NDIA Industry Day

August 2008

SBIR Safety and IM Research Area

Heather Simko
Research Area Lead

Agenda

- Topic Area Overview
  - Topic List
- Summary of Topics
- Contact Information
- Questions

Topic Area Overview

- Safety Research Area
  - Insensitive Munitions
    - Topics Are:
      - Development of Fast and Slow Cook-off Mitigation Sensor
  - Hypergolic Propulsion
    - Topics Are:
      - Safety Technologies for Liquid Hypergolic Propulsion Systems
  - Initiation System
    - **Topics Are:**
      - Mil-Std-1901A Compliant In-Line Initiation System for Propulsion Applications

Insensitive Munitions

- **Insensitive Munition**
  - Munitions which reliably fulfill their performance readiness and operational requirements on demand but which minimizes the probability of inadvertent initiation and severity of subsequent collateral damage to weapon platforms, logistic systems and personnel when subjected to unplanned stimuli.

- **DoD Directive 5000.1:**
  - 3.xx Safety. Safety shall be addressed throughout the acquisition process. Safety encompasses human (includes human / System interfaces), toxic / hazardous materials and substance, production / manufacturing testing, facilities, logistical support, weapons and munitions / explosives. **All systems containing energetics shall comply with insensitive munitions criteria.**

- **MIL STD 2105C Hazard Assessment Tests for Non-Nuclear Munitions:**
  - This document contains a description of tests or references to NATO Standardization Agreements (STANAG's) for the assessment of munition safety and insensitive munitions (IM) characteristics of non-nuclear munitions.

- **Types of Reactions Based on MIL-STD-2105C**
  - Type I Detonation
  - Type II Partial Detonation Reaction
  - Type III Explosion Reaction
  - Type IV Deflagration Reaction
  - Type V Burning Reaction

- **IM Tests Based on MIL-STD-2105C**
  - Bullet Impact
  - Fragment Impact
  - Fast Cook Off
  - Slow Cook Off
  - Shaped Charge Jet
  - Sympathetic Detonation

Insensitive Munitions

- Goals
  - DoD Goals
    - Reduce violence of SRMs when exposed to unplanned stimuli such as heat, bullets, fragments and shock
    - The ultimate objective is no reaction or simple burning
  - MDA Goals
    - New IM technology for both land and sea based operations
    - Focused on SRMs that are 12 inches or greater in diameter
    - Keep performance level of SRM or improve it
    - Technology easily adapted to many different SRM systems
  - Partner suggestions
    - Aerojet
    - ATK
    - Service Labs
    - Northrop Grumman
    - Raytheon
    - Boeing
    - Lockheed-Martin

Insensitive Munitions

- Development of Fast & Slow Cook-off Mitigation Sensor

  – Objective:
    - Develop a novel and innovative sensor no more then 2 cubic inches that uses the thermal energy of the fast and slow cook off scenarios to produce an excess of 1 amp/1 watt of power to trigger a MIL-STD squib which would activate a venting system.

  – Notes:
    - Test goes *until* *reaction*
    - STANAGs 4382 and 4240 apply

Insensitive Munitions

- Development of Fast & Slow Cook-off Mitigation Sensor
  - Phase 1:
    - Develop a small sensor that can convert the thermal energy of a cook-off scenario into sufficient energy to trigger a MIL-STD squib or venting device. The venting device should only receive power or be activated by the sensor and only when the sensor has reached 275 degrees F. To have a successful phase one, it must be demonstrated that the sensor will trigger the device under these thermal conditions.
  - Phase 2:
    - Refine the concept to meet the temperature size/volume and power requirements and integrate the sensor unit into a thermally initiated venting system. Demonstrate technology in an actual cook-off environment using an analog motor.

Hypergolic Propulsion

- A two part fuel mixture made up of an oxidizer and a fuel
- Highly toxic and corrosive substances
- Have to meet multiple safety and transportation regulations.

- Commonly used to form hypergolic systems
  - Monomethyl Hydrazine
  - RFNA
  - MON-25
  - Nitrogen tetraoxide

Hypergolic Propulsion

- Safety Technologies for Liquid Hypergolic Propulsion Systems
  - Objective:
    - Develop innovative concepts and products to improve the safety and maintainability of hypergolic propellant based propulsion systems. This includes sensor technology and leak mitigation technologies. The overall goal will be to develop and demonstrate innovative technologies to enable safe storage and employment of liquid hypergolic propulsion system for ballistic missile defense interceptors.
  - Notes:
    - Show a safe system
      - Compliance with Hazard Classification Standards
      - Compliance with IM Standards
    - Will need to eventually gain Navy approval
      - Weapons Systems Explosive Safety Review Board (WSESRB)
    - Work on Hydroxyl Ammonium Nitrate (HAN)
    - Hypergolic replacement technology

Hypergolic Propulsion

- Safety Technologies for Liquid Hypergolic Propulsion Systems

  – Phase 1:
    - Show understanding of the safety problems with different types of hypergolic systems. Propose technology solutions of system approach solution to improve the safety of LHPs. Design and conduct proof-of-principle demonstrations. Prepare paper outlining the safety benefits and improvements of the technology or system.

  – Phase 2:
    - Develop a small-scale LHP system or technology demonstration to show its safety ability, considering Navy Shipboard applications. Conduct hazard classification and insensitive munitions tests ad deemed appropriate . Provide a plan for introducing the proposed LHP system or technology.

Initiation System

- Standards
  - MIL-STD-1901A
    - Propulsion Ignition Systems utilize energy train and pyrotechnic train interruption devices whose reliability is demonstrated through approved statistical and experimental approaches unless:
      - Initiator device can only be initiated with an electrical stimulus of greater then 500 V
      - Energetic material contained in the device is equal to or less sensitive then Boron Potassium Nitrate ($BKNO_3$)
  - MIL-DTL-23659
    - Electrical Cook-off Requirements
  - MIL-STD-1316E
    - Safety Criteria for Fuze Design

Initiation System

- Development of In-line Device
  - Applications
    - Divert and Attitude Control Systems (DACS)
    - Attitude Control Systems (ACS)
    - Multiple pulse solid rocket propulsion systems
  - Problems which need to be solved
    - Potential to induce Electromagnetic Interference (EMI) into adjacent electronics
    - Produce Coronal Discharge effects when fired under vacuum

- Micro-electromechanical systems (MEMs)
  - Reduce the size and weight from 4 inches by 4 inches by 3 inches and 3.7 pounds
  - Reduce parts and cost
  - Develop miniature, highly reliable S&A and A&F device compliant with Mil-Std-1316E and Mil-Std-1901A

Initiation System

- Mil-Std-1901A Compliant In-Line Initiation Systems for Propulsion Applications
  - Objective:
    - Develop in-line initiation systems for propulsion applications that are fully compliant to all provisions of Mil-Std-1901A and Mil-DTL-23659

Initiation System

- Mil-Std-1901A Compliant In-Line Initiation Systems for Propulsion Applications
  - Phase 1:
    - Conduct studies and component demonstrations necessary to demonstrate that the selected concept can meet full requirements of Mil-Std-1901A and the topic guidelines.
  - Phase 2:
    - Demonstrate the feasibility and engineering scale-up of a fully compliant ignition system. Demonstrations shall include firing components and prototype ignition systems under representative operating conditions and with a program representative igniter. Additionally key critical safety tests as outlined in Mil-Std-1901A and Mil-Dtl-23659.

Point of Contact Information

- Development of Fast and Slow Cook-off Mitigation Sensor
  - Richard Campbell

- Safety Technologies for Liquid Hypergolic Propulsion Systems
  - Greg Stottlemyer

- Mil-Std-1901A Compliant In-Line Initiation Systems for Propulsion Applications
  - John Barkman

Point of Contact Information

- Heather Simko
  - Research Area Lead and Topic Author
  - Phone:
    - 703-882-6254
  - E-mail:
    - Heather.Simko@mda.mil

Questions