“MINOR CALIBER INSENSITIVE MUNITIONS REACTION MITIGATION IMPLEMENTATION”

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US NATIONAL DEFENSE INDUSTRIAL ASSOCIATION (NDIA)
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Outline

- Program Background
- Test Item Description
- Test Results
  - Fragment Impact
  - Multiple Bullet Impact (MBI)
  - Slow Cook Off (SCO)
  - Fast Cook-Off (FCO)
  - Shape Charge Jet Impact (SCJI)
  - Stack (Confined and Unconfined)

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Background

- The USMC, Expeditionary Fighting Vehicle (EFV) Program and the USN LPD-17 Program are fielding the 30-MM MK46 gun system.
- NSWCDD conducted USN qualification process for the 30-MM family of ammunition (APFSDS-T, HEI-T+MPLD-T, and TP-T).
- IM Testing identified reactions greater than Type V (burning) for the M592 ammunition can packaging.
- An IM Product Improvement Program (PIP) was initiated in order to mitigate these reactions; funded by PEO IWS-3C/PM4.

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IM PIP Program Map

- Different IM packaging mitigation techniques were investigated by both NSWCDD and NSWC, Crane.
- NSWCDD conducted the testing of these different techniques.
- The insertion of the steel-ceramic ball matrix packaging set demonstrated a reduction in reaction in the fragment impact (FI) test.
- The steel-ceramic ball matrix packaging insert was evaluated against all the MIL-STD-2105C.

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IM Test Results

- Mil-Std-2105 IM Test results during the USN qualification process for the 30-MM family of ammunition (APFSDS-T, HEI-T+MPLD-T, and TP-T)

30mm Ammunition Family							
Item Name	Energetic	FCO	SCO	BI	FI	SJC	SD
1. Armor Piercing Fin Stabilized Discarding Sabot-Tracer (APFSDS-T) 2. HE: Multi-Purpose Low Drag-Tracer (MPLD-T)	1. PC5214-DB PC5280-DB 2. NC1316-DB PC5221-	EXP	EXP	EXP	EXP	EXP	(PASS)
High Explosive Incendiary (HEI) - Tracer (HEI-T)	HC-25-FS-DB RP-1315FS-DB EXPRO WC 895-DB	EXP	EXP	EXP	DET *	DET *	(PASS) *
Target Practice (TP) Tracer (TP-T)	HC-25-FS-DB RP-1315FS-DB NC1316-DB RP-3115DS-DB	EXP	EXP	DEFL	EXP	EXP	(PASS)

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IM PACKAGING MITIGATION FI TEST RESULTS

Test No	Configuration	Notes	Reaction Type
1	Foam Dunnage	Baseline	**Type 1 (Detonation)**
2	Foamcrete	6 Rounds in Can	**Type 1 (Detonation)**
3	1/2 in Ceramic Balls + HH202	6 Rounds in Can w/full compliment of protection	**Type 4 (Deflagration)**
4	Kevlar Type 1 (light green)	6 Rounds in Can w/full compliment of protection	**Type 1 (Detonation)**
5	Kevlar Type 2 (Spectra)	6 Rounds in Can w/full compliment of protection	**Type 1 (Detonation)**
6	1/2 in Ceramic Balls + HH202	Fully loaded container, 30 RDS OF HEI-T/MPLD-T Mix	**Type 3 (Explosion)**
7	Pultruded Glass/Polyester Tubes	6 Rounds in Can w/full compliment of protection	**Type 1 (Detonation)**
8	Filament Wound Glass/Epoxy Tubes	6 Rounds in Can w/full compliment of protection	**Type 1 (Detonation)**
9	HH202 with Polymer Spray	6 Rounds in Can w/full compliment of protection	**Type 1 (Detonation)**

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FI Test Results (1-3)

1	  
2	 
3	  

FI Test Results (4-6)

4			
5			
6			

FI Test Results (7-9)

7		
8		
9		

Test Item

- Linked 30-MM cartridges in a mixed belt configuration in the M592 ammunition container with the shock mitigation insert
- Each belt contains 8 MK 238 Mod 0 HEI-T and 7 MK 264 MPLD-T cartridges
- Cartridges are oriented nose down supported by a polyethylene foam insert
- Shock mitigation is a ½-in ceramic ball matrix + 6K-Vk Polymer + .210-in steel
  - Developed by Dr. Ray Gamache, PATENT PENDING

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MK238 HEI-T & MK264 MPLD-T 30-MM Ammunition

Test	Reaction Type	
	Variant 3 MK 238 HEI-T	Variant 13 MK 264 MPLD-T
Fast Cook Off	Type III (Explosion)	Type III (Explosion)
Slow Cook Off	Type III (Explosion)	Type III (Explosion)
Bullet Impact	Type III (Explosion)	Type III (Explosion)
Fragment Impact	Type I (Detonation)	Type III (Explosion)

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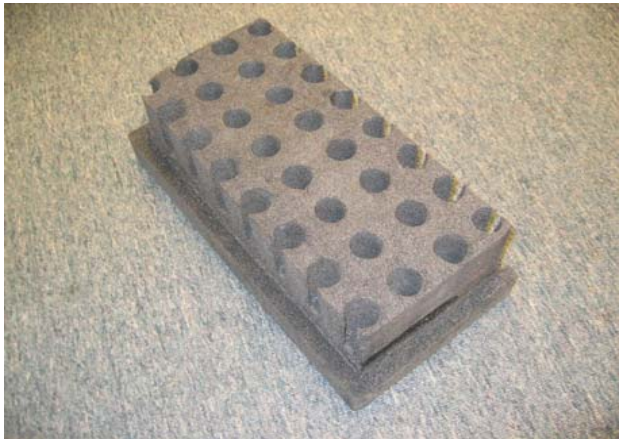
IM Mitigation System
Steel-Ceramic Ball Matrix



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IM Test Performed

- MIL-STD-2105C
- 3 Multiple Bullet Impact
  - 1 aiming at the propellant, 1 aiming at the explosives, 1 aiming at the fuze
- 2 Slow Cook Off
- 1 External Fire
- 2 Sympathetic Detonation
  - (Confined and Unconfined)
- 2 Shape Charge Jet Impact

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MBI Test 1
Aimed at the Propellant

Test Set-up

Test Results

MBI Test 2
Aimed at the Explosives

Test Results

MBI Test 3
Aimed at the Fuze

Test Results

SCO Test 1

Test Set-up

Test Results

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SCO Test 2

Test Results

FCO Test

Test Set-up

Test Results

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Stack Test (Confined)

Test Set-up

Test Results

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Stack Test (Unconfined)

Test Set-up

Test Results

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SCJI Test 1

Test Set-up

Test Results

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SCJI Test 2






Test Results

Conclusions

- NSWCDD and NSWC Crane have successfully mitigated the reaction of the 30mm HEI-T ammunition against the Fragment Impact test (Mil-Std-2105C), by using the steel-ceramic balls matrix mitigation system designed by Dr. Ray Gamache.
- At this moment, the NSWCDD Insensitive Munitions Review Board (IMRB) has not classified the reaction violence for the M592 ammunition container with the Steel-Ceramic Balls Matrix Mitigation System loaded with HEI-T and MPLD-T ammunition tactically configured for the USMC.
- Classification of the reactions is expected to occur during the fall 2007.

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  Project Manager
  NSWCDD, Code G32
- Mr. Lanny Case
  Minor Caliber Ammunition Manager
  PEO IWS3C/PM414
  NSWC Crane
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  NSWCDD, Code G64

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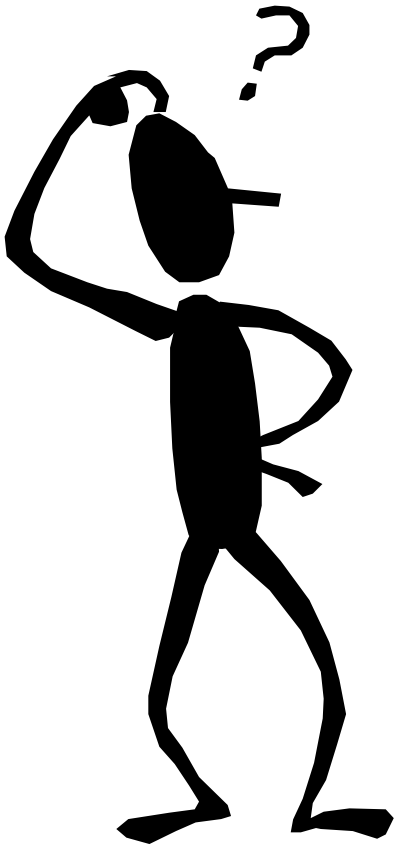
Questions??



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IM Test Results

Test	Reaction Type
Slow Cook-off #1	
Slow Cook-off #2	
Fast Cook-off (External Fire)	
Bullet Impact #1 (aim point-cartridge case)	
Bullet Impact #2 (aim point-explosive)	
Bullet Impact #3 (aim point-fuze)	
Shape Charge Jet Impact #1	
Shape Charge Jet Impact #2	
Sympathetic Detonation (Unconfined)	
Sympathetic Detonation (Confined)	

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