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Test method for energy consumption of refuse collection vehicles

Méthode d'essai pour mesurer la consommation énergétique de carburant des véhicules de collecte et de transport des déchets

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 297, *Waste collection and transportation management.*

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

As a result of the development of new drive unit concepts for refuse collection vehicles (RCV), as well as (from a European point of view) the provisions from the procurement guideline 2009/33/EC, there is now a demand for universal processes and provisions for determining the environmental effects of RCVs, with the objective of achieving a uniform evaluation for environmental efficiency.

The environmental effects in the utilization phase for RCVs are essentially determined by their energy consumption, from which the relevant CO_2 emissions will result.

In order to be able to define appropriate characteristic numbers for the environmental effect of RCVs, it is therefore necessary to differentiate between refuse collection and transport trips with and without loads. The complete logistics shall be considered for an effective comparison of the various vehicle models and their respective drive units.

The objective is to be able to issue an environmental efficiency ID for various vehicle models.

Policymakers, planners, administrators, manufacturers and users should be able to decide in the future whether consumption measuring should be executed as a simulation or by means of actual, existing test circuits.

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Test method for energy consumption of refuse collection vehicles

1 Scope

This document specifies a uniform, reproducible testing process for various drive units, chassis, constructions and lifting devices for the refuse collection vehicles described in EN 1501 (all parts, excluding EN 1501-4), with which a comparison for energy consumption can be performed.

This specification defines criteria for a reference area with regard to a synthesized tour (test circuit). This therefore serves to determine a representative test circuit and/or data for a software calculation tool, e.g. VECTO[1].

NOTE   VECTO (Vehicle Energy Consumption calculation TOol) is a simulation tool that has been developed by the European Commission for determining CO_2 emissions and fuel consumption from heavy duty vehicles with a gross vehicle mass above 3 500 kg. URL: https://ec.europa.eu/clima/policies/transport/vehicles/vecto_en#tab-0-0

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 1501-1, *Refuse collection vehicles — General requirements and safety requirements — Part 1: Rear loaded refuse collection vehicles*

EN 1501-2, *Refuse collection vehicles — General requirements and safety requirements — Part 2: Side loaded refuse collection vehicles*

EN 1501-3, *Refuse collection vehicles — General requirements and safety requirements — Part 3: Front loaded refuse collection vehicles*

EN 1501-5, *Refuse collection vehicles — General requirements and safety requirements — Part 5: Lifting devices for refuse collection vehicles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
energy consumption
amount of mechanical, electrical, hydraulic and pneumatic energy which is needed for the defined cycles of the body

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1)   VECTO is an example of a suitable product available free of charge. This information is given for the convenience of users of this document and does not constitute an endorsement by ISO of this product.

3.2
load simulation valve
valve in the hydraulic circuit of the compaction unit (packing unit) of an RCV for generating a hydraulic load

3.3
pre-control valve
valve in the hydraulic circuit for controlling the *load simulation valves* (3.2)

3.4
ballasting
loading of the collection container for an RCV and the refuse collection container with mass

3.5
measuring turbine
measuring device for the consumption of fuel using differential measurement in the fuel system

3.6
measurement run
sum of all test cycles on the test track

3.6.1
reference run
run of the *test cycle* (3.11) only with the chassis and without any further energy-consuming components

3.6.2
compaction run
run of the *test cycle* (3.11) with the chassis and the bodywork with one loading cycle

3.6.3
lifting run
run of the *test cycle* (3.11) with the chassis and one cycle of the lifting device

3.6.4
discharge run
one discharge cycle of the body with the chassis in standstill

3.7
test bench run
sum of all test cycles on the test bench

3.8
vehicle mass
mass of the RCV in a ready-to-drive and ready-for-refuse-collection status with full fuel and urea tank, full hydraulic and cooling systems

Note 1 to entry: The mass is stated in kg.

3.9
discontinuous compaction system
components of the compacting equipment, which always traverse the same route curve in the operation in cycles and return to their defined starting position after one cycle

3.10
continuous compaction system
compacting devices which continuously and without reversing follow the direction of movement of individual components after commissioning and which have no defined starting position

3.11
test cycle
sum of the defined time proportions with different operating conditions

Note 1 to entry: See Table 4 for the time proportions of the *test cycle* (3.11).

3.12
steady state
temperature level of all operating fluids which does not vary during the *test bench run* (3.7) and/or the test run

3.13
working cycle
procedures which are to be performed during the vehicle standstill

3.14
maximum pressure
maximum hydraulic pressure during the *working cycle* (3.13) in the compacting system

3.15
container emptying cycle
succession of sequences to pick up from the ground, lift, hold and empty the container into the hopper of the RCV and put it back on the ground

3.16
compaction cycle
cycle by *discontinuous* (3.9) or *continuous* (3.10) *compaction system*

Note 1 to entry: The continuous compaction system is the given (fix) time in Table 4.

4   Minimum requirements

4.1   Refuse collection vehicle (test item)

— The operating conditions shall be in accordance with the operating instructions.

— The steady state shall be achieved.

— The load simulation components shall be installed in accordance with the respective specifications from the bodywork manufacturer.

— The vehicle configuration shall be documented in accordance with Annex A.

4.2   Load simulation

The load simulation shall be carried out hydraulically.

NOTE   For an example of the installation of a hydraulic load simulation, see Annex B, Figure B.1.

4.3   Test conditions

— Temperature (°C/°F):

Range A: (10 ± 5) °C/(50 ± 9) °F;

Range B: (20 ± 5) °C/(68 ± 9) °F;

Range C: (30 ± 5) °C/(86 ± 9) °F;

Range D: (40 ± 5) °C/(104 ± 9) °F.

— Air pressure (1 013 ± 100) hPa.

— Wind speed (maximum 5 m/s).

— Dry road surface condition.

4.4 Test circuit

— The test circuit shall be a circular course.

— The road surface finish shall be asphalt or concrete.

— Gradient within the test circuit shall not exceed ± 2 %.

— Curves on the test circuit shall have a curve radius of at least 15 m.

— The stopping points shall be clearly marked, for example with traffic cones.

5 Implementation

5.1 On the test track

— The time required for a measurement run shall not exceed 60 min.

— The test should only be performed by trained personnel.

— At least three measurement runs of the same type shall be performed, taking Formula (1) into account in order to obtain valid measurement values:

$$\frac{M_{\min}}{M_{\max}} \geq 0,95 \tag{1}$$

where

$M_{\min}$ is the minimum measurement value;

$M_{\max}$ is the maximum measurement value.

— The number of test cycles within a measurement run shall correspond to Table 4.

— The energy consumption shall be indicated for each test run in kilowatt hours (kWh), in accordance with the conversion factors in Table 5.

— To measure any energy sources, a measurement procedure according to the valid state of science and technology shall be used, such as measuring the fuel consumption using measuring turbines or comparable technologies.

— To measure the energy consumption of plug-in battery systems, only the stored energy of batteries shall be considered; the energy needed for charging the batteries is not taken into account.

— The regeneration of diesel particulate filters during the test run shall be excluded.

— In addition to energy-consuming components, such as rotating beacons and air conditioning, working lights of the vehicle shall be switched off.

— Ballasting shall be carried out in accordance with Table 1.

5.2 Software calculation

5.2.1 General

With the described method, it should be possible to achieve the same results with the software calculation as those stated in 5.1. For this it is necessary to transfer the test cycles from the test circuit to the software. This is to be performed by means of various data files which shall match the form and content with the criteria set out in Table 1 to Table 4, respectively.

NOTE   The data for the chassis and the common profile to drive into the collection area and return are part of VECTO, which is the official European software calculation tool.

5.2.2 Data for the driving cycle

Driving the vehicle on the test circuit from stopping point to stopping point will be illustrated by a speed curve which shall be provided both graphically and as a readable data file (by agreement with the test bench operators). The number of test cycles shall correspond to the values in Table 4.

5.2.3 Data for the working cycle

5.2.3.1 General

The power consumption of the body shall be represented by a torque curve and an operating speed associated with this torque curve on the auxiliary drive. The duration of the working cycle shall correspond to the vehicle standstill in accordance with Table 4.

5.2.3.2 Determination of the working cycle

It is the bodywork manufacturer's responsibility to describe the working cycle. For this purpose, the requirements according to Table 3 shall be observed.

The working cycle shall proceed as follows:

— The construction test bench is equipped with a device for providing the drive capacity, generally an electrical engine. It shall be equipped with a measuring instrument for the output torque (torque measuring shaft) and a speed controller. Record the measurement values from the torque measuring shaft in a table; the working speed shall be indicated as an individual value.

— Connect the hydraulic or electric pump for the construction configuration which shall be tested to the construction test bench with the assembled and adjusted load simulation components.

— Record the measurement values at timed intervals of 0,1 s (f = 10 Hz).

— Repeat the relevant cycles for conditioning the bodywork until the steady state has been set.

— Start the measurement and repeat it 20 times for structural safety.

— Execute the test cycles in accordance with Table 2 and record the measurement values. Maintain breaks between the separate test cycles with respect to the driving times according to Table 4.

— Stop the measurement.

— Determine an average using 20 corresponding values (corresponds to the table rows) and save it in a separate table.

— Save the resulting table as the torque progression. Take this torque progression as the basis for the working cycle.