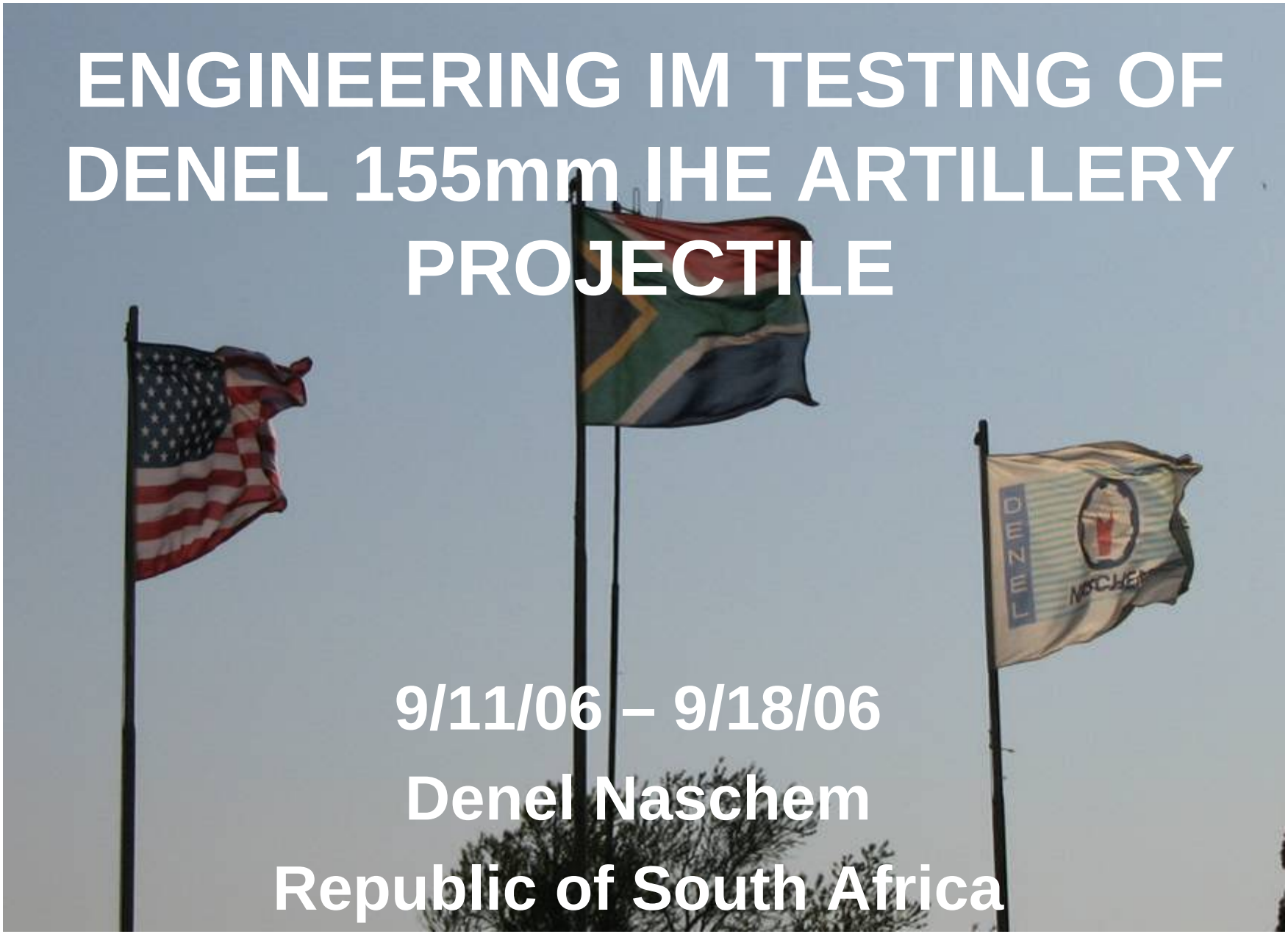


ENGINEERING IM TESTING OF DENEL 155mm IHE ARTILLERY PROJECTILE

9/11/06 – 9/18/06

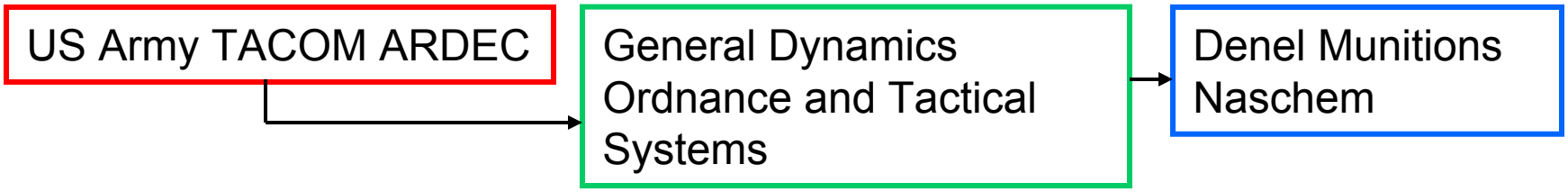
Denel Naschem

Republic of South Africa

GENERAL DYNAMICS
Ordnance and Tactical Systems

DENEL

Background



- Testing was conducted as part of the Advanced Cannon Artillery Ammunition Program (ACA^2P) evaluation of Denel 155mm ammunition
- The XM0121 IHE shell is a candidate for future replacement of the M795
- Prior testing in RSA and FRG were with bare rounds, this effort was directed mostly to rounds contained in standard US wooden pallets.
- Plans, test activities, and reports were collaborative effort of ARDEC and contactor team. All tests were at Denel or other RSA sites.

Scope

- Tests Conducted
  A. Sympathetic Reaction (SR) test
  B. Fragment Impact (FI) test
  C. Bullet Impact (BI) Test
  D. Fast Cook-Off (FCO) Test

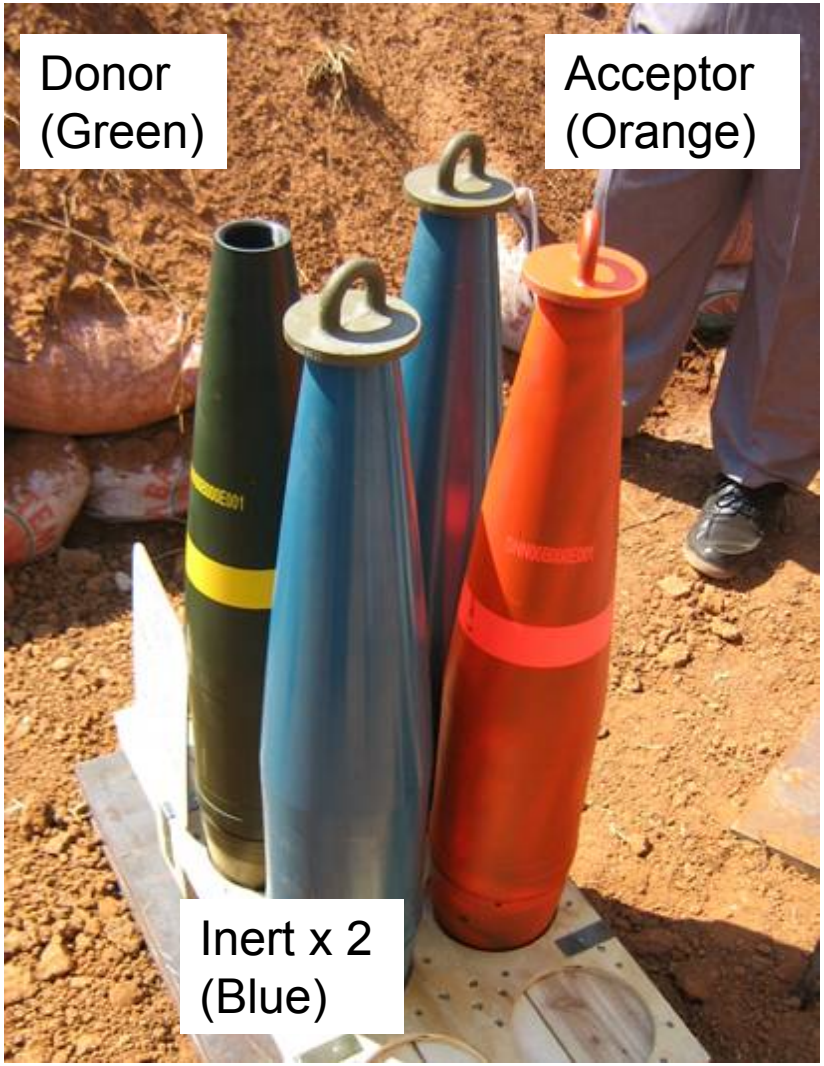
Test Item

- 155mm XM0121A18 IHE Boat Tail
  - Venting Base
- SPX-1 Explosive Main Fill
- DPX-2 Explosive Supplementary Charge
- Shell Covered with HDPE tube
- Palletised – M795 Wooden Pallet with Steel Straps

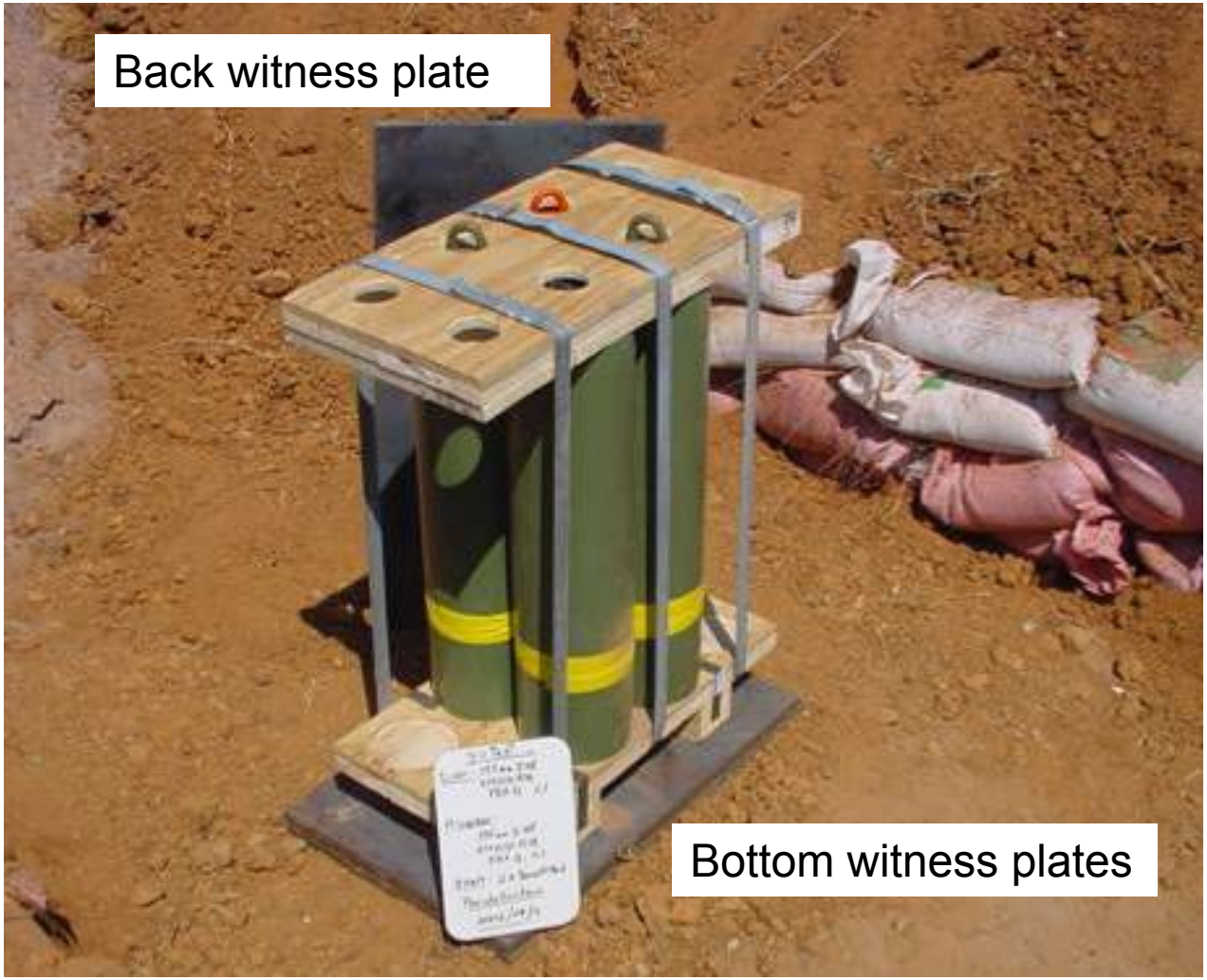
Sympathetic Reaction Test

- STANAG 4396 as Guideline
- Two Tests Conducted
- Test 1
  - 1x Donor (155mm XM0121A18 IHE BT)
  - 1x Acceptor (155mm XM0121A18 IHE BT)
- Test 2
  - 1x Donor (155mm XM0121A18 IHE BT)
  - 2x Acceptors (155mm XM0121A18 IHE BT)

SR Test 1 Set-Up



SR Test 1 Set-Up (cont.)



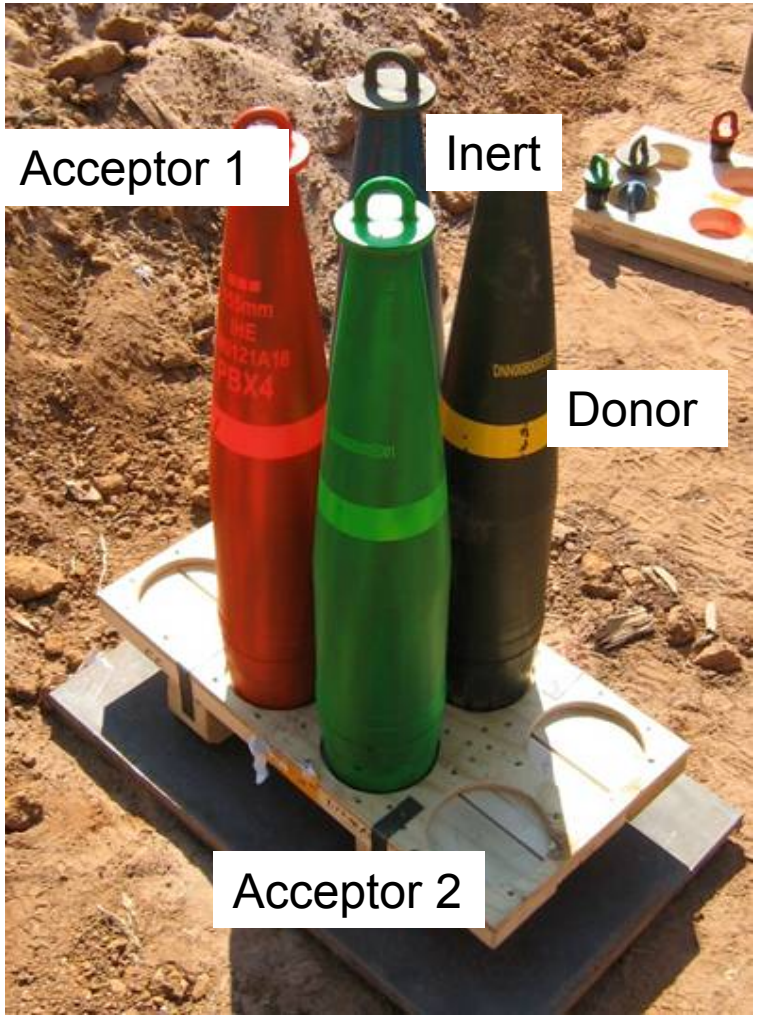
SR Test 1 Results

- Acceptor broke into large pieces which scattered over a large area out to 50m
- Slight indent of boat tail rim (acceptor) on bottom witness plate
- No indentation on vertical witness plate behind acceptor
- Explosive scattered over a large area
- Two inert rounds ruptured along their longitudinal axis
- Reaction Type III.

SR Test 1 Results (cont.)

Acceptor remains

SR Test 2 Set-Up



SR Test 2 Results

- Both acceptors broke up into large pieces which scattered over a large area out to 50m
- Slight indent of boat tail rim (acceptor 1 & 2) on bottom witness plate
- No indentation on vertical witness plate behind acceptor
- Explosive scattered over a large area
- Inert round was ruptured along its longitudinal axis
- Reaction Type III

SR Test 2 Results (cont.)

Fragment Impact Test

- STANAG 4496 used as guideline
- Bare Shell Test
  - 1x 155mm XM0121A18 IHE BT - Shell only
- In Pallet Test
  - 1x 155mm XM0121A18 IHE BT – strapped in M795 pallet with HDPE tube

Fragment

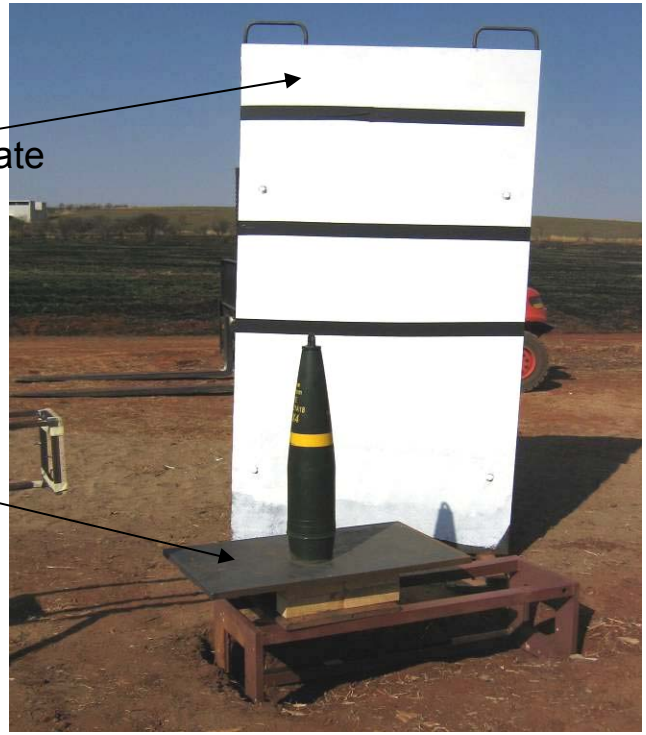
STANAG 4496 specifications:

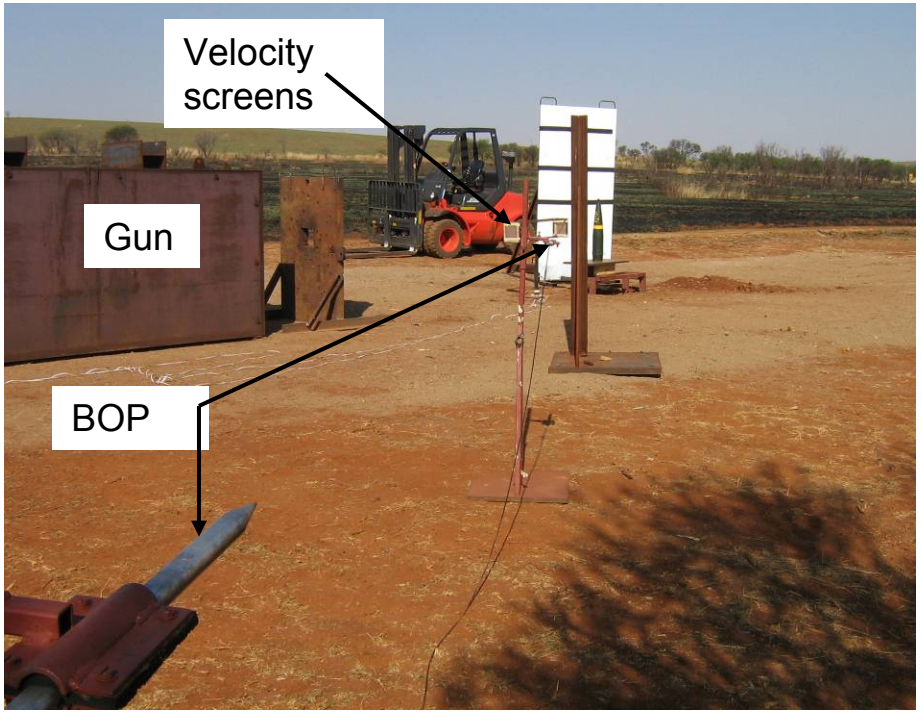
- 18.6g
- Conical shape: 14.3mm diameter, 15.56mm total length, 20º angle tip
- Mild carbon steel
- Impact velocity: 1830 ± 60m/s
  (6000 ± 200ft/s)
- Hardness <270 HB
- Conical tip facing forward

FI Bare Shell Set-Up

- One XM0121A18 shell placed on top of steel plate with white vertical witness plate behind
- 30mm gun launched fragment
- Gun positioned 6m from the test item
- Maximum sensitivity impact point was 445mm from the bottom of the shell
- Four BOP gauges were positioned in two rows
- Velocity screens were set 360mm from the shell

FI Bare Shell Set-Up (cont.)

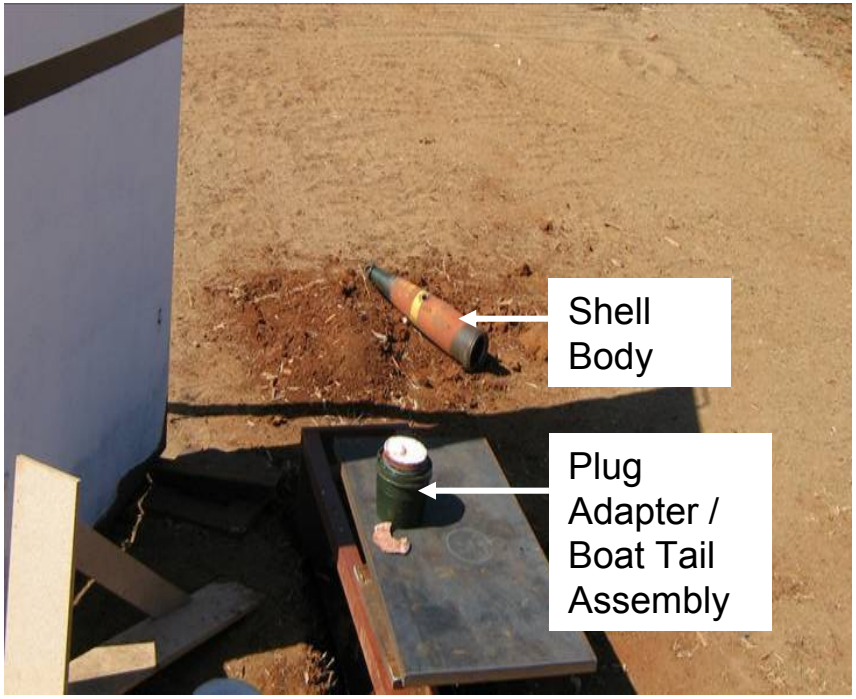




FI Bare Shell Results

- Test item vented at base and explosive burned
- No indentation on bottom witness plate
- No fragment marks on vertical witness plate
- No scattered explosive
- Explosive remains on the plug adapter
- Shell was 2.29m from its original position, 15º right of the shooting line
- Reaction Type V

FI Bare Shell Test Results (cont.)



FI In Pallet Set-Up

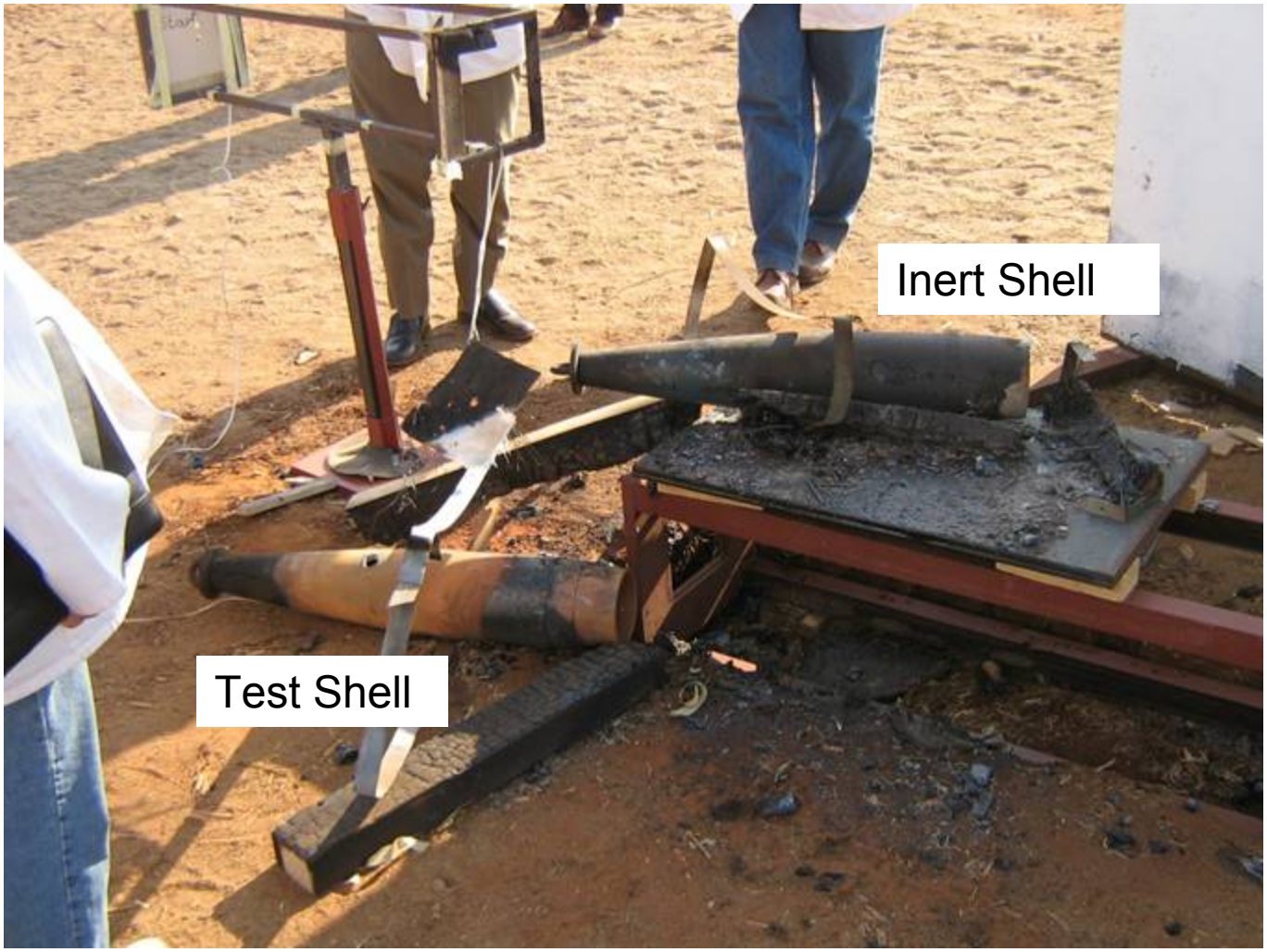
- One XM0121A18 shell assembled in pallet with HDPE tube cover, one inert shell and wood supports
- 30mm gun launched fragment
- Gun positioned 6m from the test item
- Maximum sensitivity impact point was 445mm from the bottom of the shell
- Four BOP gauges were positioned in two rows
- Velocity screens were set 360mm from the shell
- Strapped pallet placed on 25mm thick witness plate with vertical witness plate behind

FI In Pallet Set-Up (cont.)

FI In Pallet Results

- Explosive burned through frag impact hole
- Shell did not vent from base
- Pallet intact after impact, ignited by burning shell and burned out completely
- Piece of shell wall, supplementary charge cup and cavity liner recovered from inside the shell
- No indentation on witness plates
- Reaction Type V

FI In Pallet Results (cont.)



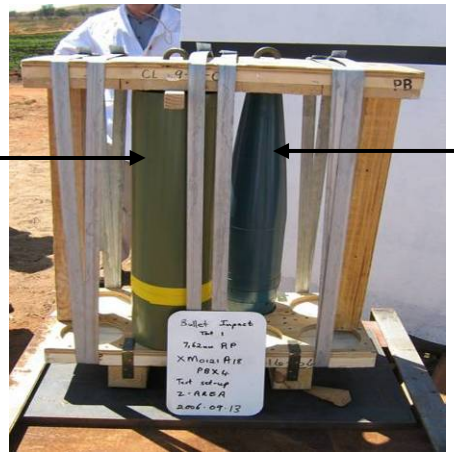
Bullet Impact Tests

- STANAG 4241 used as guideline
- Two series of tests were conducted with armor piercing ammunition – first 7.62mm then 50 cal
  - Test 1 Shot 1: 7.62mm AP – Shell inside HDPE tube, assembled in pallet
  - Test 1 Shot 2: 7.62mm bare shell in pallet
  - Test 1 Shot 3: 7.62mm bare shell in pallet
  - Test 2 Shot 1: 50 cal – Shell inside HDPE tube, in pallet
  - Test 2 Shot 2: 50 cal – bare shell no pallet

BI T1 S1/S2,S3 Set-Up and S1 & S2 Results

- 7.62mm AP
- Gun was positioned 10.3m from the test item
- Impact point was to be 445mm from the bottom of the shell
- Four BOP gauges were positioned in two rows
- Velocity screens for projectile velocity determination

Live round in tube



Inert shell

S1 Setup

No penetration on 1st or 2nd shot

S2 & S3 Setup

Live round

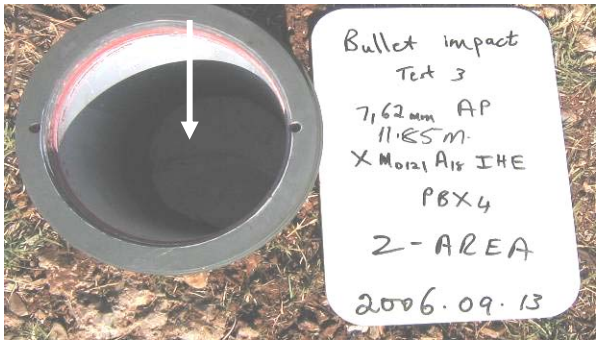
Inert shell

BI Test 1 Shot 3 Results

- Shell body perforated
- Shell vented at base and flew upwards
- Slight indentation on bottom witness plate
- No fragment marks on vertical witness plate
- Scattered explosive over a large area
- Shell was 11.85m from its original position
- Reaction Type V

BI Test 1 Shot 3 Results (cont.)

Explosive remains in shell above bullet track



BI Test 2 Shot 1 and 2 Set-Up

- 50 cal. AP
- Gun positioned 9.8m from the test item
- Impact point 445mm from the bottom of the shell
- Four BOP gauges were positioned in two rows,
- Velocity screens to measure projectile velocity

Live shell

Inert shell

Shot 1 setup

Shot 2 setup

BI Test 2 Shot 1 Results

- Projectile vented at base and flew upwards
- Slight indentation on bottom witness plate
- No fragment marks on vertical witness plate
- Scattered explosive over a large area
- Shell was 9.6m from its original position
- Plug adapter was 54mm from original position
- Reaction Type V

BI Test 2 Shot 1 Results (cont.)

Explosive remains with bullet track

BI Test 2 Shot 2 Results

- Shell vented at base and flew upwards
- Slight indentation on bottom witness plate
- No fragment marks on vertical witness plate
- Scattered explosive over a large area
- Shell was 29.2m from its original position
- Reaction Type IV

BI Test 2 Shot 2 Results (cont.)

Fast Cook-Off Test

- STANAG 4240 used as guideline
- Compact and fuel efficient setup used with bar round
- One test was conducted with bare round

- 3 x 210ℓ drums were used to construct a flue
- The shell was positioned m above the fuel level on a metal grid
- 5ℓ of JetA1 fuel was poured on top of 50ℓ water (in the bottom drum)
- 6 x Type K thermocouples were positioned around the centre line of the shell to measure the temperature
- Three 2.5m x 1.25m x 25mm vertical witness plates were positioned behind and alongside the constructed oven

FCO Test Results

- Shell vented 96 seconds after ignition
- Explosive scattered over a large area
- Charred explosive remains found inside the flue
- Shell body was intact at 11.04m
- Lifting plug was recovered 41.1m
- Bottom of fuze cavity liner was recovered
- Flame temperatures were according to STANAG
- Reaction Type IV

Intact
projectile body

Summary

Test	Palletised	HDPE Tube	Reaction Type
SR (1)	Y	Y	III
SR (2)	Y	Y	III
FI bare shell	N	N	V
FI in pallet	Y	Y	V
BI $(T1S1)_{7.62mm}$	Y	Y	No penetration
BI $(T1S2)_{7.62mm}$	Y	N	No penetration
BI $(T1S3)_{7.62mm}$	Y	N	V
BI $(T2S1)_{50\ cal.}$	Y	Y	V
BI $(T2S2)_{50\ cal.}$	N	N	IV
FCO	N	N	IV

Conclusions

- The testing was done in a very professional manner and was fully monitored by ARDEC and contractor team
- The Denel XM0121 IHE projectile has significant reduced sensitivity to stimuli utilized in test series when compared to current US 155mm ammunition


ACA2P
Team