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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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## Contents

Page

Foreword.....	iv
Introduction.....	v
1 Scope .....	1
2 Normative references .....	2
3 Terms and definitions .....	3
3.1 Auxiliaries and equipment.....	3
3.2 Engine.....	3
3.3 Power and load .....	4
3.4 Consumption and delivery.....	10
3.5 Tests.....	11
4 Symbols .....	12
5 Standard reference conditions.....	18
6 Tests.....	18
6.1 General.....	18
6.2 Test method 1 .....	18
6.3 Test Method 2.....	25
7 Method of power correction .....	28
7.1 General.....	28
7.2 Test atmospheric conditions.....	29
7.3 Correction factor $\alpha_a$ for naturally aspirated and pressure-charged spark-ignition engines (with or without charge air cooling).....	29
7.4 Correction factor $\alpha_c$ for compression-ignition (diesel) engines.....	29
7.5 Other types of engine.....	31
8 Measurement and correction of smoke value for compression-ignition (diesel) engines .....	31
8.1 General.....	31
8.2 Correction factor for the smoke light absorption coefficient .....	31
8.3 Determination of the correction factor for the smoke light absorption coefficient.....	32
8.4 Limits of application.....	32
9 Test report .....	32
9.1 Test method 1 .....	32
9.2 Test method 2 .....	33
Bibliography.....	46

## 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 15550 was prepared by Technical Committee ISO/TC 70, *Internal combustion engines*.

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## Introduction

This International Standard 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” standards contains those requirements that are necessary to tailor power measurement and declaration to suit a particular engine application.

This International Standard 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 International Standard is the “Core” standard.

This International Standard 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 ISO 15550 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).

If requirements from the regulations of any other authority (e.g. inspecting and/or legislative authority) have to be met, the relevant authority must be confirmed by the customer prior to placing the order.

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

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

## 1 Scope

1.1 This International Standard 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 applies to:

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

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

1.2 This International Standard applies to engines used for:

- 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 as defined in ISO 2288;
- 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 International Standard may 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 may be applied to tests performed both on a test bed at a manufacturer's works as well as on site.

1.3 Individual requirements for a particular engine application are given in the relevant "Satellite" standard. In order to completely specify the requirements relevant to a particular engine application this "Core" standard shall only be used in conjunction with the relevant "Satellite" standard.

## 2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 1585:1992, *Road vehicles — Engine test code — Net power*

ISO 2288:1997<sup>1)</sup>, *Agricultural tractors and machines — Engine test code — Net power*

ISO 2534:1998, *Road vehicles — Engine test code — Gross power*

ISO 2710-1:2000, *Reciprocating internal combustion engines — Vocabulary — Part 1: Terms for engine design and operation*

ISO 3046-4:1997, *Reciprocating internal combustion engines — Performance — Part 4: Speed governing*

ISO 3046-5:2001, *Reciprocating internal combustion engines — Performance — Part 5: Torsional vibrations*

ISO 3046-6:1990, *Reciprocating internal combustion engines — Performance — Part 6: Overspeed protection*

ISO 3104:1994, *Petroleum products — Transparent and opaque liquids — Determination of kinematic viscosity and calculation of dynamic viscosity*

ISO 3675:1998, *Crude petroleum and liquid petroleum products — Laboratory determination of density — Hydrometer method*

ISO 4106:1993, *Motorcycles — Engine test code — Net power*

ISO 5163:1990, *Motor and aviation-type fuels — Determination of knock characteristics — Motor method*

ISO 5164:1990, *Motor fuels — Determination of knock characteristics — Research method*

ISO 5165:1998, *Petroleum products — Determination of the ignition quality of diesel fuels — Cetane engine method*

ISO 8665:1994, *Small craft — Marine propulsion engines and systems — Power measurements and declarations*

ISO 9249:1997, *Earth-moving machinery — Engine test code — Net power*

ISO 11614:1999, *Reciprocating internal combustion compression-ignition engines — Apparatus for measurement of the opacity and for determination of the light absorption coefficient of exhaust gas*

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*

ASTM D 240-00, *Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter*

ASTM D 3338-00, *Standard Test Method for Estimation of Net Heat of Combustion of Aviation Fuels*

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1) Since withdrawn.



### 3 Terms and definitions

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

NOTE For the convenience of readers some definitions are included from ISO 2710-1, ISO 3046-4 and ISO 7876-1.

#### 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

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#### 3.2 Engine

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##### 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 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

[ISO 2710-1]

##### 3.2.4

##### **declared engine speed**

engine speed corresponding to the declared power

[ISO 2710-1]

NOTE 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

[ISO 2710-1]

**3.2.7**

**engine speed at maximum torque**

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

[ISO 3046-4]

**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 In some applications, the declared power is named "rated power".

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**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

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**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

[ISO 2710-1]

**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

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 2288 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 <sup>a</sup>	Optional <sup>a</sup>	Yes <sup>a</sup>
	Air filter	Yes, if SPE <sup>a</sup>	Optional <sup>a</sup>	Yes <sup>a</sup>
	Inlet silencer	Yes, if SPE <sup>a</sup>	Optional <sup>a</sup>	Yes <sup>a</sup>
	Speed-limiting device	Yes, if SPE <sup>a</sup>	No	Yes <sup>a</sup>
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 <sup>b</sup>	Optional, may use minimum loss test bed system <sup>b</sup>	Yes, <sup>b</sup>
	Silencer	Yes, if SPE <sup>b</sup>		Yes, <sup>b</sup>
	Tail pipe	Yes, if SPE <sup>b</sup>		Yes, <sup>b</sup>
	Exhaust brake	Yes, if SPE <sup>c</sup>	No <sup>c</sup>	No <sup>c</sup>
4	Fuel supply pump	Yes, if SPE <sup>d</sup>	Yes, if SPE <sup>d</sup>	Yes, if SPE <sup>d</sup>
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
	Mixer	Yes, if SPE	Yes, if SPE	Yes, if SPE

Table 1 (continued)

1	2	3	4	5
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 <sup>e</sup>
	Air inlet valve	Yes, if SPE <sup>e</sup>	Yes, if SPE <sup>e</sup>	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 <sup>f</sup>	No	No
	Fan	Yes, if SPE <sup>f, g</sup>	No <sup>f</sup>	No
	Fan cowl	Yes, if SPE <sup>f</sup>	No	No
	Water pump	Yes, if SPE <sup>f</sup>	Yes, if SPE	Yes, if SPE <sup>f</sup>
	Thermostat	Yes, if SPE <sup>f, h</sup>	Optional <sup>h</sup>	Yes, if SPE <sup>h</sup>
8	Air cooling: Cowl	Yes, if SPE <sup>f</sup>	No	No
	Fan or blower	Yes, if SPE <sup>f, g</sup>	No <sup>f</sup>	No <sup>i</sup>
	Temperature-regulating device	Yes, if SPE	No	No
9	Electrical equipment: Generator	Yes, if SPE <sup>j</sup>	Yes, if SPE <sup>j</sup>	Yes, if SPE <sup>j</sup>
	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 <sup>k</sup>	Yes, if SPE <sup>k</sup>	Yes, if SPE <sup>k</sup>
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 <sup>l</sup>	Yes, if SPE <sup>l</sup>	Yes, if SPE <sup>l</sup>
	Charge air cooler	Yes, if SPE <sup>f, g, m</sup>	Yes, if SPE <sup>f, g, m</sup>	Yes, if SPE, or test bed equipment <sup>i, m</sup>
	Coolant pump or fan (engine-driven)	Yes, if SPE	Yes, if SPE	No <sup>i</sup>
	Coolant flow control device	Yes, if SPE	Yes, if SPE	Yes, if SPE

Table 1 (continued)

1	2	3	4	5
11	Auxiliary test-bed fan	Yes, if necessary	Yes, if necessary	Yes, if necessary
12	Anti-pollution device	Yes, if SPE <sup>n</sup>	Yes, if SPE <sup>n</sup>	Yes, if SPE <sup>n</sup>
13	Lubricating oil pump	Yes, if SPE	Yes, if SPE	Yes, if SPE
NOTE	"Yes, if SPE" means that this equipment must be fitted for the engine power determination if it is Standard Production Equipment (SPE).			
a	<p>— For net power/gross power test:</p> <p>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.</p> <p>— For engine power test for ISO 8178:</p> <p>The complete inlet system for the intended application shall be fitted:</p> <ul style="list-style-type: none"> <li>— where there is a risk of an appreciable effect on the engine power;</li> <li>— in the case of naturally aspirated spark ignition engines;</li> <li>— when the manufacturer requests that this should be done.</li> </ul> <p>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.</p>			
b	<p>— For net power test:</p> <p>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.</p> <p>— For gross power test:</p> <p>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.</p> <p>— For engine power test for ISO 8178:</p> <p>The complete exhaust system for the intended application shall be fitted:</p> <ul style="list-style-type: none"> <li>— where there is a risk of an appreciable effect on the engine power;</li> <li>— in the case of naturally aspirated spark ignition engines;</li> <li>— when the manufacturer requests that this should be done.</li> </ul> <p>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.</p>			
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	<p>— For net power test:</p> <p>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.</p> <p>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.</p> <p>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.</p>
	<p>— For gross power test:</p> <p>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.</p>
	<p>— For engine power test for ISO 8178:</p> <p>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.</p>
g	<p>— For net power test:</p> <p>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.</p>
	<p>— For gross power test:</p> <p>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.</p>
h	<p>The thermostat may be fixed in the fully open position.</p>
i	<p>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.</p>
j	<p>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.</p>
k	<p>The spark advance shall be representative of in-use conditions established with the minimum octane fuel recommended by the manufacturer.</p>
l	<p>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.</p>
m	<p>— For net power test/gross power test:</p> <p>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.</p> <p>— For engine power test for ISO 8178:</p> <p>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.</p>
n	<p>These may include, e.g. Exhaust Gas Recirculation (EGR), catalytic converter, thermal reactor, secondary air-supply and fuel evaporation protection systems.</p>

**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 listed in Table 1, column 2 and required in column 3 (fitted for engine net power test)

NOTE 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 listed in Table 1, column 2 and required in column 4 (fitted for engine gross power test)

NOTE 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 specified by the manufacturer at the declared power with the engine being fitted only with equipment and auxiliaries as listed in Table 1, column 2 and required in column 5 (fitted for engine power test in accordance with ISO 8178)

**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 (standards.iteh.ai)

**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 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 clause 5

**3.3.7.1****ISO standard power**

continuous brake power 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 adjusted or corrected as determined by the manufacturer to the standard reference conditions specified in clause 5;
- c) with the maintenance prescribed by the engine manufacturer having been carried out.