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**Electric vehicle—
Measurement for driving range
and energy consumption**

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electricity consumption

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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 in accordance with the Industrial Standardization Law.

At the establishment, **ISO/DIS 8714 : 2000** *Electric road vehicles—Reference energy consumption and range—Test procedures for passenger cars and light commercial vehicles* was used as the basis for conformity of Japanese Industrial Standard with International Standard.

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Electric vehicle—Measurement for driving range and energy consumption

Introduction This Japanese Industrial Standard has been prepared based on **ISO/DIS 8714 : 2000** *Electric road vehicles—Reference energy consumption and range—Test procedures for passenger cars and light commercial vehicles* but modifying the technical contents.

The portions with sidelines or dotted underlines are the matters that the contents of the original International Standard are modified. The deviations is listed in Annex 1 together with details.

1 Scope This Japanese Industrial Standard specifies the test procedures to obtain the driving range and energy consumption of electric vehicles (excluding motorcycles and mopeds employing an electric motor as the prime mover) which utilize only an on-board battery (hereafter referred to as “traction battery”) as the power supply and have a gross vehicle mass not exceeding 3 500 kg.

Remarks : The International Standard corresponding to this Standard is given below.

In addition, abbreviations 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/DIS 8714 : 2000 *Electric road vehicles—Reference energy consumption and range—Test procedures for passenger cars and light commercial vehicles* (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 amendments) indicated below shall be applied.

JIS C 1211 *Alternating-current watt-hour meters (for direct connection)*

JIS D 1010 *General rules of running test method of automobiles*

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

3 Test vehicle and traction battery The test vehicle (vehicle under test) and the traction battery shall be under the conditions stated below.

- a) The battery specified by the vehicle manufacturers shall be used as the traction battery, and it shall be properly managed.
- b) The vehicle shall have been run by 300 km or more with the traction battery being on-board. The break-in distance shall be recorded on Attached Table 5.
- c) The vehicle and battery shall previously be checked and maintained based on the specification of the vehicle manufacturer.
- d) The mass of test vehicle shall be such a mass that two persons (mass of one person is 55 kg) ride or the goods of 110 kg are loaded on the unladen vehicle specified in **JIS D 1010** (hereafter referred to as “test vehicle mass”).

e) The error range of the test vehicle mass at the measurement of running resistance on the test track shall fall within ± 50 kg from the prescribed test vehicle mass.

f) The hood in which the motor is accommodated shall be closed.

g) The pneumatic pressure of tire shall be that stated in the vehicle specification.

The pneumatic pressure shall be measured while the test vehicle is standstill on a horizontal plane before running (cool condition). When the tire is installed on a chassis dynamometer, the pneumatic pressure tire may be adjusted within the limit of 1.5 times the pressure stated in the vehicle specification so that the condition becomes similar to that when the test vehicle is running on a flat paved road, if the diameter of the roller of chassis dynamometer is less than 500 mm.

h) As regards the driving shaft to which the wheel torque meter is attached, the error range of the tread shall be within ± 10 % from the value stated in the vehicle inspection specification, and the toe-in and camber shall have the respective values stated in the vehicle inspection specification.

i) For components other than those which may affect the measurements of the driving range and energy consumption, non-regular components may be used.

j) All on-board energy storage systems (electric, hydraulic, pneumatic, etc.) shall be in the operating range specified by the vehicle manufacturer, even if the system is not for travelling.

4 Accuracy and calibration of measuring instruments The chassis dynamometer and the test instruments shall have been checked, maintained and calibrated based on the instruction manual prepared by the relevant manufacturers and shall have the accuracies stated below.

a) The accuracy of thermometer shall be ± 1 °C.

b) The accuracy of barometer shall be ± 1 kPa.

c) The accuracy of anemometer shall be ± 1 m/s.

d) The accuracy of speed meter shall be ± 0.5 km/h.

e) The accuracy of distance meter on chassis dynamometer shall be ± 0.1 %.

f) The accuracy of measuring device for coasting time shall be ± 0.1 s.

g) The a.c. watt-hour meter shall be that of ± 2 % in accuracy specified in JIS C 1211 or that at least equivalent in accuracy.

h) The accuracy of wheel torque meter shall be ± 2 % of the full scale.

5 Test room The temperature of test room shall be 25 °C $\pm$ 5 °C.

The temperature shall be measured at a point close to the blower device, before initiation and after completion of the driving range test specified in 8.

6 Installation of test vehicle

6.1 Setting of equivalent inertia mass The equivalent inertia mass to be set on the chassis dynamometer shall be the standard value of equivalent inertia mass stated on the right column of Table 1 corresponding to the test vehicle mass given in the left column of the said table. If setting of the standard value of equivalent inertia mass in the right column of the said table is impossible, an equivalent inertia mass which falls within the range of 100 % to 110 % of the said equivalent inertia mass may be set.

Table 1 Standard values of equivalent inertia mass of test vehicle

Test vehicle mass (kg)	Standard value of equivalent inertia mass (kg)	Test vehicle mass (kg)	Standard value of equivalent inertia mass (kg)
to 562	500	1 626 to 1 875	1 750
563 to 687	625	1 876 to 2 125	2 000
688 to 812	750	2 126 to 2 375	2 250
813 to 937	875	2 376 to 2 625	2 500
938 to 1 125	1 000	2 626 to 2 875	2 750
1 126 to 1 375	1 250	2 876 to 3 250	3 000
1 376 to 1 625	1 500	Hereafter every 500 kg	Hereafter every 500 kg

6.2 Installation of test vehicle Care shall be taken on the points stated below when the test vehicle is installed on the chassis dynamometer.

- The mass of test vehicle shall be that under such a state that a person is on-board the test vehicle. The mass is not necessarily be the test vehicle mass.
- Water, gravel and others which may cause slip and dangerous articles shall be eliminated from the tires on driving shaft of the test vehicle.
- The test vehicle shall be so installed that the trembling or the like during driving is minimized.

7 Setting of load

7.1 The load of chassis dynamometer shall be so set that the running resistance received by the test vehicle in question running a flat paved road is reproduced. In this procedure the test vehicle and the chassis dynamometer shall be under sufficiently warmed-up state.

The procedures used for setting of load shall be those stated in the coasting method of 7.2 or the wheel torque method of 7.3. The test track used for the measurements of running resistances stated in 7.2 and 7.3 shall be as follows:

7.1.1 The test track shall be a dry straight paved road without discontinuous wind shelter or the like.

7.1.2 Facilities by which atmospheric conditions such as atmospheric pressure, air temperature and wind can be observed at the measurements of running resistance on the test track shall be provided. For atmospheric pressure and temperature, the average value of respective parameters at initiation and completion of the running resistance measurement shall be obtained. For the wind velocity, the wind velocity components parallel to and perpendicular to the test track shall be observed and recorded on demand.

7.1.3 The condition of wind at the measurement of running resistance on the test track shall be such that the wind velocity component parallel to the test track shall be not more than 5 m/s in average, and the perpendicular wind velocity component shall be not more than 2 m/s in average.

7.2 Coasting method The coasting method is such a method for setting of load, that the time spent for retardation in the coasting running of test vehicle (hereafter referred to as "coasting time") is measured, the target running resistance of the test vehicle in question is calculated from the coasting time, and the equivalent running resistance is applied to the test vehicle installed on the chassis dynamometer, and performed as follows:

7.2.1 Measurement of running resistance on test track

- a) The speeds at which the running resistance is measured (hereafter referred to as "specified speeds") shall be 20 km/h, 30 km/h, 40 km/h, 50 km/h, 60 km/h and 70 km/h.
- b) The measurement of running resistance shall be carried out in such a way that the test vehicle is let to coast at a speed exceeding the specified speed +5 km/h with its transmission gear in neutral position and the time spent from the specified speed +5 km/h to the specified speed -5 km/h (hereafter referred to as "coasting time") is measured in the digit not more than 0.1 s. During the measurement of the coasting time, brake and steering operations shall not be carried out and the clutch is being engaged.

A vehicle in which neutral position of transmission gear is not available shall be coasted with the electric braking being not operated.

- c) The measurement of coasting time at each specified speed shall be carried out three times on going way and three times on coming way, and the average value of the coasting times so measured (hereafter referred to as "average coasting time") shall be obtained.

In each of coasting time on going way and coasting time on coming way, the ratio of the maximum value and the minimum value shall not exceed 1.1. If the ratio exceeds 1.1, re-measurement shall be carried out.

7.2.2 Calculation of target running resistance

- a) The running resistance at each specified speed shall be calculated by means of the following formula:

$$F = \frac{W + W_4}{0.36t}$$

where, F : running resistance at each specified speed (N)

W : mass of test vehicle (at measurement of running resistance) (kg)

W_4 : inertia mass corresponding to rotating parts of test vehicle (kg)

(Generally 3.5 % of the vehicle mass stated in the data sheet is taken. It may be obtained actually or by calculation)

t : average coasting time at each specified speed (s)

- b) Based on the running resistance at each specified speed obtained in a), the running resistance is expressed as a quadratic function of speed as stated below by means of least square method.

$$F = a + bV^2$$

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

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

$$K = V^2$$

where, F : running resistance (N)

a : value corresponding to rolling resistance (N)

b : value corresponding to coefficient of air resistance [N/(km/h)²]

V : speed (km/h)

- c) Each coefficient obtained in b) is corrected to that under standard atmospheric conditions by means of the formulae stated below to obtain the target running resistance.

$$F_0 = a_0 + b_0 V^2$$

$$a_0 = (a - bV^2) [1 + 0.00864(T_e - 20)]$$

$$b_0 = 0.346b \frac{(T_e + 273)}{P}$$

where, F_0 : target running resistance (N)

v : average value of wind velocity component parallel to test track (km/h)

a_0 : value corresponding to rolling resistance under standard atmospheric conditions (N)

b_0 : value corresponding to coefficient of air resistance under standard atmospheric conditions [N/(km/h)²]

V : speed (km/h)

T_e : average air temperature at test track (°C)

P : average atmospheric pressure at test track (kPa)

7.2.3 Setting of load on chassis dynamometer The test vehicle is installed on the chassis dynamometer, the sum of friction resistance of driving system of test vehicle and the friction resistance of the chassis dynamometer (hereafter referred to as "overall friction loss") is obtained, and the chassis dynamometer is so adjusted that the braking force of chassis dynamometer shows the value corresponding to the difference between the target running resistance and the overall friction loss.

In a chassis dynamometer of multi-point setting system, the condition of braking force at 0 km/h shall be same as that at 10 km/h.

7.2.4 Verification of set load Such a fact that the set load (hereafter referred to as "set running resistance") has a value corresponding to the target running resistance shall be verified by the method stated below.

- a) The speed to be verified (hereafter referred to as "verification speed") shall be as given below according to the kind of chassis dynamometer.
 - 1) In the case of multi-point setting system, the speeds shall be 10 km/h, 20 km/h, 30 km/h, 40 km/h, 50 km/h, 60 km/h and 70 km/h.
 - 2) In the case of coefficient setting system, the speeds shall be 20 km/h, 40 km/h and 60 km/h.
 - 3) In the case of one-point setting system, the speed shall be 60 km/h.
- b) The test vehicle is let to coast from a speed exceeding the verification speed +5 km/h with its transmission gear being in neutral position, and the coasting time spent from the verification speed +5 km/h to the verification speed -5 km/h is measured in the digit not more than 0.1 s. During the coasting, brake operation shall not be carried out and the clutch is being engaged. A vehicle in which neutral position of transmission gear is not available, shall be coasted with the electric braking being not operated.

The measurement of coasting time shall be carried out twice at each verification speed and the average value is obtained.

- c) The running resistance to be set on chassis dynamometer is calculated from the average value of coasting time obtained in b), by means of the following formula:

$$F_c = \frac{W_{1w} + W_2}{0.36t_c}$$

where, F_c : set running resistance (N)

W_{1w} : equivalent inertia mass (kg)

W_2 : internal inertia mass corresponding to rotating parts in driving system of test vehicle (kg)

(Generally 1.8 % of the vehicle mass stated in the data sheet is taken. It may be obtained actually or by calculation.)

t_c : average of coasting time (s)

- d) The difference between the set running resistance at each verification speed and the target running resistance at the speed in question shall be within $\pm 5\%$ of the said target resistance.

7.3 Wheel torque method The wheel torque method is such a method for setting the torque, that a test vehicle to which wheel torque meters are attached is run at a constant speed, the running torque of the vehicle in question is calculated from the wheel torque applied to the driving shaft, and the same running torque is applied to the test vehicle installed on the chassis dynamometer and it is carried out as stated below.

7.3.1 Adjustment of wheel torque meter and so on

- a) The wheel torque meters shall be attached to the right and left drive wheels of the test vehicle.
- b) The wheel torque meters used for the measurement of running resistance on test track and those used for setting the load on the chassis dynamometer shall be the same meters.
- c) The wheel torque meters mounted on the test vehicle shall be subjected to zero adjustment and span adjustment immediately before the running resistance measurements and immediately before the load setting on the chassis dynamometer.

7.3.2 Measurement of running resistance on test track

- a) The specified speeds shall be 20 km/h, 30 km/h, 40 km/h, 50 km/h, 60 km/h and 70 km/h.
- b) The speed of test vehicle and the sum of left and right wheel torques shall be measured simultaneously in a sampling period not exceeding 0.25 s, for 5 s or more while the test vehicle is normally running at each specified speed.
- c) During the measurements, the average value of speeds of test vehicle, (hereafter referred to as "measured vehicle speed") and the running torque (this means "average value of the sum of right and left wheel torques" in this case) shall be obtained.
- d) The speed of the test vehicle shall be such that the difference between the speed at initiation of measurement and that at completion of measurement is not more than 0.5 km/h, and the difference between the maximum value and the minimum value during the measurements is not more than 5 % of the specified speed. Further, the difference between the measured vehicle speed and the specified speed shall be within ± 2 km/h.
- e) The sum of left wheel torque and right wheel torque shall be such that the difference between the maximum value and the minimum value does not exceed 5 % of the maximum value.
- f) The measurements of the measured vehicle speed and the running torque at each specified speed shall be carried out once in going way and once in coming way.

7.3.3 Calculation of target running resistance

- a) Based on the running torque at each specified speed obtained in 7.3.2 the running torque is expressed as a quadratic function of speed as stated below by means of least square method.