Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

IS 14553 (2008): Automotive vehicles - Apparatus for the measurement of opacity (smoke) of exhaust gas from vehicles equipped with compression ignition engines [TED 2: Automotive Primemovers]

“अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड़ नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartrhari—Nitisatakam
“Knowledge is such a treasure which cannot be stolen”
Indian Standard

AUTOMOTIVE VEHICLES — APPARATUS FOR THE MEASUREMENT OF OPACITY (SMOKE) OF EXHAUST GAS FROM VEHICLES EQUIPPED WITH COMPRESSION IGNITION ENGINES — SPECIFICATION

( First Revision )

ICS 43.060; 13.040.50
FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Automotive Primemovers Transmission, Steering Systems and Internal Combustion Engines Sectional Committee had been approved by the Transport Engineering Division Council.

The increasing emphasis on environment necessitated formulation of standards outlining the methods of measurement of different facets of emissions, such as exhaust, evaporative and crankcase emissions. The methods in turn suggest instrumentation that can measure the limits with accuracy, repeatability and reproducibility. In view of the above, a need was felt to evolve a standard for type approval of the equipment required to check the opacity of exhaust emissions from compression ignition engines covering the technical requirements and test procedures by the committee.

This standard was first published in 1998. The revision of this standard is undertaken to align it with the latest practices in the industry. In this revision, clause 4 on design and construction has been elaborated.

While formulating this standard, considerable assistance has been derived from the following:

- ISO 3173:1974 Road vehicles: Apparatus for measurement of opacity of exhaust gas from diesel engines operating under steady state conditions
- ECE R-24.03 Uniform provisions concerning the approval of vehicles equipped with positive ignition engine or with a compression ignition engine with regard to the emission of gaseous pollutants by the engine — Method of measuring of power of positive ignition engines — Method of measuring the fuel consumption of the vehicles
- Doc: MoRTH/CMVR/TAP-115/116 Issue No. 2 Part A, Chapter 1 — Technical specification and test procedure for type approval of smoke meters

Users of standards may refer to Central Motor Vehicle Rules, 1989 as amended from time to time and as enforced by Statutory Authority under the Rules.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 ‘Rules for rounding off numerical values (revised)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.
Indian Standard

AUTOMOTIVE VEHICLES — APPARATUS FOR THE MEASUREMENT OF OPACITY (SMOKE) OF EXHAUST GAS FROM VEHICLES EQUIPPED WITH COMPRESSION IGNITION ENGINES — SPECIFICATION

(First Revision)

1 SCOPE

This standard specifies the requirements and methods of test including type approval of the equipment used for the measurement of opacity (smoke) of vehicles equipped with compression ignition engines.

2 REFERENCES

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

<table>
<thead>
<tr>
<th>IS No.</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>4167 : 1980</td>
<td>Glossary of terms relating to air pollution (first revision)</td>
</tr>
<tr>
<td>8118 : 2008</td>
<td>Automotive vehicles — Opacity (smoke) of exhaust gas from vehicles equipped with compression ignition engines operating under free acceleration — Method of measurement (third revision)</td>
</tr>
<tr>
<td>9000 (Part 8) : 1981</td>
<td>Basic environmental testing procedures for electronic and electrical items: Part 8 Vibration (sinusoidal) test</td>
</tr>
</tbody>
</table>

3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 4167 and the following shall apply.

3.1 Compression Ignition Engine — Means an internal combustion engine which operates on compression ignition principle (Diesel engine).

3.2 Exhaust Gas Temperature — Temperature of the exhaust gas measured as a point in the exhaust pipe 150 mm downstream from the outlet flange of the engine manifold.

3.3 Opacity (Smoke Density) — Means the light absorption coefficient of the exhaust gases emitted by the vehicle expressed in terms of per metre or in other units such as Hartridge, Opacity. Figure 1 shows the relation between light absorption coefficient, expressed in terms of per metre, percent Opacity and Hartridge Smoke Unit (HSU).

3.4 Light Absorption Coefficient — Means the percentage of light absorption in 1/m length of measurement tube of the smoke meter. The light absorption coefficient is calculated by the following formula:

\[ \phi = \phi_o e^{-KL} \]

where

- \( L \) = effective length of light path through the gas,
- \( \phi \) = light flux at the end of the measurement chamber when filled with clean air, and
- \( \phi_o \) = light flux at the end of the measurement chamber when filled with smoke.

In case \( L \), the effective length of the light path of the opacimeter cannot be assessed directly from geometry, this can be determined by the relation with the 0-100 light absorption scale by the following formula:

\[ K = -\frac{1}{L} \log_e \left( \frac{N}{100} \right) \]

where

- \( N \) = reading on the observation scale, and
- \( K \) = value of light absorption coefficient.

3.5 Opacity Meter — Means an instrument for continuous measurement of the light absorption coefficient of the exhaust gases emitted by automotive vehicles.

3.6 Response Time

3.6.1 Physical Response Time — It is the time taken for the physical phenomena of filling up the smoke chamber from the start of the gas entering the chamber to complete filling of the smoke chamber.
3.6.2 Electrical Response Time — The response time of electrical measuring circuit is the time necessary for the indicator to reach 90 percent of full scale deflection on insertion of a screen fully obscuring the photoelectric cell.

3.7 Full Load Test — Means the test conducted on a vehicle, with the vehicle operating in suitable gear on chassis dynamometer or on an engine dynamometer with full throttle condition at a constant engine speed of approximately 60 percent of maximum rated speed.

3.8 Free Acceleration Test — Means the test conducted by abruptly but not violently, accelerating the vehicle from idle to full speed with the vehicle stationary in neutral gear or the engine on an engine dynamometer with the engine disconnected from the dynamometer.

4 DESIGN AND CONSTRUCTION

4.1 Smoke meter shall be suitable for conducting full load and free acceleration tests or only free acceleration test on different types of diesel vehicles as specified in IS 8118.

4.2 The instrument shall be so designed and constructed to provide reliable and accurate service in the vehicle repair garage environment.

4.3 Mobility

The instrument may be permanently mounted, portable or mobile.

4.4 Construction

The gas to be measured shall be confined in an enclosure having a non-reflecting internal surface in the instrument. In determining the effective length of light path through the gas, account shall be taken of the positive influence of devices protecting the light source and the photoelectric cell. The design shall be such that under steady state operating conditions, smoke chamber is filled with smoke of uniform opacity. The smoke meter shall have probes of sufficient length, minimum 2 m, to facilitate easy attachment to the tail-pipes of vehicles.

4.5 Display

The smoke meter shall indicate light absorption coefficient directly or in case of end of line full flow meter when it may not be possible to indicate light absorption coefficient directly, it shall be easily possible to calculate value of \( K \) based on the display reading using either a formula or a suitable table. The instrument shall have peak hold facility to display/print the maximum smoke reading obtained during free acceleration test.

4.6 Printer

If the instrument is provided with a printer, it shall print all the readings and shall have the facility to print arithmetical mean value of the last four valid readings as per the test procedure given in IS 8118.
4.7 Heating
The condensation in the smoke chamber shall be avoided. If necessary, instrument shall have heating facility for the same.

4.8 Temperature and Pressure
The smoke meters used for full load test shall have the pressure and mean temperature indication of the smoke into the smoke chamber. Smoke reading shall be corrected for reference pressure of 100 kPa and reference temperature of 373°K and displayed.

4.9 Calibration
The smoke meter shall have facility to adjust zero reading when the smoke meter is filled with clean air. Each smoke meter shall be supplied with a neutral density filter of known value to accuracy of ± 0.05/m (per metre) light absorption coefficient (along with the calibration certificate) in the region of 1.5 to 2.5/m. It shall be possible to calibrate the smoke meter easily in the field using this filter.

4.10 Identification
The identification of the instrument shall be permanently attached to the outer surface of the analyzer enclosure. The identification shall include the model and serial number, name and address of the instrument manufacturer, production date, electrical power requirements, operating voltage range, type of opacimeter and the formula/table for calculation of K, if it is not directly available.

4.11 Operating Instructions
Concise operating instructions including the calibration procedures and instrument calibration curves shall be supplied by the manufacturers with the instrument.

4.12 Information for Type Testing
When the smoke meter is submitted for type testing, it shall be accompanied with following information:
   a) All technical specifications of the smoke meter,
   b) A description of the general principle of measurement,
   c) A list of essential components with their characteristics,
   d) A description of the essential components with drawings and diagrams that are necessary for testing and maintenance,
   e) General information on the software required for a microprocessor equipped measuring instrument,
   f) Spectral response characteristics of the light source and reflector from a recognized organization,
   g) The operating instructions that shall be provided to the user,
   h) Details of how calculations are performed,
   i) A fully documented calibration procedure and a set of calibration filters, and
   j) A photograph of the instrument.

4.13 a) Smoke meter should be PC compatible with RS 232 port. It is required for:
   i) Operating smoke meter through PC.
   ii) Taking web cam photo of vehicle number plate for inserting in Emission certificate.
   iii) Future connectivity of PUC Centers.
   b) Smoke meter should have engine rpm measuring sensor. It is required for:
      i) Correlating smoke readings with engine rpm.
      ii) Ensuring that engines are accelerated completely from idling to full speed.
   c) Smoke meter should have engine oil temperature measuring sensor. It is required for ensuring that engines are warm before conducting test.

5 PERFORMANCE REQUIREMENTS
5.1 The scale shall be zero to at least 6/m for light absorption coefficient.

5.2 Resolution
The smoke meter shall have a resolution of at least 0.1/m between the range 0 to 4/m.

5.3 Linearity
The linearity of the smoke meter shall be within ± 0.1/m.

5.4 Drift
The instrument zero drift and span drift with neutral density filter having value between 1.5 to 2.5/m, shall be within ± 0.1/m for 4 h after warming up.

5.5 Repeatability
The repeatability of the instrument shall be within ± 0.1 m during five successive calibration tests with the neutral density filter having value between 1.5 to 2.5/m.

5.6 Light Source
The light source shall be an incandescent lamp with a colour temperature in a range 2 800 to 3 250°K or a green light emitting diode (LED) with a spectral peak between 550 nm and 570 nm.
5.7 Light Detector
It shall be a photo cell or photo diode (with filter, if necessary). Any other equivalent device can be used if the equivalence is established by the manufacturer. In the case of an incandescent light source, the detector shall have a peak spectral response in the range 550 to 570 nm and shall have gradual reduction in response to value less than 4 percent of the peak response value below 430 nm and above 680 nm.

5.8 Response Time
5.8.1 The response time of the equipment shall not exceed the following values:
   a) Physical response time 0.4 s, and
   b) Electrical response time 1.1 s.

5.8.2 The damping of the electrical measuring circuit shall be such that the initial overswing beyond the final steady reading after any momentary variation in input (for example, calibration screen) does not exceed 0.1/m with neutral density filter having value between 1.5 to 2.5/m.

5.9 Soiling of Light Source and Receiver
The smoke meter shall be capable of being used for a period sufficient to take measurements without soiling of the light source and receiver. This is considered satisfactory, if the overall drift of the instrument is less than 0.2/m for over 1 h when used on diesel engine producing smoke of light absorption coefficient between 2 to 4/m.

5.10 Warm-Up Time
Unless otherwise indicated on the meter, the smoke meter shall be stabilized for operation within 30 min after power 'ON'.

5.11 Input Power Supply
The equipment operation shall be unaffected by an electrical voltage variation of 230 V ± 10 percent or within the indicated range of the battery voltage, if battery operated. The operation is considered satisfactory, if span readings with a neutral density filter having value between 1.5 and 2.5/m at the extreme voltage conditions do not vary by more than 0.1/m.

5.12 Electromagnetic Isolation
The equipment shall be capable of providing unaffected operation in electromagnetic radiation or conductive interference produced by vehicle ignition systems and building electrical system. The operation is considered satisfactory, if span readings with a neutral density filter having value between 1.5 and 2.5/m do not vary by more than 0.1/m with/without the electromagnetic radiation.

5.13 Vibration Test
The equipment operation shall be unaffected by the vibration and shock encountered under the normal operating conditions in the motor vehicle repair garage. The operation is considered satisfactory, if span readings with a neutral density filter having value between 1.5 and 2.5/m do not vary by more than 0.1/m before and after the test.

5.14 Temperature Sensitivity
The instrument shall be suitable for ambient temperatures between 278°K and 323°K. Between these two limits the result of the measurement shall not differ from that obtained at a temperature of 303 ± 2°K by more than 0.1/m.

5.15 Drop Test
The instrument shall not be affected by accidental fall or toppling of the equipment. The operation is considered satisfactory if span readings with a neutral density filter having value between 1.5 and 2.5/m, do not vary by more than 0.1/m before and after the test.

5.16 Correlation to Reference Smoke Meter
5.16.1 The meter shall be correlatable for the full load and free acceleration tests or only free acceleration test depending on intended use of the smoke meter with the reference standard meter meeting the requirements stipulated in ECE Regulation 24.

5.16.2 For the time being, Hartridge Mark-3 smoke meter shall be used as a reference standard meter. This may be reviewed after a suitable time.

5.16.3 Permissible difference during the full load test between the two meters:

| Mean Value of K | Permissible Difference
<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>Less than 1/m</td>
<td>5.0</td>
</tr>
<tr>
<td>Between 1 and 2/m</td>
<td>7.5</td>
</tr>
<tr>
<td>Between 2 and 3/m</td>
<td>10.0</td>
</tr>
<tr>
<td>More than 3/m</td>
<td>12.5</td>
</tr>
</tbody>
</table>

5.16.4 Permissible difference during the free acceleration test between the mean of Test 1 and 4 and that of 2 and 3 for the five vehicles (as specified in 6.14.2) are:

| Mean Value of K | Permissible Difference
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent</td>
<td></td>
</tr>
<tr>
<td>3 vehicles</td>
<td>2 vehicles</td>
</tr>
<tr>
<td>Less than 1/m</td>
<td>5.0</td>
</tr>
<tr>
<td>Between 1 and 2/m</td>
<td>7.5</td>
</tr>
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<td>More than 3/m</td>
<td>12.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>or 0.1/m, whichever</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>is higher</td>
</tr>
<tr>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>20</td>
<td>25</td>
</tr>
</tbody>
</table>
6 TEST PROCEDURE

6.1 Physical Check

It shall consist of checking of the following requirements:

a) Each instrument shall be labelled with the information such as suitability and its intended usage;

b) Identification of the instrument consists of model, serial number, name and address of the manufacturer, electrical power requirement, year and month of manufacture and operating voltage range, type of opacimeter and formula for calculation of $K$, if it is not directly available;

c) Scale, Resolution, Display;

d) Peakhold facility;

e) Heating facility;

f) Calibration facility;

g) Printout specifications, if provided with printer;

h) Warm-up time;

i) Documentation; and

j) Checking of length of probe.

6.2 Linearity

The linearity shall be checked at minimum four number of points including the zero point (Five points, if the meter full scale corresponds to the total light cut-off including full scale point). This shall be checked by three different neutral density filters of $K$ values — one below 1/m, one between 1.5 and 2.5/m and one above 3/m. The tolerance on the $K$ values for the above filters shall be within ± 0.05/m. These shall be supplied by the smoke meter manufacturer or his representative along with calibration certificate from a recognized agency. The neutral density filter shall have flat response within ± 2 percent over the wave length range of 430 to 680 nm and the response at spot frequency between 550 to 570 nm as recommended by the manufacturer shall be considered for the linearity test. Prior to the test, the test agency may decide to test the accuracy of the filters.

6.3 Drift

Both zero and span drift shall be checked for 4 h with readings taken at an interval of every 30 min. Span drift shall be tested using neutral density filter having light absorption coefficient in the range of 1.5 to 2.5 m.

6.4 Repeatability

Repeatability shall be checked five times, with the neutral density filter having light absorption coefficient in the range of 1.5 to 2.5/m.

6.5 Light Source

With the voltage variation specified in 5.11, the colour temperature of the light source shall be checked and confirmed that it is within the limit or if a green light emitting diode (LED) is used, it is to be verified that its spectral peak is lying between 550 nm and 570 nm.

6.6 Light Detector

The combined receiver and filter characteristics shall be checked to ensure that they have a maximum response in the range 550 to 570 nm, and less than 4 percent of that maximum response below 430 nm and above 680 nm. Alternatively, it shall be verified that a green LED is used in conjunction with a photo diode; since the wavelength is set by the green light emitting diode (LED), it is not necessary to check the photo diode when used with a green light emitting diode (LED).

6.7 Response Time

6.7.1 Physical Response Time

Smoke meter manufacturer or its representative shall provide sufficient data and sample calculations to verify the physical response time. Test agencies shall calculate the same at minimum and maximum flow conditions based on this data.

6.7.2 Electrical Response Time

Smoke meter manufacturer or representative shall provide sufficient supporting documents to meet the specifications.

6.7.3 Damping of the electrical measuring circuit shall be checked by inserting the neutral density filter having value between 1.5 to 2.5/m.

6.8 Soiling of Light Source and Receiver

After calibration, the meter shall be used continuously for 1 h on full load test on an engine producing smoke of light absorption coefficient between 2 to 4/m. The zero reading after the test shall be checked and compared.

6.9 Input Power Supply

Smoke meter zero and span reading shall be checked at 253 V and 207 V with a neutral density filter having value between 1.5 and 2.5/m. In case of the instruments powered by a battery, the voltage shall be varied within the indicated voltage range.

6.10 Electromagnetic Isolation

This test shall be conducted in the vicinity of minimum five spark ignition engined vehicles operating within approximate distance of 3 to 5 m from the equipment. The vehicles shall not be fitted with ignition suppression
6.11 Vibration Test

The smoke meter shall be subjected to the vibrations as specified in IS 9000 (Part 8). Analyzer shall be subjected to vibration in normal mounting axis with a constant displacement of ±3.5 mm over a frequency range of 5-9 Hz and constant acceleration of ±1 g over a frequency range of 9-150 Hz for five sweep cycles, with a sweep rate of 1 oct/min, preferably with electrical power 'ON' condition. A span measurement with neutral density filter having value between 1.5 and 2.5/m shall be taken before and after the test. In case the electrical power of the instrument is switched 'OFF', the readings shall be taken after warming-up and initial calibration of the instrument.

6.12 Temperature Sensitivity

The smoke meter shall be maintained at 278°K and 323 °K temperature. Span reading with neutral density filter having value between 1.5 to 2.5/m at both these temperatures and the room temperature of 303 ± 2°K shall be taken.

6.13 Drop Test

6.13.1 The meter components (except those which are wall mounted) shall be positioned in their normal orientation of use on a rigid surface. They shall be tilted on one bottom edge and then allowed to fall freely onto the test surface. All covers shall be fitted properly. They shall be subjected to two falls on each edge from a height of 50 mm, measured from the elevated edge of the unit to the test surface.

6.13.2 This part applies only to those parts of the meter which contain electrical or electronic components and which are carried by the operator during normal use, for example, any part which is attached to the vehicle exhaust or a remote control unit. The test consists of subjecting the relevant component to two falls from a height of 0.5 m on to a smooth hard rigid surface of either concrete or steel.

6.13.3 A span measurement with neutral density filter having value between 1.5 to 2.5/m, shall be taken before and after the above tests and the difference in the reading shall be within 0.1/m. As the electrical power of the instrument is switched 'OFF', prior to testing the readings shall be taken only after warming-up and initial calibration of the instrument.

6.14 Correlation Tests

6.14.1 Full Load Test

The smoke meter under test and reference smoke meter shall be installed on an engine or a vehicle and full load test shall be carried out. If it is not possible to install both the meters simultaneously, the testing shall be carried out at first with reference smoke meter and subsequently with the meter under testing. The test shall be repeated to measure smoke of different K values (minimum five points) approximately evenly spaced over the range 0 to 4/m. If required the air system or the fuel system of the engine shall be adjusted to get smoke of different K values. The difference in the reading shall be within percentage specified in 5.16.3.

6.14.2 Free Acceleration Test

6.14.2.1 The test shall be carried out on at least five different diesel vehicles/engines as follows:

a) One engine used for passenger cars or utility vehicles, and

b) Four different engines used for light or heavy commercial vehicles.

6.14.2.2 The correlation tests shall be performed using either engines or complete vehicles. Test engines shall be at normal operating temperature as specified by the vehicle manufacturer.

6.14.2.3 The free acceleration test shall be carried out as per IS 8118. The sequence up to ten accelerations shall be scheduled leaving a gap of minimum 5 s up to a maximum of 20 s between the release of the accelerator pedal and next acceleration.

Test 1 With reference smoke meter.

Test 2 Subject meter installed on its own in the vehicle tailpipe and calibrated according to manufacturer's instructions using a neutral density filter.

Test 3 As specified in Test 2.

Test 4 As specified in Test 1.

6.14.2.4 The mean of free accelerations 7th, 8th, 9th and 10th in each test shall be calculated.

6.14.2.5 A test sequence is valid only if:

a) K value of Test 4 does not vary from Test 1 by more than 0.3/m; and

b) The result of Test 2 and Test 3 lie within ±10 percent of the mean of the two tests.

6.14.2.6 The percentage difference between the mean of the Test 1 and Test 4 and the mean of Test 2 and Test 3, for five vehicles, shall be within the percentage specified in 5.16.4.

6.14.2.7 In case one of five vehicles/engines do not meet the limits, additional two correlation tests, each consisting of five series of tests as mentioned above, shall be carried out on different vehicles/engines (other
than those vehicles/engines used in the first series of correlation tests). The meter can be considered meeting the requirements, if it meets the limits of the additional correlation tests.

7 MARKING

7.1 Each equipment shall be provided with a nameplate of marking which shall convey the following information:

a) Name or trade-mark of the manufacturer,
b) Serial number of the apparatus,
c) Type or model number,
d) Rated voltage and power,
e) Month and year of manufacture, and
f) Country of manufacture.

7.2 BIS Certification Marking

The product may also be marked with the Standard Mark.

7.2.1 The use of the Standard Mark is governed by the provisions of the Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder. The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Foreword)

COMMITTEE COMPOSITION

Automotive Primemovers Transmission, Steering Systems and Internal Combustion Engines Sectional Committee, TED 2

<table>
<thead>
<tr>
<th>Organization</th>
<th>Representative(s)</th>
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<tbody>
<tr>
<td>Automotive Research Association of India, Pune</td>
<td>Shri M. K. Choudhari (Chairman)</td>
</tr>
<tr>
<td>Ashok Leyland Ltd, Hosur</td>
<td>Shri N. V. Marathe (Alternate)</td>
</tr>
<tr>
<td>Association of State Road Transport Undertakings, New Delhi</td>
<td>Shri M. N. Gamal Kumar</td>
</tr>
<tr>
<td>Automotive Components Manufacturers Association of India, New Delhi</td>
<td>Shri S. K. Rao</td>
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<tr>
<td>Bajaj Auto Ltd, Pune</td>
<td>Shri Shrimali</td>
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<tr>
<td>Bharat Earth Movers Ltd, Mysore</td>
<td>Shri Ravindra Mandke (Alternate)</td>
</tr>
<tr>
<td>Central Institute of Road Transport, Pune</td>
<td>Shri G. P. Banerji (Alternate)</td>
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<tr>
<td>Clutch Auto Ltd, Faridabad</td>
<td>Shri S. B. Rao</td>
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<tr>
<td>Controllerate Quality Assurance (HV), Chennai</td>
<td>Shri T. M. Balaraman (Alternate)</td>
</tr>
<tr>
<td>Cummins India Ltd, Pune</td>
<td>Shri L. Namperumal (Alternate)</td>
</tr>
<tr>
<td>DGS &amp; D (Quality Assurance), Ahmedabad</td>
<td>Shri R. H. Muralidhar (Alternate)</td>
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<td>Eicher Tractors, New Delhi</td>
<td>Shri A. S. Lakra</td>
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<tr>
<td>Greaves (Cotton) Ltd, Pune</td>
<td>Shri S. G. Mani</td>
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<td>Shri S. C. Sharma (Alternate)</td>
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<td>Shri G. Venkatakrishnan</td>
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<td>Shri C. B. Madana Manoharan (Alternate)</td>
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<tr>
<td></td>
<td>General Manager (Technical Centre)</td>
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<tr>
<td></td>
<td>Shri S. G. Kinsale (Alternate)</td>
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<td>Shri V. K. Sridhar</td>
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<td>Shri P. M. Wadkar (Alternate)</td>
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<td></td>
<td>Dr. Satyamurthy</td>
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<td>Shri S. K. Seem (Alternate)</td>
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<td></td>
<td>Shri W. N. Khataukar</td>
</tr>
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<td>Shri A. S. Pathil (Alternate)</td>
</tr>
</tbody>
</table>
IS 14553 : 2008

Organization

HMT Ltd (Tractor Division), Pinjore
Indian Diesel Engine Manufacturers Association, Agra
Indian Institute of Petroleum, Dehradun
Indian Institute of Technology (IIT), New Delhi
Kinetic Engineering Ltd, Pune
Kirloskar Oil Engines Ltd, Pune
Mahindra & Mahindra Ltd, Nasik
Maruti Uuyog Ltd, Gurgaon
Ministry of Heavy Industries & Public Enterprises, New Delhi
Ministry of Road Transport & Highways, New Delhi
Motor Industries Co Ltd, Bangalore
Ordnance Factory Board, Kolkata
Rajkot Engineering Association, Rajkot
Kane Power Steering Ltd, Pudukkotai
Simpson & Co Ltd, Chennai
Society of Indian Automobile Manufacturers, New Delhi
Sona Steering Systems Ltd, New Delhi
Tata Motors Ltd, Pune
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