TECHNICAL REPORT

FIELD FORENSIC FIREARM EXPLOITATION: DEVELOPING RFID SOLUTIONS IN SUPPORT OF STOCKPILE MANAGEMENT AND POST-DIVERSION TRACING

April 2021

CONTENTS

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TABLES AND ABBREVIATIONS

TABLES

ABBREVIATIONS

ATEX	Atmosphères explosibles
CAR	Conflict Armament Research
dBm	Decibel-milliwatts
EPC	Electronic Product Code
F3E	Field Forensic Firearms Exploitation
FDA	United States Food and Drug Administration
ISO	International Organization for Standardization
mW	MegaWatt
PCB	Printed circuit board
PSSM	Physical security and stockpile management
RFID	Radio frequency identification
TTE	TTE-Europe GmbH
UHF	Ultra-high frequency

1. INTRODUCTION

OVERVIEW

In conducting more than five years of EU-funded field investigations, Conflict Armament Research (CAR) has repeatedly encountered two obstacles to tracing the origin of trafficked weapons. First, terrorist and criminal networks routinely obliterate identifying marks on illicitly acquired weapons, with the aim of concealing their origin. Second, the absence of paper records precludes easy identification of intended end users, especially with respect to weapons that may be decades old or obsolete. As the age of such weapons does not necessarily reduce their lethality, they remain a pervasive threat to conflict-affected communities.

The Field Forensic Firearms Exploitation (F3E) project aims to develop methods and tools to facilitate the traceability of seized materiel and to enhance states' ability to secure stockpiles. F3E will provide critical information to EU internal security and intelligence organs on hitherto untraceable illicit weapons and will develop the technological means to support investigations. CAR seeks to increase knowledge of the mechanisms of obliteration and uncover new patterns and vectors of weapon diversion used within the EU. CAR and implementing partner TTE-Europe GmbH (TTE) are developing targeted mitigation strategies designed to reduce security risks to EU residents both within and beyond European borders.

In the conflict-afflicted regions where CAR documents weapons 'sanitised' through the obliteration of unique serial numbers and other markings, local authorities commonly deem such items 'untraceable' and thus do not investigate their provenance. In addition to trialling new stockpile management practices to enhance post-diversion traceability, CAR plans to launch a range of in-field activities, including enhanced documentation, advanced forensic exploitation, and mark recovery. These efforts are designed to fill an important knowledge gap on weapons that are difficult to trace; resulting findings and data are expected to grant EU member states a better understanding of illicit transfer and mark obliteration practices, thus strengthening their capacity to address trafficking crimes.

For security purposes, some details of the project, notably information regarding the positioning of 'forensic tags', are reserved for law enforcement personnel.

CAR SEEKS TO INCREASE KNOWLEDGE OF THE MECHANISMS OF OBLITERATION AND UNCOVER NEW PATTERNS AND VECTORS OF WEAPON DIVERSION USED WITHIN THE EU.

DEVELOPING A RADIO FREQUENCY IDENTIFICATION SOLUTION

Building on their track record of applying innovative track and trace solutions to weapon stockpiles, TTE has launched research and development activities in support of the F3E project. In particular, TTE is using radio frequency identification (RFID) transponders to enhance the traceability of state-held stockpiles. When fixed to small arms and light weapons, RFID transponders provide redundancy for existing physical security and stockpile management (PSSM) practices, while enhancing the traceability of diverted weapons, irrespective of their age and condition.

Operational armouries are typically managed by service personnel, or armourers, who are responsible and accountable for weapons and ammunition stored within them. When armourers issue materiel to security personnel, they document the transfer using paper records or software systems. The F3E project aims to supplement these systems by integrating RFID transponder-based oversight mechanisms, and specifically by fixing RFID transponders to weapons and installing robust RFID reader gates in the issue hatch of armouries. Once these mechanisms are in place, the passage of small arms and light weapons between armourer and personnel is logged during issue and receipt, reducing the risk of human error and helping to identify shortcomings in PSSM processes.

METHODOLOGY

In addition to supporting the day-to-day administration of small arms and light weapons, the F3E RFID solution supports post-diversion tracing of sanitised weapons. TTE and CAR have developed a solution that involves the application of two RFID transponders to each weapon. The approach offers redundancy while permitting each transponder to maximise its utility as either a ‘logistics tag’ or a ‘forensic tag’. The deployment of RFID transponders equipped with internal memory allows for the collection of granular data, such as serial numbers, armoury location, and unit names. Such data supports the tracing of diverted weapons, providing immediately actionable intelligence to national partners, sanction monitors, and investigators.

Logistics tags are intended to be fixed to the exterior of small arms and light weapons, in a manner that maximises read distance and simplifies PSSM processes. The average read distance of such RFID transponders ranges between 50 cm and 100 cm, permitting reliable detection and reducing the training burden of armoury personnel.

Forensic tags are designed to fit into a weapon’s interior voids. The application of RFID transponders within metal objects significantly reduces their read distance, which is acceptable since their use is reserved for tracing efforts conducted by specially trained personnel. TTE has selected and refined the use of portable scan devices to allow trained investigators to recover information from hidden RFID transponders in non-permissive environments.

TTE has significant experience in deploying RFID transponders to support the management of explosives supply chains. In the context of the F3E project, it tested the suitability of RFID frequencies within various ranges: low frequency (100–135 kHz), high frequency (13.56 kHz), ultra-high frequency (UHF, 860–960 MHz), and microwaves (60 GHz). Low and high frequencies were deemed unsuitable for PSSM purposes, due to short read distances (several centimetres).

Initial test results with UHF transponders fixed to the interior of a deactivated assault rifle under laboratory conditions were varied, yet a number of transponders showed promise, as discussed below.

THE APPLICATION OF RFID TRANSPONDERS WITHIN METAL OBJECTS SIGNIFICANTLY REDUCES THEIR READ DISTANCE, WHICH IS ACCEPTABLE SINCE THEIR USE IS RESERVED FOR TRACING EFFORTS CONDUCTED BY SPECIALLY TRAINED PERSONNEL.

2. TRANSPONDER SELECTION AND SHORTLISTING

STUDY OF AVAILABLE RFID TRANSPONDER TYPES

In the first half of 2020, TTE ran detailed tests under laboratory conditions with 14 commercially available transponders. As a literature review and market survey showed that UHF RFID transponders have a clear advantage over items that use other frequencies, testing focused solely on transponders operating within the UHF range. To ensure that a broad spectrum of technical capabilities would be assessed for suitability for field deployment, TTE selected transponders that varied in terms of their dimensions, intended use, construction, and manufacturer. Table 1 lists the type and model name of the 14 RFID transponders that underwent initial testing.

Table 1
Read distances of RFID transponders submitted for testing

RFID type	RFID model	Figure no.	Read distance (cm)			
			100 mW on metal	500 mW on metal	100 mW without metal	500 mW without metal
UHF paper label	RC5001	1	0	0	10	10
	RC5009	2	0	0	33	30
UHF cable tie tag	RC9003	3	0	0	180	>200
UHF ceramic on-metal tags	RCC6009	4	5	15	5	5
	RCC6010	5	1	20	1	10
	RCC6011	6	30	50	19	40
	RCC6012	7	3	10	3	5
UHF on-metal label	RCO7011	8	40	60	90	120
	RCO7013	9	40	50	50	110
	RCO7018	10	30	30	40	100
UHF on-metal tags	RCO8011	11	100	140	100	120
	RCO8012	12	30	45	58	110
	RCP8002	13	60	110	5	20
UHF pallet asset tag	RCP8007	14	0	0	18	30

Note: Highlighted models were shortlisted for enhanced testing. Model RCP8002 was selected as a case study for bulkier transponders although it is too large to be applied to small arms and light weapons. For test results, see Table 2.

UHF PAPER LABELS

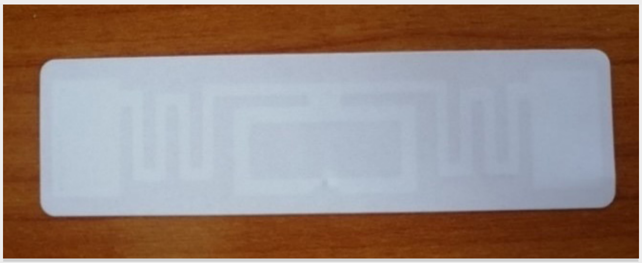
A cost-effective solution for marking large objects, paper labels are easy to apply and can be shipped in bulk. Since they are lightweight and thin, they tend to exhibit a certain degree of fragility.

Figure 1
UHF paper label RC5001

This label is compliant with the EPC C1G2 (ISO 18000-6C) standard. Its operating frequency is 860–960 MHz. Each tag has a unique ID and stores user data.

This transponder does not interact well with metal objects and is thus unsuitable for application to small arms and light weapons.

Figure 2
UHF paper label RC5009



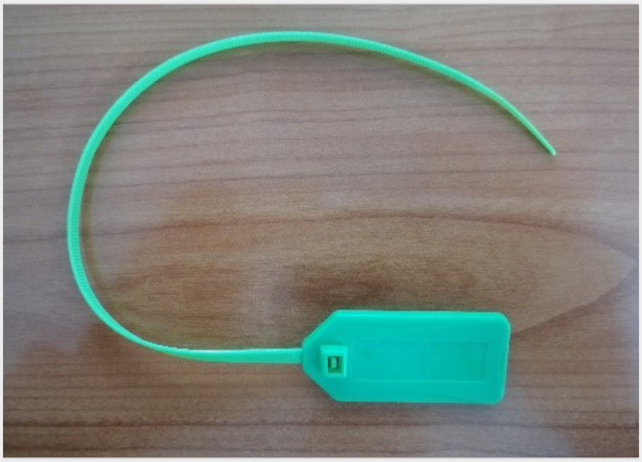
This label is compliant with the EPC C1G2 (ISO 18000-6C) standard. Its operating frequency is 860–960 MHz. Each tag has a unique ID and stores user data.

This transponder does not interact well with metal objects and is thus unsuitable for application to small arms and light weapons.

UHF CABLE TIE TAGS

UHF cable tie tags are low in cost and can be used for indoor and outdoor applications.

Figure 3
UHF cable tie tag RC9003



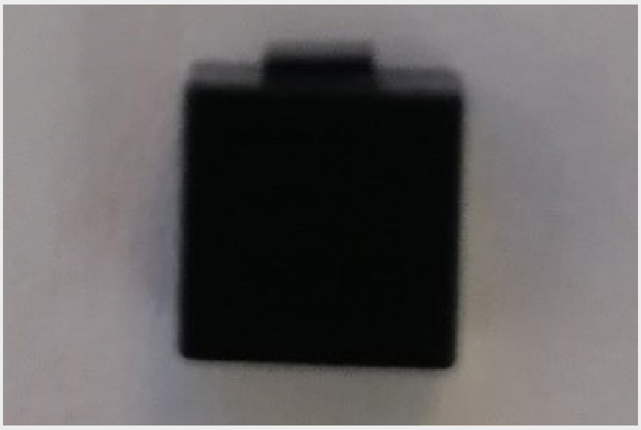
This tag is compliant with the EPC C1G2 (ISO 18000-6C) standard and has an operating frequency of 860–960 MHz.

The tag could be considered suitable for monitoring non-metallic exhibits in judicial storages. Due to its fragility and poor performance when fixed to metal items, however, it is not suitable for operational use.

UHF CERAMIC ON-METAL TAGS

When installed correctly, ceramic on-metal tags are capable of performing under harsh environmental conditions for extended periods. Furthermore, they are more tolerant of being fixed close to metallic surfaces, so long as a non-conductive material creates an insulative gap. The fixing adhesive of tags that are applied to weapon systems is expected to provide sufficient space between the transponder and the metallic surface to permit reliable detection.

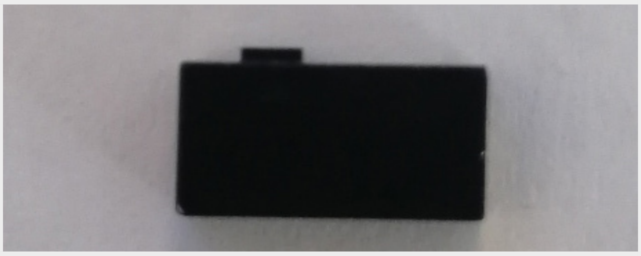
Figure 4
UHF ceramic on-metal tag RCC6009



This on-metal transponder measures 5 × 5 × 3 mm. It can withstand repeated autoclave cycles and can be embedded in metal. This transponder has ATEX certification, which the EU gives to tested equipment that proves to be intrinsically safe in explosive atmospheres. It also meets the requirements of the US Food and Drug Administration (FDA).

As the unit is only marginally larger than RCC6012 (see Figure 7) but has a significantly better read distance, it was selected for enhanced testing.

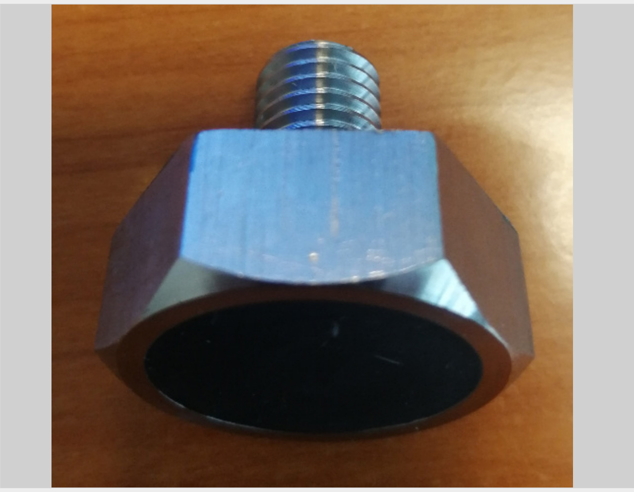
Figure 5
UHF ceramic on-metal tag RCC6010



At 10 × 5 × 3 mm, this ATEX-certified on-metal transponder can be fixed to small metal items.

As its read distance, dimensions, and construction make it appropriate for use as a logistics tag, it was selected for enhanced testing.

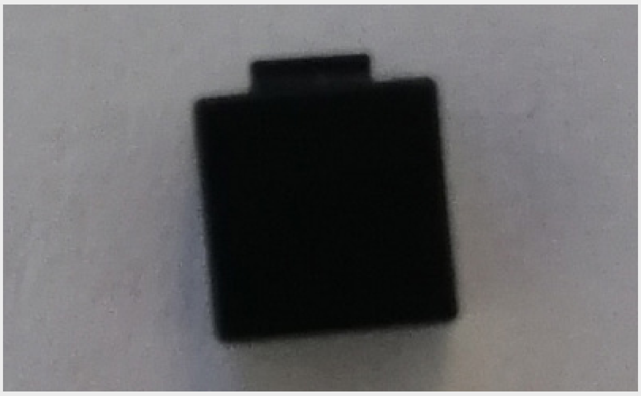
Figure 6
UHF screw on-metal tag RCC6011



This transponder uses ceramic and high-temperature epoxy as base material. This composition allows the unit to work on metal assets and supports extended use in rugged environments.

Unless modified, this transponder is unsuitable for use on small arms and light weapons. With bespoke modification, however, it could replace weapon components at the point of manufacture. Further development work on this transponder is thus warranted.

Figure 7
UHF ceramic on-metal tag RCC6012



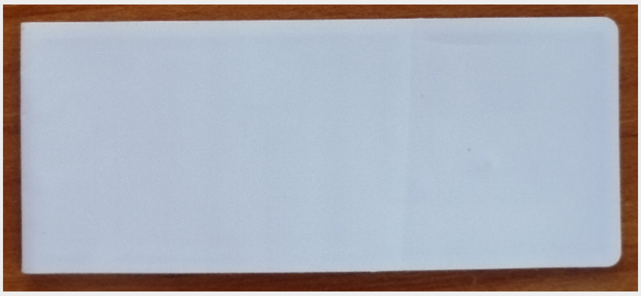
Measuring 4 × 4 × 3 mm, this on-metal transponder has the smallest of the RichRfid form factors. It is ATEX-certified and meets FDA requirements.

Since the read distance, dimensions, and construction render it appropriate for use as a logistics tag, the transponder was selected for enhanced testing.

UHF ON-METAL LABELS

RFID transponders in label form are easy to apply, cost-effective, and available in a range of sizes to suit a variety of assets.

Figure 8
UHF on-metal label RCO7011



This printable RFID adhesive label is only 1 mm thick, much thinner than some other RFID on-metal tags. As it is very thin and flexible, this label is suitable for the management of flat and chambered metal assets, such as metal shelves, containers, and IT assets.

While flat and simple to attach, this item is not suitable for use on small arms and light weapons as it is fragile and prone to impact damage. Attaching this transponder to vehicles and large-calibre weapons might be appropriate, but such use is beyond the scope of this project.

Figure 9
UHF on-metal label RCO7013

This label is flexible and is easy to attach to metal assets. It can be applied to irregular and uneven surfaces, such as steel boilers, metal containers, and steel pipes. While it can be used on metal and non-metal assets, it performs better on metal.

This item is flat and simple to attach, yet it is not suitable for fixing to small arms and light weapons as it is fragile and prone to impact damage.

Figure 10
UHF on-metal label RCO7018

This label is flexible and is easy to attach to metal assets. It can be applied to irregular and uneven surfaces, such as steel boilers, metal containers, steel pipes. It can be used on metal, liquid, and non-metal assets.

Despite its relatively large size, this transponder was selected for enhanced testing as a logistics tag, in view of its read distance and the ease with which it can be affixed to an asset.

UHF ON-METAL TAGS

UHF on-metal tags can be fixed directly to metallic objects and maintain readability at extended distances. As they sit in protective housing, which offers some degree of isolation from the effects of metallic interference, they can be relatively bulky.

Figure 11
UHF on-metal tag RCO8011

Thanks to its industrial plastic housing, this transponder is especially suitable for asset tracking in harsh environments. Depending on the specific chip, antenna, and application, it can be customised as a non-metal or high-frequency tag.

Although this transponder is rugged and has an extended read distance, it is too bulky for deployment on small arms and light weapons.

Figure 12
UHF on-metal tag RCO8012

With its industrial plastic housing, this RichRfid tag is especially suited to tracking assets in severe circumstances. Depending on the specific chip, antenna, and application, it can be customised as a non-metal or high-frequency tag.

Although this transponder is rugged and demonstrates an extended read distance, it is too bulky for deployment on small arms and light weapons.

Figure 13
UHF PCB on-metal tag RCP8002

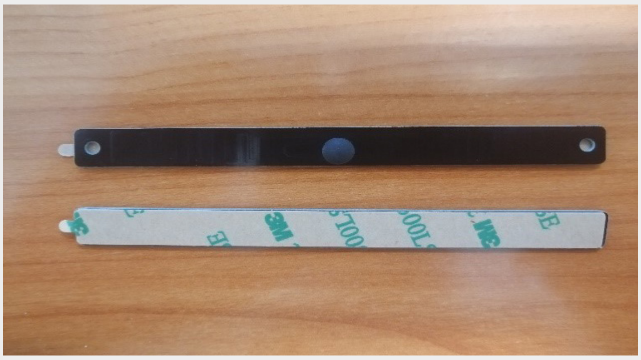
This transponder is constructed with FR-4 materials and rated IP68 for high reliability and durability in all types of environments, including outdoor water, strong acid, and strong base.

The test showed that the tag can be used for more than five years in outdoor environments. Due to its relatively large size, however, it is not suitable for use on small arms and light weapons. Nevertheless, it was submitted for enhanced testing, as a case study to demonstrate the limitations and impracticality of applying larger RFID transponders to weapons.

UHF PALLET ASSET TAG

Pallet tags are cost-effective, reliable, and durable in many types of environment. They are typically used to track pallets.

Figure 14
UHF pallet asset tag RCP8007



The dimensions of this non-metal transponder are 110 × 9.6 × 1.2 mm.

The tag suffered significantly from 'parasitic capacitance', meaning that its interaction with metal objects weakened the radio signal. While this transponder could be considered suitable for use on pallets of small arms ammunition—and therefore of interest in managing ammunition stockpiles at the strategic level, for example—it is unsuitable for use in an operational setting.

3. FIELD-DEPLOYABLE RFID READERS

Handheld, battery-operated RFID readers are used to detect RFID transponders that are fixed to small arms and light weapons. These readers can be deployed in the field, both inside and away from armouries, permitting operators to detect RFID transponders and identify the unique codes they transmit. The following RFID readers were deployed during the testing phase (see Figures 15–17).

Figure 15
Nordic ID Merlin

The Nordic ID Merlin is a robust, multifunctional system, suitable for use in an armoury setting as well as in a field-deployed role.

It has a nominal read range of up to 5 m.

Figure 16
Nordic ID HH53

The Nordic ID HH53 is an all-in-one RFID mobile data entry device, equipped with Golem software. The unit's nominal read range in the linear mode with horizontal and/or vertical polarisation is up to 10 m. The nominal read range in the circular polarisation mode is up to 6 m.

Figure 17
TSL RFID Reader with an integrated Honeywell Mobile computer (CN75)

The rugged 1166 Bluetooth reader from TSL is extremely resistant to water, mud, and mechanical trauma. A high-capability battery allows non-stop operation of the reader over the entire operating day. The device can browse and write unique data, such as serial numbers or end-user data, to a range of RFID transponders.

Its nominal read range is up to 8 m.

4. RESULTS OF ENHANCED TESTING OF LOGISTICS TAGS

TTE conducted laboratory tests of shortlisted RFID transponders as logistics tags, using each of the available field-deployable RFID readers (see Figures 15–17). Table 2 presents the measured values.

Table 2
Read distances of shortlisted RFID transponders submitted for enhanced testing

RFID type	RFID model	Mobile data entry device	Read distance (cm)			
			100 mW on metal	500 mW on metal	100 mW without metal	500 mW without metal
UHF ceramic on-metal tags	**RCC6009** (Figure 4)	**Nordic ID Merlin**	**5**	**15**	**5**	**5**
		Nordic ID HH53	–	60	–	50
		TSL RFID Reader	–	–	–	–
	RCC6010 (Figure 5)	**Nordic ID Merlin**	**1**	**20**	**1**	**10**
		Nordic ID HH53	–	7	–	7
		TSL RFID Reader	7	10	7	10
	RCC6012 (Figure 7)	**Nordic ID Merlin**	**3**	**10**	**3**	**5**
		Nordic ID HH53	–	15	–	10
		TSL RFID Reader	8	12	7	10
UHF on-metal label	**RCO7018** (Figure 10)	**Nordic ID Merlin**	**30**	**30**	**40**	**100**
		Nordic ID HH53	–	60	–	50
		TSL RFID Reader	–	–	–	–
UHF PCB on-metal tag	**RCP8002** (Figure 13)	**Nordic ID Merlin**	**60**	**110**	**5**	**20**
		Nordic ID HH53	–	120	–	110
		TSL RFID Reader	100	110	55	64

Note: The models in this table were shortlisted for enhanced testing following a first set of tests with the Nordic ID Merlin reader (see the bolded read distances and Table 1). Enhanced testing was carried out using two additional devices: the Nordic ID HH53 and TSL RFID Reader. Model RCP8002 was selected as a case study for bulkier transponders although it is too large to be applied to small arms and light weapons.

Ceramic on-metal tags in particular are compact enough to permit a range of applications without compromising on read range performance. In addition, their rugged construction means they are robust enough to be fixed to the exterior of small arms and light weapons. Figures 18–22 show their positions on weapons for testing purposes.

Figure 18
Initial position of transponder RCC6009

Figure 19
Initial position of transponder RCC6010

Figure 20
Initial position of transponder RCC6012

Figure 21
Initial position of transponder RCO7018

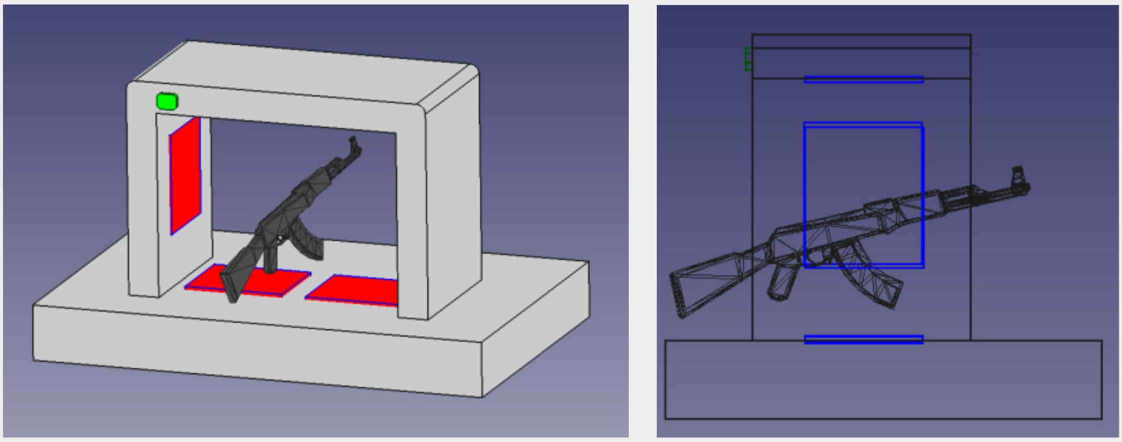
Figure 22
Initial position of transponder RCP8002

5. READER GATE TESTING

TTE and CAR have determined that a static reader gate is the most robust solution for monitoring the day-to-day issue and receipt of small arms and light weapons in an armoury that uses logistics tags. Hand-held scanners are prone to loss and damage. CAR anticipates that the use of a static unit will permit RFID scanning to be seamlessly integrated into existing PSSM practices, without requiring the armourer to add additional steps into established processes that may be error-prone.

TTE developed a prototype reader gate to test the operability of the RFID solution. It then modified the construction to test a variety of operational parameters and refine the system for deployment, as discussed in this section (see Figure 23).

Figure 23
Initial TTE design concept for the UHF armoury test gate



UHF TEST GATE A

TTE constructed a wooden test gate that measured 57 × 85 × 30 cm and featured the following components:

- six Zebra AN610 RFID antennae;
- one Zebra FX9600 RFID reader; and
- one RFID cable to connect the antennae to the reader.

TTE used this deployable reader gate to conduct initial testing of UHF RFID transponders as logistics tags (see Figure 24).

TTE conducted the tests with six antennae, assessing reading range parameters in relation to antenna power. When the antennae were set to the maximum power setting (29.2 dBm), the reliability and read range of loose RFID transponders was high and each antenna registered the RFID signal.

Based on this initial test, TTE selected the four most reliable transponders for further testing. These were models RCC6009, RCC6010, RCC6012, and RCO7018 (see Figures 4, 5, 7, and 10, respectively). TTE subsequently tested these transponders under control conditions (see Figures 25 and 26). This process involved fixing the tags to the exterior surfaces of a deactivated test weapon in the positions shown in Figures 18, 19, 20, and 21, respectively.

Figure 24
UHF test gate A

Figure 25
Test results from passing RFID transponders through test gate A

1 tags

2557 reads
256 reads/sec

00:00:10:302

Start | Stop | Clear

EPC Id	Tag Seen Count	RSSI	Antenna id	Seen Time
E200001C860B0059108021CD	185	-73	1	05/10/2020 07:02:59:886
E200001C860B0059108021CD	763	-74	2	05/10/2020 07:03:01:403
E200001C860B0059108021CD	699	-62	4	05/10/2020 07:03:03:402
E200001C860B0059108021CD	645	-61	5	05/10/2020 07:03:04:401
E200001C860B0059108021CD	265	-64	6	05/10/2020 07:02:59:312

Figure 26
A simulated weapon issue through test gate A

UHF TEST GATE B

In the next step, TTE modified test gate A to assess the effects of reducing the overall number of antennae from six to four. The result was test gate B, which measured 57 × 37 × 30 cm (see Figure 27). Reduced overall size is likely to facilitate the integration of a reader gate into armoury infrastructure.

Figure 27
A simulated weapon issue through test gate B

TTE passed the same four transponders through test gate B. The test results demonstrated that the use of four instead of six antennae resulted in a negligible difference in transponder performance, as the readability values remained acceptable (see Figure 28). TTE then set the reader gate antennae to maximum power (29.2 dBm) and repeated the experiment, having correctly anticipated that doing so would increase the readability of the transponders (see Figure 29).

Figure 28
Test results from passing RFID transponders through test gate B

1 tags

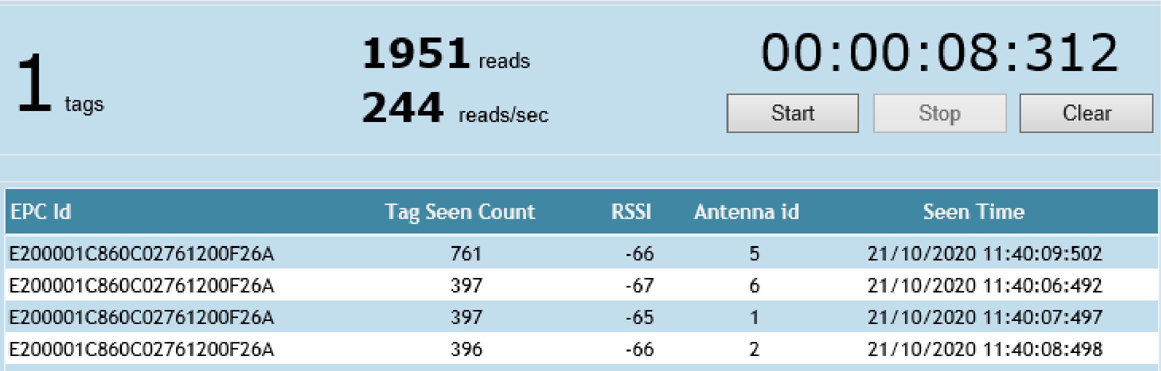
1620 reads
49 reads/sec

00:00:34:104

Start Stop Clear

EPC Id	Tag Seen Count	RSSI	Antenna id	Seen Time
E200001C860B009411403DAB	600	-70	6	21/10/2020 11:20:59:975
E200001C860B009411403DAB	550	-69	5	21/10/2020 11:20:54:876
E200001C860B009411403DAB	209	-63	1	21/10/2020 11:20:57:638
E200001C860B009411403DAB	261	-65	2	21/10/2020 11:20:58:384

Figure 29
Test results from passing RFID transponders through test gate B with antennae set to maximum power


1 tags
1951 reads
244 reads/sec
00:00:08:312
Start Stop Clear

EPC Id	Tag Seen Count	RSSI	Antenna id	Seen Time
E200001C860C02761200F26A	761	-66	5	21/10/2020 11:40:09:502
E200001C860C02761200F26A	397	-67	6	21/10/2020 11:40:06:492
E200001C860C02761200F26A	397	-65	1	21/10/2020 11:40:07:497
E200001C860C02761200F26A	396	-66	2	21/10/2020 11:40:08:498

UHF TEST GATE C

In December 2020, TTE developed test gate C with new dimensions and two new antennae. The aim was to conduct tests on linear antennae and examine their interaction with RFID transponders in a variety of orientations. TTE selected Times-7 A8060 linear antennae, measuring 650 × 90 mm. The reader gate measured 95 × 33 × 30 cm (see Figure 30).

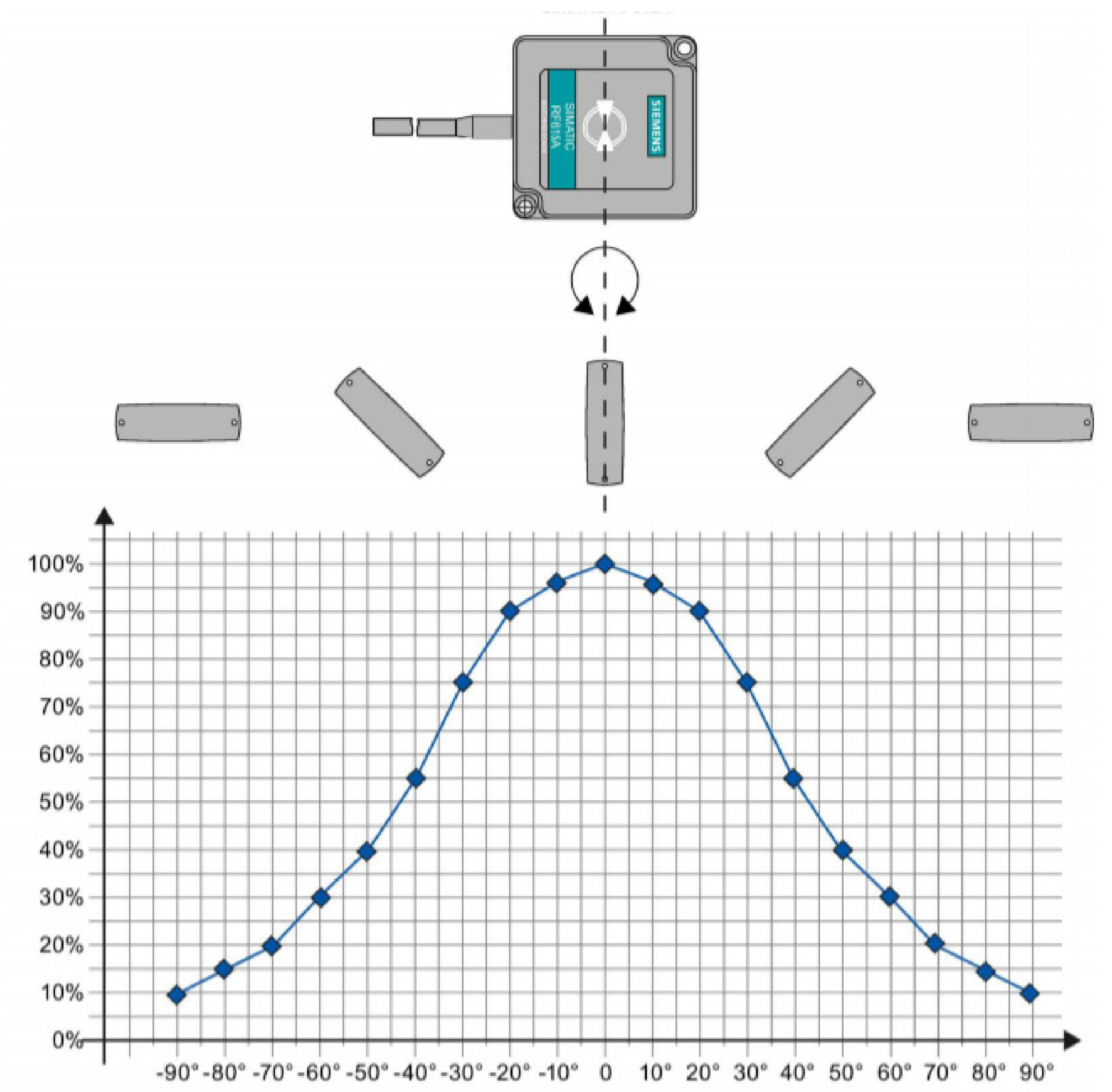
TTE carried out the test with on-weapon transponders and the antennae set to maximum power (29.2 dBm). The results showed that the linear antennae were associated with a significant reduction in transponder reliability, as the orientation of an RFID transponder influenced readability. Indeed, with this setup, RFID transponder RCC6012, shown in Figure 7, failed to be read in any orientation.

Figure 30
Test gate C

When the RFID transponders are parallel to the RFID field of the Times-7 antennae, readability is maximised.

The more a transponder shifts away from the parallel orientation, the poorer is the antenna read performance (see Figure 31).

Figure 31
The effects of RFID transponder orientation on antenna read performance



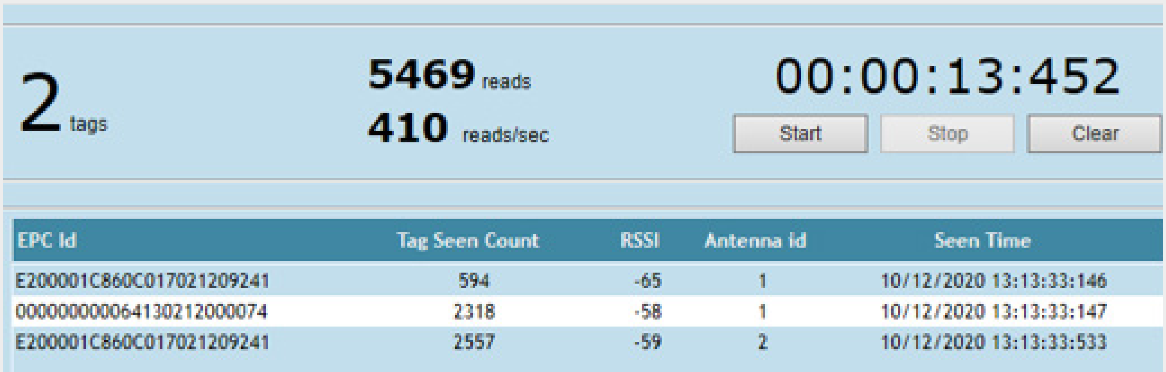
CONCLUSION

TTE's tests demonstrate that RFID transponder RCC6009, shown in Figure 4, achieved the best forensic tag results, with a read rate of 410 reads per second (see Figure 32). This read rate is sufficiently high to ensure that the antennae will detect the transponder on a weapon, even if the transfer of that weapon through the gate happens very quickly.

CAR is currently testing adhesives to develop the method by which logistics and forensic tags may be applied to small arms and light weapons. Specifically, CAR is testing the read distance of transponders that are fixed to the interior of weapons. In addition, CAR will work with providers to conduct live-fire tests, so as to ensure that RFID transponders do not interfere with tag adhesion or weapon function. During 2021, CAR will deploy the system to an armoury in West Africa, where it will conduct field trials.

CAR and TTE will release additional reports during the operational phase.

Figure 32
Test results from passing two RCC6009 RFID transponders through test gate B, with antennae set to maximum power



EPC Id	Tag Seen Count	RSSI	Antenna id	Seen Time
E200001C860C017021209241	594	-65	1	10/12/2020 13:13:33:146
000000000064130212000074	2318	-58	1	10/12/2020 13:13:33:147
E200001C860C017021209241	2557	-59	2	10/12/2020 13:13:33:533

7. ANNEX

Table 3
Data sheets

Figure	RFID Model	Data Sheet
1	RC5001	https://www.richrfid.com/uploads/c5a60949.pdf
2	RC5009	https://www.richrfid.com/uploads/30f5e2511.pdf
3	RC9003	https://www.richrfid.com/uploads/ead0381d5.pdf
4	RCC6009	https://www.richrfid.com/uploads/36320eee3.pdf
5	RCC6010	https://www.richrfid.com/uploads/6f77dd8b3.pdf
6	RCC6011	https://www.richrfid.com/uploads/cf5832182.pdf
7	RCC6012	https://www.richrfid.com/uploads/243487f63.pdf
8	RCO7011	https://www.richrfid.com/uploads/aeff24d81.pdf
9	RCO7013	https://www.richrfid.com/uploads/RCO7013-EN1.pdf
10	RCO7018	https://www.richrfid.com/uploads/0ca85c3e1.pdf
11	RCO8011	https://www.richrfid.com/uploads/5f3e70ea.pdf
12	RCO8012	https://www.richrfid.com/uploads/f98442371.pdf
13	RCP8002	https://www.richrfid.com/uploads/ea22f3373.pdf
14	RCP8007	https://www.richrfid.com/uploads/RCP8007-EN.pdf
15	Nordic ID Merlin	https://mans.io/files/viewer/602831/1
16	Nordic ID HH53	https://www.nordicid.com/wp-content/uploads/nordic-id-hh53-user-guide.pdf
17	TSL Reader	https://www.tsl.com/wp-content/uploads/1166-Bluetooth-Rugged-UHF-Reader-Datasheet.pdf
	CN75	https://www.honeywellaidc.com/en/-/media/en/files-public/data-sheets/cn75-cn75e-handheld-computer-data-sheet-en.pdf

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