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OECD Tractor Codes

60TH ANNIVERSARY
OF THE OECD
TRACTOR CODES
(1959-2019)

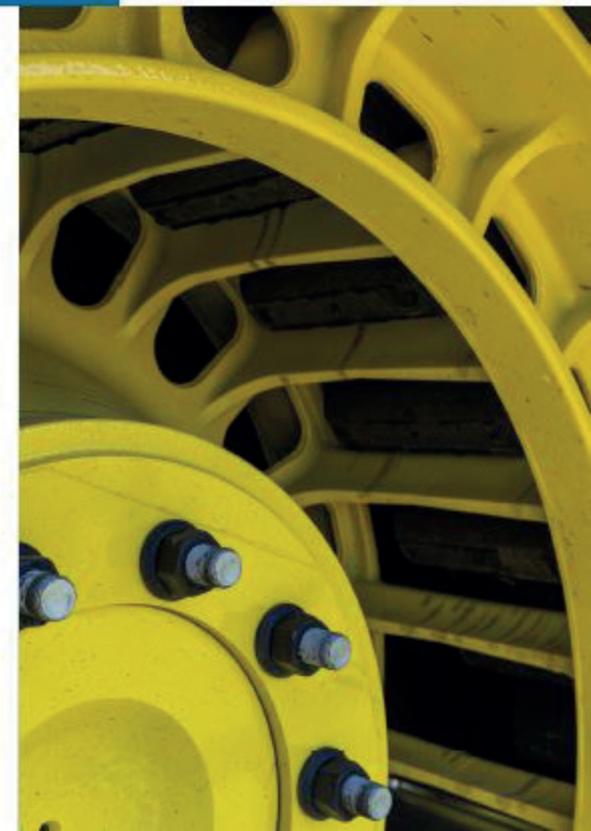


GUIDELINES

CODE 2

Tractor Performance

- Engine Power Output and Fuel Consumption
- Drawbar Power Output and Fuel Consumption
- Hydraulic Power Output
- Hydraulic (3-point lift)



www.oecd.org/agriculture/tractors



OECD Guidelines for Code 2

2019

ORGANISATION FOR ECONOMIC COOPERATION AND DEVELOPMENT

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Table of contents

1 Introduction	5
2 Defining OECD Tractor Codes	6
3 Implementing OECD Tractor Code 2. The case of the US	10
4 Tractor performance test: A brief history of Code 2	12
5 Tests eligible for the OECD approval – Compulsory and optional	13
Compulsory tests	13
Optional tests	13
6 General rules and directions for tests	15
Selection of tractor and manufacturer's instructions	15
Ambient conditions, fuels and lubricants	16
Tractors equipped with Diesel Particulate Filters	16
7 Power take-off and engine tests	17
8 Hydraulic power and hydraulic lift	22
9 Drawbar power and fuel consumption	25
10 Presenting results	28
Power take-off Power test	28
Drawbar Power test	30
Interpretation of the results measured in a Power Take-Off Power test	31
Interpretation of the results measured in a Drawbar Power test	32
11 How to read an OECD Code 2 abstract	34
12 Definitions used in OECD Code 2	39
13 Units used	44

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 recognised 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 organised in addition to a biennial Test Engineer Conference, which is organised by a different Member Country on a rotational basis (OECD currently has 30 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 take into account improvements in technical performance, safety and environmental protection.

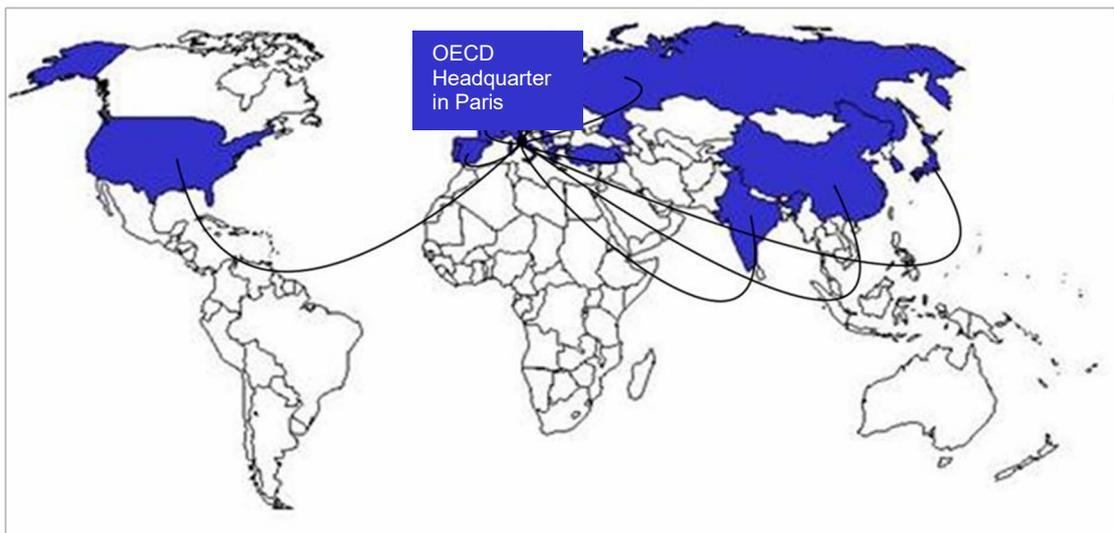


Figure 1: Countries where OECD approvals are accepted

Tests of tractors and protective structures are carried out by the accredited participating countries according to recognised procedures. The first accreditation of the OECD test station is undertaken by the OECD Secretariat along with a representative of a 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.

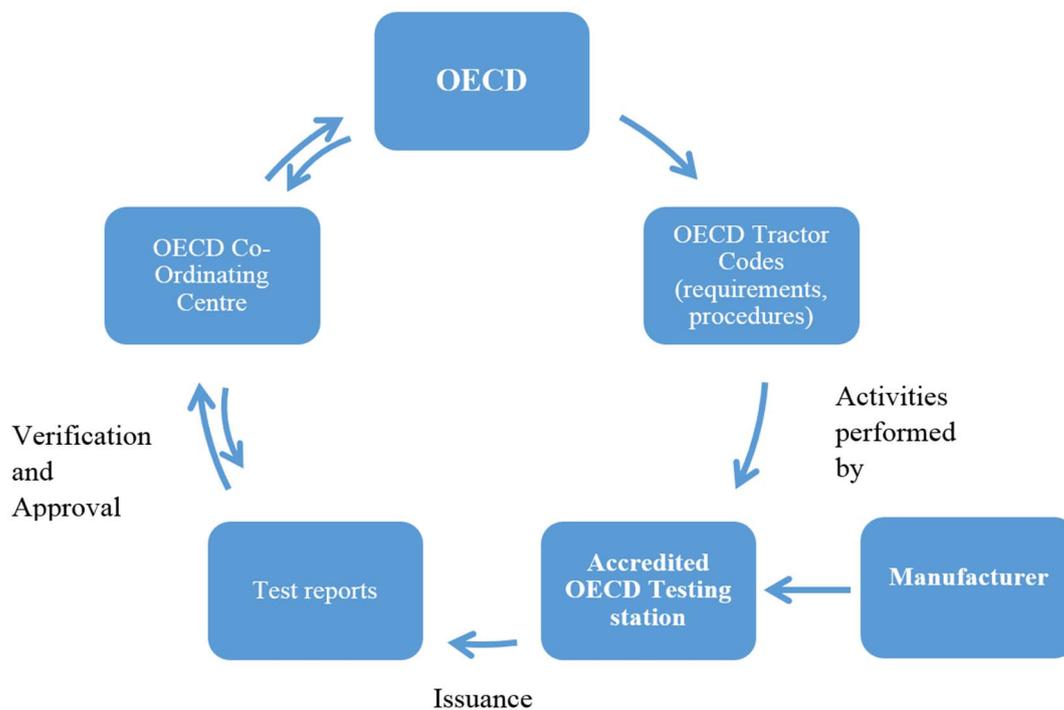


Figure 2: Test procedure of the OECD Tractor Codes

For tractor performances only, it is possible to consult the main results online at <http://www.oecd.org/agriculture/tractors/>.

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.

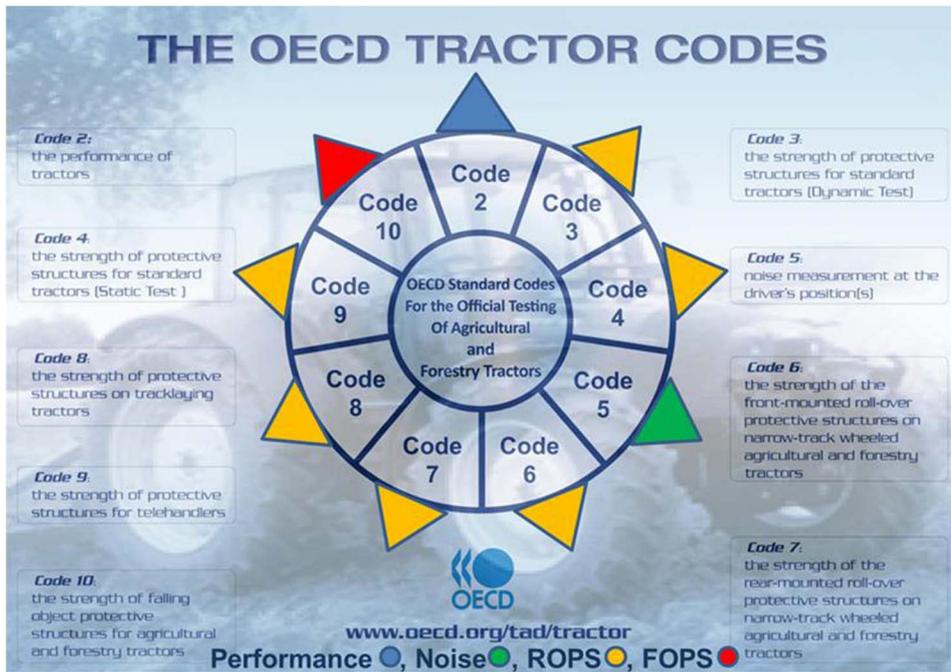


Figure 3: Overview of the OECD tractor codes

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 Organization 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 Organization for Economic Cooperation and Development testing;

(b) Cooperate with the United States Department of Commerce when planning and conducting Organization 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 Organization 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 with regard to 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-recognised 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. Between April 1959 and 2017, over 3 000 tractor models have been approved.

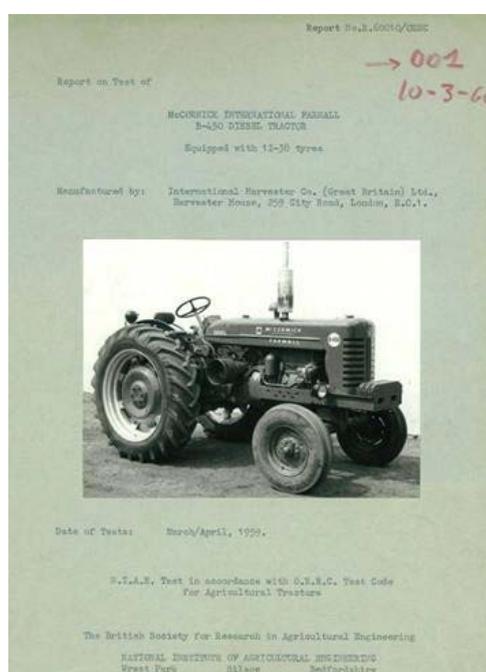


Figure 4: The first OECD standard code test report from 1959

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 (called Code 1) was replaced with Code 2. Continuous updating allows for the testing of 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 in order to obtain an OECD approval number for an OECD Code 2 test report:

- The Power take-off power output and the correlating fuel consumption available under stationary conditions.
- Hydraulic Power Output (as available at the auxiliary service couplings) and Hydraulic (3-point linkage) Lift Capacity (measured at the lower link ends and on a coupled frame)
- Drawbar Power Output and Fuel Consumption on an unballasted tractor (measured using a dynamometer loading car on a concrete or asphalt test track or on a chassis dynamometer).

Optional tests

Code 2 also provides a series of optional tests that can be added to the aforementioned tests:

- Power take-off tests with different P.T.O ratio (economy) or different power curves
- Drawbar tests with ballast or with different tyres
- Braking tests (wheeled tractors only)
- Centre of gravity
- External noise level (wheeled tractors only)
- Fuel consumption at varying drawbar loads
- Additional hydraulic power tests

- Low temperature starting test
- Noise level at the driving position(s) according to OECD Code 5
- Reagent consumption measurement during power take-off and drawbar power testing
- repeats of any of the compulsory or optional tests at different settings.
- ten-hour test (ballasted tractors)
- turning area and turning circle
- waterproofing test

It is possible for the manufacturer to append to the report other tests performed according to internationally recognised methods. If such tests are reported, it must be clearly indicated that they have not been subject to the OECD approval procedure. The test methods need to be mentioned in the report and made available to the OECD in a published form in either of the official languages of the organisation.

6

General rules and directions for tests

Selection of tractor and manufacturer's instructions

A tractor submitted for testing shall be taken 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 done, the testing station must certify in the report that it has checked that the series production conforms to the tested tractor.

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

The manufacturer may make adjustments in conformity with the specifications during the period prior to testing. These adjustments shall not be changed during the test.

Once the test has started the tractor shall never be operated in a way that is not in accordance with the manufacturers published instructions in the form of an operating handbook unless specifically required by test criteria and then only by arrangement 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 possible because of conditions of altitude, a modified injection pump setting may have to be used. Stable operating conditions must have been attained at each load setting before beginning test measurements.

Fuels and lubricants shall be selected from the range of products commercially available in the country where the equipment 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 P.T.O 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 current 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 (P.T.O.) test is the first compulsory test for Code 2 and is used for the measurements of the following parameters:

- **Engine speed, P.T.O. speed and Fan speed (min^{-1})**
- **Torque at the P.T.O. (Nm)**
- **Fuel consumption (kg/h), hourly consumption (l/h)**
- **Fuel temperature ($^{\circ}\text{C}$)** at a suitable point between the tank and the engine;
- **Oil temperature ($^{\circ}\text{C}$)** at a suitable point in the oil flow;
- **Coolant temperature ($^{\circ}\text{C}$)** 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 ($^{\circ}\text{C}$)** 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 $^{\circ}\text{C}$.
- Atmospheric pressure shall not (except in some case of altitude) be less than 96.6 kPa, and the relative humidity must be recorded.
- The maximum temperature of oil, coolant and fuel must be recorded.

Those particular conditions prevent excessive influence upon engine performance and give the possibility to achieve results which are comparable

among all the testing stations.

As instrumentation 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. In order to obtain more precise results, the fuel is supplied by an external tank.



Figure 5: Dynamometer for Power-Take-Off (P.T.O.) measurements

When a laboratory verifies the data, there can be a discrepancy between the declared power by the manufacturer for engine “flywheel” power output, and the real value obtained at the P.T.O. shaft. This is more evident in modern tractors, where the electrical devices and instrumentations used by the operator (cooling fans, hydraulic suspension pumps, air conditioning systems, etc.) will cause a significant loss in power of the engine before such power is transmitted to the P.T.O. shaft. Taking into consideration that there is also a loss in power due to normal driveline from the engine to the P.T.O., as an hypothetical maximum power transmission at the tractors P.T.O., it is possible to assume a value of 90% – 95 % of the manufacturer declared “rated” engine power. It is important to note that Code 2 verifies, for example, the maximum power at rated engine speed at the main power take-off, and not to 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	EU 2016/1628	ECE R 24	OECD Tractor Code 2	
		ECE R 120				
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 according 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 with Selective Catalytic Reduction (SCR) and/or Diesel Particulate Filter (DPF). For tractors with SCR systems the reagent consumption and at tractors with DPF the time of regeneration and the additional fuel consumption are measured under the manufacturers request.

The Code 2 P.T.O. tests require different results and in all of them the torque, engine speed, hourly fuel consumption, and hourly reagent consumption shall be recorded.

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

1. Maximum power test

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

2. Test at full load and varying speed

The test shall go down to 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 governor control is set for maximum power:

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

This test starts with the torque corresponding to maximum power at the two engine speeds mentioned above. During the test, the torque will be reduced to certain constant measurement points and the engine speed and the corresponding fuel and reagent consumption (if applicable) is measured. For the last measurement, the tractor is disconnected from the brake or the torque control is 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 establish fuel consumption and reagent consumption (if applicable) figures and a diagram, which characterises the engine itself.

Table 2: Extra points (part load points) measured at the P.T.O.

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 shall be described and the main power take-off shall be, if possible, repeated in each of these operating modes in order 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 is the hydraulic lift.

The hydraulic power measures the tractors' ability to produce hydraulic power, as would be 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 shall be 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 this maximum pressure is recorded, enabling calculation of maximum hydraulic power availability.

This kind of tests may be repeated using also more pair of couplers simultaneously if available and if a single coupler may limit maximum flow rate. All those tests are performed without a return pressure. Anyway can be performed supplementary tests with a return of pressure via coupler pair, as it would often be the case in normal use.

It is possible to perform supplementary tests in order to provide additional information relative to the hydraulic system performance characteristics.

The second part of the hydraulic test is the hydraulic lift. This test shows the tractors' hydraulic lift capacity throughout the entire range of linkage movement. It is possible to do a complete measurement of the geometry of the three-point (3pt) linkage. For the measurement, the linkage shall be adjusted in accordance with the tables in ISO 730: 2009/Amd.1:2014, or at the maximum achievable power range.

The real capacity to lift depends not only to the mass of the implement, but also to the Centre of Gravity (Centre of Mass) and the linkage geometry. To eliminate the influence of the deformation of the wheels during the lifting test, the chassis is supported with bearings. To equilibrate the whole tractor, it is additionally fastened to the ground (Figure 6).



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

The results must be checked at the lift at the lower hitch points and on a coupled frame attached to the lower and upper (top) links, 610 mm behind the lower link attachment points (Figure 7); measuring the height of lower hitch points above ground in down position and the vertical movement, both with and without lifting force. The maximum tilt angle of mast from vertical should be not less than 10° and the value of the lifting forces measured at various points throughout the lift range is correspond to a hydraulic pressure equivalent to 90% of actual relief valve pressure setting of the hydraulic lift system.



Figure 7: Composition for hydraulic lift measurement at the lower hitch points (l.). Frame for lower and upper links (r.)

For both the hydraulic power test and for the hydraulic lift, it is possible to perform supplementary tests at the manufacturers request in order to test different linkage conditions.

9

Drawbar power and fuel consumption

The third compulsory test is the drawbar power and fuel consumption tests. These tests show the ability of the tractor to use engine power not only for the P.T.O. (first compulsory test), but also for the drawbar pull.

During the drawbar power test, the governor control shall be set at maximum power. The test shall be made at least in gears/speed settings, 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 the case of tractors with a continuously variable transmission, instead of different gears with fixed ratios, at least 7 evenly spaced forward speeds/ratios shall be selected in order to obtain results in the range 2.5 km/h to 17.5 km/h.

In the case of wheeled tractors performance values only up to 15% mean wheel slip, and in case of track-laying tractors performance values only up to 7 % mean trackslip shall be reported.

The test shall be performed on a concrete or asphalt track. This is not a typical surface in agricultural work, but it gives a comparable test procedure and provides results without the variability of different surface conditions.

To perform the test the accredited testing stations use a specific truck (or other modified vehicle) with a dynamometer that applies a controlled braking force to the load truck wheels (Figure 8). Like the P.T.O. test, the load truck is equipped with a fuel tank to supply the tested tractor.



Figure 8: Specific truck for the compulsory drawbar test

A moving track (chassis dynamometer) can also be used, subject to the condition that the results are comparable to those obtained on the surfaces mentioned above.



Figure 9: Chassis dynamometer for drawbar measurements

The tractors drawbar power is calculated out of the drawbar pull and the vehicle forward speed reached.

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

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

Fuel consumption will be measured in two gear/speed settings typically used for fieldwork. One shall have a nominal speed of 7.5 km/h (or a gear / speed setting giving a nominal speed nearest to that target) and the other giving a nominal speed between 7 and 10 km/h, chosen by the manufacturer in agreement with the testing station. If such a gear/speed setting is not available, the nearest available gear/speed setting shall be chosen even though the speed may be less than 7 km/h or more than 10 km/h.

Measurements must be recorded according to the following test configurations:

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

10 Presenting results

The Power take-off Power and the Drawbar Power test results must allow the following graphical presentations to be plotted.

Power take-off Power test

- 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).

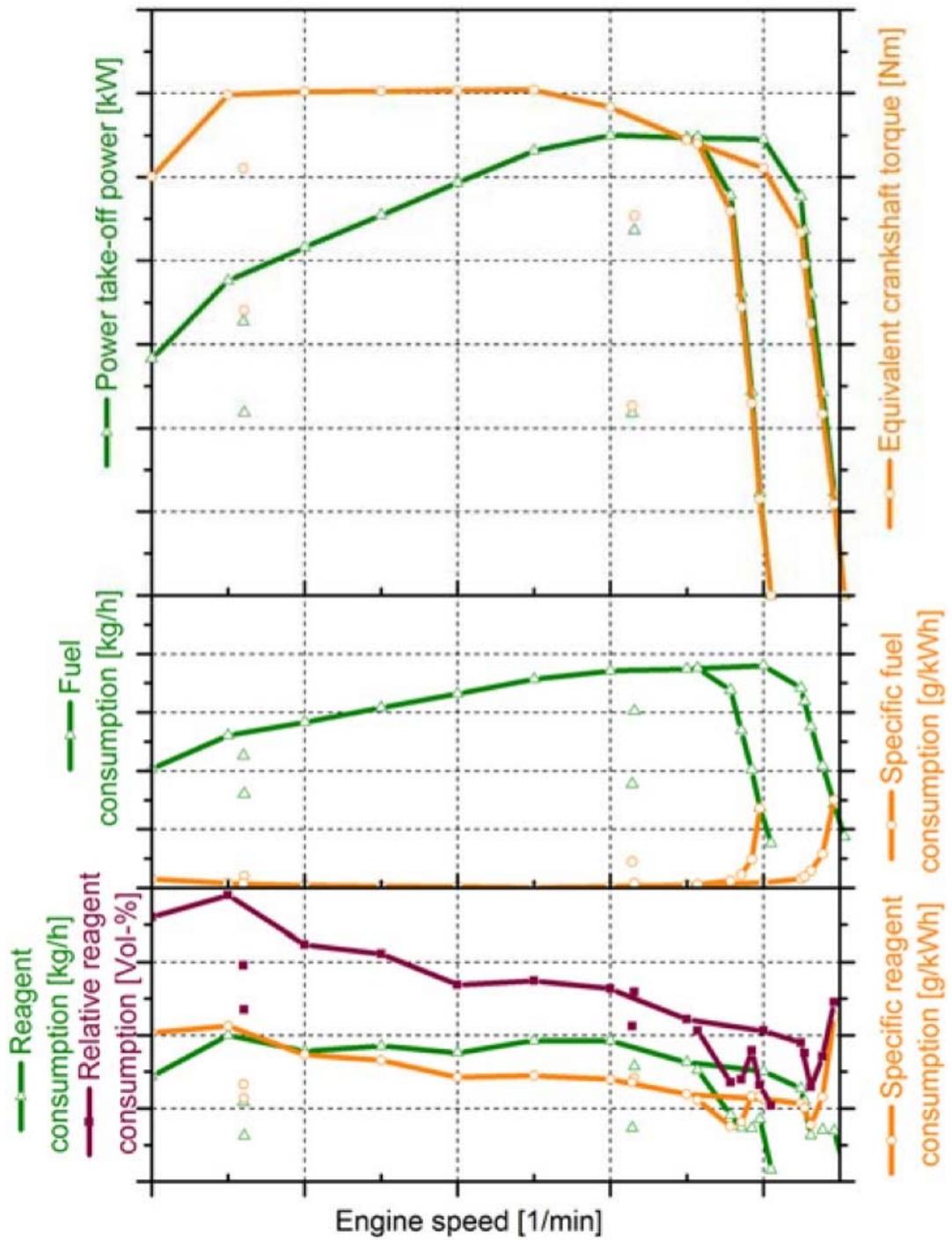


Figure 10: Graphical presentation of the P.T.O. test results

Drawbar Power test

- **Standard graphical presentation**

A table with the following results shall be presented in the 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 must be 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).

Interpretation of the results measured in a Power Take-Off Power test

The figure below is an example of the engine characteristic of a tractor with governor control set for maximum power (Figure 11). The green curve shows the course of the power, while the orange curve shows the course of the measured torque.

The percentage difference between the torque at rated speed and the maximum torque is named torque rise. The higher this value is, the better the engine can compensate load peaks without the need to shift down.

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

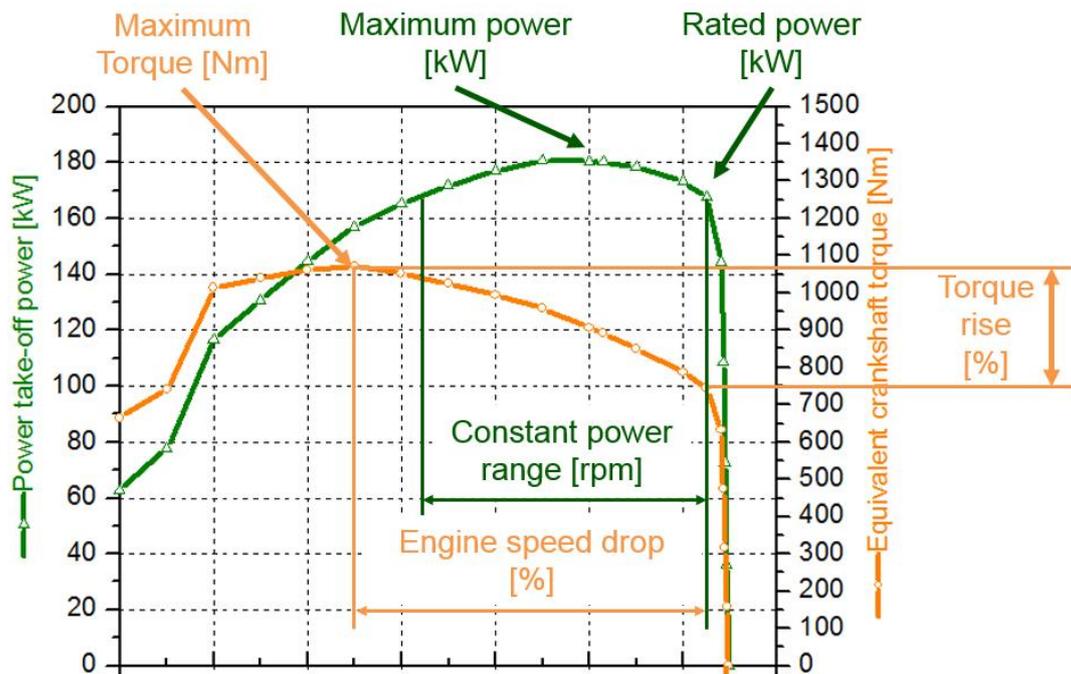


Figure 11: Engine characteristic of a tractor

In the figure below, the part load points (extra points) are diagrammed (Figure 12). These are chosen points within the performance chart of the engine which demonstrate the torque and the power the engine is able to provide in these load cases. These are indications of the engines' behaviour when using, for example, light implements which do not take advantage of the full engine power.

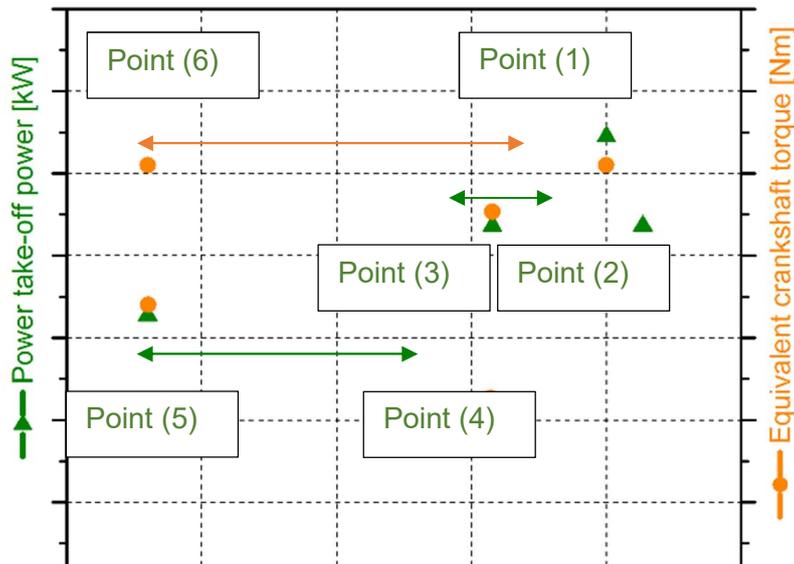


Figure 12: Part load points of a P.T.O. test

There are relations between the measured results. Point (2) and (3) and point (4) and (5) are strongly related in respect to the supplied power. The only difference is the reduced engine speed in point (3) and (5) and as an outcome the decreased fuel consumption. Without any negative influences, the farmer can do his work with less fuel consumption. In point (1) and (6) the delivered torque is comparable.

Interpretation of the results measured in a Drawbar Power test

The figure below shows examples for the measured values at different part load points of the drawbar test (Figure 13). The highlighted values show it is possible to decrease the fuel consumption by selecting a higher gear speed setting. If the engine pursues a higher speed which is not possible 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 even though the same work is 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 consumption g/kWh	Specific energy kWh/dm ³	Specific reagent consumption 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 ; same pull and travelling speed as in 3.3.2.1.1									
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 in 3.3.2.1.1									
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 ; same pull and travelling speed as in 3.3.2.2.1									
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 3.3.2.2.1									
11	166.2	61.78	9.69	1456	747	1.3	240	3.46	27.19

Figure 13: 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 each tractor approved under OECD Code 2 and their possible distribution remain the testing stations responsibility, the OECD gives the opportunity to download a summary report of them.

With the manufacturer and Testing Station agreement, it is possible to consult Code 2 main results at <http://www.oecd.org/agriculture/tractors/>.

A search on tractors is possible using the following criteria:

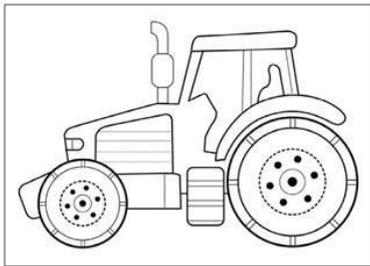
- select a Make (or all)
- select a Range of Power (or all)
- select an OECD Approval Number.

Once the results are obtained, it is possible to download the full results of P.T.O. test, an .xls (excel) file, and a summary report with the main results of the compulsory tests (.pdf file).

This summary report is publicly available and can be viewed and downloaded by all. The file appearance is more or less similar to the following example. (The data used as an example 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



Make	Model - Type	OECD approval number
SPECIFICATIONS		

ENGINE		

<i>Make</i>		x
<i>Model</i>		x
<i>Type</i>		x
<i>Supercharging</i>		Yes/No
<i>Cylinders</i>		x
<i>Disposition</i>		x
<i>Capacity</i>		cm ³
<i>Cooling</i>		x

TRANSMISSION		

<i>Gear box</i>		x
<i>Number of forward and reverse speeds</i>	xx	xx
<i>Speed at rated engine speed</i>	from xxx	to xxxx km/h

POWER TAKE-OFF SPECIFICATIONS		

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



[Page 1/6]

Testing Station Logo



[Page 2/6]

Testing Station Logo

Figure 14: Pages 1 and 2 of an OECD Code 2 abstract: Tractor specifications

Figure 14 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 about 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 published.

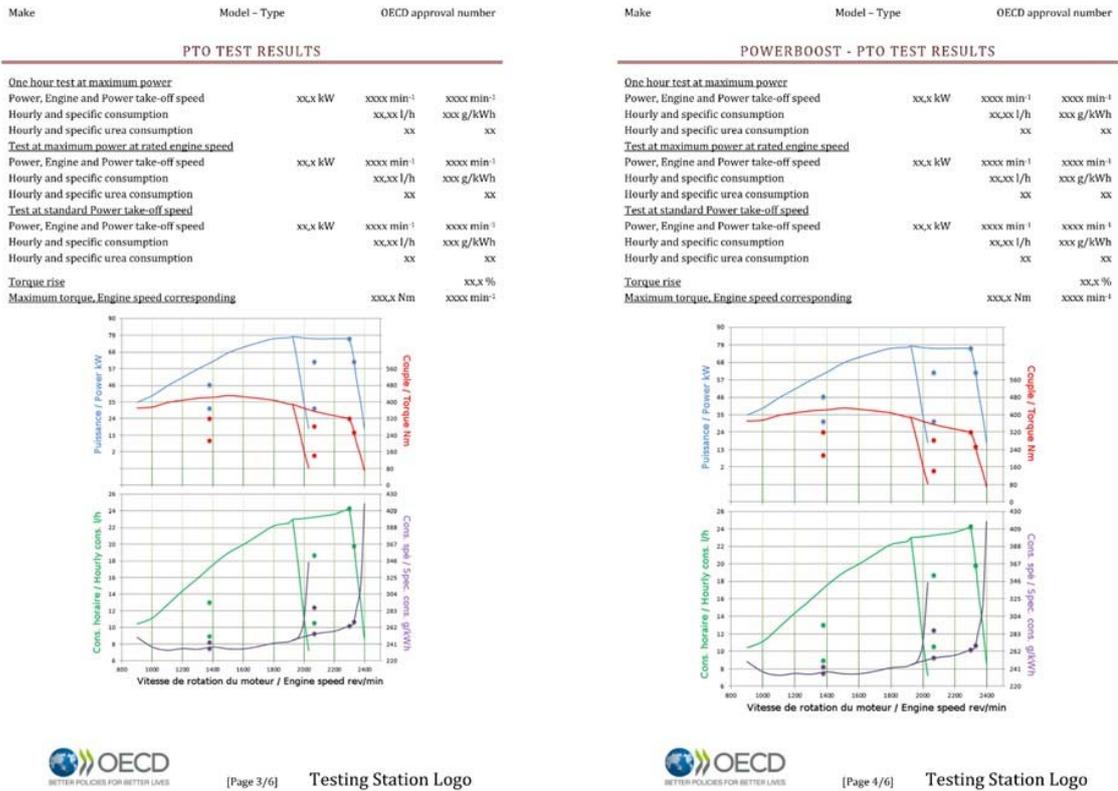


Figure 15: Pages 3 and 4 of an OECD Code 2 abstract: Main results of the P.T.O. tests

The second part of the abstract (Figure 15) is dedicated to the P.T.O. 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 P.T.O. 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 if this test has been undertaken.



Figure 16: Pages 5 and 6 of an OECD Code 2 abstract: hydraulic-, powerlift, and drawbar test results

The last part of the abstract (Figure 16) is dedicated to the particulate filter active regeneration fuel use, 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 ballasted.

The full P.T.O. test is also available for downloading on the OECD website. These data are very useful to check and consult the main results of the tractors.

An example of the full P.T.O. test report is reported in (Figure 17).

	Power Puissance kW	Engine speed Vitesse moteur min ⁻¹	PTO speed Vitesse PDF min ⁻¹	Torque Couple N.m	Hourly consumption Consommation horaire lh	Specific consumption Consommation spécifique g/kWh	Make & model Marque & modèle
Maximum power Puissance maximale							MAKE - MODEL (TYPE)
Maximum torque Couple maximal							OECD approval number Numéro d'approbation OCDE
							2/x xxx
A. Nominal speed Régime nominal							
B. 85% of torque obtained in A du couple obtenu en A.							
C. 75% of torque defined in B du couple défini en B							
D. 50% of torque defined in B du couple défini en B							
E. 25% of torque defined in B du couple défini en B							
F. Unloaded A vide							
G. Standard PTO speed Régime normalisé PDF							
H. 85% of torque obtained in G du couple obtenu en G							
I. 75% of torque defined in H du couple défini en H							
J. 50% of torque defined in H du couple défini en H							
K. 25% of torque defined in H du couple défini en H							
L. Unloaded A vide							
M. Nominal speed Régime nominal							
N. 80% of power obtained in M. de la puissance obtenue en M.							
O. 80% of power obtained in M. with governor control set to 90% of rated engine speed de la puissance obtenue en M. commande du régulateur réglée sur 90% du régime nominal							
P. 40% of power obtained in M. with governor control set to 90% of rated engine speed de la puissance obtenue en M. commande du régulateur réglée sur 90% du régime nominal							
Q. 60% of power obtained in M. with governor control set to 60% of rated engine speed de la puissance obtenue en M. commande du régulateur réglée sur 60% du régime nominal							
R. 40% of power obtained in M. with governor control set to 60% of rated engine speed de la puissance obtenue en M. commande du régulateur réglée sur 60% du régime nominal							

Figure 17: Example for a full P.T.O. test report

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 taking into account of 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 P.T.O. 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 18).

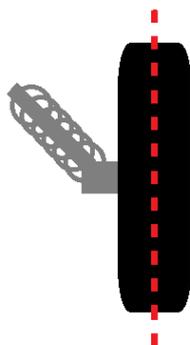


Figure 18: Median plane of the wheel

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 19).

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.

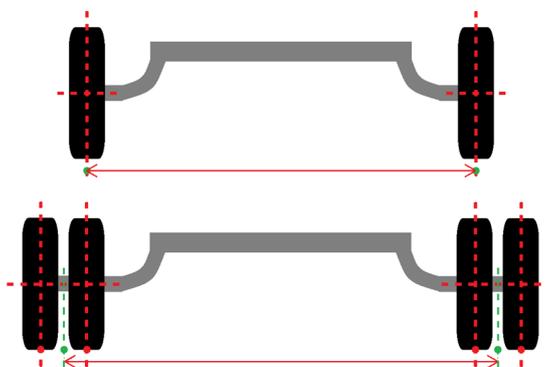


Figure 19: Definition of track

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:

$$\text{Wheel or track slip (\%)} = 100 \frac{N_1 - N_0}{N_1}$$

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