



IM Compliance for Mortar Illumination Cartridges



Thomas Peter

Jeffrey Smith, Samuel Perez, Joseph Rando, Eli Martinez, Frank Rizzi and Mary Baird, US Army Research, Development and Engineering Command - Armaments Research, Development and Engineering Center, Sal Ghazi & Jason Surmanek - US Army Office of the Project Manager, Combat Ammunition Systems, and John Niles, OGL Enterprises LLC

**Armaments, Research, Development and Engineering Center
US Army Research, Development and Engineering Command**

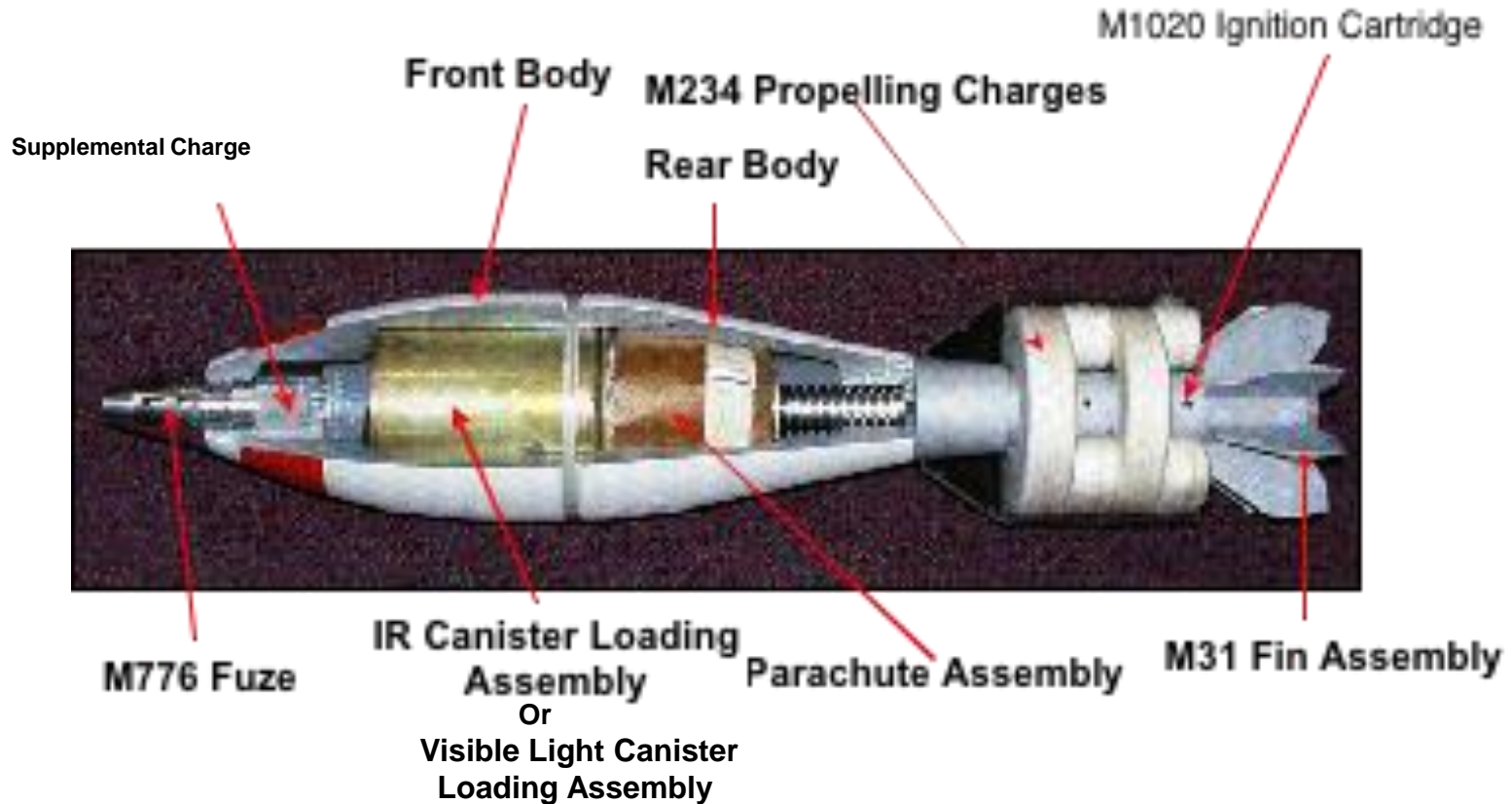


Acronym/Abbreviation Description

- IM: Insensitive Munition
- AIMB: Army Insensitive Munitions Board
- SD: Sympathetic Detonation
- SCJI: Shaped Charge Jet Impact
- FCO: Fast Cook off
- SCO: slow Cook off
- BI: Bullet Impact
- FI: Fragment Impact

M930/M983

Internal Configuration



- Item contains very significant amounts of energetics in candle and fuze
- For proper function, the munition pressurizes internally
- Pressurization issue complicates IM mitigation

M930/M983 Current Packaging Configuration



- Individual munition is packed in PA 167 fiber tube
- Two cartridges are packed in PA 154 metal can

Threat Hazards Assessment

IM Test	Configuration	Threat Stimuli	Comments
Fast Cook off	Pallet	Liquid Fuel Fire	1472 Deg F 20 minutes
Slow Cook off	Pallet	Heat	6 Deg F per hour after preconditioning
Bullet Impact	Pallet	12.7 mm (50 caliber)	Two tests; three shots per test
Fragment Impact	Pallet	Army fragment	8300 +/-300 fps
Sympathetic Detonation	Pallet	M930/M983 donor	Assessed to pass
Shaped Charge Jet Impact	Pallet	PG-7 series warhead	Assessed to pass

- Army IM Board requested data to confirm assessments
- Most practical way to obtain such data was to perform SCJI
- SCJI was conducted and received a passing score, confirming SD assessment

Test Configuration

Munition Configuration	Threat Rationale	Damage Summary	Most Credible Threat Configuration
Individual Munition (Operational)	Small target opportunity	Limited collateral effects	No
Palletized Munition (Logistical)	Large target opportunity	Significant collateral effects	Yes

- Joint IM Test Criteria specify testing in logistical and operational configuration
- Joint Criteria allows tailoring of configuration with supporting rationale
- For this munition, logistical is the most credible threat configuration

Baseline Test

Liquid Fuel Fire (Fast Cook off – FCO)



Test Setup



Tail Section at 339 feet



Ignition Cartridge Base at 248 feet

- Reaction was very violent and propulsive in nature
- Fragments of test munition were thrown almost 340 feet

Baseline Tests

Slow Cook off (SCO)



Test Setup



Piece of Tail Boom at 79 feet

- Reaction was violent and propulsive in nature
- Fragments of test munition were thrown almost 80 feet

Baseline Tests

Bullet Impact



Test Setup



Section of Nose at 55 feet



Projectile Remnant at 70 feet

- Reaction was violent and propulsive in nature
- Fragments of test munition were thrown 70 feet

Baseline Tests

Fragment Impact



Test Setup

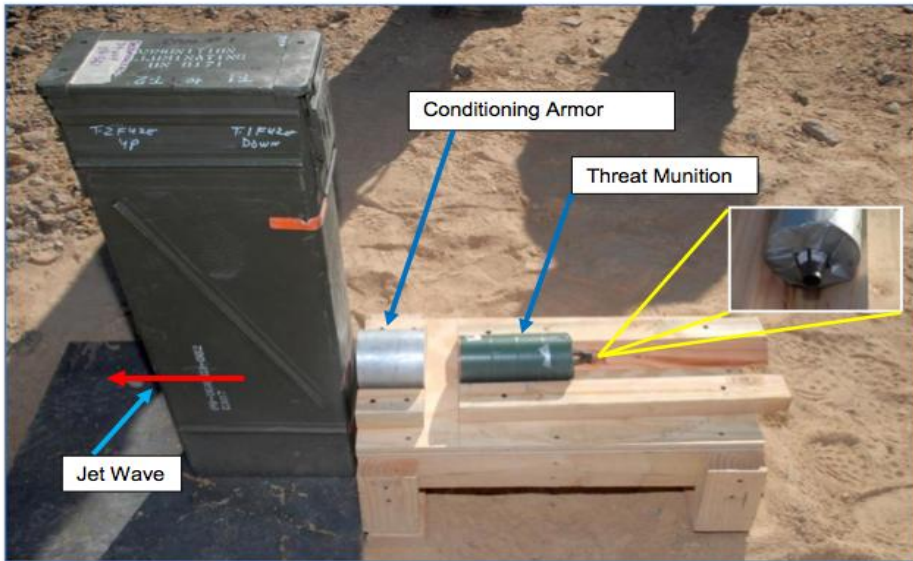


Test Results

- Reaction was very mild
- Debris was constrained to no greater than 20 feet from target munition
- Adjacent munition was virtually intact (see left side of results)

Baseline Tests

Shaped Charge Jet Impact



- Test items were destroyed by SCJ warhead
- Results obtained by pressure gage readings
- Readings confirmed virtually no contribution of target munition energetics

Baseline Test Results

IPT Scores

IM Test Result Summary for M930/M983 120mm Illumination Cartridges						
Test Configuration	FCO	SCO	BI	FI	SD	SCJI
Aim point warhead	IV	IV	IV	V	Pass*	Pass
Aim point expulsion charge	IV	IV	IV	V	Pass*	Pass
Full-up Round-logistical	IV	IV	IV	V	Pass*	Pass

- SD “Pass” is by assessment made upon analysis of characteristics of main charge fill and was later confirmed when SCJI passed
- Army IMB score is slightly different in presentation
- Difference in score presentation does not affect mitigation plan

M930/M983 IM Mitigation Plan

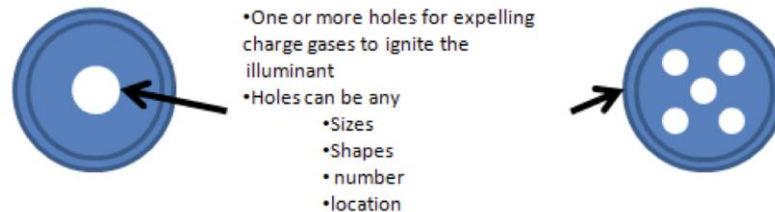
- Engineered materials (EM) for shear pins
 - Materials weaken under thermal stress
 - Effect allows front and rear bodies to separate and vent
- Blocking foams for thermal threats
 - Prevents or delays ignition from fuze to candle
 - Located in front body cavity
 - Used in conjunction with EM shear pins or vents
 - Foam reacts at a set temperature range
- Vents for thermal threats
 - Fuze well
 - Front body
 - Ignition cartridge
- Barriers for Bullet Impact

Engineered Materials

- Engineered materials (EM) for shear pins
 - Match strength of current pin (mild steel) at operational temperatures
 - Weaken reliably at a specific, elevated temperature range prior to initiation of internal energetics
 - Would allow for orderly separation of front and aft bodies, providing a large vent
- Engineered material may be applied to fuze or body vents if success
- EM shear pins may be used alone, or in combination with other mitigation techniques

Blocking Foams

- Foams are used industrially in rubbers and plastics at large scale for various purposes
- Two basic types-endergonic and exothermic
- Plan is to identify several candidates that reliably expand at a a specific, elevated temperature range prior to initiation of internal energetics
- Concept is to delay or prevent ignition from fuze to candle until internal pressure separates front and aft bodies or vents function
- Foam can be molded into almost any shape and is rubbery and flexible until reacted



Vents

- Fuze well vent design leverages prior IM technology developed for 60mm HE cartridge IM effort
- Fuze front body vent allows more flexibility in positioning
- Pressurization issue greatly complicates vent design, requiring sufficient strength to allow normal functioning
- May require an EM solution

Conclusion

- Illumination cartridges provide a challenge for IM compliance
- Such munitions respond poorly under thermal and some impact threats
- Mitigation solutions may require a combination of traditional and novel approaches
 - IPT is in the process of down selecting the technologies /design for future work
 - Expected to have a revised "go forward plan" within few weeks based on all test data already collected or being collected.
- Latest Activities
 - Four types of "Proof of Concept Tests" were performed at Yuma Proving Ground at the end of July, 2011
 - Data being analyzed by the IPT for potential down selection of technologies