



TRIAL REPORT

Matching Thermal Sensor and Display Technology

APC Private Venture Trial

10 – 28 June 2019



american panel corporation



MOVE FORWARD WITH COMPETITIVE EDGE

Author: David Rae MSM
Foxbury Solutions Ltd

Reference: 2019-APC-01-Trial Report
Version: 01
Date: 29 July 2019

Conditions for release

This information is released by Foxbury Solutions Ltd to the recipient for Defence Purposes only. This information must be accorded the same degree of security protection as that accorded thereto by the recipient. Permission is to be sought from the recipient before this report can be disclosed to any third party.

List of Abbreviations

ARMCEN	The Armour Centre (UK MoD establishment)
ATDU	Armoured Trials and Development Unit
BFM	Battlefield Mission
FoV	Field of View
C-IED	Counter Improvised Explosive Device
CLV	Command and Liaison Vehicle
DRI	Detect-Recognise-Identify
FoV	Field of View
FSL	Foxbury Solutions Limited
LSA	Local Situational Awareness
LRUs	Line Replaceable Units
MIV	Mechanised Infantry Vehicle Programme
MoE	Method of Evaluation
MoP	Measure of Performance
PDU	Power Distribution Unit
PID	Positive Identification
PoT	Plan of Test
PV	Private Venture (Trial)
RWS	Remote Weapon Station
STA	Surveillance and Target Acquisition
Trg	Training
WCSP	Warrior Capability and Sustainment Programme

Table of Contents

Conditions for release	2
List of Abbreviations	2
Executive Summary.....	3
Introduction	5
Trial Organisation and planning	6
Trial Execution and Method of Evaluation (MoE)	9
Observations – Measure of Performance (MoP)	10
Summary of observations	12
Analysis	12
Conclusions.....	13
Annex A to 2019-APC-01-Trial Report – Target Mapping	15
Annex B to 2019-APC-01-Trial Report – Data Collection Sheets	16
Annex C to 2019-APC-01-Trial Report – Comparative images.....	23
Annex D to 2019-APC-01-Trial Report – Further imagery	26

Matching Thermal Sensor and Display Technology – American Panel Corporation (APC), Kent Modular Electronics (KME) and Technobit (TNB) Private Venture (PV) Capability Demonstrator Trial; 10-28 June 2019

Executive Summary

Background

1. The next generation of sensor to screen capability was successfully trialled at the Armoured Trials and Development Unit (ATDU) over the period 10-28 Jun 19. This new capability included a latest generation 10-bit capable sensor from TNB that streamed live feed with a specific gamma correction setting to a 10-bit capable APC and KME display. To note – it was not possible in this trial to stream the 8-bit feed from the RWS to the APC/KME screen. This can be achieved, however requires more bench level integration work.
2. This capability not only transforms the user experience by furnishing the commander with feed that is easier to interpret; but crucially also enabling the commander to Detect, Recognise and Identify (DRI) targets and objects at far greater ranges than with the legacy, 6 or 8-bit capability on the in-service Remote Weapon Station (RWS).
3. By using this new system, the commander will be able to effect at greater ranges too – particularly in the new era of vehicles and weapon load modularity. This capability will enable simpler and faster changes of weapons systems (both direct and indirect) on a single multi-weapon mount, giving commanders true variety and choice to their tactical capability.

Aim

4. The aim of the trial was to:
 - a. Determine the DRI capabilities of a 10-bit display capability.
 - b. Undertake comparative testing against the current in service RWS 6>8-bit sensor and viewing/control screen.
 - c. Understand the benefits of the TNB HD sensor (10-bit) when used in conjunction with the APC / KME display (10-bit).
 - d. Showcase the combined capability to key UK MoD and Defence Industry personnel.

Recommendations

5. The following recommendations should be noted:
 - a. The system should be properly integrated into a Challenger 2 on Ex STREETFIGHTER for further user and live firing range trials.
 - b. If deemed successful on the above, the system should then be deployed on Op CABRIT (Estonia) in order to gain user assessment within the deployed operational construct.
 - c. The legacy RWS STAWS algorithm should be modified to allow 320x240 to 1024x768 resolution (increased performance) and so enable its feed to be displayed on an APC screen.

- d. Dialogue is opened with the UK MoD's Strike Experimentation Group (SEG) and other A vehicle project staff in order to inform MIV, WCSP and AJAX programme future pulses.
- e. Noting the observations of the main report, a post-trial User Workshop is conducted in order to allow APC/KME engineers and designers to further enhance the system whilst incorporating on-screen graphics and user requirements.
- f. Further exposure of the capability to other Combat arms such as the Infantry through ITDU, and supporting arms, particularly the Royal Engineers through RETDU for C-IED should be encouraged.

Conclusions

6. The trial was deemed a success by both the UK MoD and Foxbury Solutions Ltd trials managers. The system proved that in comparison to the legacy in-service RWS, the system exceeded current crew DRI capability and provided a much clearer picture at all distances. This new DRI capability surpasses anything in service with current UK Land Forces. As a result, this step change means that crews will no longer have to rely on additional assets to DRI at greater ranges. Also of note is that the appetite for collateral damage is rightly low on current operations. The increased detail afforded by this new system allows the operator to make better informed decisions on engagements and so reduce the risk of collateral damage, particularly in time-critical situations.

7. The LSA enhancement afforded by this system will aid operations across the whole mounted fleet; and will undoubtedly reduce the risk of fratricide on own, friendly or civilian elements by increasing PID ranges and certainty, thereby enabling greater (and more certain) prosecution of targets in low and no light.

EXECUTIVE SUMMARY ENDS

Introduction

1. It is clear to any that sit in the turret of any in-service UK armoured vehicle, and look through the sensor suite, that an upgrade to the system as a whole is long overdue. There are three components that must all be upgraded in tandem if vehicle crews are to improve their detect, recognise and identify (and so fight) ranges. These components are:
 - a. The Sensor capability – often upgraded alone.
 - b. The Display (Screen) on which the sensor feed is displayed.
 - c. A specific gamma correction setting that enhances the sensor video source so that it can be displayed on a compatible display (screen).
2. When increasing sensor suite capability, users have often only upgraded the Long Wave Infra-Red (LWIR) sensor, without also considering upgrading the display (screen) and applying the correct gamma correction setting between the two sub-systems. The gamma correction setting can be described as the fine luminance balance tuning between the sensor and the display (screen) that maximizes the highest definition video signal to be viewed. Currently a single (standard) gamma correction setting is applied to the vast majority of armoured vehicle sensor suites. This one-size-fits-all solution means that the majority of feeds being displayed are not enhanced to the highest level possible, as gamma correction settings are scalable, and a specific rate should be matched to the specific display (screen) and sensor type.
3. Coupling this imbalance, Long Wave Infra-Red (LWIR) and Medium Wave Infra-Red (MWIR) cooled sensors have developed at a faster rate and are more capable than ever before. In-service display screens, however, have not developed at the same pace, owing largely to the availability of COTS LCD components and an incorrect gamma correction setting applied between sensor and display (screen) means that the user is not receiving the best experience. As a result, the user is unable to DRI¹ objects, vehicles or personnel at ranges that an upswing in the display (screen) capability and application of a correct gamma correction setting may allow. Any upswing in capability must be done in concert with implementation of Generic Vehicle Architecture (GVA) parameters – allowing for speedy future growth.
4. Displays (Screens) mounted on in-service armoured vehicles are generally COTS based, using 6 or 8-Bit display driver chips, offering 64 to 256 grey shades respectively which provide a basic, low resolution picture for the user. Changes in colours or shades are marked by dramatic ‘steps’ in which detail can be lost or hard to define, especially upon zoom. These steps are characterised by the Minimum Resolvable Temperature Difference (MRTD) that the 3rd generation IR sensor is seeking to distinguish. APC has developed a 10-bit display panel offering 1024 grey shades and is matched to the resolution of both LWIR and MWIR sensors on board M1A2SEP V3. These display panels have been integrated into a KME ruggedised housing, affording the user an un-rivalled display capability. This configuration provides greater graduated changes of colours and shades, meaning that the user is not presented with significant steps between different light or colour levels, at longer distances, than existing in-service technology allows. To an armoured vehicle crew, this offers a radical upswing in the DRI capability. The basic difference in image smoothness can be seen below in **Fig 1**:

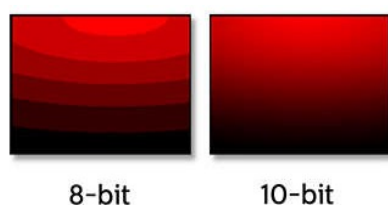


Fig. 1 – Comparison between screen resolutions.

¹ The method of quantifying system proficiency.

5. APC, KME and TECNOBIT submitted a request to trial this new capability by way of private venture (PV) trial; gaining valuable feedback from the user whilst simultaneously exposing the capability to a targeted group within the UK MoD. As UK MoD qualified trial managers, Foxbury Solutions Ltd specialises in trials management and was appointed by APC/KME/TNB to plan and execute the trial on their behalf, in conjunction with the UK MoD trial manager. The trial was conducted at the UK MoD's Armoured Trials and Development Unit (ATDU) in the Armour Centre (ARMCEN) in Bovington, Dorset.

Trial Organisation and planning

6. **Trial Authority.** The trial was funded by APC and UK MoD authority was provided by ATDU and a UK MoD Trials Manager was assigned. David Rae from Foxbury Solutions Ltd was assigned as the trial manager representing the client.

7. **Phases.** The trial was executed in 3 phases:

- a. Area reconnaissance – 10-14 June 19.
- b. System integration and training – 17-19 June 19.
- c. Comparative Testing – 20-21 & 24-25 June 19.

8. **Trial Aims.** The over-arching aim of the trial was to:

- a. Determine the DRI capabilities of a 10-bit display capability.
- b. Undertake comparative testing against the current in service RWS 6>8-bit system sensor and viewing/control screen.
- c. Understand the benefits of the TECNOBIT HD sensor (10-bit) when used in conjunction with the APC / KME display (10-bit).
- d. Showcase the combined capability to key MOD and Defence Industry personnel.

9. **Trial objectives.** The trial objectives were to:

- a. Conduct integration of APC/KME/TNB system with a UK MoD Panther CLV.
- b. Record DRI capability for the in-service RWS on PANTHER CLV as a baseline.
- c. Record the APC/KME/TNB DRI capability and compare against the baseline.
- d. Identify and report any Human Factors (HF) issues and preferences from the end user for future product development.
- e. Observe and report on ease of training, operation and if applicable maintenance.

10. **Dates and Locations.** The trial was conducted on private land West of Swanage, Dorset and in ATDU. The maps at **Annex A** show locations and target information.

11. **Trial Personalities.** Key personnel involved in the trial are listed below:

Ser	Appointment	Name	Responsibility	Contact details
1	APC Trial Manager	David Rae	1. Manage the trial on behalf of the private syndicate. 2. Production of the PoT. 3. Trial execution (client lead).	david@foxburysolutions.com

			4. Collate all data, conclusions and recommendations for inclusion in the trial report. 5. Generate trial report.	
2	MoD Trials Manager	WO1 (RSMI) Rich Reeves	1. Command and control of MoD trials personnel. 2. Duty of care holder. 3. Trial execution (MoD lead). 4. MoD trial report.	through David Rae
3	APC Lead	Jamie Boulet	1. Integration. 2. Training assist / briefing as required. 3. Data Collection. 4. Visitor co-ord.	jboulet@american-panel.com
4	KME Lead	Sam Wills	1. Integration. 2. Training assist / briefing as required. 3. Data Collection. 4. Visitor co-ord.	swills@kme.co.uk
5	TNB Lead	Patrick Body	1. Integration. 2. Training assist / briefing as required. 3. Data Collection. 4. Visitor co-ord.	pbody@oesia.com

12. **Trial Vehicles.** A UK MoD Panther CLV, supported by a Ford Ranger was used to trial the capability.

13. **APC/KME/TNB Equipment.** The following is a list of equipment used in the trial:

Ser	Equipment Type	Quantity	Comments
1	Screen LRU	2	1 operational and 1 in reserve in case of failure/malfunction.
2	Sensor	1	TNB Centinela.
3	Power cabling	2	Vehicle batteries to screen Vehicle batteries to TNB PDU.
4	Control cable	1	TNB PDU to sensor.
5	Video cable	1	Feed from sensor to screen.
6	Control Laptop	1	Used to integrate sensor to control unit and screen.
7	Control Unit	1	Joystick for pan-tilt, FoV, digital zoom and focus.



Fig 1. TNB Sensor



Fig 2. APC Screen in KME housing

14. **Equipment installation locations.** The following shows equipment set up:



Fig 3. TNB sensor fixed to RWS sensor



Fig 4. APC/KME screen (R) and RWS screen(L)

15. **UK MoD GFE.** The following was provided by ATDU:

Ser	Equipment Type	Quantity	Comments
1	Panther CLV	1	Trial vehicle, complete with RWS
2	Crew	1	Dvr, Comd/operator.
3	Hanger space		For integration.
4	Targets	2	Chase vehicle used as mobile and static vehicle targets.
5	Targets	2	Soldiers wearing full fighting order.

16. **Vehicle Equipment Integration and Training.** Separate equipment integration and training days were utilised in order to integrate the system into the vehicle and familiarise. For the trial, a mounting plate was manufactured by the ATDU metalsmiths, which was placed on top of the existing RWS sensor². As a result, the TNB sensor could be slaved to the RWS system's pan-tilt unit and controlled in conjunction with the RWS. This positioning meant that the two sensors could be positioned as closely as possible to vertical alignment thereby reducing some of the comparative variables.

17. ATDU metalsmiths also manufactured a temporary frame to allow the APC screen and KME control bezel to be mounted where the Bowman User Control Display screen is situated. This enabled both systems (RWS and APC/KME/TNB) to display their feeds concurrently alongside each other – enabling comparative assessment and ease of control.

18. A joystick controller was connected to the commander's station and was used by the operator to control the zoom function, FoV, focus, and heat settings (black hot/white hot).

19. Separate cables attached to the battery banks in the rear of the vehicle supplied the power. These cables ran to an individual system power distribution unit which subsequently supplied the sensor via a control cable, the control laptop and the control unit. A video cable supplied feed from the sensor to the screen via the commander's hatch. The screen was powered in the same manner on an independent power supply from the System Batteries.

20. Training was provided on site by the client and passed on to the UK MoD crew. The crew were able to gain a functional level of understanding of the equipment within a very short timeframe. The training and cognitive burden for this equipment is therefore assessed as very low.

² To note: wash/wipe unit had to be removed to enable the TNB sensor to be mounted in (vertical) line with the RWS sensor.

Trial Execution and Method of Evaluation (MoE)

21. **Method of Evaluation (MoE).** Objective comparison data (qualitative) was achieved through bench-testing prior to the ATDU trial. This data is available from the manufacturers if required. This trial, hosted by ATDU, was geared to gain subjective observations from the user's perspective. The comparison criterion were UK MoD definitions of Detect-Recognise-Identify (DRI) and the targets observed were vehicles, dismounted personnel and local infrastructure at differing lux levels. The tables at **Annex B** show the data capture.

22. **Trial Constraints.** The following should be noted:

- a. **Environmental conditions.** The system was trialled in ambient temperatures. Further trials in other conditions (particularly in hot weather and freezing weather conditions) are recommended. The table below shows the local conditions:

Date	Temp (°C)		Cloud Cover	Precipitation	Wind (Force)
	Min	Max			
20 June 19	11	20	2/8	Dry	1
21 June 19	12	17	6/8	Dry	1
24 June 19	13	21	2/8	Dry day Light Showers evening	2
25 June 19	14	20	4/8	Dry	1
26 June 19	12	23	1/8	Dry	1
27 June 19	N/A – ATDU Visitor Day and Demo				

- b. **APC/KME/TNB equipment condition.** There were no serious equipment failures other than the video cable (coax) lead breaking at the sensor connection. This was due to over-elevation of the sensor and the cable snagging resulting in a break. This issue was only due to the temporary integration on-top of the RWS and so would not occur normally.

23. **Targets.** The system was trialled using the Panther CLV in an Observation Post (OP) in a prominent position overlooking varying ground (including open ground, wooded terrain and urban) with direct line of sight to an array of target areas ranging from 200m to 14+km. The targets were a mixture of:

- a. An ATDU Ford Ranger acting as an improvised military type vehicle ("Technical").
- b. Military personnel dressed and equipped in standard fighting order.
- c. Civilian vehicles, personnel and infrastructure.

The following table lists target information:

Tgt No	Target Ref	GD Bearing	Distance	Orientation
Obs Post Vehicle/Sensor location	Godlingston Hill	NA	NA	NA
1	Studland Ferry Carpark	0480mils	5,800m	North
2	Obelisk (+200m east)	1500mils	1,000m + 1,200m	East
3	Langton Matravers	3950mils	3,300m	South
4	Swanage Carpark	2360mils	3,800m	South East
5	Bater Park Poole	0130mils	9,300m	North
6	Bournemouth Pier	0730mils	12,200m	North East
7	Boscombe Pier	0830mils	14,300m	North East

24. **Daily routine.** System fitting and calibration was conducted daily once in the OP location prior to conducting data capture on the targets. Data was captured on the listed targets in daylight, low light and no light periods. Longer range serials were run on private land near Swanage (Dorset) and close target assessments were conducted on separate days on ATDU's W1 training area.

Observations – Measure of Performance (MoP)

25. The new sensor and screen are not a single system, rather a system of systems that were integrated the week prior to the trial. This level of integration only allowed for static operation; further trials will be required for moving operation. The following were observed by the trial managers and the users:

- a. **Screen.** The following were observations made for the APC/KME 10-bit screen:
 - i. The 10-bit screen allowed for an extremely high level of DRI, at greater ranges, which far exceeded the RWS capability as the pictures below show.
 - ii. The time it took to DRI vehicles and personnel at all ranges was much faster than with the RWS system.
 - iii. The size of the screen was deemed to be ideal. The user did not want the screen size to be altered – as is, the screen offered excellent functionality, clarity of picture and ease of operation.
 - iv. Further functionality would be possible; a workshop would be a good setting to explore these options.
 - v. A more considered integration phase on future trials would be needed to enable a more 'permanent' fit to be made and evaluated.
- b. **Sensor.** The following observations were made specifically of the sensor:

- i. **Wide Field of View (FoV)** – The Wide FoV on the TNB sensor was comparative in angle to the RWS sensor Wide FoV; it was, however, able to detect at far greater ranges.
 - ii. **Medium FoV** – Was again comparative to the RWS sensor at x6 magnification (max), however, the TNB sensor was able to detect and recognise at far greater ranges.
 - iii. **Narrow FoV** – There were no comparative readings due to RWS limitations – the RWS simply could not pick up detail enough to qualify comparison. The TNB solution drastically increased identification distances, far beyond current weapon ranges.
 - iv. **Pan/Tilt** – The elevation and depression afforded by the TNB pan/tilt unit exceeded that of the RWS. This caused a minor fault as outlined in Para 22b. Proper installation and integration would eliminate this fault.
 - v. **Stability** – There was a small amount of rocking of the sensor which affected the sight picture when the crew entered or exited the vehicle. This was due to the temporary nature of the integration – a more deliberate integration would resolve this issue.
 - vi. **Pre-sets** – The varying pre-set FoV's worked well but manual zoom would have been advantageous as periphery view was lost in between settings.
- c. **System Set Up.** The system required a convoluted start up sequence which took too long. This sequence involved powering up a laptop connected to the PDU and entering a number of commands using the joystick (in conjunction with the laptop). This took ~5 mins – too long for the combat user, however the solution was adequate for a capability demonstrator. Any future design work will address this start up process and design in faster start up sequences.
- d. **Comparison Screen Shots.** Comparative screen shots were taken where the RWS and APC system were able to be compared. As the legacy RWS was unable to recognise at ranges which exceeded the current RWS mounted weapons range, no comparison could be made at those further distances. Comparative images are shown below:



Fig 5. The operational system from which comparison was made. RWS (l) and APC/KME/TNB (r)



Fig 6 (l) and 7 (r). The two extremes used for comparison.

A full selection of comparison images can be found at **Annex C**.

Summary of observations

26. The following are the points for further work:
27. Increase zoom capability on the TNB from pre-set only.
28. Configure and integrate the APC/KME screen to current RWS sensor to enable assessment of enhancement to an 8-bit sensor.
29. Build function into the screen bezel to allow the operator to adjust settings.
30. Start-up process to be refined.

Analysis

31. In conjunction with user observations taken during the demonstration, the following points are of note:

- a. **Capability enhancer.** The 10-bit capability will enable a crew to positively detect threats and targets faster and at increased ranges due to a far higher screen resolution. The ability to PID targets at greater ranges and in cluttered urban environments is a capability enhancement and allows Commanders a greater degree of certainty when prosecuting potential targets. This enhancement will be of immense value to all levels and types of units. Due to the speed, range and clarity of the new system, it was concluded that this capability would reduce the need for additional sensors or assets to be tasked in order to confirm targets.
- b. **Supporting Arms.** The system would benefit Royal Engineer Counter Improvised Explosive Device (C-IED) operators. Off route mines, trip wires and disturbed earth were all identified during the trial from a distance of 50m. This level of detection and identification would allow a C-IED team to conduct a preliminary survey of an area or vulnerable point prior to dismounting from the safety

of a platform. Whilst the capability directly enhances the combat user's capability, it should also be considered for wider fleet utilisation.

c. **Situational Awareness.** Crew situational awareness is also greatly increased. When combined with troop/platoon LSA (and higher up to battlegroup level) a far more capable Surveillance and Target Acquisition Plan (STAP) can be constructed; which in turn increases unit/sub-unit survivability when at the halt (either temporarily or in a hides). This will also improve any reconnaissance screen capability.

d. **Cognitive burden.** The low cognitive burden placed on operators was noteworthy – it is possible to operate the system with minimal training and was easily operation is intuitive.

Conclusions

32. The trial was deemed a success by both the UK MoD and Foxbury Solutions Ltd trials managers. The system proved that in comparison to the legacy in-service RWS, the system exceeded current crew DRI and provided a much clearer picture at all distances. A 10-bit solution with far higher resolution has overcome the deficiencies identified with 6 or 8-bit systems. Target acquisition and accurate target identification and reporting was increased exponentially.

33. Over the course of the trial, it was noted that the APC/KME/TECNOBIT solution is a capability enhancer in the following areas:

- a. Ability to DETECT out to ranges of ~20km.
- b. Ability to RECOGNISE targets between 10-14km (dependent on background and lux levels).
- c. Ability to clearly IDENTIFY targets within the range of the weapon system.
- d. PID off-route mines, trip wires and disturbed earth up to 50m.
- e. Ability to report Pattern of Life in built up areas at ranges above 10km.

34. This new DRI capability surpasses anything in service with current UK Land Forces. This new capability will reduce the user's need for additional assets to DRI at greater ranges. Also of note is that the appetite for collateral damage is rightly low on current operations. The increased detail afforded by this new system allows the operator to make better informed decisions on engagements and so reduce the risk of collateral damage.

35. This capability allowed the operator to report on everyday pattern of life activity within a clustered thermal picture in a built-up area, at range. Capable beyond the range of current RWS mounted weapon systems, the trial identified the system's increased capability as a very accurate Surveillance and Target Acquisition (STA) or indirect fire support tool.

36. Crucially, due to the size, dimensions, positioning of the sensors, and other HMI/HFI considerations, this system could be fitted to CR2 (e.g. with the Streetfighter Squadron) and any platform deploying an RWS system. Further user trials and in-depth integration work is highly recommended



D Rae, Foxbury Solutions Ltd, Trial Manager

Annexes

- A. Target Mapping.
- B. Data Collection Sheets.
- C. Comparative images.
- D. Further images.

Distribution:

APC

Jamie Boulet

KME

Sam Wills

TNB

Patrick Body

UK MoD

ATDU: Rich Reeves – RSMI CVS

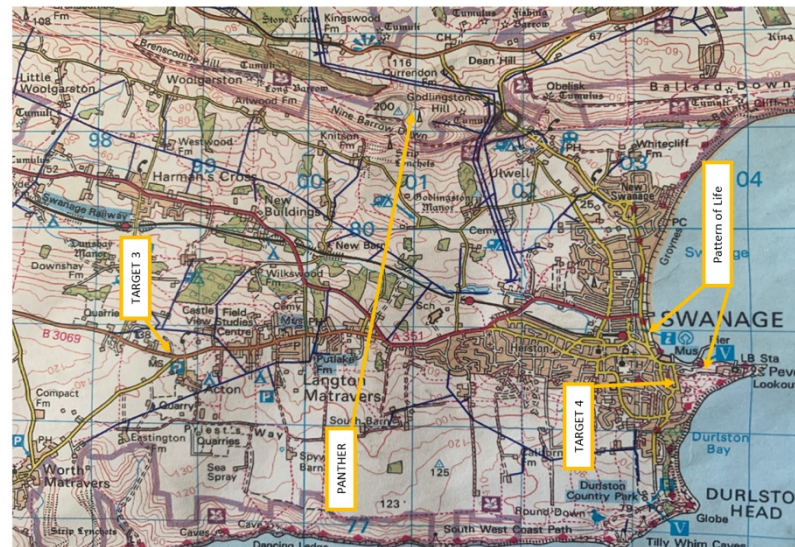
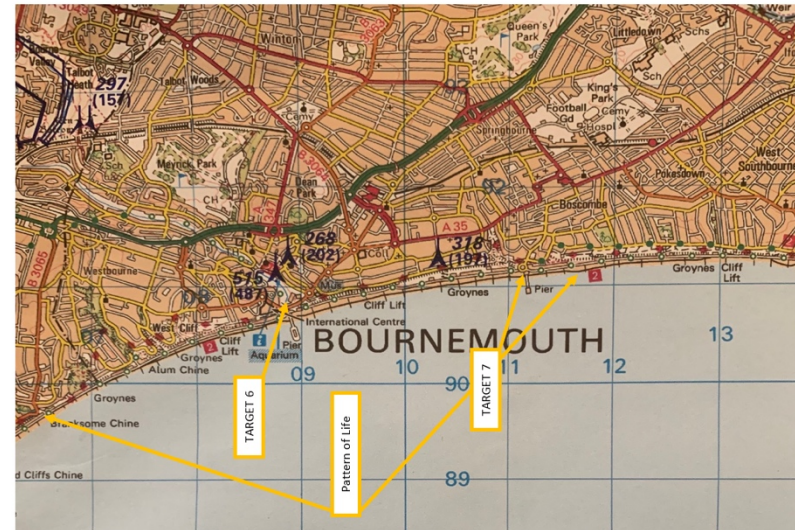
Foxbury Solutions

Eoin Carson

File

Annex A to 2019-APC-01-Trial Report – Target Mapping

Map 1 (below), 2 (top r) and 3 (bottom r) – Panther location and targets.



Annex B to 2019-APC-01-Trial Report – Data Collection Sheets

Table 1 - Full Light – Close

DTG: 210619 1000hrs	Met: Overcast/Dry 17 Degrees Celsius	Crew ID: Military Vehicle commander	Location: W1 Training Area ATDU
----------------------------------	--	--	---

Ser	Target Description	Range to tgt	Time start	Detect (Angle)	Recognise (Angle)	Identify (Angle)	Notes
01	Soldier	200m	1005	Y (WIDE)	Y (WIDE)	Y (NARROW)	1. Soldier was PID wearing NATO uniform. 2. Weapon identified as M4 variant with UGL, bipod, ACOG sight, retractable stock and sling. 3. Helmet identified as SpecOps with Night Obs and attached headset. 4. Pistol identified on right hip and magazine pouches x3. 5. Soldier was able to be tracked in open ground and still whilst in cover behind trees/foilage. Although PID was broken behind cover, it was still able to recognize the same person and any change of direction whilst behind this cover.
02	Enemy Combatant	200m	1005	Y (WIDE)	Y (WIDE)	Y (NARROW)	1. Enemy PID wearing shemagh on head, waistcoat type jacket, military trousers and boots. 2. Weapon identified as AK47 with folding stock and front hand grip on the stock.
03	IED Ground sign	200m	1005	Y (WIDE)	Y (NARROW)	Y (NARROW)	1. Ground sign approx. 1m squared was identified. 2. It was DETECTED on WIDE but required adjustment to NARROW to PID disturbed earth.

Table 2 - Full Light – Far

DTG: 240619 1530hrs	Met: Light Cloud/Dry 21 Degrees Celsius	Crew ID: Military Vehicle commander	Location: Godlingston Hill Upton nr Swanage
-------------------------------	---	---	--

Ser	Target Description	Range to tgt	Time start	Detect (Angle)	Recognise (Angle)	Identify (Angle)	Notes
01	Soldier in open ground	1200m	1545	Y (WIDE)	Y (MEDIUM)	Y (NARROW)	1. PID weapon with sight and possible bipod/UGL. 2. ID wearing helmet and body armour. 3. Able to PID friendly.
	Vehicle in open ground	1200m	1545	Y (WIDE)	Y (WIDE)	Y (MEDIUM)	1. Recognised vehicle outline as a 4x4 in MEDIUM FoV. 2. PID vehicle as Ford Ranger in NARROW FoV.
02	Soldier in open ground	1400m	1600	Y (WIDE)	Y (MEDIUM)	Y (NARROW) (NARROW+2)	1. ID wearing BA. 2. ID carrying a weapon. 3. Couldn't PID friend or foe.
	Vehicle in open ground	1400m	1600	Y (WIDE)	Y (WIDE)	Y (NARROW)	1. ID vehicle grill as Ford Ranger 2. Wheels easily defined 3. Hard top on rear of vehicle distinguishable as raised in comparison to the remainder of the vehicle
03	Civilian in street and on street	1600m	1620	Y (WIDE)	Y (WIDE)	Y (NARROW+2)	1. Able to identify a person in a window of a house with a walking stick. 2. No other distinguishing features.
	Vehicles static and moving in road	1600m	1620	Y (WIDE)	Y (WIDE)	Y (NARROW)	1. Able to PID different moving and static vehicles by type i.e. Hatchback, van, truck, estate car.
04	Soldier in car park in built up housing estate	2000m	1700	Y (NARROW)	Y (NARROW)	Y (NARROW)	1. Able to ID weapon in hand but not type. 2. Unable to PID friend or foe. 3. Required to use NARROW due to being in a built-up area with numerous cluttered thermal signatures around the target.
04	Vehicle in car park in built	2000m	1700	Y (WIDE)	Y (WIDE)	Y (NARROW)	1. Vehicle grill ID. 2. VW Beetle PID in same area.

	up housing estate						
05	Soldier in car park in built up town centre	3700m	1730	Y (NARROW)	Y (NARROW)	N (NARROW+2)	1. Built up area required NARROW to scan in specified area of interest. 2. Unable to PID but was able to ID a person using a pick (tool) in the ground.
	Vehicle in car park in built up town centre	3700m	1730	Y (MEDIUM)	Y (NARROW)	N (NARROW)	1. Able to ID front grill. 2. Able to ID wheels and number of windows on the side.
06	Soldier in hedgerow	3300m	1730	Y (NARROW)	Y (NARROW)	N (NARROW+2)	1. Able to RECOGNISE as a person but no detail to ID.
	Vehicle on roadside in open country	3300m	1730	Y (MEDIUM)	Y (NARROW)	N (NARROW)	1. Able to ID as a 4x4 Pick-up truck. 2. Vehicle Hard top rear identified.

Table 3 - Low Light – Far

DTG: 240619 2115hrs	Met: Low Cloud/Light Rain 16 Degrees Celsius	Crew ID: Military Vehicle commander	Location: Godlingston Hill Upton nr Swanage
-------------------------------	---	---	--

Ser	Target Description	Range to tgt	Time start	Detect (Angle)	Recognise (Angle)	Identify (Angle)	Notes
01	Soldier in open ground	1200m	2130	Y (WIDE)	Y (MEDIUM)	Y (NARROW)	1. PID weapon. 2. PID wearing helmet and body armour. 3. No PID of friend or foe due to heat distortion.
	Vehicle in open ground	1200m	2130	Y (WIDE)	Y (MEDIUM)	Y (NARROW)	1. Recognised vehicle outline as a 4x4 in MEDIUM FoV. 2. PID vehicle as Ford Ranger in NARROW FoV. 3. ID windscreen wipers moving.
02	Soldier in open ground	1400m	2145	Y (WIDE)	Y (NARROW)	Y (NARROW) (NARROW+2)	1. ID wearing BA. 2. ID carrying a weapon. 3. Couldn't PID friend or foe.
	Vehicle in open ground	1400m	2145	Y (WIDE)	Y (NARROW)	Y (NARROW)	1. ID vehicle grill as Ford Ranger. 2. Wheels easily defined. 3. Hard top on rear of vehicle distinguishable as raised in comparison to the remainder of the vehicle.
03	Soldier in car park in built up town centre	3700m	2155	Y (MEDIUM)	Y (NARROW)	Y (NARROW+2)	1. Built up area required NARROW to scan in specified area of interest to DETECT. 2. Unable to PID but was able to recognise a person using a pick in the ground.
	Vehicle in car park in built up town centre	3700m	2155	Y (MEDIUM)	Y (NARROW)	Y (NARROW+2)	1. Able to ID number of wheels. 2. Able to ID front windscreen and hot bonnet.
04	Soldier in hedgerow	3300m	2200	Y (MEDIUM)	Y (NARROW)	N (NARROW+2)	1. Able to RECOGNISE as people but no detail to ID.

	Vehicle on roadside in open country	3300m	2200	Y (MEDIUM)	Y (MEDIUM)	Y (NARROW+2)	1. Able to ID as a 4x4 Pick-up truck. 2. Vehicle Hard top rear identified. 3. Tracked vehicle from Target 4 to 3 in MEDIUM and RECOGNISE as 4x4 box body.
--	-------------------------------------	-------	------	---------------	---------------	-----------------	---

Table 4 - No Light - Far

DTG: 240619 2230hrs	Met: Cloudy/Light Rain 14 Degrees Celsius	Crew ID: Military Vehicle commander	Location: Godlingston Hill Upton nr Swanage
-------------------------------	--	---	--

Ser	Target Description	Range to tgt	Time start	Detect (Angle)	Recognise (Angle)	Identify (Angle)	Notes
01	Soldier in open ground	1200m	2230	Y (WIDE)	Y (MEDIUM)	Y (NARROW+2)	1. PID weapon. 2. PID wearing helmet and body armour. 3. No PID due to heat distortion.
	Vehicle in open ground	1200m	2130	Y (WIDE)	Y (MEDIUM)	Y (NARROW)	1. Recognised vehicle outline as a 4x4 in MEDIUM FoV. 2. PID vehicle as Ford Ranger in NARROW FoV. 3. ID windscreen wipers moving.
02	Soldier in car park in built up town centre	3700m	2245	Y (MEDIUM)	Y (NARROW)	N (NARROW+2)	1. Built up area required NARROW to scan in specified area of interest to DETECT. 2. Unable to PID but was able to RECOGNISE as a person.
	Vehicle in car park in built up town centre	3700m	2245	Y (MEDIUM)	Y (MEDIUM)	Y (NARROW+2)	1. Able to ID as a box body type vehicle. 2. Required MEDIUM in a specified area due to busy sight picture with multiple sig and cluttered thermal picture.
03	Soldier in hedgerow	3300m	2255	Y (MEDIUM)	Y (NARROW)	N (NARROW+2)	1. Able to RECOGNISE as people but no detail to ID.
	Vehicle on roadside in open country	3300m	2255	Y (MEDIUM)	Y (NARROW)	Y (NARROW+2)	1. Able to ID as a 4x4 Pick-up truck. 2. Vehicle Hard top rear identified. 3. Tracked vehicle from Target 4 to 3 in MEDIUM and RECOGNISE as 4x4 box body.
04	Soldier on road	5600m	2315	Y (NARROW)	Y (NARROW)	N (NARROW+2)	1. Able to recognize as people when moving.

04	Vehicle on road	5600m	2315	Y (NARROW)	Y (NARROW)	Y (NARROW+2)	1.Unable to ID when vehicle was head on or rear facing 2.Able to ID as box body 4x4 type vehicle when moving and side on only
----	-----------------	-------	------	---------------	---------------	-----------------	--

Annex C to 2019-APC-01-Trial Report – Comparative images

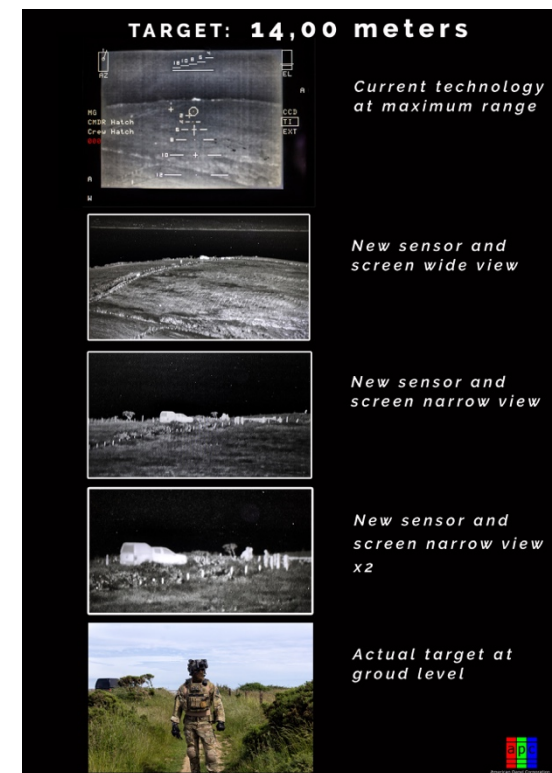
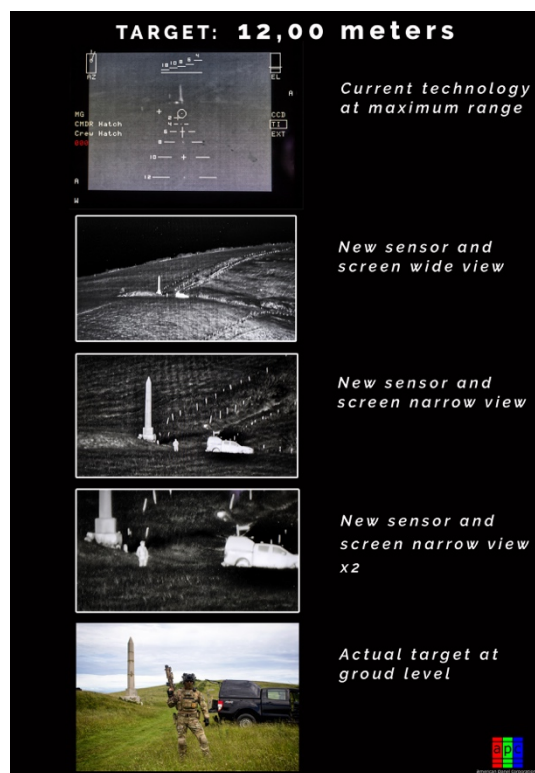
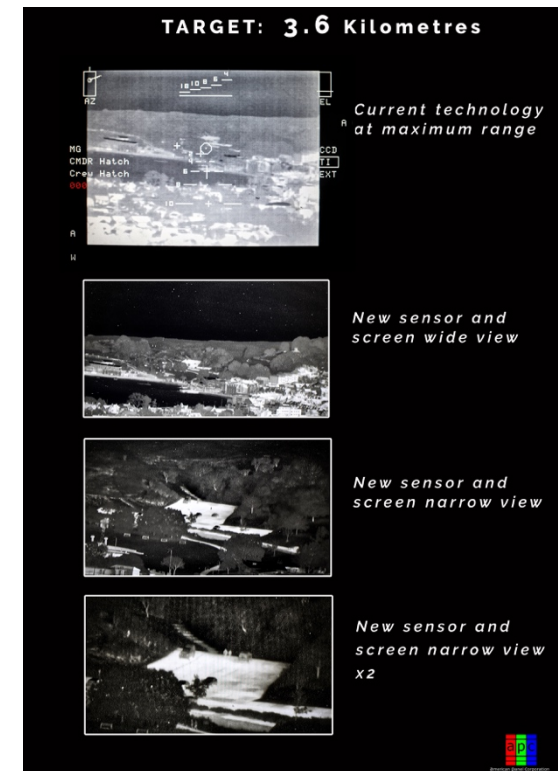
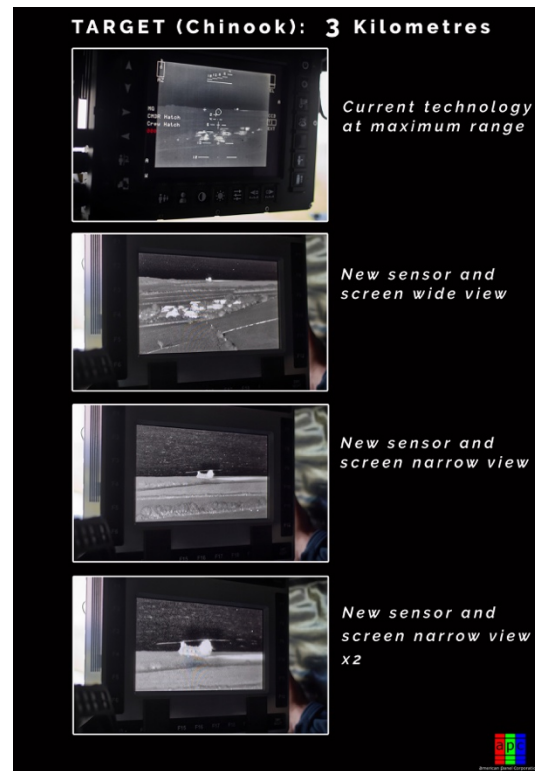
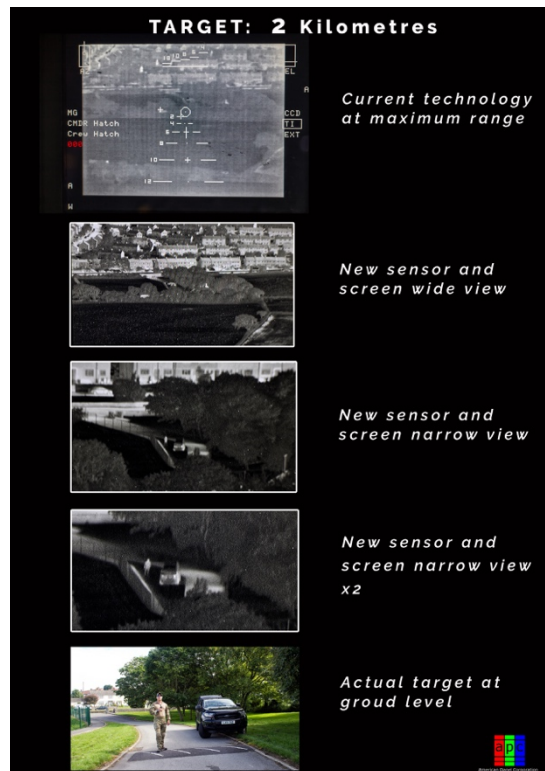


Fig 8, 9 and 10. Dismount at 200m (l), dismount and vehicle at 1.2Km (centre) and dismount and vehicle at 1.4Km (r).

Comparative images continued



Figs 11, 12 and 13. Targets: Dismount and vehicle at 2Km (l), Chinook in transit at 3Km (centre) and Car Park 3.6 Km (r).



Fig 14. Comparison at 5.6 and 8 Km, then APC/KME/TNB only at 8 and 12 Km.

Annex D to 2019-APC-01-Trial Report – Further imagery



Fig 15. 250m Daylight, Narrow FoV-APC/KME/TNB



Fig 16. 250m Daylight, Narrow FoV- RWS