



# AEROFLEX

## Aerodynamic and Flexible Trucks for Next Generation of Long Distance Road Transport

**EUROPEAN COMMISSION**  
**Horizon 2020 | GV-09-2017 | Aerodynamic and Flexible Trucks**  
**GA - 769658**

Deliverable No.	AEROFLEX 6.3	
Deliverable Title	Test programme and protocol	
Deliverable Date	2019-05-15	
Deliverable Type	Report	
Dissemination level	Public	
Written By	À. Freixas (IDIADA) and P. Mentink (TNO)	2019-04-01
Checked by	J. Engasser (MAN), P. Elofsson [Scania], M. Olbäck (Volvo) and G. Cordua (CNH)	2019-05-15
Approved by	B. Kraaijenhagen (MAN) - Coordinator	2019-05-15
Status	Final	2019-05-15

**Publishable Executive Summary**

As overall objective, AEROFLEX WP6 aims to define a suitable physical test protocol that concludes in energy efficiency and energy consumption results and a wide assessment framework which provides impact results of the developed technologies against the various logistic applications.

To accurately determine the improvement in fuel economy for the aerodynamic and distributed powertrain technological innovations and more effective loading space utilization, a test matrix and a test protocol have been defined to consider all of these innovations in a structured manner for different vehicle configurations and types of test. This test protocol for vehicles fuel consumption measurements is based on the SAE J1526-III protocol with some minor additions and is confirmed by the SAE Charmain, B. McAuliffe as suitable approach for evaluating the performance of the distributed powertrain and aerodynamic innovations. The air drag test protocol is an extension of the Commission Regulation (EU) 2017/2400.

The test program defined, include five different test use-cases being:

1. Fuel consumption tests at steady-state speed on test track
2. Fuel consumption tests on the public road
3. Air drag on test track
4. Vehicle dynamic measurement on test track and
5. Terminal loading tests at a customer's depot.

All these test use cases are included in a test matrix (Figure 1) that includes nine different vehicle configurations including tractor semi-trailers (16,5m) and European Modular System (EMS) configurations (both EMS1 of 25,25m and EMS2 of 32m).

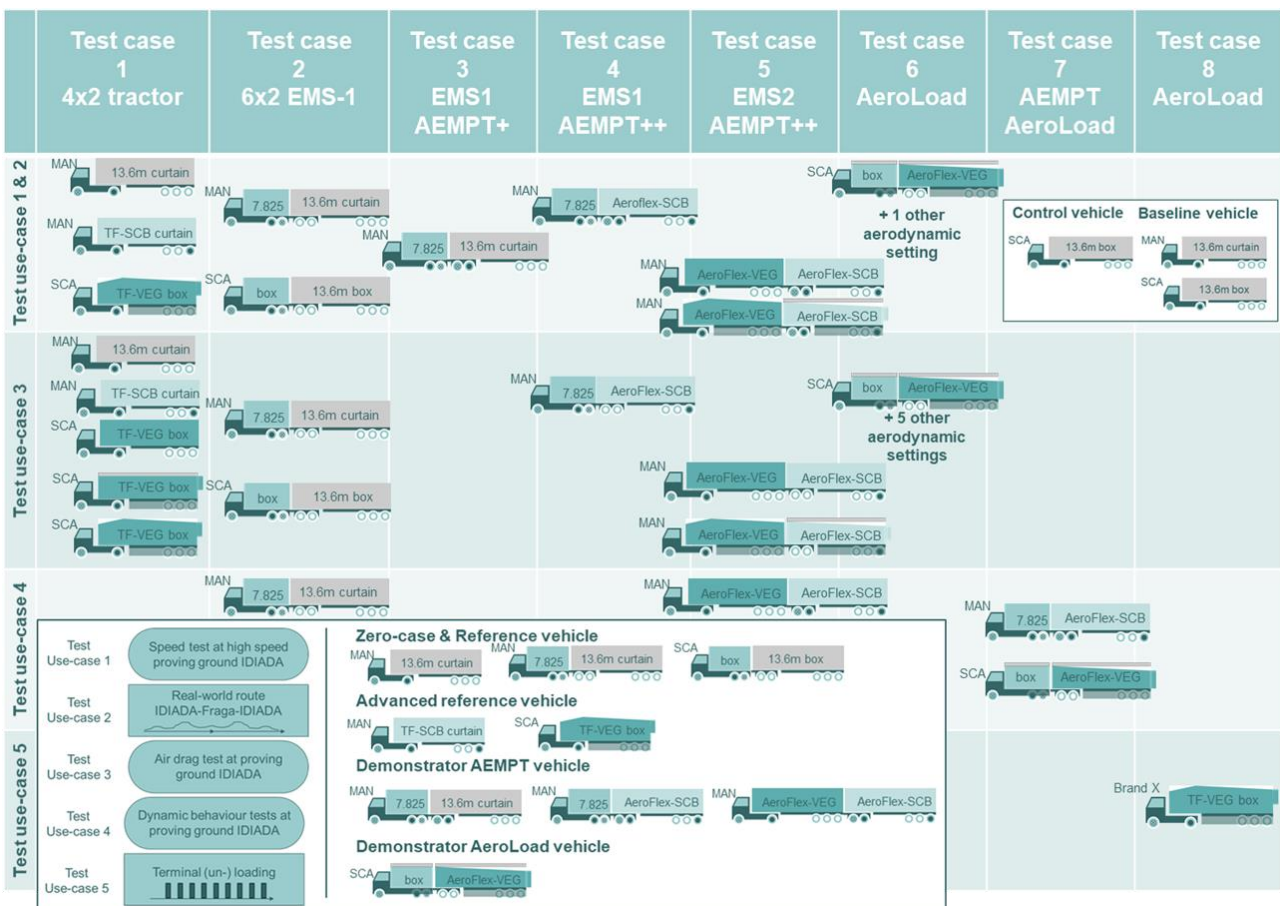


Figure 1. WP6 Test matrix with 8 test cases and 5 test use-cases. Four classes of vehicles are separated: 1) Reference vehicles including zero-case, 2) Advanced reference vehicles, 3) Demonstrator AEMPT vehicles and 4) Demonstrator AeroLoad vehicle

The smart selection of test cases and test use-cases has been made to deal with the trade-off between number of possible vehicle variations and number of repetitions for accurate and significant measurement results versus available test time, budget, equipment and resources. The objective is to evaluate the newly developed

technologies, concepts, and architectures within WP2, WP3 and WP4 and to demonstrate their impact under real conditions followed by a validation and an assessment of the application potential for these concepts in Europe.

Parts of this test protocol are the necessary vehicle preparations, the characteristics of the measurement equipment for each test use case, vehicle loading conditions for the three vehicle configurations, test tracks and specific external location to carry on the tests as real route and loading terminal.

Based on the results of this test program, the aim of WP6 is to execute a technical impact assessments by simulation to quantify the impact of the AEROFLEX innovations for various relevant logistic applications (as part of D6.6).

# Contents

1	Purpose of the document.....	10
2	Introduction.....	11
	Fuel consumption efficiency .....	11
	Aerodynamic efficiency.....	11
	Loading efficiency.....	11
	Safety standards.....	11
3	Test matrix.....	12
3.1	Introduction to the test matrix .....	12
3.2	Test-cases (vehicle configurations).....	
	3.2.1 Zero-case vehicle .....	
	3.2.2 Reference vehicles .....	
	3.2.3 Advanced reference vehicles .....	
	3.2.4 Demonstrator AEMPT vehicles .....	
	3.2.5 Demonstrator AeroLoad vehicle.....	
	3.2.6 Control and baseline vehicles .....	
3.3	Test use-cases (type of tests).....	
	3.3.1 Test use-case 1 – Steady-state speed test at proving ground .....	
	3.3.2 Test use-case 2 – Real world Route Fraga .....	
	3.3.3 Test use-case 3 – Air drag measurement at proving ground.....	
	3.3.4 Test use-case 4 – Dynamic behaviour tests at proving ground .....	
	3.3.5 Test use-case 5 – Terminal (un-) loading tests .....	
3.4	Overview vehicle comparisons .....	
	3.4.1 Vehicle comparisons for KPI – Fuel consumption efficiency .....	<b>Error! Bookmark not defined.</b>
	3.4.2 Vehicle comparisons for KPI – Aerodynamic efficiency.....	
	3.4.3 Vehicle comparisons for KPI – Loading efficiency.....	
	3.4.4 Vehicle comparisons for KPI – Safety standards.....	
3.5	Deviations from initial test matrix .....	
4	Measurement equipment and protocol.....	
4.1	Test use cases location.....	
	4.1.1 IDIADA facilities location for test use cases 1, 2, 3 and 4. ....	
	4.1.2 Real world route Fraga. Test use case 2. ....	
	4.1.3 Terminal (un)-loading for test use case 5 .....	
4.2	Vehicle preparation and checklist at IDIADA’s facilities .....	
	4.2.1 Objective.....	
	4.2.2 Vehicle set up.....	
	4.2.3 IDIADA’s safety check .....	
	4.2.4 Functional checklist .....	
	4.2.5 Instrumentation.....	
	4.2.6 Shake down.....	<b>Error! Bookmark not defined.</b>
	4.2.7 Daily vehicle checking.....	
	4.2.8 Others .....	
	4.2.9 Flowchart of the entire vehicle preparation process .....	
4.3	Test use case 1 and test use case 2 - Fuel consumption measurement .....	
	4.3.1 Objective.....	
	4.3.2 Test constraints.....	
	4.3.3 Measurement equipment.....	
	4.3.4 Control vehicle.....	
	4.3.5 Fuel consumption on test track (tests use-case 1). ....	
	4.3.6 Fuel consumption protocol on world real route (Test use-case 2).....	
	4.3.7 Deviations from reference SAE J1526 – Fuel consumption test procedure .....	
	4.3.8 Deviations from Grant Agreement proposed test protocol. ....	
	4.3.9 Advanced data processing .....	
	4.3.10 Flowchart of the test use-cases 1 and 2 .....	

4.4	Test use-case 3 - Air drag measurement at proving ground.....	
4.4.1	Objective.....	
4.4.2	Air drag specific test track characteristics .....	
4.4.3	Test constraints.....	
4.4.4	Measurement equipment.....	
4.4.5	Deviations from the Regulation .....	
4.4.6	Test procedure.....	
4.4.7	Data processing.....	
4.5	Test use-case 4 - Dynamic vehicle behaviour .....	
4.5.1	Objective.....	
4.5.2	Test constraints.....	
4.5.3	Measurement equipment.....	
4.5.4	Dynamic vehicle behaviour protocol .....	
4.6	Loading and unloading (test case 5) .....	
4.6.1	Objective of the test use-case: .....	
4.6.2	Description of the tests to quantify the KPI's .....	
4.6.3	Needed equipment .....	
4.6.4	The measurement /planning template.....	
5	Measurement data.....	
5.1	Data format.....	
5.2	Data storage.....	
5.3	Data synchronization and logging.....	
5.3.1	Fuel consumption tests (test use case 1 and 2).....	
5.3.2	Aidrag tests (test use case 3) .....	
5.3.3	Dynamic tests (test use case 4).....	
5.3.4	Additional information from truck or tractor .....	
5.3.5	Semi-trailer, dolly and tires.....	
5.4	Vehicles reports .....	
5.4.1	Individual report for each test vehicle.....	
5.4.2	Overview vehicle comparative reports.....	
5.5	Data post-processing .....	
5.6	Data/ test validity-check .....	
6	Risk and quality assurance .....	
6.1	Risk Register.....	
6.2	Quality Assurance .....	
7	References.....	
8	Acknowledgement .....	
9	Appendix A – Risk table.....	
10	Appendix B – Vehicle specifications.....	
10.1	Pulling units: tractor/truck.....	
10.2	Trailer .....	
10.3	Dolly .....	
11	Appendix C – FALCON payload conversions.....	

## Figures

Figure 1. WP6 Test matrix with 8 test cases and 5 test use-cases. Four classes of vehicles are separated: 1) Reference vehicles including zero-case, 2) Advanced reference vehicles, 3) Demonstrator AEMPT vehicles and 4) Demonstrator AeroLoad vehicle.....	2
Figure 2. EU Transformers vehicle on the Swedish public road, left Schmitz Cargo Bull semi-trailer, right Van Eck Group semi-trailer [Source: TRANSFORMERS-D6.4-Final report and Conclusions-PU-FINAL-2017.09.28].....	14
Figure 3. WP6 Test matrix with 8 test cases and 5 test use-cases. Four classes of vehicles are separated: 1) Reference vehicles including zero-case, 2) Advanced reference vehicles, 3) Demonstrator AEMPT vehicles and 4) Demonstrator AeroLoad vehicle.....	
Figure 4. Overview of the different Test Vehicle (TV) configurations for AEMPT and AeroLoad both using the same Control Vehicle throughout the testing period. ....	
Figure 5. Example vehicle speed and slope profile of the IDIADA-Fraga route for a 40t tractor semi-trailer (GPS data). Red circle indicated the location of Google Street Maps view in Figure 6.....	
Figure 6. Impression of IDIADA-Fraga route (GPS data) taken from Google Street Maps at location indicated in Figure 5.....	
Figure 7. Foreseen route between the two P&G warehouses in Euskirchen and Crailsheim from Google Street Maps, distance of approx. 360 km single trip.....	
Figure 8. Original test matrix as part of the project description .....	
Figure 9. Aerial view of IDIADA's proving ground.....	
Figure 10. Proving ground map .....	
Figure 11. General road detailed plan .....	
Figure 12. High-speed track map.....	
Figure 13. Dynamic platform map .....	
Figure 14. Test hill map.....	
Figure 15. Route IDIADA-Fraga-IDIADA overview.....	
Figure 16. Safety check dynamic locations.....	
Figure 17. Vehicle preparation flowchart.....	
Figure 18. AIC 6004 fuel consumption equipment .....	
Figure 19. Hioki 3390 electrical consumption equipment.....	
Figure 20. Racelogic VBox IISx .....	
Figure 21 Telematic C4 max.....	
Figure 22. High speed track HST .....	
Figure 23. Flowchart test use cases 1 and 2 .....	
Figure 24. HST diagram.....	
Figure 25. DPA measurement sections scheme .....	
Figure 26. Ultrasonic anemometer and its position .....	
Figure 27. Racelogic VBox 3i with DGPS acquisition (VBox) .....	
Figure 28. Strain gauges on half shafts and telemetry system.....	
Figure 29. Flowchart of the entire process.....	
Figure 30: Connector on trailer to charge battery.....	
Figure 31: Fork lift needed to lift the flex floor .....	

## Tables

Table 1. Overview of the test use-cases as part of the test matrix and connected to a particular KPI.....	12
Table 2. Overview of the test-cases as part of the test matrix.....	13
Table 3. Overview of main tractor/semi-trailer reference vehicle specifications .....	
Table 4. Overview of aerodynamic settings, Global Energy Management (GEM) logic type and payloads for the tractor/semi-trailer zero-case vehicle .....	
Table 5. Overview of main EMS1 reference vehicle specifications .....	
Table 6. Overview of aerodynamic settings, Grobal Energy Management (GEM) logic type and payloads for the EMS1 reference vehicles. ....	
Table 7. Overview Main features of the Transformers trailers .....	
Table 8. Overview of main advanced reference vehicle specifications.....	
Table 9. Overview of aerodynamic settings, Global Energy Management (GEM) logic type and payloads for the advanced reference vehicles. All specified configurations are tested at test use-case 3 (air drag), but only one is evaluated on fuel consumption as specified in the table .....	
Table 10. Overview of main AEMPT demonstrator vehicle specifications.....	
Table 11. Overview of aerodynamic settings, Global Energy Management (GEM) logic type and payloads for the AEMPT demonstrator vehicles. All specified configurations are tested at test use-case 3 (air drag).....	
Table 12. Overview of main AeroLoad demonstrator vehicle specifications .....	
Table 13. Overview of aerodynamic settings, Global Energy Management (GEM) logic type and payloads for the AeroLoad demonstrator vehicle. All specified configurations are tested at test use-case 3 (air drag). ....	
Table 14. Overview of main tractor/semi-trailer control vehicle specifications .....	
Table 15. Overview of main tractor/semi-trailer baseline vehicle specifications .....	
Table 16. IDIADA-Fraga route characteristics for 40t tractor/semi-trailer.....	
Table 17. Overview of the fuel consumption comparisons between the different vehicle configurations.....	
Table 18. Overview of the air drag comparisons between the different vehicle configurations.....	
Table 19. Overview of the loading efficiency comparisons between the different vehicle configurations.....	
Table 20. Overview of the dynamic vehicle behaviour comparisons between the different vehicle configurations .	
Table 21. General road main characteristics .....	
Table 22. High-speed track main characteristics .....	
Table 23. Dynamic platform main characteristics .....	
Table 24. Test hills main characteristics .....	
Table 25. IDIADA-Fraga route characteristics for 40t tractor/semi-trailer.....	
Table 26. Characteristics of safety check static.....	
Table 27. Characteristics of safety check dynamic .....	
Table 28. Tire characteristics .....	
Table 29. Weather conditions during test cases 1 and 2.....	
Table 30. Vehicle payload for type of vehicle.....	
Table 31. Test use case 1 and 2 measurement equipment .....	
Table 32. Fuel consumption equipment characteristics.....	
Table 33. Control signals.....	
Table 34. Electrical consumption equipment characteristics.....	
Table 35. Additional GPS characteristics .....	
Table 36. Overview of main tractor/semi-trailer reference vehicle specifications.....	
Table 37. Measurement equipment installed on control vehicle .....	
Table 38. Fraga route main characteristics.....	
Table 39. Fraga route detailed information .....	
Table 40. Air drag criteria .....	
Table 41. Anemometer characteristics.....	
Table 42. Measurement data .....	
Table 43. Data processing.....	
Table 44. Dynamic behaviour measurement equipment .....	
Table 45. Section 1 pallet Description per shipment.....	
Table 46. Pallet positioning per shipment .....	
Table 47. Efficiency improvements per shipment .....	

Table 48. Signals measured using external sensors and at least stored with 1 Hz, except for the tire related signals  
.....

Table 49. Calculated airdrag results .....  
Table 50. Calculated data from different airdrag runs .....  
Table 51. Additional information from truck and tractor measured with at least 1 Hz  
Table 52. AERoload specific signals.....  
Table 53. Information from TF-SCB semitrailer .....  
Table 54. Data from WP2 E-dolly.....  
Table 55. Overview of test vehicle units and its application for the different test vehicle configurations.....  
Table 56. Overview of tractor specifications .....  
Table 57. Overview of trailer specifications .....  
Table 58. Overview of dolly specifications .....



## List of Abbreviations

AEMPT: Advanced Energy Management Power Train  
KPI: Key Performance Indicator  
WP: Work Package  
EMS: European Modular System  
GCW: Gross Combination Weight  
NCW: Net Combination Weight  
HOD: Hybrid on Demand  
CFD: Computational Fluid Dynamics  
SOC: State Of Charge  
CV: Control Vehicle  
TF: Transformers  
GETMS: Global Energy and Torque Management  
EMG: Electric Motor Generator  
GPS: Global Positioning System  
DPF: Diesel Particulate Filter  
ECU: Engine Control Unit  
OBD: On Board Diagnosis  
SCR: Selective Catalytic Reduction  
PEMS: Portable Emissions Measurement System  
VECTO: Vehicle Energy Consumption Calculation Tool  
GRC: General Road circuit  
HST: High Speed Track  
DPA: Dynamic Platform  
P&G: Procter & Gamble  
WP: Work Package  
NET: Net Energy Change

# 1 Purpose of the document

The overall objective of the 6.3 Test program and protocol deliverable is to evaluate the benefits of the different technologies developed in the WP 2, 3 and 4. To achieve this objective, first a list of assessment and measurement Key Performance Indicators (KPI's) are identified together with the different Work Packages (WP's).

This initial evaluation has allowed to clearly identify the objectives to evaluate each new technology and how to define the test matrix. These KPI's include fuel consumption, aerodynamics, performance based safety standards, and loading efficiency.

Once, the KPI's have been defined, preparations started for defining the final test matrix. The test matrix includes test-cases, which are groups of vehicles that consider the same innovations(s) for a given vehicle type. On the other hand, the test matrix contains test use-cases, which are the different type of tests. The test cases contain nine vehicle configurations which are classified as follows:

- Zero-case;
- Reference vehicles;
- Advanced reference vehicles
- Demonstrator vehicle of the AEMPT type
- Demonstrator vehicles of the AeroLoad type

The test use-cases contain:

- Fuel consumption tests at steady-state speed at proving ground;
- Fuel consumption test at a real-world route;
- Vehicles air drag measurements at proving ground
- Dynamic vehicle behaviour tests at proving ground
- Terminal (un-) loading tests at a customer's depot.

The definition of this test matrix allows us to determine an overview of vehicle comparisons necessary to understand for each vehicle category and KPI. This comparison focusses on the defined KPI's, e.g. fuel consumption, fuel efficiency, air drag reduction, loading and unloading performance as well as performance-based safety standards.

The definition of the test protocol deals with the difficulty to evaluate the different vehicle configurations during a long period of two test years. For this reason, the test protocol includes the necessary tools to control the results obtained and evaluate the benefits of each technology without interferences of external influences, like ambient conditions.

The testing activities will be carried out in IDIADA's test track (fuel consumption test at steady-state speed, air drag and dynamic tests) and surroundings for the fuel consumption on public roadway.

The terminal (un-) loading evaluations will be carried out at P&G facilities.

The data will be provided in a standardized format that can be easily used by each partner to do its own calculations and data post processing.

## 2 Introduction

A specific test matrix and test programme has been defined to align the interests of each WP and the budget allocated to the testing activities. The WP needs has been identified and explained in the deliverable 6.1 Definition of use cases/test cases and the overall KPIs and the information extracted from that deliverable has been essential for the development of to the test programme and protocol.

The KPI's defined in the deliverable 6.1 used to determine the test matrix and test programme are the following:

### Fuel consumption efficiency

- Fuel consumption [l/km] (Energy consumption)
- Fuel consumption [l/tonne-km] (Energy efficiency)
- Average vehicle speed [km/h]

### Aerodynamic efficiency

- Air drag reduction factor [-]

### Loading efficiency

- Fill speed [minutes]
- Payload capacity [tonnes]
- Load factor [Volume-%]

### Safety standards

- Startability
- Gradeability
- Acceleration capability
- Low speed swept path width
- Tail swing
- Static rollover threshold
- Rearward amplification
- Directional stability under braking
- High speed transient offtracking (HSTO)
- Yaw damping
- 360° Circle

### 3 Test matrix

Important part of the test program is the test matrix. This chapter describes in detail the combinations of test cases (containing different vehicle configurations) and test use-cases (types of tests), as main dimensions of the test matrix, supplemented with the specifications of these so-called third dimensions, like payload and aerodynamic settings. The Chapter starts with an introduction to the test matrix (Section 3.1) explaining the different dimensions of the test matrix, followed by the test-cases in Section **Error! Reference source not found.** and the test use-cases in Section **Error! Reference source not found.**. Moreover, this Chapter provides an overview of the comparisons to be made, which besides others are applied in the final assessment D6.6 (Section **Error! Reference source not found.**). Finally, deviations from the initial test matrix as part of the Grant Agreement are listed in Section **Error! Reference source not found.**, including its reasoning behind.

#### 3.1 Introduction to the test matrix

It is important to determine accurately the improvement on fuel economy for the different technological innovations towards improved aerodynamics, distributed powertrains and more effective loading space utilization. So, the test matrix considers all of these innovations in a structured manner for different vehicle types and types of tests.

The test matrix contains three vehicle types:



Tractor semi-trailer (16.5m)



EMS1 (25.25m)  
(European Modular System)



EMS2 (32m)  
(European Modular System)

For each vehicle type, different topologies are possible that demonstrate the innovations. The different vehicles that consider the same innovation(s) for a given vehicle type, are grouped in a so-called test-case. Within a test-case, more than one demonstrator could be tested. That is why the actual number of vehicles tested exceeds the number of test-cases. Additionally each vehicle configuration will need specific type of tests (test use-case).

To limit the number of tests however, usually one vehicle is tested per test use-case. Also to limit the size of the test matrix, not all vehicles are subject to the same number of tests. A smart selection of test-cases and test use-cases is made to deal with the trade-off between number of possible vehicle variations and number of repetitions for accurate and significant measurement results versus available test time, budget, equipment and resources.

The complete test matrix is given in **Error! Reference source not found.** at the end of this Section on page **Error! Bookmark not defined.** and is explained in detail in the successive Sections. It contains of eight test-cases using nine different vehicle configurations and five test use-cases. The test use-cases are listed in Table 1 and each links to a particular KPI category. The test use-cases 1 and 2, which relates to the fuel consumption efficiency KPI category, are executed both on test track and public road. Only test use-case 5 will not be tested at IDIADA premises, but will be executed at the premises of a client of Van Eck Group.








Test use-case	Focus of test	Location	KPI
1.	Fuel consumption	Proving ground of IDIADA	Fuel consumption efficiency
2.	and emissions	Public road close to IDIADA	
3.	Air drag	Proving ground of IDIADA	Aerodynamic efficiency
4.	Dynamic vehicle behaviour	Proving ground of IDIADA	Safety standards
5.	Loading and unloading of cargo	Loading dock	Loading efficiency

Table 1. Overview of the test use-cases as part of the test matrix and connected to a particular KPI

The test-cases are listed in Table 2 and are classified as:

- Zero-case vehicle;
- Reference vehicles;
- Advanced reference vehicles;
- Demonstrator vehicles.

For simplicity, this table does not include all different topology and innovation settings. These are covered in the successive sections as well as the complete test matrix (**Error! Reference source not found.**).

	Vehicle classification	Configuration	Name	Part of test-case
0.	Zero-case vehicle	MAN 	MAN zero-case	1
1.	Reference vehicles	MAN 	MAN EMS1 reference	2
2.		SCA 	SCANIA EMS1 reference	2
3.	Advanced reference vehicles	MAN 	Advanced reference AEMPT	1
4.		SCA 	Advanced reference AeroLoad	1
5.	AEMPT demonstrator vehicles	MAN 	AEMPT+ EMS1	3
6.		MAN 	AEMPT++ EMS1	4 and 7
7.		MAN 	AEMPT++ EMS2	5
8.	AeroLoad demonstrator vehicle	SCA 	AeroLoad EMS1	6, 7 and 8

**Table 2. Overview of the test-cases as part of the test matrix**

The zero-case classification represents the current on-road state-of-the-art with high market sales volume in the EU of the tractor semi-trailer configuration. The reference vehicles are the 25.25m combinations (EMS1) treated as references for the Advanced Energy Management PowerTrain (AEMPT) and AeroLoad demonstrator vehicles. These demonstrators are also of the EMS1 type (except for the additional EMS2 AEMPT demonstrator). The advanced reference vehicles contain of tractor semi-trailer vehicles using the following EU TRANSFORMERS demonstrator trailers:

- Schmitz Cargo Bull (SCB) TRANSFORMERS (TF) Hybrid-on-Demand trailer (HOD)
- Van Eck Group (VEG) TF trailer.

Both semi-trailers have advanced aerodynamics and are visible in Figure 2.

Detailed specifications of the semi-trailers is given in Appendix B.



Figure 2. EU Transformers vehicle on the Swedish public road, left Schmitz Cargo Bull semi-trailer, right Van Eck Group semi-trailer [Source: TRANSFORMERS-D6.4-Final report and Conclusions-PU-FINAL-2017.09.28]

The AEROFLEX demonstrator vehicles are logically grouped in the demonstrator vehicles classification and contain of EMS1 and EMS2 configurations. The AEMPT demonstrator is always configured with a MAN pulling unit, whereas the AeroLoad demonstrator is pulled with a SCANIA unit. This is done, since MAN is involved in the AEMPT developments and SCANIA in the AeroLoad developments. To avoid influences of differences in powertrain controls between brands on the results, the advanced reference pulling units are aligned accordingly. This means that the TF-SCB with HOD is pulled by a MAN tractor unit and the TF-VEG trailer by a SCANIA tractor. Consequence is, that these advanced reference vehicles actually are not the TF demonstrators anymore, because back than DAF and VOLVO pulling units were involved (see Figure 2). Though, for accurate comparisons of the AEROFLEX demonstrators with the advanced references, exclusion of difference between brands is decided to be much more important. Additionally, no concessions are necessary on the tractor semi-trailer interaction, because the AEROFLEX pulling units are equipped with similar aerodynamic devices like in Transformers and the same HOD control functionality is present in the MAN tractor driving with the TF-SCB trailer. Detailed descriptions of both these vehicle configurations are given in Section **Error! Reference source not found.**

Beside the type of tests and vehicle configurations, other properties (“third dimensions”) have to be specified like payload and aerodynamic settings. Additionally in case of distributed powertrains also State Of Charge (SOC) related settings have to be specified. Since in particular this topic is linked to the fuel consumption measurement protocol it is described in Chapter **Error! Reference source not found.** Payloads and aerodynamic settings are described in detail in the next Section. Chapter **Error! Reference source not found.** Measurement equipment and protocols, describes in detail the applied methodology to conduct representative and accurate measurements for the individual test use-cases.

The test-case categorization is made to distinguish between tractor semi-trailers at one and the EMS1/EMS2 vehicles at the other end. The latter is splitted further into EMS1 reference vehicles, containing of current on-road rigid trucks, dollies and semi-trailers and the demonstrators, each in its own test-case. Only, test-cases 7 and 8 contain of vehicle configurations originating from test-case 3 (AEMPT) and test-case 6 (AeroLoad). The three AEMPT test-cases (3-5) contain two levels of rated electric propulsion power (test-cases 3 and 4), indicated with the + and ++ signs in Table 2 originating from either the E-dolly (+) supplemented with E-trailer (++) and EMS2 in test-case 5 only with E- dolly and single E-trailer (++)).

By conducting the tests according to the test matrix, the following goals are served:

- Quantification of the KPI's for the different test-cases at the corresponding test use-cases, allowing for the comparison with the set KPI targets;
- Providing input for the WP6 final technical assessment to validate the models:
  - Vehicles air drag.
  - Vehicles rolling resistance.
  - Fuel consumption.
- Demonstrate that 4x2 tractors or 6x2 trucks with 13l engines can deal with a broader vehicle portfolio, like EMS1 (European Modular System, configuration 1 containing of 25.25m vehicle with a 6x2 rigid truck – dolly – semi-trailer) and EMS2 (32m vehicle with a 4x2 tractor – semi-trailer – dolly – semi-trailer), if equipped with distributed powertrain and advanced aerodynamics, compared to current situation.