EUROPEAN
COMMISSION

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ANNEXES 1 to 5

ANNEXES

to the

Commission Implementing Regulation

amending Implementing Regulation (EU) 2022/1362 as regards the performance of heavy-duty trailers with e-axles, refrigeration units, solar systems or advanced aerodynamic devices with regard to their influence on the CO_2 emissions, fuel consumption, energy consumption and zero emission driving range of motor vehicles

ANNEX I

Annex I, point 2, is amended as follows:

(1) Table 1 is replaced by the following:

‘**Table 1**
Vehicle groups for semi-trailers

Description of elements relevant to the classification				Vehicle group	Allocation of mission profile and vehicle configuration				
Number of axles	Bodywork type	TPMLM(**) axle assembly [t]	Volume orientation		Long haul	Long haul (EMS*)	Regional delivery	Regional delivery (EMS*)	Urban delivery
DA semi-trailers									
1	soft shell box body	≥ 8,0 t	No	111	5RD		5RD		5RD
			Yes	111V	5RD		5RD		5RD
	hard shell box body	≥ 8,0 t	No	112	5RD		5RD		5RD
			Yes	112V	5RD		5RD		5RD
	refrigerated box body	≥ 8,0 t	No	113	5RD		5RD		5RD
			Yes	113V	5RD		5RD		5RD
2	soft shell box body	≥ 8,0 t and ≤ 18 t	No	121	5LH		5LH		5LH
			Yes	121V	5LH		5LH		5LH
		> 18 t	No	122	5LH		5LH		5LH
			Yes	122V	5LH		5LH		5LH
	hard shell box body	≥ 8,0 t and ≤ 18 t	No	123	5LH		5LH		5LH
			Yes	123V	5LH		5LH		5LH
		> 18 t	No	124	5LH		5LH		5LH
			Yes	124V	5LH		5LH		5LH
	refrigerated box body	≥ 8,0 t and ≤ 18 t	No	125	5LH		5LH		5LH
			Yes	125V	5LH		5LH		5LH
		> 18 t	No	126	5LH		5LH		5LH
			Yes	126V	5LH		5LH		5LH
3	soft shell box body	≥ 8,0 t	No	131	5LH		5LH		5LH
			Yes	131V	5LH		5LH		5LH
	hard shell box body	≥ 8,0 t	No	132	5LH		5LH		5LH
			Yes	132V	5LH		5LH		5LH
	refrigerated box body	≥ 8,0 t	No	133	5LH		5LH		5LH
			Yes	133V	5LH		5LH		5LH
4	soft shell box body	---	No	(141)					
		---	Yes	(141V)					
	hard shell box body	---	No	(142)					
		---	Yes	(142V)					
	refrigerated box body	---	No	(143)					
			Yes	(143V)					

(*) EMS – European Modular System
(**) TPMLM – Technically permissible maximum laden mass

RD = Regional delivery
LH = Long haul

’;

(2) Table 4 is replaced by the following:

‘Table 4
Vehicle groups for drawbar trailers

Description of elements relevant to the classification in vehicle groups				Vehicle group	Allocation of mission profile and vehicle configuration				
Number of axles	Bodywork type	TPMLM(**) axle assembly [t]	Volume orientation		Long haul	Long haul (EMS*)	Regional delivery	Regional delivery (EMS*)	Urban delivery
DB drawbar trailers									
2	soft shell box body	---	No	421	9LH		9LH		9LH
			Yes	421V	9LH		9LH		9LH
	hard shell box body	---	No	422	9LH		9LH		9LH
			Yes	422V	9LH		9LH		9LH
	refrigerated box body	---	No	423	9LH		9LH		9LH
			Yes	423V	9LH		9LH		9LH
3	soft shell box body	---	No	431	4LH		4LH		4LH
			Yes	431V	4LH		4LH		4LH
	hard shell box body	---	No	432	4LH		4LH		4LH
			Yes	432V	4LH		4LH		4LH
	refrigerated box body	---	No	433	4LH		4LH		4LH
			Yes	433V	4LH		4LH		4LH
4	soft shell box body	---	No	(441)					
			Yes	(441V)					
	hard shell box body	---	No	(442)					
			Yes	(442V)					
	refrigerated box body	---	No	(443)					
			Yes	(443V)					

(*) EMS – European Modular System
(**) TPMLM – Technically permissible maximum laden mass

LH = Long haul

’;

(3) Table 6 is replaced by the following:

‘Table 6
Vehicle groups for centre-axle trailers

Description of elements relevant to the classification in vehicle groups				Vehicle group	Allocation of mission profile and vehicle configuration				
Number of axles	Bodywork type	TPMLM axle assembly [t]	Volume orientation		Long haul	Long haul (EMS*)	Regional delivery	Regional delivery (EMS*)	Urban delivery
DC centre-axle trailers									
1	soft shell box body	---	No	611	2RD		2RD		2RD
		---	Yes	611V	2RD		2RD		2RD

	hard shell box body	---	No	612	2RD		2RD		2RD
		---	Yes	612V	2RD		2RD		2RD
2	soft shell box body	≤ 13.5 t	No	621	2RD		2RD		2RD
			Yes	621V	2RD		2RD		2RD
		> 13.5 t	No	622	9LH		9LH		9LH
			Yes	622V	9LH		9LH		9LH
	hard shell box body	≤ 13.5 t	No	623	2RD		2RD		2RD
			Yes	623V	2RD		2RD		2RD
		> 13.5 t	No	624	9LH		9LH		9LH
			Yes	624V	9LH		9LH		9LH
	refrigerated box body	> 13.5 t	No	625	9LH		9LH		9LH
			Yes	625V	9LH		9LH		9LH
3	soft shell box body	---	No	631	4LH		4LH		4LH
		---	Yes	631V	4LH		4LH		4LH
	hard shell box body	---	No	632	4LH		4LH		4LH
		---	Yes	632V	4LH		4LH		4LH
	refrigerated box body	---	No	633	4LH		4LH		4LH
		---	Yes	633V	4LH		4LH		4LH

(*) EMS – European Modular System
(**) TPMLM – Technically permissible maximum laden mass

RD = Regional delivery
LH = Long haul

’.

ANNEX II

In Annex II, the following Appendix 3 is added:

‘**Appendix 3**

TEMPLATE OF THE LICENCE NUMBER FOR THE OPERATION OF THE SIMULATION TOOL TO ASSESS THE INFLUENCE OF NEW VEHICLES ON THE CO_2 EMISSIONS AND FUEL CONSUMPTION

1. Numbering

The number for the simulation tool licence shall comprise the following:

eX*YYYY/YYYY*ZZZZ/ZZZZ*V*00000*00

section 1	**section 2**	**section 3**	**Additional letter to section 3**	**section 4**	**section 5**
Indication of country issuing the licence	HDV CO_2 determination for (semi-) trailers ‘2022/1362’	Latest amending Regulation (ZZZZ/ZZZZ)	V = Trailer licence	Base certification number 00000	Extension 00

’.

ANNEX III

Annex III is replaced by the following:

‘ANNEX III

INPUT INFORMATION ABOUT THE CHARACTERISTIC OF THE VEHICLE

1. Introduction

This Annex describes the list of parameters to be provided by the vehicle manufacturer as input to the simulation tool. The applicable XML schema as well as example data are available at the dedicated electronic distribution platform.

2. Definitions

For the purposes of this Annex, the following definitions apply:

(1) ‘parameter ID’ means the unique identifier used in the simulation tool for a specific input parameter or set of input data;

(2) ‘type’: Data type of the parameter

string ……..	sequence of characters in ISO8859-1 encoding
token ……..	sequence of characters in ISO8859-1 encoding, no leading/trailing whitespace
date ……	date and time in UTC time in the format: YYYY-MM-DD*T*HH:MM:SS*Z*
integer ……	value with an integral data type, no leading zeros
double, X	fractional number with exactly X digits after the decimal sign (“.”) and no leading zeros
boolean ……	accepted values ‘true’, ‘false’, and also ‘1’ (for true) and ‘0’ (for false)

(3) ‘unit’ …… means the physical unit of the parameter;

(4) ‘trailer coupling point high’ means the clevis type drawbar coupling, with a jaw and an automatic closing and locking pin on the towing vehicle for connecting to the trailer by means of a drawbar eye, with higher clearance from the centre of coupling point to the ground, commonly intended for towing trailers type DB and DC;

(5) ‘trailer coupling point low’ means the clevis type drawbar coupling, with a jaw and an automatic closing and locking pin on the towing vehicle for connecting to the trailer by means of a drawbar eye, with lower clearance from the centre of coupling point to the ground, commonly intended for towing trailers type DC;

(6) ‘maximum external dimensions of body’:

(a) ‘external length of the body’ means the external length of the body dimension without taking into account external body projections (aerodynamic devices and equipment).

(b) ‘external width of the body’ means the external width of the body dimension without taking into account external body projections (aerodynamic devices and equipment).

(c) ‘external height of the body’ means the external height of the body dimension without taking into account external body projections (aerodynamic devices and equipment).

(7) ‘total height of the trailer’ (unladen) means the distance between the supporting surface and a horizontal plane touching the topmost part of a vehicle, as defined in point 6.3 of Standard ISO 612:1978.

(8) ‘cargo volume’ means the internal volume of the body which is available to be filled with load;

(9) ‘axle-lift device’ means a mechanism as defined in Annex XIII, Part 2, Section A, point 1.33 of Implementing Regulation (EU) 2021/535;

(10) ‘lift axle or retractable axle’ means an axle as defined in Annex XIII, Part 2, Section A, point 1.34 of Implementing Regulation (EU) 2021/535;

(11) ‘steering axle’ means, for trailers, either of the following:

(a) an axle equipped with a system designed to create a change of steering angle on wheels when acted upon by forces or moments applied through the tyre to road contact;

(b) an axle equipped with a system in which the steering forces to change steered wheels direction are produced by a change in direction of the towing vehicle and in which the movement of the steered trailer wheels is linked to the relative angle between the longitudinal axis of the towing vehicle and that of the trailer;

(c) an axle equipped with a system which produces the steering forces as decoupled system by an algorithm or manually;

(12) ‘drop side tarpaulin body’ means a bodywork with hinged tail and side panels and a tarpaulin body with a total body height comparable to that of curtain-sided bodywork;‘

(13) ‘corrected mass in running order’ means the mass in running order of a vehicle determined in accordance with Annex XIII, Part 2, Section A, point 1.3(b) of Implementing Regulation (EU) 2021/535, except that the fuel tanks for an internal combustion engine used to operate a refrigeration compressor, or the nitrogen tanks used to operate a corresponding refrigeration system, shall be filled to 50% of their capacity;

The mass for the refrigeration system is corrected as specified in point 5.2 and determined without specific types of equipment as specified in point 5.3;

(14) ‘intermodal trailer’ means a trailer that is equipped with ferry lashings and/or grappler pockets to be loadable on trains in accordance with UIC Leaflet 596-5 or UIC Leaflet 597, or on ships (i.e. ferries etc.) in accordance with MSC.479(102);

(15) ‘e-axle trailer’ means a trailer that is equipped with at least one e-axle;

(16) ‘brake blending’ means a feature of an e-axle trailer that uses electric regenerative braking to partially replace the service (friction) brake in driving conditions where a braking request is made by the towing vehicle;

(17) ‘free recuperation’ means a feature of an e-axle trailer which applies electric regenerative braking in driving conditions where the trailer is pushing but no braking request is made by the towing vehicle. To determine the state that the trailer is pushing, direct (e.g. coupling force sensor) or indirect sensors (e.g. acceleration, inclination sensor) and corresponding calculation models are used;

(18) ‘generator mode’ means a dedicated mode of operation of an e-axle trailer in which the e-axle applies electric resistive force to supply the vehicle with electric energy (e.g. for supply of a refrigeration unit) and/or to increase the state of charge of the rechargeable electric energy storage system (REESS). Electric resistive force in generator mode is mainly or exclusively applied in driving conditions where the towing vehicle is pulling the trailer;

(19) ‘propulsion support’ means a mode of operation of an e-axle trailer in which the propulsion of the vehicle combination is supported by the application of motive power;

(20) ‘electric machine system’ or ‘EMS’ means an electric machine system as defined in point 2(20) of Annex Xb to Regulation (EU) 2017/2400;

(21) ‘additional driveline component’ or ‘ADC’ means an additional driveline component as defined in Article 3, point 9, of Regulation (EU) 2017/2400;

(22) ‘transmission’ means a transmission as defined in Article 3, point 6, of Regulation (EU) 2017/2400;

(23) ‘axle component’ means an axle as defined in Article 3, point 10 of Regulation (EU) 2017/2400, except that torque can also be transferred from the wheels to the shaft ;

(24) ‘integrated electric powertrain component’ or ‘IEPC’ means an integrated electric powertrain component as defined in point 2(40) of Annex Xb to Regulation (EU) 2017/2400;

(25) ‘battery system’ means a battery system as defined in point 2(3) of Annex Xb to Regulation (EU) 2017/2400;

(26) ‘representative battery subsystem’ means a representative battery subsystem as defined in Annex Xb, point 2(4) of Regulation (EU) 2017/2400;

(27) ‘capacitor system’ means a capacitor system as defined in Annex Xb, point 2(12) of Regulation (EU) 2017/2400;

(28) ‘refrigeration supply type’ means the method by which energy is provided to supply cooling power in a refrigeration system;

(29) ‘ICE driven compressor’ means a refrigeration supply type that uses a compressor that is mechanically connected to an internal combustion engine;

(30) ‘electric driven compressor’ means a refrigeration supply type that uses a compressor that is mechanically connected to an electric motor;

(31) ‘liquid nitrogen’ means a refrigeration supply in which the cooling effect is provided by the vaporisation of liquid nitrogen;

3. For the purposes of this Annex, the devices and equipment referred to in Annex XIII, Part 2, Section F, to Implementing Regulation (EU) 2021/535 shall not be taken into account for the determination of the length, width or height of the vehicle or of the maximum external dimensions of the body.

4. Set of general input parameters

In Tables 1 and 2, the set of general input parameters regarding the characteristics of the vehicle are specified.

Table 1: Input parameters "Vehicle/General"

Parameter name	Parameter ID	Type	Unit	Description/Reference
Manufacturer	T001	token	[-]	
Manufacturer Address	T002	token	[-]	
Model / Commercial name	T003	token	[-]	
VIN	T004	token	[-]	
Date	T005	dateTime	[-]	Date and time when input information and input data is created.
Legislative category	T006	string	[-]	Allowed values: 'O3', 'O4'
Number of axles	T007	integer	[-]	Allowed values: 1, 2, 3
Trailer type	T008	string	[-]	Allowed values: 'DA', 'DB', 'DC'
Bodywork type	T009	string	[-]	Allowed values: 'dry box', 'refrigerated', 'conditioned', 'curtain-sided', 'drop-side with tarpaulin body' in accordance with Table 3 of this Annex.
Volume orientation	T010	boolean	[-]	In accordance with point 7 of Annex I to this Regulation.
Corrected mass in running order	T011	integer	[kg]	In accordance with point 2(13) of this Annex.
TPMLM trailer	T012	integer	[kg]	In accordance with point 1.6, Section A, Part 2, of Annex XIII to Implementing Regulation (EU) 2021/535.
TPMLM axle assembly	T013	Integer	[kg]	In accordance with point 1.13, Section A, Part 2, of Annex XIII to Implementing Regulation (EU)

Parameter name	Parameter ID	Type	Unit	Description/Reference
				2021/535. In case of trailer type 'DB', no input shall be provided.
External length of the body	T014	double, 3	[m]	In accordance with point 2(6)(a) of this Annex.
External width of the body	T015	double, 3	[m]	In accordance with point 2(6)(b) of this Annex.
External height of the body	T016	double, 3	[m]	In accordance with point 2(6)(c) of this Annex.
Total maximum height of the trailer	T017	double, 3	[m]	In accordance with point 2(7) of this Annex. For trailers with variable height, the value shall be specified in the highest configuration but limited to a maximum of 4 meters.
Length from trailer front end to centre of first axle	T018	double, 3	[m]	Distance between front end of the trailer to centre of first axle. In case of 3-axle DB trailer: distance from the front end of the trailer to the centre of the last axle from the first set of axles.
Length between centres of axles	T019	double, 3	[m]	Distance between centre of first and last axle. In case of 3-axle DB trailer: distance from the centre of the last axle of the first set of axles to the first axle of the last set of axles. In case of a single-axle trailer, 0 shall be provided as input.
Trailer Coupling Point	T020	string	[-]	Allowed values: 'high', 'low' In accordance with points 2(4) and 2(5) of this Annex. Input only relevant for trailer type DC.
Cargo volume	T021	double, 3	[m^3]	In accordance with point 2(8) of this Annex. For trailers with cargo volume dependent aerodynamic devices, the maximum volume shall be provided.
Standard aerodynamic	T022	string	[-]	Allowed values: 'side cover short', 'side cover long', 'rear flap short',

Parameter name	Parameter ID	Type	Unit	Description/Reference
devices				'rear flap long' Multiple entries allowed. Inputs shall be declared in accordance with Appendix 5 to Annex V. The combination of input for standard aerodynamic devices with the input of certified aerodynamic devices is only permitted in accordance with point 4 of Appendix 6 to Annex V.
Input data on aerodynamic devices in accordance with Appendix 6 to Annex V				Only applicable if the component is present on the vehicle. Only a combination of aerodynamic devices in different bounding regions is permitted.
Vehicle type approval number	T0XX	token	[-]	The whole vehicle type approval number shall be provided. In the case of individual vehicle approvals, the individual vehicle approval number shall be provided.
Simulation tool licence number	T0XX	token	[-]	Licence number related to the operation of the simulation tool in accordance with Article 5.
Intermodal	T0XX	boolean	[-]	In accordance with point 2(14) of this Annex.
EX/III certificate number	T0XX	token	[-]	Point 1 of the model certificate of approval for vehicles carrying certain dangerous goods specified in Part 9, Chapter 9.1, point 9.1.3.5, of the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR)[1].
Side-opening doors	T0XX	boolean	[-]	Presence of rigid doors on at least one side of the vehicle that can be opened to allow access across the entire length of the body. Input only relevant for trailers with bodywork of type ‘dry box’, ‘refrigerated’ and ‘conditioned’.

[1] Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), done at Geneva on 30 September 1957 and entered into force on 29 January 1968, as amended.

Parameter name	Parameter ID	Type	Unit	Description/Reference
Additional Information as set out in Regulation (EU) 2019/1242 Annex IV Part B				Optional input Only applicable if the component is present in the vehicle.

Table 2: Input parameters "Vehicle/Axle configuration" per wheel axle

Parameter name	Parameter ID	Type	Unit	Description/Reference
Axle number	T0XX	integer	[-]	Position of the wheel axle on the trailer, counting from the front to the rear starting with 1.
Tyre input data in accordance with Appendix 3 of Annex X of Regulation (EU) 2017/2400				
Twin tyres	T025	boolean	[-]	
Steered	T026	boolean	[-]	In accordance with point 2(11) of this Annex.
Liftable	T027	boolean	[-]	In accordance with point 2(10) of this Annex.
Wheel end friction	T0XX	double, 1	[Nm]	Declared wheel end friction value. Determined in accordance with point 9 of this Annex. The wheel ends installed shall have the same or lower friction values as declared. In the case of standard values for wheel end friction no input shall be provided.
Certification number wheel end	T0XX	token	[-]	Certification number(s) of the certificate(s) for the declared wheel end friction referred to by the input on wheel end friction (T0XX). Input only relevant for axles where an input on wheel end friction is actually provided. Multiple entries possible.
E-axle	T0XX	boolean	[-]	Presence of an e-axle for which further input data shall be specified in accordance with point 7. In case point 7.5 (multiple e-axles with differing powertrain architectures and/or components) applies, an e-axle shall only be declared for the axle position of the e-axle with the highest

Parameter name	Parameter ID	Type	Unit	Description/Reference
				rated power.

4. Bodywork types

The vehicle manufacturer shall declare the bodywork type in the input to the simulation tool in accordance with Table 3.

Table 3: Bodywork types

Bodywork type to be declared as input	Bodywork code in accordance with Appendix 2 to Annex I to Regulation (EU) 2018/858
'dry box'	'03'
'refrigerated'	'04'
'conditioned'	'05'
'curtain-sided'	'06'
'drop-side tarpaulin body'	'32' with a tarpaulin body height as defined in Annex III, point 2(12).

5. Vehicle mass

5.1 The vehicle mass used as input for the simulation tool shall be the corrected actual mass of the vehicle.

5.2 In case of incomplete vehicles with 04 bodywork without equipment to maintain the interior temperature, a generic mass of X[kg]=(850 kg/85m³)×cargo volume[m³] shall be added.

5.3 The mass of the following types of equipment shall not be included in the corrected mass in running order:

(a) tail lift with a cantilever, fold away, column or retractable design,

(b) forklift holder,

(c) rear-mount forklift,

(d) non-structural components for affixing the load inside the cargo volume,

(e) non-structural components of a powered system for moving the load inside the cargo volume,

(f) components of a double stack system.

6. Input parameters for trailers with bodywork type ‘refrigerated’

For trailers with bodywork type ‘refrigerated’, the vehicle manufacturer shall declare the input parameters in accordance with Table 4 and with the definitions as set out in points 2(27) to 2(30) of this Annex.

Table 4: Input parameters for refrigerated trailers

Parameter name	Parameter ID	Type	Unit	Description/Reference
Refrigeration supply type	T0XX	string	[-]	Allowed values: ‘ICE driven compressor’, ‘Electric driven compressor’, ‘Liquid nitrogen’, ‘N/A’. ‘N/A’ shall be declared for refrigerated trailers for which the refrigeration supply type is not known.
Electrical energy supply type	T0XX	string	[-]	Input only relevant for refrigeration supply type ‘Electric driven compressor’ and to be provided in accordance with Table 5. Multiple entries possible.
ICE fuel type	T0XX	string	[-]	Allowed values: ‘Diesel’, ‘CNG’, ‘Hydrogen’ Input relevant for refrigeration supply type ‘ICE driven compressor’ and for refrigeration supply type ‘Electric driven compressor’ in combination with electrical energy supply type ‘ICE electric’.
K coefficient	T0XX	double,2	[W/(m²K)]]	Optional input, in accordance with point 7.2.4 of the model certificate of compliance of the equipment specified in Annex 1, Appendix 3 to the Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage (ATP)[2]. In case no input is provided, the tool

[2] Agreement on the International Carriage of Perishable Foodstuffs and on the Special Equipment to be Used for such Carriage (ATP), done at Geneva on 1 September 1970 and entered into force on 21 November 1976, as amended.

Parameter name	Parameter ID	Type	Unit	Description/Reference
				shall assign a value of 0.38 W/(m²K).

Table 5: Electrical energy supply types

Electrical energy supply type	Description/Reference
'ICE electric'	Electrical energy can be provided by a generator driven by a dedicated internal combustion engine.
'Battery'	Electrical energy can be provided by a battery system. Declaration of this electrical energy supply type requires input data for the battery system in accordance with point 7 of this Annex.
'E-axle'	Electrical energy can be provided by an e-axle. Declaration of this electrical energy supply type requires input data for an e-axle in accordance with point 7 of this Annex.
'Photovoltaic modules'	Electrical energy can be provided by electric supply from photovoltaic modules. Declaration of this electrical energy supply type requires input data for photovoltaic modules in accordance with point 8 of this Annex and for battery systems in accordance with point 7 of this Annex.
'Fuel cell'	Electrical energy can be provided by electric supply by a fuel cell system as mounted on the trailer.

Input regarding electrical energy supply from the towing vehicle is not requested by the simulation tool as it is assumed by default that this type of supply is possible.

7. Input parameters for e-axle trailers

7.1 General features

For e-axle trailers the general features shall be specified in accordance with Table 6.

Table 6: General features of the e-axle trailer

Parameter name	Parameter ID	Type	Unit	Description/Reference
Off-vehicle charging	T0XX	boolean	[-]	Vehicle where the REESS can be charged from an external source.
Free recuperation	T0XX	boolean	[-]	In accordance with point 2(17) of this Annex.
Brake blending	T0XX	boolean	[-]	In accordance with point 2(16) of this Annex.
Generator mode active during braking	T0XX	boolean	[-]	The generator mode is activated not only when the towing vehicle is pulling the trailer but also when it sends a braking request to the trailer. Input only relevant for e-axle trailers with the refrigeration supply type 'Electric driven compressor'.
Propulsion support	T0XX	boolean	[-]	In accordance with point 2(19) of this Annex.
Propulsion support maximum speed	T0XX	integer	[km/h]	Maximum vehicle speed up to which under normal operating conditions (i.e. REESS with sufficient state of charge) propulsion support is provided. Input only relevant for trailers for which propulsion support is true.
Powertrain architecture	T0XX	string	[-]	Allowed values: 'E2', 'E3', 'E4', 'E-IEPC' In accordance with point 7.2 of this Annex.
Number of driven wheel sides	T0XX	integer	[-]	Allowed values: '1', '2' Input only relevant for powertrain architecture 'E4' and 'E-IEPC'.
Disengagement clutch	T0XX	boolean	[-]	In case the e-axle is equipped with a functionality that actively, under certain operating conditions, allows for mechanically disconnecting all electric machines from the rest of the powertrain towards the wheels, this input shall be set to true. Input not relevant for powertrain architecture 'E-IEPC'.
Electric machine system input data in accordance with Regulation (EU) 2017/2400, Annex Xb, Appendix 15				Applicability and determination of input data in accordance with point 7.3.1 of

Parameter name	Parameter ID	Type	Unit	Description/Reference
				this Annex.
Additional driveline component input data in accordance with Regulation (EU) 2017/2400, Annex VI, Appendix 12, Table 6 and Table 7				Applicability and determination of input data in accordance with point 7.3.2 of this Annex.
Transmission input data in accordance with Regulation (EU) 2017/2400, Annex VI, Appendix 12, Table 1 to 3				Applicability and determination of input data in accordance with point 7.3.3 of this Annex.
Axle component input data in accordance with Tables 1 and 2 of Appendix 6 to Regulation (EU) 2017/2400				Applicability and determination of input data in accordance with point 7.3.4 of this Annex.
Integrated electric powertrain component input data in accordance with Appendix 15 to Annex Xb to Regulation (EU) 2017/2400				Applicability and determination of input data in accordance with point 7.3.5 of this Annex.

7.2 Definition of the powertrain architecture

The powertrain architecture shall be determined in accordance with the following definitions:

(a) 'E' where an EMS component is present in the vehicle supplemented by the position index for the EMS in accordance with Table 7;

(b) 'E-IEPC' where an IEPC component is present in the vehicle.

Table 7: Position index of an EMS in the powertrain

Position index	Definition*
2	The EMS is connected to the transmission input shaft.
3	The EMS is connected to the input shaft of an axle component, and no transmission component is present.
4	The EMS is connected to the wheel hub.
* As used in this table, 'EMS' includes any additional ADC component, if present.	

Table 8 lists the valid entries for powertrain architectures in the simulation tool and the associated powertrain components that shall be specified in the input.

Table 8: Valid inputs of powertrain architecture into the simulation tool

Powertrain	Powertrain component present in vehicle

architecture	EMS in position 2	Transmission	EMS in position 3	Axle	EMS in position 4
E2	yes	yes	no	yes	no
E3	no	no	yes	yes	no
E4	no	no	no	no	yes
E-IEPC	no	no	no	*	no
* 'Yes' (i.e. axle component present) only in the case that in the IEPC both parameters 'DifferentialIncluded' and 'DesignTypeWheelMotor' are set to 'false'.					

7.3 E-axle powertrain components

7.3.1 Electric machine system

7.3.1.1 Input data for an electric machine system component shall be provided if the powertrain architecture is 'E2', 'E3' or 'E4'.

7.3.1.2 The input data shall be the certified values for an electric machine system certified in accordance with Article 14 of Regulation (EU) 2017/2400 in case of certified values or the standard values determined in accordance with Article 14(10) of Regulation (EU) 2017/2400 in case of standard values.

7.3.2 Additional driveline component

7.3.2.1 Input data for an additional driveline component shall be provided if an EMS is present in combination with an additional single-step gear ratio and this gear ratio is not represented by other components in the input data.

7.3.2.2 The input data shall be the certified values for an additional driveline component certified in accordance with Article 14 of Regulation (EU) 2017/2400 in case of certified values or the standard values determined in accordance with Article 14(6) of Regulation (EU) 2017/2400 in case of standard values.

7.3.3 Transmission

7.3.3.1 Input data for a transmission component shall be provided if the powertrain architecture 'E2'.

7.3.3.2 The input data shall be the certified values for a transmission certified in accordance with Article 14 of Regulation (EU) 2017/2400 in case of certified values or the standard values determined in accordance with Article 14(3) of Regulation (EU) 2017/2400 in case of standard values.

7.3.3.3 Only the gearbox types 'AMT' (Automated Manual Transmission or Automatic Mechanically- engaged Transmission and 'APT-N' (Automatic Powershifting Transmission without a torque converter) as defined in Annex VI to Regulation (EU) 2017/2400 are permitted.

7.3.4 Axle component

7.3.4.1 Input data for an axle component shall be provided if the powertrain architecture is 'E2' or 'E3'.

7.3.4.2 The input data shall be the certified values for an axle certified in accordance with Article 14 of Regulation (EU) 2017/2400 in case of certified values.

The certified values shall be determined with the torque range for medium lorries in accordance with Point 4.3.3 of Annex VII to Regulation (EU) 2017/2400 if the rated input torque of the axle is 1 kNm or lower, or with the torque range for heavy lorries and heavy buses in accordance with point 4.3.3 of Annex VII to Regulation (EU) 2017/2400 if the rated input torque of the axle is larger than 1 kNm.

7.3.4.3 In case of standard values, the input data shall be determined in accordance with Appendix 3 to Annex VII to Regulation (EU) 2017/2400.

By derogation from the provisions stated therein, the following values shall be used:

(a) Basic drag torque (wheel side) T_{d0}:

$$T_{d0} = (25 + 15 \cdot i_{gear}) \cdot \frac{T_{out,max}}{10\,000}$$

where:

i_{gear} = Axle gear ratio [-]

$T_{out,max}$ = Maximum output torque (wheel side) [Nm]

(b) Generic efficiency for load dependent losses η:

$$\eta = 0{,}98$$

7.3.5 Integrated electric powertrain component

7.3.5.1 Input data for an integrated electric powertrain component shall be provided for the powertrain architecture ‘E-IEPC’.

7.3.5.2 In case of certified values the input data shall be determined in accordance with point 4 of Annex Xb to Regulation (EU) 2017/2400.

In deviation from the definition in point 2(41) of Annex Xb to Regulation (EU) 2017/2400, the following applies to ‘IEPC design type wheel motor’, configuration ‘L’: In the case of one output shaft, either the same component is installed twice in symmetrical application (in case both wheel sides of the e-axle are driven) or the component is installed only once if only a single wheel side is driven.

7.3.5.3 In case of standard values the input data shall be determined in accordance with Appendix 9 of Annex Xb to Regulation (EU) 2017/2400.

By derogation from the provisions stated therein, the basic drag torque $T_{diff,d0}$ set out in option 2 point (3) ‘IEPC internal component differential’ in item (e) shall be calculated based on the formula as provided in point 7.3.4.3 a) of this Annex.

7.4. E-axle torque limitations

In the case that the maximum operating range of the e-axle during operation is restricted compared to the values specified in the input data for components as referred to in point 7.3, the vehicle manufacturer shall declare e-axle torque limitations in accordance with Table 9. The following provisions apply:

– The torques to be entered shall correspond to the torques at the wheel hub position and refer to the sum of both wheel sides of the e-axle.

– If the trailer is equipped with more than one e-axle, the limitations to be entered shall refer to the sum of the wheel hub torques of all e-axles.

– The input data shall contain at least entries for wheel end rotational speed '0' and the rotational speed corresponding to a vehicle speed of 90 km/h. It is permitted to specify further entries.

– For e-axles with multiple gears the torque limitations shall be specified together with the information on the applicable gear number.

Table 9: E-axle torque limitations per gear (optional)

Parameter name	Parameter ID	Type	Unit	Description/Reference
Wheel end rotational speed	T0XX	integer	[1/min]	
Maximum propulsion torque	T0XX	integer	[Nm]	
Maximum electric braking torque	T0XX	integer	[Nm]	

7.5. Multiple e-axles with differing powertrain architectures and/or components

In case the e-axle trailer is equipped with multiple e-axles, where the specifications of the e-axles differ in terms of the powertrain architecture and/or the components used, only the e-axle with the highest rated power shall be specified in the input.

In this case, the inputs to Tables 6 (general features of the e-axle trailer), 9 (e-axle torque limitations) and 10 (input parameters for the REESS) shall be specified in such a way that the description of the functions corresponds as closely as possible to the actual operating behaviour of the trailer.

8 Input parameters for the REESS

Input parameters for the REESS shall be provided for:

– trailers with refrigeration supply type 'electric driven compressor' and electrical energy supply type 'battery'

– e-axle trailers.

Input data shall only be provided for such REESS components, that are involved in at least one of the following two tasks:

– energy supply or storage for the e-axle

– energy supply of the electric compressor of the refrigeration unit

The inputs for the REESS shall be specified according to Table 10.

In case of batteries, the arrangement of representative battery sub-systems in accordance with Annex Xb to Regulation (EU) 2017/2400 on vehicle level shall be declared by allocation of each representative battery sub-system to a specific string

ID (T0XX). All specific strings are connected in parallel, all representative battery sub-systems located in one specific parallel string are connected in series.

Table 10: Input parameters for the REESS

Parameter name	Parameter ID	Type	Unit	Description/Reference
REESS input data in accordance with Appendix 15 of Annex Xb to Regulation (EU) 2017/2400				
String ID	T0XX	integer	[-]	Allowed values: “1”, “2”, “3”, … Only relevant for batteries.
Minimum usable SOC*	T0XX	Double, 1	[%]	Optional input, only relevant for batteries. Parameter only effective in simulation tool in case input is higher than the generic value as documented in the user manual.
Maximum usable SOC*	T0XX	Double, 1	[%]	Optional input, only relevant for batteries. Parameter only effective in simulation tool in case input is lower than generic value as documented in the user manual.
* Parameter related to the limitation of the utilisation of the capacity specified in the input data for the battery system or the representative battery subsystem in real operation.				

9 Input parameters for photovoltaic modules

Input parameters for photovoltaic modules installed on the vehicle shall be provided in accordance with Table 11.

Table 11: Input parameters for photovoltaic modules

Parameter name	Parameter ID	Type	Unit	Description/Reference
On the vehicle installed power at STC – horizontally oriented modules	T0XX	integer	[W]	Installed power under standard test conditions determined in accordance with IEC 60904-1 Ed. 3. The input value should correspond to the sum of all module surfaces as installed on the vehicle that deviate less than 5° from the horizontal plane.

10. Wheel end friction

10.1 Input data on wheel end friction shall be provided in accordance with Table 2 to this Annex.

10.2 In case of certified values, the values shall be determined in accordance with point 3.6 of Annex VIIa to Regulation (EU) 2017/2400.

10.3 No wheel end friction value shall be provided for an e-axle if one of the following conditions are met:

(a) The e-axle includes an axle component in accordance with the provisions in point 7.3.4.

(b) The e-axle includes a certified IEPC as defined in point 7.3.5.2 and wheel ends were part of the measurement setup

(c) The e-axle includes an IEPC using standard values as defined in point 7.3.5.3

10.4 In the case of standard values, the wheel end friction loss value shall be 5.5 Nm.

Appendix 1

TEMPLATE OF AN INPUT DATA AND INPUT INFORMATION DOCUMENT FOR THE PURPOSE OF THE ASSESSMENT OF THE PERFORMANCE OF NEW VEHICLES WITH REGARD TO THEIR INFLUENCE ON CO_2 EMISSIONS AND FUEL CONSUMPTION

1. Main vehicle data

1.1. Name of the vehicle manufacturer …

1.2. Address of the vehicle manufacturer …

1.3. Model / Commercial name ...

1.4. Vehicle identification number (VIN) …

1.5. Legislative category (O_3, O_4) …

1.6. Number of axles …

1.7. Trailer type (DA; DB, DC) …

1.8. Bodywork code (03,04,05,06,32) ...

1.9. Trailer coupling point – only for DC (high, low) ...

1.10. Volume orientation (yes/no)

1.11. Corrected mass in running order (kg)...

1.12. Technical Permissible Maximum Laden Mass of trailer (kg)...

1.13. Technical Permissible Maximum Laden Mass of axle assembly (kg)...

1.14. Whole vehicle type approval number or individual vehicle approval number …

1.15. Simulation tool licence number …

1.16. Intermodal trailer (yes/no) …

1.17. EX/III certificate number …

1.18. Side-opening doors (yes/no) …

2. Vehicle dimensions

2.1. External length of the body (m)...

2.2. External width of the body (m)...

2.3. External height of the body (m)...

2.4. Total maximum height of the trailer (m)...

2.5. Cargo volume (m^3)...

2.6. Length from trailer front end to centre of first axle (m)...

2.7. Length between centres of axles (m)...

2.8. Trailer coupling point (high/low)

3. Aerodynamic device

3.1. Input data for the certified aerodynamic device (XML format)...

3.2. Elements of the standard aerodynamic device (none, short side covers ...) …

4. Axle and tyre features

4.1. Axle 1

4.1.1. Tyre component input data (XML format)...

4.1.2. Twin tyre (yes/no) ...

4.1.3. Axle steered (yes/no) ...

4.1.4. Axle liftable (yes/no) ...

4.1.5. Wheel end friction (Nm) …

4.1.6. Certification number wheel end …

4.1.7. E-axle (yes/no) …

4.2. Axle 2

4.2.1. Tyre component input data (XML format)...

4.2.2. Twin tyre (yes/no) ...

4.2.3. Axle steered (yes/no) ...

4.2.4. Axle liftable (yes/no) ...

4.2.5. Wheel end friction (Nm) …

4.2.6. Certification number wheel end …

4.2.7. E-axle (yes/no) …

4.3. Axle 3

4.3.1. Tyre component input data (XML format)...

4.3.2. Twin tyre (yes/no) ...

4.3.3. Axle steered (yes/no) ...

4.3.4. Axle liftable (yes/no) ...

4.3.5. Wheel end friction (Nm) …

4.3.6. Certification number wheel end …

4.3.7. E-axle (yes/no) …

5. Data for refrigerated trailers

5.1. Refrigeration supply type (ICE driven compressor, electric driven compressor …) …

5.2. Electrical energy supply type (ICE electric, battery …) …

5.3. ICE fuel type (Diesel, CNG …) …

5.4. K coefficient (W/m^2K) …

6. Data for e-axle trailers

6.1. Off-vehicle charging (yes/no) …

6.2. Free recuperation (yes/no) …

6.3. Brake blending (yes/no) …

6.4. Generator mode active during braking (yes/no) …

6.5. Propulsion support (yes/no) …

6.6. Propulsion support maximum speed (km/h) …

6.7. Powertrain architecture (E2, E3 …) …

6.8. Number of driven wheel sides (1, 2) …

6.9. Disengagement clutch (yes/no) …

6.10. Electric machine system input data (XML format) …

6.11. ADC input data (XML format) …

6.12. Transmission input data (XML format) …

6.13. Axle component input data (XML format) …

6.14. Integrated electric powertrain component input data (XML format) …

6.15. E-axle torque limitations per gear (min/max Nm as a function of wheel rpm) ...

7. REESS data

7.1. REESS input data (XML format) …

7.2. String ID …

7.3. Minimum usable SOC …

7.4. Maximum usable SOC …

8. Photovoltaic modules data

8.1. On the vehicle installed power at STC – horizontally oriented modules (W) …

Appendix 2

Vehicle technologies for which the obligations laid down in Article 8 do not apply

Table 1: Exempted vehicle technologies

Vehicle technology category	Criteria for exemption	Value for input parameter 'Technology' in Table 2 of this Appendix
E-axle trailer	The vehicle is equipped with an e-axle where at least one of the following criteria applies: • The vehicle has a powertrain architecture other than E2 to E4 or E-IEPC in accordance with point 6.2 of this Annex. • The vehicle is equipped with a REESS that includes both battery systems and capacitor systems	'E-axle Article 8 exempted'
Refrigeration energy supply type	The vehicle is of bodywork type '04' and equipped with a refrigeration system which is not covered by the refrigeration supply types as defined in points 2(28) to 2(31) of this Annex.	'Refrigeration Article 8 exempted'

Table 2: Input parameters for vehicle technologies exempted under Article 8

Parameter name	Parameter ID	Type	Unit	Description/Reference
Manufacturer	T001	token	[-]	
Manufacturer Address	T002	token	[-]	
Model / Commercial name	T003	token	[-]	
VIN	T004	token	[-]	
Date	T005	dateTime	[-]	Date and time when input information and input data are created.
Legislative category	T006	string	[-]	Allowed values: 'O3', 'O4'
Number of axles	T007	integer	[-]	Allowed values: 1, 2, 3
Trailer type	T008	string	[-]	Allowed values: 'DA', 'DB', 'DC'
Bodywork type	T009	string	[-]	Allowed values: 'dry box', 'refrigerated', 'conditioned', 'curtain-sided', 'drop-side with tarpaulin body' in accordance with Table 3 of this Annex.
Volume orientation	T010	boolean	[-]	In accordance with Point 7 of Annex I to this Regulation.
Corrected mass in running order	T011	integer	[kg]	In accordance with point 2(13) of this Annex.
TPMLM trailer	T012	integer	[kg]	In accordance with point 1.6, Section A, Part 2, of Annex XIII to Implementing Regulation (EU) 2021/535.
TPMLM axle assembly	T013	Integer	[kg]	In accordance with point 1.13, Section A, Part 2, of Annex XIII to Implementing Regulation (EU) 2021/535. In case of trailer type 'DB', no input shall be provided.
Cargo volume	T021	double, 3	[m^3]	In accordance with point 2(8) of this Annex.
Vehicle type approval number	T0XX	token	[-]	The whole vehicle type approval number shall be provided. In the case of individual vehicle approvals, the individual vehicle

Parameter name	Parameter ID	Type	Unit	Description/Reference
				approval number shall be provided.
Simulation tool licence number	T0XX	token	[-]	Licence number related to the operation of the simulation tool in accordance with Article 5.
Intermodal trailer	T0XX	boolean	[-]	In accordance with point 2(14) of this Annex.
EX/III certificate number	T0XX	token	[-]	Point 1 of the model certificate of approval for vehicles carrying certain dangerous goods specified in Part 9, Chapter 9.1, point 9.1.3.5, of the Agreement concerning the International Carriage of Dangerous Goods by Road (ADR).
Side-opening doors	T0XX	boolean	[-]	Presence of rigid doors on at least one side of the vehicle that can be opened to allow access across the entire length of the body. Input only relevant for trailers with bodywork of type 'dry box', 'refrigerated' and 'conditioned'.
Technology	T0XX	string	[-]	In accordance with Table 1 of this Appendix. Allowed values: 'E-axle Article 8 exempted', 'Refrigeration Article 8 exempted'

'.

ANNEX IV

Annex IV is amended as follows:

(1) Part I is amended as follows:

(a) the following points are inserted after point 1.1.14:

‘1.1.15. Vehicle type approval number …

1.1.16. Intermodal trailer (yes/no) …

1.1.17. EX/III certificate number …

1.1.18. Side-opening doors (yes/no) …’;

(b) the following point is inserted after point 1.2.5:

‘1.2.5a. Minimum cargo volume (only for vehicles with cargo volume dependent aero dynamic devices) (m^3) …’;

(c) point 1.3.3 is replaced by the following:

‘1.3.3. Aerodynamic reductions (per technology, if applicable)’;

(d) the following point is inserted after point 1.3.4:

‘1.3.5. Aerodynamic device technology (fixed, retractable non-cargo volume, retractable cargo volume, active non-cargo volume, active cargo volume, and combinations of these) …’;

(e) the following points are inserted after point 1.4.1.9:

‘1.4.1.10. Wheel end friction (Nm) …

1.4.1.11. E-axle (yes/no) …’;

(f) the following points are inserted after point 1.4.2.9:

‘1.4.2.10. Wheel end friction (Nm) …

1.4.2.11. E-axle (yes/no) …’;

(g) the following points are inserted after point 1.4.3.9:

‘1.4.3.10. Wheel end friction (Nm) …

1.4.3.11. E-axle (yes/no) …

1.5. **E-axle features**

1.5.1. General features

1.5.1.1. Off-vehicle charging (yes/no) …

1.5.1.2. Free recuperation (yes/no) …

1.5.1.3. Brake blending (yes/no) …

1.5.1.4. Generator mode active during braking (yes/no) …

1.5.1.5. Propulsion support (yes/no) …

1.5.1.6. Propulsion support maximum speed (km/h) …

1.5.1.7. Powertrain architecture (E2, E3, E4, E-IEPC) …

1.5.1.8. Number of driven wheel sides (1, 2) …

1.5.1.9. Disengagement clutch (yes/no) …

1.5.1.10. E-axle torque limitations (per gear if applicable) …

1.5.2. Electric machine system (EMS) specifications

1.5.2.1. Model ...

1.5.2.2. Certification number ...

1.5.2.3. Type (PSM, ESM, IM, SRM) ...

1.5.2.4. Rated power (kW) ...

1.5.2.5. Maximum continuous power (kW) ...

1.5.2.6. Option for generation of electric power consumption map (standard values/measurement) ...

1.5.2.7. Hash of the EMS input data and input information ...

1.5.3. Additional driveline component (ADC) specifications

1.5.3.1. Model ...

1.5.3.2. Certification number ...

1.5.3.3. Option used for generation of an ADC loss map (measurement/standard values) ...

1.5.3.4. Ratio ...

1.5.3.5. Hash of the ADC input data and input information ...

1.5.4. Transmission specifications

1.5.4.1. Model …

1.5.4.2. Certification number …

1.5.4.3. Main option used for generation of loss maps (Option 1, Option 2, Option 3, Standard values) …

1.5.4.4. Transmission type (SMT, AMT, APT-S, APT-P, APT-N) …

1.5.4.5. No. of gears …

1.5.4.6. Ratio final gear …

1.5.4.7. Hash of the transmission input data and input information …

1.5.5. Axle specifications

1.5.5.1. Model …

1.5.5.2. Certification number …

1.5.5.3. Option used for generation of loss map (measurement/standard values) …

1.5.5.4. Axle ratio …

1.5.5.5. Hash of the axle input data and input information …

1.5.6. Integrated electric powertrain component (IEPC) specifications

1.5.6.1. Model …

1.5.6.2. Certification number …

1.5.6.3. Rated power (kW) …

1.5.6.4. Maximum continuous power (kW) …

1.5.6.5. Number of gears …

1.5.6.6. Lowest total transmission ratio (highest gear times axle ratio if applicable) …

1.5.6.7. Differential included (yes/no) …

1.5.6.8. Design type wheel motors (yes/no) …

1.5.6.9. Disengagement clutch (yes/no) …

1.5.6.10. Option for generation of electric power consumption map (measurement/standard values) …

1.5.6.11. Hash of the IEPC input data and input information …

1.6. **Rechargeable energy storage systems specifications – battery**

1.6.1. Model …

1.6.2. Certification number …

1.6.3. Nominal voltage (V) …

1.6.4. Total storage capacity (kWh) …

1.6.5. Total usable capacity in simulation (kWh) …

1.6.6. Certification option (measurement/standard values) …

1.6.7. Hash of the input data and input information …

1.6.8. StringID (-) …

1.7. **Rechargeable energy storage systems specifications – capacitor**

1.7.1 Model …

1.7.2. Certification number …

1.7.3. Capacitance (F) …

1.7.4. Minimum voltage (V) …

1.7.5. Maximum voltage (V) …

1.7.6. Certification option (measurement/standard values) …

1.7.7. Hash of the input data and input information …

1.8. **Photovoltaic modules**

1.8.1 Installed power at horizontally oriented modules (W) …

1.9. **Refrigerated trailers**

1.9.1 Refrigeration supply type (e.g. electric driven compressor) …

1.9.2. Electrical energy supply type (e.g. ICE electric, battery) …

1.9.3. ICE fuel type (Diesel, CNG, Hydrogen) …

1.9.4. K coefficient (W/m²K) …';

(h) the following is inserted after point 2:

‘For e-axle trailers with off-vehicle charging feature, the results shall be provided separately for charge depleting mode, charge sustaining mode and weighted over both modes.’;

(i) the following point is inserted after point 2.1.3:

‘2.1.4. Cargo volume (m³) …’;

(j) the following points are inserted after point 2.2.6.3:

‘2.2.7 Electric energy consumption and electric ranges (for e-axle trailers with propulsion support)

2.2.7.1. Trailer electric energy consumption (kWh/km) …

2.2.7.2. Trailer electric energy consumption (kWh/t-km) …

2.2.7.3. Trailer electric energy consumption (kWh/m³-km) …

2.2.7.4. Trailer electric range (km) …

2.2.7.5. Extension of the electric range of the towing vehicle (km) …’;

(k) the following point is inserted after point 3.1:

‘3.1a. Cargo volume (m³) …’;

(l) the following points are inserted after point 3.4.3:

‘3.5. Electric energy consumption

3.5.1. Trailer electric energy consumption (kWh/km) …

3.5.2. Trailer electric energy consumption (kWh/t-km) …

3.5.3. Trailer electric energy consumption (kWh/m³-km) …

3.6. Trailer electric range (km) …

3.7. Extension of the electric range of the towing vehicle (km) …’;

(m) the following point is inserted after point 4.2:

‘4.3. Number of licence to operate the simulation tool …’;

(2) Part II is amended as follows:

(a) the following point is inserted after point 1.1.14:

‘1.1.15. Vehicle type approval number …’;

(b) the following point is inserted after point 1.2.5:

‘1.2.5a. Minimum cargo volume (only for vehicles with cargo volume dependent aero dynamic devices) (m³) …’;

(c) point 1.3.3 is replaced by the following:

‘1.3.3. Aerodynamic reductions (per technology, if applicable)’;

(d) the following point is inserted after point 1.3.3.4:

‘1.3.4. Aerodynamic device technology (fixed, retractable non-cargo volume, retractable cargo volume, active non-cargo volume, active cargo volume, and combinations of these) …’;

(e) the following point is inserted after point 1.4.1.6:

‘1.4.1.7. E-axle (yes/no) …’;

(f) the following point is inserted after point 1.4.2.6:

‘1.4.2.7. E-axle (yes/no) …’;

(g) the following points are inserted after point 1.4.3.6:

‘1.4.3.7. E-axle (yes/no) …

1.5. **E-axle features**

1.5.1. Number of e-axles (1, 2, 3) …

1.5.2. Number of driven wheel sides (1, 2) …

1.5.3. Powertrain architecture (E2, E3, E4, E-IEPC) …

1.5.4. Total rated power (kW) …

1.5.5. Total maximum continuous power (kW) …

1.5.6. Braking features

1.5.6.1. Free recuperation (yes/no) …

1.5.6.2. Brake blending (yes/no) …

1.5.6.3. Maximum braking power (kW)…

1.5.7. Propulsion support features

1.5.7.1. Propulsion support (yes/no) …

1.5.7.2. Propulsion support maximum speed (km/h) …

1.5.7.3 Maximum propulsion support power (kW) …

1.6. **Rechargeable electric energy storage system**

1.6.1. Off-vehicle charging feature (yes/no) …

1.6.2. Installed total storage capacity (kWh)…

1.6.3. Useable storage capacity in simulation (kWh) …

1.7. **Photovoltaic modules**

1.7.1 Installed power at horizontally oriented modules (W) …

1.8. **Refrigerated trailers**

1.8.1 Refrigeration supply type (e.g. electric driven compressor) …

1.8.2. Electrical energy supply type (e.g. ICE electric, battery) …

1.8.3. ICE fuel type (Diesel, CNG, Hydrogen) …

1.8.4. K coefficient (W/m^2K) …’;

(h) the following point is inserted after point 2.1.3:

‘2.1.4. Cargo volume (m^3) …’;

(i) the following points are inserted after point 2.2.6.1:

‘2.2.7. Electric energy consumption and electric ranges (for e-axle trailers with propulsion support)

2.2.7.1. Trailer electric energy consumption (kWh/km) …

2.2.7.2. Trailer electric energy consumption (kWh/t-km) …

2.2.7.3. Trailer electric energy consumption (kWh/m³-km) …

2.2.7.4. Trailer electric range (km) …

2.2.7.5. Extension of the electric range of the towing vehicle (km) …';

(j) the following point is inserted after point 3.1:

'3.1a. Cargo volume (m³) …';

(k) the following points are inserted after point 3.4.3:

'3.5. Electric energy consumption

3.5.1. Trailer electric energy consumption (kWh/km) …

3.5.2. Trailer electric energy consumption (kWh/t-km) …

3.5.3. Trailer electric energy consumption (kWh/m³-km) …

3.6. Trailer electric range (km)…'.

ANNEX V

Annex V is amended as follows:

(1) in point 2, the following points are added:

‘(3) ‘Fixed aerodynamic device’ means an aerodynamic device that has a fixed geometrical shape and position with respect to the vehicle;

(4) ‘Retractable aerodynamic device’ means an aerodynamic device that is designed to have more than one geometrical shape or position with respect to the vehicle, and the geometrical shape or position can only be altered by human intervention;

(5) ‘Retractable non-cargo volume dependent’ means a retractable aerodynamic device that does not reduce the cargo volume in any of its shapes or positions;

(6) ‘Retractable cargo volume dependent’ means a retractable aerodynamic device that reduces the cargo volume in at least one of its shapes or positions;

(7) ‘Active aerodynamic device’ means an aerodynamic device that is designed to have more than one geometrical shape or position with respect to the vehicle, and the geometrical shape or position is automatically altered under certain controlled conditions when the vehicle is in motion.

(8) ‘Active non-cargo volume dependent’ means an active aerodynamic device that does not reduce the cargo volume in any of its shapes or positions;

(9) ‘Active cargo volume dependent’ means an active aerodynamic device that reduces the cargo volume in at least one of its shapes or positions.’;

(2) in point 3.1, the following text is added:

‘The approval of the CFD method shall be renewed in the following cases:

(a) If any change is made to the CFD method that could potentially affect the validity of the results

(b) four years after the approval of the CFD method

(c) At the request of the approval authority

If the approval of the CFD method is not renewed, the CFD method may no longer be used for the purpose of this Annex.’;

(3) point 3.2 is replaced by the following:

‘3.2. Requirements for the validation of the CFD method

3.2.1. CFD model requirements

3.2.1.1 The validation process shall consist of simulating three different CFD simulation sets as follows:

(a) BASE set:

– Generic 4x2 tractor

– Generic ST1 semi-trailer.

(b) TRF set:

– Generic 4x2 tractor

– Generic ST1 semi-trailer

– Generic tall rear flaps

(c) LSC set:

– Generic 4x2 tractor

– Generic ST1 semi-trailer

– Generic long side covers

3.2.1.2. Each set shall be simulated at β=0.0, 3.0 and 6.0 degrees of yaw to account for crosswind effects coming from the left hand side of the vehicle, as shown in Figure 2.

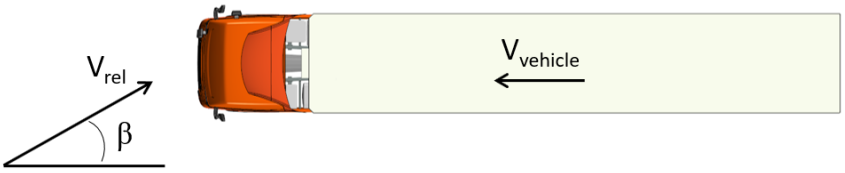


Figure 2: β yaw angle

3.2.1.3. The heat exchangers pressure drop shall be modelled as per equation [1]:

$$\frac{dp}{dx} = -(P_i \cdot v^2 + P_v \cdot v) \qquad [1]$$

where the coefficients for each heat exchanger shall be as listed in Table 1.

Table 1. Porous media resistance coefficients

Coefficient	Condenser	Charge Air Cooler	Radiator
Inertial Resistance (P_i) [kg/m^4]	140,00	60,00	120,00
Viscous Resistance (P_v) [kg/m^{3}s]	450,00	300,00	450,00

3.2.1.4. The CFD shall comply with the requirements listed in Table 2. The compliance for the minimum CFD requirements shall be demonstrated to the approval authority.

Table 2. Minimum CFD requirements

Field	Value	Comments
Vehicle velocity	25,00 m/s	To be used as the drag coefficient reference velocity.
Vehicle frontal area	10.047 m^2	To be used as the drag coefficient reference area.
Tractor Front Wheel Rotation axis-to-Ground Vertical Distance	527,00 mm	

Semi-trailer Rear Wheel Rotation axis-to-Ground Vertical Distance	514,64 mm	
Simulation Domain dimensions. Length	Length ≥ 145,00 m	
Simulation Domain dimensions. Width	Width ≥ 75,00 m	
Simulation Domain dimensions. Height	Height ≥ 25,00 m	
Vehicle Position Air Inlet to Vehicle Front End Distance	≥ 25,00 m	
Vehicle Position Air Outlet to Vehicle Rear End Distance	≥ 100,00 m	
Domain Discretization. Cell Count	≥ 60 million cells	Mesh refinement applied to properly capture aero-relevant areas.
Ground surface and wheels	25,00 m/s	The ground surface of the simulation domain has to move backwards relative to the vehicle and the wheels of the vehicles have to rotate with the corresponding tangential velocity.

3.2.2. The CFD method shall fulfil an accuracy for Δ(CD×A) during the validation for each of the six comparisons with respect to the reference ranges as shown in Table 3.

Table 3. Reference ranges for the validation process

Simulation set	**Yaw Angle – β [deg]**		
	0,0°	**3,0°**	**6,0°**
TRF	-8,6% ≤ Δ(C_D×A) ≤ -1,6%	-9,0% < Δ(C_D×A) < -2,0%	-10,3% < Δ(C_D×A) < -3,3%
LSC	-8,8% < Δ(C_D×A) < -1,8%	-8,0% < Δ(C_D×A) < -1,0%	-8,1% < Δ(C_D×A) < -1,1%

$\Delta(C_D \times A)(\beta)[\%]$ shall be calculated as follows:

$$\Delta(C_D \times A)(\beta) = \frac{C_D \times A(\beta)_{BASE} - C_D \times A(\beta)_{CONFIG}}{C_D \times A(\beta)_{BASE}} \times 100$$

Where:

$C_D \times A(\beta)_{BASE}$ is the the aerodynamic resistance (in m^2) of the BASE set computed by the CFD method for β = 0.0, 3.0, 6.0 and 9.0 degrees.

$C_D \times A(\beta)_{CONFIG}$ is the aerodynamic resistance (in m^2) of the TRF or LSC set computed by the CFD method for β = 0.0, 3.0, 6.0 and 9.0 degrees.

The value of the aerodynamic resistance shall be the average of the last 1000 iterations in case of steady-state methods, or the average of the last 5 seconds in case of transient methods.

3.2.3. Other requirements

3.2.3.1. All simulations required for the validation of the CFD method shall run for the same number of iterations in case of steady-state methods, or the same number of seconds in case of transient methods.

3.2.3.2. The solution shall be considered converged when:

(a) For steady-state methods: the standard deviation of the last 1000 iterations ≤ 0.5% of the mean of the last 1000 iterations

(b) For transient methods: the standard deviation of the last 5 seconds ≤ 3.5% of the mean of the last 5 seconds

3.2.3.3. Simulation files used for CFD validation shall be hashed.

3.2.4. The validation report shall contain all of the following:

3.2.4.1. The validation report shall reflect the $C_D \times A(\beta)_{Config}[m^2]$ value for all nine CFD simulations as shown in Table 4.

$C_D \times A(\beta)_{Config}[m^2]$ results:

Table 4. (C_D×A) [m^2] results

Simulation set	Yaw Angle – β [deg]		
	0.0°	3.0°	6.0°
BASE			
TRF			
LSC			

3.2.4.2. in the case of steady-state methods:

– raw data of the evolution of C_D, C_D×A[m^2] or drag force [N] vs iteration, in *.csv format for at least the last 2000 iterations.

– the average of the last 1000 iterations.

– the standard deviation of the last 1000 iterations.

3.2.4.3. in the case of transient methods:

– raw data of the evolution of C_D (or C_D×A) vs time, in *.csv format for at least 10.0 seconds of simulation time

– the average of the last 5.0 seconds.

– the standard deviation of the last 5.0 seconds.

3.2.4.4. A XY plane section intersecting the entire simulation domain:

– passing through the tractor front axle wheel rotation point,

– showing the airflow velocity magnitude in a scale going from 0 to 30 m/s and with a colour bar divided in, at least, 18 colour levels as shown in Figure 3.

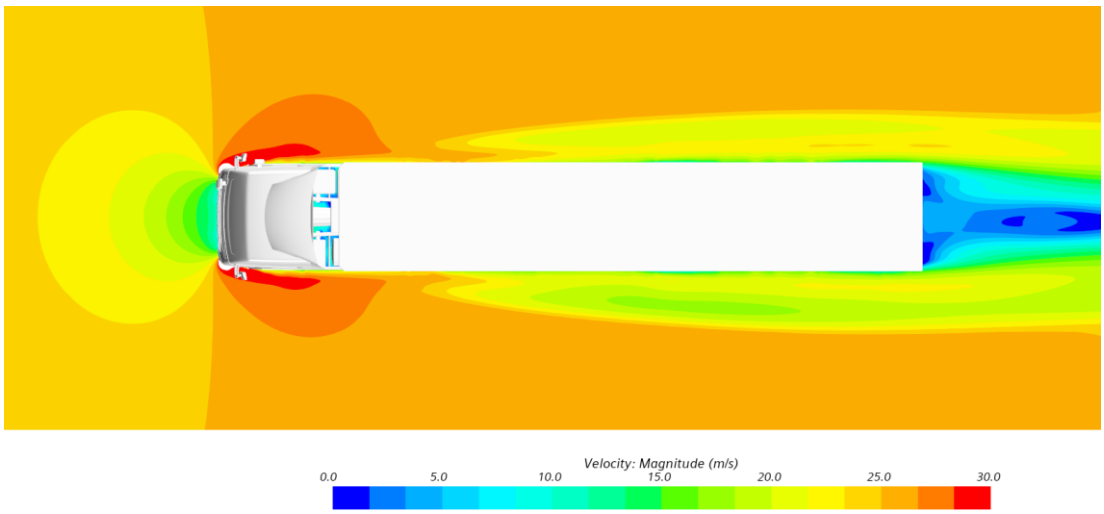


Figure 3: XY plane view passing through the front axle wheel rotation point

3.2.4.5. A XY plane section intersecting the entire simulation domain:

– passing through the tractor side mirrors,

– showing the airflow velocity magnitude in a scale going from 0 to 30 m/s and with a colour bar divided in, at least, 18 colour levels as shown in Figure 4.

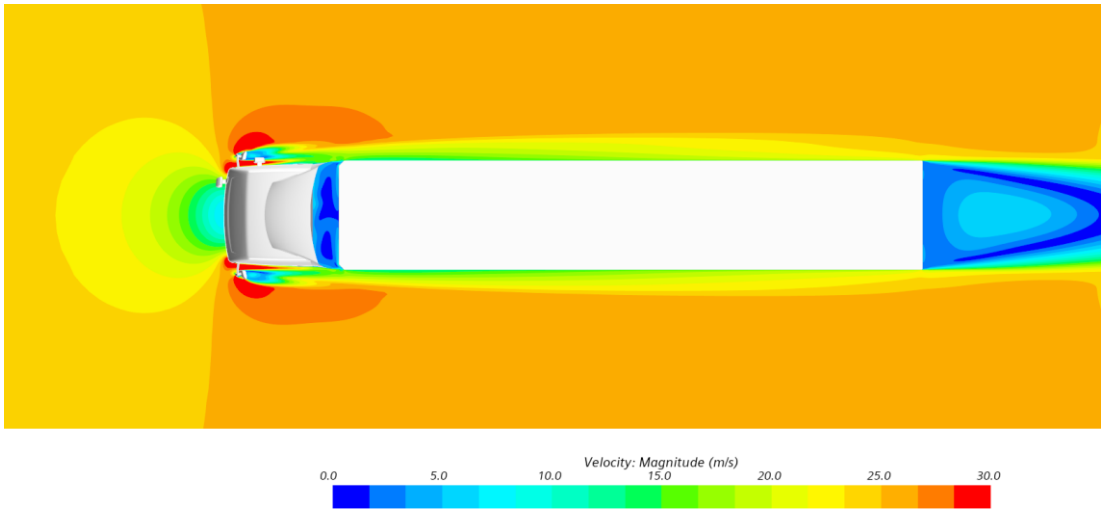


Figure 4: XY plane view passing through the tractor side mirrors

3.2.4.6. A YZ plane section intersecting the entire simulation domain:

– passing through the tractor front axle wheel rotation point,

– showing the airflow velocity magnitude in a scale going from 0 to 30 m/s and with a colour bar divided in, at least, 18 colour levels as shown in Figure 5.

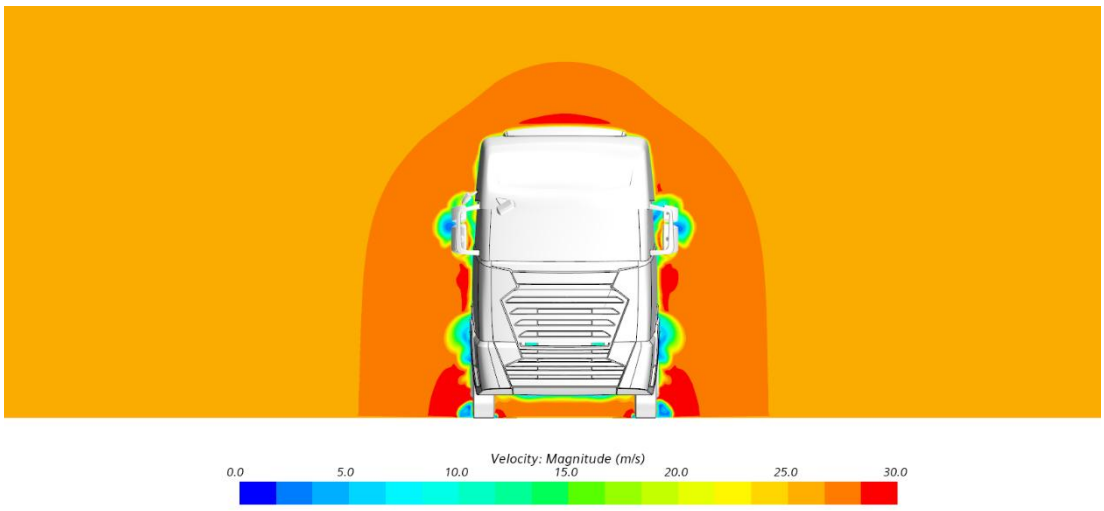


Figure 5: YZ plane view passing through the front axle wheel rotation point

3.2.4.7. A XZ plane section intersecting the entire simulation domain:

– passing through the centre of the vehicle,

– showing the airflow velocity magnitude in a scale going from 0 to 30 m/s and with a colour bar divided in, at least, 18 colour levels as shown in Figure 6.

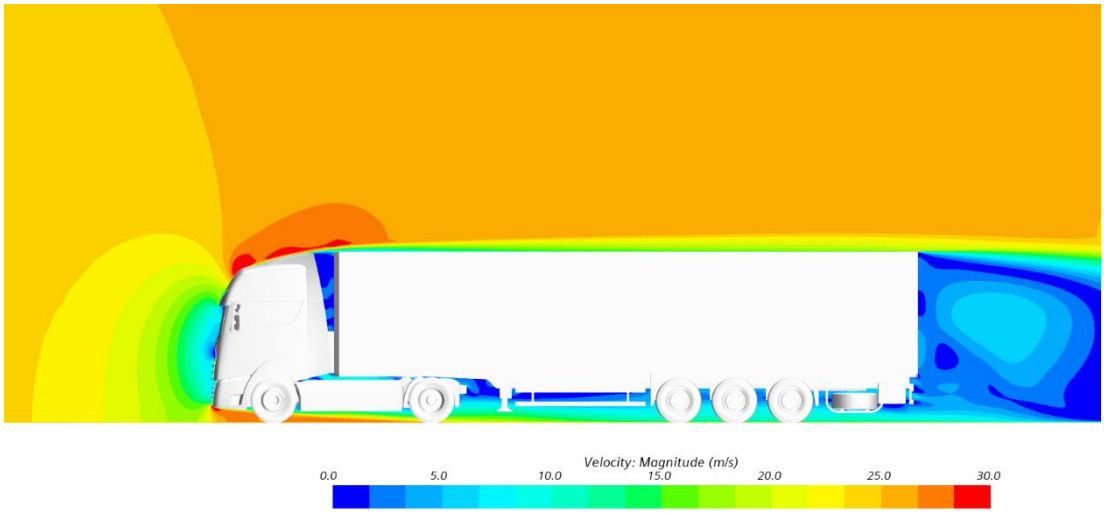


Figure 6: XZ plane view passing through the centre of the vehicle

3.2.4.8. The XY, YZ and XZ planes use a coordinate system fixed to the vehicle as shown in Figure 7, where,

– the X-axis is oriented along the longitudinal direction of the vehicle,

– the Y-axis is oriented along the width of the vehicle,

– the Z-axis is oriented along the height of the vehicle.

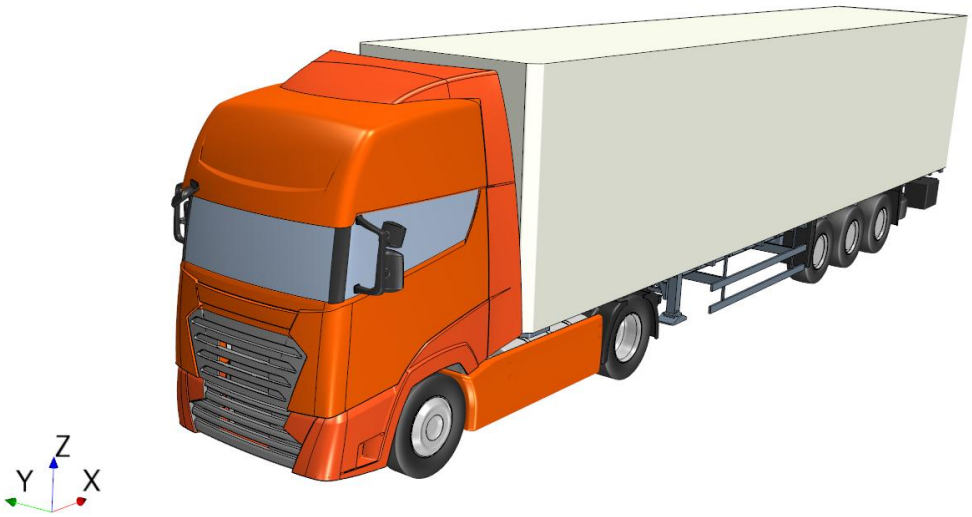


Figure 7: position of the coordinate system in relation to the vehicle

’;

(4) point 3.3 is replaced by the following:

‘**3.3. Certification of an aerodynamic device**

The manufacturer of the aerodynamic device or devices shall use generic vehicle geometries to demonstrate the performance of the aerodynamic devices mounted on a trailer or semi-trailer. For that purpose, the 3D model of the aerodynamic devices shall be added to the generic vehicle geometries of the BASE set in the same position as if they were mounted on a real vehicle, resulting in modified geometries.

Upon agreement of an approval authority, the manufacturer of the aerodynamic devices may make changes to the generic geometries if that is necessary for the correct installation or proper operation of the aerodynamic devices and if that change adequately reflects reality.

The validated CFD method shall be applied to the modified geometries and $\Delta(C_D \times A)$ values for the four yaw angles $\beta = 0.0$, 3.0, 6.0 and 9.0 degrees shall be computed for each modified geometry MOD_i with respect to the generic geometries of the BASE set according to the formula specified in point 3.4.

All simulations required for the certification of an aerodynamic device shall run for the same number of iterations in case of steady-state methods, or the same number of seconds in case of transient methods.

3.3.1. Certification of fixed aerodynamic devices

To obtain the modified geometry MOD_1, fixed aerodynamic devices shall be added or applied to the generic vehicle geometries in their fixed position.

3.3.2. Certification of retractable non-cargo volume dependent aerodynamic devices

To obtain the modified geometry MOD_1, retractable non-cargo volume dependent aerodynamic devices shall be added or applied to the generic vehicle geometries in their fully deployed position.

3.3.3. Certification of retractable cargo volume dependent aerodynamic devices

To obtain the modified geometry MOD_1, retractable cargo volume dependent aerodynamic devices shall be added or applied to the generic vehicle geometries in their fully deployed position, meaning the position where the cargo volume is reduced to its minimum.

Retractable cargo volume dependent aerodynamic devices shall only be allowed for the vehicle groups in Table 1 from Annex I.

3.3.4. Certification of active aerodynamic devices

To obtain the modified geometry MOD_1, active aerodynamic features shall be added or applied to the generic vehicle geometries in their fully deployed position. For active cargo volume dependent aerodynamic features this is the position where the cargo volume is reduced to its minimum.

Active cargo volume dependent aerodynamic devices shall only be allowed for the vehicle groups in Table 1 from Annex I.

It shall be demonstrated to the approval authority that the active aerodynamic device is always fully deployed and effective to reduce the air drag at vehicle speeds equal to or greater than 60 km/h.

The applicant shall provide a technical description of the system and a statement of compliance. It shall be possible to demonstrate the fulfilment of this requirement by means of testing, upon request of the approval authority.

3.3.5. Combination of aerodynamic devices

More than one aerodynamic device may be included in the same certificate application, including devices of different technologies. Combinations that include a retractable cargo volume dependent device or an active cargo volume dependent device are limited to 1 device of this technology and a retractable cargo volume dependent device shall not be combined with an active cargo volume dependent device.

For the certification of a combination of aerodynamic devices of different technologies, the CFD method shall be applied to the modified geometries specified in Table X1, X2, X3, X4 or X5, depending on the type of technologies combined.

Tables X1 to X5 shall apply to combinations of aerodynamic device technologies as follows:

- Table X1 shall apply to combinations of fixed aerodynamic devices and active non-cargo volume aerodynamic devices.
- Table X2 shall apply to combinations of fixed aerodynamic devices and/or active non-cargo volume aerodynamic features with retractable non-cargo volume dependent aerodynamic devices.
- Table X3 shall apply to combinations of fixed aerodynamic devices and/or active non-cargo volume dependent aerodynamic devices with (retractable or active) cargo volume dependent aerodynamic devices.

- Table X4 shall apply to combinations of retractable non-cargo volume dependent aerodynamic devices and (retractable or active) cargo volume dependent aerodynamic devices.
- Table X5 shall apply to combinations of fixed aerodynamic devices and/or active non-cargo volume dependent aerodynamic devices with retractable non-cargo volume dependent and (retractable or active) cargo volume dependent aerodynamic devices.

Table X1. Simulations needed for combinations of fixed devices and active non-cargo volume devices

Generic vehicle geometries of the BASE set and modified geometry MOD_1		
	Fixed devices	Active non-cargo volume devices
BASE	Not mounted	Not mounted
MOD_1	Mounted	Deployed

Table X2. Simulations needed for combinations of fixed devices and/or active non-cargo volume devices with retractable non-cargo volume dependent devices

Generic vehicle geometries of the BASE set and modified geometries MOD_i			
	Fixed devices, if present	Active non-cargo volume devices, if present	Retractable non-cargo volume dependent devices
BASE	Not mounted	Not mounted	Not mounted
MOD_1	Mounted	Deployed	Not mounted
MOD_2	Mounted	Deployed	Deployed

Table X3. Simulations needed for combinations of fixed devices and/or active non-cargo volume devices with cargo volume dependent devices

Generic vehicle geometries of the BASE set and modified geometries MOD_i			
	Fixed devices, if present	Active non-cargo volume devices, if present	Cargo volume dependent devices
BASE	Not mounted	Not mounted	Base volume
MOD_1	Mounted	Deployed	Base volume

MOD_2	Mounted	Deployed	Minimum volume

Table X4. Simulations needed for combinations of retractable non-cargo volume dependent devices and cargo volume dependent devices

Generic vehicle geometries of the BASE set and modified geometries MOD_i		
	Retractable non-cargo volume dependent devices	Cargo volume dependent devices
BASE	Not mounted	Base volume
MOD_1	Not mounted	Minimum volume
MOD_2	Deployed	Minimum volume
MOD_3	Deployed	Base volume

Table X5. Simulations needed for combinations of fixed devices and/or active non-cargo volume devices with retractable non-cargo volume dependent devices and cargo volume dependent devices

Generic vehicle geometries of the BASE set and modified geometries MOD_i				
	Fixed devices, if present	Active non-cargo volume devices, if present	Retractable non-cargo volume dependent devices	Cargo volume depenent devices
BASE	Not mounted	Not mounted	Not mounted	Base volume
MOD_1	Mounted	Deployed	Not mounted	Base volume
MOD_2	Mounted	Deployed	Not mounted	Minimum volume
MOD_3	Mounted	Deployed	Deployed	Minimum volume
MOD_4	Mounted	Deployed	Deployed	Base volume

’;

(5) point 3.4 is replaced by the following:

‘**3.4. Declaration of air drag reduction values**

The technical report shall reflect the aerodynamic benefit $\Delta(C_D \times A)[\%]$ for all 4 yaw angles as shown in Table 5.

Table 5. $\Delta(C_D \times A)[\%]$ per yaw angle of the modified (semi-)trailer

$\Delta(C_D \times A)(\beta)$ [%]	Yaw Angle – β [deg]			
	0.0°	3.0°	6.0°	9.0°
Benefit of modified geometry MOD_1				
Benefit of modified geometry MOD_2, if applicable				
Benefit of modified geometry MOD_3, if applicable				
Benefit of modified geometry MOD_4, if applicable				

computed in accordance with the following formula [2]:

$$\Delta(C_D \times A)(\beta)_{MOD_i} = \frac{C_D \times A(\beta)_{BASE} - C_D \times A(\beta)_{MOD_i}}{C_D \times A(\beta)_{BASE}} \times 100 \qquad [2]$$

Where,

$C_D \times A(\beta)_{MOD_i}$ is the aerodynamic resistance (in m^2) of the i-the modified geometry computed by the validated CFD method for β = 0.0, 3.0, 6.0 and 9.0 degrees.

$C_D \times A(\beta)_{BASE}$ is the the aerodynamic resistance (in m^2) of the BASE set computed by the validated CFD method for β = 0.0, 3.0, 6.0 and 9.0 degrees.';

(6) the following points are added:

'**3.5. Determination of installation region / area of influence / bounding region**

The manufacturer shall specify the installation location of the aerodynamic device relative to the vehicle.

A device shall be considered part of a single bounding region if it is entirely contained within it, even if it interacts with other bounding regions. If a device is not enclosed within a single bounding region but is fully encompassed by multiple bounding regions, it shall be assigned to all such bounding regions.

The determination of the bounding regions shall be demonstrated through drawings or CAD, and shall be subject to agreement with the approval authority.

3.5.1. Bounding regions

The bounding regions are defined in relative terms with respect to the cargo box main faces:

3.5.1.1. FRONT bounding region limits as shown in Figure 8:

– Vertical: 1000 mm upwards from the top wall of the box, and 500 mm downwards from the bottom wall of the box.

– Longitudinal: +-1000 mm from the front wall of the box.

– Transversal: 500 mm outwards from the side walls of the box.



Figure 8: FRONT Bounding Region

3.5.1.2. REAR bounding region limits as shown in Figure 9:

– Vertical: 1000 mm upwards from the top wall of the box, and 500 mm downwards from the bottom wall of the box.

– Longitudinal: 1000 mm to the front and 3000 mm to the back from the rear wall of the box.

– Transversal: 500 mm outwards from the side walls of the box.

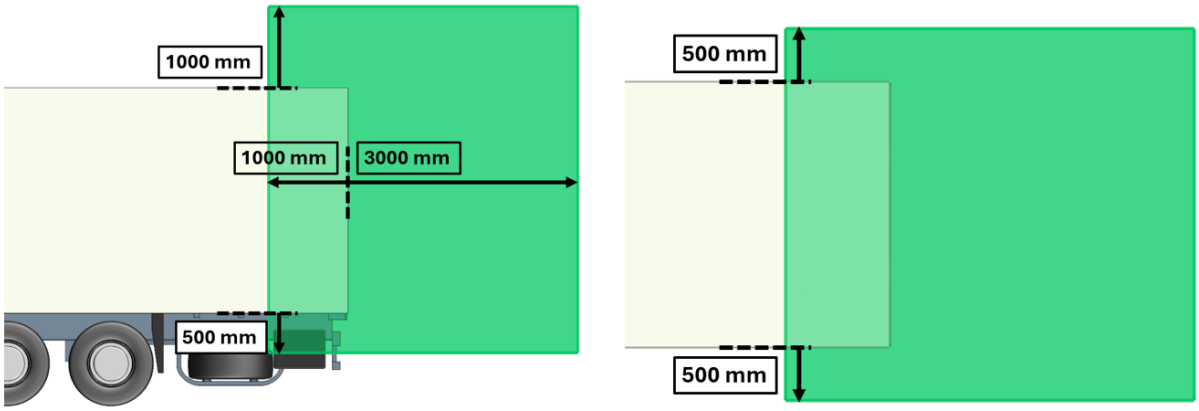


Figure 9: REAR Bounding Region

3.5.1.3. SIDES bounding region limits as shown in Figure 10:

– Vertical: 1000 mm upwards from the top wall of the box, and 500 mm downwards from the bottom wall of the box.

– Longitudinal: 250 mm to the front from the front wall of the box, and 250 mm to the back from the rear wall of the box.

– Transversal: 500 mm outwards and 300 mm inwards from the side wall of the box.

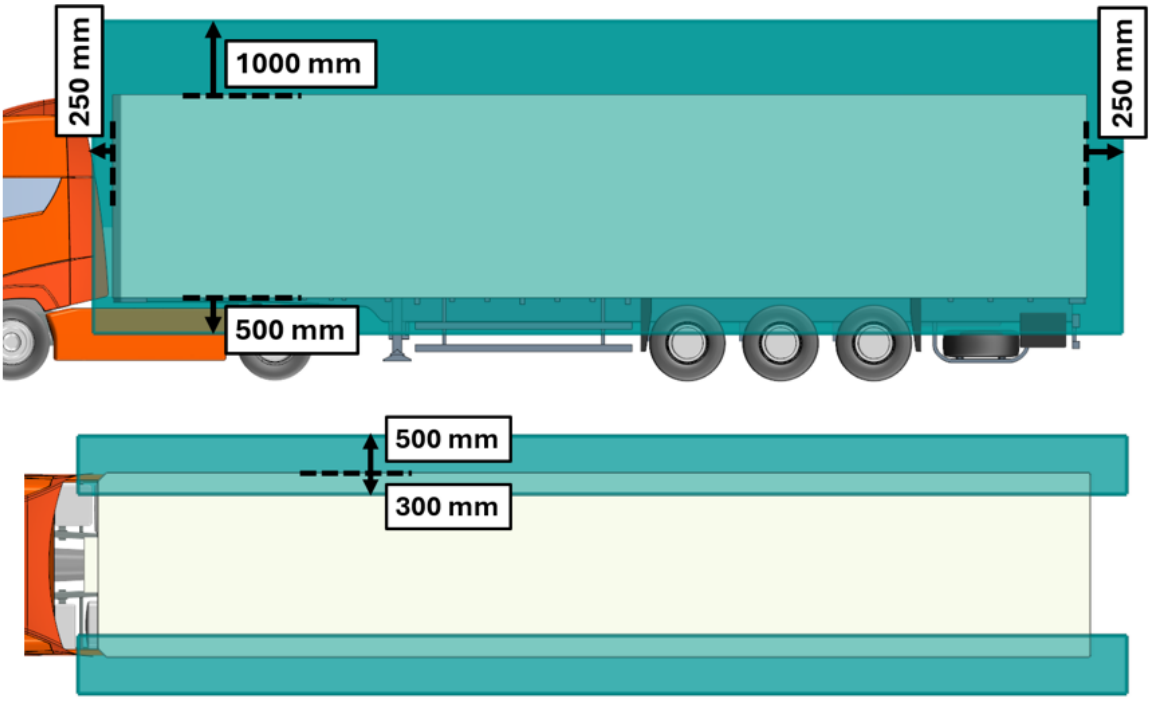


Figure 10: SIDES Bounding Regions

3.5.1.4. TOP bounding region limits as shown in Figure 11:

– Vertical: 1000 mm upwards and 500 mm downwards from the top wall of the box.

– Longitudinal: 250 mm to the front from the front wall of the box, and 250 mm to the back from the rear wall of the box.

– Transversal: 500 mm outwards from the side walls of the box.

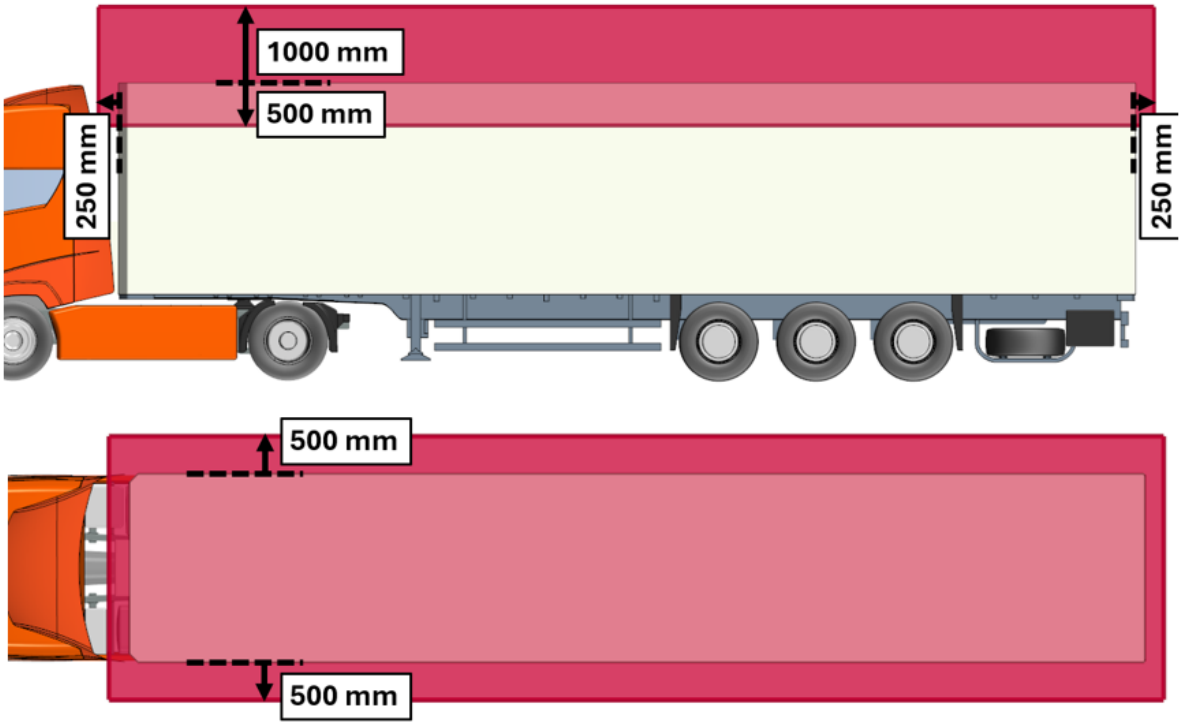


Figure 11: TOP Bounding Region

3.5.1.5. UNDERBODY bounding region limits as shown in Figure 12:

– Vertical: 250 mm upwards from the bottom wall of the box, and to the ground.

– Longitudinal: 250 mm to the front from the front wall of the box, and 3000 mm to the back from the rear wall of the box.

– Transversal: 500 mm outwards from the side walls of the box.

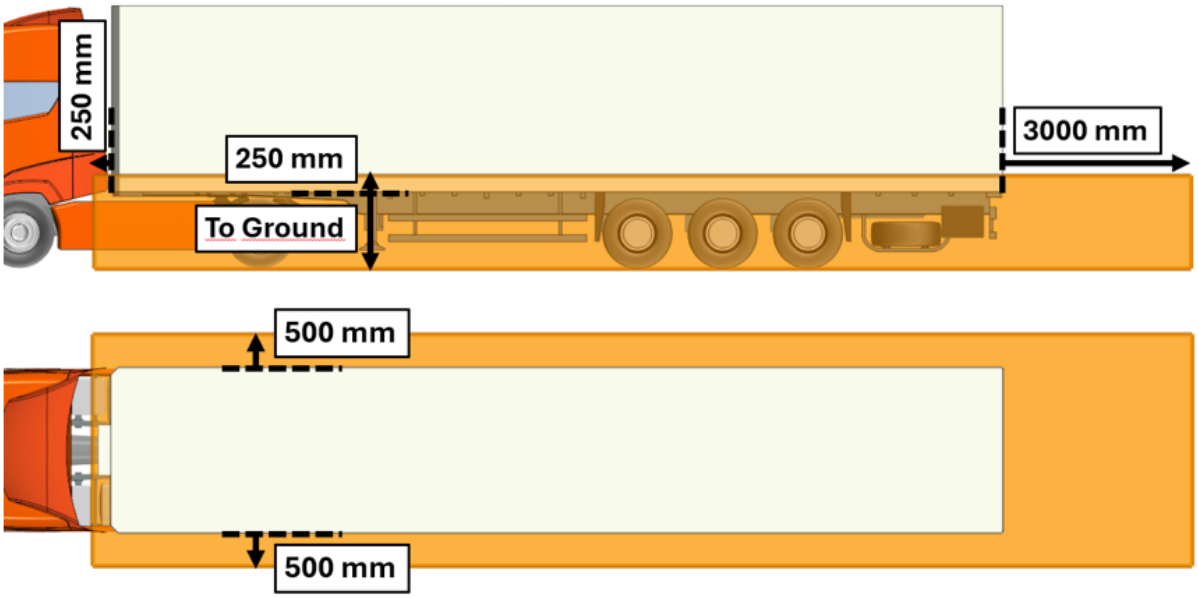


Figure 12: UNDERBODY Bounding Region

3.5.1.6. Cargo volume dependent devices as shown in Figure 13:

In the case of retractable or active cargo volume dependent devices, the bounding regions shall be determined with the cargo volume reduced to its minimum.

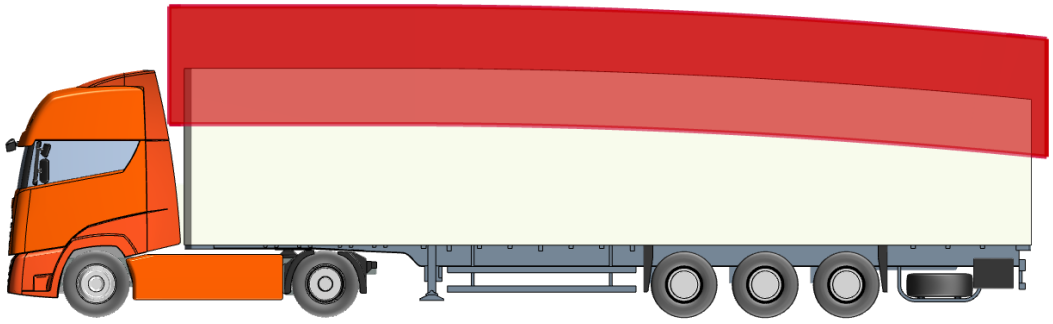


Figure 13. Bounding box TOP for modified cargo box shape

’;

(7) in Appendix 3, point 1.4, the second paragraph is replaced by the following:

‘For this Regulation, the sequence number shall be 01.’;

(8) in Appendix 4, point 3, the following item is added:

‘fixed, retractable or active, (non-)cargo volume dependent;’;

(9) in Appendix 5, Table 1, the following rows are added:

‘

Aerodynamic device technologies	TXXX	string	[-]	Allowed values: ‘F’, ‘R-NCV’, ‘R-CV’, ‘A-NCV’, ‘A-CV’, or a combination of these WITH: F: Fixed, as defined in point 2(3) of this Annex R-NCV: Retractable Non-Cargo Volume, as defined in point 2(5) of this Annex R-CV: Retractable Cargo Volume, as defined in point 2(6) of this Annex A-NCV: Active Non-Cargo Volume, as defined in point 2(8) of this Annex A-CV: Active Cargo Volume, as defined in point 2(9) of this Annex A combination of technologies

				shall be specified as a concatenated string, e.g. 'F+R-NCV+A-CV'.
Maximum cargo volume	TXXX	double, 3	[m³]	Only applicable to cargo volume dependent devices.
Fully deployed cargo volume	TXXX	double, 3	[m³]	Only applicable to cargo volume dependent devices. The minimum cargo volume, when the device is fully deployed, shall be provided.
Bounding Region(s)	TXXX	String	[-]	Allowed values: 'FRONT', 'REAR', 'SIDES', 'TOP', 'UNDERBODY', or a combination of these A combination of regions shall be specified as a concatenated string, e.g. 'FRONT+REAR'.

'.