

AIS-039

AUTOMOTIVE INDUSTRY STANDARDS

**Battery Operated Vehicles –
Measurement of
Electrical Energy Consumption**

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ON BEHALF OF:
AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER
CENTRAL MOTOR VEHICLE RULES – TECHNICAL STANDING COMMITTEE

SET-UP BY
MINISTRY OF ROAD TRANSPORT & HIGHWAYS
GOVERNMENT OF INDIA

September 2003

Status chart of the Standard to be used by the Purchaser for
Updating the record.

Sr.	Corrigenda	Amend- ment	Revision	Date	Remark	Misc.

General Remarks:

Introduction

The Government of India felt the need for a permanent agency to expedite the publication of Standards and development of test facilities in parallel when the work of preparation of Standards is going on, as the development of improved safety critical parts can be undertaken only after the publication of the Standard and commissioning of test facilities. To this end, the Ministry of Surface Transport (MoST) has constituted a permanent Automotive Industry Standard Committee (AISC) vide order no. RT-11028/11/97-MVL dated September 15, 1997. The Standards prepared by AISC will be approved by the permanent CMVR Technical Standing Committee (CTSC) after approval, The Automotive Research Association of India, (ARAI), Pune, being the secretariat of the AIS Committee, has published this Standard. For better dissemination of this information, ARAI may publish this document on their website.

This Standard prescribes the requirements for the measurement of electrical energy consumption.

Considerable assistance has been taken from ECE 101.

The Committee responsible for preparation of this standard is given in Annexure- 1.

Battery Operated Vehicles - Measurement of Electrical Energy Consumption

1.0 SCOPE

This standard specifies the method for measurement of electrical energy consumption of battery-operated vehicles (BoVs). This is also used to verify the performance of the vehicle with that declared by the manufacturer.

2.0 TERMINOLOGY

Refer Annexure – E of AIS – 049 for the definitions.

3.0 VEHICLE PREPARATION

3.1 Condition of the vehicle

The vehicle tyres shall be inflated to the pressure specified by the vehicle manufacturer. Higher inflation in pressure is permitted as per para 6.1.3 of Chapter-3 of Part-III of MoST/TAP/CMVR-115/116/126. The viscosity of the oils for the mechanical moving parts shall conform to the specifications of the vehicle manufacturer. The lighting, light – signaling and auxiliary devices shall be off, except those required for testing and usual daytime operation of the vehicle.

3.2 All energy storage systems available for other than traction purpose (electric, hydraulic, pneumatic, etc.) shall be charged up to their maximum level specified by the manufacturer.

3.3 The first charging of the battery shall be carried out as per para 3.5 below, if not already done.

3.4 If the batteries are operated above the ambient temperature, the operator shall follow the procedure recommended by the vehicle manufacturer in order to keep the temperature of the battery in the normal operating range. The vehicle shall have undergone at least 300 km or as specified by the manufacturer during the seven days before the test with those batteries that are installed in the test vehicle. This condition can be waived on request of the vehicle manufacturer.

3.5 Initial charge of the battery

Charging the battery consists of the following procedures.

NOTE: "Initial charge of the battery" applies to the first charge of the battery, at the reception of the vehicle. In case of several combined tests or measurements, carried out consecutively, the first charge carried out shall be an "initial charge of the battery" and the following may be done in accordance with the "normal charge" procedure.¹

3.5.1 Discharge of the battery

The procedure starts with the discharge of the battery of the vehicle while driving (on the test track, on a chassis dynamometer etc.) at a steady speed of $70\% \pm 5\%$ of the maximum thirty minutes speed of the vehicle. Discharge is stopped when one of the following occurs:

- a) when the vehicle is not able to run at 65 % of the maximum thirty minutes speed.
- b) or when an indication to stop the vehicle is given to the driver by the standard on-board instrumentation
- c) or after covering the distance of 100 km.

3.5.2 Application of a normal charge

The battery shall be charged according to the following procedure.

3.5.2.1 Normal charge procedure

The charge is carried out

- a) with the on-board charger, if fitted
- b) with an external charger recommended by the manufacturer, the connection being made with the domestic plug whose pattern has been recommended by the manufacturer.
- c) in an ambient temperature

The procedure excludes all type of special charges that could be manually initiated like, for instance, the equalization charges or the servicing charges. The vehicle manufacturer shall be in a position to attest that during the test, a special charge procedure has not occurred.

3.5.2.2 End of charge criteria

The end of charge criteria corresponds to a charging time of 12 h except if a clear indication is given to the driver by the standard instrumentation that the battery is not yet fully charged or as specified by the manufacturer. In this case

The maximum time is =

Claimed battery capacity (Wh)

Mains power supply (W)

W = maximum power of the charger as specified by manufacturer.

4.0 TEST CONDITIONS

Test shall be conducted at temperature between 20°C and 40 °C.

The battery capacity shall be corrected to 27° C based on the following formula.

$$\text{Capacity at } 27^{\circ} \text{ C} = C_t + \{ C_t \times R \times (27 - t) / 100 \}$$

Where;

C_t is observed capacity at $t^{\circ} \text{ C}$

R is variation factor chosen from Table-1

t is average temperature during entire test (add temperature on hourly basis during discharge and divide by number of readings).

Table – 1

Discharge rate	Factor for variation in capacity per degree C (R) percentage
C_{10}	0.43
C_9	0.45
C_8	0.47
C_7	0.50
C_6	0.54
C_5	0.58
C_4	0.62
C_3	0.68
C_2	0.76
C_1	0.90

5.0 TEST PROCEDURE

5.1 Test Sequence

5.1.1 The driving cycle shall be the Indian Driving Cycle (IDC) as given in Annexure-II of CMVR, for all vehicles other than 4-wheeled vehicles with maximum speed exceeding 80 km/h.

5.1.2 The driving cycle shall be Part-I of the modified Indian driving cycle as given in Annexure-IV B of CMVR for 4-wheeled vehicles with maximum speed exceeding 80 km/h.

5.1.3 In cases where the vehicle does not reach the required acceleration during driving, the accelerator control shall remain fully activated until the reference curve has been reached again.

5.2 Power setting of the chassis dynamometer

The procedure prescribed in the document MOST/TAP/CMVR-115/116/126 shall be adopted. The decision taken in the Standing Committee on Emissions shall be followed for the same. Reference mass shall be taken as defined in Annexure-E of AIS 049.

5.3 Test Method

5.3.1 Principle

The test method described hereafter permits to measure the electric energy consumption expressed in Wh/km

5.3.2 Parameters, Units and Accuracy of Measurements

Parameter	Unit	Accuracy	Resolution
Time	s	± 0.1 s	0.1 s
Distance	m	± 1 m	1 m
Speed	km/h	± 1 km/h	1 km/h
Mass	kg	± 20 kg*	1 kg
Energy	Wh	± 0.2 %	Class 0.2 s according to IEC 687

* In the case of 2-wheeler, the accuracy is ± 2 %.
IEC : International Electro-technical Commission.

5.4 Application of the Cycle and Measurement of the Distance

- 5.4.1 The time at the end of charging t_0 (plug off) is reported.
- 5.4.2 The chassis dynamometer shall be set as per the settings in point 5.2 above. Starting within 4 h from t_0 , 36 cycles of IDC (of 108 s duration each) or 2 cycles of modified IDC (of 1220 s duration each) as applicable (refer para 5.1.1 or 5.1.2 above) are run. At the end, the covered distance (D) in km is recorded.

5.4.3 Charge of the battery:

The vehicle shall be connected to the mains within 30 minutes after the conclusion of the Driving Cycle. The vehicle shall be charged according to normal charge procedure (Refer clause 3.5.1.2 above). The energy measurement equipment, placed between the mains socket and the vehicle charger, measures the charge energy E delivered from the mains as well as its duration. Charging is stopped after 24 h from the previous end of charging time t_0 .

NOTE

In case of any power disruptions during charging, the 24 h period shall be exceeded according to the disruption duration. The maximum total Power disruption of 30 minutes duration is allowed irrespective of the number of failures. Validity of the charge shall be discussed between the technical services of the approval laboratory and the vehicle's manufacturer.

5.4.4 Electric Energy Consumption Calculation

The Energy E in W-h and charging time measurements shall be recorded in the test report. The electric energy consumption is defined by the formula :

$$C = E / D$$

Where C is expressed in W-h/km & rounded off to the nearest whole number, E is W-h and D is the range in km.

5.5 Interpretation of the Results

- 5.5.1 The electric energy consumption adopted as the type approved vehicle, shall be the value declared by the manufacturer if the value measured during testing does not exceed the declared value by more than 4%. The measured value can be lower without any limitations.

5.5.2 If the measured value of energy consumption exceeds the manufacturers declared value by more than 4% then another test shall be carried out on the same vehicle. When the average of the two test results does not exceed the manufacturer's declared value, by more than 4 % then the value declared by the manufacturer shall be taken as the type approval value.

5.5.3 If the average still exceeds the declared value by more than 4%, a final test shall be run on the same vehicle. The average of the three tests shall be then taken as the type approval value.

5.5.4 Test Results

The result of the electric energy consumption shall be expressed in Watt - hour per kilometer (W-h/km) rounded off to the nearest whole number.

6.0 TECHNICAL SPECIFICATIONS

The details of technical specification, approvals of changes in specification shall be as per para 6.0 of AIS-049.

Annexure – 1
(See Introduction)
COMMITTEE COMPOSITION
Automotive Industry Standards Committee

Chairman	
Shri B. Bhanot	Director The Automotive Research Association of India, Pune
Members	Representing
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Shri Sushil Kumar	Ministry of Road Transport & Highways, New Delhi
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Shri L.R. Singh	Bureau of Indian Standards, New Delhi
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