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FINALIZED DRAFT

AUTOMOTIVE INDUSTRY STANDARD

Remote Sensing Devices for on-road Emissions Monitoring – Product Specifications and Programme Guidelines

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 erstwhile 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 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, will publish this standard.

The matter of control of in-use vehicle emissions by was deliberated in the 60th Meeting of Standing Committee on Implementation of Emission Legislation (SCOE) held on 22nd August, 2019 and subsequently an AIS panel under the Chairmanship of Director-ICAT was constituted with focus to finalise technical guidance on remote sensing equipment, remote sensing data reporting which specifies design, construction, networking and data sharing of motor vehicle and recommend polluter thresholds for different vehicle and different fuel types. In the 61st Meeting of Standing Committee on Implementation of Emission Legislation (SCOE) held on 13th February, 2020, it was directed to consider polluter thresholds based on prevalent emission norms and in the absence of authentic data for these thresholds, the Committee had agreed to consider the first year as monitoring phase to arrive at threshold values.

This standard is technology neutral and does not restrict any arrangement for implementation based on the recommendations for implementing of remote sensing of emissions of in-use vehicles for on-road monitoring as per the directions of the Hon'ble Supreme Court and the EPCA Report No 99 dated 26th July, 2019. The EPCA report refers to the New Delhi Real World Emission Study (NDRWES) using Remote Sensing Technology, from which considerable reference has been drawn.

Reference has also been drawn from the following documents while preparing this standard:

- Commonwealth of Virginia State Air Pollution Control Board – 9VAC5 Chapter 91 - Regulation for the Control of Motor Vehicle Emissions in the Northern Virginia Area.
- EPA: Guidance on Use of Remote Sensing for Evaluation of I/M Program Performance
- ICCT Paper - Remote Sensing of Motor Vehicle Exhaust Emissions
- ICCT Paper - Remote-Sensing Regulation for Measuring Exhaust Pollutants from in-use Diesel Vehicles in China

The AISC panel responsible for formulation of this standard is given in Annex Y.

The Automotive Industry Standards Committee (AISC) responsible for approval of this standard is given in Annex Z.

Remote Sensing Devices for on-road Emissions Monitoring – Product Specifications and Programme Guidelines

1.0	**SCOPE**
	The standard lays down the minimum technical and performance requirements for remote sensing equipment and programme guideline.
2.0	**REFERENCES**
2.1	New Delhi Real World Emission Study (NDRWES) using Remote Sensing Technology
2.2	DOC.NO.: MoRTH/CMVR/TAP-115/116, Issue No. 4 – Document on Test Method, Testing Equipment and Related Procedures for Testing, Type Approval and Conformity of Production (CoP) of Vehicles for Emission as per CMV Rules 115, 116 and 126
2.3	Finalized Draft AIS-137 (Part 8) – Technical Specifications and Related Test Procedure for Type Approval and Conformity of Production (COP) of PUC Equipment (Gas Analyser and Smoke Meter) As per CMV Rules 115, 116
2.4	ISO/IEC VIM:1993: International Vocabulary of Basic and General Terms in Metrology
2.5	ISO/IEC Guide 99: International vocabulary of metrology – Basic and general concepts and associated term (VIM)
3.0	**TERMS AND DEFINITIONS**
	For the purpose of this standard, the following definitions shall apply:
3.1	**"Calibration gas"** means stable gas mixture of known concentration used for periodic calibration of the instruments and for various performance tests.
3.2	**"Manufacturer"** means the RSD manufacturer or equipment supplier.
3.3	**"Remote Sensing Device (RSD)"** means a device that measures exhaust emissions by absorption spectroscopy without interference with the vehicle or its driver. **Note:** This standard does not restrict any device/ instruments or principle of their operation as long as they meet the technical and performance requirements of this standard.
3.4	**"Monitoring phase"** means the time duration for arriving at threshold limits for different vehicle, different emission norms and different fuel types with a focus on vehicles of category M and N.

3.5	**"Adjustment (of a measuring system)"** means a set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured
3.6	**"User adjustment (of a measuring Instrument)"** means Adjustment employing only the means at the disposal of the user.
3.7	**"Manual adjustment facility"** means a facility allowing the adjustment of the instrument by the user.
3.8	**"Semi-automatic adjustment facility"** means a facility allowing the user to initiate an adjustment of the instrument without having the possibility of influencing its magnitude whether the adjustment is automatically required or not. **Note:** For those Instruments that require the values of the calibration gas to be entered manually, the facility is considered to be semi-automatic.
3.9	**"Automatic adjustment facility"** means a facility performing the adjustment of the instrument as programmed without the intervention of the user, to initiate the adjustment or its magnitude.
3.10	**"Checking facility"** means a facility that is incorporated in the instrument and that enables significant faults to be detected and acted upon. **Note:** "Acted upon" means any adequate response by the Instrument (luminous or acoustic signal, by blocking of process, etc.)
3.11	**"Automatic checking facility"** means a checking facility operating without the intervention of the user.
3.12	**"Zero adjustment of a measuring system"** means adjustment of a measuring system so that it provides a null indication corresponding to a zero value of a quantity to be measured.
3.13	**"Calibration gas adjustment facility"** means a facility to adjust the instrument to the value of a calibration gas.
3.14	**"Internal adjustment facility"** means a facility to adjust the instrument to a designated value without the use of an external calibration gas.
3.15	**"Warm-up time"** means the elapsed time between the instant power is applied to an instrument and the instant at which the instrument is capable of complying with the metrological requirements.
3.16	**"Resolution"** means the smallest change in quantity being measured that causes a perceptible change in the corresponding indication.
3.17	**"Error (of indication)"** means the indication of a measuring instrument minus a true value of the corresponding input quantity.

3.18	**"Intrinsic error"** means the Error of a measuring instrument, determined under reference conditions.
3.19	**"Absolute error of measurement"** is the result of a measurement minus the conventional true value of the **measurand** .
3.20	**"Relative error"** means the absolute error of measurement divided by the conventional true value of the measurand.
3.21	**"Fault"** means the difference between the error of indication and the intrinsic error of the instrument.
3.22	**"Significant fault"** means a fault, the magnitude of which is greater than the magnitude of the maximum permissible error on initial verification. **Note:** The following faults are considered not to be significant. a) Fault arising from simultaneous and mutually independent causes in the instrument itself or in its checking facilities b) Faults implying the impossibility to perform any measurement c) Transitory faults being momentary variations in the indication, which cannot be interpreted, recorded or transmitted as a measurement result and d) Faults giving rise to variations in the measurement results that are so large as to be noticed by all users of the instruments.
3.23	**"Reference condition"** is the operating condition prescribed for evaluating the performance of a measuring instrument or measuring system or for comparison of measurement results,
3.24	**"Stability"** of a measuring instrument means the property of the instrument, whereby its metrological properties remain constant in time.
3.25	**"Step response time"** means the duration between the instant when an input quantity value of a measuring instrument or measuring system is subjected to an abrupt change between two specified constant quantity values and the instant when a corresponding indication settles within specified limits around its final steady value.
3.26	**"Testing Agency"** means an agency notified under the Rule 126 of The Central Motor Vehicle Rules, 1989.
4.0	**REQUIREMENTS**
	The instruments shall have a permanent and easily readable label or labels giving the following information: a) Manufacturer's trade mark/corporate name b) Year of manufacture c) Model number d) Nominal mains voltage, frequency and power required

	e) Site code f) RSD unit ID g) System number
	The RSD shall meet the requirements specified in the following Annexures of this standard. These requirements specified in the standard shall be verified by a Testing Agency before implementation is commissioned.
4.1	Technical specifications of the RSD and allied equipment: **Annexure A**.
4.2	Guidelines on the programme including equipment, networking and data sharing: **Annexure B**.
4.3	Communication protocol with the concerned authorities such as MoRTH, NIC and State Transport department or any other body authorized by the Govt. of India: **Annexure C**.
4.4	Monitoring phase guidelines: **Annexure D.**
4.5	Reporting format: **Annexure E.**
4.6	Computation of polluter threshold limits: **Annexure F**.

Annexure A
(see 4.1)
Technical Specifications of RSD and allied equipments

A.1 The requirements for the RSD can be broadly classified in the following segments:

- Emission analyser
- Weather sensor
- Data storage and networking equipment
- Communication Protocol – Real time evaluation
- Allied equipment / services etc.,

A.2 The RSD must be able to measure the following pollutants:

Table 1 : Mandatory Parameters

Parameter	**Range**	**Min. Resolution**	**Max. Absolute intrinsic error***	**Max. Relative intrinsic error***
HC	0-12000 ppm vol	±1 ppm vol	±12 ppm vol	±5%
CO#	0-13% vol	0.01% vol	±0.06 vol	±5%
Opacity#	0-100%	0.1%	±2%	±5%

Table 2 : Optional Parameters

Parameter	**Range**	**Min. Resolution**	**Max. Absolute intrinsic error***	**Max. Relative intrinsic error***
NO	0-6000 ppm	± 10 ppm vol	± 10 ppm vol	±5%
NH_3	0-4000 ppm	± 8 ppm vol	± 8 ppm vol	±5%
CO_2	0-999000 ppm	± 50 ppm vol	± 50 ppm vol	±5%
SO_2	0-6000 ppm	± 12 ppm vol	± 15 ppm vol	±5%
CH_4	0-6000 ppm	± 15 ppm vol	± 15 ppm vol	±5%
NO_2	0-6000 ppm	± 15 ppm vol	± 15 ppm vol	±5%

*whichever is greater (taken to the reading)
#Values shall be rounded to two decimal places.
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

(Parameters may be included as per specific requirements)

A.3 Requirements for ambient weather and site condition testing:

The system should be able to provide stability during measuring the following parameters and should have a step response time such that it does not hinder the functioning or the accuracy of the RSD as established in A.2 above.

	<table><tr><th>Parameter</th><th>Range</th><th>Error</th></tr><tr><td>Temperature</td><td>- 5°C to 52°C</td><td>±0.5°</td></tr><tr><td>Relative humidity</td><td>5-95%</td><td>±3%</td></tr><tr><td>Wind speed</td><td>0 –25 m/s</td><td>±10%</td></tr><tr><td>Pressure</td><td>70-102.4 kPa</td><td>±5%</td></tr><tr><td>Slope angle</td><td>-15° to +15°</td><td>±0.1°</td></tr><tr><td>Speed</td><td>0 - 120 km/ hr</td><td>± 1%</td></tr><tr><td>Acceleration</td><td>35 km/h/s</td><td>± 1%</td></tr></table> Automatic compensation of the pollutant parameters listed above, and their corresponding correction with the environmental factors should be taken care of in the RSD software.
A.4	The RSD must be GPS/ IRNSS enabled – to identify the location of the device and communication with the authorized servers for data exchange (real time data transfer).
A.5	The vehicle sampling rate of the device shall be greater than 1Hz.
A.6	There must be a system to capture the image of the registration number of the vehicle at a rate of 99% or greater of the vehicles passing through the RSD measurement location. The system must be equipped with, 1. Optical Character Recognition (OCR) to identify the registration numbers of the vehicles automatically or any other suitable technology to identify the registration numbers. 2. FASTag reader for mapping registration numbers and linking in the central database.
A.7	Following parameter shall also be linked to the vehicle records and superimposed on every image: • Site (where the RSD is installed) code • Test date and time • RSD System / unit number • Record number • GPS/ IRNSS location • Emission readings • Emission stage and threshold limits • Vehicle registration number (characters e.g HR XX XXXX) • Vehicle FASTag ID The equipment system shall create a new record each time for a vehicle and each record shall be assigned a unique sequence number.
A.8	The RSD setup should have an independent power supply/ source with a voltage stabilizer and a power backup of minimum of one hour for stationary units and four hours for mobile units, of uninterrupted operation, in case the primary source fails.

	It should be compatible with 230V, 50Hz single phase AC supply. (Mains voltage variation: –15 % to + 10 % of the nominal voltage, ±2 % of the nominal frequency.) *See IEC 61000-3-3 / IEC 61000-3-11/ IEC 61000-4-11/ IEC 61000-4-29* If a battery is used to power the instrument, the limits of power supplied shall be within the instrument manufacturer's specifications. In case the battery power drops outside the limits, there should be an indication on the instrument and it should not be possible to make any measurement with the instrument. If a portable generator is used, its requirements shall comply with the specifications for the mains voltage. It shall include all the cables, proper light illumination, for operation during the sampling period. The RSD must be able to capture the values irrespective of all categories of vehicles irrespective of placement of the vehicle exhaust pipe i.e. front and rear, sides- either / both left or right, without any adjustment in the device fixture/ frame.
A.9	The system should be complete with the following: • Data server • Photo/ Video data server • Backup server • Router • Network printer • Mobile workstation • Software support services such as firewall, data integrity evaluation (ex. discarding measurements with inadequate signal strengths, measurements with too much uncertainty) etc. • Link with Central database (e.g VAHAN / authorized server) • Warning issuing system for heavy polluters (through on-road display, SMS, email etc.) • Date storage for at least ***5,00,000*** records at any point of time • Should be practically portable
A.10	Calibration Checks
A.10.1	The system should be calibrated automatically or at a frequency recommended by the manufacturer so as to ensure accuracy of the parameters of the vehicle emission data.
A.10.2	Manufacturer's calibration certificate shall be provided with RSD;

<table>
<tr><td>A.10.3</td><td>Adjustment facilities</td></tr>
<tr><td>A.10.3.1</td><td>The Instrument shall have an adjustment facility that provides operations for zero-setting, gas calibration (if applicable), and internal adjustment.</td></tr>
<tr><td>A.10.3.2</td><td>The facility shall be automatic for zero-setting and internal adjustment.</td></tr>
<tr><td>A.10.3.3</td><td>Instrument shall be controlled by an automatic self-checking facility that shall operate in such a way that before a measurement can be indicated or printed, all internal adjustments, calibration gas adjustments, and all other checking facility parameters shall be confirmed for proper values or status (i.e. within limits
i.</td></tr>
<tr><td>A.11</td><td>Ingress Protection (IP)</td></tr>
<tr><td>A.11.1</td><td>The device must be able to work in dusty environment that are typically encountered by the vehicles where these would be installed. IP rating (IS/IEC 60529: 2001) is used for specifying the environmental protection characteristics of the device.
The device shall be tested for dust and water ingress as per following requirement:
<table>
<tr><td rowspan="2">IP rating</td><td>Dust</td><td colspan="2">Water</td></tr>
<tr><td>6</td><td>3</td><td>5</td></tr>
<tr><td></td><td>Dust tight</td><td>For internal parts, for example, display, controller</td><td>For exterior parts for example, sensors, camera</td></tr>
</table></td></tr>
<tr><td>A.12</td><td>Robustness of equipment :
The equipment should be stable under vibrations from operating conditions.</td></tr>
<tr><td>A.13</td><td>The RSD system should be tamper proof and should able to detect any unauthorised access to the device.</td></tr>
<tr><td>A.14</td><td>Disturbances</td></tr>
<tr><td>A.14.1</td><td>Significant faults (as defined in 3.22) shall not occur or shall be detected and acted upon by means of checking facilities for the following disturbances:
a) Mechanical shock and vibrations
b) Short time power reductions
c) Bursts from the mains (transients)
d) Electrostatic discharges
e) Radiated radio frequency electromagnetic fields
f) Mains frequency magnetic fields
Repeatability (as per A.16) shall be esured after the completion of each test.</td></tr>
<tr><td>A.14.1.1</td><td>Mechanical shock and Vibrations Test</td></tr>
<tr><td></td><td>For mechanical shock testing, the tested Instrument shall be placed in its normal position of use on a rigid surface. It shall be tilted on one bottom edge and then</td></tr>
</table>

	allowed to fall freely onto the test surface. The following conditions shall be applied: Height of fall: 25 mm Number of falls: 1 on each bottom edge. *See IEC 60068-2-31*
	Vibration test should be conducted as per IS 9000 Part VIII 1981. Analyser may be subjected to vibration in normal mounting axis for 5 to 9 Hz ± 3 mm displacement and 9 to 150 Hz ±1 g acceleration amplitude, preferably with electrical power 'ON' condition. This test should be repeated for other two axes also. However, during the test the instrument shall be mounted in its normal position only.
A.14.1.2	Short Time Power Reductions Test
	A test generator suitable for reducing the amplitude of the A.C. mains voltage is used. It shall be adjusted before being connected to the Instruments. The mains voltage interruptions and reductions shall be repeated 10 times with an interval of at least 10 s between successive disturbances. 100 % reductions shall be effectuated for duration of 10 ms 50 % reductions shall be effectuated for duration of 20 ms. *See IEC 61000-4-5*
A.14.1.3	Burst from the mains (transients)
	The test consists of exposure of the Instruments to bursts of voltage spikes of 1 kV and having a double exponential waveform. Each spike shall have a rise time of 5 ns and a half amplitude duration of 50 ns. The burst length shall be 15 ms, the burst period (repetition time interval) shall be 300 ms. Repetition frequency of the impulses and peak values of the output voltage on 50 Ω load: 5 kHz ± 1 kHz. The transient generator shall have an output impedance of 50 Ω and shall be adjusted before connecting the Instrument. At least 10 positive and 10 negative bursts randomly phased shall be applied. Insertion of blocking filters in the cables to the Instrument may be necessary to prevent the burst energy being dissipated in the mains. *See IEC 61000-4-4*
A.14.1.4	Electrostatic discharges Test
	A capacitor of 150 pF shall be charged by a suitable DC voltage source of 6 kV in contact mode and 8 kV in air mode. Then it shall be discharged through the Instrument by connecting one terminal to the Instrument's ground chassis and the other through a 330 Ω resistance to the Instrument's surfaces that are normally accessible to the user. At least 10 successive discharges shall be applied with a time interval between discharges of at least 10 s. An Instrument not equipped with a grounding terminal shall be placed on a grounded plane

	surface that projects beyond the Instrument by at least 0.1 m on all sides. The associated grounded connection to the capacitor shall be as short as possible. *See IEC 61000-4-2*
	In the contact discharge mode, to be carried out on conductive surfaces, the electrode shall be in contact with the Instrument and the discharge shall be actuated by the discharge switch of the generator. In the air discharge mode, on insulating surfaces, the electrode is approached to the Instrument and the discharge occurs by spark.
A.14.1.5	Radiated, radio frequency, electromagnetic fields test
	Instruments shall be exposed to electromagnetic field strength as follows: Frequency range: 26 MHz to 1000 MHz Field strength: 10 V/m Modulation: 80 % AM, 1 kHz sine wave
	The field strength may be generated in the following ways: a) Absorber Lined Shielded Enclosure (ALSE) Chamber for all frequency ranges b) A strip line for low frequencies for small instruments from DC to 150 MHz c) A TEM cell (Transverse Electromagnetic Mode cell) for higher frequencies, up to 1 GHz d) A biconical antenna (26 MHz to 300 MHz) e) A log periodic antenna (100 MHz to 1000 MHz) The specified field strength shall be established prior to the actual testing (without the Instruments in the field). When the test is carried out in a shielded enclosure to comply with international laws prohibiting interference to radio communications care needs to be taken to handle reflections from walls. Anechoic shielding may be necessary. *See IEC 61000-4-3* **Note:** The attention is drawn to the fact that IEC 61000-4-3 refers to the frequency range from 80 MHz to 1000 MHz. The lower frequencies are covered by IEC 61000-4-6.
A.14.1.6	Mains Frequency Magnetic Fields Test
	The Instrument tested shall be exposed in all directions to a magnetic field of 30 A/m at mains frequency. *See IEC 61000-4-8*

A.15	Stability with time or drift
	When used in accordance with the manufacturer's operating instructions, the measurements made by the instruments, under stable environmental conditions and after adjustment using a calibration gas or the internal adjustment facility shall remain within the maximum permissible errors on initial verification for at least 4 hours without the need for calibration gas or internal re-adjustments by the user. If the Instruments are equipped with a means for drift compensation, such as automatic zero or automatic internal adjustment, then the action of such adjustments control shall not produce an indication / display that can be confused with a measurement of an external gas. It should not be possible to pass the gas sample and measure the same while the automatic adjustments are in process.
A.16	Repeatability
	For 20 consecutive measurements, using the same calibration gas mixture, carried out by the same person with the same Instrument within relatively short time interval the experimental standard deviation of the 20 results shall not be greater than one third of the modulus of the "maximum permissible error on initial verification" taken from Table 1/2 for the relevant gas.
A.17	Dry Heat Test
	This test consists of exposure of the Instruments to a temperature of 5° C under "free air" conditions for 2 hours (the time duration specified begins after the Instruments have reached temperature stability). During the heating up or cooling down of the Instrument, the rate of change in temperature shall not exceed 1° C/min. Repeatability (as per A.16) shall be esured after the completion of test.
A.18	Damp Heat, Steady State Test
	This test consists of exposure of the Instruments to a constant temperature of 30° C and a constant relative humidity of 85 % for two days. The exposure shall be such that water does not condense on the Instruments. The temperature is deemed to be steady when the difference between the extreme temperatures does not exceed 5° C, and the rate of change does not exceed 5° C/h. Repeatability (as per A.16) shall be esured after the completion of test.
A.19	Power Supply Variation Test
	The A.C. power supply test consists of exposure of the Instruments to extreme values of the nominal power supply voltage and nominal frequency for a period long enough to perform the required measurement under following variation conditions.

	Voltage: Nominal Voltage (230V), +10% ~ -15% Frequency: Nominal Frequency (50 Hz), ± 1 Hz. The AC power supply test will be repeated with frequency of 50 Hz ± 2 Hz also and the results of the test will be noted. These tests results will be provided in the manual for the information of the user. Repeatability (as per A.16) shall be esured after the completion of test. *See IEC 61000-3-3 / IEC 61000-3-11/ IEC 61000-4-11/ IEC 61000-4-29*
A.20	Warm-up time
A.20.1	After the warm-up time, the Instruments shall meet the metrological requirements as stated in this document. Instruments shall have the means to prevent measurement and an indication of measured gas volume fractions during the warm-up time. Instruments shall have a warm-up time not exceeding 10 min.
A.20.2	At reference conditions and at 5° C, the warm-up time test shall consist of the following steps:
	a) Stabilize the Instrument at each temperature b) Let the Instrument warm up c) Immediately after either the manufacturer's prescribed warm-up period has elapsed or an automatic warm-up lockout has been de-activated, perform a volume fraction measurement (with any necessary internal adjustment being performed prior to this measurement) d) At time intervals of 2 min, 5 min and 15 min after warm-up, perform a measurement with the same calibration gas as above. e) The difference between any of the measured values above shall not exceed the modulus maximum permissible error on initial verification. **Note:** At reference conditions, the warm-up time test may be included with the drift test.
A.21	Warranty and Maintenance
A.21.1	Warranty Requirements: minimum 2 year from the date of operation.
A.21.2	Annual Maintenance with local support: minimum 2 year from the date of operation. Note: The requirements shall be the part of tender document or any arrangement between the equipment supplier and the implementing authority.
A.22	Warranty and Maintenance
A.22.1	Warranty Requirements: minimum 2 year from the date of operation.

A.22.2	Annual Maintenance with local support: minimum 2 year from the date of operation. **Note**: The requirements shall be the part of tender document or any arrangement between the equipment supplier and the implementing authority.

Annexure B
(see 4.2)
Programme Guidelines

B.1	**OPERATION**
	Instrument parameters
	At a minimum the following parameters shall also be recorded in all RSD programs for each RSD site in a stations log. The log may be kept electronically or in a hardcopy format. • A description of the RSD equipment including light source, make/ model of the instrument, and detector type • The name of the operator (and the data capturing station/ van). If more than one operator or van are used, key and record which operator and/ or van was used for each measurement. • Complete description of the calibration procedure • Audit check results • Calibration check results • Any equipment changes • Verification of speed and acceleration measurement devices.
B.2	**PROCEDURE**
B.2.1	A RSD generally includes the following sub-systems which are linked to a computer: • A speed and acceleration measurement system • A license plate capture system, and • Emission analyser
B.2.2	After identifying the ideal location, the Emission analyser module is set up.
B.2.3	The speed and acceleration measurement system is set up at a distance prescribed by the manufacturer.
B.2.4	The primary camera shall where it may be able to capture the license plate of the passing vehicle as its exhaust is being measured.
B.2.5	The speed and acceleration measurement system may be set up in-line with the camera.
B.2.6	After a trial–run and warm up(s) of the speed and acceleration measurement system, the emission analyser is set up in such a way that it maximises the infrared/laser and/ or UV signals received by the detector.
B.2.7	The system is calibrated as per the guidelines of the manufacturer.

B.2.8	A calibration verification audit is done immediately to confirm the sensor's accuracy and the calibrations' validity.
B.2.9	Three consecutive measurements of the calibration/ audit gases of pre-known concentration within accuracy tolerances shall constitute a successful calibration.
B.2.10	If the audit fails, the calibration is corrected and the process is repeated until a successful calibration is achieved.
B.2.11	The audit must be done once at the pre specified frequency and should happen continuously with the time difference between two consecutive checks not exceeding pre-determined hours, when in operation.
B.2.12	As per the manufacturer's specifications, the frequency of calibration may be higher and if operating conditions warrant, further calibration(s) may be conducted.
B.2.13	After the setup is complete, the operator is required to perform periodic audits over the course of the working day cycle to verify and optimise the RSD's calibration and accuracy.
B.2.14	The emission results obtained during testing as prescribed above shall be electronically uploaded through online process to the designated government portal on a daily basis.
B.2.15	The software used should be registered and shall be secured from unauthorized access.
B.2.16	The manufacturer must develop a cloud based data management system (DMS) for the storage, processing, quality-review and analysis of the collected RSD data.
B.3	**SYSTEM PHYSICAL VERIFICATION**
B.3.1	The initial verification of the Instruments may include the following tests:
	a) Check the power supply voltage and frequency at the location of use to determine compliance with the specifications on the measuring Instrument's label. b) Check the activation of the warm-up lockout Instruments by attempting to make a measurement within 1 min of initial power-on of the Instruments.
B.3.2	Subsequent verification of an Instrument at the same location may include the following tests: For short-term subsequent verification, perform all tests included in the initial verification except for the power check and the warm-up check.

	For long-term subsequent verification, perform all tests included in the initial verification. When the Instruments have been moved to a new location, or have undergone repairs, perform all tests included in the initial verification.
B.4	**PULL-OVER INSPECTIONS**
B.4.1	Roadside pull-over inspections may be carried out for the purpose of random sampling/ invalid data capturing/ high emiiter identification etc..
B.4.2	The RSD manufacturer shall also supply a PUC instrument complying with AIS-137 Part 8, as amended from time to time.
B.4.3	On-road PUC measurements will be taken and data shall be recorded as per the requirements of AIS-137 Part 8, as amended from time to time.
B.5	**VALID / IN-VALID DATA**
B.5.1	Invalid data information/ report to be provided on daily or X hour in time. (X is flexible)
B.5.2	Negative VSP limits will be treated as invalid
B.5.3	Exhaust plume of previous vehicle should not interfere with current measurements
B.5.4	Other parameters for valid/invalid flags: - Record doesn´t have a vehicle emissions and license plate record - VSP out of range - Delta CO_2 is out of range

Annexure C
(see 4.3)
Communication Protocol

C.1	The RSD equipment shall communicate with authorized server(s) on the real time bases.
C.2	The RSD must be GPS/ IRNSS enabled – to identify the location of the device and communication with the Authorized servers for data exchange (real time data transfer). Note: It should be ensured that the accuracy of data transfer and sanctity of data at both the ends i.e. receiver and transmitter is maintained throughout.
C.3	The system should be capable of/ provide: • Data server (Photo/ Video / information data etc) • Backup server (control room)* • Router • Mobile workstation / computers etc • Software support services such as firewall, data integrity evaluation (ex. discarding measurements with inadequate signal strengths, measurements with too much uncertainty) etc. • Link with Central database (e.g VAHAN / authorized server) • Warning issuing system for heavy polluters (through on-road display, SMS, email etc.) • Date storage for at least 5,00,000 records at any point of time • To identify and exclude all samples that fail to meet desired predefined criterion of valid record (as defined in F.1) * this room can be mutually agreed between RSD manufacturer or implementing authority **Note:** These requirements are not limited and may vary depending on the specifications considered by the implementing authority.
C.4	The minimum information that has to be pushed to authorized server(s) shall include: 1. Date and time 2. RSD Unit No. 3. Site location 4. Registration number of vehicle 5. FASTag number 6. Observed results, including valid or invalid data.

Annexure D
(see 4.4)
Guidelines for Monitoring Phase

D.1	A monitoring phase shall be established to capture vehicular emissions and define accurate polluter thresholds.
D.2	The thresholds must be decided categorically while differentiating from the following parameters: • Category of vehicle • Emission norms (Bharat Stage) • Fuel type
D.3	Relevant pollutants are to be captured as per A.2.
D.4	The percentage of data rejection by RSD is to me captured to monitor efficacy.
D.5	High emitters shall be pulled and on-road PUC test to be carried out.
D.5	Data shall be uploaded a centralised server (in conjunction with NIC).
D.6	RSD database shall be linked with VAHAN for information as required in Annexure E.
D.7	The information recorded shall not be stored, and no copy of the data shall be retained. The confidentiality agreement shall be made between the RSD manufacturer and the implementing authority.
D.8	Nodal agency to collate data and propose threshold limits.
D.9	Necessary changes in the standard may be made based on the experience gained during the monitoring phase.

Annexure E
(see 4.5)
Monitoring Format

Format for recording RSD results and identifying High Emitters					
1	Date & Time		2	Site Code	
3	System No.		4	Record No.	
5	RSD Unit ID		6	Operator Code	
7	GPS/ IRNSS coordinates		8	Road Grade	
9	**Ambient Conditions:**				
9.1	Temperature		9.2	Relative Humidity	
9.3	Wind Speed & Direction		9.4	Pressure	
10	**Emission Readings:**				

Pollutant	Ambient Value	Measured Value	Adjusted Value
Pollutant 1 Pollutant 2 ... *And so on...*			

11	**Vehicle Details:**				
11.1	Vehicle Speed		11.2	Vehicle Acceleration	
11.3	FASTag ID		11.4	Registration No.	
	Link with Central database (e.g VAHAN / authorized server)				
11.4.1	Vehicle Category/ Class		11.4.2	Vehicle type	
11.4.3	Fuel Type		11.4.4	Emission norms	
11.4.5	Maker's name		11.4.6	Model name	
11.4.7	Engine displacement (cc)		11.4.8	Month-Year of Mfg.	
11.4.9	Unladen weight		11.4.10	Owner's Name	

Specifications for the entries to be done in the Reporting Format			
Sr. No.	**Field**	**Format**	**Character Properties**
1.	Date & time	Date: DD-MM-YYYY Time: HHMM hours (24 hrs format)	Numeric Numeric
2.	Site Code	16 characters	Alpha-numeric
3.	System No.	16 characters	Numeric
4.	Record No.	16 characters	Numeric
5.	RSD Unit ID	16 characters	Alpha-numeric
6.	Operator Code	24 characters	Alpha-numeric
7.	GPS/ IRNSS coordinates	XX°YY'ZZ.Z" A1, XX°YY'ZZ.Z" A2	XYZ – Numeric A1&A2 – Alphabetical
8.	Road Grade	XXX°	Numeric
9.1	Temperature	XX.X°C	Numeric
9.2	Relative humidity	XX%	Numeric
9.3	Wind speed and direction	Speed: XX km/h Direction: YY	Numeric Alphabetical
9.4	Pressure	XXX.X kPa	Numeric
10	Pollutant	4 characters	Alpha-numeric
	Ambient value	8 characters	Numeric
	Measured value	8 characters	Numeric
	Adjusted value	8 characters	Numeric
11.1	Vehicle speed	XX.X km/h	Numeric
11.2	Vehicle acceleration	XX.X km/h/s	Numeric
11.3	FASTag ID	16 characters	Numeric
11.4	Registration No.	10 characters	Alpha-numeric
11.4.1	Vehicle category/ class	30 characters	Alphabetical
11.4.2	Vehicle type	3 characters	Alphabetical
11.4.3	Fuel	14 characters	Alphabetical
11.4.4	Emission norms	14 characters	Alpha-numeric
11.4.5	Maker's name	50 characters	Alphabetical
11.4.6	Model name	50 characters	Alpha-numeric
11.4.7	Cubic capacity	XXXX cc	Numeric
11.4.8	Month-Year of Mfg.	MM-YYYY	Numeric
11.4.9	Unladen weight	XXXX kg	Numeric
11.4.10	Owner name	32 characters	Alphabetical

Annexure F
(see 4.6)
Thresholds

<table>
<tr><td>F.1</td><td>POLLUTER THRESHOLDS</td></tr>
<tr><td>F.1.1</td><td>[Limits to be finalised after the completion of Monitoring Phase]
<table>
<tr><th>Vehicle class*/ Type</th><th>Fuel type</th><th>Emission Stage</th><th>Pollutant 1 limits (ppm)</th><th>Pollutant 2 limits (ppm)</th><th>And so on....</th></tr>
<tr><td></td><td></td><td>BS XX</td><td></td><td></td><td></td></tr>
</table>
Note – The above limits are subject to be reviewed and recommended from time to time.</td></tr>
</table>

Annexure G
(see 4.5)
Reporting Format

(To be finalised after the completion of monitoring phase)

ANNEXURE Y

COMPOSITION OF AISC PANEL*

Name	Organisation
Convener	
Mr. Dinesh Tyagi	Director International Centre for Automotive Technology (ICAT), Manesar
Members	**Representing**
Ms. Vijayanta Ahuja	International Centre for Automotive Technology (ICAT), Manesar
Mr. Shakti N. Khanna	International Centre for Automotive Technology (ICAT), Manesar
Mr. Parag G. Mengaji	The Automotive Research Association of India (ARAI), Pune
Mr. Manoj Kumar	State Transport Department, Haryana
Mr. Sukhbir Singh	State Transport Department, Haryana
Mr. Karunesh Kumar	National Informatics Centre (NIC)
Mr. Sanchit Seth	OPUS Group
Mr. Niranjan Vescio	OPUS Group
Ms. Rucy Phansalkar	NTT DATA Business Solutions India Pvt. Ltd.
Mr. Ravindra Inamdar	Horiba
Mr. Rajiv Sharma	Horiba
Mr. Nituj Bhatnagar	AVL
Mr. Andreas Pein	AVL
Mr. Akshat Mathur	AVL

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

ANNEXURE Z

COMMITTEE COMPOSITION*
Automotive Industry Standards Committee

Chairperson	
Shri Neelkanth V. Marathe	Officiating Director The Automotive Research Association of India, Pune
Members	**Representing**
Representative from	Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi
Representative from	Ministry of Road Transport and Highways (Dept. of Road Transport and Highways), New Delhi
Shri S. M. Ahuja	Office of the Development Commissioner, MSME, Ministry of Micro, Small and Medium Enterprises, New Delhi
Shri Shrikant R. Marathe	Former Chairman, AISC
Shri R. R. Singh	Bureau of Indian Standards, New Delhi
Director	Central Institute of Road Transport, Pune
Director	International Centre for Automotive Technology, Manesar
Director	Global Automotive Research Centre
Director	Indian Institute of Petroleum, Dehra Dun
Director	Vehicles Research and Development Establishment, Ahmednagar
Director	Indian Rubber Manufacturers Research Association
Representatives from	Society of Indian Automobile Manufacturers
Shri R. P. Vasudevan	Tractor Manufacturers Association, New Delhi
Shri Uday Harite	Automotive Components Manufacturers Association of India, New Delhi

Member Secretary
Shri Vikram Tandon
Dy. General Manager
The Automotive Research Association of India, Pune

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