ARMSCOR
Armaments Corporation of South Africa Ltd

RHEINMETALL
DENEL MUNITION

SOUTH AFRICAN NAVY 76/62mm AMMUNITION EVOLUTION FROM PRIORITISATION TO THA TO CHARACTERISATION AND EVENTUALLY IM COMPLIANCE

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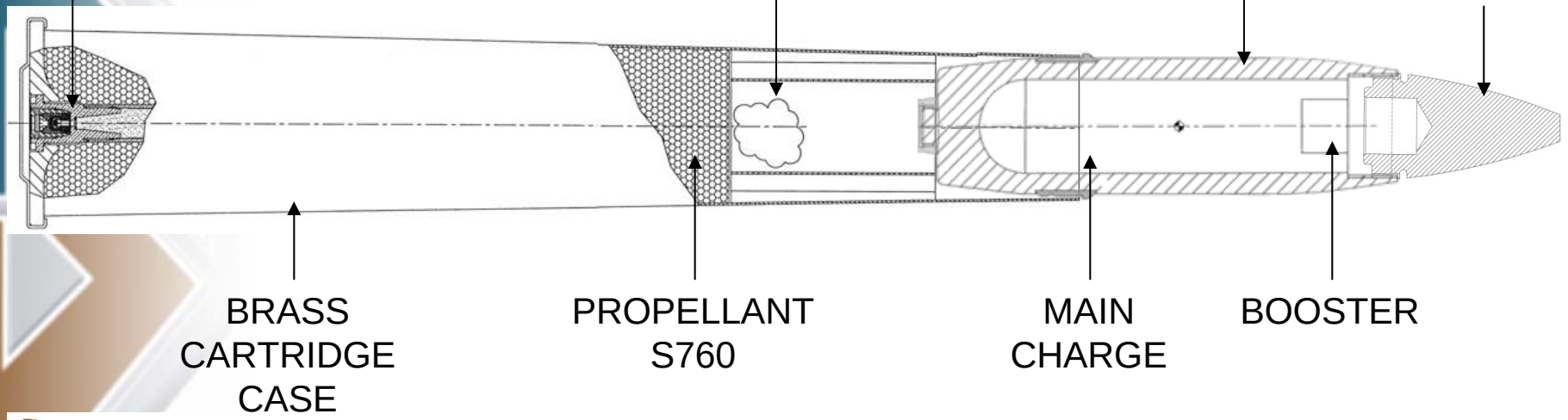
AGENDA

- INTRODUCTION
- IM PRIORITISATION
- THREAT HAZARD ASSESSMENT:
  - New software approach
- IM CHARACTERISATION
- IM TECHNOLOGY FOR HIGH SET-BACK APPLICATIONS
- CONCLUSION
- ACKNOWLEDGEMENTS

INTRODUCTION

- The road to IM compliance
- IPT approach
- Various players
- The naval 76/62 mm ammunition is a “vehicle” to illustrate the “road” to IM compliance

INTRODUCTION



76/62mm NAVAL AMMUNITION

INTRODUCTION

- **THE SA DODI LOG NO 00053/2005 (ED. 1) POLICY ON IM CALLS FOR INTER ALIA THE FOLLOWING:**

Auditable Outcomes

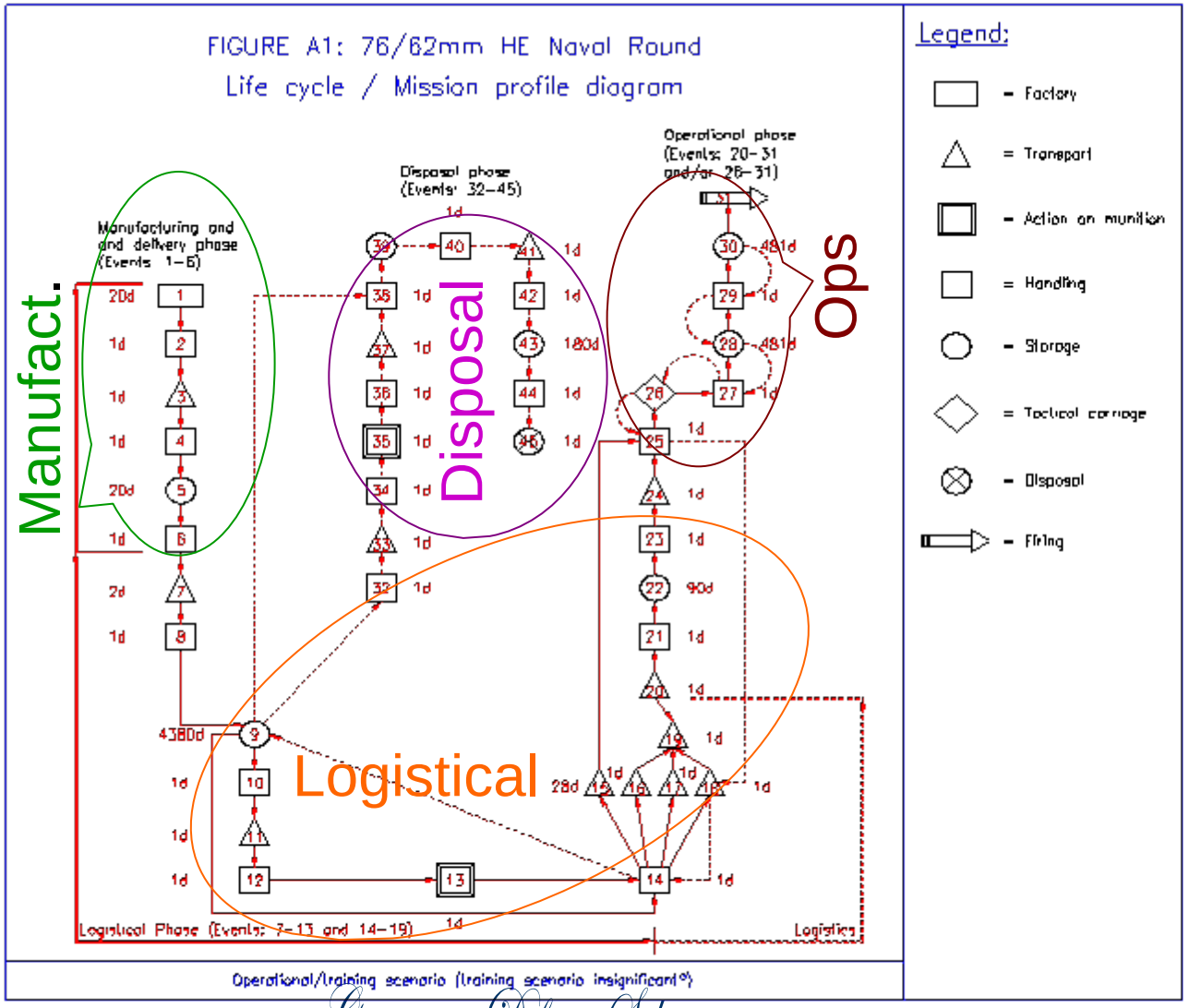
- *A comprehensive schedule reflecting the IM characterisation of all ammunition in order of priority.*
- *Complete insensitive munitions characterisation of existing stock.*
- *The achievement of IM compliance requires a systems approach. Where, even with the systems approach it is not possible to achieve full IM compliance, reduction in risk becomes the overall objective.*

IM PRIORITISATION

- The prioritisation process was shown
- The 76/62mm Medium Gun Weapon (MGW) naval ammunition was starting point
- Extensive work already done on the 76/62mm ammunition
- IM prioritisation leads the way
- Not much benefit in performing IM characterisation tests hastily
- A paper titled: *THA methodology, a South African approach*

THREAT HAZARD ASSESSMENT

LIFE CYCLE DIAGRAM



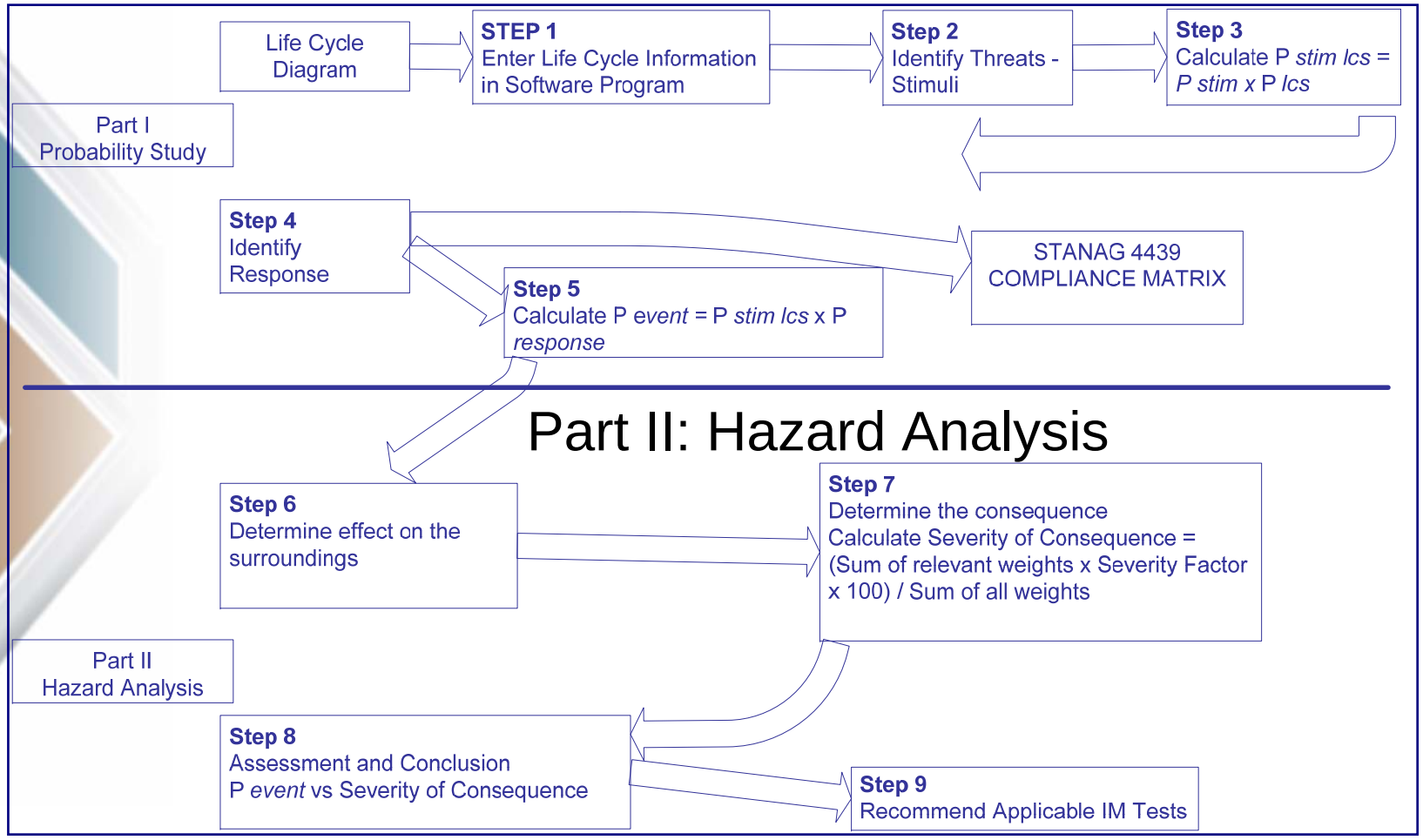
THREAT HAZARD ASSESSMENT

- Each situation was analysed
- Historically MS Excel was used
- The likelihood of situation, threats and responses determined
- Probability of a major event calculated
- Technically involved for the user community

New Software Approach

- **The SA IM steering committee new approach**
  - Use of a MS Access database program
  - Engage the stakeholders
  - User friendly
  - Central registry
  - Facilitate standardisation
  - Ease of cross reference to the THAs
  - Applicable to all arms of service
  - Facilitator of IPT had “drop down” menu

New Software Approach



New Software Approach

Life Phase ID	Life Phase Description	Life Phase Notes	Duration/Days	Repeats
HE 020101	020101 Log.: Handling - Depot Load/Uload, Manual / Fork Lift	3,10,12,14,16,18,23,24,26,28	0	1

Logistics: Handling at Depot

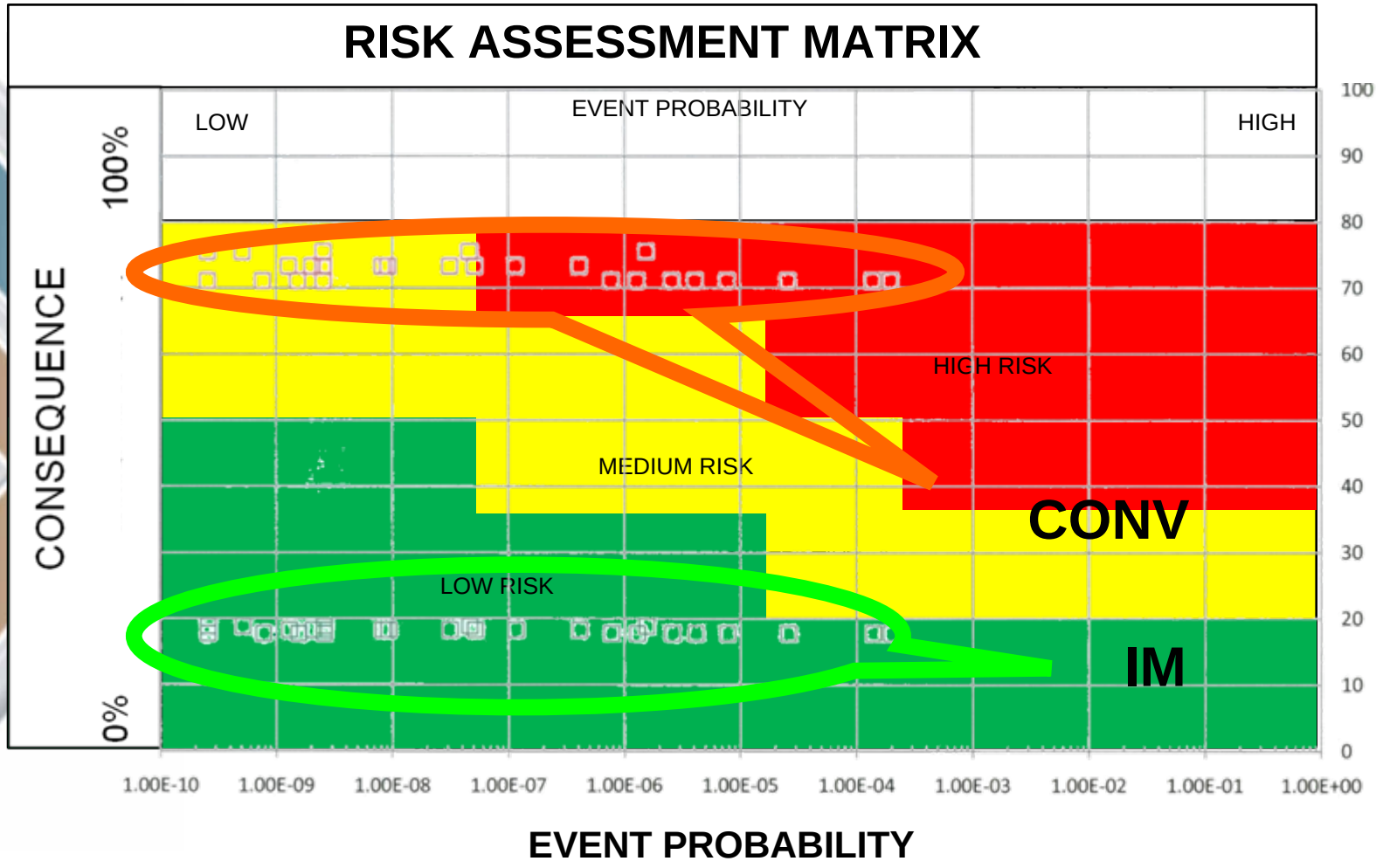
Ammunition Type	Stimulus	Probability	Threat - Stimulus Notes	Response	Probability	Response Notes
76/62mm HE Plugged	Fragment Impact	1.00E-06	60mm; 81mm Mortar; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	
76/62mm HE Fuzed	Fragment Impact	1.00E-06	60mm; 81mm Mortar; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	
76/62mm HE Plugged	Spall Impact	0.00E+00	-; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	
76/62mm HE Fuzed	Spall Impact	0.00E+00	-; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	
76/62mm HE Plugged	Shaped Charge Jet Impact	0.00E+00	RPG 7; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	
76/62mm HE Fuzed	Shaped Charge Jet Impact	0.00E+00	RPG 7; 8-18 plgd, 23-28 fzd	State of the Art	Type I	1.00E+00 Type I-II Always, Type III 50%
				Product		
76/62mm HE Plugged	Sympathetic Detonation	1.00E-03	Palletised; 8-18 plgd, 23-28 fzd	State of the Art	Type I	
				Product	Type I	Type I-V Always
76/62mm HE Fuzed	Sympathetic Detonation	1.00E-03	Palletised; 8-18 plgd, 23-28 fzd	State of the Art	Ty	

In process of updating

CONV

IM

New Software Approach



IM CHARACTERISATION

IM characterisation results for various 76/62 mm naval ammunition types

Type	FCO	SCO	SD	SD (mono-cont)	BI	FI	SCJI
HE	III	I	III	NR	V (main) II (expl)	II (main) II (expl)	I (main) I (expl)
HE PFF	II	I	II	NR	V (main) I I (expl)	I (main) I (expl)	III (main) I (expl)
AA Flash	III	III	III	NR	III	III	NR (main) I (expl)
Su Prac	III	III	III	NR	IV	IV	III

IM CHARACTERISATION

Figure 5: Liquid Fuel Fire for 76/62 mm ammunition test set-up

Test was conducted in accordance with STANAG 4240

IM CHARACTERISATION

Figure 6: Liquid Fuel Fire for 76/62 mm HE ammunition test results

The remains shows that the reaction was an explosion which is the third most violent event. This was as expected.

Figure 7: Liquid Fuel Fire for 76/62 mm SU PRAC ammunition test results

This result shows that an explosion for the SU Prac was also obtained primarily because of ignition of propelling charge.

IM CHARACTERISATION

Figure 8: Slow Cookoff for 76/62 mm ammunition test set-up



STANAG 4382 was used with a heating rate of 5°C/ hour and the test item was preheated to 60°C in the interest of time saving.

Figure 9: 76/62 mm AA Flash Slow Cookoff results

This result shows that an explosion for the AA Flash was obtained with limited remains of the oven.

IM CHARACTERISATION

Figure 10: Bullet Impact Test Set Up

Test was conducted according to STANAG 4241. Target range determined as 30m. Impact was through main charge and also exploder charge.

Figure 11: Bullet Impact test results for 76/62 mm HE and PFF through main charge

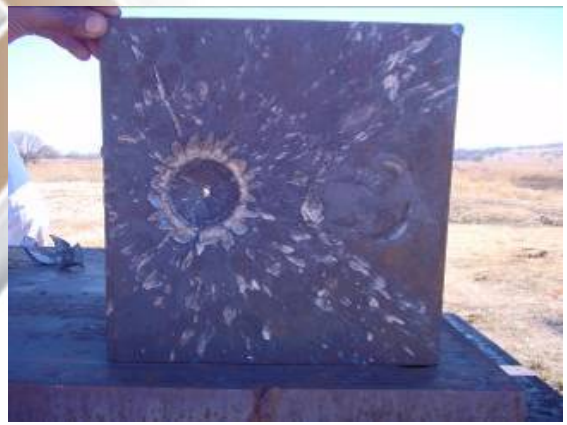
No reaction observed through main charge, but a type II observed through the more sensitive exploder charge (CH6)

IM CHARACTERISATION

Figure 12: 76/62mm SU PRAC Sympathetic Detonation (SD) test set up

STANAG 4396 (1991) donor acceptor/basis test. Gap determined to be 20mm. Donor was detonated by electric detonator. Witness plate positioned at acceptor

Figure 13: 76/62 mm HE SD results



A type III reaction was obtained. There was a significant indentation on the 20mm witness plate. There is some unexploded energetic material in the debris.

IM CHARACTERISATION

Figure 14: 76/62 mm HE SD results (packaged in mono-containers)

A type V (no reaction) was obtained and this is because the transfer of the detonation from the donor to the acceptor was mitigated by the aluminium wall of the mono-container that deformed and absorbed some of the energy. This prevented the violent reaction. It is evident that just by changing the packaging that IM can be achieved on a system level.

IM CHARACTERISATION

Figure 15: Shaped Charge Jet Impact test set up

Shaped charges (diameter 32mm) were utilized with a 100 mm air gap between shaped charge and the test item. Witness plates were placed around the test.

Figure 16: 76/62mm HE PFF Shaped Charge Jet results

A type III reaction was obtained when aimed at the main charge and type I at the exploder charge.

IM CHARACTERISATION

Figure 17: Test set up for Fragment Impact (FI)

A conical shaped projectile made of mild steel is fitted into a plastic sabot then into a 30mm round. The weapon is positioned approx 10m away. Charge adjustment performed until impact velocity of 1830+/- 60 m/s was reached. Fragment aimed at the target by direct aiming through the barrel, onto a mark on the target object.

Figure 18: Test results of 76/62mm AA Flash

Type III reactions were obtained when aiming at the flash pellet. (TNT/Al). Note there is no main charge.

IM FOR HIGH SET-BACK APPL.

- IM applicable technology project is referred to as PBX and IM for high set-back munitions
- Initiated several years ago
- International papers presented
- The funding facilitates know-how and IM technology insertion
- Managed by ARMSCOR through a joint defence industry initiative by the Rheinmetall Denel Munition group

IM FOR HIGH SET-BACK APPL.

- Ammunition incorporates a booster, main and exploder charge.
- Initial years RXHR-5 was main charge and HSKF-2 as the booster charge
- Exploder charge was NREV 9502 (NTO/RDX/EVA) or HXHR 9201 (HMX/Hytemp/Plasticizer) or RXHR 9501 (RDX/Hytemp/Plasticizer)
- Now promising pressed PBX formulations include NTO based NREV 9506 and RDX based RXHR-5

IM FOR HIGH SET-BACK APPL.

Figure 19: Liquid Fuel Fire test result for 76/62 mm filled shell with main charge NREV 9506 with no booster

Shell was recovered without any damage. Burning type V reaction was observed. It must be noted that the conventional filling RDX/Wax (91/9) showed a type I reaction after 2 minutes and 40s.

Figure 20: Shaped Charge Jet Impact set up and results: RXHR-5 main charge formulation

Jet entered and exited the shell at the main charge using RXHR-5. A burning reaction type V was observed for a 50mm plate and type 1 for a 25mm, both with 40mm air gap.

IM FOR HIGH SET-BACK APPL.

Figure 21: Bullet Impact test set-up/results NREV 9506 and HNS/KelF booster

12,7mm AP showed a burning reaction type V

Figure 22: Test set up for Sympathetic Detonation with varying air gap for RXHR-5

The picture 22b shows that when there is a 20mm air gap there is somewhere between a type III and type IV reaction. The picture 22c on the right shows the result for an 80 mm air gap which shows minor damage to the shell and is thus classified as a type V reaction.

IM FOR HIGH SET-BACK APPL.

IM performance characteristics (lethality)

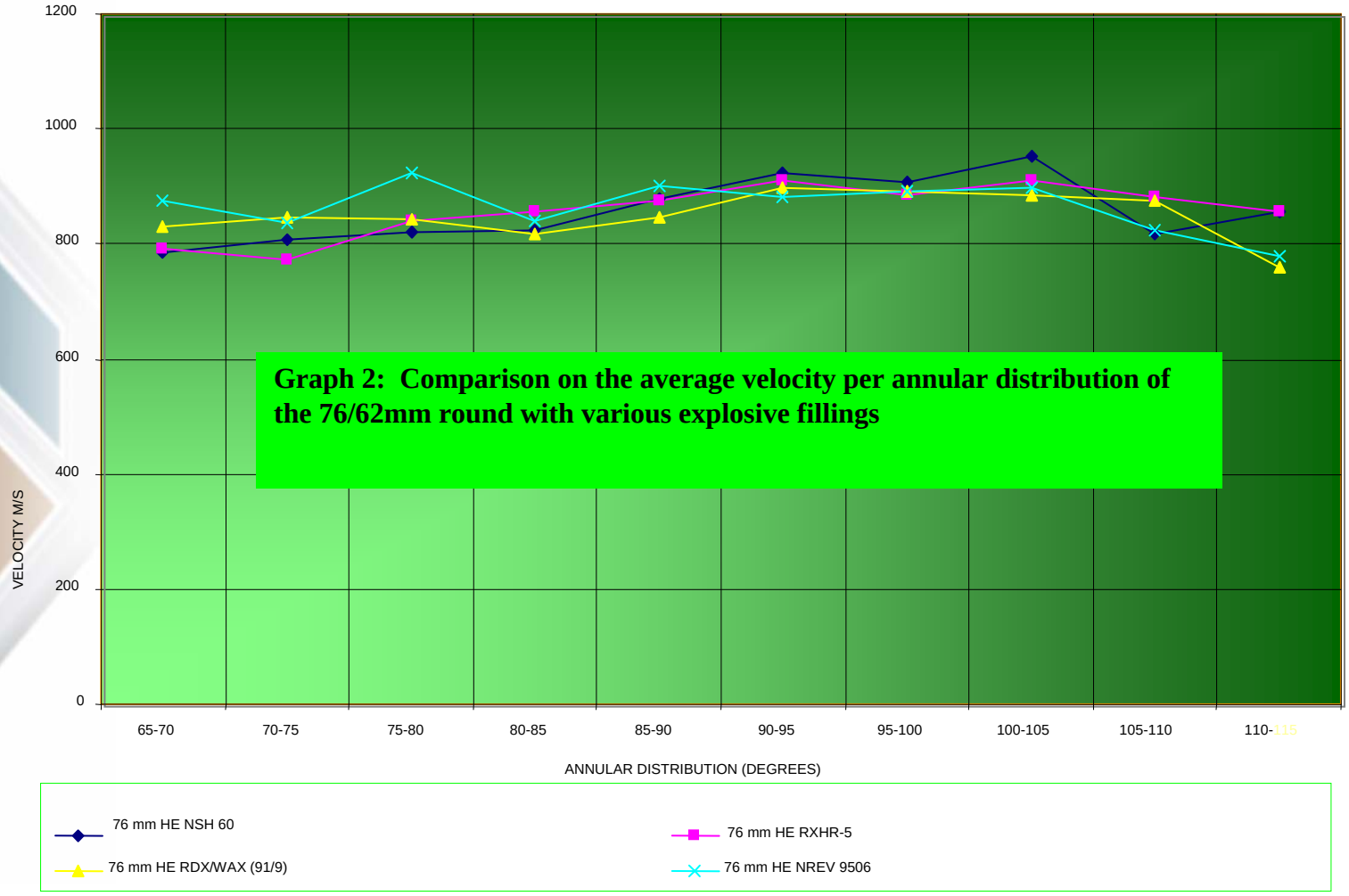
Static performance tests were carried out and the fragment velocity as well as fragment penetration tests on mild steel plates of 2,5mm; 4,5mm; and 6mm thickness

RXHR-5

NREV 9506

RDX/WAX

IM FOR HIGH SET-BACK APPL.



Graph 2: Comparison on the average velocity per annular distribution of the 76/62mm round with various explosive fillings

IM FOR HIGH SET-BACK APPL.

Table 3: Summary of IM characterisation tests performed

Explosive Formulations	FCO	SD	BI (12,7mm AP)	SCJI (40mm air gap)
76/62 mm HE: Main Charge NREV 9506 (NTO/RDX/EVA) Booster: None	V	V (80mm gap) V (40mm gap) IV (20mm gap)	V	V (50mm armour plate) I (25mm armour plate)
76/62 mm HE: Main Charge NREV 9506 (NTO/RDX/EVA) Booster: HNS/KelF	V	No evaluation	V	No evaluation
76/62 mm HE: Main Charge: RXHR-5 Booster: None	V	V(80mm gap) 40mm gap) – pressure burst Between III and IV (20mm gap)	V	V (50mm armour plate) I (25mm armour plate)
76/62 mm HE: Main Charge: RDX/WAX (91/9)	I	V(80mm gap) IV (40mm gap) I (20mm gap)	III	I (50 mm armour plate)

CONCLUSION

- The systematic and methodical approach was used for the 76/62 mm SA Navy ammunition
- Process requires commitment from all the stakeholders and an IPT approach
- Significant progress made in reducing vulnerability
- Packaging also plays an important role
- Hoped for process to be followed diligently in SA
- Comparison, maturity build up and technology insertion

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LOVE ALL SERVE ALL