



## **EAST AFRICAN STANDARD**

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The determination of performance (at net power) of internal combustion engines — Part 2: Compression ignition engines at altitude

**EAST AFRICAN COMMUNITY**

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## Foreword

Development of the East African Standards has been necessitated by the need for harmonizing requirements governing quality of products and services in East Africa. It is envisaged that through harmonized standardization, trade barriers which are encountered when goods and services are exchanged within the Community will be removed.

In order to meet the above objectives, the EAC Partner States have enacted an East African Standardization, Quality Assurance, Metrology and Test Act, 2006 (EAC SQMT Act, 2006) to make provisions for ensuring standardization, quality assurance, metrology and testing of products produced or originating in a third country and traded in the Community in order to facilitate industrial development and trade as well as helping to protect the health and safety of society and the environment in the Community.

East African Standards are formulated in accordance with the procedures established by the East African Standards Committee. The East African Standards Committee is established under the provisions of Article 4 of the EAC SQMT Act, 2006. The Committee is composed of representatives of the National Standards Bodies in Partner States, together with the representatives from the private sectors and consumer organizations. Draft East African Standards are circulated to stakeholders through the National Standards Bodies in the Partner States. The comments received are discussed and incorporated before finalization of standards, in accordance with the procedures of the Community.

Article 15(1) of the EAC SQMT Act, 2006 provides that "Within six months of the declaration of an East African Standard, the Partner States shall adopt, without deviation from the approved text of the standard, the East African Standard as a national standard and withdraw any existing national standard with similar scope and purpose".

East African Standards are subject to review, to keep pace with technological advances. Users of the East African Standards are therefore expected to ensure that they always have the latest versions of the standards they are implementing.

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# The determination of performance (at net power) of internal combustion engines — Part 2: Compression ignition engines at altitude

## 1 Scope

**1.1** This part of CD/K/049 covers a method for determining the net power of compression ignition engines at an altitude of 1400 m above sea level.

**1.2** This part of CD/K/049 covers compression ignition engines used for the propulsion of landborne vehicles, excluding motor cycles. The engines may be fitted with turbochargers or mechanically driven superchargers.

**1.3** It does not cover compression ignition engines for rail traction or marine use, or engines used to propel road construction and earth moving machines or industrial trucks.

## 2 Normative references

The following referenced documents are indispensable for the application of this East African Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1585, *Road vehicle — Engine test code — Net power*

CD/K/049-1:2008, *The determination of performance (at net power) of internal combustion engines — Part 1: Road vehicle internal combustion engines at sea level*

CD/K/049-3:2008, *The determination of performance (at net power) of internal combustion engines — Part 3: Agricultural vehicle internal combustion engines at sea level*

## 3 Definitions

For the purposes of this part of CD/K/049, the definitions given in CD/K/049-1:2008 and the following definitions apply:

### 3.1

#### **altitude**

altitude corresponding to the reference atmospheric conditions subject to the variations allowed by the correction factor, and normally 1400 m above sea level

### 3.2

#### **correction factor**

factor by which the observed power, torque, and specific fuel consumption are multiplied to determine the engine performance under the reference atmospheric conditions given in 6.1

## 4 Accuracy of measurements

When an engine that is covered by CD/K/049-1:2008 is tested at the reference altitude, the accuracy of measurement shall be as given in CD/K/049-1:2008.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, the accuracy of measurement shall be as given in CD/K/049-3:2008.

## CD/K/049-2:2008

### 5 Tests

#### 5.1 Auxiliaries

When an engine that is covered by CD/K/049-1:2008 is tested at the reference altitude, the fitting and removal of auxiliaries shall be as given in CD/K/049-1:2008.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, the fitting and removal of auxiliaries shall be as given in CD/K/049-3:2008.

#### 5.2 Setting conditions

The injection timing, injector break pressures, and fuel pump calibration recommended by the engine or vehicle manufacture for operation at altitude shall be used.

#### 5.3 Test conditions

The test conditions given in CD/K/049-1:2008 shall apply except that in the case of intercooled engines, the net power at the maximum permissible temperature of charge of air recommended by the manufacturer shall be determined.

#### 5.4 Test procedure

##### 5.4.1 Engine settings

Check by suitable tests the fuel injection timing, injector break pressures, fuel pump calibration, and governor settings.

##### 5.4.2 Part-load performance

Select at least four speeds, including maximum torque speed and maximum rated speed. Start each constant speed part-load curve at full load and record data at a sufficient number of load conditions to define completely the part-load curve between maximum load for each speed and 20 % of that value.

##### 5.4.3 Full-load performance

Select a sufficient number of operating speeds to define completely the power curve, including the governor run-out characteristic. For engines where the minimum full-load operating speed is not specified by the manufacturer, start the performance curves at an engine speed of 1 000 r/min or 45 % of the maximum rated speed, whichever is the greater. For engines where the minimum full-load speed is specified, conduct the performance tests between the speeds recommended by the manufacturer.

#### 5.5 Data to be recorded

When an engine that is covered by CD/K/049-1:2008 is tested at the reference altitude, the data to be recorded shall be that required by CD/K/049-1:2008.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, the data to be recorded shall be that required by CD/K/049-3:2008.

In both cases the data obtained in terms of 5.4 and clause 7 shall also be recorded.

### 6 Correction factors (see 3.2)

#### 6.1 Reference atmospheric conditions

The reference atmospheric conditions shall be as follows:

- a) temperature: 25 °C (298 K); and
- b) total pressure: 87 kPa, humidity being neglected.

## 6.2 Limitations in the use of correction formulae

When an engine that is covered by CD/K/049-1:2008 is tested at reference altitude, the limitations in the use of correction factors shall be those given in CD/K/049-1:2008.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, the limitations in the use of correction factors shall be those given in CD/K/049-3:2008.

## 6.3 Determination of correction factors

When an engine that is covered by CD/K/049-1:2008 is tested at reference altitude, the correction factors shall be determined by using the appropriate formulae for diesel engines given in CD/K/049-1:2008 but with a substitution of "87" for "99" wherever "99" appears.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, the correction factors shall be determined by using the appropriate formulae for diesel engines given in CD/K/049-3:2008 but with the substitution of "87" for "99" wherever "99" appears.

## 7 Measurement of smoke values

Measure the emission of smoke in accordance with CD/K/049-1:2008, or CD/K/049-3:2008, or ISO 1585, as applicable.

## 8 Test report

### 8.1 General

When an engine that is covered by CD/K/049-1:2008 is tested at the reference altitude, include in the test report the relevant data required by CD/K/049-1:2008.

When an engine that is covered by CD/K/049-3:2008 is tested at the reference altitude, include in the test report the relevant data required by CD/K/049-3:2008.

In all the cases plot the exhaust smoke emission curve at the limiting smoke value derived from Figure 1.

### 8.2 Statement of net output

The engine net output may be expressed as follows provided that the exhaust smoke emission values are below the value derived from Table 1 and Figure 1 for the appropriate steady state speed conditions :

Maximum net power..... kWat..... r/min (this part of CD/K/049)

Minimum net torque ..... N-m at..... r/min

Minimum specific fuel consumption at full load ..... g/kW-h at..... r/min

Date of test.....

### 8.3 Part-load performance

Draw the characteristic curves of the specific fuel consumption as a function of the corrected power for each speed setting, using for specific fuel consumption a scale of 1 mm = 2 g/kW-h.

Table 1 — Steady-state smoke limiting values of absorption coefficient versus nominal flow for engines rated in terms of this part of CD/K/049

1	2
Nominal flow G L/s	Absorption coefficient K m <sup>-1</sup>
≤42	2.76
45	2.69
50	2.58
55	2.485
60	2.40
65	2.34
70	2.275
75	2.22
80	2.165
85	2.12
90	2.075
95	2.035
100	1.995
105	1.965
110	1.925
115	1.895
120	1.87
125	1.845
130	1.82
135	1.80
140	1.77
145	1.75
150	1.725
155	1.705
160	1.69
165	1.67
170	1.655
175	1.64
180	1.625
185	1.610
190	1.595
195	1.58
≥200	1.565

NOTE 1 Although the values in column 2 are rounded to the nearest 0.01 or 0.005, it does not mean that the measurements need to be made to this degree of accuracy.

NOTE 2 The values correspond to those given in ECE Regulation 24 plus an allowance of 0.5 m<sup>-1</sup>

$$\begin{aligned} \text{Nominal gas flow} &= \frac{Vn}{60} \text{ L/s for two-stroke engines} \\ &= \frac{Vn}{120} \text{ L/s for four-stroke engines} \end{aligned}$$

where  
 V is the total cylinder swept volume, in litres;  
 n is the crankshaft speed, in revolutions per minute.

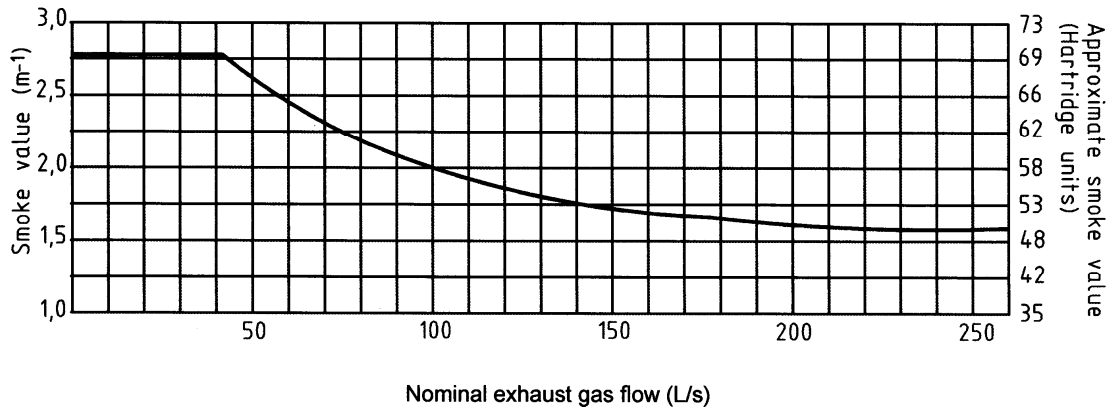


Figure 1 — Steady-state smoke limitations for engines in a new condition rated in terms of this part of CD/K/049 at 1 400 m above sea level

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## Bibliography

ECE Regulation 24, *Uniform provisions concerning: I: The approval of compression ignition (C.I) engines with regard to the emission of visible pollutants; II: The approval of motor vehicles with regard to the installation of C.I engines of an approved type; III: The approval of motor vehicles equipped with C.I engines with regard to the emission of pollutants by the engine; IV: The measurement of power of C.I engine*

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*

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