AIS-102 (Part 2)

AUTOMOTIVE INDUSTRY STANDARD

CMVR Type Approval for Hybrid Electric Vehicles of M and N Category with GVW > 3500 kg

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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
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

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Status chart of the standard to be used by the purchaser for updating the record

Sr. No.	Corrigenda.	Amendment	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 erstwhile 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.

Worldwide hybrid electric vehicles are gaining popularity with authorities and users because they can deliver better on-road fuel efficiency (and thus reduced green house gases) and reduced pollution as compared to similar combustion engine vehicles.

The Indian automotive industry is also developing and/or producing hybrid electric vehicles to meet this demand. Consequently a framework of type approval needs to be created under the CMVR Rules 1989 to ensure that these vehicles comply with the appropriate safety and emission norms. AIS-102 (Part 1) is the result of such an exercise and addresses four wheelers with gross vehicle mass not exceeding 3500 kgs and L category vehicles, which are basically vehicles tested on the chassis dynamometer for ensuring compliance to tailpipe emissions requirements.

The purpose of this standard AIS-102 (Part 2) is to provide an appropriate frame-work for type approval for four wheelers whose gross vehicle mass exceeds 3500 kgs. The tailpipe emission compliance of these categories of vehicles is certified by an engine dynamometer test procedure.

This standard is to be treated as an interim standard for the following reasons.

1. Hybrid Electric Vehicle technology worldwide is still in its infancy and growing continuously to achieve better performance and efficiencies. This standard would need to be upgraded progressively to incorporate this evolving technology.

2. Partly because the technology is in its infancy, no worldwide comprehensive standards exist for legislative approval of hybrid electric vehicles in these vehicle categories. In order to encourage the early implementation of these Hybrid Electric Vehicles into wide-spread use, India has taken leadership in creating these regulations. This standard may need to take the benefit of the new elements in legislation that may be introduced in regulations worldwide as they evolve.

3. This regulation requires that the combustion engine of the hybrid electric vehicle comply as stand alone entity with the tailpipe emissions requirements based on the engine dynamometer test procedure given in document no. MoRTH/TAP/115-116. While this meets the minimum requirements of emissions, it fails to encourage technology innovations where more fuel efficient vehicles could be developed by having the complete power train holistically deliver further reduced levels of green house gases and other pollutants. The AISC sub-committee responsible for this standard is already seized of this objective and is working towards creating a test procedure which would encourage development of vehicles which can better meet the twin objective of better fuel economy and lower pollution.

4. Because of the infancy of the technology, both for part-1 and part-2, it has been decided to create a support framework for type approval and once both the technology and the approval procedures reach the required maturation, these approval requirements can be appropriately embedded into the CMVR Rules 1989 and the standards called therein.

   The AISC panel and the Automotive Industry Standard Committee (AISC) responsible for preparation of this standard is given in Annex C and Annex D respectively.

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1.0 SCOPE

This standard is applicable to hybrid electric vehicles of M and N category of vehicles as defined in AIS-053, whose GVW exceeds 3500 kg.

2.0 REFERENCES

2.1	AIS-004 (Part 1): 1999	:	Electromagnetic Radiation from Automotive Vehicle - Permissible Levels & Methods of Tests
2.2	AIS-007: 2007 (Rev. 3)	:	Information on Technical Specifications to be submitted by the Vehicle Manufacturer
2.3	AIS-017: 2000	:	Procedure for Type Approval and Certification of Vehicles for Compliance to Central Motor Vehicles Rules
2.4	AIS-018: 2001	:	Automotive Vehicles - Speed Limitation Devices – Specifications
2.5	AIS-038 : 2003	:	Battery Operated Vehicles – Requirements for Construction and Functional Safety
2.6	AIS-041 : 2003	:	Battery Operated Vehicles Measurement of Net Power and the Maximum 30 Minute Power and Speed
2.7	AIS-049 : 2003	:	Battery Operated Vehicles - CMVR Type Approval for Battery Operated Vehicles
2.8	AIS-052 (Rev 1) : 2008	:	Code of Practice for Bus Body Design and Approval
2.9	AIS-053 : 2005	:	Automotive Vehicles – Types – Terminology
2.10	AIS-102 (Part 1) : 2009	:	CMVR Type Approval of Hybrid Electric Vehicles
2.11	IS 2 : 1960	:	Rules for Rounding off Numerical Values
2.12	IS 11852: 2001 (Parts 1 to 9)	:	Automotive Vehicles - Brakes and Braking Systems
2.13	IS 11921 : 1993	:	Automotive Vehicles – Method of Evaluation of Fuel Consumption
2.14	IS 14283 : 1995	:	Automotive Vehicles – Accelerator Control System – Safety Requirements
2.15	IS 14599 : 1999	:	Automotive Vehicles – Performance Requirements (Measurement of Power, SFC, Opacity) of Positive and Compression Ignition Engines – Method of Test

2.16	MoRTH/CMVR/ TAP-115/116: Issue 4	:	Document on Test Methods, Testing Equipment Related Procedure for Testing Type Approval Conformity of Production (COP) of Vehicles Emission as per CMV Rules 115, 116 and 126
2.17	ECE R 13	:	Uniform Provisions Concerning the Approval of vehicles of Categories M, N and O with Regard to Braking
2.18	ECE R 100	:	Uniform provisions concerning the approval of battery electric vehicles with regard to specific requirements for the construction and functional safety
2.19	SAE J 551/2	:	Test limits and methods of measurement of radio disturbance characteristics of vehicles, motorboats, and spark ignited engine driven devices

Abbreviated forms of the above references are used throughout this standard. Those abbreviated forms are intended to refer to the detailed forms above.

3.0 DEFINITIONS

3.1 For the purposes of this standard the definitions given in clause 3.0 of AIS-102 (Part 1) shall apply.

3.2 **A Rechargeable Energy Storage System (RESS)** is the system intended for storing and providing electrical energy for electric propulsion.

3.3 A **Parallel Hybrid Electric Vehicle** means any vehicle which allows power to be delivered to the driven wheels by either a combustion engine and/or by a RESS powered electric motor.

3.4 A **Series Hybrid Electric Vehicle** means any vehicle which allows power to be delivered to the driven wheels solely by a RESS powered electric motor, but which also incorporates the use of a combustion engine to provide power to the RESS and/or electric motor.

3.5 A **Series Parallel Hybrid Electric Vehicle** is a Parallel HEV which additionally incorporates a system for the combustion engine to provide power to the RESS and/or electric motor.

3.6 **An Electric Component or Circuit** is classified as High Voltage if its operating voltage lies between 60 V and 1500 V DC (direct current) or between 30V and 1000 V AC (alternating current) rms (root mean square)

3.7 A **High Voltage Bus** is an electric circuit and its coupling system (connectors) which operates on high voltage and which is intended for charging the RESS.

3.8 **Service Mode** is a mandatory mode provided on a HEV for troubleshooting and diagnostics of a HEV. At the minimum it must incorporate functionality to run and modulate the speed of the combustion engine by operating the vehicle speed control pedal. In this mode it is envisaged that vehicle will be stationary

3.9 Where necessary, the definitions given in Annex E of AIS-049 shall apply.

However definitions specific to Battery Operated Vehicles given in clause E 1.7, E1.14, E1.30, E1.37, E1.38, and E1.40 & E1.41 shall not apply to HEV's.

4.0 APPLICABILITY OF THE RULES PRESCRIBED IN CENTRAL MOTOR VEHICLES RULES, 1989 (CMVR)

Hybrid Electric Vehicles of categories specified in the scope of this standard shall be type approved as per the rules applicable for the vehicle categories to which they belong and the fuel used in the combustion engine, as defined in AIS-053.

4.1 Further the following exemptions and modifications in test procedure shall be applicable to these vehicles

4.1.1 Engine Power Test

Measurement of Power of the combustion engine of HEV shall be conducted as per MoRTH/CMVR/TAP 115-116 for Compression Ignition Engines and IS 14599:1999 for Positive Ignition Engines.

4.1.2 Tail Pipe Emission Test

Combustion Engines fitted on HEV's type approved to this standard shall comply with prevailing tail pipe emission norms specified in CMV Rule 115 and document no. MoRTH/CMVR/TAP-115/116 with due regard for category of vehicle and geographic place of its use. However, the following exemptions shall apply

4.1.2.1 Free Acceleration Smoke Test Requirement for Diesel Engines

4.1.2.1.1 HEV's such as Parallel HEV's and Series Parallel HEV's on which the speed of the combustion engine can vary depending on the operating condition, shall be subjected to this test as specified in CMV Rule 115 (2) in the service mode of the HEV.

4.1.2.1.2 HEV's such as Series HEV's on which the combustion engine runs only at one speed for all vehicle operating conditions shall be exempted from this test.

4.1.2.2 **Idle Emissions test for SI Engines**

4.1.2.2.1 HEV's such as Parallel HEV's and Series Parallel HEV's on which the speed of the combustion engine can vary depending on the operating condition, shall be subjected to this test as specified in CMV Rule 115 (2) in the service mode of the HEV.

4.1.2.2.2 HEV's such as Series HEV's on which the combustion engine runs only at one speed for all vehicle operating conditions shall be exempted from this test.

4.1.2.3 Manufacturer shall inform the procedure to activate service mode in customer care documentation accompanying the vehicle to facilitate tests to be conducted on in-service vehicles of categories described in 4.1.2.1.1 and 4.1.2.2.1.

4.1.3 **Accelerator Control Test as per IS 14283:1995**

All HEV's shall be exempted from the accelerator control test specified in CMV Rule 124 (1).

4.1.4 **Constant Speed Fuel Consumption Test as per IS 11921:1993**

All HEV's shall be exempted from Constant Speed Fuel Consumption test specified in CMV Rule 124 (1).

4.1.5 **Measurement of Pass by Noise Level as per IS 3028 : 1998**

Noise test shall be conducted as per IS 3028: 1998 with the following changes.

4.1.5.1 Test speed shall be 50 kmph or 75% of maximum vehicle speed in that gear, whichever is lower. The combustion engine shall be running

4.1.5.2 On HEV's such as Series HEV's in which combustion engine, if running operates only at the specified constant speed, this test shall be conducted with engine running at the constant speed. Further any uncontrolled variations in this engine speed shall not exceed ± 10% of the specified constant speed between the test boundary lines AA' and BB' specified in the standard.

4.1.6 **Measurement of Interior Noise Level as per AIS-020 : 2004**

Interior noise tests as laid down in AIS-020: 2004 shall be conducted as mentioned in this standard.

4.1.6.1 Steady Speed test :

Test shall be conducted as per procedure laid down in clause 7.4.1 of AIS-020 : 2004. The combustion engine shall be running.

On HEV's such as Series HEV's in which combustion engine, if running operates only at the specified constant speed, this test shall be conducted with engine running at the constant speed. Further any uncontrolled variations in this engine speed shall not exceed ± 10% of the specified constant speed during noise measurement.

4.1.6.2 Full throttle acceleration (Maximum accelerator position) test

Test shall be conducted as per procedure laid down in clause 7.4.2 of AIS-020: 2004. The combustion engine shall be running.

For the purpose of this standard in clause 7.4.2 of AIS-020 : 2004, "Engine speed for maximum power" shall be read as "Vehicle max speed in the selected gear" and words " Engine speed" shall be read as "Vehicle Speed"

On HEV's such as Series HEV's in which combustion engine, if running operates only at the specified constant speed, this test shall be conducted with engine running at the constant speed. Further any uncontrolled variations in this engine speed shall not exceed ± 10% of the specified stabilized initial speed during noise measurement.

4.1.6.3 Stationary test

4.1.6.3.1 Test shall be conducted as per clause 7.4.3 of AIS-020: 2004 using the service mode.

4.1.6.3.2 However, Series HEV's shall be exempted from this test.

4.1.7 **Brake Performance as per IS 11852 : 2001**

4.1.7.1 All HEV's shall conform to the braking requirement of IS 11852 : 2001, Parts 1 to 9.

4.1.7.2 Guidelines on the use of regenerative braking system during tests shall be as per Annex A.

4.1.7.3 All Series HEV's shall be exempted from the Engine connected Type P test as laid down in clause 3.2.2.2 of IS 11852 (Part 3): 2001.

4.1.8 **Measurement of Electromagnetic Radiations as per AIS-004 (Part 1) : 1999**

4.1.8.1 Hybrid Electric Vehicle shall be tested as per procedure laid down in Annexure D of AIS-049 over a measurement frequency range from 30 MHz to 1000 MHz with both the combustion engine and electric drive running.

4.1.8.2 If the above condition is not possible, two separate tests shall be conducted as follows.

4.1.8.2.1 Electric Motor Drive Mode :

Test shall be conducted as per Annexure D of AIS-049 over a measurement frequency range from 30 MHz to 1000 MHz, provided that a continuous power source may be supplied to the RESS to keep the vehicle running without starting the combustion engine. Manufacturer may facilitate this through service mode.

4.1.8.1.2 Engine Mode :

The test shall be conducted as per AIS-004 – Part1, as applicable for Engine type. Manufacturer may recommend energy storage level of RESS, such that combustion engine does not charge the RESS during the test.

4.1.9 **Speed Limitation Devices as per AIS-018 : 2001**

4.1.9.1 HEV's shall be exempted from all the requirements of AIS-018 except clause 5.7.

4.1.9.2 The speed limitation function of HEV's shall be exempt from the requirements of AIS-037.

4.1.10 **Code of Practice for Bus Body Design and approval as per AIS-052 (Rev 1)**

Hybrid Electric Vehicles in the scope of AIS-052 (Rev 1) : 2008 shall comply with the requirements of the standard.

However, the High Voltage Bus of HEV's shall be exempt from the following.

4.1.10.1 BIS marking requirement as laid down in clause 5.1.1 of AIS-052 (Rev 1) : 2008.

4.1.10.2 Conductor size requirement as laid down in clause 5.1.3 of AIS-052 (Rev1) : 2008.

4.1.11 **Retrofitment of CNG/LPG Kits :**

Retro-fitment of CNG / LPG kits as per CMV Rule 115-B and 115-C to in-use vehicles shall not be permitted for HEV's.

4.2 **Additional Requirements :**

Hybrid Electric Vehicles shall also comply with the following additional requirements

4.2.1 HEV shall meet requirements laid down in following clauses of AIS-038.

4.2.1.1 Clause 3.1. Traction Battery

4.2.1.2 Clause 3.2 Protection against Electric Shock

4.2.1.3 HEV's shall meet functional safety requirements as per clause 3.3, except the requirement of clause 3.3.11.

However, requirements of clause 3.3.14 shall be applicable only if the vehicle has a provision for off-vehicle ("plug-in") charging.

4.2.2 **Measurement of Net Power and Maximum Thirty Minute Power**

4.2.2.1 Test shall be conducted as per AIS-041: 2003 except clauses 4.3 and 6.0.

5.0 TECHNICAL SPECIFICATIONS

The information to be submitted by the manufacturer for type approval shall contain the information given in the version of AIS-007 as applicable to that category of vehicle.

The additional information needed to be submitted for HEV's are given in Annex B.

6.0 ISSUE OF PROVISIONAL TYPE APPROVAL

Testing agency may issue a provisional type approval certificate of compliance to CMVR for HEV's, based on compliance to this standard, before this standard is adopted by CMVR TSC and/or notified in CMVR.

Such provisional certificates shall indicate the following:

"This type approval certificate is issued based on compliance to AIS-102 (Part 2), which is not yet notified in CMVR. This type approval certificate is valid for 6 months after the notified date of implementation of the standard."

7.0 VALIDITY OF REQUIREMENTS UNDER THIS STANDARD

It is expected that in due course of time these approval requirements will be appropriately incorporated into the CMV Rules 1989 and the standards called therein. Once, such as inclusion has been notified, such notification would automatically supersede the requirements of this standard.

8.0 CHANGES IN THE TECHNICAL SPECIFICATIONS ALREADY TYPE APPROVED

8.1 Every modification pertaining to the information declared in accordance with paragraph 5.0 shall be intimated by the manufacturer to the testing agency.

8.2 If the changes are in parameters not related to the provisions, no further action need be taken.

If the changes are in parameters related to the provisions, the testing agency shall then consider, whether,

8.2.1 the model with the changed specifications still complies with provisions;

or,

8.2.2 any further verification is required to establish compliance.

For determining whether any further verification is required or not, guidelines given in Annex F of AIS-049 : 2003 shall be considered for the electrical requirements as per AIS-038 : 2003 as applicable for HEV's. For other cases, the guide lines given in the individual standards shall be considered. Where parameters in criteria for extension of approval stated in individual standards are not relevant and can not be applied directly for HEVs till such the CEA details for HEV's are incorporated in this standard, the criteria shall be as agreed

between the test agency and manufacturer.

8.3 In case of 8.2.2, verification for only those requirements which are affected by the modifications needs to be verified for the compliance.

8.4 In case of fulfillment of criterion of para 8.2.1 or after results of further verification as per para of 8.2.2 are successful, the approval of compliance shall be extended for the changes carried out.

8.5 If a vehicle has been converted in design by the manufacturer from a vehicle type previously approved, the tests (subject to CEA thereof) which are not affected by the conversion to a HEV shall not be reconducted and such previous type approval shall be automatically extended for HEV.

9.0 CONFORMITY OF PRODUCTION (COP) REQUIREMENTS

9.1 A vehicle approved under this standard shall be so manufactured as to conform to the vehicle type approved under this standard.

9.2 Verification of COP of the HEV by the testing agencies for the emission requirements shall be as per the procedure laid down in CMVR and document MoRSTH/CMVR/TAP-115/116.

9.3 Verification of COP by the testing agency for the components notified in CMV Rule 124 (4), as applicable for the category of vehicle and type of fuel used shall be as per the procedure laid down in AIS-037: 2004.

ANNEX A

(See 4.1.7.2)

ADDITIONAL REQUIREMENTS FOR REGENERATIVE BRAKING SYSTEM

A-1.0 Definitions

A-1.1 **Electric Regenerative Braking System:** A braking system, which during deceleration, provides for the conversion of vehicle kinetic energy into electrical energy.

A-1.2 **Electric Regenerative Brake Control:** A device which modulates the action of the electric regenerative braking system

A-1.3 **Electric Regenerative Braking System of Category A:** An electric regenerative braking system, which is not part of the service braking system.

A-1.4 **Electric Regenerative Braking System of Category B:** An electric regenerative braking system, which is part of the service braking system.

A-2.0 Additional Requirements for Vehicles of Categories M2 and N2 < 5 tonnes GVW Equipped with Electric Regenerative Braking System of Category A

A-2.1 The vehicles of categories M2 and N2 (< 5 tonnes GVW), the electric regenerative braking control can be a separate switch or lever.

A-3.0 Additional Requirements for Vehicles of Categories M2 and N2 < 5 tonnes GVW Equipped with Electric Regenerative Braking System of Category B

A-3.1 It shall not be possible to disconnect partially or totally one part of the service braking system other than by an automatic device.

A-3.2 The service braking system control shall also actuate the action of the electric regenerative braking system simultaneously.

A-3.3 The service braking system shall not be adversely affected by the disengagement of the motor(s) or gear ratio used, except during the short duration of operation of gear shifting.

A-4.0 If so desired by the manufacturer the performance requirements may be verified without the use of the electric regenerative system by appropriately disconnecting the system. If, so this shall be recorded in the test report.

A-5.0 General

A-5.1 For vehicles powered completely or partially by an electric motor or motor(s), permanently connected to the wheels, all tests must be carried out with these motor(s) connected.

A-5.2 On HEV's equipped with anti-lock device, the anti-lock device shall control the electric regenerative braking system of either category. (A or B)

A-5.3 The operation of the electric regenerative braking shall not be adversely affected by magnetic or electric fields.

However, this requirement shall become applicable only to vehicles manufactured after the date of implementation of AIS-004 (Part 2) and (Part 3).

A-5.4 The contribution of the electric regenerative braking system to the braking force generated shall not exceed that minimum level guaranteed by the system design.

This requirement is deemed to be satisfied if the RESS is at one of the following state of charge conditions that where state of charge is

(a) at the maximum charge level as recommended by the manufacturer in the vehicle specification, or

(b) at a level not less than 95 per cent of the full charge level, where the manufacturer has made no specific recommendation, or

(c) at the maximum level which results from automatic charge control on the vehicle.

ANNEX B
(See 5.0)
THE ADDITIONAL INFORMATION NEEDED FOR HEV'S

B -1.0 General Description of Vehicle

B -1.1 Vehicle Model

B -1.2 Vehicle Type

B -1.3 Drawing and /or photographs of the vehicle

B -1.4 Type of hybrid vehicle (Externally chargeable/Not externally chargeable, Parallel HEV, Series HEV, Series Parallel HEV)

B -1.5 Mode selection switch provided: Yes/No

B -1.5.1 If yes the modes available

B -1.5.2 In the case of Externally Chargeable HEV's

B-1.5.2.1 The hybrid mode which can be proven to have the highest electricity consumption

B-1.5.2.2 The hybrid mode which can be proven to have the highest fuel consumption

B -1.5.3 In the case of Not Externally Chargeable HEV's, the mode which is automatically set after turn on of the ignition key (normal mode)

B - 2.0 Description of the RESS

B -2.1 Trade Name and Mark of the RESS

B -2.2 Kind of Electro – Chemical Couple, if applicable

B -2.3 Nominal Voltage , V

B -2.4 RESS Maximum Thirty Minutes Power (Constant Power Discharge), kW

B -2.5 RESS Performance in 2 h Discharge (Constant Power or Constant Current)

B -2.5.1 RESS Energy , kWh

B -2.5.2 RESS Capacity , Ah in 2 h

B -2.6 End of Discharge Voltage Value , V

B -2.7 Provision of ventilation for RESS Yes / No

B -2.7.1 Brief description of the ventilation system adopted in the vehicle. (Refer AIS-038 clause 3.1.1). Provide drawing if necessary.

B -2.7.2 Brief description of the ventilation system adopted in the RESS compartment. (Refer AIS-038 clause 3.1.2). Provide drawing if necessary.

B-2.8 On-board Indication of RESS state of charge (Applicable if there is a "pure electric mode"

B-2.8.1 Details of indication when state of charge of the RESS reaches a level when the manufacturer recommends re-charging.

B-2.8.1.1 Indication format.

B-2.8.1.2 Relationship of state of charge indicator and the indication.

B-2.8.1.3 Make

B-2.8.1.4 Model

B -2.8.2 Indication of state of charge of RESS reaches a level at which driving vehicle further may cause damage to RESS.

B-2.8.2.1 Indication format.

B-2.8.2.2 Relationship of state of charge indicator and the indication.

B-2.9 RESS Mass, kg

B-2.10 Brief description of maintenance procedure, if any

B-3.0 Description of the Drive Train

B-3.1 **General**

B-3.1.1 Make

B-3.1.2 Type

B-3.1.3 Use : Mono motor / multi motors (number)

B-3.1.4 Transmission Arrangement parallel / transaxial / others

B-3.1.5 Test Voltage , V

B-3.1.6 Motor Nominal Speed , Min $^{-1}$

B-3.1.7 Motor Maximum Speed, Min $^{-1}$ or by default reducer outlet shaft / gear box speed (specify gear engaged)

B-3.1.8 Maximum Power Speed , Min $^{-1}$ and km/h

B-3.1.9 Maximum Power , kW

B-3.1.10 Maximum Thirty Minutes Power, kW

B-3.1.11 Maximum Thirty Minutes speed km/h

B-3.1.12 Speed at the beginning of the range, Min $^{-1}$

B-3.1.13 Speed at the end of the range , Min $^{-1}$

B-3.2 Traction Motor

B-3.2.1 Make

B-3.2.2 Working Principle

B-3.2.2.1 Direct current / alternating current / number of phases

B-3.2.2.2 Separate excitation / series / compound

B-3.2.2.3 Synchron / asynchron

B-3.2.2.4 Coiled rotor / with permanent magnets / with housing

B-3.2.2.5 Number of Poles of the Motor

B-3.2.3 Motor power curve (kW) with motor RPM (min^{-1}) / vehicle speed in km/h

B-3.3 Power Controller

B-3.3.1 Make

B-3.3.2 Type

B-3.3.3 Control Principle : vectorial / open loop / closed / other (to be specified)

B-3.3.4 Maximum effective current supplied to the Motor, A

B-3.3.5 Voltage range use , V to V

B-3.4 Cooling System
motor : liquid / air
controller : liquid / air

B-3.4.1 Liquid cooling equipment characteristics

B-3.4.1.1 Nature of the liquid ,

circulating pumps , yes / no

B-3.4.1.2 Characteristics or make(s) and type(s) of the pump

B-3.4.1.3 Thermostat : setting

B-3.4.1.4 Radiator : drawing(s) or make(s) and type(s)

B-3.4.1.5 Relief valve : pressure setting

B-3.4.1.6 Fan : Characteristics or make(s) and type(s)

B-3.4.1.7 Fan : duct

B-3.4.2 Air-cooling equipment characteristics

B-3.4.2.1 Blower : Characteristics or make(s) and type(s)

B-3.4.2.2 Standard air ducting

B-3.4.2.3 Temperature regulating system yes / no

B-3.4.2.4 Brief description

B-3.4.2.5 Air filter : make(s)
type(s)

B-3.4.3 Maximum temperatures recommended by the manufacturer:

B-3.4.3.1 Motor Outlet : ^{o}C

B-3.4.3.2 Controller inlet : ^{o}C

B-3.4.3.3 At motor reference point(s) ^{o}C

B-3.4.3.4 At controller reference point(s) ^{o}C

B-3.5 Insulating Category :

B-3.5.1 International Protection (IP)-Code :

B-3.6 Lubrication System Principle

Bearings : friction / ball
Lubricant : grease / oil
Seal : yes / no
Circulation : with / without

B-4.0 Charger (Applicable only for Externally Chargeable HEV's)

B-4.1 Charger : on board / external

B-4.1.1 Trademark , model, rating

B-4.2 Description of the normal profile of charging system :

B-4.3 Specifications of mains

B-4.3.1 mains : single phase/ three phase :

B-4.3.2 Nominal Voltage (V) & frequency (Hz) with tolerances :

B-4.4 Reset period recommended between the end of the discharge and the start of the charge

B-4.5 Recommended duration of a complete charge

B-4.6 In case of on-board charger

B-4.6.1 Continuous rating of charger socket (A) :

B-4.6.2 Time rating (h) of charger socket, if any :

B-4.6.3 Whether soft-start facility Yes / No :

B-4.6.4 Maximum initial in-rush current (A)

B-5.0 Electrical Details of Vehicle for Functional Safety

B-5.1 Schematic diagram showing the electrical layout giving all major electrical items along with their physical location in the vehicle. It shall include RESS, power-train components, protection fuses, circuit breakers etc. (Reference in AIS-038 clause 3.1.3)

B-5.2 Specifications of circuit breakers/ fuses used for protection of RESS / power-train (Reference in AIS-038 clause 3.1.3)

B-5.2.1 IS / IEC specifications

B-5.2.2 Rating (A)

B-5.2.3 Opening time (ms)

B-5.3 Working voltage V (Reference in AIS-038 clause 3.2)

B-5.4 Schematic highlighting physical location of live parts having working voltage greater than 60 V DC or 25 V AC (Reference in AIS-038 clause 3.2.1.2)

B-5.5 Electric cables / connectors / wiring harness (Reference in AIS-038 clause 3.2.2.2)

B-5.5.1 IEC protection class

B-5.5.2 Insulation material used

B-5.5.3 Conduits provided Yes / No

B-5.6 List of exposed conductive parts of on-board equipment. (Reference in AIS-038 clause 3.2.2.3)

B-5.6.1 Any potential equalization resistance used to electrically connect these parts Yes/ No

B-5.6.2 If yes, give details

B-5.7 List of failures due to which the vehicle will come to standstill (Reference in AIS-038 clause 3.3.6)

B-5.8 List of conditions under which the performance of vehicle is limited and how. (Reference in AIS-038 clause 3.3.13)

B-5.9 Declaration regarding Design guidelines followed with respect to various requirements

B-6.0 Special gear shifting pattern if any

ANNEX C
(See Introduction)

COMPOSITION OF AISC PANEL ON HYBRID ELECTRIC VEHICLES

Convener	
Dr. Arvind Bharadwaj	Automotive Infotronics Pvt. Ltd
Members	**Representing**
Mr. A. B. Komawar	The Automotive Research Association of India (ARAI)
Mr. M. K. Choudhari	The Automotive Research Association of India (ARAI)
Mrs. Rashmi Urdhwareshe	The Automotive Research Association of India (ARAI)
Mr. Vikas Sadan	International Centre for Automotive Technology (ICAT)
Mr. S. Ravishankar	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Mr. T. M. Balaraman	Society of Indian Automobile Manufacturers (SIAM) (Bajaj Auto Ltd.)
Mr. K. K. Gandhi	Society of Indian Automobile Manufacturers (SIAM)
Mr. P. K. Banerjee	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Mr. S. Govindrajan	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Dr. Philip Jose	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Mr. Suresh Arikapudi	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Mr. Rajendra Khile	Society of Indian Automobile Manufacturers (SIAM) (Tata Motors Ltd)
Mr. B. K. Vaishya	Society of Indian Automobile Manufacturers (SIAM) (Electrotherm (India) Ltd.)
Mr. G. V. N. Prasad	Society of Indian Automobile Manufacturers (SIAM) (Ashok Leyland Ltd)
Mr. S. Arun	Society of Indian Automobile Manufacturers (SIAM) (Ashok Leyland Ltd)
Mr. C. Nandagopalan	Society of Indian Automobile Manufacturers (SIAM) (Mahindra & Mahindra Ltd.)
Mr Jayanta K. Biswas	Cummins India Ltd.

ANNEX D

(See Introduction)

COMMITTEE COMPOSITION *

Automotive Industry Standards Committee

Chairman	
Shri Shrikant R. Marathe	Director The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport & Highways (Dept. of Road Transport & Highways), New Delhi
Representative from	Ministry of Heavy Industries & Public Enterprises (Department of Heavy Industry), New Delhi
Shri S. M. Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small & Medium Enterprises, New Delhi
Shri T. V. Singh	Bureau of Indian Standards, New Delhi
Director Shri D. P. Saste (Alternate)	Central Institute of Road Transport, Pune
Dr. M. O. Garg	Indian Institute of Petroleum, Dehra Dun
Shri C. P. Ramnarayanan	Vehicles Research & Development Establishment, Ahmednagar
Representatives from	Society of Indian Automobile Manufacturers
Shri T.C. Gopalan	Tractor Manufacturers Association, New Delhi
Shri K.N.D. Nambudiripad	Automotive Components Manufacturers Association of India, New Delhi
Shri Arvind Gupta	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Mrs. Rashmi Urdhwareshe
Deputy Director
The Automotive Research Association of India, Pune

* At the time of approval of this Automotive Industry Standard (AIS)