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**Powered two-wheeled vehicles—
Measurement method of exhaust
(tail pipe) gases from spark ignition
engines**

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Foreword

This translation has been made based on the original Japanese Industrial Standard established by the Minister of Economy, Trade and Industry through deliberations at the Japanese Industrial Standards Committee according to the proposal of establishing a Japanese Industrial Standard from Society of Automotive Engineers of Japan, Inc. (JSAE), with a draft of Industrial Standard based on the provision of Article 12 Clause 1 of the Industrial Standardization Law.

This Standard has been prepared based on **ISO 6460 : 1981** *Road vehicles—Measurement method of gaseous pollutants emitted by motor-cycles equipped with a controlled ignition engine* for the purposes of making easy to compare this Standard with International Standards; to prepare Japanese Industrial Standard conforming with International Standards; and to propose a draft of International Standard which is based on Japanese Industrial Standard.

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Powered two-wheeled vehicles— Measurement method of exhaust (tail pipe) gases from spark ignition engines

Introduction This Japanese Industrial Standard has been prepared based on the first edition of **ISO 6460** *Road vehicles—Measurement method of gaseous pollutants emitted by motorcycles equipped with a controlled ignition engine* published in 1981 with conforming to the International Standard in the corresponding part (clauses) without modifying the technical contents, but it has some provisions, as Japanese Industrial Standard, adding to or altering the corresponding International Standard.

The portions given sidelines or underlines with dots in this Standard are the matters added to or altered from the original International Standard.

1 Scope This Standard specifies measurement methods, by using analyzers, which are dilution method as collecting the sample gas to be measured after dilution with air and direction method as collecting the sample directly at the tail pipe(s), of gaseous pollutants emitted by powered two-wheeled vehicles equipped with a controlled ignition gasoline engine (refer to moped, motorcycle and motorcycle with sidecar hereafter referred to as moped/motorcycle) during a mode driving (hereafter referred to as “operating cycle”) or idling.

Remarks : The International Standard corresponding to this Standard is as follows.

In addition, symbols which denote the degree of correspondence in the contents between the relevant International Standard and **JIS** are IDT (identical), MOD (modified), and NEQ (not equivalent) according to **ISO/IEC Guide 21**.

ISO 6460 : 1981 *Road vehicles—Measurement method of gaseous pollutants emitted by motorcycles equipped with a controlled ignition engine* (MOD)

2 Normative references The following standards contain provisions which, through reference in this Standard, constitute provisions of this Standard. The most recent editions of the standards (including the amendments) indicated below shall be applied.

JIS D 1012 *Automobiles—Rate of fuel consumption test methods*

JIS D 1030 *Automobiles—Analytical procedure for measurement of carbon monoxide, carbon dioxide, total hydrocarbons and oxides of nitrogen in exhaust gas*

JIS D 1036 *Mopeds and motorcycles—Method of coasting test*

JIS D 1037 *Motorcycles—Measurement of maximum speed*

JIS K 2202 *Motor gasoline*

JIS K 2249 *Crude petroleum and petroleum products—Determination of density and petroleum measurement tables based on a reference temperature (15 °C)*

Remarks : **ISO 649-1** : 1981 *Laboratory glassware—Density hydrometers for general purposes—Part 1 : Specification* and **ISO 91-1** : 1992 *Petroleum measurement tables—Part 1 : Tables based on reference temperatures of 15 degrees C and 60 degrees F* are identical with the said standard, and **ISO 3675** : 1998 *Crude petroleum and liquid petroleum products—Laboratory determination of density—Hydrometer method* and **ISO 3838** : 1983 *Crude petroleum and liquid or solid petroleum products—Determination of density or relative density—Capillary-stoppered pycnometer and graduated bicapillary pycnometer methods* are equivalent to the said standard.

JIS K 2254 *Petroleum products—Determination of distillation characteristics*

Remarks : **ISO 3405** : 2000 *Petroleum products—Determination of distillation characteristics at atmospheric pressure* and **ISO 3924** : 1977 *Petroleum products—Determination of boiling range distribution—Gas chromatography method* are identical with the said standard.

JIS K 2255 *Petroleum products—Gasoline—Determination of lead content*

JIS K 2258 *Crude oil and petroleum products—Determination of vapour pressure—Reid method*

Remarks : **ISO 3007** : 1999 *Petroleum products and crude petroleum—Determination of vapour pressure—Reid method* is equivalent to the said standard.

JIS K 2261 *Petroleum products—Motor gasoline and aviation fuels—Determination of existent gum—Jet evaporation method*

JIS K 2280 *Petroleum products—Fuels—Determination of octane number, cetane number and calculation of cetane index*

JIS K 2536 *Liquid petroleum products—Testing method of components*

Remarks : **ISO 3837** : 1993 *Liquid petroleum products—Determination of hydrocarbon types—Fluorescent indicator adsorption method* is identical with the said standard.

JIS K 2541 *Crude oil and petroleum products—Determination of sulfur content*

JIS Z 8401 *Guide to the rounding of numbers*

Remarks : **ISO 31-0** : 1992 *Quantities and units—Part 0 : General principles* is identical with the said standard.

3 Definitions For the main terms used in this Standard, the definitions given in **JIS D 1030** and the following definitions apply.

- a) **exhaust gas** Gaseous substance, including pollutants, emitted into atmosphere through the tail pipe(s) while a moped/motorcycle engine is operating. For the purpose of this Standard, the gaseous pollutants refer to carbon monoxide (hereafter referred to as CO), hydrocarbons (THC or HC), nitrogen oxides (NO_x) and carbon dioxide (CO₂).
- b) **test moped/motorcycle** A moped/motorcycle, after subjected to breaking-in, completed check and maintenance. For the means of breaking-in and check and maintenance such as idling engine speed adjustment, the legal regulation and the moped/motorcycle manufacturer's recommendation are applied.

- c) **test moped/motorcycle kerb weight** Unladen mass of moped/motorcycle, of which the fuel tank is filled with fuel to 90 % of the capacity specified.
- d) **reference weight (of the test moped/motorcycle)** The mass corresponding to the test moped/motorcycle kerb weight increased by the legal rider mass. The number of riders, while it is one person in this test, shall be two persons in the case of a motorcycle with sidecar.
- e) **equivalent inertia** The total inertia of the rotating masses of the roller and dynamometer composing the chassis dynamometer.
Remarks : This equivalent inertia, for which the standard value determined with respect to the reference weight of the test moped/motorcycle is given, is to be used in setting the chassis dynamometer with the running resistance.
- f) **test track** To be used for measuring the running resistance of test moped/motorcycle on actual road. A dry, straight and flat paved road without discontinuous windbreak fence and the like. For the test track length, etc., **JIS D 1036** applies.
- g) **operating cycle** The mode of operating given in 8.2.2, to be applied for measurement of gaseous pollutants emitted by moped/motorcycle, simulating a certain operation on flat paved street in a town area.
- h) **analyzer** A generic term for non-dispersive infrared analyzer (hereafter referred to as "NDIR"), hydrogen-flame ionization detector-type analyzer (FID) and chemiluminescence analyzer (CL).
- i) **dilution (measurement) method** The method in which exhaust gas is diluted with clean air and collected through a constant volume sampling apparatus (hereafter referred to as "CVS apparatus") to be determined the concentration or quantity emitted of the objective pollutants in the dilute exhaust mixture.
- j) **direct (measurement) method** The method in which the exhaust gas is collected directly and continuously, by using a direct sampling apparatus to be determined the concentration of the objective pollutants in the exhaust gas.
- k) **sampling equipment** A device to collect sample gas and introduce it into analyzer. CVS apparatus, direct sampling apparatus and the like are applied appropriately.
- l) **CVS apparatus** Sampling device by which exhaust gas is diluted with clean air as allowed the total flow rate to be approximately uniform and part of the dilute exhaust mixture is collected into sample collection bag at a certain flow ratio to the total flow rate. Positive displacement pump method (hereafter referred to as "PDP method") or critical flow venturi method (hereafter referred to as "CFV method") may be used.
- m) **direct sampling apparatus** A device to collect directly, at the tail pipe(s), a part of exhaust gas for the sample tested.

4 Type of measurement methods For measuring the gaseous pollutants in exhaust gas, direct method and dilution method are serviceable. These methods shall be chosen according to the properties of the sample to be measured or the test result required. Table 1 shows each measurement method applicable to the tests, and Table 2, analyzers to be used in each method.

Table 1 Applicable test and measurement method

Applicable test	Measurement method
Measurement of concentration and calculation of emission quantity of gaseous pollutants in dilute exhaust mixture	Dilution method
Measurement of each gaseous pollutant concentration in exhaust gas	Direct method

Table 2 Analyzers used for each measurement method

Object gaseous pollutant	Dilution method	Direct method
CO, CO ₂	NDIR	NDIR
THC	FID	—
HC	—	NDIR
NO _x	CL	—

5 Test equipment

5.1 Test room The test room in which measurements of gaseous pollutants are carried out shall be provided with a cooling device and chassis dynamometer, and capable of controlling the room temperature at $25\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

5.2 Cooling device The cooling device shall have a blower performance as allow cooling of moped/motorcycle operated on the chassis dynamometer to be equivalent to that of the actual road operation, and shall be as follows besides.

- The blower duct shall have an opening area at least 0.4 m^2 , and shall be arranged as that the bottom of the outlet is between 0.15 m and 0.2 m above floor level and the distance from the outlet end to front end of the test moped/motorcycle is between 0.3 m and 0.45 m .

In the case of testing grade 1 moped or scooter type motorcycle, the bottom of the blower outlet may be between 0.05 m and 0.2 m above floor level.

- The cooling air velocity shall be controlled as being within $\pm 5\%$ of the operating speed for the chassis dynamometer roller speed of 10 km/h to 50 km/h . Where the roller speed is less than 10 km/h , the air velocity may be 0 km/h .

If the cooling device fixed in the test room does not attain the equivalent cooling to the actual operation of the test moped/motorcycle, an auxiliary cooling device may be used.

- To be positioned in front of the test moped/motorcycle.

5.3 Chassis dynamometer The chassis dynamometer shall have a performance capable of setting as being equivalent to running resistance of the test moped/motorcycle on actual road, and shall meet the requirements for each method of setting for running resistance specified in clause 6.

6 Setting of chassis dynamometer for running resistance A running resistance shall be applied, through setting of equivalent inertia and brake, to the chassis dynamometer. For the setting of brake for loading, any one of the three methods described in 6.3 shall be chosen.

6.1 General conditions of setting for running resistance

a) **Accuracy of instrument** The accuracy of measurement instruments used in these tests shall be according to **JIS D 1012** and as follows besides.

- 1) speedometer ± 0.5 km/h
- 2) coasting time measuring device ± 0.1 s
- 3) thermometer ± 2 °C
- 4) barometer ± 1 kPa
- 5) anemometer ± 1 m/s

b) **Calibration of instrument** The instruments shall be that, of which the accuracy has been verified, maintained and calibrated based on the relating manufacturer's instruction.

c) **Measurement of running resistance** In measuring running resistance on a test track, the riding posture of the rider shall be as specified in **JIS D 1036** and as follows.

- 1) The tolerance for test moped/motorcycle kerb weight shall be ± 20 kg thereof.
- 2) The atmospheric pressure and temperature shall be measured, by using a barometer and thermometer, to obtain the respective mean values of them at the commencement and end of measuring running resistance. Where the means for setting of brake is the method of coasting by running test on test track (hereafter referred to as "coasting method") or the method of limiting throttle valve opening rate by such road test (hereafter referred to as "limited throttling method"), see Attached Tables 1.1 and 1.2.

As to the wind, each wind velocity component of parallel to and vertical to the test track shall be observed or recorded, by using a vane and anemometer, at any time. The conditions of this wind are as follows. The mean parallel wind component parallel to the test track shall be 5 m/s or less, and that vertical, 2 m/s or less.

d) **Installation of test moped/motorcycle on chassis dynamometer** The test moped/motorcycle shall be treated as follows:

- 1) The test moped/motorcycle is allowed to be in a condition completed warming-up sufficiently.

The test moped/motorcycle, where it is warmed-up separately shall be driven at the highest speed in the operation cycle.

- 2) To make the test moped/motorcycle being in the state ridden by a rider. The test moped/motorcycle kerb weight in this case need not corresponding to the reference weight.
- 3) To remove such a substance possible causing slips as water and gravels and any hazardous objects from the driving wheel tyre of test moped/motorcycle.
- 4) To inflate the tyres at the value recommended by the moped/motorcycle manufacturer, which shall be measured while the moped/motorcycle is standing still on a horizontal plane before (cold) starting. When it is installed on a chassis dynamometer, however, if the roller diameter of the chassis dynamometer is less than 0.5 m, the tyre pressure may be adjusted within a limit of 1.5 times the moped/motorcycle manufacturer's recommendation as allow the test moped/motorcycle approaching the state of running on a flat paved road.
- 5) To install the test moped/motorcycle as causing lesser vibration and the like during the operation.

6.2 Setting for equivalent inertia The chassis dynamometer shall be set for the equivalent inertia with selecting either of by the reference weight of the test moped/motorcycle or by the standard value of equivalent inertia, IM , corresponding to the reference weight, m , given in Table 3. Where it is impossible to setting by a standard value of equivalent inertia in Table 3, setting by the equivalent inertia of one rank upper the relating standard value is permissible.

Table 3 Standard value of equivalent inertia and power absorbed at 50 km/h constant speed running

Reference weight m (kg)	Standard value of equivalent inertia ⁽¹⁾ IM (kg)	Power absorbed at 50 km/h constant speed running P_{V50} (kW)
$m \leq 85$	80	0.85
$85 < m \leq 95$	90	0.86
$95 < m \leq 105$	100	0.88
$105 < m \leq 115$	110	0.90
$115 < m \leq 125$	120	0.91
$125 < m \leq 135$	130	0.93
$135 < m \leq 145$	140	0.94
$145 < m \leq 165$	150	0.96
$165 < m \leq 185$	170	0.99
$185 < m \leq 205$	190	1.02
$205 < m \leq 225$	210	1.05
$225 < m \leq 245$	230	1.09
$245 < m \leq 270$	260	1.14
$270 < m \leq 300$	280	1.17
$300 < m \leq 330$	310	1.21
$330 < m \leq 360$	340	1.26
$360 < m \leq 395$	380	1.33
$395 < m \leq 435$	410	1.37
$435 < m \leq 475$	450	1.44
$475 < m \leq 515$	490	1.50
$515 < m \leq 555$	530	1.57
hereafter every 40 kg	hereafter every 40 kg	hereafter $P_{V50} = 0.001\ 6IM + 0.72$ ⁽²⁾

Notes (1) The deviation in equivalent inertia shall be within $\pm 1\%$ of the set value.

(2) The calculated value shall be rounded off to two decimal places.

6.3 Setting for load For the setting for load, any one of the specified methods, which are coasting method, limited throttling method and the method of using the power absorbed corresponding to the test moped/motorcycle reference weight (hereafter referred to as “equivalent inertia method”), shall be applied.

Where the coasting method or limited throttling method is used, for a test moped/motorcycle having such performance as that the speeds for measuring the running resistance stated in **6.3.1**, **6.3.2** and **6.3.3** (hereafter referred to as “specified speed”), the speeds for verifying the load for setting the chassis dynamometer (hereafter referred to as “verification speed”) or the speed at initiating the verification are not reached, replacing the specified speed, verification speed and initiating verification speed exceeding the maximum speed of said test moped/motorcycle with the maximum speed, a speed measurable but as high as possible shall be determined.

6.3.1 Setting for load by coasting method This method for the setting for load, in which allow the test moped/motorcycle coasting on the test track to measure the time elapsed for the deceleration (hereafter referred to as "coasting time") and, calculating the objective running resistance under the standard atmospheric conditions from the coasting time, apply a running resistance equivalent to that value to the test moped/motorcycle installed on the chassis dynamometer, shall be carried out as follows.

a) **Measurement of running resistance** The running resistance shall be measured as follows:

- 1) The specified speed shall be 20 km/h, 30 km/h, 40 km/h and 50 km/h.
- 2) For the measurement, while the test moped/motorcycle is allowed coasting from at a speed exceeding the specified speed +5 km/h, the elapsed time in the deceleration from the specified speed +5 km/h or +10 % to the specified speed -5 km/h or -10 % shall be measured in a unit of 0.1 s or less.

During the measurement of coasting time, the operation of brake or steering shall not be applied and the gear shall be in the state of in neutral or the clutch disengaged. For a test moped/motorcycle equipped with an automatic gear box incapable of being in the state of gear in neutral or clutch disengaged, after checked on the running stability, the relevant vehicle shall be made running, by means of traction and the like, to a speed equal to or exceeding the specified speed, and then only the test moped/motorcycle shall be allowed coasting.

- 3) The measurement of coasting time at each specified speed shall be made for each three times in both directions, and those mean values (hereafter referred to as "mean coasting time") shall be taken to be rounded at decimal two places by the method of JIS Z 8401.

For the coasting times in each of both directions, the ratio between the respective maximum and minimum values shall not be exceeding 1.1, and a re-measurement shall be made for the specified speed at which the ratio is exceeding 1.1.

b) **Calculation of objective running resistance** The objective running resistance (F_0) shall be calculated as follows using mean coasting time (t) measured in a).

- 1) Obtain running resistance in each specified speed by the formula (1).

$$F = \frac{(M + M_2)}{3.6 \times t} (V_U - V_L) \dots \dots \dots (1)$$

where, F : running resistance at each specified speed (N)
 M : total mass of the test moped/motorcycle including rider mass and instruments at measurement of running resistance (kg)
 M_2 : equivalent inertia of rotating parts mass (kg)
 (7.0 % of the relative vehicle mass stated by the manufacturer in general. It may be obtained by actual weighing or calculation)

t : mean coasting time at each specified speed (s)
 V_U : coasting speed at commencement (km/h)
 V_L : coasting speed at ending (km/h)

- 2) Based on the running resistance at each specified speed obtained from formula (1), to represent the running resistance, which is taken as a quadratic function of speed by means of least squares method, as formula (2).

$$F = a + bV^2 \dots\dots\dots (2)$$

$$a = \frac{(\sum K_i^2 \sum F_i - \sum K_i \sum K_i F_i)}{n \sum K_i^2 - (\sum K_i)^2}$$

$$b = \frac{n \sum K_i F_i - \sum K_i \sum F_i}{n \sum K_i^2 - (\sum K_i)^2}$$

$$K_i = V_i^2$$

where, F : running resistance (N)
 a : equivalent value to rolling resistance (N)
 b : equivalent value to coefficient of air resistance [N/(km/h)²]
 V : speed (km/h)
 n : number of data
 F_i : running resistance at each specified speed (N)
 K_i : square of each specified speed [(km/h)²]
 V_i : each specified speed (km/h)

- 3) To correct each coefficient obtained from formulae (2) into that under the atmospheric condition by using formulae (3) to round it off, according to **JIS Z 8401**, to the nearest tenth. This value shall be taken as the objective running resistance.

$$F_0 = a_0 + b_0 V^2 \dots\dots\dots (3)$$

$$a_0 = (a - b v^2) [1 + 0.006 (T_e - 20)]$$

$$b_0 = 0.345b \frac{T_e + 273}{P}$$

where, F_0 : objective running resistance (N)
 a_0 : equivalent value to rolling resistance under standard condition (N)
 b_0 : equivalent value to coefficient of air resistance under standard condition [N/(km/h)²]
 v : mean value of wind velocity component parallel to the test track (km/h)
 T_e : mean ambient temperature at the test track (°C)
 P : mean atmospheric pressure at the test track (kPa)

- c) **Setting of brake** With the chassis dynamometer on which the test moped/motorcycle is placed, the setting device shall be adjusted as that the sum of the braking force of the chassis dynamometer including the resistance inside the test moped/motorcycle driving system and the friction resistance inside the chassis dynamometer driving system shows a corresponding value to the value of the objective running resistance.
- d) **Verification of set load** The load which has been set shall be verified as follows.
- 1) The verification speed shall be 10 km/h, 20 km/h, 30 km/h, 40 km/h and 50 km/h.
 - 2) For the verification, with the test moped/motorcycle allowed to coast from a speed exceeding the verification speed +5 km/h, the time elapsed while decelerated from the specified speed +5 km/h or +10 % to the specified speed -5 km/h or -10 % shall be measured in a digit of 0.1 s or less. The measurement of coasting time shall be made for twice on each specified speed, and each of their mean values shall be obtained to be rounded off, according to **JIS Z 8401**, to two decimal places.
 - 3) By use of each mean value of coasting time obtained in 2), the running resistance for setting to the chassis dynamometer, F_c , shall be calculated by formula (4) to be rounded off, according to **JIS Z 8401**, to the nearest tenth.

$$F_c = \frac{(IM + M_1)}{3.6 \times t_c} (V_U - V_L) \dots\dots\dots (4)$$

where, F_c : running resistance for setting as each verification speed (N)

IM : equivalent inertia (kg)

M_1 : equivalent inertia of driving system rotating parts mass of test moped/motorcycle (kg)

(It is 4.0 % of the relating vehicle mass stated by the manufacturer, in general. It may be obtained by means of weighing or calculation.)

t_c : mean coasting time (s)

V_U : coasting speed at commencement (km/h)

V_L : coasting speed at ending (km/h)

- 4) The difference between the running speed for setting at each verification speed and the objective running resistance at the relevant speed shall be within ± 5 % of the relevant objective running resistance.

6.3.2 Setting for load by limited throttling method To drive the test moped/motorcycle equipped with a device (hereafter referred to as "throttle control device") for limiting the throttle valve opening rate (hereafter referred to as "throttling rate") in a constant speed running on the test track at the specified speed. This load setting method, in which the running resistance value is set with the throttling rate being equal to that of the test moped/motorcycle placed on the chassis dynamometer, shall be carried out as follows.

a) **Measurement of running resistance on test track** The measurement of running resistance on the test track shall be as follows.

- 1) For the purpose of measuring speed in this test a vehicle equipped speedometer or an electrical apparatus shall be used. The electrical apparatus shall be so installed, by using any means of phototube, tape switch and the like and based on **JIS D 1037**, as capable of measurement for a range of 50 m or longer.
- 2) The specified speed shall be 50 km/h. In this running test, the gear engagement may be selected so as capable of steady running, and such gear engagement used shall be recorded in the format of Attached Table 1.2.
- 3) The throttle control device shall be preliminarily subjected to adjustment or inspection as limiting the throttling rate to the running at the specified speed ± 5 km/h. The adjustment and the like for limiting the throttling rate shall be carried out as follows.
 - 3.1) For a running at the maximum speed not exceeding the specified speed, the throttle control device need not be used.
 - 3.2) The throttle control device, for which such a mechanical or electrical throttling meter as partial ring is used, shall be attached in the throttle.

Further a recorder or other device capable of telling that the throttle control device is full-open shall also be attached. For such device for recognizing the throttle control device or the throttle being in full-open, the vehicle equipped lighting system may be used.

The same throttle control device shall be used for the test of constant speed running on the test track and for setting for the load on the chassis dynamometer.

- 3.3) For using an electric throttle control device, it shall be completed the zero and span adjustments just before the running speed measurement and just before the setting of the chassis dynamometer brake.
 - 3.4) For the specified speed running, constant running speeds for each twice in the both directions, go and return, shall be measured. For these measured values, after confirming that the difference between the maximum and minimum values is within 5 % of the maximum value, the mean value shall be obtained to be rounded off, according to **JIS Z 8401**, to the nearest tenth, and taken it as the objective running speed.
- b) **Setting of brake** The test moped/motorcycle is then placed on the chassis dynamometer, the throttle control device being in locked position obtained by the test track running, and allowed to run at a constant speed with the same gear engaged as using in the test track running. Then the load control brake of the chassis dynamometer shall be adjusted in order to obtain the objective running speed ± 2 km/h obtained in a).

For the purpose of serving the load verification, the value of the power absorbed by the chassis dynamometer brake at 50 km/h running including the mechanical loss shall be measured, after the setting for the objective speed.