BS ISO 15550:2016

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Internal combustion engines — Determination and method for the measurement of engine power — General requirements

bsi.

National foreword

This British Standard is the UK implementation of ISO 15550:2016. It supersedes BS ISO 15550:2002 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee MCE/14, RIC engines.

A list of organizations represented on this committee can be obtained on request to its secretary.

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Internal combustion engines — Determination and method for the measurement of engine power — General requirements

Moteurs à combustion interne — Détermination et méthode de mesure de la puissance du moteur — Exigences générales

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 70, *Internal combustion engines*.

This second edition cancels and replaces the first edition (ISO 15550:2002), of which it constitutes a minor revision.

Introduction

This document establishes the framework for ISO engine power measurement standards. By applying this framework, the disadvantages of the existence of many similar, but different, ISO standards for the definition and determination of engine power can be avoided.

This framework uses the "Core" and "Satellite" approach. The "Core" standard contains the requirements that are common to all engine applications described in the scope and the "Satellite" standard contains those requirements that are necessary to tailor power measurement and declaration to suit a particular engine application.

This document is only applicable in conjunction with a particular "Satellite" standard in order to completely specify the requirements for the particular engine application. The "Core" standard, therefore, is not a document that can stand alone, but only represents addenda to a particular "Satellite" standard used to create a complete standard together with the said "Satellite" standard.

The advantage of this approach is that the use of standards for the same or similar engines used in different applications will be rationalized and the harmonization of standards in the course of revision or development will be ensured.

This document is the "Core" standard.

This document was prepared in order to serve as the "Core" standard for making engine power measurements. It was drafted in close co-operation with technical committees ISO/TC 22 *Road vehicles*, ISO/TC 23 *Machinery for forestry and agriculture*, ISO/TC 127 *Earth moving machinery* and ISO/TC 188 *Small craft*. The prerequisite for any future modification of this document will be the formal approval of all the above technical committees. Together with the "Satellite" standard for each engine application, the "Core" standard serves as the basis for engine power declaration and measurement. Each technical committee is fully responsible for the administration of its own "Satellite" standard(s).

Any further requirements are subject to agreement between the manufacturer and customer.

INTERNATIONAL STANDARD ISO 15550:2016(E)

Internal combustion engines — Determination and method for the measurement of engine power — General requirements

1 Scope

1.1 This document specifies standard reference conditions and methods of declaring the power, fuel consumption, lubricating oil consumption and test methods for internal combustion engines in commercial production using liquid or gaseous fuels. It is applicable to the following:

a) reciprocating internal combustion (RIC) engines (spark-ignition or compression-ignition engines) but excluding free piston engines;

b) rotary piston engines.

These engines can be naturally aspirated or pressure-charged either using a mechanical pressure-charger or turbocharger.

1.2 This document is applicable to engines used for the following:

a) land, rail-traction and marine use as defined in ISO 3046-1;

b) the propulsion of automotive vehicles as defined in ISO 1585 and ISO 2534;

c) motorcycles as defined in ISO 4106;

d) the propulsion of agricultural tractors and machines

e) the propulsion of earth-moving machinery as defined in ISO 9249;

f) the propulsion of recreational craft or other small marine craft up to 24 m hull length as defined in ISO 8665.

This document can be applied to engines used to propel road construction machines, industrial trucks and for other applications where no suitable International Standard for these engines exists.

It also can be applied to tests performed both on a test bed at a manufacturer's works as well as on site.

2 Normative references

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

ISO 2710-1, *Reciprocating internal combustion engines — Vocabulary — Part 1: Terms for engine design and operation*

ISO 3046-4, *Reciprocating internal combustion engines — Performance — Part 4: Speed governing*

ISO 3046-5, *Reciprocating internal combustion engines — Performance — Part 5: Torsional vibrations*

ISO 3046-6, *Reciprocating internal combustion engines — Performance — Part 6: Overspeed protection*

ISO 3104, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 5163, *Petroleum products — Determination of knock characteristics of motor and aviation fuels — Motor method*

ISO 5164, *Petroleum products — Determination of knock characteristics of motor fuels — Research method*

ISO 5165, *Petroleum products — Determination of the ignition quality of diesel fuels — Cetane engine method*

ISO 11614, *Reciprocating internal combustion compression-ignition engines — Apparatus for measurement of the opacity and for determination of the light absorption coefficient of exhaust gas*

ASTM D 240, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter*

ASTM D 3338/D 3338M, *Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 2710-1, ISO 3046-4, ISO 7876-1 and the following apply.

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

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 Auxiliaries and equipment

3.1.1
dependant auxiliary
item of equipment, the presence or absence of which affects the final shaft power output of the engine

3.1.2
independent auxiliary
item of equipment that uses power supplied from a source other than the engine

3.1.3
essential auxiliary
item of equipment that is essential for the continued or repeated operation of the engine

3.1.4
non-essential auxiliary
item of equipment that is not essential for the continued or repeated operation of the engine

3.1.5
standard production equipment
SPE
equipment specified by the manufacturer for a particular engine application that is fitted as standard to the engine

3.2 Engine

3.2.1
engine adjustment
physical procedure of modifying an engine for the purpose of adapting it to deliver a power adjusted to a different set of ambient conditions, such as by moving the limiting fuel stop, re-matching the turbocharger, changing the fuel injection timing or other physical changes

Note 1 to entry: Once the modifications have been completed, the engine is an adjusted engine.

3.2.2
non-adjusted engine
engine which is pre-set so that no physical procedure of modifying the engine for the purpose of adapting it to a different set of ambient conditions is carried out

3.2.3
engine speed
number of revolutions of the crankshaft in a given period of time

[SOURCE: ISO 2710-1:2000, 11.1]

3.2.4
declared engine speed
engine speed corresponding to the *declared power* (3.3.1)

[SOURCE: ISO 2710-1:2000, 11.1.2 — modified]

Note 1 to entry: In some applications, the declared engine speed is named “rated speed”.

3.2.5
declared intermediate engine speed
engine speed less than 100 % of the declared speed, declared by the manufacturer taking into account the specific requirement defined in the relevant “Satellite” standard

3.2.6
low idle engine speed
idling speed
lowest steady-state engine speed without load

[SOURCE: ISO 2710-1:2000, 11.1.4 — modified]

3.2.7
engine speed at maximum torque
engine speed at maximum torque on maximum fuel stop, including additional torque fuel setting, if applicable

[SOURCE: ISO 3046-4:2009, 2.3.13 — modified]

3.3 Power and load

3.3.1
declared power
value of the power, declared by the manufacturer, which an engine will deliver under a given set of circumstances

Note 1 to entry: In some applications, the declared power is named “rated power”.

3.3.1.1
declared propeller shaft power
value of the power, declared by the manufacturer, at the propeller shaft of an engine sold with complete propulsion units or at the coupling to the propeller shaft of an engine sold with reduction and/or reversing gears

3.3.1.2
declared crankshaft power
value of the power, declared by the manufacturer, at the engine power output shaft of an engine sold without reduction or reversing gears, stern drives or sail drive units

3.3.2
indicated power
total power developed in the working cylinders as a result of the pressure of the working medium acting on the pistons

[SOURCE: ISO 2710-1:2000, 13.1]

3.3.3
brake power
power or the sum of the powers delivered at the end of the crankshaft or its equivalent, with the equipment and auxiliaries fitted as required by the relevant "Satellite" standard

Note 1 to entry: See Table 1.

Table 1 — Equipment and auxiliaries to be installed for the test to determine engine power

1	2	3	4	5
No.	Equipment and auxiliaries	Fitted for engine net power test in accordance with ISO 1585 ISO 8665 ISO 9249 ISO 4106	Fitted for engine gross power test in accordance with ISO 2534	Fitted for engine power test in accordance with ISO 14396
1	Inlet system: Inlet manifold	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Crankcase emission control system	Yes, if SPE	Optional	Yes, if SPE
	Control devices for dual induction	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Inlet manifold system: Air flow meter	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Air inlet ductwork	Yes, if SPE[a]	Optional[a]	Yes[a]
	Air filter	Yes, if SPE[a]	Optional[a]	Yes[a]
	Inlet silencer	Yes, if SPE[a]	Optional[a]	Yes[a]
	Speed-limiting device	Yes, if SPE[a]	No	Yes[a]
2	Induction-heating device of inlet manifold	Yes, if SPE. If possible, to be set in the most favourable condition.		
3	Exhaust system: Exhaust purifier	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Exhaust manifold	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Pressure-charging device	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Connecting pipes	Yes, if SPE[b]	Optional, may use minimum loss test bed system[b]	Yes[b]
	Silencer	Yes, if SPE[b]		Yes[b]
	Tail pipe	Yes, if SPE[b]		Yes[b]
	Exhaust brake	Yes, if SPE[c]	No[c]	No[c]
4	Fuel supply pump	Yes, if SPE[d]	Yes, if SPE[d]	Yes, if SPE[d]
5	Carburation equipment: Carburettor	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Electronic control system, air flow meter, etc.	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Equipment for gas engines: Pressure reducer	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Evaporator	Yes, if SPE	Yes, if SPE	Yes, if SPE

Table 1 *(continued)*

	Mixer	Yes, if SPE	Yes, if SPE	Yes, if SPE
6	Fuel injection equipment [spark-ignition (petrol) and compression-ignition (diesel)]: Prefilter	Yes, if SPE	Optional	Yes, if SPE or test bed equipment
	Filter	Yes, if SPE	Optional	Yes, if SPE
	Fuel injection pump	Yes, if SPE	Yes, if SPE	Yes, if SPE
	High-pressure pipes	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Injector	Yes, if SPE	Yes, if SPE	Yes, if SPE[e]
	Air inlet valve	Yes, if SPE[e]	Yes, if SPE[e]	Yes, if SPE
	Electronic control system, air flow meter, etc.	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Governor/control system	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Automatic full-load stop for the control rack depending on atmospheric conditions	Yes, if SPE	Yes, if SPE	Yes, if SPE
7	Liquid-cooling equipment: Radiator	Yes, if SPE[f]	No	No
	Fan	Yes, if SPE[f,g]	No[f]	No
	Fan cowl	Yes, if SPE[f]	No	No
	Water pump	Yes, if SPE[f]	Yes, if SPE	Yes, if SPE[f]
	Thermostat	Yes, if SPE[f,h]	Optional[h]	Yes, if SPE[h]
8	Air cooling: Cowl	Yes, if SPE[f]	No	No
	Fan or blower	Yes, if SPE[f,g]	No[f]	No[i]
	Temperature-regulating device	Yes, if SPE	No	No
9	Electrical equipment: Generator	Yes, if SPE[j]	Yes, if SPE[j]	Yes, if SPE[j]
	Spark distribution system	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Coil or coils	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Wiring	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Spark-plugs	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Electronic control system including knock sensor/ spark-retard system	Yes, if SPE[k]	Yes, if SPE[k]	Yes, if SPE[k]
10	Pressure-charging equipment: Compressor driven either directly by the engine and/or by the exhaust gases:	Yes, if SPE	Yes, if SPE	Yes, if SPE
	Boost control	Yes, if SPE[l]	Yes, if SPE[l]	Yes, if SPE[l]
	Charge air cooler	Yes, if SPE[f,g,m]	Yes, if SPE[f,g,m]	Yes, if SPE, or test bed equipment[i,m]
	Coolant pump or fan (engine-driven)	Yes, if SPE	Yes, if SPE	No[i]
	Coolant flow control device	Yes, if SPE	Yes, if SPE	Yes, if SPE
11	Auxiliary test-bed fan	Yes, if necessary	Yes, if necessary	Yes, if necessary
12	Anti-pollution device	Yes, if SPE[n]	Yes, if SPE[n]	Yes, if SPE[n]
13	Lubricating oil pump	Yes, if SPE	Yes, if SPE	Yes, if SPE

Table 1 *(continued)*

NOTE "Yes, if SPE" means that this equipment shall be fitted for the engine power determination if it is Standard Production Equipment (SPE).

[a] — For net power/gross power test:

If used (for gross power test) and except in the case where there is a risk of the system having a noticeable influence upon engine power, an equivalent may be used. In this case, a check shall be made to ascertain that inlet depression does not differ by more than 100 Pa from the limit specified by the manufacturer for a clean air filter.

— For engine power test for ISO 8178:

The complete inlet system for the intended application shall be fitted

— where there is a risk of an appreciable effect on the engine power;

— in the case of naturally aspirated spark ignition engines;

— when the manufacturer requests that this should be done.

In other cases, an equivalent system may be used and a check shall be made to ascertain that the inlet pressure does not differ by more than 100 Pa from the upper limit specified by the manufacturer for a clean air filter.

[b] — For net power test:

Except in the case where there is a risk of the system having a noticeable influence upon engine power, an equivalent system may be used. In this case, a check shall be made to ascertain that the back-pressure in the engine exhaust system does not differ by more than 1 000 Pa from the upper limit specified by the manufacturer.

— For gross power test:

If used and except in the case where there is a risk of the system having a noticeable influence upon engine power, an equivalent system may be used. In this case, a check shall be made to ascertain that the back-pressure in the engine exhaust system does not differ by more than 1 000 Pa from that specified by the manufacturer. However, a minimum loss system may be used.

— For engine power test for ISO 8178:

The complete exhaust system for the intended application shall be fitted:

— where there is a risk of an appreciable effect on the engine power;

— in the case of naturally aspirated spark ignition engines;

— when the manufacturer requests that this should be done.

In other cases an equivalent system may be installed provided that the pressure measured does not differ by more than 1 000 Pa from the upper limit specified by the manufacturer.

[c] If an exhaust brake is incorporated in the engine, the throttle valve shall be fixed in the fully open position.

[d] If necessary, the fuel feed pressure may be adjusted to reproduce the fuel pressures existing in the particular engine application (particularly when a "fuel return" system, e.g. to tank or filter, is used).

[e] The air inlet valve is the control valve for the pneumatic governor of the injection pump. The governor or the fuel injection equipment may contain other devices which may affect the amount of fuel injected.

Table 1 *(continued)*

[f] — For net power test: The radiator, fan, fan cowl, water pump and thermostat shall be located on the test bed in the same relative positions that they are to occupy on the vehicle or machine. The cooling liquid circulation shall only be operated by the engine water pump. Cooling of the liquid may be provided either by the engine radiator or by an external circuit, provided that the pressure loss of this circuit and the pressure at the pump inlet remains substantially the same as those of the engine cooling system. The radiator shutter, if incorporated, shall be set in the open position. Where the fan, radiator and cowl system cannot conveniently be fitted to the engine, the power absorbed by the fan when separately mounted in its correct position in relation to the radiator and cowl (if used), shall be determined at the speeds corresponding to the engine speeds used for measurement of the engine power either by calculation from standard characteristics or by practical tests. This power, corrected to the standard atmospheric conditions defined in Clause 5, shall be deducted from the corrected power. — For gross power test: When the engine cooling fan or blower is of the fixed type, that is neither disconnectable nor progressive, and it is fitted for the test, then the power absorbed shall be added to the test results. The fan or blower power shall be determined at the speeds corresponding to the engine speeds used for the measurement of engine power either by calculation from standard characteristics or by practical tests. — For engine power test for ISO 8178: The cooling-liquid circulation shall only be operated by the engine pump. Cooling of the liquid may be produced by an external circuit, such that the pressure loss in this circuit and the pressure at the pump inlet remain substantially the same as those of the engine cooling system.
[g] — For net power test: Where a disconnectable or progressive fan or blower is incorporated, the test shall be performed with the fan or blower disconnected or with the progressive fan running at maximum slip. — For gross power test: Where a separate disconnectable or progressive fan or blower is incorporated for the charge air cooler, the test shall be performed with the disconnectable fan or blower disconnected or with the progressive fan running at maximum slip.

Table 1 *(continued)*

[h] The thermostat may be fixed in the fully open position.

[l] When the cooling fan or blower is fitted for the test, the power absorbed shall be added to the test results. The power absorbed by the fan or blower shall be determined at the speeds used for the test either by calculation from standard characteristics or by practical tests.

[j] The electrical power of the generator shall be the minimum. It shall be limited to that necessary for operation of accessories which are indispensable for engine operation. If the connection of a battery is necessary, a fully charged battery in good condition shall be used.

[k] The spark advance shall be representative of in-use conditions established with the minimum octane fuel recommended by the manufacturer.

[l] For engines equipped with variable boost as a function of charge or inlet air temperature, octane rating and/or engine speed, the boost pressure shall be representative of in-vehicle or in-machine conditions established with the minimum octane fuel as recommended by the manufacturer.

[m] — For net power test/gross power test:

Charge air-cooled engines shall be tested with the charge air-cooling system operating, whether this system is liquid- or air-cooled. If the engine manufacturer prefers, a test bed system may replace an air-cooled cooler. In either case the measurement of power at each speed shall be made with the pressure drop and temperature drop of the engine air across the charge air cooler in the test bed the same as those specified by the manufacturer for the system on the complete vehicle or machine.

— For engine power test for ISO 8178:

Charge air-cooled engines shall be tested with the charge air-cooling system operating, whether this system is liquid- or air-cooled. If the manufacturer prefers, a test bed system may replace an air-cooled cooler. In either case, the measurement of power at each speed shall be made with the maximum pressure drop and the minimum temperature drop of the engine air across the charge air-cooler in the test bed system the same as those specified by the manufacturer.

[n] These may include, e.g. Exhaust Gas Recirculation (EGR), catalytic converter, thermal reactor, secondary air-supply and fuel evaporation protection systems.

3.3.3.1
net power
power obtained on a test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the equipment and auxiliaries specified by ISO 1585, ISO 8665, ISO 9249 or ISO 4106

Note 1 to entry: If the power measurement can only be carried out with a mounted gear-box, the losses in the gear-box should be added to the measured power to give the net engine power.

3.3.3.2
gross power
power obtained on a test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the equipment and auxiliaries specified by ISO 2534

Note 1 to entry: If the power measurement can only be carried out with a mounted gear-box, the losses in the gear-box should be added to the measured power to give the gross engine power.

3.3.3.3
engine power for ISO 8178
power obtained on a test-bed at the end of the crank-shaft or its equivalent, at the *declared engine speed* (3.2.4) specified by the manufacturer at the *declared power* (3.3.1) with the engine being fitted only with the equipment and auxiliaries specified in ISO 14396

3.3.4
continuous power
power which an engine is capable of delivering continuously, between the normal maintenance intervals stated by the manufacturer, at the stated speed and under stated ambient conditions, the maintenance prescribed by the manufacturer having been carried out

3.3.5
overload power
power which an engine may be permitted to deliver, with a duration and frequency of use depending on the service application, at stated ambient conditions, immediately after operating at the *continuous power* (3.3.4) restricted to 1 h in a 12 h time span

3.3.6
fuel stop power
power which an engine is capable of delivering during a stated period corresponding to its application, and stated speed and under stated ambient conditions, with the fuel limited so that this power cannot be exceeded

3.3.7
ISO power
power determined under the operating conditions of the manufacturer's test bed and adjusted or corrected as determined by the manufacturer to the standard reference conditions specified in ISO 14396

3.3.7.1
ISO standard power
continuous *brake power* (3.3.3) that the engine manufacturer declares that an engine is capable of delivering with only the essential dependent auxiliaries fitted, between the normal maintenance intervals as stated by the manufacturer, and under the following conditions:

a) at a stated speed at the operating conditions of the engine manufacturer's test bed;

b) with the *declared power* (3.3.1) adjusted or corrected as determined by the manufacturer to the standard reference conditions specified in ISO 14396;

c) with the maintenance prescribed by the engine manufacturer having been carried out.

3.3.8
service power
power delivered under the ambient and operating conditions of an engine application

3.3.8.1
service standard power
continuous *declared power* (3.3.1) that the engine manufacturer declares that an engine is capable of delivering, with only the essential dependent auxiliaries fitted, between the normal maintenance intervals stated by the manufacturer and under the following conditions:

a) at a stated speed at the ambient and operating conditions of the engine application;

b) with the *declared power* (3.3.1) adjusted or corrected as determined by the manufacturer to the stated ambient and operating conditions of the engine application;

c) with the maintenance prescribed by the engine manufacturer having been carried out.

3.3.9
power adjustment
calculation procedure by which a power value under one set of ambient conditions is modified to represent the power value expected under another set of ambient conditions, to maintain approximately constant thermal and/or mechanical load in critical engine components

3.3.10
power correction
calculation procedure by which a power value determined under engine test conditions is modified so that it represents the power value expected under other operating or reference conditions without any *engine adjustment* (3.2.1)

Note 1 to entry: In this case, the power and performance parameters may vary as a function of ambient conditions (see Clause 7).

3.3.11
load
general term describing the magnitude of the "power" or "torque" demanded from the engine by its driven machinery and usually expressed relative to a *declared power* (3.3.1) or torque

Note 1 to entry: The term "load" is physically imprecise and should be avoided. For quantitative purposes, the terms "power" or "torque" should be used, instead of "load", together with a statement of speed.

[SOURCE: ISO 2710-1:2000, 13.4]

3.3.12
net torque
torque transmitted on a test bed at the end of the crankshaft or its equivalent at the corresponding engine speed with the equipment and auxiliaries specified by ISO 1585, ISO 8665, ISO 9249 or ISO 4106

3.4 Consumption and delivery

3.4.1
fuel consumption
quantity of fuel consumed by an engine per unit of time at stated power and under stated ambient conditions

3.4.1.1
specific fuel consumption
quantity of fuel consumed by an engine per unit of power and time

3.4.1.2
ISO specific fuel consumption
name given to the specific fuel consumption at the *ISO standard power* (3.3.7.1)

3.4.2
fuel delivery
metered volume (mass) of fuel delivered by a fuel injection system during one working cycle

[SOURCE: ISO 7876-1]

3.4.2.1
specific fuel delivery
metered volume (mass) of fuel delivered by a fuel injection system during one working cycle per litre of engine swept volume

3.4.3
lubricating oil consumption
quantity of lubricating oil consumed by an engine per unit of time

[SOURCE: ISO 2710-1:2000, 14.3]

3.5 Tests

3.5.1
acceptance test
test carried out as an overall check of the manufacturing quality and to establish that the contractual commitments have been fulfilled

3.5.2
type test
test carried out on a representative engine of a certain engine type to establish its main performance data and, as far as possible, to enable its reliability and durability in service to be assessed

3.5.3
special test
test additional to acceptance or *type test* (3.5.2) carried out to meet the requirements of the inspecting and legislative authorities, classification societies or customers, e.g. type approval test

3.5.4
production conformity test
test performed to verify that a production engine meets the requirements of the declared design specification or approval

4 Symbols

The symbols used in Formula (1) to Formula (11) and in the relevant "Satellite" standard are given in Table 2. Subscripts to these symbols are given in Table 3.

Symbols and subscripts used in this document for parameters under measurement are given in Table 4.

Table 2 — Symbols

Symbol		Designation	Unit
Common use	EDP representation		
a	A	Humidity factor	1
b_r	BR	Specific fuel consumption under standard reference conditions	kg/(kW·h)
b_x	BX	Specific fuel consumption under site ambient conditions	kg/(kW·h)
b_y	BY	Specific fuel consumption under test ambient conditions	kg/(kW·h)
f_a	FA	Atmospheric factor	1
f_m	FM	Engine factor (characteristic parameter for each type of engine)	1
k	K	Ratio of indicated power	1
m	M	Exponent of the dry air pressure ratio or total barometric pressure ratio	1
n	N	Exponent of the ambient air thermodynamic temperature ratio	1
p_d	PD	Ambient dry barometric pressure during test	kPa
p_r	PR	Standard reference total barometric pressure	kPa
p_{ra}	PRA	Substitute reference total barometric pressure	kPa
p_{sr}	PSR	Standard reference saturated water vapour pressure	kPa
p_{sx}	PSX	Ambient saturated water vapour pressure on site	kPa
p_{sy}	PSY	Ambient saturated water vapour pressure during test	kPa
p_x	PX	Ambient total barometric pressure on site	kPa
p_y	PY	Ambient total barometric pressure during test	kPa
P	PP	Power measured at the end of the crankshaft or its equivalent	kW
P_o	PPO	Corrected net power; i.e. power under standard reference conditions and at the end of the crankshaft	kW
P_r	PPR	Brake power under standard reference conditions	kW

Table 2 *(continued)*

Symbol		Designation	Unit
Common use	**EDP representation**		
P_{ra}	PPRA	Brake power under substitute reference conditions	kW
P_x	PPX	Brake power under ambient conditions on site	kW
P_y	PPY	Brake power under ambient conditions during test	kW
q	Q	Fuel mass per cycle per litre of engine swept volume	mg/(cycle·l)
q_c	QC	Fuel mass per cycle per litre of air available for combustion	mg/(cycle·l)
r	R	Boost pressure ratio (ratio of absolute air pressure at the compressor outlet to that at the compressor inlet)	1
r_r	RR	Boost pressure ratio under standard reference conditions	1
$r_{r,max}$	RRMAX	Maximum permissible boost pressure ratio under standard reference conditions	1
s	S	Exponent of the charge air coolant thermodynamic temperature ratio	1
t_{cr}	TCR	Standard reference charge air coolant temperature	°C
t_{cx}	TCX	Ambient charge air coolant temperature on site	°C
t_r	TR	Standard reference ambient air temperature	°C
t_x	TX	Ambient air temperature on site	°C
T_{cr}	TTCR	Standard reference charge air coolant thermodynamic temperature	K
T_{cra}	TTCRA	Substitute reference charge air coolant thermodynamic temperature	K
T_{cx}	TTCX	Ambient charge air coolant thermodynamic temperature on site	K
T_{cy}	TTCY	Ambient charge air coolant thermodynamic temperature during test	K
T_r	TTR	Standard reference ambient air thermodynamic temperature	K
T_{ra}	TTRA	Substitute reference ambient air thermodynamic temperature	K
T_x	TTX	Ambient air thermodynamic temperature on site	K
T_y	TTY	Ambient air thermodynamic temperature during test	K
α	ALP	Power adjustment factor	1
α_a	ALPA	Power correction factor for spark-ignition engines	1
α_c	ALPC	Power correction factor for compression-ignition (diesel) engines	1
α_m	ALPM	Power correction factor for efficiency of the transmission	1
α_s	ALPS	Correction factor for smoke light absorption coefficient	1
β	BET	Fuel consumption recalculation factor	1
η_i	ETAI	Efficiency of each element constituting the transmission	1
η_m	ETAM	Mechanical efficiency	1
η_t	ETAT	Efficiency of the transmission which is located between the crankshaft and the measurement point	1
ϕ_r	PPHIR	Standard reference relative humidity	%
ϕ_x	PPHIX	Ambient relative humidity on site	%
ϕ_y	PPHIY	Ambient relative humidity during test	%

Table 3 — Subscripts

Subscript	Meaning
a	Atmospheric
c	Compression-ignition engine[a] Coolant[a] Corrected[a]
d	Dry
i	Each element
m	Mechanical
max	Maximum
o	Standard reference conditions and at the end of the crankshaft
P	Maximum power
r	Standard reference conditions
ra	Substitute reference conditions
s	Saturated[a] Smoke[a]
t	Total
T	Maximum torque
x	Site conditions

[a] Dependant on the application.

Table 4 — List of parameters

No.	Parameter	Definition	Symbol	Unit	Permissible deviation
1	**2**	**3**	**4**	**5**	**6**
1	**General parameters**				
1.1	Engine brake torque[a]	Mean torque delivered by the engine, measured at the engine driving shaft extremity	T_{tq}	kNm	±2 %
1.2	Engine speed[b]	Number of revolutions of the crankshaft in a given period of time	n	s^{-1} min^{-1} r/min	±2 %
1.3	Engine driving shaft speed	Number of revolutions of the engine driving shaft in a given period of time	n_d	s^{-1} min^{-1} r/min	±2 %
1.4	Turbocharger speed	Number of revolutions of the turbocharger shaft in a given period of time	n_t	s^{-1} min^{-1} r/min	±2 %
1.5	Brake power[c]	Power or sum of the powers measured at the driving or shafts	P_d	kW	±3 %
2	**Pressure**[e,f]				
2.1	Ambient pressure[g]	Pressure level of the atmosphere in the vicinity from where the engine takes its air	p_a	kPa	±0,5 %
2.2	Compression pressure in a cylinder[h]	Maximum pressure of the working medium present in a cylinder at momentary fuel cut-off	p_{co}	MPa	±5 %
2.3	Maximum cylinder pressure[h]	Maximum pressure of the working medium present in a cylinder attained during a working cycle	p_{max}	MPa	±5 %

Table 4 *(continued)*

No.	Parameter	Definition	Symbol	Unit	Permissible deviation
1	**2**	**3**	**4**	**5**	**6**
2.4	Inlet depression	Arithmetic mean inlet depression at engine or pressure-charger inlet	Δp_d	kPa	±5 %
2.5	Pressure	Arithmetic mean absolute pressure at engine or pressure-charger inlet	p_d	kPa	±1 %
2.6	Boost pressure	Arithmetic mean charge air pressure after a pressure-charger	p_b	kPa	±2 %
2.7	Boost pressure before cylinder inlet	Arithmetic mean of the air pressure before the cylinder inlet	p_{ba}	kPa	±2 %
2.8	Boost pressure drop through the air cooler		Δp_{ba}	kPa	±10 %
2.9	Exhaust gas pressure at the turbine inlet or inlet of other exhaust gas-assisted pressure charger (valid only for engines with a constant-pressure system)	Arithmetic mean of the pressure in the exhaust pipe before the turbine	p_{g1}	kPa	±5 %
2.10	Exhaust back pressure	Arithmetic mean of the pressure in the exhaust pipe after the turbine	p_{g2}	kPa	±5 %
2.11	Coolant pressure	Pressure(s) at given point(s) of the fluid cooling system(s)	p_d	kPa	±5 %
2.12	Lubricating oil pressure	Oil pressure(s) at given point(s) of the lubricating system(s) (in individual circuits before and after filters, coolers, etc.)	p_o	kPa	±5 %
2.13	Fuel supply pressure	Arithmetic mean of the fuel pressure at the inlet of the injection pump	p_t	kPa	±10 %
3	**Temperatures**[i,j]				
3.1	Ambient temperature	Temperature level of the atmosphere in the environment of the engine installation at a given point or location	T_a	K	±2 K
3.2	Inlet temperature	Air temperature at the engine or pressure-charger inlet	T_d	K	±2 K
3.3	Charge air temperature after the pressure-charger		T_b	K	±4 K
3.4	Charge air temperature after the air cooler	Air temperature before the cylinder inlet	T_{ba}	K	±4 K
3.5	Exhaust gas temperature at the cylinder outlet	Mean temperature of the exhaust gas measured by the thermal pick-up at a given cylinder	$T_{g,cyl}$	K	±25 K
3.6	Exhaust gas temperature at the turbine inlet or inlet of other exhaust gas-assisted pressure-charger	Mean temperature of the exhaust gas measured by the thermal pick-up before the turbine	T_{g1}	K	±25 K

Table 4 *(continued)*

No.	Parameter	Definition	Symbol	Unit	Permissible deviation
1	**2**	**3**	**4**	**5**	**6**
3.7	Exhaust gas temperature in the exhaust pipe or after the turbine or other exhaust gas-assisted pressure-charger	Mean temperature of the exhaust gas measured by the thermal pick-up in the exhaust manifold or after the turbine	T_{g2}	K	±15 K
3.8	Coolant temperature	Temperature(s) at given point(s) of the fluid cooling system(s)	T_d	K	±2 K
3.9	Lubricating oil temperature	Oil temperature(s) at given point(s) of the lubricating system(s)	T_o	K	±2 K
3.10	Fuel temperature	Fuel temperature at a given point of the fuel system	T_t	K	±5 K
4	**Consumptions**[k]				
4.1	Fuel consumption	Mass of fuel consumed by the engine per unit of time	B	g/s kg/s kg/h	±3 %
4.2	Specific fuel consumption	Fuel consumption per unit of power	b	g/(kW·h) g/MJ	±3 %
4.3	Cylinder lubricating oil consumption	Mass of cylinder oil supplied by the lubricator per unit of time	C_{cyl}	g/s kg/s kg/h	±10 %
4.4	Specific consumption of cylinder oil	Cylinder lubricating oil consumption per unit of power	c_{cyl}	g/(kW·h) g/MJ	±13 %
4.5	Air consumption	Mass of air drawn into the engine from the atmosphere per unit of time	A	kg/s kg/h	±5 %
4.6	Specific air consumption	Air consumption per unit of power	a	kg/(kW·h) kg/MJ	±5 %
5	**Flows**				
5.1	Cooling fluid flow	Mass of fluid flowing through the engine cooling system per unit of time	m_{cl}	kg/s kg/s	±10 %
5.2	Lubricating oil flow	Mass of fluid flowing through the engine lubricating system per unit of time	m_o	kg/s kg/h	±10 %
6	**Exhaust gas emission characteristics**				
6.1	Smoke index[l]	Filter soiling (expressed as function of light reflectivity) by undiluted gas	r	Smoke number	±0,3 on a scale of 10 units[n]
6.2	Smoke opacity[l]	a) Light obscuration by undiluted gas b) Coefficient of light absorption[p]	N k	% m^{-1}	±5 % ±5 %
6.3	Soot content[l]	Gravimetric carbon concentration[q]	C_c	g/m3	±10 %
6.4	Gaseous emission composition[r]	Volumetric concentration of gaseous components	C_B s	% or ppm	AMC[t]

Table 4 *(continued)*

No.	Parameter	Definition	Symbol	Unit	Permissible deviation
1	2	3	4	5	6
6.5	Emission rate[u]	Mass of each component emitted per unit of time	E_B s	g/h	AMC[t]
6.6	Specific emission	Emission rate per unit of power	E_B[a]	g/(kW·h)	AMC[t]

[a] Measured by hydraulic brake, electric dynamometer or similar equipment.

[b] Measured by a tachometer, revolution counter, tachoscope or similar equipment.

[c] Calculated from measured values of engine driving shaft torque and speed.

[d] Where necessary the suffix "e" shall be used in accordance with ISO 2710-1 to distinguish brake power from another power.

[e] The permissible deviation of each pressure (except those in 2.1 and 2.5) is given as a percentage of the gauge pressure.

[f] Bar may be used instead of kPa or MPa.

[g] Measured by spring-loaded, fluid-type barometers or similar equipment.

[h] Measured by a recording maximum pressure gauge, mechanical indicator, from an indicator diagram or similar means.

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

[j] The unit °C may be used instead of K.

[k] Consumptions are measured using mass or volume methods (the unit assumes using mass in this document), by determining the time during which a given quantity of fluid is consumed, or alternatively by using normal pressure differential systems or other types of flowmeter.

[l] The engine manufacturer may select either parameter indicated in 6.1 or 6.3 for non-opacity measurement or in 6.2 for opacity measurement according to the facilities available.

[m] 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.

[n] For automatic continuous measurement, the permissible deviation in 6.1 may be ±0,6 on a scale of 10 units.

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

[p] The value k is given by the following formula:

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

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

[q] 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 reference temperature and pressure.

[r] Measured by chemical or physical method appropriate to each component (and/or its concentration).

[s] "B" is suffix of an individual component of the exhaust gas.

[t] By agreement between engine manufacturer and customer.

[u] Calculated from the emission concentration measurement and calculated rate of exhaust gas flow.

5 Standard reference conditions

For the purpose of determining the power and fuel consumption of an engine, the following standard reference conditions shall be used:

Total barometric pressure: p_r = 100 kPa;

Air temperature: T_r = 298 K (t_r = 25 °C);

Relative humidity: ϕ_r = 30 %;

Charge air coolant temperature: T_{cr} = 298 K (t_{cr} = 25 °C)

NOTE A relative humidity of 30 % at a temperature of 298 K corresponds to a water pressure of 1 kPa. The corresponding dry barometric pressure is 99 kPa.

6 Tests

6.1 General

There are two different procedures for engine testing identified as method 1 and method 2. Depending upon the particular engine application, the appropriate method to be used is specified in the relevant "Satellite" standard.

6.2 Test method 1

6.2.1 Preamble

This test method is used for verifying the declared parameters of an individual engine in accordance with the requirements of the contract. It establishes the requirements for acceptance tests, type tests and/or special tests to be performed with the engine mounted on a test bed at the manufacturer's plant or installed on site.

If required, acceptance tests shall be included in the contract. Type tests and/or special tests are subject to agreement between the manufacturer and customer.

6.2.2 Test designation

Test method 1 gives two test categories; reference may be made to the relevant category of test as follows:

a) for acceptance tests (see 3.5.1) ISO _____ A;

b) for type tests (see 3.5.2) ISO _____ T.

6.2.3 Extent of tests

6.2.3.1 The programme of acceptance and type tests shall be established by the manufacturer.

6.2.3.2 It is the responsibility of the manufacturer to define the measurements to be taken, which shall be agreed with the customer.

Table 5 may be taken as a guide for selecting the engine groups appropriate to the test measurements given in list A (see Table 6).

Table 5 — Engine groups for selection of test measurements

Engine group number	Typical engine group characteristics
1	Engines whose operating conditions are not measured in service; usually with maximum design engine speeds of more than 1 800 min^{-1}.
2	Naturally aspirated engines with maximum design engine speeds of approximately 1 500 min^{-1} and above.
3	Pressure-charged engines with maximum design engine speeds of approximately 1 500 min^{-1} and above.
4	Engines with maximum design engine speeds of approximately 250 min^{-1} to 1 500 min^{-1}.
5	Engines with maximum design engine speeds up to 250 min^{-1}.

6.2.3.3 For mass-produced engines which are not all tested on-load, an adequate inspection procedure may be used instead of a full acceptance test.

6.2.3.4 Dependent on the test category and the engine group number, five lists of recommended test measurements, calculated values and functional checks (lists A, B, C, D, E) are given in 6.2.6.

The following requirements are not included in the purchase contract and are subject to agreement between the manufacturer and customer:

a) additional measurements or tests requested to be performed during the test procedure by the customer or his representative;

b) if necessary, the source and date of provision of data necessary for additional calculations.

6.2.3.5 Whether some or all of the results from previous tests shall be recognized as a part of the acceptance test is subject to agreement between the manufacturer and customer.

6.2.4 Measurement techniques

6.2.4.1 Measurements methods

Methods to be used during acceptance tests and type tests, symbols for parameters under measurement, units, etc. are described in 6.2.4.3.

6.2.4.2 Data storage

Printed and/or stored data measured or recorded shall be displayed during the test.

6.2.4.3 Test measurements

6.2.4.3.1 Measurement accuracy

The measurement accuracy depends on a number of factors. Therefore, for each measured parameter, it is necessary to specify the permissible deviation to cover the following factors which result in measurement uncertainty:

a) instrument accuracy;

b) correctness of the measuring instrument location;

c) conditions under which the measuring instrument is used;

d) accuracy of the readings;

e) scatter of the readings of the measuring instrument during the measuring period.

The permissible deviations define the permissible range between the extreme values of each individual measurement for the engine under consideration.

6.2.4.3.2 Operating conditions

Before a set of measurements is taken, the engine shall have been operated at particular conditions of load and speed for a sufficient length of time to ensure that it has reached stable operating conditions as specified by the engine manufacturer.

During the period in which a set of measurements is being made, the torque, speed and all fluid temperatures and pressures shall be maintained constant within the permissible deviations given in Table 4.

6.2.4.3.3 Measurement methods

Measurement methods shall be selected by the engine manufacturer and, if necessary, may be subject to contractual agreement between the engine manufacturer and customer and/or inspecting authority.

The location of the measurement points shall be specified by the engine manufacturer.

6.2.4.3.4 Permissible deviation of parameters

The permissible deviation for each individual measurement and for the engine under consideration given in Table 4, column 6, applies only to the declared power shown in the relevant "Satellite" standard.

The permissible deviation quoted is that considered adequate for most acceptance test purposes. Engine manufacturers may adopt reduced permissible deviations for

a) type tests, and

b) special contractual or legislative requirements.

Unless otherwise agreed, all measuring instruments and apparatus used during tests shall be tested and calibrated periodically over the range of expected readings at the time intervals specified by the engine manufacturer.

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

Where measurements are used in subsequent calculations, measurement uncertainties of the measured parameters shall be selected so that the deviation of the final calculated parameter complies with the corresponding permissible deviation.

6.2.4.4 List of parameters

Engine performance parameters and their permissible deviations are given in Table 4.

NOTE All footnotes appear at the end of Table 4.

6.2.5 Test conditions

6.2.5.1 Before an engine test, when mutually agreed between the manufacturer and customer, the manufacturer shall submit the necessary technical documentation concerning the engine type and application.

6.2.5.2 A period of running-in and preliminary testing considered adequate by the manufacturer shall precede any acceptance or type test.

6.2.5.3 Measurements for an acceptance or type test shall be carried out only when the engine has reached stable operating conditions as specified by the manufacturer.

6.2.5.4 Unless otherwise agreed between the manufacturer and customer, tests shall be carried out on a test bed at the manufacturer's works.

— If the acceptance test is carried out on site, testing shall take place after the engine is in its operating condition and at a time agreed upon by the customer and engine manufacturer. The presence of the engine manufacturer or his representative and their authority during acceptance testing, if required, should be included in the purchase agreement. The engine manufacturer or his representative shall be given the opportunity to instruct all on-site personnel in operating the engine set and in the application of the measuring equipment.

— lf the acceptance test is carried out on site, the customer shall provide sufficient fuel, lubricants, coolants and auxiliary personnel to support the programme, unless otherwise agreed with the engine manufacturer.

— For engine-related machinery not supplied by the engine manufacturer, the points of measurement shall be identified by the customer on instructions from the engine manufacturer.

6.2.5.5 Tests shall be carried out on the engine with any dependent auxiliaries necessary for its operation, either supplied with the engine or belonging to the test-bed equipment, fitted.

6.2.5.6 Test-bed equipment (e.g. air-inlet system, exhaust system and independent auxiliaries such as water pumps, oil filters, heat exchangers, etc.) may be used, provided that the contractual requirements are met.

6.2.5.7 Engines that are supplied with built-in transmission systems (e.g. hydraulic mechanisms, reversing couplings) or electric generators, and that cannot be tested separately from them, shall be tested with the transmission system or generator installed.

lf engines are tested with driven machinery or a transmission system fitted and these are separable, any variation in power, due to these coupled items, shall be eliminated from the power declared in accordance with this document.

6.2.5.8 lf the acceptance test is carried out on site and the declared power at the corresponding speed cannot be verified or achieved, due to special circumstances and/or situation of the installation, the manufacturer and the customer shall accept the test report prepared from the test performed on the manufacturer's works test bed as valid, and verify only a) the declared speed at a power other than the declared power, or b) the declared power at an engine speed other than the declared speed.

In either case, measurement of the fuel consumption shall be omitted.

6.2.5.9 During the engine tests, no additional measures, other than those required to maintain the test conditions and those required for normal operation as given in the working manual, shall be taken.

6.2.5.10 The only permitted interruptions in testing are those necessary for engine maintenance as given in the working manual. If an interruption should occur caused by a defect in the engine or test equipment, the decision to partially or entirely repeat the tests shall be taken between the manufacturer and customer.

6.2.5.11 The standard reference conditions and declarations of power, fuel and lubricating oil consumption shall be as specified in Clause 5 and the relevant "Satellite" standard.

6.2.5.12 In cases where it is not possible to maintain the specified ambient conditions and the fuel or fluid properties for the acceptance or type test, the influence of the differing conditions and/or properties and the necessary correction of the test results shall be subject to agreement between the manufacturer and customer.

In dual-fuel engines, the acceptance test shall be performed using liquid fuel. An additional acceptance test with gaseous fuel may be stipulated if gaseous fuel is available at the manufacturer's works with approximately the same ignition characteristics as the gaseous fuel available on site, if agreed between the manufacturer and customer.

In the case of spark-ignition gas engines and pilot injection gas engines, the acceptance test may be carried out at the manufacturer's works only if the composition and ignition characteristics of the gaseous fuel available are approximately the same as those of the gaseous fuel used on site.

If, after agreement between the manufacturer and customer, the acceptance test is performed at the manufacturer's works using gaseous fuel with chemical values and properties differing significantly from those on site, the test may be made at agreed values of declared power, declared speed and fuel consumption by resetting the engine accordingly. Readjustment of the engine to achieve correct operation with fuel having properties different from those on site is acceptable in this case.

6.2.6 Test procedures

6.2.6.1 Acceptance tests

6.2.6.1.1 Acceptance tests comprise a specified sequence of power settings, measurements and calculated values given in list A (see Table 6).

6.2.6.1.2 The duration of the acceptance test programme depends on the engine power and applications.

6.2.6.1.3 The measurements shown in list A (see Table 6) shall be made according to the specified engine group for each operating condition wherever appropriate and where provision exists on the engine for doing so.

Measurements carried out to verify the declaration of power, engine speed and fuel consumption, shall be carried out at least twice. A measurement shall be considered valid if the variations of the engine brake torque and engine speed values in relation to the settings of the operating values do not exceed ±2 %. The variation of the power output during this period shall not exceed ±3 %. This requirement shall not apply to spark-ignition engines with a brake power less than 50 kW.

The measurements shown in list A (see Table 6) are arranged in an ascending order of test measurement complexity and are presented for guidance when the contract is drawn up between the manufacturer and customer. Either party may, by agreement, add to or delete from the measurements in list A, to suit the particular type of engine involved. Where no provision exists on the engine for a particular measurement, this shall be stated by the manufacturer.

Table 6 — List A: Test measurements

No.	Parameter to be measured	Engine group number (see Table 5)				
		1	2	3	4	5
A1	Barometric pressure, humidity and ambient temperature	X	X	X	X	X
A2	Engine speed or cycle frequency	X	X	X	X	X
A3	Engine brake torque and/or fuel pump or governor	X	X	X	X	X
A4	Throttle control rod setting					
A5	Fuel consumption		X	X	X	X

Table 6 *(continued)*

No.	Parameter to be measured	Engine group number (see Table 5)				
		1	2	3	4	5
A6	Lubricating oil pressure		X	X	X	X
A7	Temperature and pressure of exhaust gas leaving the engine		X	X	X	X
A8	Air inlet pressure and temperature at the engine or pressure charger inlet		X	X	X	X
A9	Exhaust-gas temperature at the turbine inlet			X	X	X
A10	Boost pressure in the air manifold			X	X	X
A11	Turbocharger speed			X	X	X
A12	Coolant mean temperature in and out of the cylinder block			X	X	X
A13	Lubricating oil temperature at the engine inlet and outlet			X	X	X
A14	Boost pressure drop through the charge air cooler			X	X	X
A15	Boost pressure after each charge air cooler			X	X	X
A16	Charge air temperature after each charge air cooler			X	X	X
A17	Coolant mean temperature at the inlet and outlet of the charge air cooler			X	X	X
A18	Maximum cylinder pressure				X	X
A19	Exhaust-gas pressure at the turbine inlet			X	X	X
A20	Exhaust-gas temperature of each cylinder				X	X
A21	Individual coolant circuit temperatures and pressures				X	X
A22	Lubricating-oil pressure in individual circuits, e.g. turbocharger, piston cooling, etc.				X	X
A23	Lubricating-oil pressure before and after filters and coolers				X	X
A24	Secondary coolant and lubricating oil temperatures in and out of heat exchangers				X	X
A25	Fuel supply pressure and temperature				X	X
A26	Compression pressure					X

Table 7 — List B: Test results

No.	Parameter to be calculated
B1	Brake power
B2	Specific fuel consumption

6.2.6.1.4 Where appropriate, the manufacturer shall supply the calculated values given in list B (see Table 7) on the basis of the test measurements mode from list A (see Table 6).

Measurement of the fuel consumption shall be carried out during the measurement of power.

For engines having a brake power of 200 kW and above, if the variation between the results of two fuel consumption measurements is more than 2 %, the measurement shall be repeated for this operating point.

Fuel fed to the engine and that is not consumed shall be taken into account in the fuel consumption measurements.

6.2.6.1.5 List C (see Table 8) shows the functional checks which may additionally be carried out on engines in groups 2 to 5 in Table 5.

Selection from list C shall be made by agreement between the manufacturer and customer.

6.2.6.2 Type tests

6.2.6.2.1 A type test comprises running the engine at a specified sequence of power/engine speed combinations, reversals and stop.

6.2.6.2.2 Type tests shall include, as far as applicable, all measurements, calculations and functional checks shown in list A, engine group 5 (see Table 6), and lists B and C (see Table 7 and Table 8), and in additional list D (see Table 9).

Table 8 — List C: Functional checks

No.	Function to be verified
C1	The correct functioning of the overspeed limiting device in accordance with ISO 3046-6
C2	The correct functioning of the speed governing system in accordance with ISO 3046-4
C3	The ability of all malfunction protection and warning devices to respond correctly to the fault conditions in which they should operate (e.g. low lubricating oil pressure, high lubricating oil temperatures, high coolant temperatures, pressure rise in the engine crankcase, etc.)
C4	The correct functioning of all automatic pressure and temperature controls
C5	The ability of the starting system to perform prior to and/or after the acceptance test conditions of the engine are reached, subject to agreement between the manufacturer and customer
C6	The correct functioning of the reversing mechanism, built-in reverse reduction gear and couplings
C7	That the temperature of important components is satisfactory
C8	That the crank web deflection does not exceed the given limits
C9	Stability of the engine on its support
C10	The condition after test of one or more piston and cylinder assemblies and bearings, chosen randomly for inspection

Table 9 — List D: Additional tests

No.	Parameter/measure
D1	Air consumption
D2	Lubricating oil consumption
D3	Dismantling, inspection and measuring of important parts subject to wear

6.2.6.3 Special tests

Special tests are defined as any of those shown in list E (see Table 10) which may be required by inspection authorities, classification societies, legislation or the customer.

Table 10 — List E: Special tests (examples)

No.	Parameter or function
E1	Torsional vibration frequencies and amplitudes at prescribed power/engine speed combinations when the engine is tested coupled to its contract driven machinery, in accordance with ISO 3046-5
E2	Engine heat balance
E3	Sound level
E4	Exhaust-gas emission characteristics
E5	Tests in conjunction with contract driven machinery
E6	Parallel running and other electrical tests of engine-driven generators
E7	Emergency reversal of marine engines
E8	Determination of minimum stable engine speed of marine engines

Table 10 *(continued)*

No.	Parameter or function
E9	Change-over on dual-fuel engines
E10	Ability to carry out maintenance tasks within the time stated by the manufacturer
E11	Ability to manoeuvre and provide a stated power when operating with specified malfunctions, e.g. with one or more turbochargers inoperative

6.3 Test method 2

6.3.1 General

This test method is used for verifying the net and/or gross power of an engine type with the declared values. It presents engine performance at full power/torque as a function of engine speed by generating curves of power and fuel consumption.

It also applies to the determination of engine power for exhaust emission measurement in accordance with the requirements of ISO 8178.

Conformity of the engine type to the declaration is fulfilled when the difference between the measured and declared values are within the tolerances specified in the relevant "Satellite" standard.

6.3.2 Measuring equipment and instrument accuracy

6.3.2.1 Torque

6.3.2.1.1 The dynamometer torque measuring system shall have an accuracy of ±1 % in the range of values required for the test.

6.3.2.1.2 The torque measuring system shall be calibrated to take friction losses into account. The accuracy in the lower half of the measuring range of the dynamometer bench may be ±2 % of measured torque.

6.3.2.2 Engine speed

The engine speed measuring system shall have an accuracy of ±0,5 %.

6.3.2.3 Fuel flow

The fuel flow measuring system shall have an accuracy of ±1 %.

6.3.2.4 Fuel temperature

The fuel temperature measuring system shall have an accuracy of ±2 K.

6.3.2.5 Engine inlet air temperature

The air temperature measuring system shall have an accuracy of ±2 K.

6.3.2.6 Barometric pressure

The barometric pressure measuring system shall have an accuracy of ±100 Pa.

NOTE 1 Pa = 1 N/m^2

6.3.2.7 Back pressure in exhaust system

The system used to measure the back pressure in the exhaust system shall have an accuracy of ±200 Pa. The measurement shall be made subject to Table 1, footnote [b].

6.3.2.8 Depression in inlet system

Subject to Table 1, footnote [a], this pressure shall be measured to ±50 Pa.

6.3.2.9 Absolute pressure in inlet duct

The system used to measure the absolute pressure in the inlet duct shall have an accuracy of ±2 % of the measured pressure.

6.3.3 Setting conditions

The setting conditions for the test to determine engine power are indicated in Table 11.

Table 11 — Setting conditions

1	Setting of carburettor(s)	Set in accordance with the manufacturer's specifications and used without further alteration for the particular engine application
2	Setting of injection-pump delivery system	
3	Ignition or injection timing (timing curve)	
4	Governor setting	
5	Anti-pollution devices	
6	Boost control	

6.3.4 Test conditions

6.3.4.1 The power test shall consist of a run at full throttle for spark-ignition engines, and at fixed full load fuel injection pump setting for compression-ignition (diesel) engines, the engine being equipped with standard SPE and as specified in Table 1.

6.3.4.2 Performance data shall be obtained under stabilized operating conditions, with an adequate fresh-air supply to the engine.

Before the test, the engine shall have been run-in in accordance with the manufacturer's recommendations. Combustion chambers may contain deposits, but in limited quantity. Test conditions such as inlet air temperature shall be selected to be as near to the standard reference conditions (see Clause 5) as possible in order to minimize the magnitude of the correction factor.

6.3.4.3 The temperature of the inlet air to the engine shall be measured within the inlet ductwork. The inlet depression measurement shall be made at the same point.

The thermometer or thermocouple shall be shielded from fuel spray-back and radiant heat and located directly in the air stream. A sufficient number of locations shall be used to give a representative average of the inlet temperature.

6.3.4.4 The inlet depression shall be measured downstream of the entry ducts, air filter, inlet silencer or speed-limiting device (if fitted).

6.3.4.5 The absolute pressure at the entry to the engine downstream of the compressor and heat exchanger, if fitted, shall be measured in the inlet manifold and at any other point where pressure is to be measured to calculate correction factors.

6.3.4.6 The exhaust back pressure shall be measured at a point at least three pipe diameters downstream from the outlet flange(s) of the exhaust manifold(s) and downstream at the turbocharger(s), if fitted.

The location shall be specified.

6.3.4.7 No data shall be taken until torque, engine speed and temperatures have been maintained substantially constant as specified by the manufacturer.

6.3.4.8 The engine speed during a test run or reading shall not deviate from the selected speed by more than ±1 % or ±10 min^{-1}, whichever is greater.

6.3.4.9 Observed brake load, fuel flow and inlet air temperature data shall be taken simultaneously and shall, in each case, be the average of at least two stabilized consecutive readings. No adjustment shall be made to the engine between these readings.

6.3.4.10 The temperature of the coolant at the outlet from the engine shall be kept within ±5 K from the upper thermostatically controlled temperature specified by the manufacturer. If no temperature is specified by the manufacturer, the temperature shall be 353 K ± 5 K.

For air-cooled engines, the temperature at a point indicated by the manufacturer shall be kept within $^{0}_{-20}$ K of the maximum value specified by the manufacturer for the reference conditions.

6.3.4.11 Fuel temperatures shall be as follows.

a) For spark-ignition engines, the fuel temperature shall be measured as near as possible to the inlet of the carburettor or fuel injector manifold assembly. Fuel temperature shall be maintained to within ±5 K of the temperature specified by the manufacturer. However, the minimum test fuel temperature allowed shall be the ambient air temperature. If the test fuel temperature is not specified by the manufacturer, it shall be 298 K ± 5 K.

b) For compression-ignition (diesel) engines, the fuel temperature shall be measured at the inlet to the fuel injection pump. At the manufacturer's request the fuel temperature measurement can be made at another point in the pump representative of the engine operating condition or in the fuel supply pipe between the filter and the fuel injection pump, upstream of the entry point for any backflow fuel.

   Fuel temperature shall be maintained within to ±3 K of the temperature specified by the manufacturer. In all cases, the minimum permissible fuel temperature at the pump inlet is 303 K. If the test fuel temperature is not specified by the manufacturer, it shall be 313 K ± 3 K for distillate fuels.

6.3.4.12 The temperature of the lubricating oil shall be measured at either the gallery inlet, the outlet from the oil cooler (if fitted) or as specified by the manufacturer. The temperature shall be maintained within the limits specified by the manufacturer.

6.3.4.13 If necessary, an auxiliary regulation system may be used to maintain the temperatures within the limits specified in 6.3.4.10, 6.3.4.11 and 6.3.4.12.

6.3.4.14 The selection of fuel for the power test shall be agreed by the parties involved and be selected in accordance with the requirements of Table 12.

Table 12 — Test Fuels

Test Purpose	Interested parties	Fuel selection
Type approval (certification)	Certification body, manufacturer or supplier	Reference fuel, if one is defined Commercial fuel if no reference fuel is defined
Acceptance test	Manufacturer or supplier Customer or inspector	Commercial fuel as specified by the manufacturer

6.3.5 Test procedure

Measurements shall be taken at a sufficient number of engine speeds to completely define the power and torque curve between the lowest and the highest engine speeds recommended by the manufacturer. The speed range shall include the point at which the engine produces its maximum power and torque.

6.3.6 Data to be recorded

Data to be recorded shall be those indicated in 9.2.1 or as specified in the relevant "Satellite" standards.

7 Method of power correction

7.1 General

This power correction method has been verified by tests on a representative number of pre-set engines with engine speeds of 2 000 min^{-1} and above. Manufacturers may extend this method to other engines as considered appropriate, or restrict it, if justified by experience.

This power correction method shall be used to calculate the power at the standard reference conditions specified in Clause 5 from the power observed (determined) under test ambient conditions.

For the purpose of power correction, the observed (determined) power shall be multiplied by a factor as follows:

for spark-ignition engines:

$$P_r = \alpha_a \times P_y \quad (1)$$

or, for compression-ignition (diesel) engines:

$$P_r = \alpha_c \times P_y \quad (2)$$

7.2 Test atmospheric conditions

The atmospheric conditions during the test shall be within the ranges given below.

a) Temperature, T_y

— for spark-ignition engines: $288\ K \le T_y \le 308\ K$

— for compression-ignition (diesel) engines: $283\ K \le T_y \le 313\ K$

b) Dry Pressure, p_d

NOTE $p_d = p_y - \Phi_y p_{sy}$

— for all engines: $90\ kPa \le p_d \le 110\ kPa$

7.3 Correction factor α_a for naturally aspirated and pressure-charged spark-ignition engines (with or without charge air cooling)

The correction factor α_a shall be as calculated from Formula (3):

$$\alpha_a = \left(\frac{p_r - \phi_r p_{sr}}{p_y - \phi_y p_{sy}} \right)^{1,2} \left(\frac{T_y}{T_r} \right)^{0,6} \tag{3}$$

Formula (3) applies to engines with carburettors and to other engines where the fuel management system is designed to maintain a relatively constant fuel/air ratio as ambient conditions change. For other engine types, see 7.5.

Formula (3) is only applicable if:

$$0,96 \leq \alpha_a \leq 1,06$$

If these limits are exceeded, the corrected power value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

7.4 Correction factor α_c for compression-ignition (diesel) engines

7.4.1 General

The power correction factor (α_c) for compression-ignition (diesel) engines at constant fuel delivery setting (pre-set fuel delivery) is obtained by applying Formula (4):

$$\alpha_c = \left(f_a \right)^{f_m} \tag{4}$$

where

f_a is the atmospheric factor (see 7.4.2);

f_m is the characteristic parameter for each type of engine and fuel setting (see 7.4.3).

Limitation in use of Formula (4) is given in 7.4.4.

7.4.2 Atmospheric factor f_a

This factor, which indicates the effects of environmental conditions (pressure, temperature and humidity) on the air drawn in by the engine and differs according to the type of engine, shall be as calculated from Formula (5), Formula (6) or Formula (7):

for naturally aspirated engines and mechanically pressure-charged engines:

$$f_a = \left(\frac{p_r - \phi_r p_{sr}}{p_y - \phi_y p_{sy}} \right) \left(\frac{T_y}{T_r} \right)^{0,7} \tag{5}$$

for turbocharged engines without charge air cooling or with charge air cooling by air/air cooler:

$$f_a = \left(\frac{p_r - \phi_r p_{sr}}{p_y - \phi_y p_{sy}} \right)^{0,7} \left(\frac{T_y}{T_r} \right)^{1,2} \tag{6}$$

for turbocharged engines with charge air cooling by air to liquid charge air cooler:

$$f_a = \left(\frac{p_r - \phi_r p_{sr}}{p_y - \phi_y p_{sy}} \right)^{0,7} \left(\frac{T_y}{T_r} \right)^{0,7} \tag{7}$$

7.4.3 Engine factor, f_m

Factor f_m is dependent on the type of engine and the trapped air/fuel ratio corresponding to the fuel setting.

The engine factor f_m is a function of the corrected specific fuel delivery q_c, and shall be calculated from Formula (8):

$$f_m = 0,036 q_c - 1,14 \tag{8}$$

in which

$$q_c = \frac{q}{r_r} \tag{9}$$

where q is the fuel delivery parameter in milligrams per cycle per litre of engine swept volume $\left[\text{mg} / \left(\text{l} \cdot \text{cycle} \right) \right]$ and is equal to:

$$q = \frac{\left(Z \right) \times \left[\text{Fuel flow g} \left(\text{g/s} \right) \right]}{\left[\text{Displacem ent} \left(\text{l} \right) \right] \times \left[\text{Engine speed} \left(\text{min}^{-1} \right) \right]} = \frac{z \left(1 \right) \times \dot{V} \left(\text{g} / \text{s} \right)}{v_H \left(\text{l} \right) \times n \left(\text{min}^{-1} \right)} \tag{10}$$

where

Z 120 000 for four-stroke cycle engines and Z = 60 000 for two-stroke cycle engines;

r_r is the ratio between the absolute static pressure at the compressor outlet and compressor inlet under standard reference conditions (r_r = 1 for naturally aspirated engines). For two-stage turbocharging, r is the overall pressure ratio.

Formula (8) is valid for the following range of q_c (mg/l·cycle):

$37,2 \leq q_c \leq 65$

For q_c values lower than 37,2, a constant value of f_m equal to 0,2 (f_m = 0,2) shall be taken. For q_c values higher than 65, a constant value of f_m equal to 1,2 (f_m = 1,2) shall be taken (see Figure 1).

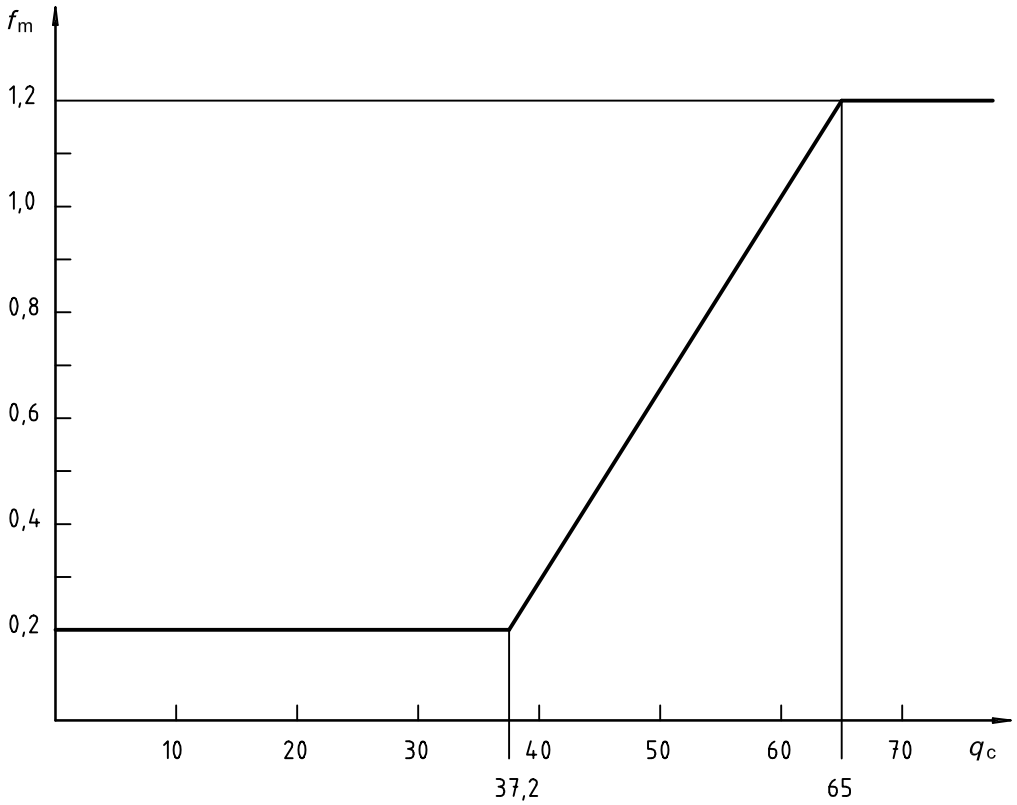

Figure 1 — Engine factor, f_m, as a function of the corrected fuel delivery, q_c

7.4.4 Limitation in use of correction factor equation

The correction factor Formula (4) is only applicable if $0{,}96 \leq \alpha_c \leq 1{,}06$.

If these limits are exceeded, the corrected power value obtained shall be given and the test conditions (temperature and pressure) precisely stated in the test report.

7.5 Other types of engine

For engines not covered by 7.3 and 7.4, a correction factor equal to 1 shall be applied when the ambient air density does not vary by more than ±2 % from the density at standard reference conditions. When the ambient air density is outside these limits, no correction shall be applied, but the test conditions shall be stated in the test report.

8 Measurement and correction of smoke value for compression-ignition (diesel) engines

8.1 General

If necessary, smoke value shall be measured and recorded. The opacimeter used, and its installation, shall be designed in accordance with ISO 11614.

8.2 Correction factor for the smoke light absorption coefficient

This is the factor by which the smoke light absorption coefficient, k, expressed in absolute units, shall be multiplied in order to determine the engine light absorption coefficient of smoke at the standard reference conditions specified in Clause 5 and is given by Formula (11):

$$k_r = \alpha_s \, k \tag{11}$$

where

α_s is the correction factor (see 8.3);

k is the measured smoke light absorption coefficient in reciprocal metres (observed smoke).

8.3 Determination of the correction factor for the smoke light absorption coefficient

The correction factor, α_s, for compression-ignition (diesel) engines under constant fuel delivery settings is obtained from Formula (12):

$$\alpha_s = 1 - 5 \, (f_a - 1) \tag{12}$$

where f_a is the atmospheric factor (see 7.4.2).

8.4 Limits of application

This correction factor, α_s, only applies when:

$0{,}92 \leq f_a \leq 1{,}08$

$283 \text{ K} \leq T_y \leq 313 \text{ K}$

$80 \text{ kPa} \leq p_d \leq 110 \text{ kPa}$

9 Test report

9.1 Test method 1

9.1.1 General

For engines to which Test method 1 of 6.2 is applied, the requirements for the test report are as follows.

9.1.2 Type test report

The manufacturer shall provide a test report. Normally, acceptance test reports shall be provided only for engine groups numbers 3, 4 and 5 (see Table 5).

Type test reports shall be provided for all groups of engine.

The test report shall include the engine identification and the following test information:

a) a reference to this document, i.e. ISO 15550;

b) the date, place and designation of test and inspecting authority;

c) the type of fuel and lubricating oil used during tests. Selection of test fuel shall be as follows:

   1) If the fuel used complies with the specification of a national or International Standard, the properties need be verified by explicit agreement between the manufacturer and customer.

   2) If the fuel does not comply with the specification of a National or International Standard, the properties and constituents should be stated, as agreed between the manufacturer and customer.

   3) The lower calorific value of the fuel and its method of determination should be stated.

d) the dependent auxiliaries, engine settings and proprietary equipment installed;

e) the table of values measured during the test;

f) the parameters calculated during the test;

g) the results of functional checks;

h) the results of additional tests or special tests, if required.

9.2 Test method 2

9.2.1 General

For engines to which Test method 2 of 6.3 is applied, the requirements for the test report are as follows.

9.2.2 Type test report

The manufacturer shall provide a test report including the following engine identification and test information.

NOTE In this test report, state "none" where inapplicable or delete.

9.2.2.1 Compression-ignition engines — Essential characteristics[1)]

9.2.2.1.1 Engine description

Make: .....

Type: .....

Cycle: four-stroke/two-stroke[2)]

Bore: ..... mm

Stroke: ..... mm

Number of cylinders: .....

Layout of cylinders: ..... Firing order: .....

Engine swept volume: .....litres

Compression ratio[3)]: .....

---

1) In the case of non-conventional engines and systems, particulars equivalent to those referred to here shall be supplied by the manufacturer.

2) Strike out what does not apply.

3) Specify the tolerances.

9.2.2.1.2 Cooling system

a) Liquid:

Nature of liquid: .....

Circulating pump: yes/no[2)].....

Characteristics or make(s): ..... Type(s): .....

Drive ratio: .....

Thermostat setting: .....

Radiator: drawings or make(s)[2)]: ..... Type(s): .....

Relief valve; pressure setting: .....

Fan: characteristics or make(s)[2)]: ..... Type(s): .....

Fan drive system: .....

Drive ratio: .....

Fan cowl: .....

b) Air:

Blower characteristics or make(s)[2)]: .....Type(s): .....

Drive ratio: .....

Air ducting (standard production): .....

Temperature regulating system: yes/no[2)]: .....

Brief description: .....

9.2.2.1.3 Temperatures specified by the manufacturer

a) Liquid cooling:

Maximum temperature at outlet: ..... K

b) Air cooling:

Reference point (description): .....

Maximum temperature at reference point: ..... K

Maximum exhaust temperature: ..... K

Fuel temperature, min: ..... K max.: ..... K

Lubricant temperature, min.: ..... K max.: ..... K

9.2.2.1.4 Pressure charger: with/without[2)]

Description of the system: .....

Make: .....Type: .....

Compressor system, Make: ..... Type: .....

Charge air cooling system, Make: ..... Type: .....

9.2.2.1.5 Inlet system

Description and diagrams of air inlets and their accessories (heating device, inlet silencer, etc.):

Inlet manifold: ..... Description: .....

Air filter: .....Make: .....Type: .....

Inlet silencer: .....Make: .....Type: .....

9.2.2.1.6 Additional anti-pollution devices (if any, and if not covered by another heading)

Description and diagrams: .....

9.2.2.1.7 Fuel feed system

Fuel feed: .....

Feed pump: .....

Pressure: .....kPa

or characteristic diagram[2),3)] .....

Injection system: .....

Pump:

Make(s): .....

Type(s): .....

Delivery: ..... mm^3 per stroke[3)] ..... at pump speed of .....min^{-1} [3),4)]

..... at full injection, or characteristic diagram[3)] .....

Quote the method used: on engine/on pump bench[2)]

Injection advance[3)]: .....

Injection advance curve: .....

Timing: .....

Injection piping:

Length: ..... mm

Internal diameter: ..... mm

Injector(s):

Make(s): .....

Type(s): .....

Opening pressure: ..... kPa

or characteristic diagram[2),3)]: .....

4) 1 min^{-1} = 1 r/min

Governor:

Make(s): .....

Type(s): .....

Speed at which cut-off starts under full load: ..... min^{-1}

Maximum no-load speed: ..... min^{-1}

Idling speed: ..... min^{-1}

Cold-starting system:

Make(s): .....

Type(s): .....

Description: .....

9.2.2.1.8 Valve timing

Maximum lift of valves and angles of opening and closing in relation to dead centre:

.....

Reference and/or setting ranges[2]: .....

9.2.2.1.9 Exhaust system

Description of exhaust manifold: .....

Description of other parts of the exhaust equipment if the test is made with the complete exhaust equipment provided by the manufacturer, or indication of the maximum back-pressure at maximum power specified by the manufacturer[2]

9.2.2.1.10 Lubrication system

Description of system: .....

Position of lubricant reservoir: .....

Feed system (circulation by pump, injection into inlet, mixing with fuel, etc.): .....

Circulating pump[3]:

Make: .....

Type: .....

Mixture with fuel[3]: .....

Percentage: .....

Oil cooler: with/without[2]

Drawing(s) or make(s)[2]: .....Type(s): .....

9.2.2.1.11 Electrical equipment

Generator/alternator[2]: .....

Characteristics or make(s)[2]: ..... Type(s): .....

9.2.2.1.12 Auxiliary equipment driven by the engine and not removed for the test

(List and brief description if necessary): .....

9.2.2.2 Spark-ignition engines — Essential characteristics[1)]

9.2.2.2.1 Description of engine

Make: .....

Type: .....

Cycle: four-stroke/two-stroke[2)]

Bore: ..... mm

Stroke: ..... mm

Number of cylinders: .....

Layout of cylinders: ..... Firing order: .....

Engine swept volume: ..... litres

Compression ratio[3)]: .....

9.2.2.2.2 Cooling system

a) Liquid:

Nature of liquid: .....

Circulating pump: yes/no[2)]

Characteristics or make(s)[2)]: ..... Type(s): .....

Drive ratio: .....

Thermostat setting: .....

Radiator: drawing(s) or make(s)[2)]: ..... Type(s): .....

Relief valve: .....

Fan: characteristics or make(s)[2)]: ..... Type(s): .....

Fan drive system: .....

Drive ratio: .....

Fan cowl: .....

b) Air:

Blower: characteristics or make(s)[2)]: ..... Type(s): .....

Drive ratio: .....

Air ducting (standard production): .....

Temperature regulating system: yes/no[2)]

Brief description: .....

9.2.2.2.3 Temperatures specified by the manufacturer

Liquid cooling:

Maximum temperature at outlet:..... K

Air cooling:

Reference point (description): .....

Maximum temperature at reference point: ..... K

Maximum exhaust temperature: ..... K

Fuel temperature : min :..... K max.: ..... K

Lubricant temperature: min.:..... K max.: ..... K

9.2.2.2.4 Pressure-charger: with/without[2)]

Description of the system: .....

Make: ..... Type: .....

Compressor system: Make: ..... Type: .....

Charge air cooling system: Make: ..... Type: .....

9.2.2.2.5 Inlet system

Description and diagrams or air inlets and their accessories (dash-pot, heating device, inlet silencer, etc.):

.....

Inlet manifold: ..... Description: .....

Air filter: ..... Make: ..... Type: .....

Inlet silencer: ..... Make: ..... Type: .....

9.2.2.2.6 Additional anti-pollution devices (if any, and if not covered by another heading)

Description and diagrams: .....

9.2.2.2.7 Fuel feed systems

Fuel feed:

By carburettor(s)[2)]: ..... Number: .....

Make: .....

Type: .....

Adjustments [or provide a curve of fuel delivery plotted against air flow and setting required to keep the curve[3)]]:

Jets: .....

Venturis: .....

Float-chamber level: .....

Float mass: .....

Float needle: .....

Manual/automatic choke[2]: .....

Closure setting[3]: .....

Feed pump:

Pressure: ..... kPa ..... or characteristic diagram[2]: .....

By fuel injection[2]:

Make(s): .....

Type(s): .....

Description (general): .....

Calibration: ..... kPa ..... or characteristic diagram[2]: .....

9.2.2.2.8 Valve timing

Maximum lift of valves and angles of opening and closing in relation to dead centre:

.....

Reference and/or setting ranges[2]: .....

9.2.2.2.9 Ignition systems

Ignition distributor:

Knock sensor: yes/no[2]

Strategy: retard only or advance/retard[2]

Make: .....

Type: .....

Ignition advance curve[3]: .....

Ignition timing[3]: .....

Contact-point gap[3] and dwell-angle[3]: .....°

Spark-plugs:

Make: .....

Type: .....

Spark-gap setting: .....

Ignition coil:

Make: .....

Type: .....

Ignition condenser:

Make: .....

Type: .....

Radio interference suppression equipment:

Make: .....

Type: .....

9.2.2.2.10 Exhaust system

Description and diagrams: .....

9.2.2.2.11 Lubrication system

Description of system:

Position of lubricant reservoir: .....

Feed system (circulation by pump, injection into inlet, mixing with fuel, etc.): .....

.....

Circulating pump[3)]:

Make: .....

Type: .....

Mixture with fuel[3)]:

Percentage: .....

Oil cooler: with/without[2)]

Drawing(s) or make(s)[2)]: ..... Type(s): .....

9.2.2.2.12 Electric equipment

Generator/alternator[2)]:

Characteristics or make(s)[2)]: ..... Type(s): .....

9.2.2.2.13 Auxiliary equipment driven by the engine and not removed for the test

(List and brief description if necessary): .....

9.2.2.3 Test conditions for measuring net and gross power[3)]

Trade-name or -mark of the engine: .....

Type and identification number of engine: .....

Test conditions:

Pressures measured at maximum power: .....

Total barometric pressure: ..... kPa

Water vapour pressure: ..... kPa

Exhaust back-pressure : ..... kPa

Location of exhaust back-pressure measurement point: .....

Inlet depression: ..... Pa

Absolute pressure in the inlet ductwork: ..... Pa

Temperatures measured at maximum power:

of the inlet air: ..... K

at the engine charge air cooler: ..... K

of the cooling fluid:

at the engine cooling fluid outlet: ..... K[2)]

at the reference point in the case of air cooling: ..... K[2)]

of the lubricating oil:

at measurement point: ..... K

of the fuel:

at the carburettor inlet/fuel injection manifold inlet[2)]: ..... K

in the fuel flow-measuring device: ..... K

Characteristics of the dynamometer:

Make: ..... Model: .....

Type: .....

Rating: .....

Characteristics of the opacimeter:

Make: ..... Model: .....

Type: .....

Fuel flow-measuring apparatus: gravimetric/volumetric[2)]:

Fuel:

For spark-ignition engines operating on liquid fuel:

Make and type:.....

Specification:

Research Octane Number (RON): ..... (in accordance with ISO 5164)[5)]

Motor Octane Number (MON): ..... (in accordance with ISO 5163)[5)]

Percentage and type of oxygenates: .....

Density: ..... g/cm^3 at 288 K (in accordance with ISO 3675)[5)]

Lower calorific value, measured[1)]: .....kJ/kg (in accordance with ASTM D 240)

or, lower calorific value, estimated[1)]: ... kJ/kg (in accordance with ASTM D 3338/D 3338M)

Fuel temperature: ..... K

5) ASTM Standards also exist.

For spark-ignition engines operating on gaseous fuel:

Make: .....

Specification: .....

Storage pressure: ..... kPa

Utilization pressure: ..... kPa

Lower calorific value: ..... kJ/kg

For compression-ignition engines operating on gaseous fuel:

Feed systems for gas: .....

Specification of gas used: .....

Fuel oil/gas proportion: .....

Lower calorific value: ..... kJ/kg

For compression-ignition engines operating on liquid fuel:

Make: .....

Specification of fuel used: .....

Cetane number: .....(in accordance with ISO 5165)[5)]

Viscosity: ..... mm^2/s at 40 °C (in accordance with ISO 3104)[5)]

Density: ..... g/cm^3 at 288 K (in accordance with ISO 3675)[5)]

Lower calorific value, measured: ..... kJ/kg (in accordance with ASTM D 240)

or lower calorific value, estimated: ..... kJ/kg (in accordance with ASTM D 3338)

Fuel temperature: ..... K

Lubricant:

Make: .....

Specification: .....

SAE viscosity: .....

9.2.2.4 Statement of results as a function of engine speed[6)]

The statement of results shall be presented in the format of Table 13.

6) The characteristic curves of net or gross power and net or gross torque, of the specific fuel consumption and of the exhaust smoke values shall be drawn as a function of the engine speed.

Table 13 — Statement of results

Parameter		Result	Unit
Engine speed			min^{-1}
Measured torque			Nm
Measured power			kW
Measured fuel flow			g/s[a]
Measured smoke			m^{-1}
Barometric pressure			kPa
Water vapour pressure			kPa
Inlet air temperature			K
Power to be added for auxiliaries in excess of Table 1 (see 9.2.2.1.12 and 9.2.2.2.13)	No. 1		kW
	No. 2		kW
	No. 3		kW
Power correction factor			1
Corrected fuel flow			g/s[a]
Corrected brake power, [with/without b) fan or blower]			kW
Power of fan or blower, (to be subtracted if fan or blower is not fitted)[b]			kW
For gross power, the power of fan or blower, (to be added if fan or blower is fitted)[b]			kW
Net or gross power			kW
Net or gross torque			Nm
Specific fuel consumption			g/kWh[c]
Smoke correction factor			1
Corrected smoke			m^{-1}
Coolant temperature at outlet/reference point[b]			K
Lubricating oil temperature at measuring point			K
Air temperature after pressure-charger			K[b]
Fuel temperature at injection pump inlet			K
Air temperature after charge air cooler			K[b]
Pressure after pressure-charger			kPa[b]
Pressure after charge air cooler			kPa[b]

[a] For spark-ignition engines, the corrected fuel flow is the measured fuel flow multiplied by the power correction factor. The concept of corrected fuel flow is added only for calculation purposes. For compression-ignition engines, the corrected fuel flow is equal to the measured fuel flow, except for constant power engines.

[b] Strike out what does not apply.

[c] Calculated with corrected net power and corrected fuel flow.

Bibliography

[1] ISO 1585, *Road vehicles — Engine test code — Net power*

[2] ISO 2534, *Road vehicles — Engine test code — Gross power*

[3] ISO 3046-1, *Reciprocating internal combustion engines — Performance — Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods — Additional requirements for engines for general use*

[4] ISO 3833:1977, *Road vehicles — Types — Terms and definitions*

[5] ISO 4106, *Motorcycles — Engine test code — Net power*

[6] ISO 7876-1:1990, *Fuel injection equipment — Vocabulary — Part 1: Fuel injection pumps*

[7] ISO 8178-1, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 1: Test-bed measurement of gaseous and particulate exhaust emissions*

[8] ISO 8178-2, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 2: Measurement of gaseous and particulate exhaust emissions under field conditions*

[9] ISO 8178-3, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 3: Definitions and methods of measurement of exhaust gas smoke under steady-state conditions*

[10] ISO 8178-4, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 4: Steady-state test cycles for different engine applications*

[11] ISO 8178-5, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 5: Test fuels*

[12] ISO 8178-6, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 6: Report of measuring results and test*

[13] ISO 8178-7, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 7: Engine family determination*

[14] ISO 8178-8, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 8: Engine group determination*

[15] ISO 8178-9, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 9: Test cycles and test procedures for test bed measurement of exhaust gas smoke emissions from compression ignition engines operating under transient conditions*

[16] ISO 8178-10, *Reciprocating internal combustion engines — Exhaust emission measurement — Part 10: Test cycles and test procedures for field measurement of exhaust gas smoke emissions from compression ignition engines operating under transient conditions*

[17] ISO 8665, *Small craft — Marine propulsion reciprocating internal combustion engines — Power measurements and declarations*

[18] ISO 9249, *Earth-moving machinery — Engine test code — Net power*

[19] ISO 14396, *Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178*

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