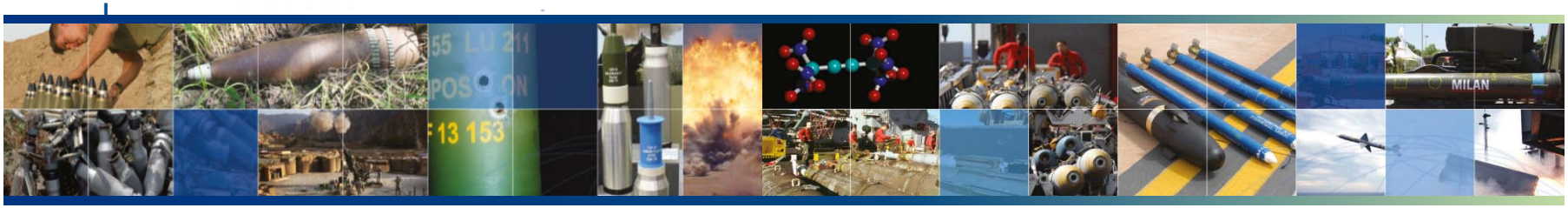
MSIAC

Munitions Safety Information Analysis Center

Supporting Member Nations in the Enhancement of their Munitions Life Cycle Safety



IM State of the Art

2013 INSENSITIVE MUNITIONS & ENERGETIC MATERIALS TECHNOLOGY SYMPOSIUM

8 Oct, 2013
CORONADO BAY, SAN DIEGO, CA

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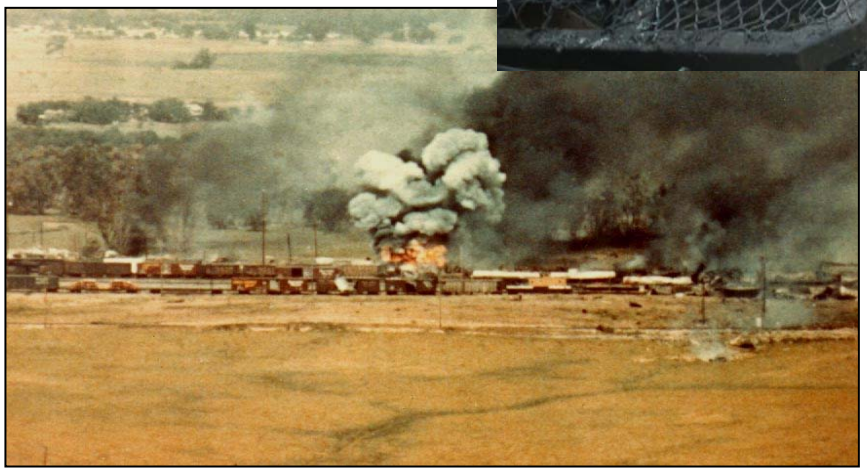
INTRODUCTION

- Presentation will describe IM State of the Art and trends with respect to IM Technology
  - Available to members http://www.msiac.nato.int/
- Changing Nature of Technology, Munitions and Threats

IM SOTA Technology



IM International Success Stories

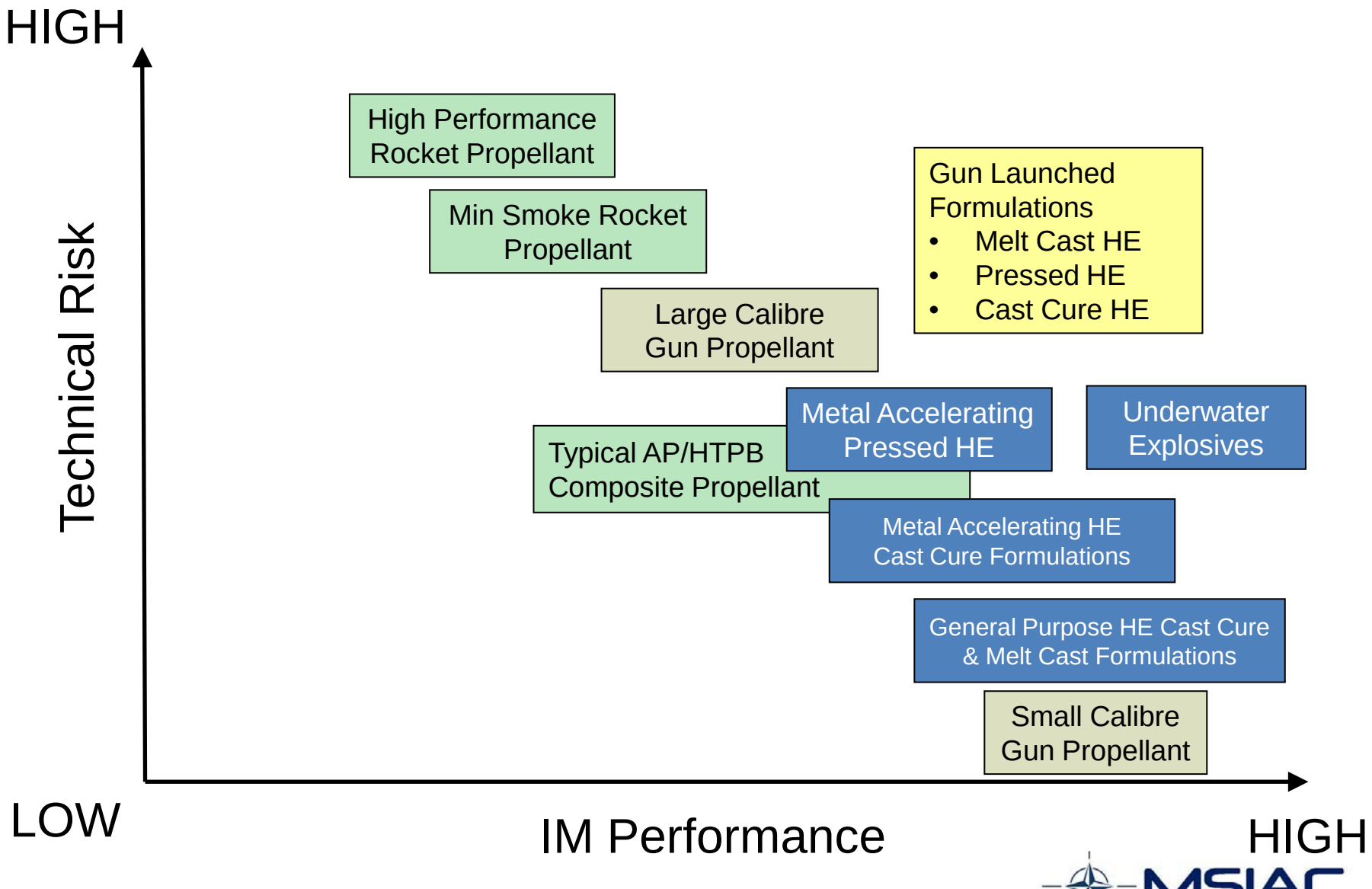
- Many examples of IM compliant / near compliant systems

Misconception – IM means reduced performance

  - IM definition; Munitions which reliably fulfill their performance, readiness and operational requirements on demand
    - There are examples of IM rounds with increased performance against the target set
    - And, there are examples where a reduced performance requirement was deemed acceptable to achieve increased IMness
  - Munitions can significantly impact the survivability of platforms in operational scenarios

MSIAC IM SOTA project captures information on latest munition developments

IM SOTA Trends



IM SOTA Trends

HIG

120mm HE Mortar

60mm MAPAM

Gun Launched Cast Cure Formulations

Gun Launched Melt Cast HE

Gun Launched Pressed HE

Min Smoke Rocket Propellant

Large Calibre Gun Propellant

Metal Accelerating Pressed HE

Underwater Explosives

Metal Accelerating HE Cast Cure Formulations

M0125
105mm

RH30
155mm

LU 211 155mm

M795
155mm

Excalibur 155mm

L

IM Performance

HIGH

Gun Launch Trends

	FCO	SCO	BI	FI	SR	SCJ
PBXN-110	V	V	V *	V *	IV*	
M934A2	IV**	IV**	IV**	IV**	IV***	IV
M0125	IV	IV	V	V	IV	IV
RH30	IV/V	IV/V	IV/V			*
M795	V	V	IV*	V	Pass	IV
LU211-IM	V	V	NR	NR	IV	IV
XM-982	V	III	V	V	III	I

60mm MAPAM

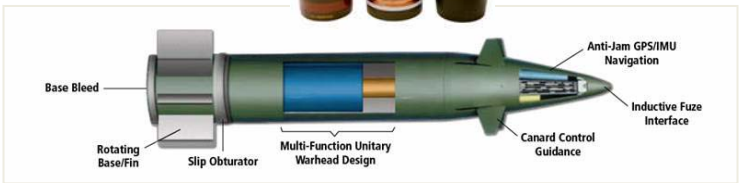
120mm HE Mortar

M0125 105mm

RH30 155mm

M795 155mm

LU 211 155mm



Excalibur 155mm

Changing Nature of Munitions

IM reality

Munition	Donor (D) and Acceptor (A) Charge Features					Mitigation			Test Set up			Results			
Return to Front Page Name	Energetic Material	Composition	External Diameter (mm)	Case Thickness (mm)	Case Material	Mitigation Material	Mitigation Thickness (mm)	ρ (g/cm³)	Distance Donor Skin to Acceptor Skin (mm)	Distance Skin of Donor to Mitigation (mm)	Distance Skin of Acceptor to Mitigation (mm)	Initiation Mechanism	Reaction Type	Configuration	Ref
155 mm Shell	TNT (D) RDX/TNT (A)	(D) 100TNT (A) 50TNT 50RDX	155		Steel	Poly-ethylene	40	-	40			SDT	IV	One on One Buffered	32
155 mm Shell	TNT (D) TNH (A)	(D) 100TNT (A) TNT HNS	155		Steel	Poly-ethylene	40	-	40	0	0	SDT	IV	One on One Buffered	32
155 mm Shell	TNT (D) TT (A)	(D) 100TNT (A) 40TNT 60NTO	155		Steel	Poly-ethylene	40	-	40	0	0	SDT	NR	One on One Buffered	32
155 mm LU-211M	XF-13333	48NTO 31TNT 14Al 7Wax	155	16.4 15 8	Steel	-	-	-	35 35 114			SDT SDT DSDT	IV	One on Many Unbuffered	15
155 mm M107	PAX-196	RDX Wax	155	20 to 23	Steel	Possibly HDPE						SDT DSDT	II	One on Many Buffered	81
155 mm M107	PBXW-108 mod	82RDX 18Wax binder	155	20 to 23	Steel	HDPE	9.53	0.95				SDT DSDT	II	One on Many Buffered	84
155 mm M795 Shell	IMX-101	DNAN NTO Other	155		Steel	-	-	-	29 29 105			DSDT	ND	One on Many Unbuffered	80
155 mm M795 Shell	IMX-102	TNT NTO Chlorinated Wax	155		Steel	-	-	-	29 29 105			DSDT	ND	One on Many Unbuffered	80
155 mm M795 Shell	IMX-103	NQ RDX DETN EDD MeNQ HBNQ	155		Steel	-	-	-	29 29 105			DSDT	ND	One on Many Unbuffered	80
155 mm M795 Shell	PAX-196	RDX Wax	155		Steel	Possibly HDPE			29 29 105	0	0	SDT DSDT	II	One on Many Buffered	81
155 mm XM0121A18 Shell (Assegai)	SPX-1 (Filling) DPX-2 (Sup. charge)	SPX-1 (Pres.) RDX Binder DPX-2 92HMX 2Hytemp 6DOA	155		Steel	Polyethy-lene	#12.7 tube around each shell	0.95	29 29 105	0	0	SDT DSDT	II	One on Many Buffered	82
155 mm XM982 Shell (Excalibur)	PBXN-9	92HMX 2Hytemp 6DOA	155		Steel	Packaging						SDT DSDT	ND	One on Many Buffered	85

Search Results for 155 mm Shells that Pass Sympathetic Reaction Test
(MSIAC Tool SYR v1.2)

Gun Launch Trends

	FCO	SCO	BI	FI	SR	SCJ
PBXN-110	V	V	V *	V *	IV*	
M934A2	IV**	IV**				
M0125	IV	IV				
RH30	IV/V	IV/V				
LU211-IM	V	V				
XM-982	V	III	V	V	III	

60mm MAPAM

120mm HE Mortar

IM Maturity and IM Performance Assessment

- IM rounds are in Service e.g. RH30 deployed with the Dutch in Afghanistan.
- Systems close to IM compliance (some require package mitigation
- Recent experience introducing rounds has led to some issues; in particular gun launch survivability hence higher technical risk.

Excalibur 155mm

IM SOTA Trends

HIGH

Technical Risk

SeaHake DM2A4

Light Weight Torpedo MK-46 Mod 5

Large Calibre Gun Propellant

Gun Launched Cast Cure Formulations

Heavy Weight Torpedo TP2000

Metal Accelerating Pressed HE

Underwater Explosives

Sea Mine 2000

LOW

IM Performance

HIGH

Underwater Explosives

	FCO	SCO	BI	FI	SR
TP-2000	V	V	IV	IV	>III*

	FCO	SCO	BI	FI	SR
FOXIT	V		V		III*

	FCO	SCO	BI	FI	SR
Mk 46 [1]	V	IV	IV	F	>III*

	SeaHake	FCO	SCO	BI	FI	SCJ	SR
DM2A4							
PBXN-111 Warhead		IV	IV	IV	IV	III	I
DM29 Booster		V	V	V	V	I	NR

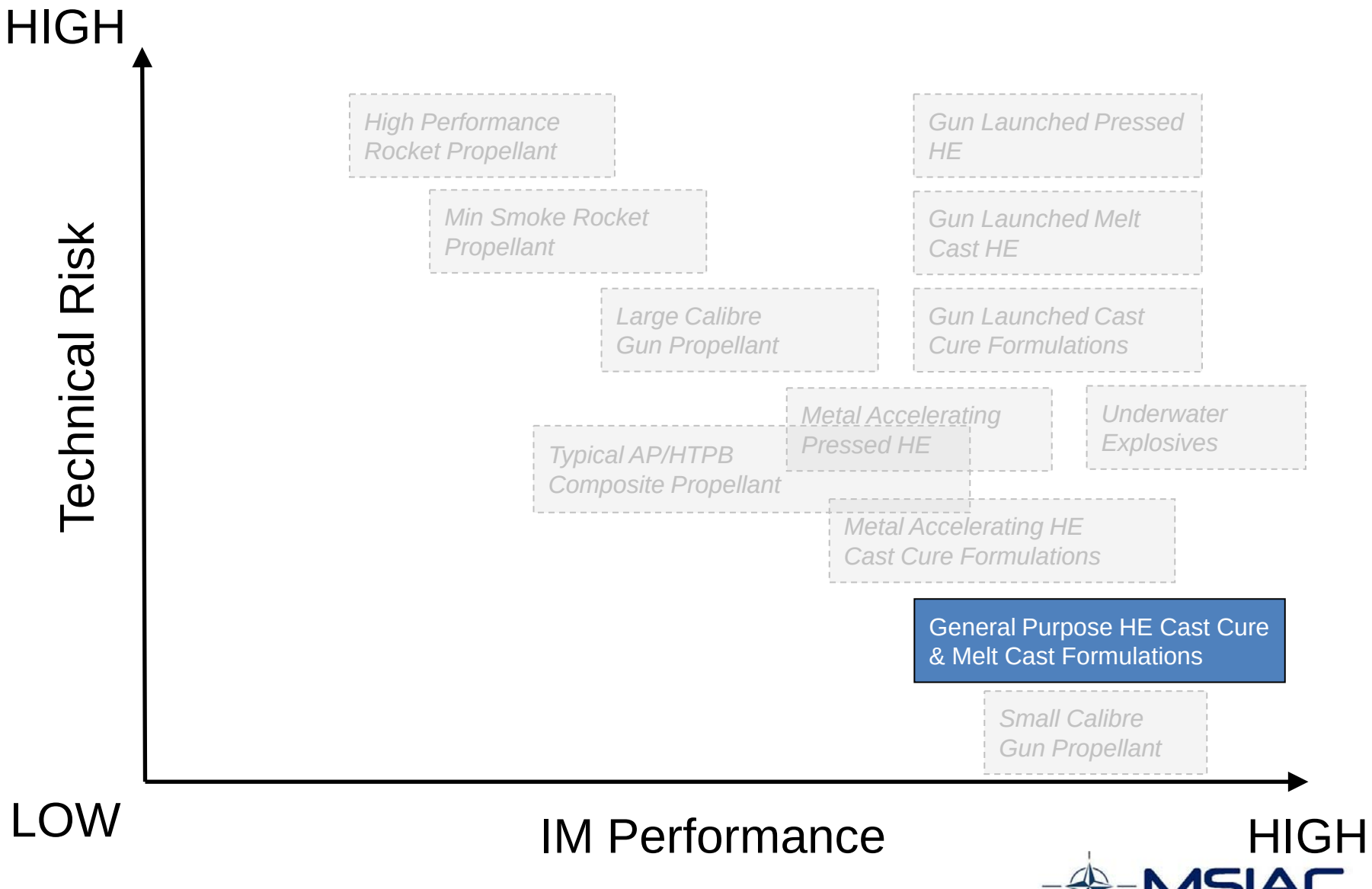
Underwater Explosives

	FCO	SCO	BI	FI	SR
TP-2000	V	V	IV	IV	>III*
FOXIT	V		V		
Mk 46 [1]	V	IV	IV	F	
DM2A4 SeaHake	IV	IV	IV	IV	
PBXN-111 Warhead	V	V	V	V	
DM29 Booster					

IM Maturity and IM Performance Assessment

- TP2000 in service
- Underwater optimised formulations PBXN-111 or B-2211D has excellent IM properties and improved underwater performance
- Mitigation required to pass SR for large warheads

IM SOTA Trends



IM SOTA Trends

HIGH

Technical Risk

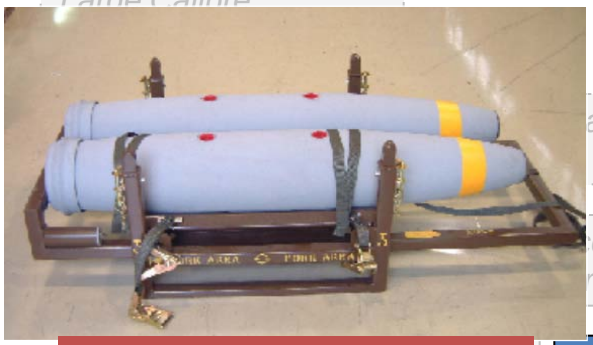
General purpose bomb
BLU-111/B

CBEMS/BANG 250 kg

ormance
ropellant

Large Calibre

Gun Launched Cast Cure Formulations



Precision Guided Bomb
Paveway IV

ating

Underwater Explosives

celerating HE
re Formulations

General Purpose HE
Cast Cure Formulations

LOW

IM Performance

HIGH

General Purpose Bombs

	FCO	SCO	BI	FI	SR
BLU-111C/B	V	IV	V	IV	I*

	FCO	SCO	BI	FI	SR
BLU-117C/B	V	V	III	III	I*

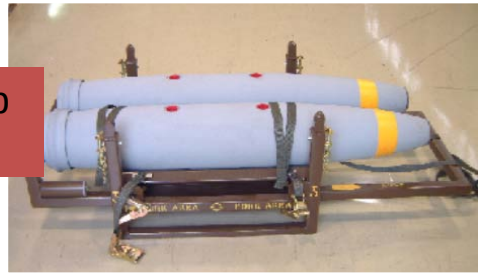
	FCO	SCO	BI	FI	SR
CBEMS/BANG	V		V	V	III

	FCO	SCO	BI	FI	SR
PGB	V	V	V*	V	I*

General purpose bomb
BLU-111C/B

CBEMS/BANG 250 kg

Precision Guided Bomb
Paveway IV



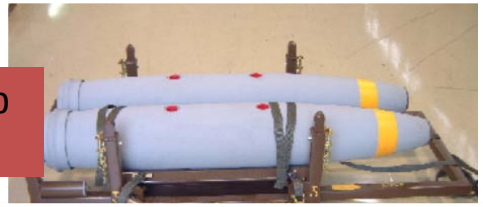
General Purpose Bombs

	FCO	SCO	BI	FI	SR
BLU-111C/B	V	IV	V	IV	I*
BLU-117C/B	V	V	III	III	I*
CBEMS/BANG	V		V	V	III
PGB	V	V	V*	V	I*

General purpose bomb
BLU-111C/B

CBEMS/BANG 250 kg

Precision Guided Bomb
Paveway IV



IM Maturity and IM Performance Assessment

- ❑ IM rounds are in Service (PGB dropped in Libya)
- ❑ Systems close to IM compliant
- ❑ Sympathetic reaction difficult to pass for large diameter warheads

IM SOTA Trends

HIGH

Technical Risk

LOW

High Performance Rocket Propellant

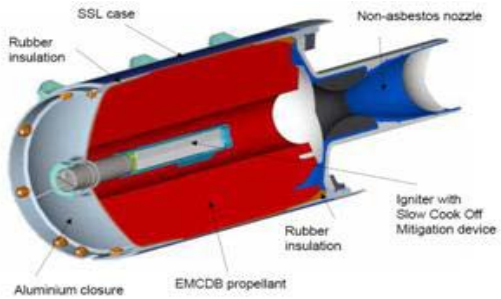
Min Smoke Rocket Propellant

Min Smoke Rocket Propellant SLIM

Typical AP/HTPB Composite Propellant

Rocket Motor Design plays a major role in Reducing IM signature:

- Case selection
- Mitigation features and devices



Gun La… HE

Gun La… Cast HE

Large Calibre Gun Propellant

Cure Formulations

Metal Accelerating

Underwater Explosives

Metal Accelerating HE Cast Cure Formulations

General Purpose HE Cast Cure & Melt Cast Formulations

Small Calibre Gun Propellant

IM Performance

HIGH

Changing Nature of Munitions (theirs…)

MSIAC GAPS workshop (The Hague, The Netherlands June 2011)

- IED threats
- Shaped Charge Jet threats – unlike a 50mm Rockeye
- Nations identified need for standard SCJ threat for test and analysis

I-AMMO Working group addressing Marking of Munitions

- IM rounds more resilient to destruction
- EOD desire for stamp / Stencil Explosive fill
- NATO AOP-2(c) will be amended

Changing Nature of Munitions (ours…)

It's cheap, **it's safe,** it's the future . . . and the future is here.

"Ours" and "Theirs"

Pictures from recent MSIAC newsletters & workshops

Technology Gaps

- **Designing gun propellants for IM not funded in most countries**
  - **Gun propellant response to FI and SCJ generally resulting in a pass with most recent gun propellants**
  - **System design critical**
- **Rocket Propellant**
  - High energy min signature rocket motor
    - Low temp capability, performance, signature, higher requirements not yet achieved by reduced vulnerability propellant.
  - High Performance Propellant
    - Type III response may present unacceptable collateral damage
- **Design Toolkits required**
  - Codes and Models, small scale predictive tests…

Knowledge Transfer

- Common Standards
  - Common Procedures
- Compete reporting
  - Processes
  - Results
    - Successes
    - "Failures"
- Information
  - Accurate
  - Standardized
  - Disseminated

Trust

MSIAC Workshop Spring 2014

IMEMTS
NDIA/IMEMG

Summary - IM Technology

- Significant progress has been made in terms of technology availability
- An increasing number of reduced vulnerability systems are now in service or are in development
- Recent conflicts have emphasised importance of IM in the operational environment

Request information on systems not included

QUESTIONS ?

Thank you