

AMENDMENT NO. 3 / MAY 2002

TO

AIS-003/1999

**Automotive Vehicles - Starting Gradeability
- Method of Measurement and Requirements
(Incorporating Amendment No. 1/September 1999
& Amendment No. 2/September 2000)**

1. (Page No.3, Clause No. 6.1).

Replace “70 cc” by “85 cc”

PRINTED BY:

THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA
P. B. NO. 832, PUNE 411 004

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

AIS - 003/1999

AUTOMOTIVE INDUSTRY STANDARD

**Automotive Vehicles -
Starting Gradeability -
Method of Measurement
and Requirements ∞**

(Incorporating Amendment No. 1/September 1999
&
Amendment No. 2/September 2000)

PRINTED BY:
THE AUTOMOTIVE RESEARCH ASSOCIATION OF INDIA
P. B. NO. 832, PUNE 411 004

ON BEHALF OF :
DEPT. OF INDUSTRY
GOVERNMENT OF INDIA
AND
MINISTRY OF SURFACE TRANSPORT
GOVERNMENT OF INDIA

January 1999

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

| Sr. No. | Corr-igenda | Amend-ment | Revision | Date | Remark | Misc. |
|---------|-------------|------------|----------|------|--------|-------|
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General remarks :

This standard includes Amendment No.1/1999 & Amendment No.2/2000. They are shown with symbol ∞, italic and in blue colour in the soft copy of the standard.

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 on the preparation of the 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 Standards Committee (AISC) vide order No. RT-11028/11/97-MVL dated September 15, 1997.

The requirements of the minimum gradeability had been recommended by the erstwhile CMVR Technical Sub-Committee and these have been accepted by Ministry of Surface Transport vide letter no. RT - 11036/16/97 dated 11.06.1997. This Standard is prepared to lay down a uniform testing procedure for evaluating the gradeability of the vehicle. While preparing this standard assistance of IS : 13988 - 1994 has been taken.

This has been approved by the permanent CMVR Technical Standing Committee (CTSC) in its meeting held on -----.

This Standard will be used as the test procedure from this date and shall remain in operation till the corresponding Indian Standard is made effective.

The Automotive Research Association of India (ARAI), Pune, being the Secretariat of AIS Committee, has printed this Standard .

The committee responsible for preparation of this standard is given in Annexure : B

Automotive Vehicles - Starting Gradeability - Method of Measurement *And Requirements* ∞

1. SCOPE

This standard specifies the method for measurement ∞ *and minimum requirements* of starting gradeability for all types of road vehicles, for the purpose of establishing compliance to statutory requirements. This may also be used to verify the capability of vehicle with the maximum recommended gradeability declared by the vehicle manufacturer.

2. TERMINOLOGY

2.1 Starting Gradeability

The starting gradeability of a vehicle is the maximum gradient, on which the vehicle can start climbing from stand-still condition, with all the wheels of the vehicle on the gradient at the time of start.

2.2 Percentage Gradient

It is $100 \times \tan \theta$, where, ' θ ' is the angle between the gradient and horizontal plane.

3. VEHICLE PREPARATION

3.1 The vehicle shall be run in as per the practice recommended by the vehicle manufacturer.

3.2 The vehicle shall conform in all its parts, components and systems to the technical specification declared by the manufacturer.

3.3 The adjustment of brakes, clutch, idling speed etc. and the adjustment of fuel system, ignition system, and grade, quality, quantity of lubricants for various moving parts shall conform to the manufacturer's recommendation.

3.4 The tyres shall be run in at the same time as the vehicle and shall have a tread depth not less than 90 percent of tread depth of a new tyre and shall have operated for at least 500 km or the distance recommended for running-in of the vehicle, whichever is lower on road, prior to test.

3.5 The tyre pressure shall be adjusted, when cold, to the value recommended by the vehicle manufacturer.

3.6 All the fuel enriching devices other than those required for the normal functioning of the vehicle shall be made inoperative.

- 3.7 Additional attachments which consume power like air-conditioner, etc. shall also be made inoperative.
- 3.8. In case of vehicle with more than one live axle, all combinations of live axles provided for selection on the vehicle shall be tried out.
- 3.9 The vehicle shall be loaded to the specified GVW and load distribution between the axles shall be as per the manufacturer's specification.
- 3.10 Before test, the vehicle including all its parts, components and systems, shall have reached a stable operating temperature normal to the vehicle operation.

4 TEST CONDITIONS

4.1 Atmospheric Conditions

- 4.1.1 The atmospheric conditions at test site such as pressure, temperature and relative humidity shall be recorded. The air density at test site (d_t) shall be calculated by the formula given below. The air density so calculated shall not differ from the reference air density (d_o) by more than 7.5 %.

$$d_t = d_o \times (H_t/H_o) \times (T_o/T_t)$$

where,

- d_t = Air density at test conditions in kg/m^3
 H_t = Atmospheric pressure at test site expressed in kPa
 T_t = Atmospheric temperature at test site expressed in K
 d_o = Air density at reference conditions (1.168 kg/m^3)
 H_o = Atmospheric pressure at reference conditions (100 kPa)
 T_o = Temperature at reference conditions (300 K)

- 4.1.2 The relative humidity at the test site shall be between 45 to 75 percent.

4.2 Features of Test Track

- 4.2.1 The surface of the test track shall be dry, roadway covered with asphalt, concrete. The lateral gradient of the track shall not exceed 3 percent. The length of the gradient shall be at least equal to the wheel base of the vehicle plus 15 meters.
- 4.2.2 The inclination of stretch on which the trials are conducted shall be measured at least at three places and the average angle of these values shall be quoted as gradient.

5 TEST PROCEDURE

- 5.1 The test shall be conducted preferably on the specified gradient. If such a gradient is not available, the nearest gradient available shall be used. Park the vehicle on the gradient using parking brake, front of the vehicle facing upwards with all the wheels standing on the gradient and the rearmost point of the vehicle lies at least one meter ahead of the bottom of the gradient. If necessary, wheel chock may also be placed behind the rearmost wheels.
∞In case of two-wheelers, the vehicle shall be parked as above using the front/rear brake or by using wheel chock behind rear wheel .
- 5.2 The vehicle shall be started from neutral gear position with engagement of the lowest gear (i.e. the gear with highest numerical reduction ratio). Attempt shall be made to start the vehicle in this position.
- 5.3 In case, the test is done on a gradient which is not the specified gradient, increase/decrease the load in/on the vehicle till the vehicle is just capable of starting and negotiating the gradient. This shall be possible without excessive shuddering or vibration of the vehicle. Record the weight of vehicle at this condition. The test shall be repeated three times, successfully in all three cases. The vehicle shall be brought to the normal operating temperature of engine/clutch between these tests.

Note: The amount of extra load on the vehicle and the axles shall be as agreed by the vehicle manufacturer. In case the load requirement is excessive, the test shall be conducted at another appropriate gradient.

- 5.4 The starting gradeability of the vehicle in percentage shall be expressed as :

$$G = 100 \times \tan[\sin^{-1} ((\sin \theta \times W_T) / W_R)]$$

where,

G = Starting gradeability of vehicle in percentage

θ = Slope angle of the test track used for the test

W_T = Weight of the vehicle as recorded in 5.3

W_R = Maximum recommended GVW of the vehicle in Para 3.9

∞6. REQUIREMENTS

When tested as per this procedure, the vehicle in the rated GVW condition (GCW in case of Tractor-Trailer Combination) shall comply with the following:

- 6.1 Two wheelers with fixed transmission ratio and engine capacity not exceeding 70 cc : 1 in 15 (3.81°).
- 6.2 All other vehicles : 7°.

7. TECHNICAL SPECIFICATIONS OF THE VEHICLE

The technical specifications submitted by the vehicle manufacturer to the test agency shall contain at least the details given in Annexure A.

Note : In case the specification submitted for whole type approval of vehicle contain the above information, it is not necessary to submit them again.

8. CHANGES IN TECHNICAL SPECIFICATIONS

8.1 In case the testing is for the purpose of verifying compliance to the statutory limits, the changes in the technical specifications declared as per para 6 above shall be intimated to the test agency by the manufacturer. For deciding whether the changes in specifications affect the gradeability adversely or not, the guide lines given below shall be used.

8.2 In case of the following changes, the tests may be necessary for establishing compliance. However re-testing may not be required, if the conditions given at para 8.4 given are met.

8.2.1 Any increase in GVW

8.2.2 Any decrease in max. engine torque

8.2.3 Any decrease in overall transmission ratio (engine rpm/wheel rpm) in the lowest gear (i.e. the gear with highest numerical reduction ratio)

8.2.4 Any increase in tyre size which increases the rolling radius

8.2.5 Permanent 4 wheel drive to 2 wheel drive configuration

8.3 In case of changes given in 8.2.1 to 8.2.4 above, the gradeability shall be calculated for the new combination using the following formula, from the results of the tested combination.

$$G_n = (T_n / T_o) \times (G_{rn} / G_{ro}) \times (GVW_o / GVW_n) \times (T_{ro} / T_{rn}) \times (G_o)$$

Where G_n = Extrapolated gradeability for the modified combination

G_o = Test result of the gradeability for the combination tested

T_o = Engine torque for the combination tested

T_n = Engine torque for the modified combination

G_{ro} = Transmission ratio for the combination tested

G_{rn} = Transmission ratio for the modified combination

G_{VW_o} = Gross vehicle weight for the combination tested

G_{VW_n} = Gross vehicle weight for the modified combination

T_{r_o} = Rolling radius of the tyre for the combination tested

T_{r_n} = Rolling radius of the tyre for the modified combination

8.4 Conditions on which retesting may not be required

- G_n is more than 1.2 times the statutory limit for the gradeability.
- The ratio G_o/G_n is less than 1.3.

Note: The same procedure can be adopted for verification of the value declared by the manufacturer for the modified combination.

Annexure : A

TECHNICAL SPECIFICATIONS FOR GRADEABILITY TEST

A.0 GENERAL

A.0.1 Manufacturer's Name and Address

A.0.2 Telephone/ Fax No.

A.0.3 Contact Person

A.1 VEHICLE

A.1.1 Model

A.1.2 Variant

A.1.3 Type & Category of vehicle

A.2 CONFIGURATION

A.2.1 No. of Axles
Driven
Non-driven

A.2.2 Type of Drive

A.2.3 Wheel base (mm)

A.2.4 Overhang
Front (mm)
Rear (mm)

A.2.5 Angle of approach (deg.)

A.2.6 Angle of departure (deg.)

A.2.7 Ramp angle (deg.)

A.2.8 Operation of Parking Brake (Hand/ Foot)

A.3 WEIGHMENT (kg.)

A.3.1 Unladen weight

A.3.2 GVW

A.3.3 Recommended axle load distribution

A.3.4 Maximum permitted axle load distribution

A.3.5 Maximum recommended gradient

A.4 DRIVE LINE

A.4.1 Max. engine torque at _____ rpm

A.4.2 Overall transmission ratio providing max. torque

A.4.3 Tyre size & ply rating

A.4.4 Tyre inflation pressure (kPa)

Note: The specifications as per A.2.5 to A.2.7 are required for selection of test gradient.

Annexure : B
(Introduction)
COMMITTEE COMPOSITION
Automotive Industry Standards Committee

Chairman

Brig. (Retd.) S. R. Puranik

Representing

Director
The Automotive Research Association of India, Pune.

Members

Shri. Sushil Kumar

Department of Industrial Policy & Promotion,
Ministry of Industry, New Delhi.

Shri. Mohan Jeet Singh
Shri. S. K. Jain (Alternate)

Department of Industrial Development,
Ministry of Industry, New Delhi.

Shri. J. R. Kapoor

Ministry of Surface Transport, New Delhi.

Shri. A. R. Gulati

Bureau of Indian Standards.

Shri. R. C. Sethi
Shri. N. Karuppaiah (Alternate)

Vehicle Research & Development Establishment,
Ahmednagar.

Shri. S. R. Tapade
Shri. P. C. Barjatia (Alternate)

Central Institute of Road Transport, Pune.

Dr. P. D. Singhal

Association of Indian Automobile Manufacturers.

Shri. T. M. Balaraman

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Association of Indian Automobile Manufacturers.

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Shri. G. P. Banerji

Automotive Components Manufacturers Association

Member Secretary

Shri. M. S. Ogale

Assistant Director,

The Automotive Research Association of India, Pune.