GUIDELINES

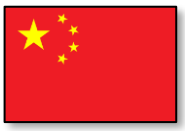
CODE 2
Tractor Performance

- Engine Power Output and Fuel Consumption
- Drawbar Power Output and Fuel Consumption
- Hydraulic Power Output
- Hydraulic lift capacity


Austria


Belgium


Brazil


China


Czech Republic


Finland


France

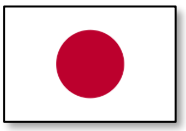

Germany


Iceland


India


Ireland


Italy


Japan


Korea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Norway


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Portugal


Russia


Serbia


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OECD Guidelines for Code 2

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

The OECD is a unique forum where governments work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Union takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

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1 Introduction

The overarching objectives of the Codes & Schemes are to simplify existing international trade procedures, increase transparency, reduce technical barriers to trade, contribute to international harmonisation of standards, environmental protection, and, to increase market confidence through enforcement of quality control and inspection procedures, as well as the traceability of the traded products. These objectives are achieved via regular dialogue with the designated authorities of member countries, observers and stakeholders.

2 Defining OECD Tractor Codes

The OECD Standard Codes for the official testing of agricultural and forestry tractors represent a set of rules and procedures. They were first established in 1959.

The aim of the Codes is to facilitate trade by updating international rules to certify tractors and their protective structures. OECD approval numbers are recognized in 27 countries, including five non-OECD members – Brazil, the People's Republic of China, India, Russian Federation, and Serbia (Figure 1). Regular international meetings are organized in addition to a biennial Test Engineer Conference, which is organized by a different Member Country on a rotational basis (OECD currently has 18 Testing Stations located in Europe, Asia and America). These meetings ensure compliance with OECD tests and procedures and provide the opportunity for regular updates that consider improvements in technical performance, safety and environmental protection.

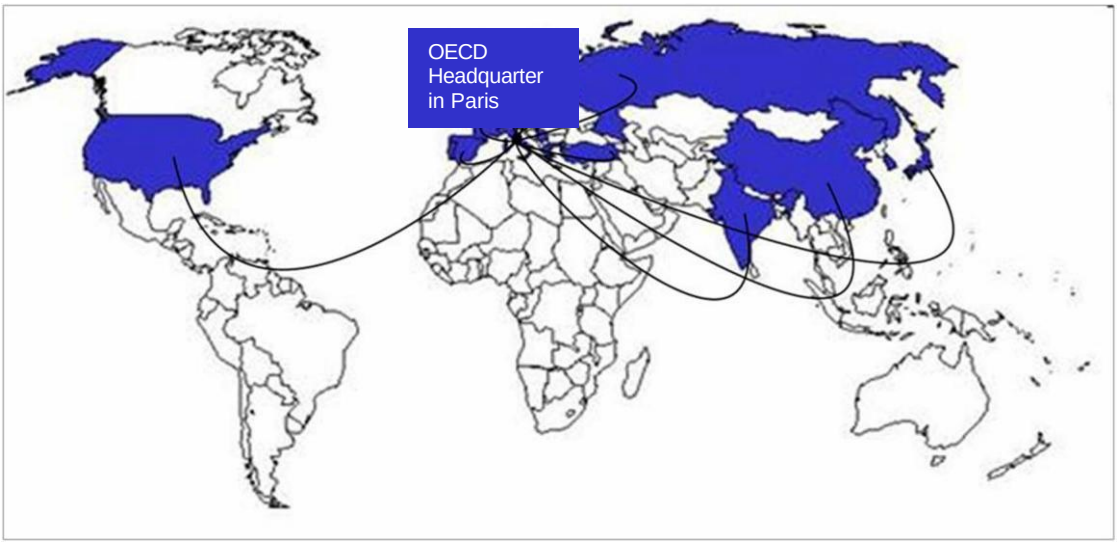

Figure 1: Countries where OECD approvals are accepted

Tests of tractors and protective structures are carried out by the accredited Testing Stations according to the OECD recognized procedures. The first accreditation of the OECD Test Station is undertaken by the OECD Secretariat along with a representative of the National Designated Authority of the applicant Country. The results are then submitted to the OECD for approval with verifications subcontracted to a Coordinating Centre which ensures that the testing conditions are in compliance with the OECD Tractor Codes and the Specimen Test Report. This procedure guarantees the independence and worldwide comparability of the tests. Figure 2 shows an overview of the whole procedure.

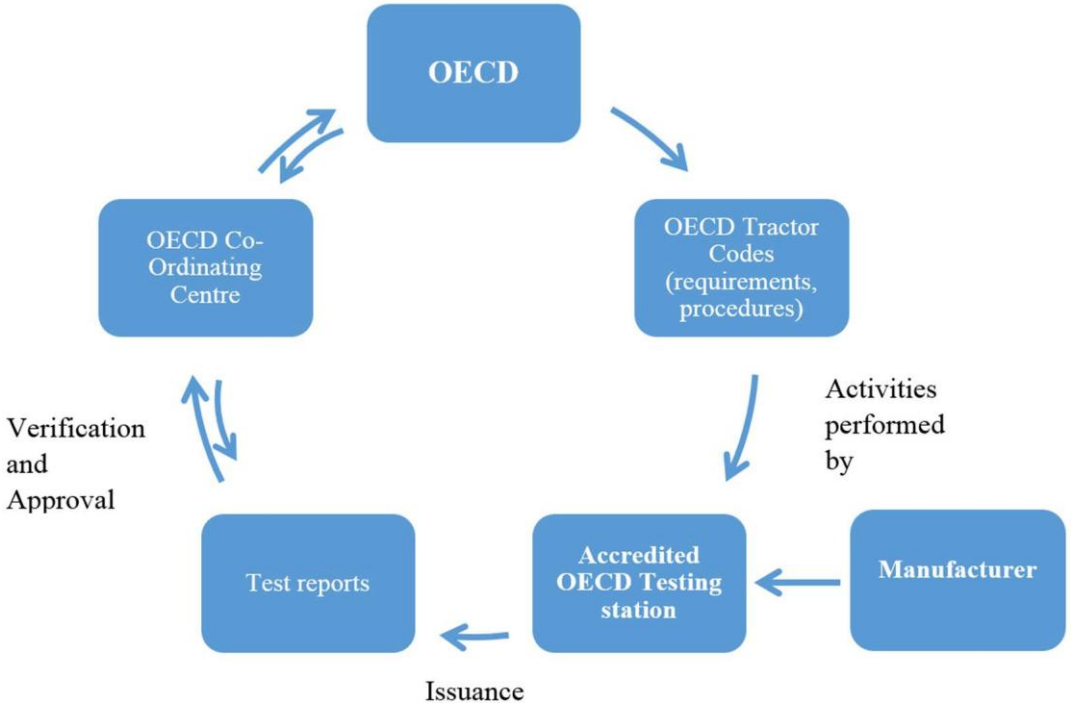

Figure 2: Test procedure of the OECD Tractor Codes

The OECD Standard Codes for the Official Testing of Agricultural and Forestry Tractors present many advantages to stakeholders, including farmers, industry and trade. To date, there are nine codes:

Code 2: OECD Standard Code for the Official Testing of Agricultural and Forestry Tractor Performance.

Code 3: OECD Standard Code for the Official Testing of Protective Structures on Agricultural and Forestry Tractors (Dynamic Test).

Code 4: OECD Standard Code for the Official Testing of Protective Structures on Agricultural and Forestry Tractors (Static Test).

Code 5: OECD Standard Code for the Official Measurement of Noise at the Driving Position(s) of Agricultural and Forestry Tractors.

Code 6: OECD Standard Code for the Official Testing of Front-mounted Protective Structures on Narrow-track Wheeled Agricultural and Forestry Tractors.

Code 7: OECD Standard Code for the Official Testing of Rear-mounted Protective Structures on Narrow-track Agricultural and Forestry Tractors.

Code 8: OECD Standard Code for the Official Testing of Protective Structures on Agricultural and Forestry Tracklaying Tractors.

Code 9: OECD Standard Code for the Official Testing of Protective Structures for Telehandlers (Testing of Falling-Object and Roll-Over Protective Structures fitted to self-propelled variable reach all-terrain trucks for agricultural use).

Code 10: OECD Standard Code for the Official Testing of Falling Object Protective Structures on Agricultural and Forestry Tractors.

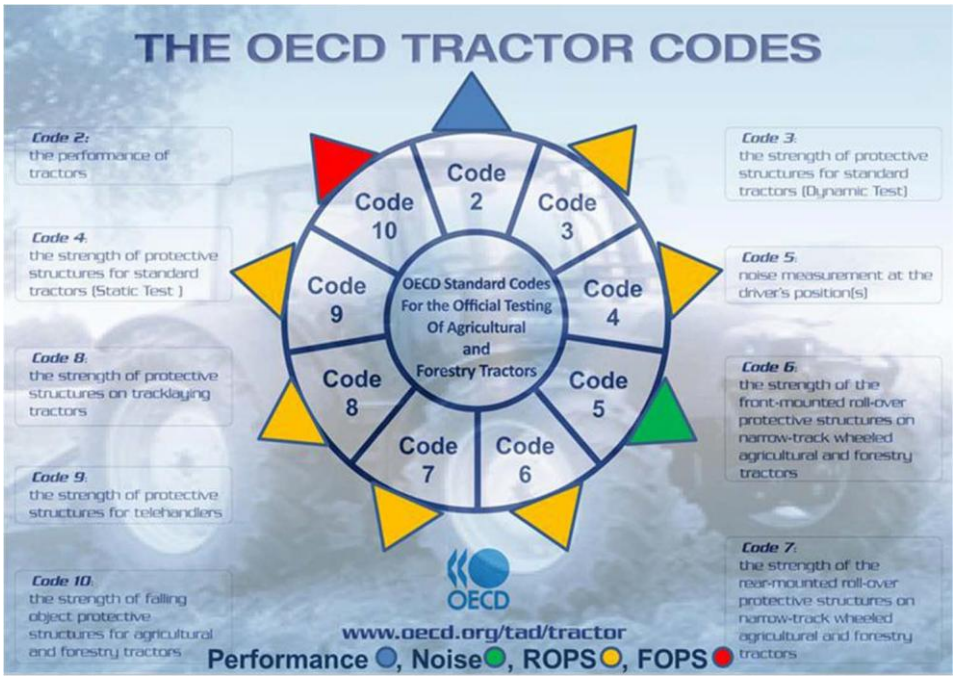

Figure 3: Overview of the OECD tractor codes

3 Implementing OECD Tractor Code 2. The case of the US

In 1919, the legislature of the State of Nebraska enacted the Nebraska Tractor Test Law which required the University of Nebraska to test a representative sample of each tractor model sold in the state. The current law can be consulted at: https://nebraskalegislature.gov/laws/statutes.php?statute=2-2701.01. Several sections highlighted below show how OECD Test codes have been incorporated into this law:

2-2702 Board of Regents of the University of Nebraska; powers and duties.

(1)(a) The Board of Regents of the University of Nebraska shall adopt and promulgate rules and regulations setting forth codes for the official testing of tractors.

(b) The Board of Regents of the University of Nebraska shall adopt procedures for the official testing of agricultural tractors as prescribed by the Organisation for Economic Cooperation and Development.

(c) The Board of Regents of the University of Nebraska shall also adopt and promulgate rules and regulations for the testing of tractors as published by the Society of Automotive Engineers and the American Society of Agricultural Engineers.

(2) In addition to the powers and duties prescribed in sections 2-2701 to 2-2711, the University of Nebraska shall have the power to:

(a) Authorize the use of the Nebraska Tractor Testing Laboratory facilities to conduct Organisation for Economic Cooperation and Development testing;

(b) Cooperate with the United States Department of Commerce when planning and conducting Organisation for Economic Cooperation and Development testing;

(c) Conduct offsite tractor tests; and

(d) Submit and certify tractor test results to the federal government.

2-2073 below speaks to the acceptability of OECD test reports conducted outside the United States as appropriate for use:

Tractor model test results; board; duties.

Once a tractor model has been duly tested by the University of Nebraska **or by any Organisation for Economic Cooperation and Development test station,** the board shall submit the results of such test to the department. Prior to the issuance of a permanent sales permit by the department to any person for the sale of a tractor model, the board shall compare the test results with the manufacturer's representations as to power, fuel, and other ratings of the tractor model. If any such representations are found to be false, the board shall recommend that the department deny a permit for the sale of such tractor model. Any representation which a person makes regarding the performance of its tractor at other than the customarily used power outlets shall be subject to test at the option of the board.

While the laws mention the use of SAE and ASAE standards, these standards have been withdrawn and in practice only OECD testing procedures are used.

4 Tractor performance test: A brief history of Code 2

The first OECD (at the time, OEEC) Standard Code for the Official Testing of Agricultural Tractors was approved in April 1959. The first report – on the McCormick International B-450 tractor – was used as a pilot study to develop and publicize an internationally- recognized standard method for tractor performances.

The approved report gave test engineers the possibility to resolve the problem of comparing test results produced in different countries. More than 3000 tractor models have been approved till now.

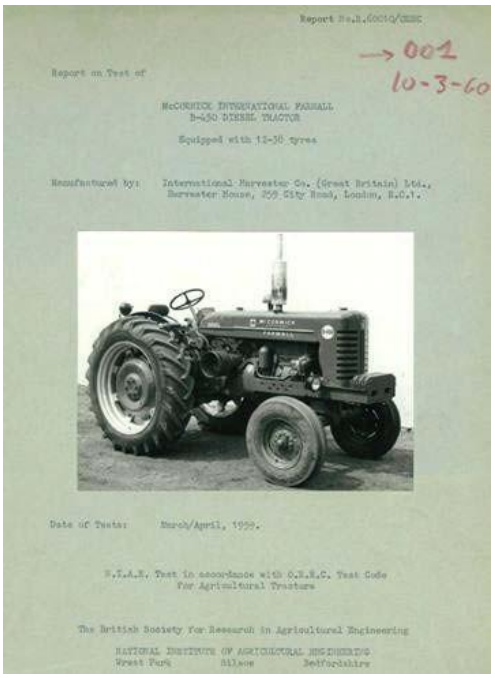

Figure 4: The first OECD standard code test report from 1959

In over 60 years of activity, the OECD Performance Code has been continuously updated. At the beginning of the new millennium, the “old” performance Code (namely Code 1) was repealed and replaced by the current version of Code 2. Continuous updating of the testing procedures allows for testing the most recent features on the tractors. These include the Diesel Particulate Filters, Selective Catalytic Reduction systems, and the new types of transmission (Continuously Variable Transmissions and Power shift).

5 Tests eligible for the OECD approval – Compulsory and optional

Compulsory tests

The following tests are required to obtain the OECD approval number for an OECD Code 2 test report:

- Power take-off power (PTO) output and the correlating fuel consumption available under stationary conditions.
- Hydraulic Power Output (as available at the auxiliary service couplings) and Hydraulic Lift Capacity (measurements at the lower link ends and on a coupled frame)
- Drawbar Power Output and Fuel Consumption on the unballasted tractor (by using a dynamometer loading car on a concrete or asphalt test track.

Optional tests

Code 2 also provides a series of optional tests to the aforementioned tests:

- additional Power take-off tests (economy)
- reagent consumption during Power take-off and Drawbar Power testing
- additional drawbar tests
- braking tests (wheeled tractors only)
- center of gravity
- external noise level (wheeled tractors only)
- fuel consumption at varying drawbar loads
- optional hydraulic power tests
- low temperature starting test
- noise level at the driving position(s) according to OECD Code 5
- reagent consumption measurement during PTO and drawbar power testing
- ten-hour test (ballasted tractors)
- turning area and turning circle
- waterproofing test

Moreover Code 2 allows for repeats of any of the compulsory or optional tests at different settings.

Finally, tractor manufacturer is allowed to ask for other tests performed according to internationally recognized methods. These tests are reported in the test report, with clearly pointed out that they are outside the OECD approval process.

6 General rules and directions for tests

Selection of tractor and manufacturer's instructions

A tractor submitted for testing shall be selected from series production by the manufacturer, with the agreement of the Testing Station.

The tractor shall normally be a production model in all respects, shall be new and run in by the manufacturer before the test in collaboration with the Testing Station, strictly conforming to the description and specification sheet submitted by the manufacturer.

The testing of a pre-production model tractor is permitted exceptionally. If this is the case, the Testing Station must certify that the tested tractor conforms to the series production.

The adjustment of the injection pump and the governor settings shall conform to the specifications provided by the manufacturer.

The manufacturer is allowed for adjustment in conformity with the specifications during the period prior to testing. These adjustments shall not be modified during the test.

Once the test runs the tractor shall be operated in accordance with the manufacturer instructions unless specifically required by test criteria and then only by agreement with the manufacturer.

Ambient conditions, fuels and lubricants

No corrections shall be made to the test results for atmospheric conditions or other factors. Atmospheric pressure shall not be less than 96.6 kPa. If this is not feasible because of altitude conditions, a modified injection pump setting is allowed. Stable operating conditions are required at each load setting before test measurements.

Fuels and lubricants shall be selected from the range of products commercially available in the Country where the tractor is tested but shall conform to the minimum standards approved by the tractor manufacturer.

Tractors equipped with Diesel Particulate Filters

Before beginning the official test and at the discretion of the manufacturer, a regeneration of the diesel particulate filter may be performed. Additionally, a regeneration of the diesel particulate filter may be performed before each separate test – e.g. before the PTO test, before starting drawbar testing, before the hydraulic lift test, etc. If during any of the official tests, the tractor initiates a regeneration of the diesel particulate filter, the test should be suspended, and the regeneration should be allowed to complete before continuing the test.

7 Power take-off and engine tests

The power take-off (PTO) test is the first compulsory test and is addressed to measure:

- ***Engine speed, PTO speed and Fan speed (min^{-1})***
- ***Crankshaft Torque (Nm)***
- ***Fuel consumption (kg/h)***, ***hourly consumption (l/h)***
- **Fuel temperature *(°C)*** at a suitable point between the tank and the engine;
- **Oil temperature *(°C)*** at a suitable point in the oil flow;
- **Coolant temperature *(°C)*** at the outlet of the cylinder block or cylinder head before the thermostat or, in the case of air-cooled engines, the engine temperature at a point specified by the manufacturer;
- **Air temperature *(°C)*** measured at two points: one approximately 2 m in front of the tractor and approximately 1.5 m above the ground, the other at the engine air intake;
- **Atmospheric pressure (kPa)**
- **Relative humidity (%)**

All results are obtained under controlled laboratory conditions:

- Ambient temperature shall be 23 ± 7 °C.
- Atmospheric pressure shall not be less than 96.6 kPa (except in some case of altitude), and the relative humidity must be recorded.

The maximum temperature of oil, coolant and fuel must be recorded.

Controlled laboratory conditions prevent high influence on the engine performance to achieve comparable results among all Testing Stations.

To check the engine power output, measured at the power take-off shaft, the laboratory needs a dynamometer bench (Figure 5). If there is an exhaust gas discharge device, it must not affect the engine performance. To obtain more precise results, the fuel is supplied by an external tank.

Figure 5: Dynamometer for Power-Take-Off (PTO) measurements

When a laboratory verifies the test data, there can be a discrepancy between the declared power by the manufacturer for engine “flywheel” power output, and the value obtained at the PTO shaft. This is more evident in modern tractors, where the electronical devices and instrumentations used by the operator (cooling fans, hydraulic suspension pumps, air conditioning systems, etc.) cause a significant loss in power of the engine before such power is transmitted to the PTO shaft. It is important to note that Code 2 verifies the maximum power at rated engine speed at the main power take-off, and not at the engine “flywheel”.

Table 1: Comparison of standards for power measurement at the flywheel and at the interfaces of a tractor

Standard	SAE J1995	ISO TR14396 ECE R 120	EU 2016/1628	ECE R 24	OECD Tractor Code 2	
Measuring point	Flywheel	Flywheel	Flywheel	Flywheel	Power-Take-Off	Driven wheels
Turbocharger	Yes	Yes	Yes	Yes	Yes	Yes
Intercooler	Yes	Yes	Yes	Yes	Yes	Yes
Injection pump	Yes	Yes	Yes	Yes	Yes	Yes
Coolant pump	**No**	Yes	Yes	Yes	Yes	Yes
Water cooler	**No**	**No**	Yes	Yes	Yes	Yes
Air filter	**No**	Yes	Yes	Yes	Yes	Yes
Exhaust pipe	**No**	Yes	Yes	Yes	Yes	Yes
Fan	**No**	**No**	**No**	Yes (min. speed)	Yes	Yes
Additional aggregates (Air conditioner, transmission, clutch, hydraulic, etc.)	**No**	**No**	**No**	**No**	Yes	Yes
Consideration of air and fuel temperature and atmospheric pressure	Yes	Yes	Yes	Yes	Limited	Limited
Examples of OECD Tractor Code 2 tested tractors						
Tractor 1		221 kW			208 kW	175 kW
Tractor 2		291 kW		287 kW	258 kW	219 kW
Tractor 3		139 kW			119 kW	100 kW
Tractor 4			93 kW		86 kW	74 kW

In the recent past, many tractors have been equipped with exhaust after treatment devices, as Selective Catalytic Reduction (SCR) and/or Diesel Particulate Filter (DPF). For tractors with SCR and DPF systems the reagent consumption and the time of regeneration with the additional fuel consumption are measured if requested by the manufacturers.

The Code 2 PTO tests require different tests and the torque, engine speed, hourly fuel consumption, and hourly reagent consumption are measured and recorded.

The test is performed with the scope to obtain the following results:

1. Maximum power test

   The tractor governor control being set for the maximum power, the tractor operates for a period of one hour and the maximum power reported is the average of at least six readings made during the one-hour period.

2. Test at full load and varying speed

   The test runs at an engine speed at least 15 per cent below the speed at which maximum torque occurs or to an engine speed at least 50 per cent of rated engine speed, whichever speed is lower. The recorded data must permit to plot the curves for a graphical presentation.

3. Tests at varying load

   The tractor governor control is set for the maximum power:

   - at rated engine speed
   - at standard power take-off speed [540 or 1000 min^{-1} (rev/min)].

   The test starts at the torque corresponding to the maximum power at the two engine speeds required. During the test, the torque is reduced to five extra measurement points and the engine speed and the corresponding fuel and reagent consumption (if applicable) are measured. The last measurement requires the tractor to be disconnected from the brake and the torque control set to 0 Nm to measure the highest possible speed.

4. Fuel consumption tests

   The five extra points serves not only to show the power available at the power take-off shaft, but also to measure the fuel and reagent consumption (if applicable) to characterise the engine behaviour.

Table 2: Extra points (part load points) measured at the PTO

Extra point	Explanation	Settings	Typical operation
Point (1)	Power obtained at rated engine speed in the main test	maximum power at rated engine speed in the main test	
Point (2)	High power at max. speed	80% of power obtained in point (1) at maximum speed setting	Heavy drawbar work
Point (3)	High power at 90% speed	80% of power obtained in point (1) with governor control set to 90% of rated engine speed	Heavy drawbar or power take-off work at standard speed
Point (4)	Low power at 90% speed	40% of power obtained in point (1) with governor control set to 90% of rated engine speed	Light power take-off- or drawbar work
Point (5)	High power at 60% speed	60% of power obtained in point (1) with governor control set to 60% of rated engine speed	Heavy drawbar or power take-off work at economy power take-off speeds or automatic engine speeds, near the most economical operating range of engine
Point (6)	Low power at 60% speed	40 % of power obtained in point (1) with governor control set to 60 % of rated engine speed	Light drawbar or power take-off work at reduced speeds

If, under some conditions, the engine can have different operational modes and show different power curves, and if requested by the tractor manufacturer, these conditions are described and the main power take-off shall be, if possible, repeated in each of these operating modes to obtain the different power curves.

8 Hydraulic power and hydraulic lift

The second compulsory test is the hydraulic test. There are two components to this test: the first is the hydraulic power and the second the hydraulic lift performance.

The hydraulic power measures the tractors' ability to provide hydraulic power, as required to power hydraulic motors or actuate hydraulic rams on attached implements. Many tractors deliver hydraulic flow externally via auxiliary or spool valves.

The test is conducted with the throttle or governor control lever adjusted to the maximum engine speed condition.

The first test checks the maximum (sustained) pressure with relief valve open as measured at the coupler, and it must be reported if the pump is stalled or not.

The hydraulic flow rate delivered by the coupler at 90% of the maximum pressure is recorded, enabling calculation of maximum hydraulic power availability.

The test is repeated using more pair of couplers simultaneously if available and if a single coupler may limit the maximum flow rate. Tests are performed without a return pressure. Supplementary tests with a return pressure via coupler pair, as it would often be the case in the normal use of the tractor, can be performed.

The supplementary tests provide additional information relative to the hydraulic system performance.

The second step of the hydraulic test is the hydraulic lift performance. The test provides the tractor hydraulic lift capacity throughout the entire range of linkage movement. A complete measurement of the geometry of the three-point (3pt) linkage is performed. In the test, the linkage adjustment is in accordance with the ISO 730: 2009/Amd.1:2014 standard, For those tractors which do not achieve the standard power range, the lift force will be measured at the maximum achievable power range or at the maximum achievable power range.

The capacity to lift depends not only on the mass of the linked implement but is affected also by the Centre of Gravity (Centre of Mass) and the linkage geometry. The whole tractor is fastened to the floor during the lifting test and to eliminate the influence of the wheels deformation the tractor chassis is supported with bearings. (Figure 6).

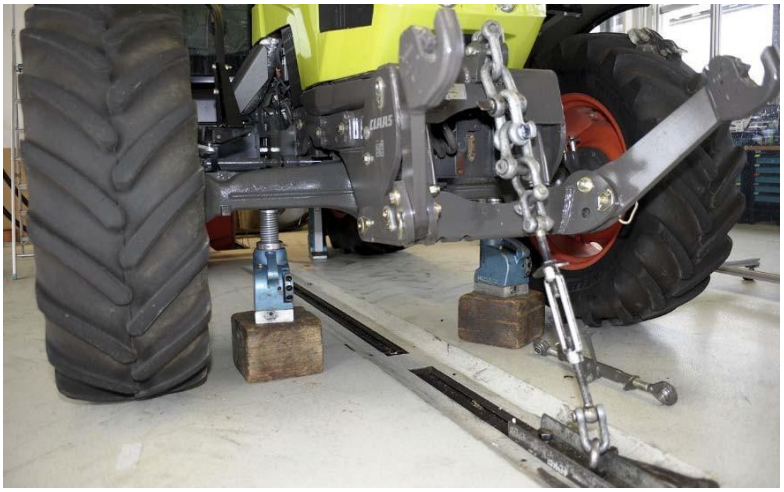

Figure 6: Bearings under the chassis, the tractor is fastened to the ground

The test results are measured directly at the lower hitch points and on a dedicated frame connected to the lower hitch points and to the upper (top) link point, 610 mm behind the lower link attachment points. The height of the lower hitch points above the ground in down position and the vertical movement, both with and without lifting force, are measured. The maximum tilt angle of the mast from the vertical has to be not less than 10° and the lifting forces measured throughout the lift range are obtained at a hydraulic pressure equivalent to 90% of the actual relief valve pressure setting of the hydraulic lift system.

For both the hydraulic power test and the hydraulic lift, supplementary tests at the manufacturers request are performed to test different linkage conditions.

9 Drawbar power and fuel consumption

The third compulsory test is addressed to measure the drawbar power and the fuel consumption. The test shows the ability of the tractor to use engine power not only at the PTO (first compulsory test) but also for the drawbar pull.

During the drawbar power test, the governor control is set at the maximum power. The test runs in gears/speed settings ranging from one giving a travel speed immediately faster than in the gear/speed setting in which the greatest maximum power is developed down to one immediately slower than the gear/speed setting allowing maximum pull to be developed.

In case of tractors mounted with a continuously variable transmission, gears at fixed ratios are not available; during the drawbar power test at least 7 evenly spaced forward speeds/ratios are selected to obtain results in the speed range from 2.5 km/h to 17.5 km/h.

For wheeled tractor performance values only up to 15% mean wheel slip are reported in the test report and for track-laying tractor performance values only up to 7 %.

The test is performed on a concrete or asphalt track. The track is not a typical ground for the normal operation of the tractor, but it represents a standard test ground to obtain comparable results not affected by different field conditions.

The accredited Testing Stations to perform the test connect a dedicated loading car (or other modified vehicle) equipped with a dynamometer to the tested tractor to apply a controlled braking force (Figure 7). The loading car is complemented with an external fuel tank to supply fuel to the tested tractor.

Figure 7: Specific loading vehicle for the compulsory drawbar test

The tractors drawbar power is calculated on the drawbar pull with respect to the vehicle forward speed.

For the compulsory test, the tractor is unballasted. However, the ballasted configuration and other manufacturer configurations are tested as options.

The results of the specific fuel consumption are different to those obtained during PTO test due to wheel slip and additional gears in the driveline.

Fuel consumption is measured in two gear/speed settings typically used for fieldwork. One has a nominal speed of 7.5 km/h (or a gear / speed setting giving a nominal speed nearest to this) and the other giving a nominal speed between 7 and 10 km/h, chosen by the manufacturer in agreement with the Testing Station. If this gear/speed setting is not available, the nearest available gear/speed setting is selected but the speed may be less than 7 km/h or more than 10 km/h.

Measurements are recorded according to the following test configurations:

1. Maximum drawbar power available in the selected gear/speed setting at rated engine speed
2. A pull equal to 75 per cent of the pull corresponding to maximum power at rated engine speed
3. A pull equal to 50 per cent of the pull corresponding to maximum power at rated engine speed
4. Reduced engine speed in a higher gear/speed setting, which can develop the same pull and travelling speed as in point 2)
5. Reduced engine speed in the same gear/speed setting used in point 4) with the same pull and travelling speed as in point 3)

10 Test results

The Power take-off Power and the Drawbar Power test results are plotted according to the following graphical instructions.

Power take-off Power test

Figure 8 shows:

– Power as a function of engine speed (with standard power take-off speed indicated)
– Equivalent crankshaft torque as a function of engine speed (except for fluid transmission)
– Hourly and specific fuel consumption as a function of engine speed
– Hourly and specific reagent consumption as a function of engine speed (if applicable and if requested).

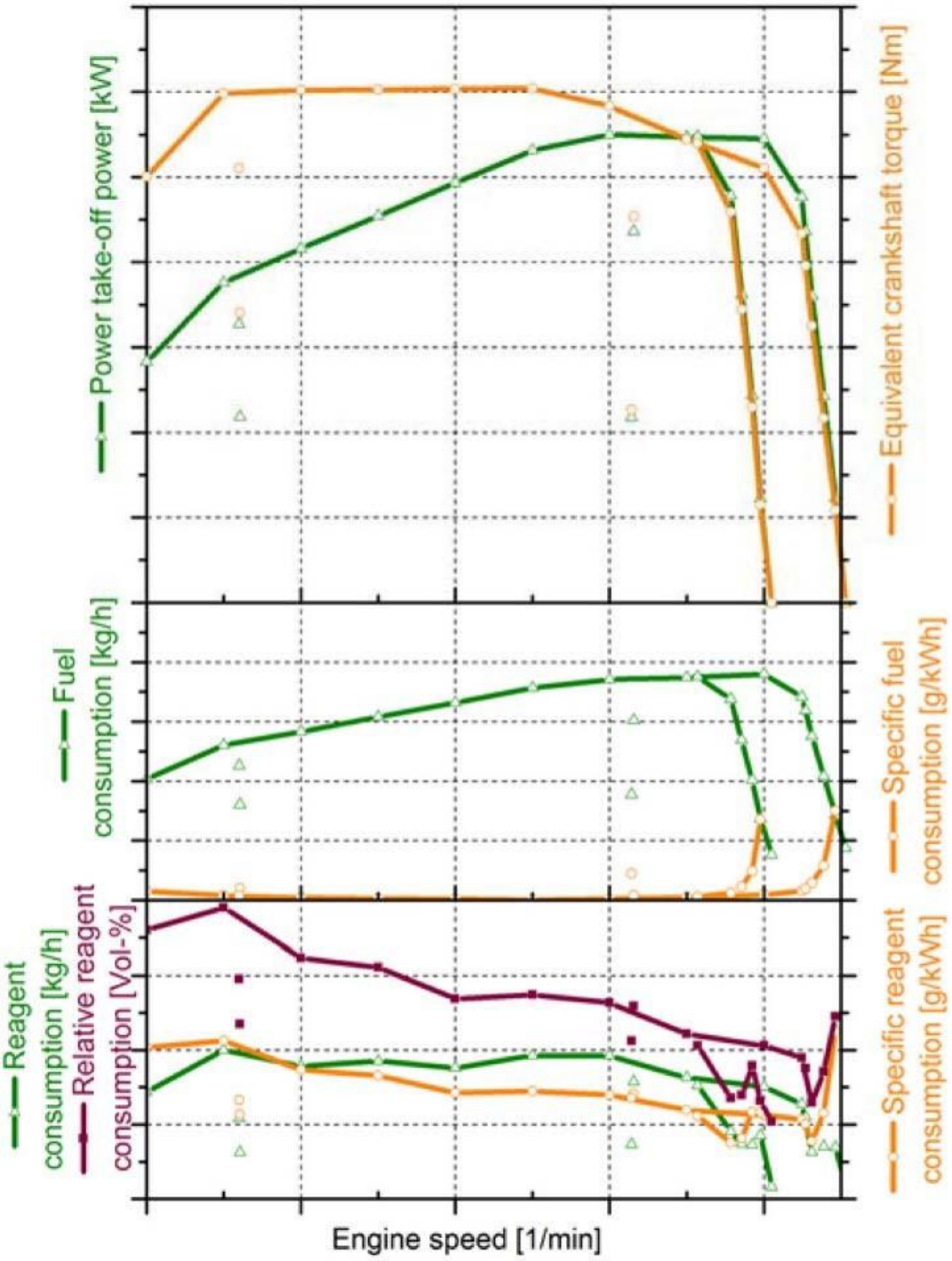

Figure 8: Graphical presentation of the PTO test results

Drawbar Power test

Standard graphical presentation

A table with the following results is presented in the test report:

- Gear/speed designation
- Drawbar power, kW
- Drawbar pull, kN
- Travel speed, km/h
- Engine speed, min^{-1}
- Fan speed, min^{-1}
- Slip, %
- Hourly fuel consumption, kg/h
- Specific fuel consumption g/kWh
- Fuel temperature, °C
- Coolant temperature, °C
- Engine oil temperature, °C
- Atmospheric temperature, °C
- Relative humidity, %
- Atmospheric pressure, kPa.

Graphical presentation in special cases

In some special cases e.g. tractors without a power take-off or with a power take-off unable to transmit the full power from the engine the following graphical presentation is added.

- Drawbar power as a function of engine speed
- Increase in pull as a function of engine speed
- Hourly and specific fuel consumption as a function of engine speed
- Hourly and specific reagent consumption as a function of engine speed (if applicable).

Results of the Power Take-Off Power test

Figure 9 is an example of tractor engine performance with the governor control set for the maximum power. The green curve refers to the calculated power, the orange curve shows to the measured torque.

The difference between the torque at rated speed and the maximum torque is named torque rise. Higher values characterise engine able to compensate load peaks without the need to shift down.

The engine speed drop describes the range between rated engine speed and the engine speed where the maximum torque is available. In this speed range, the engine provides the torque and the power for heavy work. Based on fuel consumption efficiency, the engine speed range between maximum power and maximum torque is favorable.

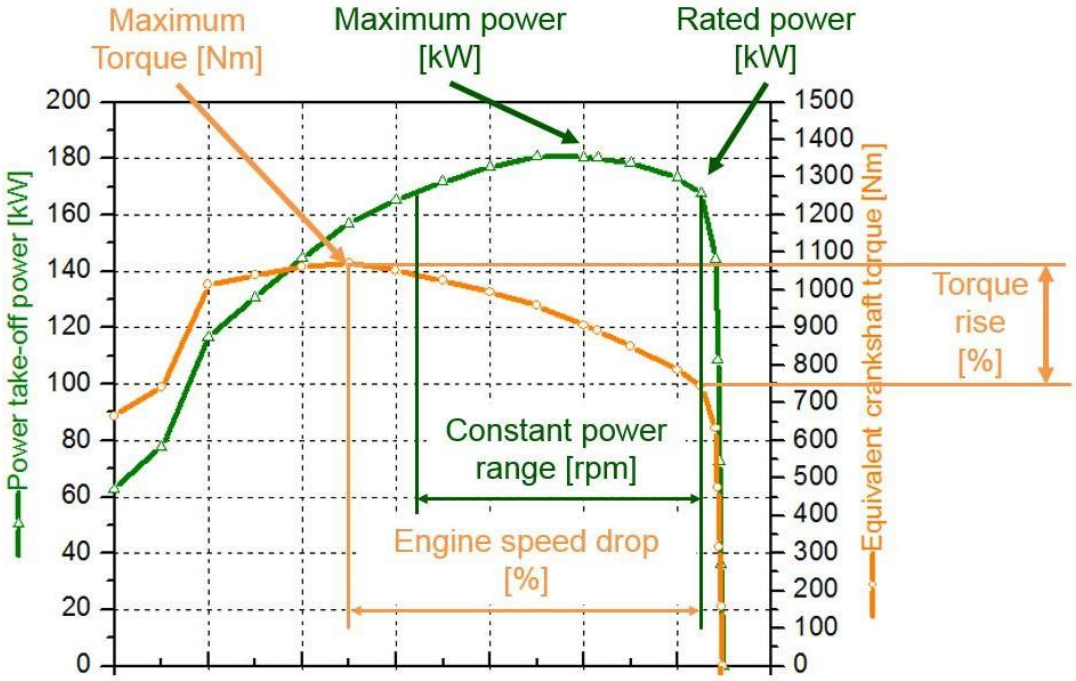

Figure 9: Engine performance of a tractor

In Figure 10 the part load points (extra points) are represented. These points are within the performance chart of the engine and demonstrate the torque and the power the engine can provide in these load cases. These denote the engines behavior with light implements where the full engine power is not required.

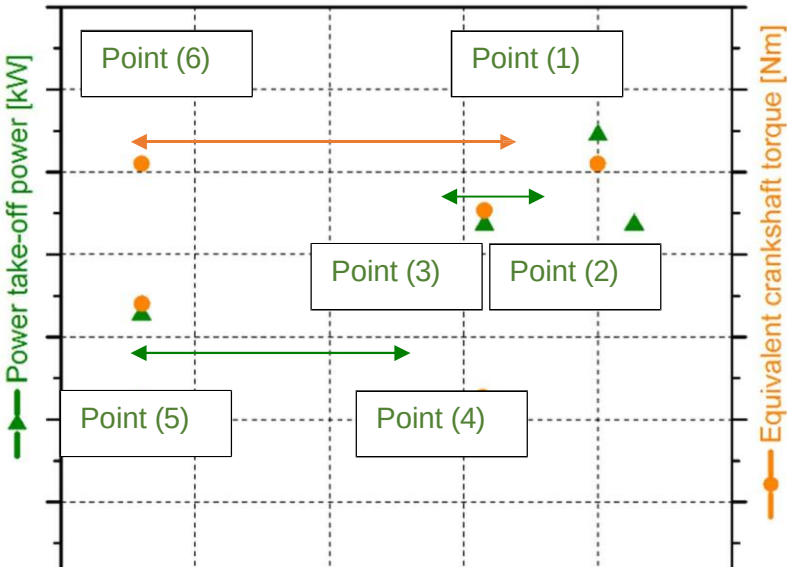

Figure 10: Part load points of a PTO test

Point (2) and (3) and point (4) and (5) are strongly related to the supplied power. The only difference is the reduced engine speed in points (3) and (5) and as an added value the decreased fuel consumption. Without any negative influences, the farmer can perform the work with less fuel consumption. In point (1) and (6) the torque is comparable.

Results measured of the Drawbar Power test

Figure 11 shows measured values at different part load points of the drawbar test. The highlighted values denote a decrease of the fuel consumption by selecting a higher gear speed setting. If the engine pursues a higher speed not feasible because of the load, the tractor runs with the same drawbar power, drawbar pull, and speed but with reduced engine speed. This results in lower fuel consumption and the same work being performed.

Speed setting	Power kW	Drawbar-pull kN	Speed km/h	Engine speed min^{-1}	Fan speed min^{-1}	Slip of wheels and/or tracks %	Specific fuel consump-tion g/kWh	Specific energy kWh/dm³	Specific reagent consump-tion g/kWh
3.3.2 FUEL CONSUMPTION									
3.3.2.1 in selected gear/speed setting nearest 7.5 km/h, at maximum power at rated engine speed									
7.5	302.9	145.18	7.51	1702	1380	4.9	248	3.36	21.20
3.3.2.1.1 75 % of pull corresponding to maximum power at rated engine speed									
7.5	240.9	109.04	7.95	1751	1275	2.5	246	3.38	21.79
3.3.2.1.2 50 % of pull corresponding to maximum power at rated engine speed									
7.5	165.3	72.41	8.22	1767	931	1.4	261	3.18	18.51
3.3.2.1.3. highest gear/speed setting at reduced engine speed able to achieve both 3.3.2.1.1 and 3.3.2.1.2 ; sar									
9	240.8	108.83	7.97	1457	1123	2.5	233	3.56	19.46
3.3.2.1.4 same gear/speed selection as 3.3.2.1.3 at reduced engine speed; same pull and travelling speed as ir									
9	165.5	72.58	8.21	1473	856	1.6	243	3.42	26.20
3.3.2.2 in selected gear/speed setting nearest between 7 km/h and 10 km/h at rated engine speed									
9	308.2	123.36	8.99	1699	1310	3.3	243	3.42	21.09
3.3.2.2.1 75 % of pull corresponding to maximum power at rated engine speed									
9	243.2	92.90	9.42	1752	1134	1.9	246	3.37	22.79
3.3.2.2.2 50 % of pull corresponding to maximum power at rated engine speed									
9	166.7	61.77	9.71	1770	895	1.2	263	3.16	20.73
3.3.2.2.3 highest gear/speed setting at reduced engine speed able to achieve both 3.3.2.2.1 and 3.3.2.2.2 ; sar									
11	242.1	92.61	9.41	1435	1126	2.0	231	3.59	21.07
3.3.2.2.4 same gear/speed setting as 3.3.2.2.3 at reduced engine speed; same pull and travelling speed as in 3									
11	166.2	61.78	9.69	1456	747	1.3	240	3.46	27.19

Figure 11: Test results of a drawbar test at different part load points

11 How to read an OECD Code 2 abstract

As the full access to the results of tractors approved according to the OECD Code 2 remains under the Testing Stations responsibility, if the manufacturers agree the OECD gives the opportunity to download summary reports.

With the manufacturer and Testing Station agreement, it is possible to consult Code 2 main results.

A search on tractors is possible using the criteria:

– select the Make (or all)

– select the tractor model

–

The summary report is publicly available and can be downloaded. The file appearance is more or less like the following example (data used do not much necessarily match with a real tractor performance test).

OECD ABSTRACT OF AGRICULTURAL AND FORESTRY TRACTOR PERFORMANCE TEST

OECD Approval Number	**2/X xxx**
OECD Approval Date	**dd/mm/yyyy**
Make	**Manufacturer**
Model	**Approval denomination**
Type	**wheels or tracks**
Transmission	Type
Speed	km/h
Manufacturer	Name
Testing Station	Acronym – Country

OECD [Page 1/6] Testing Station Logo

Make Model – Type OECD approval number

SPECIFICATIONS

ENGINE

Make	x
Model	x
Type	x
Supercharging	Yes/No
Cylinders	x
Disposition	x
Capacity	cm³
Cooling	x

TRANSMISSION

Gear box		x
Number of forward and reverse speeds	xx	xx
Speed at rated engine speed	from x,xx	to xx,xx km/h

POWER TAKE-OFF SPECIFICATIONS

Standard Power take-off speed	540 min⁻¹	1000 min⁻¹
Power take-off speed at rated engine speed	xxx min⁻¹	xxxx min⁻¹
Diameter of the shaft	xx mm	xx mm
Number of splines	xx	xx

OECD [Page 2/6] Testing Station Logo

Figure 12: Pages 1 and 2 of an OECD Code 2 abstract: Tractor specifications

Figure 12 represents a summary of the main characteristics of the tractor. On the first page, the photo of the tractor with the approval number and date under OECD appears, along with the main information of the tractor, the manufacturer, and the Testing Station.

On the second page, the main specifications regarding the engine, the transmission and the power take-off are reported.

Figure 13: Pages 3 and 4 of an OECD Code 2 abstract: Main results of the P.T.O. tests

The second part of the abstract (Figure 13) is dedicated to the PTO compulsory test. There is a graphical presentation of the main results obtained during tests; maximum power at one-hour, maximum power at rated engine speed and power at standard PTO speed (540 or 1000 min^{-1}). If tested, the optional boosted data is also reported.

In this section, results of reagent consumption (urea) also appear.

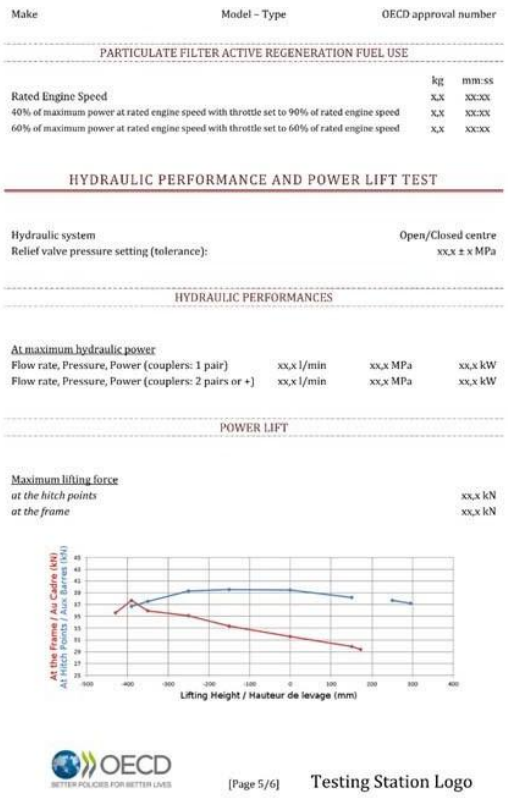

Figure 14: Pages 5 and 6 of an OECD Code 2 abstract: hydraulic-, powerlift, and drawbar test results

The last part of the abstract (Figure 14) is dedicated to the particulate filter active regeneration, if available and tested, and to the other two compulsory tests: the hydraulic and power lift test and the drawbar test. For the drawbar test, if performed there are information about the optional drawbar test on the ballasted tractor.

12 Definitions used in OECD Code 2

Agricultural and Forestry Tractors Eligible for Test (tractor definition)

Self-propelled wheeled tractors, having at least two axles, or with tracks, designed to carry out the following operations, primarily for agricultural and forestry purposes:

- to pull trailers
- to carry, pull or propel agricultural and forestry tools or machinery and, where necessary, supply power to operate them with the tractor in motion or stationary.

Rated Speed

The engine speed specified by the manufacturer for continuous operation at full load.

Power Take-Off Power

The power measured at any shaft designed by the tractor manufacturer to be used as a power take-off.

Equivalent crankshaft torque

The torque with respect to the crankshaft of the forces created by the combustion gases pressure on the pistons, not considering the mechanical losses. The losses are a consequence of the piston rings friction on the slaves and the various bearings frictions.

Engine Power

The power measured at the flywheel or the crankshaft.

Power at the Drawbar

The power available at the drawbar, sustainable over a distance of at least 20 meters.

Maximum Drawbar Pull

The mean maximum sustained pull, which the tractor can maintain at the drawbar over a given distance, the pull being exerted horizontally and in the vertical plane containing the longitudinal axis of the tractor.

Units of Consumption

When consumption is measured by mass, to obtain hourly consumption by volume, a conversion of units of mass to units of volume shall be made using the fuel density value at 15°C.

When consumption is measured by volume, the mass of fuel per unit of work shall be calculated using the density corresponding to the fuel temperature at which the measurement was made. This figure shall then be used to obtain hourly consumption by volume using the density value at 15°C for conversion from units of mass to units of volume.

Specific fuel consumption

The mass of fuel consumed per unit of work. [g/kWh]

Specific reagent consumption

The mass of reagent consumed per unit of work. [g/kWh]

Specific energy

Work per unit volume of fuel consumed. [kWh/l]. indicates how the test tractor can convert the energy present in 1 liter of diesel fuel into practical PTO work (at a given engine torque-speed setting).

Selective Catalytic Reduction (SCR)

Some tractors may inject a reagent (Diesel Exhaust Fluid or DEF) into a catalytic converter located in the exhaust system. The reagent that is currently an aqueous

urea solution is consumed during normal tractor operation and must be replenished for the tractor to operate correctly.

Reagent

Reagent means any consumable or non-recoverable medium required and used for the effective operation of the exhaust after-treatment system.

Diesel Particulate Filter (DPF)

Some tractors may be equipped with a DPF system. A DPF system traps particulate matter and either passively or actively converts the trapped particulate matter into carbon dioxide and ash. The carbon dioxide is released to the atmosphere and the ash is stored within the DPF.

Passively regenerating Diesel Particulate Filters – These filters completely rely on the normal exhaust gas temperature to provide heat for converting particulate matter to ash. No special requirements are associated with these filters.

Actively regenerating Diesel Particulate Filters – These filters may regenerate both passively and actively. During active regeneration, fuel is injected directly into the exhaust system or engine settings are modified to create the necessary heat to accomplish the active regeneration.

Median Plane of the Wheel

The median plane of the wheel is equidistant from the two planes containing the periphery of the rims at their outer edges (Figure 15).

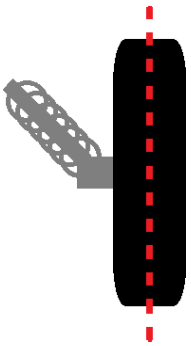

Figure 15: Median plane of the wheel

Track width (wheel/track)

The vertical plane through the wheel axis intersects its median plane along a straight line which meets the supporting surface at one point. If A and B are the two points thus defined for the wheels on the same axle of the tractor, then the track width is the distance between points A and B. The track may be thus defined for both front and rear wheels (Figure 16).

If there are twin wheels, the track is the distance between two planes each being the median plane of the pairs of wheels.

For track-laying tractors, the track is the distance between the median planes of the track.

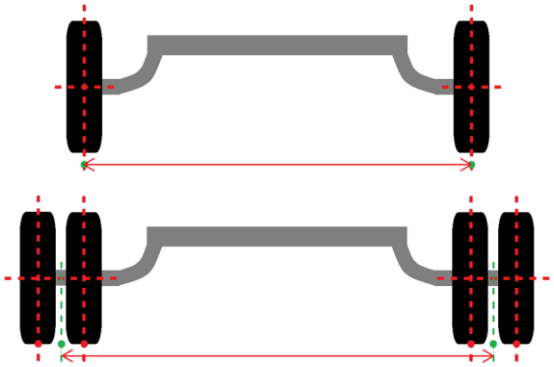

Figure 16: Definition of track

Median plane of the tractor

Take the extreme positions of points A and B for the tractor rear axle, which gives the maximum possible value for the track. The vertical plane at right angles to the line AB at its centre point is the median plane of the tractor.

Slip of wheels or tracks

Slip of the driving wheels or tracks is determined by the following formula:

$$\text{Wheel or track slip (\%)} = 100\ \frac{N1 - NO}{N_1}$$

Where N_1 is the sum of the revolutions of all driving wheels or tracks for a given distance with slip, and N_0 is the sum of the revolutions of all driving wheels or tracks for the same distance without slip.

Unballasted Mass

The mass of the tractor without ballasting devices; in the case of tractors with pneumatic tyres, without liquid ballast in the tyres. The tractor shall be in running order with tanks, circuits and radiator full and any track equipment or additional front wheel drive components required for a normal use. The driver mass is not included.

Ballasted Mass

The mass of the tractor with ballasting devices; in the case of tractors with pneumatic tyres, sometimes with liquid ballast in the tyres. The tractor shall be in running order with tanks, circuits and radiator full and any track equipment or additional front wheel drive components required for a normal use. The driver mass is not included.

13 Units used

Units	
Force	1 kN = 1000 N
Power	1 kW = 1000 N
Pressure	100 kPa = 1000 mbar 1 Mpa = 10 bar
Rotational speed	1 min^{-1} = 1 rev/min
Torque	1 Nm
Specific consumption	1 g/kwh
Forward speed	1 km/h
Volumetric Flow	1 l/min