INTERNATIONAL STANDARD ISO 3046/III

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Reciprocating internal combustion engines : Performance — Part III : Test measurements

Moteurs alternatifs à combustion interne : Performances — Partie III : Mesures pour les essais

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FOREWORD

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 3046/III was developed by Technical Committee ISO/TC 70, *Internal combustion engines*, and was circulated to the member bodies in May 1977.

It has been approved by the member bodies of the following countries :

Australia	Italy	South Africa, Rep. of
Austria	Japan	Spain
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Bulgaria	Korea, Rep. of	Turkey
Chile	Mexico	United Kingdom
France	Netherlands	U.S.A.
Germany, F.R.*	Philippines	U.S.S.R.
India	Poland	Yugoslavia
Ireland	Romania	

* with the exception of clause 4.3.1, second paragraph.

The member bodies of the following countries expressed disapproval of the document on technical grounds :

Czechoslovakia
Denmark

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Reciprocating internal combustion engines : Performance — Part III : Test measurements

1 SCOPE

This International Standard summarizes the common techniques of measurement of the main parameters of reciprocating internal combustion engines to ensure the required precision in measurements. Where necessary, individual requirements may be given for particular engine applications.

2 FIELD OF APPLICATION

This International Standard applies to reciprocating internal combustion engines for land, rail-traction and marine use, excluding engines used to propel road construction and earth-moving machines, agricultural and industrial types of tractors, automobiles and trucks and aero-engines.

3 REFERENCES

ISO 3046/I, *Reciprocating internal combustion engines : Performance — Part I : Standard reference conditions and declarations of power, fuel consumption and lubricating oil consumption.*

ISO 3046/II, *Reciprocating internal combustion engines : Performance — Part II : Test methods.*

ISO 3046/IV, *Reciprocating internal combustion engines : Performance — Part IV : Speed governing.*

4 MEASUREMENT CONDITIONS AND DEFINITIONS OF DEGREE OF ACCURACY

4.1 Operating conditions

4.1.1 Before a set of measurements is commenced, the engine shall have operated at the particular conditions of load and rotational frequency (speed) for a sufficient length of time to ensure that the operating temperatures have reached stable conditions as laid down by the manufacturer.

4.1.2 During the period in which a set of measurements is being made, the load, rotational frequency (speed) and all fluid temperatures and pressures shall be maintained constant within the limits of accuracy of measurement given in clause 5, column 6 of this International Standard.

4.2 Methods of measurement

4.2.1 Methods of measurement are selected by the manufacturer and, if necessary, may be subject to contractual agreement between the manufacturer, customer and/or inspecting authority.

4.2.2 The location of points of measurement is selected by the manufacturer.

4.3 Accuracy of measurement

4.3.1 The accuracy of measurement indicated in column 6 of clause 5 of this International Standard applies only to the power declared in the contract, and not only includes the accuracy of the instrument being used but also involves the correctness of its location, the conditions under which it is being used, and the interpretation of the results obtained.

Where the total accuracy involves measurements of a number of quantities, each with its own accuracy, or where an individual measurement is dependent on several parameters, each with its own accuracy, the overall accuracy is taken as the square root of the sum of the squares of the separate accuracies, each multiplied by an appropriate factor equal to the exponent of its parameter in the formulae.

4.3.2 The accuracy quoted is that considered adequate for most acceptance test purposes. Manufacturers may adopt greater accuracy of measurement :

a) for type tests;
b) for special contractual or legislative requirements.

Where measurements are used in subsequent calculations, accuracies other than those specified for the measured parameters may be chosen to achieve the specified accuracy of the final calculated parameters.

4.3.3 The degree of accuracy assumes that the instruments selected are operating within their range of maximum accuracy.

4.3.4 All measuring instruments and apparatus used during tests shall be checked and calibrated over the range of the expected readings.

4.3.5 Hydraulic brakes, electric dynamometers or other similar appliances for measurement of torque should be statically calibrated by suspending weights on a lever arm of constant length or by other suitable methods.

Electric dynamometers shall be calibrated for both "brake" and "motoring" positions.

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5 LIST OF PARAMETERS

No.	Parameter	Definition	Symbol	Unit	Accuracy
1	2	3	4	5	6
5.1	**General parameters**				
5.1.1	Engine torque[1]	Mean torque measured at the engine driving shaft extremity	T_{tq}	kN·m	± 2 %
5.1.2	Rotational frequency of engine (engine speed)	The number of revolutions of the crankshaft in a given period of time	n	s^{-1} r/min	± 2 %
5.1.3	Rotational frequency of engine driving shaft (engine driving shaft speed)	The number of revolutions of the engine driving shaft in a given period of time	n_d	s^{-1} r/min	± 2 %
5.1.4	Brake power[3]	The power or sum of the powers measured at the driving shaft or shafts	P_e	kW	± 3 %
5.2	**Pressures**[4][5]				
5.2.1	Barometric pressure[6]		p_a	kPa	± 0,5 %
5.2.2	Compression pressure in a cylinder[7]	Maximum pressure in a cylinder at momentary fuel cut-off	p_c	kPa	± 5 %
5.2.3	Maximum pressure in a cylinder[7]	Maximum combustion pressure in a cylinder	p_{max}	kPa	± 5 %
5.2.4	Air pressure at the engine or pressure charger inlet				
5.2.4.1	Depression at engine or pressure charger inlet		Δp_k	kPa	± 5 %
5.2.4.2	Absolute pressure at engine or pressure charger inlet		p_k	kPa	± 1 %
5.2.5	Charge air pressure after a pressure charger		p_b	kPa	± 2 %
5.2.6	Boost pressure after the air cooler	Mean pressure before the engine inlet	p_{int}	kPa	± 2 %
5.2.7	Charge air pressure drop in the air cooler		Δp_{int}	kPa	± 10 %
5.2.8	Exhaust gas pressure at the inlet to the turbocharger or other exhaust gas assisted pressure charger (valid only for engines with a constant pressure system)	Mean pressure in the exhaust pipe before the turbine	p_{g1}	kPa	± 5 %
5.2.9	Exhaust gas pressure in the exhaust pipe	Mean pressure in the exhaust manifold or after the pressure charger	p_{g2}	kPa	± 5 %
5.2.10	Coolant pressure	Pressure at given points of the fluid cooling system	p_{cool}	kPa	± 5 %
5.2.11	Lubricating oil pressure	Oil pressure at given points of the lubricating system (in individual circuits before and after filters, coolers, etc.)	p_o	kPa	± 5 %
5.2.12	Fuel pressure	Mean fuel pressure after the fuel supply pump	p_f	kPa	± 10 %

1) Measured by hydraulic brake, electric dynamometer or other similar arrangements.

2) Measured by a tachometer, revolution counter or tachoscope.

3) Calculated from measured values of torque and rotational frequency of engine driving shaft (speed).

4) The accuracy of each pressure (except the pressure in 5.2.1 and 5.2.4.2) is given as a percentage of the gauge pressure.

5) The unit bar may be used instead of kPa.

6) Measured by spring-loaded or fluid-type barometers.

7) Measured by a recording maximum pressure gauge, mechanical indicator or from an indicator diagram.

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List of parameters (*continued*)

1	2	3	4	5	6
5.3	**Temperatures**[1) 2)]				
5.3.1	Air temperature at the engine or pressure charger inlet (ambient temperature)		T_a	K	± 2 K
5.3.2	Charge air temperature after the pressure charger		T_b	K	± 4 K
5.3.3	Charge air temperature after the cooler	Air temperature before the engine intake	T_{int}	K	± 4 K
5.3.4	Exhaust gas temperature at the cylinder outlet	Mean temperature of the thermal pick-up	T_g	K	± 25 K
5.3.5	Exhaust gas temperature at the inlet to the turbocharger or other exhaust gas assisted pressure charger	Mean temperature of the thermal pick-up	T_{g1}	K	± 25 K
5.3.6	Exhaust gas temperature in the outlet pipe or after turbo-charger or other exhaust gas assisted pressure charger	Mean temperature of the thermal pick-up	T_{g2}	K	± 15 K
5.3.7	Coolant temperature	Temperature(s) at given point(s) of the fluid cooling system(s)	T_{cool}	K	± 2 K
5.3.8	Lubricating oil temperature	Oil temperature(s) at given point(s) of the lubricating system(s)	T_o	K	± 2 K
5.3.9	Fuel temperature	Fuel temperature at a given point of the fuel system	T_f	K	± 5 K
5.4	**Consumptions**[3)]				
5.4.1	Fuel consumption	The quantity of fuel consumed by the engine per unit of time	G_f	g/s kg/s kg/h	± 3 %
5.4.2	Specific fuel consumption	The fuel consumption per unit of power	g_f	g/kW·h g/MJ	± 3 %
5.4.3	Cylinder lubricating oil consumption	The quantity of cylinder oil supplied by the lubricator per unit of time	G_{cyl}	g/s kg/s kg/h	± 10 %
5.4.4	Specific consumption of cylinder oil	The lubricating cylinder oil consumption per unit of power	g_{cyl}	g/kW·h g/MJ	± 13 %
5.4.5	Circulating lubricating oil consumption	The quantity of circulating oil consumed per unit of time *by the engine, irrecoverably*	G_{cir}	g/s kg/s kg/h	± 10 %
5.4.6	Specific consumption of circulating lubricating oil	The circulating lubricating oil consumption per unit of power	g_{cir}	g/kW·h g/MJ	± 13 %
5.4.7	Air consumption	The quantity of air drawn into the engine from the atmosphere per unit of time	G_{air}	kg/s kg/h	± 5 %
5.4.8	Cooling fluid flow	The quantity of fluid flowing through the engine cooling system per unit of time	G_{cool}	kg/s kg/h	± 10 %
5.4.9	Lubricating oil flow	The quantity of oil flowing through the engine lubricating system per unit of time	G_o	kg/s kg/h	± 10 %

1) Measured by electrical methods (resistance thermometers or a thermocouple with measuring apparatus) or fluid-type thermometers.

2) The unit °C may be used instead of K.

3) Consumptions are measured by mass or volume methods, by determining the time during which a given quantity of fluid is consumed, using normal pressure differential systems or other types of flowmeter.

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List of parameters (*concluded*)

1	2	3	4	5	6
5.5	**Exhaust gas emission characteristics**				
5.5.1	Smoke index[1]	Filter soiling (expressed as function of light reflectivity) by undiluted gas[2]	r	Smoke number	± 0,3 in a scale of 10 units[3]
5.5.2	Smoke opacity[1]	a) Light obscurement by undiluted gas[4]	N	%	± 5 %
		b) Coefficient of light absorption[5]	k	m^{-1}	± 5 %
5.5.3	Soot content	Gravimetric carbon concentration[6]	C	g/m^3	± 10 %
5.5.4	Gaseous emission composition[7]	Volumetric concentration of gaseous components	c_i[8]	% or ppm	AMC[9]
5.5.5	Emission rate[10]	Mass of each component emitted in unit of time	E_i[8]	g/h	AMC[9]
5.5.6	Specific emission	Emission rate per unit of power	e_i[8]	g/kW·h	AMC[9]

1) The engine manufacturer may select either parameter for the measurement indicated in 5.5.1 or 5.5.2 according to the facilities available.

2) Measured by passing a known volume of gas through a specified area of (white) filter paper and determining the reduction in light reflected from the filter.

3) For automatic continuous measurement, the accuracy in 5.5.1 may be ± 0,6 on a scale of 10 units.

4) Measured over the entire cross-section of the exhaust plume close to the point of exit from the exhaust pipe or over a defined length of the smoke column, the linear dimension in each case being denoted by L, expressed in metres.

5) The value k is given by the equation :

$$k = \frac{-1}{L} \log_e \left(1 - \frac{N}{100}\right)$$

where N is the reading of smoke opacity on a linear scale from 0 to 100 units.

6) Measured by the increase in mass of a filter through which a known volume of undiluted exhaust gas has been passed and corrected to standard temperature and pressure.

7) Measured by chemical or physical methods appropriate to each component (and/or its concentration).

8) "i" is the suffix of an individual component of the exhaust gas.

9) AMC represents "by Agreement between Manufacturer and Customer".

10) Calculated from emission concentration measurement and calculated rate of exhaust gas flow.

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