

Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation

Service contract CLIMA.C.2/SER/2012/0004

Draft Certification Procedure

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1 Introduction

Within the activities of service contract CLIMA.C.2/SER/2012/0004 "*Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation*" a certification procedure for a way of providing robust data on the levels of CO₂ emitted by complete HDVs - including their trailers and different bodies - was to be developed.

In view of the vast number of variations and combinations possible in the construction and usage of HDVs it does not seem possible to determine the CO₂ emissions through tests that are representative for a vehicle type, as is the case for light duty vehicles. In place of such testing, the "VECTO" simulation tool has been developed.

VECTO can simulate the performance of each vehicle produced based on input data relating to certain vehicle components. Based on the use of this tool, it seems appropriate that the CO₂ values per vehicle produced can be generated by the manufacturers of the vehicles themselves, taking into account the final specifications of the vehicles. A downloadable and executable version of the VECTO simulations tool would be used for this purpose.

The aim of the certification procedure is therefore to ensure that the CO₂ values thus determined are **comparable** between different manufacturers, **verifiable** by a third party and **monitorable** by the competent authorities (EU Commission and Member States). A simple accountability framework for the OEMs (vehicle manufacturers) - as the main entities accountable for HDV fuel consumption and CO₂ emissions - is considered highly desirable.

Furthermore, the complete process shall be robust, traceable and reproducible as well as repeatable, and shall ensure solid and definite provisions without loopholes. The development and optimization of CO₂-relevant components should be driven forward and promoted.

Over the medium term, the monitoring of CO₂ emissions will generate knowledge of the CO₂ emissions of different vehicle segments (elements) which could also be used as a basis for further actions regarding HDV CO₂ emissions.

2 Technical Approach

The HDV CO₂ value will be generated by simulation making use of the Vehicle Energy Consumption calculation tool (VECTO). The simulation employs vehicle component input data originating from component testing and verification. The intention of the certification process is to:

- create a procedure to generate a robust CO₂ / fuel consumption value for each HDV produced and
- allow for recording and monitoring of such values.

In addition, the simulation process should deliver a high degree of

- Repeatability
- Reproducibility and
- Robustness.

A particular CO₂ value shall be generated for each newly produced vehicle. The simulation by VECTO using component input values for each specific vehicle put on the road requires well defined procedures on how to establish these input values (described in the “Technical Annex”). The VECTO tool is designed in such a way that at the very beginning, the particular vehicle configuration is specified and described within the applicable vehicle segment(s) defined. For the time being 17 vehicle segments (trucks only, buses and coaches to be integrated later) are defined. Besides the base vehicle definition, also the bodies - trailer / semi-trailers respectively - are allocated to the vehicles based on standard configurations (in a further step, individual bodies and trailers may also be included). After the overall vehicle configuration is specified, the CO₂-affecting parameters necessary as input for the VECTO are determined by testing and verification. This part of the process is considered as *component testing*. Within a very generic view, the component testing activities are related to the following issues:

- Air drag test; an additional assessment tool called the *CSE (constant speed test evaluation)* tool for the calculation of the air drag coefficient C_d is part of the VECTO.
- Transmission / Axle test; this covers the determination of the efficiency of the complete vehicle drive train, such as gearboxes, axles, transfer boxes etc..
- Engine test; this test is necessary to describe the engine fuel consumption map and use it as a VECTO input¹.

¹ see also section 2.7.4 and 6 of “Development and validation of a methodology for monitoring and certification of greenhouse gas emissions from heavy duty vehicles through vehicle simulation”, Consortium Report to Service contract CLIMA.C.2/SER/2012/0004, Report No. I 07/14/Rex EM-I 2012/08 699, 15.04.2014

As an option it may be possible to describe default values (at least for the axle, the transmission and - with respect to a few applications - for the air drag) which can be used instead of values generated by testing. These default values shall be set within ranges which are less attractive than values made possible by state-of-the-art technologies, in order to encourage the use of advanced components.

Furthermore, some of the auxiliaries installed in the vehicle and on the engine are CO₂-affecting components. Unlike the testing specification indicated in the Technical Annex for the air drag, the transmission / axles and the engine, specific testing specifications for such auxiliaries are not available so far. For this reason, the power consumption of truck auxiliaries is considered within the CO₂ calculation by adding a constant power demand to the engine load. This power demand is defined (in tables within the Technical Annex) for the specific auxiliary type but can be dependent on the vehicle segment, the application and the specific technology. The power consumption of the following auxiliaries shall be considered:

- Cooling fan(s)
- Steering pump(s)
- Electrical system
- Pneumatic system(s)
- Air-conditioning system(s)

For the time being, these default auxiliaries values are only applicable to trucks. For buses and coaches (where auxiliaries may have a higher share of the total energy consumption), a more sophisticated approach is currently under development². This is of particular importance for HVAC (heating, ventilation, and air-conditioning) systems for buses and coaches.

Another important VECTO input value is the *rolling resistance co-efficient (RRC)* of the vehicle tyres. This value does not need to be determined separately within the CO₂ process since it is available from the tyre manufacturer (considered as supplier to the vehicle manufacturer). With regard to the tyre labeling specified in Regulation EC 1222/2009 (EC 1235/2011), the RRC to be declared is already determined in accordance with ISO 28580. The applicable tyre rolling resistance coefficient (RRC) for each of the tyres installed on the vehicle is declared by the vehicle manufacturer.

Figure 1 shows a flow-chart giving a simplified overview of VECTO execution and handling.

² Quantify energy consumption of Heavy Duty Vehicle auxiliary components and their contribution to CO₂ emissions of buses and coaches. Integrate auxiliaries into the VECTO simulator and into the certification methodology for HDV CO₂ emissions. CLIMA.C.2/FRA/2013/0007

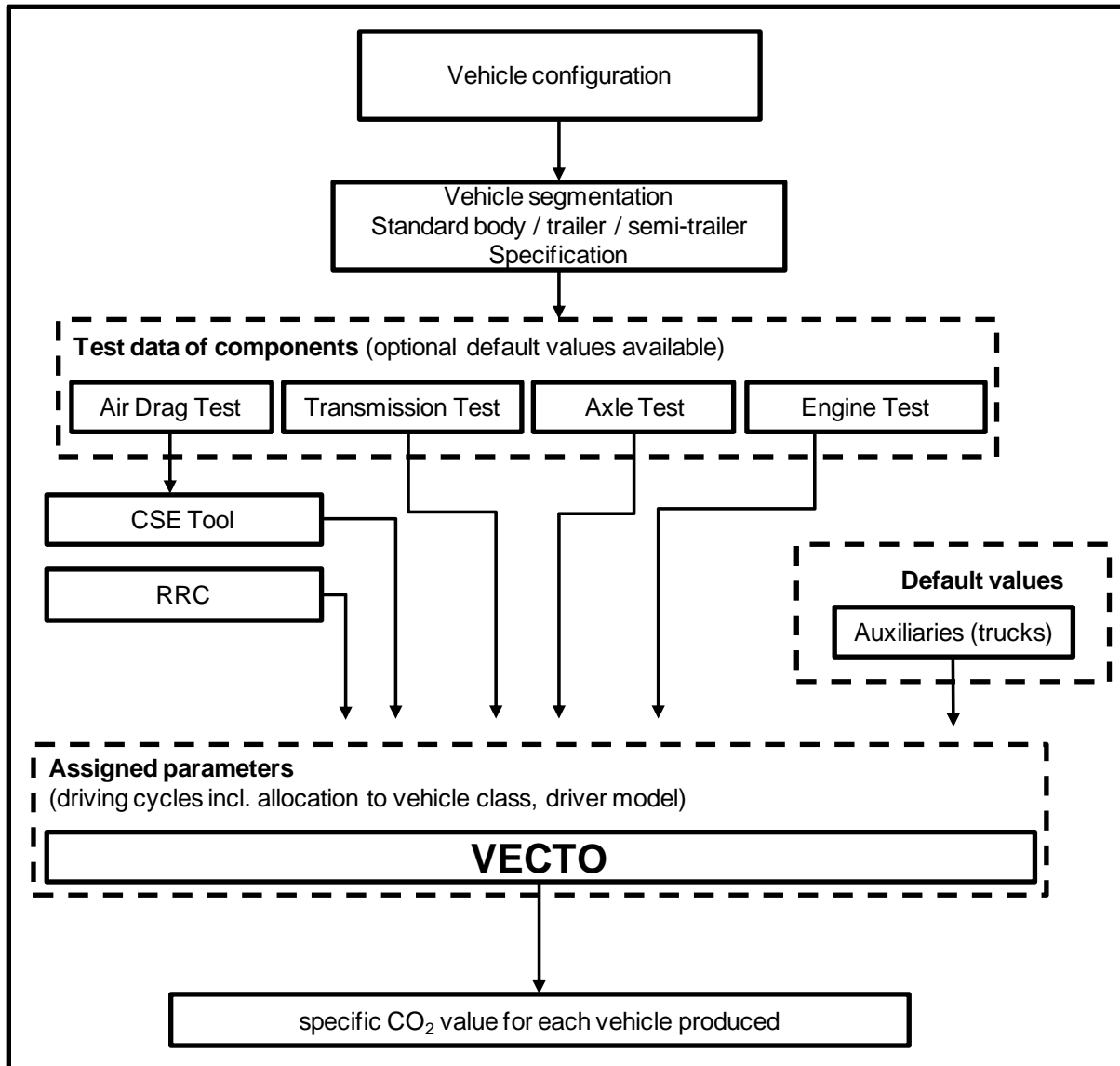


Figure 1: VECTO flowchart

Further CO₂-affecting parameters are applied as fixed assigned parameters within the VECTO database. These are:

- The driving cycle. Five cycles defined: long haul, regional delivery, urban delivery, municipal utility and construction (for trucks only, buses and coaches to be considered at a later stage). Depending on the vehicle segmentation, it is possible that a particular vehicle configuration may be allocated to more than one driving cycle, depending on the mission profiles of the vehicle (e.g. rigid 12t truck allocated to regional and urban delivery)
- The driver model
- The payload to be considered for each vehicle segment
- The distribution of the axle load to be considered for each vehicle segment

3 Requirements for certification

3.1 Possible subjects for certification

The following possible subjects for a certification process can be derived from the technical approach described above. In view of the huge number of variations and combinations possible in the construction and usage of HDVs, it seems not to be possible to determine the CO₂ emissions through physical tests that are representative for a vehicle type, as is the case for light duty vehicles. Instead, the VECTO simulation tool can simulate the performance of each vehicle produced based on input data relating to certain vehicle components.

The advantage of using a simulation tool is that the specificity of each single vehicle can be taken into account and a realistic individual CO₂/fuel consumption value can be determined for each vehicle. For all possible subjects of certification, the generation of such a vehicle-specific value seems to be the most appropriate way forward.

Alternatively, vehicle families could also have been considered as an element relevant to certification. But such a family-based CO₂ value (representative of a certain family) may be less significant than a vehicle-specific value, on the assumption that a large family is covered. The family value can be defined as a “worst case” or “mean value” but will never reflect the real CO₂ value of the particular vehicle.

If the family is defined within much narrower boundaries, the family value then created again becomes more significant. By narrowing the family further, almost the same conditions as for a vehicle specific value will apply.

As long as simulation offers the opportunity to generate vehicle specific values for each HDV produced, family values do not need to be considered for certification.

3.1.1 Certification of the CO₂ determination process

Certification of the CO₂ determination process means that the overall process to define a vehicle specific CO₂ value is certified or approved. In the overall process, all necessary test procedures on the components, the complete data handling as well as the simulation within VECTO are considered. The final vehicle-specific CO₂ value is not covered by the described process certification since the final vehicle-specific CO₂ value for each HDV is generated “end of line” after its production. Due to that such final vehicle-specific values do not exist during certification since certification is considered to be applied prior to a vehicle order / production. The test results of the components are indirectly covered, since they are produced through a certified process. On that basis it seems appropriate that the CO₂ values will be generated by the manufacturers themselves, taking into account the final specification of the vehicle, by applying a downloadable and executable version of the VECTO simulation

tool. The applicant for certification / approval (vehicle manufacturer) delivers all the component and input data for VECTO. The particular CO₂ value of each vehicle produced is recorded and kept by the manufacturer. For that reason a CO₂ value representative for a group (type) of similar HDV does not need to be considered.

The process allows the applicant / manufacturer to create individual CO₂ values for individual vehicles at the “end of line” after certification / approval was granted for the component / input data and the declaration process. This approach provides a direct possibility for creating individual HDV CO₂ values for each vehicle. **Figure 2** provides an overview of the current status of the process certification.

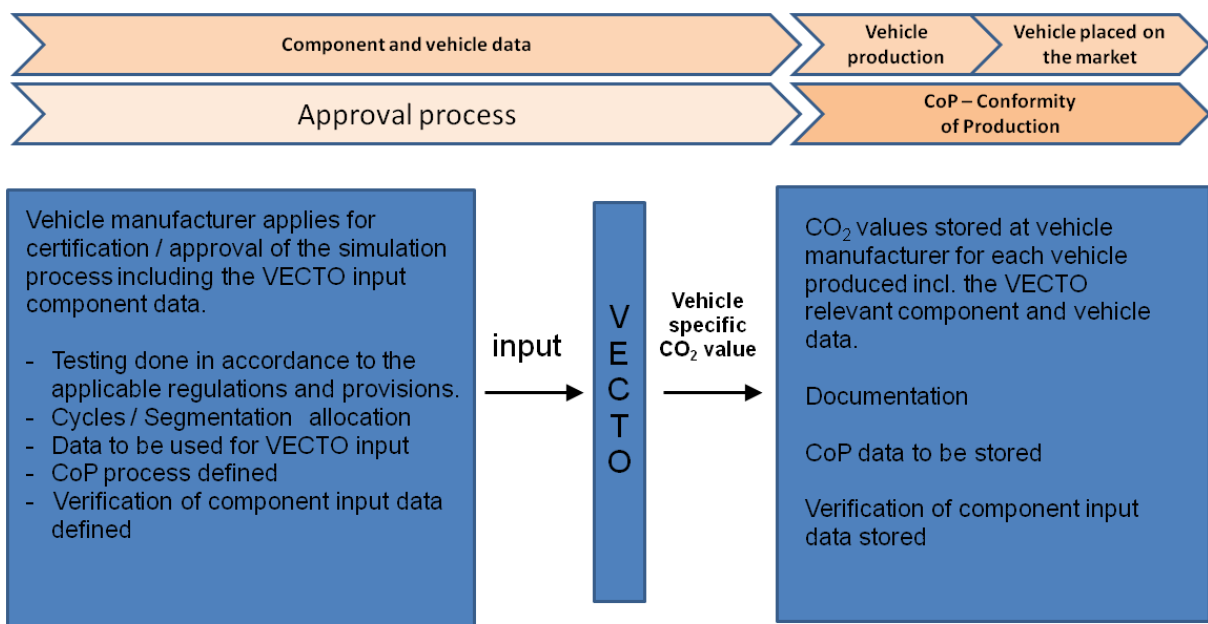


Figure 2: Certification of the CO₂ determination process

3.1.2 Certification of VECTO input data

This concept is based on the approach that all data necessary for the input into VECTO are certified prior to the final generation of a vehicle specific CO₂ value, instead of performance of overall process certification. This means that the component test procedures and the component test results are the focus of the certification.

Identical to the certification of the CO₂ determination process the final vehicle-specific CO₂ value will not be certified / approved by a third body (e.g. approval authority). The certification will address the input data for the VECTO only. As mentioned earlier one of the advantages of simulation is to generate a specific value for each HDV produced. The final vehicle-specific CO₂ value is not known during this certification process. For that reason a certification of such final vehicle-specific CO₂ values cannot be applied within such an approach. Due to

the vast variety of possible HDV configurations the certification of vehicle-specific values for all configurations (including all variations of different components) is considered being too complex for certification

Depending on the later legislative approach it may become necessary to have special provisions developed for the input data certification (e.g. separate regulations for each component). For the time being, all necessary test procedures are described in the technical annex and will be used for both the certification of the CO₂ determination process (incl. VECTO) and the certification of the input data only.

3.2 Conformity of Production

For any possible legislative approach, a robust Conformity of Production (CoP) procedure is considered to be necessary. Such a CoP procedure shall ensure that adequate arrangements have been made by the manufacturer and/or applicant for certification / approval to ensure that the final vehicle-specific CO₂ value complies with general requirements (e.g. that the components installed in the vehicle comply with the component input data for VECTO). CoP is usually carried out for a final product, and certain certified characteristics and properties are compared with real products from production. By calculating CO₂ value(s) within a simulation process, where component input data is of great importance for the final value, different possibilities for CoP seem to be available.

3.3 Verification of component input data

For the future application of a simulation based calculation tool, a random verification of the VECTO-calculated fuel consumption and CO₂ emissions against real on-road measured fuel consumption and CO₂ emissions is considered necessary as an additional measure. The recent project status stipulates certain measures for this verification. The simulated CO₂ value for a certain vehicle can be checked by applying real-world testing to vehicles equipped with fuel flow measurement devices³. The real-world fuel consumption can then be checked against the VECTO fuel consumption or CO₂ value calculated for a correlating simplified and partial driving profile.

At the present time, the verification described above can also be seen as a possible CoP tool, since an initial value (the simulated VECTO value) is compared to a value determined on a finalised product (the measured verification value). This implies a possible administrative and technical issue as a result of comparing simulated values with measured values.

For the verification contemplated here, the VECTO tool will be used for computation - already during the simulation run - of the final HDV CO₂ value, in addition to the fuel consumption

³ Similar to Euro VI PEMS testing; although fuel flow meters are not necessary for Euro VI PEMS

and CO₂ emissions for the CO₂ test cycles specified, and also of the fuel consumption for a simple vehicle speed cycle. This *simple constant speed test (SiCo)* can be used later for testing vehicles on a test track in the same cycle and the fuel consumption so measured can be compared with the ‘*ex-post simulation*’ results from VECTO. This simplified test procedure comprises the following steps:

- Simulation of a simple constant speed test (SiCo) by VECTO
- Measurement of the SSC on a test track with the corresponding HDV
- Evaluation of the SSC test

The measurements shall be performed on selected HDVs under the following conditions:

- The HDV has to be equipped with the components defined in the SSC file
- The HDV has to have a total mileage of between [--] and [--] km
- The tyre profile depth shall be not less than 80% of the new tyre, otherwise tyres shall be changed
- No additional equipment shall be installed which influences the aerodynamic resistance

The manufacturer shall test [--] HDVs in order to report to the type approval authority and/or any third party involved.

3.4 Responsibility

The current project status stipulates that the overall responsibility and accountability for the final vehicle specific CO₂ value lies in the hands of the applicant for certification / approval. This requires that suppliers to the vehicle manufacturer are covered by the vehicle manufacturer and its certification and approval. Some of the possible legislative approaches mentioned in the following clearly describe this responsibility placed on a certification / approval holder, which is usually the vehicle manufacturer⁴.

Regardless of any legislative approach, the responsibility for the final vehicle specific CO₂ value shall lie with the vehicle manufacturer who is applying a certain CO₂ value to a particular vehicle. Since HDVs are often finalized by a different manufacturer (e.g. base vehicle plus body manufacturer) special provisions need to be developed to consider this particular market situation. Also, some procedures already in existence that are described in available legislation can be used as examples, or even transferred to the HDV CO₂ in order to consider the HDV market and the entire vehicle production process.

⁴ In special cases it is also possible that a representative (e.g. importer, local representation) of the vehicle manufacturer is considered to be holder of type approvals.

3.5 Provisions for all possible HDV configurations

Heavy-duty vehicles are often individual vehicles produced by more than one manufacturer in several stages (e.g. base vehicle produced by manufacturer A, completed with a super-structure by manufacturer B). A rigid tipper truck is a typical example of such a vehicle, where the tipper body is installed by manufacturer B onto a base vehicle of manufacturer A.

Other vehicles and vehicle configurations need to be considered in a different way. Examples of this are buses and coaches. In this area, chassis are often sold by a chassis manufacturer to the final bus manufacturer. This does not mean that the vehicle is completed in more than one step (multi-stage) as described above. It means that the final product consists of components relevant to the CO₂ value supplied by different manufacturers. For such configurations it may be necessary to define provisions where the final vehicle manufacturer (here the bus manufacturer) becomes the responsible party within the HDV CO₂ procedure.

For the time being and reflecting the current status of the project, only standardized bodies, trailers and semi-trailers are considered. For the future, non-standard vehicle configurations and combinations (truck plus trailer, tractor plus semi-trailer) shall be incorporated within the HDV CO₂. Additional provisions and measures may be developed for such vehicles. This is particularly true with regard to vehicle combinations. Vehicles used for combinations are exclusively type approved as single vehicles today (e.g. approval for the tractor, approval for the semi-trailer). Possible combinations are not regarded as entities today. For HDV CO₂, such combinations become very significant due to the fact that the semi-trailer can also add greatly to the CO₂ value of a combination (as long as a particular vehicle combination is of interest).

3.6 Recording of the CO₂ value

As already mentioned, the final vehicle-specific CO₂ value(s)⁵ for each HDV produced shall be recorded (e.g. by the manufacturer) for later monitoring purposes. This documentation of each individual CO₂ value shall be part of the vehicle documentation provided with the particular HDV. This defined requirement for certification can be obtained in different ways. On the one hand existing legislative provisions (as summarized in the chapters below) already describing the vehicle documentation can be used. On the other hand, completely new recording documents and provisions can be developed. In addition to or instead of documents attached to the vehicle, electronic storage of the CO₂ value(s) in one of the particular HDV electronic control units (ECUs) is also possible. However, such a solution requires a defined read-out process, which is not available for CO₂ value(s) so far.

⁵ There may be several values for one vehicle, since several cycles may become applicable.

3.7 Third Party Control

For the HDV CO₂ approach developed so far, integration of third-party control is considered necessary in order to have an independent organisation involved in the CO₂ certification / approval. This independent organisation can reliably assure the correctness of the data supplied. This means certification / approval can only be granted under the control of a third party (e.g. Approval Authorities, Technical Services or Notified Bodies, depending on the legislative approach).

Third-party certification means that an independent, recognized body or organization has reviewed a product and/or its characteristics and has independently determined that the final product complies with a specific standard. This adds transparency to the overall HDV CO₂ procedure and helps to create fair conditions and a level playing field for all stakeholders.

4 Legal implementation

4.1.1 Comitology Procedure

The EU legislator may delegate powers to the Commission to implement EU legislation (as actually foreseen in the case of existing type approval legislation). With the Treaty of Lisbon, the comitology process changed and new comitology acts were introduced, i.e. delegated acts and implementing acts. The type approval legislation was introduced before the entry into force of the new treaty.

However, there are still a number of delegations performed prior to the entry into force of the Lisbon Treaty that are still in force. In considering whether a comitology solution can be found for the HDV procedure it is necessary to take into account the current state of delegations as well as changes that may occur within the near future. It should be noted that where a delegation exists, the Commission must explore whether the draft implementing measures fall within the scope of that delegation. Only if that is not the case, would recourse be had to the ordinary legislative procedure (often referred to as the co-decision procedure).

4.1.2 The ordinary legislative procedure (co-decision)

Under this procedure, the Commission draws up a proposal for EU legislation that is put before the EU legislator, i.e. the European Parliament and the Council of the European Union. The procedure is based on negotiations within the Council and between the two institutions and may in general require one or two readings within the Parliament and the Council. A one-reading agreement is estimated to take at least one year from the proposal by the Commission to the entry into force of the act.

5 Legislative approach

Within the framework service contract, different options, sub-options and alternatives for the legislative approach were discussed. In the following paragraphs, the current status on the “legislative approach” is described based on three options defined within the project so far.

These three **main options** for the creation of a legislative approach are:

- **the Type Approval Approach in accordance with Framework directive 2007/46/EC**
- **a complete new created Stand Alone Regulation (outside existing frameworks)**
- **a Regulation in accordance with the EC conformity assessment criteria, referred to as the New Approach**

Based on these three main options describing possible different legislative approaches, several sub-options are defined which can either be applied to all the main options or are firmly linked to particular defined conditions within the three main options.

5.1 Main options

5.1.1 Type Approval Approach (2007/46/EC)

Since almost all motor vehicle⁶-related EC requirements are regulated by framework directive 2007/46/EC⁷, this well-established “Type Approval” scheme is considered as a possible route to the certification of heavy-duty vehicles (HDV) with respect to their CO₂ emissions.

Beside the fact that framework directive 2007/47/EC has been in use for a very long time (its predecessor was directive 70/156/EEC) and for that reason is related to long-term experiences within the motor industry, there are other clear reasons for hosting the HDV CO₂ issue under the umbrella of the current framework. These reasons are

- Article 3.32 of 2007/46/EC allows the use of simulation based on virtual testing (*virtual testing method*). Since the determination method (VECTO) considered for the HDV CO₂ is based on a calculation model, the *virtual testing method* reference in 2007/46/EC gives adequate freedom for this approach.
- Article 3.27 of 2007/46/EC clearly indicates the responsibility of the *manufacturer* as the accountable entity for the CO₂ value to be generated. This adds certainty to the

⁶ ‘motor vehicle’ means any power-driven vehicle which is moved by its own means, having at least four wheels, being complete, completed or incomplete, with a maximum design speed exceeding 25 km/h

⁷ Framework for the approval of motor vehicles and their trailers and of systems, components and separate technical units intended for such vehicles.

procedure and makes the process clear by which a particular party is seen as responsible for the naming of a particular CO₂ value. It is also clearly stated that it is not essential that the manufacturer is involved in all stages of the construction of the vehicle, system, component or separate technical unit. This opens the way to delegation of certain necessary verification and analysis tasks to the supplier and component manufacturer.

- In accordance with Article 12, the manufacturer (as the responsible and accountable entity) is obliged to carry out conformity of production (CoP) measures in order to ensure that production vehicles, systems, components or separate technical units conform to the approved Type. This provides an additional requirement within the process to ensure that all vehicles produced are in conformity with the product characteristics that are specified and certified.
- Furthermore, framework directive 2007/46/EC requires in Article 18 that the manufacturer shall deliver a certificate of conformity (CoC document) to accompany each vehicle, whether complete, incomplete or completed (by more than one manufacturer), to testify that it is manufactured in conformity with the approved vehicle Type. This document (CoC) provides an existing basis for indication of the HDV CO₂ value. For passenger cars and light-duty vehicles where a CO₂ declaration procedure is already in force, the CO₂ value is also indicated in the CoC.

The European type approval scheme based on framework directive 2007/46/EC is applicable to passenger cars, truck, buses and their trailers. The current framework directive on type approval of motor vehicles makes a whole vehicle type approval (WVTA) possible for all categories of motor vehicles and their trailers. For this reason, third party approval is requested in the form of testing, certification and production conformity assessment by a *Type Approval Authority (TAA)* or *Technical Service (TS)*. Each Member State is required to appoint an Approval Authority to issue the approvals, and Technical Services to carry out the testing to the applicable EC or UN-ECE regulations. An approval issued by one Authority is accepted in all other Member States. A comparable procedure is in place for the relevant ECE regulations, where the Contracting Parties are put into a similar role as the EC Member States.

The framework directive on type approval requires the Member States to take appropriate measures at two stages:

- before granting type approval, the approval authority must verify that the Type to be approved complies with the relevant safety and environmental requirements and that adequate arrangements for ensuring conformity of production (CoP) have been taken by the manufacturer;
- after having granted type approval, the approval authority must verify that the conformity of production (CoP) arrangements of the manufacturer continue to be

adequate. This verification must be carried out in accordance with the procedures set out in the directive, and, where appropriate, with the specific provisions of the relevant Regulatory Acts listed in the framework directive. This procedure may be carried out with manufacturers' technical equipment and control programs, but may also be extended to the actual testing of selected production samples.

The type approval approach is based on the proposition that new types of components, systems or vehicles are tested and checked prior to their placing on the market. This means the overall approach of approval is based on "prototype stage" testing and verification. Nonetheless, the type approval legislation does not refer only to the prototype stage, but also to the production process through conformity of production (CoP), and to registered vehicles through in-service conformity (ISC).

The granted type approval is then applied to such types of vehicles without the need for any confirmation check for each vehicle produced within the type approved specifications. The manufacturer must, however, certify that each vehicle conforms to the type approved by issuing a certificate of conformity for the individual vehicle.

The proposed CO₂ approach for HDVs based on the certification of a process or of input data is intended to generate a specific CO₂ for each vehicle produced. In this sense, the approach differs from the determination of CO₂ emissions from light duty vehicles, where emissions are tested and considered representative for a vehicle type or for pre-defined vehicle families. This difference will also have implications on how the certification procedure can be implemented within the type approval framework. The existing type approval legislation offers an appropriate framework for the implementation of the CO₂ certification procedure outlined. A certification based on the CO₂ determination process or on the input data which is completely integrated in the type approval framework may require some adjustment to the framework but is considered possible. Consultations between DG CLIMA, DG ENTR and the Legal Service are ongoing in order to describe the necessary details, since the CO₂ determination is considered to be done on production vehicles with a particular CO₂ value for each vehicle instead of testing a prototype prior to the start of production which is representative for the later series production.

Conformity of Production (CoP)

Inter alia, this will require consideration of the CoP issue, in view of the fact that it is one of the cornerstones of the type approval framework. CoP describes the measures and provisions to be introduced by the applicant for type approval to make sure that his products are produced in accordance with the type approved characteristics and performance criteria. The CoP process is typically applied to a type approved value or criterion (as embodied in a final product) to be checked during / after production. At the present time, CoP is considered to be applied to the components or the component input data. Another possibility is to consider the method for the verification of component input data (*simple speed cycle (SSC)*) as a possible alternative methodology.

The necessary responsibility of the “manufacturer” is a well-described principle of the type approval framework. The overall responsibility and accountability for the final product lies in the hands of the applicant for type approval (Article 5.1, 5.2 and 3.27 of 2007/46/EC).

Multi-Stage Type Approval

Since heavy-duty vehicles are often individual vehicles completed by more than one manufacturer in several stages (e.g. base vehicle produced by manufacturer A, completed with a superstructure by manufacturer B), so-called multi-stage type approvals are usual. Article 3 of 2007/46/EC explicitly allows this method of type approval, in which each manufacturer is responsible for the approval and conformity of production of the systems, components or separate technical units added at the stage of vehicle completion handled by him (**Figure 3**). This provision delivers a solution as to how to handle the issue of consideration of non-standard bodies and trailer vehicle configurations.

The multi-stage approach for whole vehicle type approval could be transferred to the CO₂ determination process for incomplete vehicles. Within the multi-stage approach, one or more Member States certifies that, depending on the state of completion, an incomplete or completed vehicle corresponds to the relevant administrative provisions and technical requirements of 2007/46/EC.



Figure 3: Multi-Stage Type Approval

Certificate of Conformity / Recording of the CO₂ value

Described in the form of a necessary certification requirement, the final CO₂ value(s) for each HDV produced are recorded for later monitoring. Under the 2007/46/EC framework, the CoC (Certificate of Conformity) document can be used for such documented recording.

The CoC is considered to be the reference document that could be used for the purpose of a CO₂ statement from the vehicle manufacturer, as it is the case with light-duty vehicles. At the present time, a type approval process in accordance with the framework directive is necessary for the inclusion of CO₂ values into the CoC. In this respect, for instance, Article 18 of the framework directive sets out that *"the manufacturer, in his capacity as the holder of an EC type approval for the vehicle, shall deliver a certificate of conformity to accompany each vehicle, whether complete, incomplete or completed, that is manufactured in conformity with the approved vehicle Type"*.

The indication of the CO₂ values in the CoC can be applied in a similar way to the procedure described in Article 3 of Regulation EC 1230/2012 "masses and dimensions". In accordance with this article, the actual mass of the vehicle must be stated in the CoC. This means the mass of the vehicle including all optional equipment. Presumably this is also not known at the stage of type approval (similar to the certification of a process) but only at the time of the final specification of the vehicle.

From a technical perspective there is no need for the final CO₂ figure to emerge from the type approval tests, but at least the process for obtaining such a figure has to be addressed during the tests.

The necessary features in the realisation of the CoP procedure as well as for the indication of the CO₂ value in the CoC despite non-existing type approval values may be achieved with the introduction of CO₂ ranges for vehicle families, to be defined during the type approval process.

This means that instead of type approving the process or input data to generate individual CO₂ values per vehicle, minimum to maximum CO₂ ranges would be defined during type approval in order to state values to which later reference (e.g. for CoP) becomes possible. Such ranges can be defined in relation to vehicle families or classes (not yet defined). Whilst a vehicle is allocated to such a family or class, the individual CO₂ value defined later can be indicated in the CoC. A later CoP becomes possible (using whatever procedure) based on the type approved range but also respecting the individual value.

Such an alternative approach may need to be supported by the following provisions:

- Setting out vehicle families (to be defined), so that the CoP can be checked against a span / range of CO₂ values narrow enough to be considered as representative of the final product. It has to be checked with stakeholders whether this option is feasible.
- Requesting, in the Type Approval information document, a number of CO₂ values / ranges linked to the input parameters stated in it. In this way, type approval authorities could check manufactured vehicles against these values.

The alternative of a CO₂ range or a family based CO₂ value will probably require additional administrative work without being able to provide useful information on the performance of an individual vehicle.

As mentioned earlier, Regulation EC 1230/2012 on "masses and dimensions" can be used as an example. This regulation also defines ranges of maximum masses and maximum dimensions which are applied as boundaries for the later vehicle types. The indication of the CO₂ values in the CoC can be applied similarly to the procedure described in Article 3 of EC 1230/2012. According to this article, the actual mass of the vehicle must be provided in the CoC. The actual mass here means the mass of the vehicle including all optional equipment.

Presumably this is also not known at the stage of type approval (similar to the certification of a process) but only at the time of the final specification of the vehicle.

5.1.1.1 Type Approval Procedures

Furthermore, the framework directive (2007/46/EC) allows for three different type approval procedures in Article 3. These procedures are

- step-by-step type-approval
- single-step type-approval
- mixed type-approval

These three different type approval procedures shall not be mixed up with the multi-stage approval. In the case of multi-stage type approval, each manufacturer is responsible for the approval and conformity of production of systems, components or separate technical units added at the stage of vehicle completion handled by him. Within one stage of the “multi-stage” completion process all three mentioned procedures are applicable.

The ‘step-by-step type-approval’ means a vehicle approval procedure consisting of the step-by-step collection of the whole set of EC type approval certificates for the systems, components and separate technical units relating to the vehicle, and which leads, at the final stage, to the approval of the whole vehicle. This means that wherever a single regulation exists for a vehicle system, component or separate technical unit (such as e.g. engine emissions covered by Regulation EC 582/2011 as implementing act under Regulation EC 595/2009) a manufacturer of a system, component or separate technical unit can also apply for type approval. The applicant for the whole vehicle type approval can make use of those type approvals for his own application. In this case the “owner” of a vehicle system, component or separate technical unit remains responsible for his own approval. Understandably, approval for a system, component or separate technical unit can only be obtained within the step-by-step approach as long as a regulation is applicable to the relevant “stand alone” systems, components or separate technical units.

The ‘single-step type approval’ means a procedure consisting of the approval of a vehicle as a whole by means of a single operation. In this case all applicable requirements of the regulation need to be fulfilled, but only one type approval will be granted for the relevant applicant. In this case the applicant is responsible for the whole vehicle and its systems, components or separate technical units.

The ‘mixed type approval’ means a step-by-step type-approval procedure for which one or more system approvals are achieved during the final stage of the approval of the whole vehicle, without it being necessary to issue the EC type approval certificates for those systems. This procedure describes the process where a manufacturer of a system, component or separate technical unit provides all the necessary information and data usually

needed for type approval to the later applicant for type approval. This applicant for the whole vehicle type approval then applies with all this information and data for his own approval. In this case also, the applicant for the whole vehicle type approval is the only responsible body in the process.

For the HDV CO₂, responsibility and accountability need to be attributed in a robust and resilient way. This elementary demand is thoroughly covered by the procedures described above. This is of some importance for the HDV CO₂, since many parts and components (such as gearboxes, axles, et cetera) of the final vehicle are developed, manufactured and delivered by suppliers, and these components affect the CO₂ and VECTO input data to a significant degree. Since separate regulations are not available for most of these CO₂ related '*components*' a step-by-step approach as made possible by the framework of 2007/46/EC cannot be applied. For this reason, the applicant remains responsible and accountable (single-step type approval).

The only exemption can be applied to the rolling resistance coefficient (RRC) of the tyres, where regulation EC 1222/2009 (EC 1235/2011) is in effect. The RRC determined for this approval can be forwarded to the vehicle manufacturer under the single-step approach.

For this reason, any approach described within this document is based on the assumption that overall responsibility and accountability is held by the vehicle manufacturer, since the overall vehicle is described with the final HDV CO₂ value. Delegation of responsibility and accountability to a supplier or other involved parties is not possible. This does not mean that the HDV manufacturer needs to be involved in all steps of the component design and production process, but he should be responsible for the handling of the data / input since the CO₂ value is applicable to the whole vehicle.

Contracts with suppliers or similar arrangements can help to ease the process but cannot exempt the HDV manufacturer from responsibility and accountability. This means that it is possible for a vehicle manufacturer to delegate duties such as testing to a third party. Article 3.31, Article 11 and Article 41 of 2007/46/EC describe the procedure for making use of designated Technical Services for that particular purpose.

These type approval procedures applied to the whole vehicle type approval also can be used as an instant solution for particular HDV configurations.

The single-step type approval can be considered to be the only possible basis for a HDV CO₂ type approval for the time being since, as already mentioned, separate directives and regulations for the type approval of components are not existing.

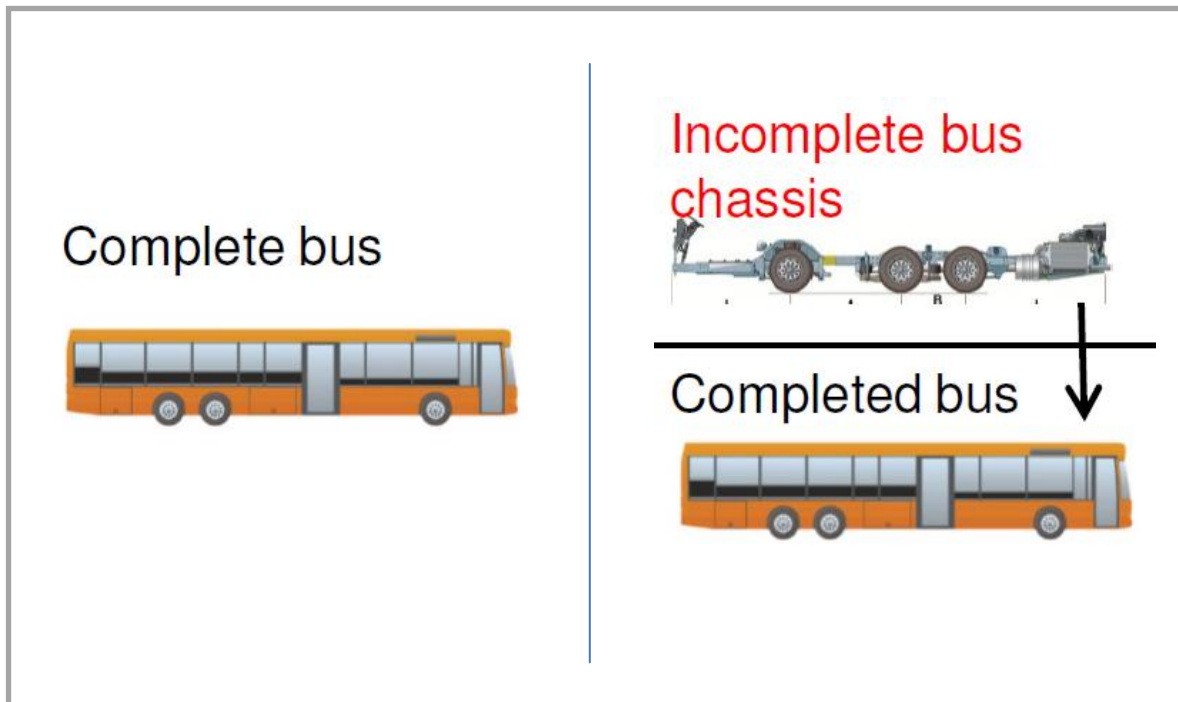


Figure 4: Bus completed by one or more manufacturer.

For some specific issues (such as the case of bus production showed in **Figure 4**) the approach developed for trucks with the OEM responsible for the whole HDV (with standard body / trailer / semi-trailer) may cannot be applied due to the relative share of the vehicle built by the end-product manufacturer and may require the transfer of responsibility to the final stage manufacturer.

5.1.1.2 Sub-Options to the Type Approval Approach

To take the possible methods described above and to make use of the 2007/46/EC framework two, or possibly three, options can be considered.

Option 1

Amendment to Commission Regulation (EU) No 582/2011⁸ which is an implementing act under Regulation 595/2009⁹.

In 582/2011, Annex VIII already describes the fuel consumption and CO₂ emission measures to be applied to the **HDV engines only**. A new annex could be introduced dealing with the

whole HDV vehicle. Nonetheless, such a proceeding would give rise to an engine only regulation to deal with whole vehicle aspects.

⁸ Euro VI engine criteria pollutants etc.

⁹ The legal basis is Article 5(4)(e)

Option 2

New Commission implementing act (Regulation) under Regulation (EU) No 595/2009⁴

This would be a new stand-alone technical implementing act (Regulation) dealing with fuel consumption / CO₂ emission of the whole HDV (comitology procedure). It needs to be verified if the legal basis, Article 5(4)(e) of Regulation (EC) No 595/2009, provides the necessary scope for this approach.

Option 3

Option 3 deals with a completely new Regulation adopted under the ordinary legislative procedure, i.e. as a parallel act to Regulation (EU) No 595/2009.

5.1.2 Stand Alone Regulation

The possibility of a regulation adopted under the ordinary legislative procedure (co-decision) was mentioned. This would be the way forward should the legal basis provided in Regulation (EC) 595/2009 not be appropriate for the implementation of the whole HDV CO₂ procedure.

A complete new regulation can be considered which would also apply under the type approval framework. The working assumption under this option should thus be to establish such a new regulation in order to be able to define new boundary conditions customised to the particular needs of HDV CO₂ certification.

If the HDV CO₂ certification is completely detached from the type approval framework, which means creating a separate Act outside the framework, further work is necessary in order to define appropriate general conditions. Nonetheless, many of the undoubtedly very well established type approval specifications and requirements could be transferred to such a new Act. The accountability and responsibility of the applicant as well as the involvement of Type Approval Authorities and Technical Services are only a few of these well developed type approval principles. The need, mentioned earlier, to integrate a CoP process and to make use of the CoC (or similar procedure) can be solved by creating appropriate new provisions for these tasks. Furthermore, the framework of 2007/46/EC needs to be slightly adjusted in any case as long as the mentioned indication of the CO₂ value in the CoC remains necessary. If an additional document for the CO₂ value is contemplated, such a slight adjustment is not necessary.

An example for such a “stand-alone regulation” outside an existing framework is Regulation 1222/2009 on the labelling of tyres with respect to fuel efficiency and other essential parameters.

5.1.3 New Approach Regulation

Another possibility to be considered is a regulation under the “New Approach” scheme in accordance with the EC conformity assessment criteria. “New Approach” directives were designed to streamline the certification / approval process for the European market. Such

regulations can apply to many aspects - from labelling of a product by a manufacturer up to very challenging provisions similar to the established type approval procedures.

An example for such regulation is Directive 94/25/EC on recreational crafts based on the New Approach. Directive 94/25/EC includes elements very similar to the type approval procedures, such as a third party involvement. The inspection bodies involved are so called Notified Bodies and act in a somewhat similar way to the Technical Services in the Type Approval framework.

5.2 Type Approval Authorities / Technical Services (Third Party)

Article 3.29 of 2007/46/EC declares that member states need to define approval authorities (Type Approval Authorities) *which are the authorities of Member States with competence for all aspects of the approval of a type of vehicle, system, component or separate technical unit or of the individual approval of a vehicle; for the authorisation process, for issuing and, if appropriate, withdrawing approval certificates; for acting as the contact point for the approval authorities of other Member States; for designating the technical services and for ensuring that the manufacturer meets his obligations regarding the conformity of production.*

This means an approval can only be granted under the control of those authorities and under consideration and involvement of Technical Services. Usually this process is considered as a third-party approval approach with supervisory control.

A technical service means an organisation or body designated by the approval authority of a Member State as a testing laboratory to carry out tests, or as a conformity assessment body to carry out the initial assessment and other tests or inspections on behalf of the approval authority, it being possible for the approval authority itself to carry out those functions (Article 3.31 of 2007/46/EC).

5.3 Vehicle Families

Depending on the design of the final certification process, certain vehicle families may need to be defined for the grouping of vehicles which possess similar if not identical specifications. The definition of families may become necessary for certification when a simulation, providing a specific value for each vehicle, is considered being not the appropriate way or when a simulation is based on a group of vehicles.

Two possible solutions for families are listed below

- Give freedom to the manufacturer to define the number and characteristics of families to be certified, in accordance with certain parameters stated in the legislation. By these means, the parameters would be provided, but the manufacturer could combine

them in order to certify different HDV in the way that best fits their production. For this approach, it needs to be decided if robust family criteria are necessary or if a vehicle family can be defined without any boundary conditions (e.g. a vehicle family considered to mirror the complete vehicle portfolio of a manufacturer).

- Set out the families in the legislation, the manufacturer being bound to them. For instance, engine families in Euro VI follow such a scheme and refer to characteristics which define possible similarities with respect to pollution limits. Other characteristics need to be defined for the HDV CO₂.

5.4 Information Package / Information Document

The information document is an essential part of the European type approval system and is required by every single regulation for the technical description of the system, component or separate technical unit. The framework directive also makes use of information documents.

In the information document, the technical specifications necessary for the type approval documentation and testing are described by the manufacturer or applicant for type approval. The data is usually checked and verified by the Approval Authority or Technical Service.

For the HDV CO₂ approach, the complete set of the VECTO input data as well as all necessary data to define and generate (by testing) these input data need to be listed in the information document as a very important part of the overall process. Very extensive data sets such as complete component performance maps should be indicated with a clear and unmistakable identification. Furthermore, a robust procedure defining which data need to be handled in a strictly confidential way within the process needs to be developed after the finalisation of the overall procedure.

All data that has to be specified and documented are listed in the Technical Annex.

The data has to be specified as described within the testing provisions of the Technical Annex. Furthermore, many of the data details listed in the information document are necessary for the CoP process (depending on how CoP will be performed / applied). In any case, the information document needs to be accompanied by a Technical Report indicating the final test results and stating the compliance with the applicable provisions. This Technical Report is usually issued by the Technical Services and is the basis (together with the information document) for the type approval certificate issued by the type approval authority.

6 Vehicles < 7.5 t

At the present time, the overall VECTO approach as well as the possible certification approaches explained within this document are considered to be applicable to vehicles above 7.5 tons gross weight.

Since HDVs are considered as Category N (N, N₁ to N₃) vehicles as described in 2007/46/EC, the extent to which vehicles below 7.5 tons also have to be considered under the HDV CO₂ approach must be discussed.

More specifically, the following vehicle cluster is stated by 2007/46/EC to comprise HDVs:

- **Category N: Motor vehicles designed and constructed primarily for the carriage of goods.**
- **Category N₁: Vehicles of category N having a maximum mass not exceeding 3.5 tons.**
- **Category N₂ Vehicles of category N having a maximum mass exceeding 3.5 tons but not exceeding 12 tons.**
- **Category N₃ Vehicles of category N having a maximum mass exceeding 12 tons.**

As pollutant and CO₂ provisions for passenger cars and light-duty vehicles are limited to a scope (Regulation EC 715/2007) of vehicles of categories N₁ and N₂ with a reference mass not exceeding 2610kg, all vehicles with a reference mass above this limit are considered as HDVs. At the manufacturer's request, the mass range can be extended to 2840kg (possible if an approval for 2610kg was already granted).

7 Cooperation between stakeholders

Throughout the complete development process of the VECTO tool and the certification possibilities described within this document, a high degree of convergence was reached amongst all stakeholders. ACEA (European Automobile Manufacturers' Association), CLCCR (International Association of the Body and Trailer Building Industry) as well as all other associations and organisations involved provided a great deal of support, especially as regards the technical approach, the component test procedures and the technical requirements as they are described in the Technical Annex. Without this contribution, the overall process development would not have reached its current status. The overall approach of declaring a vehicle-specific CO₂ value for each HDV produced is also based on ACEA input.

This does not mean, that all contents of the LOT 3 deliverables are commonly agreed by all stakeholders but a common understanding exists to a large extend. The following input was developed in close co-operation, delivered or agreed by the indicated stakeholders:

- **Cycles (target speed and slope): defined by ACEA, reviewed by Lot 3 consortium**
- **Vehicle segmentation: co-operation between ACEA and Lot 3 consortium**
- **Specification of bodies / trailer / semi-trailer: CLCCR, reviewed by Lot 3 consortium**
- **Simulation methods in VECTO: LOT 3 with input from ACEA and gear box manufacturers**
- **Test procedures:**
 - Air drag: co-operation between ACEA and Lot 3 consortium, default values delivered / to be delivered by ACEA
 - Engine: co-operation between ACEA and Lot 3 consortium
 - Transmission: ACEA (including default values), supply industry, reviewed by Lot 3 consortium
 - Axle: ACEA (including default values), reviewed by Lot 3 consortium
 - Auxiliaries: co-operation between ACEA and Lot 3 consortium, most default values delivered by ACEA
 - RRC: co-operation between ETRMA and Lot 3 consortium
- **Ex-post validation: Lot 3 consortium with input from industry**
- **Certification procedure: Lot 3 consortium**

8 Attachments

Technical Annex