NATO STANDARD

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PERFORMANCE OF NON-LETHAL LAND VEHICLE ARRESTING DEVICES

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NATO LETTER OF PROMULGATION

6 February 2020

1. The enclosed Allied Engineering Publication AEP-74, Edition C, Version 1, on PERFORMANCE OF NON-LETHAL LAND VEHICLE ARRESTING DEVICES, which has been approved by the nations in the NATO Army Armaments Group (NAAG), is promulgated herewith. The agreement of nations to use this publication is recorded in STANREC 4729.

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4. This publication shall be handled in accordance with C-M(2002)60.

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Brigadier General, HUNAF
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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS
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RECORD OF SPECIFIC RESERVATIONS

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CHAPTER 1 INTRODUCTION

NATO nations are increasingly involved in establishing a Non-Lethal Capability (NLC) in order to fulfill current and future military objectives. Non-Lethal Weapons (NLW) systems are the tools of choice for the establishment of a NLC. To date, individual nations made efforts to determine the performance of such systems, and assess their military value in specified tasks.

1.1. SCOPE AND PURPOSE

This document provides guidance on appropriate measures and metrics, for the purpose of objectively determining the technical and operational performance of non-lethal land Vehicle Arresting Devices (VADs). A VAD is a technical means specifically designed and primarily employed to deliberately stop a moving vehicle.

The aim of this STANREC is to have a capability-based standard, i.e. explicitly linking the technical performance of NLW to their purpose as a NLC.

The current edition is not meant to be a standard for the qualification of VADs. Instead, it is a common frame of reference to promote exchange and enable comparison of performance test results between nations. This document shall therefore provide a set of measures and metrics that, when assessed, would determine the performance of non-lethal VADs, relevant to the capability it represents.

The following general categories of non-lethal land VADs are recognized.

a. Permanent VADs: devices planned and intended to be part of a comprehensive obstacle system at permanent sites to defeat vehicles. These VADs typically require heavy/specialized equipment and skilled labour for their installation, and are constructed over a lengthy period of time (typically days/weeks).
b. Deliberative VADs: devices planned and intended for use at deployed sites to defeat vehicles. These VADs can be recovered, relocated and emplaced at other sites. These VADs require no heavy/specialised equipment and skilled labour, and are constructed over a moderate period of time (typically hours).
c. Hasty VADs: mobile devices that provide limited scale/scope defence against vehicles. These VADs require no heavy/specialised equipment and skilled labour for their installation. These VADs are quickly emplaced, employed and recovered (typically seconds).

The current edition of the AEP-74 is limited to:

a. Non-lethal land VADs primarily based on mechanical technology.
b. Deliberative and hasty emplaced VADs.
c. Targets which are wheeled, civil-based, land vehicles.

1.2. INTENDED AUDIENCE

The following groups are considered the primary users of this document.

a. Test and evaluation community, wanting to objectively determine the technical performance of VADs (e.g. for reasons of procurement and qualification).
b. Operational community, wanting to have a clear understanding of the capability offered by specific VADs in theatre.

CHAPTER 2 CAPABILITY DESCRIPTION

In order for an operational commander to understand the capability offered by a specific VAD, the following questions should be answered:

a. What is the primary intended effect of the device (i.e. ‘what does it do’)?
b. Against which range of targets will the device perform adequately?
c. Which resources (i.e. time, manpower, and tools) are needed to emplace, operate and maintain the capability?
d. Under which conditions is the performance established/maintained?
e. To which degree can the capability be integrated in operations?
f. Which safety issues should be taken into account?

The comprehensiveness of the capability description is determined by the quality of answers to the questions. The following measures and metrics shall be used in support of answers.

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CHAPTER 3 MEASURES AND METRICS OVERVIEW

The capability description includes measures on the VAD system, the target system, the environment and the interaction. The following sections provide an overview of measures that together form a minimal set to properly characterize the capability. Furthermore, each measure is linked to an appropriate metric. The following types of measures are listed:

a. Measures of performance (MoP), characterizing the inherent properties of the VAD system or the target system, in a given environment.
b. Measures of effectiveness (MoE), characterizing the outcome of the technical engagement of the VAD system with the target system, in a given environment.
c. Measures of suitability (MoS), characterizing the utility of the VAD system, in a given environment.

3.1. VAD SYSTEM

This group of measures and metrics involves the VAD and its utility.

Table 1: VAD System measures and metrics description.

TYPE	MEASURE	METRIC
MoP	System type (primary operating mechanism)	Short description
MoP	Suited for which targets (manufacturer specification)	Target type, mass, velocity, trajectory, geometry
MoP	Suited in which climate (manufacturer specification)	Wet/dry, hot/cold, humid, altitude
MoP	Dimensions (one complete VAD, packed)	Mass, Length x Width x Height per package and number of packages
MoP	Dimensions (area covered in deployed state)	Length x Width or Height (see Figure 1)
MoP	Complexity	List of main components (including trigger if present), interfaces
MoP	Manner of deployment (needed to switch VAD on/off)	Type (mechanical, electrical,…), short description, resources needed (e.g. electrical power), modes (if any)
MoS	Deployment reliability	Percentage of proper deployments and sample size
MoS	Durable (multiple set-ups/deployments)	Yes (maximum number of times) / No
MoS	Reusable (multiple engagements)	Yes (maximum number of times, reset time/resources needed) / No

TYPE	MEASURE	METRIC
MoS	Tools and equipment needed for VAD set-up, sustainment and regular maintenance	Short description (minimal, best)
MoS	Labour needed to construct, sustain and maintain the VAD	Number of personnel (skilled / unskilled)
MoS	Personnel needed to operate the VAD	Number of personnel (minimal, best)
MoS	Site preparation (needed for minimal deployment)	Short description (e.g. anchor points, run-off areas, troops positions, channeling)
MoS	Site preparation (needed for best deployment)	Short description (e.g. anchor points, run-off areas, troops positions, channeling)
MoS	Utility times	(see Figure 2)
MoP	Visibility	Colour, contrast, covert use
MoS	Interoperability	Interfacing VAD's with each other, interfacing VAD with other systems
MoS	Impact on environment	VAD debris, target debris, property damage due to set-up, deployment, engagement, other items of interest/relevance.

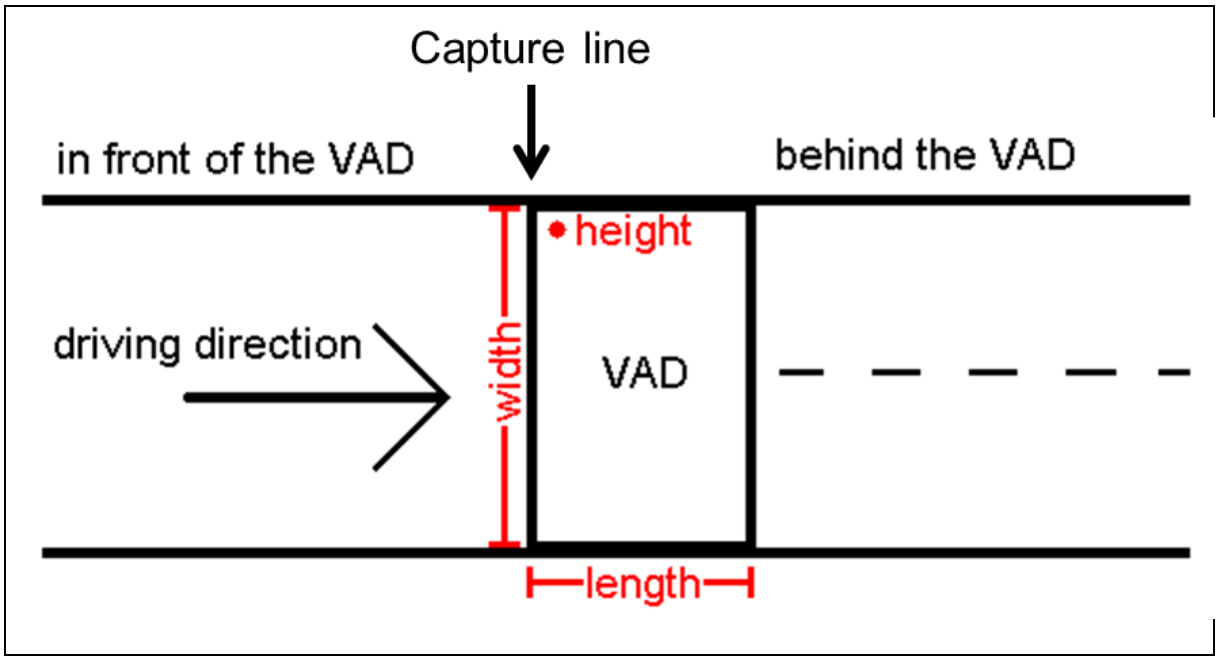

Figure 1: VAD Dimensions.

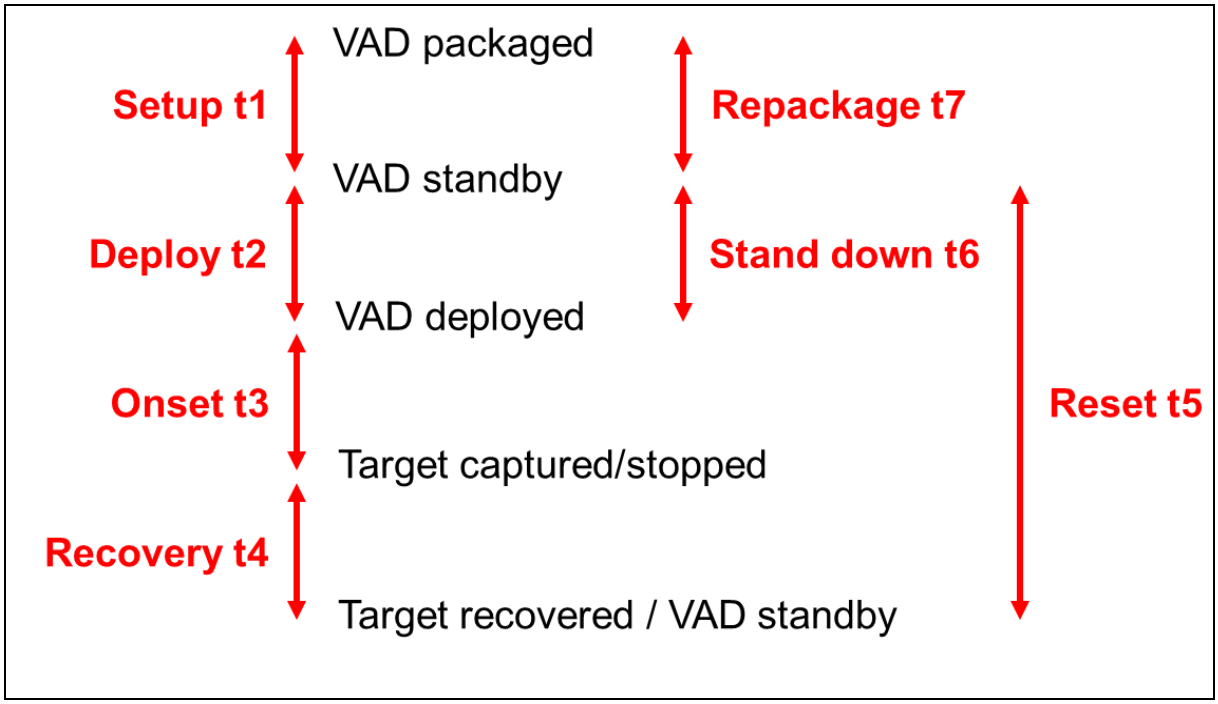

Figure 2: Definition of utility times, i.e. times needed to perform state transitions.

Remarks:

a. The state 'VAD standby' implies that traffic may still bypass the device without significant hindrance.
b. The lenght of utility times depend on available tools and manpower. This does not affect the definition of utility times.
c. In VAD tests, the proper (i.e. according to applicable operation specifications) deployment shall be checked before the test continues.
d. Utility time t5 includes several steps which can be performed in series or parallel, namely: clear engagement area, clear run-off area, disengage VAD from vehicle, reinstate VAD to standby mode.
e. Electrical as well as electronic components, if any, shall be properly EMI protected.
f. Resources required to operate and maintain the capability can be visualized as depicted in Figure 3.

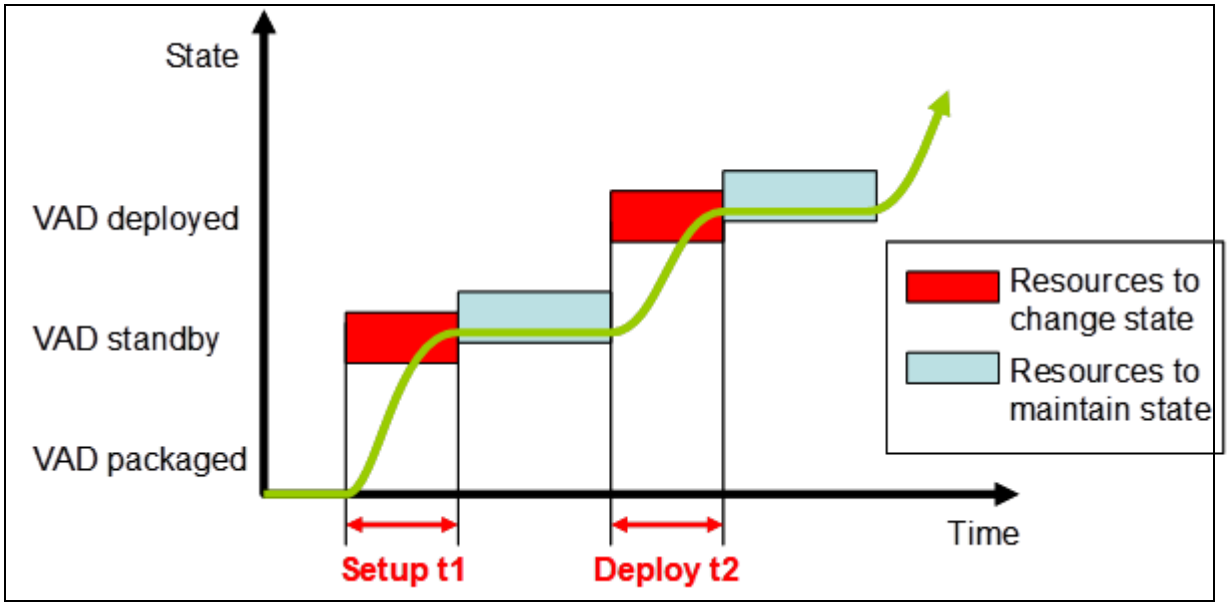

Figure 3: Illustration of resource planning for vehicle arresting capability.

3.2. TARGET SYSTEM

This group of measures and metrics involve the vehicle to be engaged.

Table 2: Target System measures and metrics description.

TYPE	MEASURE	METRIC
MoP	Vehicle type	Make and model
MoP	Mobility type	Front wheel drive, rear wheel drive, or 4-wheel drive
MoP	Vehicle geometry	Shape, dimensions (see Figure 4)
MoP	Optional: wheel base	Distance between centre lines
MoP	Mass	Total mass at point of engagement
MoP	Tires	Type, size, tread, state (old/new), pressure, with/without spikes
MoP	Optional: wheel bay dimensions (front)	Arc and depth (see Figure 5)
MoP	Engagement velocity	Vehicle velocity at capture line
MoE	Vehicle orientation to VAD (at capture line)	Angle of the normal vector of the front vehicle bumper with projected path (measured from the intersection with the capture line)
MoE	Optional: timing (moment of engagement)	Time between VAD deployed and target system engaged
MoP	Optional: driver characteristics	Age, gender, experience
MoE	Driver actions	Throttle, brake, steering

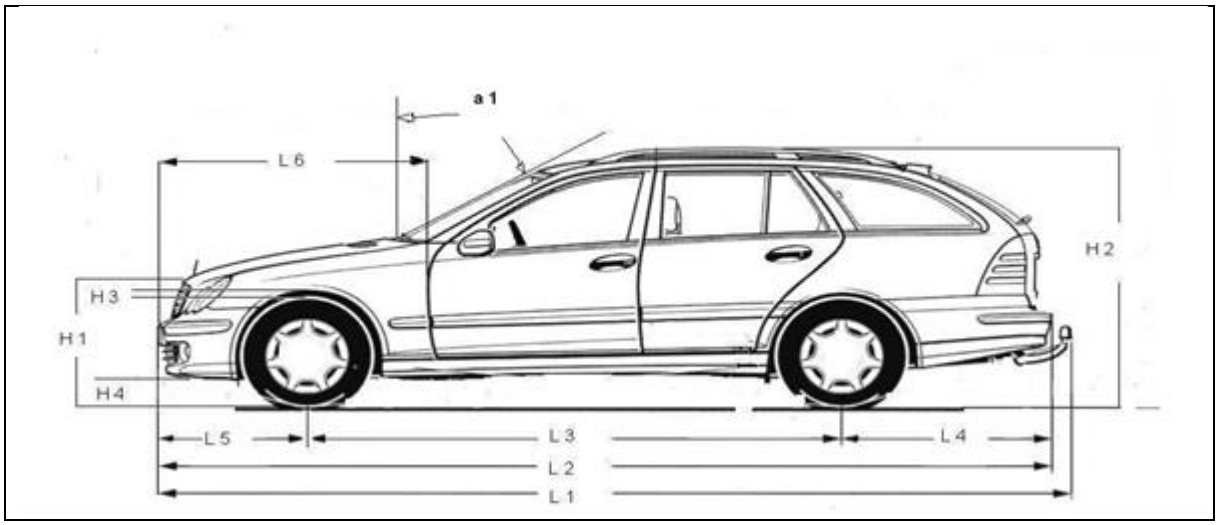

Figure 4: Measurement of vehicle geometry.

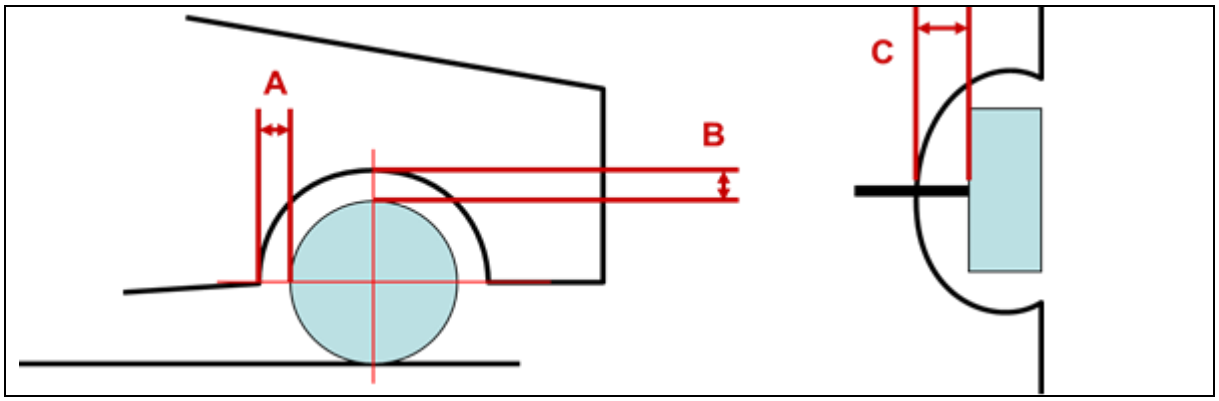

Figure 5: Measurement of front wheel bay dimensions.

Remarks:

a. Vehicle geometry may not be a relevant measure with some VAD systems, whereas tires are, and vice versa. The VAD system type shall provide sufficient details to determine which measure is relevant.
b. Optional measures may be relevant to specific VAD system types, or may only be relevant during tests.

3.3. ENVIRONMENT

This group of measures and metrics involves climate and road conditions.

Table 3: Environment measures and metrics description.

TYPE	MEASURE	METRIC
MoP	Weather (atmospheric conditions)	Dry, rain, snow, ice, fog, sun, wind, dust
MoP	Temperature	Temperature
MoP	Light	Day, twilight, night
MoP	Terrain	Road or open terrain
MoP	Road type	Improved or unimproved
MoP	Ground conditions (9 conditions, dealing with slipperiness and firmness)	Dirt/grass wet and dry, sand wet and dry, pavement wet and dry, icy, snowy, oily
MoP	Site condition	Short description (shoulder, obstacles, anchor points, road slope and curves)
MoP	Site dimensions	Acceleration area, capture area, run-off area, channeling

3.4. INTERACTION

This group of measures and metrics involve the interaction of the VAD System with the Target System, in the Environment.

Table 4: Interaction measures and metrics description.

TYPE	MEASURE	METRIC
MoE	Engagement (with primary operating mechanism of VAD)	Full, partial, no
MoE	Capture (given proper or improper deployment)	Full, partial, no
MoP	Number of tires captured	Number, position on vehicle
MoE	Angle of engagement	Angle between VAD main stopping action and projected path of the vehicle
MoE	Distance to full stop	Distance from capture line to front of vehicle bumper (middle) along traveled path
MoE	Vehicle position	Distance of front of vehicle bumper (middle) lateral to projected path
MoE	Vehicle orientation (at stopped position)	Angle of the normal vector of the front vehicle bumper with projected path (measured from the intersection with the capture line)
MoE	Vehicle damage	Description of damage, time to reinstate vehicle to previous

TYPE	MEASURE	METRIC
MoS	Vehicle capture team positioning	condition (equals t4 in Figure 3), resources needed to reinstate Short description (considering safe positions and positions from where to initiate follow-on actions)

Remark:

a. A VAD may stop and not capture the target system, meaning that the capturing function may be provided in another system or capability.

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CHAPTER 4 ASSESSMENT OF PERFORMANCE

Statements on performance, effectiveness or suitability require the comparison of known characteristics from Section 3 with the expressed military need from Section 2. The military need may include some or all of the measures provided in Section 3. Also, this may depend on the needs of the requesting military agency (e.g. procurement, operations).

The user shall make clear which measures are included in the assessment of which specific performance. Also, the procedure by which the performance is assessed (e.g. weighted summation of measures) shall be explicitly described.

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ANNEX A DEFINITION OF TERMS

The following defines terms used in the main text of this document.

Recovery: restoring (the vehicle) to its pre-engagement functions. Full recovery implies that non-lethal reversibility is fully accomplished.
Reversibility: ability to restore the engagement, in particular

a. Damage and repair of the target vehicle.
b. Injury risk (of operators, drivers and bystanders).
c. Impact on environment.

Packed: state with the VAD is in its organic transport package.
Standby: state with the VAD is ready to use (i.e. on the side of the road). It implies that a vehicle is able to bypass the VAD without engagement.
Deployed: state with the VAD is armed/ready to capture the target vehicle (i.e. on the road).
Engaged: state where the target vehicle has interacted with the primary operating mechanism of the VAD.

a. Partial: target vehicle and VAD got into contact with each other, with primary capture mechanism not exploited to its fullest.
b. Full: target vehicle and VAD got into contact with each other as intended.

Capture line: front position of the VAD intersecting with the projected path of the vehicle.
Captured: state where the target vehicle has been immobilised by the VAD.

a. Partial: temporary disability or deceleration of the target vehicle (can eventually drive away by itself).
b. Full: disability of the target vehicle (cannot drive away by itself).

Durable: the VAD can be set-up or deployed several times without attrition/detrition (at least twice).
Reusable: the VAD can engage a target vehicle several times without attrition/detrition (at least twice).
Effectiveness: the outcome of the technical engagement of the VAD with the target vehicle, in a given environment. It implies a level of task completion (i.e. vehicle stopping).
Performance: the inherent properties of the VAD or the target vehicle, in a given environment.
Suitability: the utility of the VAD, in a given environment.

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ANNEX B GUIDANCE ON DATA GATHERING

Metrics are determined in tests, i.e. field trials, exercises, or recordings during operational use. The measures of interest depend on the nature and purpose of the test. Examples are technical performance tests, utility tests, safety tests, etc.
The manner in which metrics are gathered is not prescribed in detail. Instead, guidance is offered based on currently known best practices. In the following, details are provided on test site design, risk mitigation during tests, and data recording.

B.1 TEST SITE LAYOUT

The test site shall have a general layout as shown in Figure B.1.

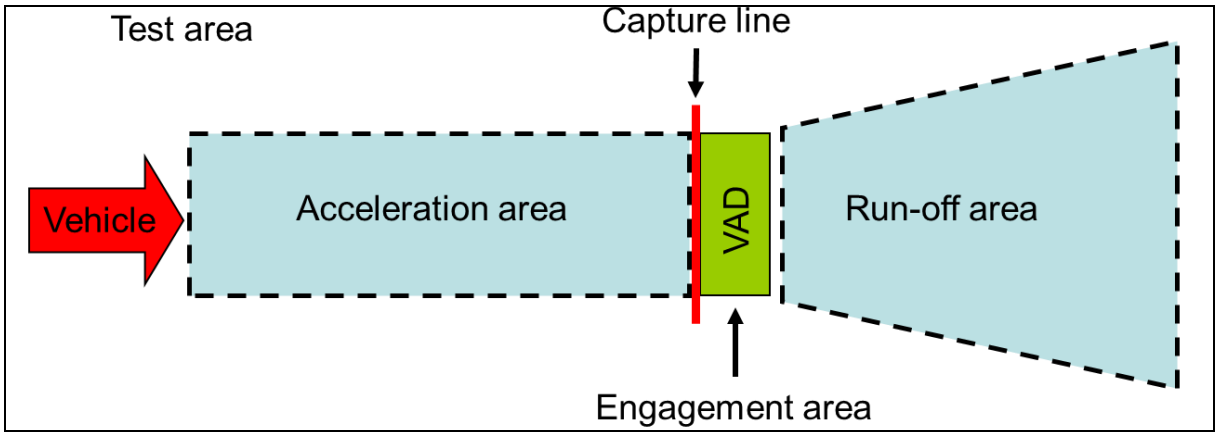

Figure B.1: General layout of a VAD test site.

B.2 TEST OPERATION

The following is an overview of data gathering activities to be performed or considered before, during or after a vehicle capture test.

Table B.1 Data gathering guidance on the VAD System (pre-test).

VAD and any additional components (AddC)	
Metric	**Method or device**
Length X Width X Height and Weight per box and number of boxes (VAD PACKED)	
Length X Width X Height and Weight (VAD DEPLOYED)	

VAD and any additional components (AddC)	
Metric	**Method or device**
Additional components (AddC) to the main VAD system, remote control etc. (Yes / No)	If yes, short description will be provided.
Length X Width X Height and Weight per box and number of boxes (AddC PACKED)	
Length X Width X Height and Weight (AddC DEPLOYED)	
Deployment time	
Number of manpower in the deployment process	
Tools for the deployment process	
Considerable site preparation efforts necessary for the deployment of VAD and AddC? (Yes)/No	If yes, short description will be provided.

Table B.2 Data gathering guidance on the test site (pre-test).

Test site	
Metric	**Method or device**
Length X Width of the track before the capture line	Measuring tape or digital measurement instrument
Width of the track at the capture line	Measuring tape or digital measurement instrument
Length X Width of the Run-off area after the capture line	Measuring tape or digital measurement instrument

NOTE: the inherent properties of the test site (e.g. type of road, slope etc.) is typically captured in a survey, with measures and matrics as described in Table 3.

Table B.3 Data gathering guidance on test risk mitigation (pre-test).

Risk mitigation	
Metric	**Method or device**
Safety measures for the acceleration track	Large and heavy tires, hay bales along the track
Safety measures for the run-off area	Large and heavy tires, hay bales along all edges. The length and width of the run-off area must be, as a minimum, due to the manufacture’s recommendations

Risk mitigation	
Metric	**Method or device**
Safety measures for the driver and co-driver (if present)	Seat belts must be used during each run. High performance helmets. Extra breaking pedal can be considered.
Safety measures for the track monitors	Track monitors must stand behind safety barriers and fitted with working boots and safety vests.

Table B.4 Data gathering guidance on the Environment (in-test).

Environmental conditions	
Metric	**Method or device**
Temperature and local wind (speed and direction)	Commercial weather stations with temperature sensor and wind (speed and direction) sensors may be available

Table B.5 Data gathering guidance on the capture action (in-test and post-test).

Data recording	
Metric	**Method or device**
Before the capture line	
Vehicle's speed before the capture line	Differential GPS with car passage recording / Self-contained GPS logger / Stop watches
Angle of the vehicle driving path related to the capture line	Video camera
Position of the VAD relative to the driving track	Coordinates recorded by GPS before each run / foto / video / measurements by hand
During the engagement	
Time and distance from the vehicle arriving at the VAD until the vehicle is engaged	High speed camera / normal speed video camera with a running clock.
Time and distance from the point where vehicle is engaged until vehicle is captured	High speed camera / normal speed video camera with a running clock
Time and distance from the vehicle arriving at the VAD until the vehicle is captured	Differential GPS with car passage recording / Self-contained GPS logger / Stop watches
Vehicle's de-acceleration time from the capture until it has stopped	Video recording / GPS speed profile after engagement

Angle of the vehicle's path deviating from the straight line in the run-off area	Measurement tape
Position of the vehicle relative to the driving track and VAD position	Necessary if GPS devices are used to measure deviation in the run-off area
Captured vehicle (depends on the VAD's capture method): Number of wheels captured Number of wheels punctured Vehicle is fully or partly captured	Track monitor notes / video recording
If present - driver's response during engagement: brake pedal operation, gear shifting, steering wheel actions	Video recording inside the test vehicle
If present - dummy's response during engagement: forces acting on dummy	Dedicated data recording
After the engagement	
Description of the impact on the site	Track monitor notes
Time needed to sustain the site	Running clock
Tools/labour used in sustaining the site	Track monitor notes / video recording
Time needed to reinstate the VAD to standby or deployed state (in case of multi-use)	Running clock
Tools/labour needed to reinstate the VAD to standby or deployed state (in case of multi-use)	Track monitor notes / video recording
Time needed to reinstate the target vehicle to pre-test functionality	Running clock
Tools/labour needed to reinstate the target vehicle to pre-test functionality	Track monitor notes / video recording
Target vehicle part(s) repaired	Track monitor notes / video recording

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