  - Same components as traditional tracer cartridges except igniter and tracer compositions
  - Same ballistic as visible tracer
  - Detection by enemy is reduced
  - Good performance in infrared

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