Amendment No 7(05/2025)

To

AIS-160 Safety Requirements for Construction Equipment Vehicle(s)

1.0 Clause No. 3.1 (Part 2):

Add following new clause 3.1.1 after clause 3.1:

3.1.1 **Alternative Test Methods**

If a machine is longer than 12 m and/or wider than 2.60 m and/or higher than 4.00 m and/or machine weight is greater than 15 ton, then the test may be alternatively performed in an outdoor test site as per below test standards:

Radiated Emission

Radiated Emission Test of Construction Equipment Vehicle (CEVs) can be performed at outdoor test site as per Annex B of ISO 13766-1: 2018 and CISPR 12 Ed 6.1

Immunity Test

Radiated Immunity Test of Construction Equipment Vehicle (CEVs) can be performed with BCI (bulk current injection) method according to ISO 11451-4: 2013 for frequency range 20MHz to 400 MHz with severity level of 60mA, provided ESA level Radiated Immunity Test Report as per Cl. 4.7 of ISO 13766-1: 2018 for "Main Prime mover and/or Machine Controller" is submitted to the test agency.

Note: Above mentioned alternative procedures for Machine type approval may be used at the discretion of the test agency and Construction Equipment Vehicle Manufacturer.

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P. B. NO. 832, PUNE 411 004

ON BEHALF OF

AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER

CENTRAL MOTOR VEHICLES RULES - TECHNICAL STANDING COMMITTEE

SET-UP BY

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

GOVERNMENT OF INDIA

7th May 2025

Amendment No 6 (08/2024)

To

AIS-160 Safety Requirements for Construction Equipment Vehicle(s)

1.0 Part 2, Clause 3.2

Substitute following text for existing text:

3.2 Seat Belt and Seat belt anchorages

3.2.1 In case of two-point seat belt / lap belt, seat belt and seat belt anchorages shall be tested as per IS/ISO: 6683: 2005 (This requirement is not applicable to Tracked Asphalt Pavers with maximum design speed up to 5 km/h).

3.2.2 In case of three-point seat belt, in compliance with UN R 16 or IS:15140:2018 as amended from time to time, shall be tested for seat belt anchorages for CEV drivers cabin seat as given below

3.2.2.1 For Anchorages for a three-point seat belt, apply in the direction in which the occupant faces, a force of 9.0 kN to a pelvic body block, as described in Figure 1 and 7.5 kN simultaneously to an upper torso body block, as described in Figure 2, with an initial force application angle of 45 ±10 degrees above the horizontal, (as shown in Figure 3). All.test forces shall be attained in not more than 30 sand maintained for not less than 10 s.

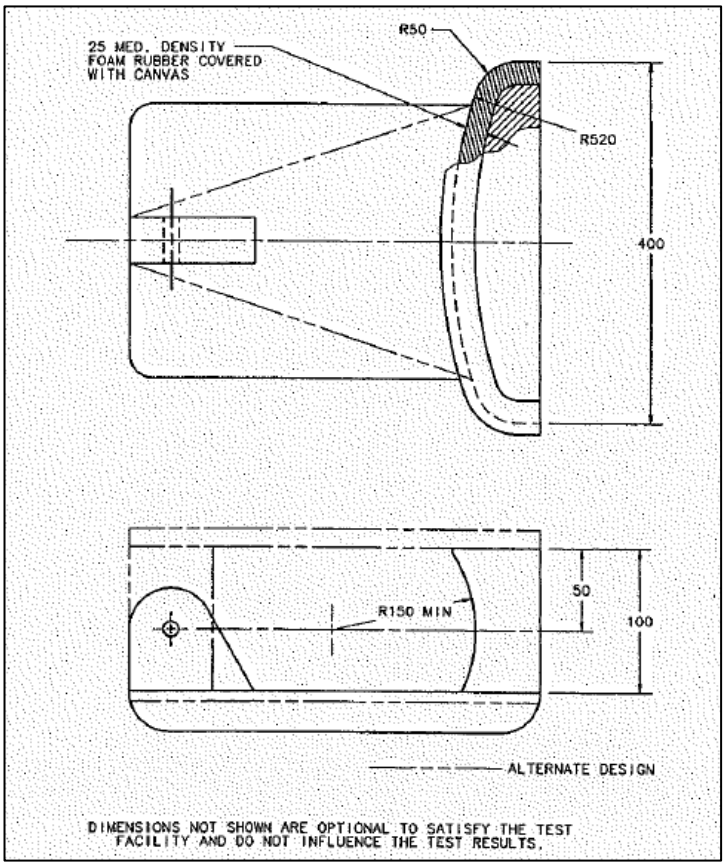

Figure 1 Pelvic Body Block

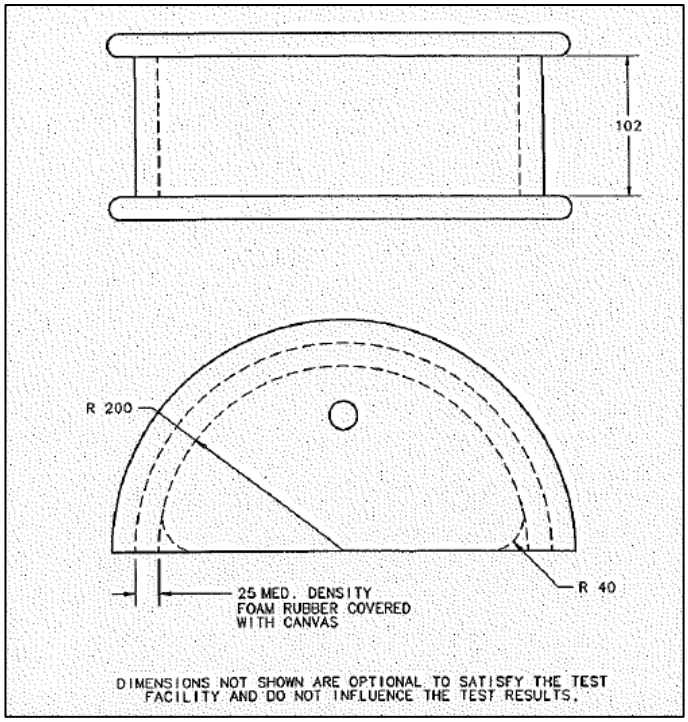

Figure 2 Torso Body Block

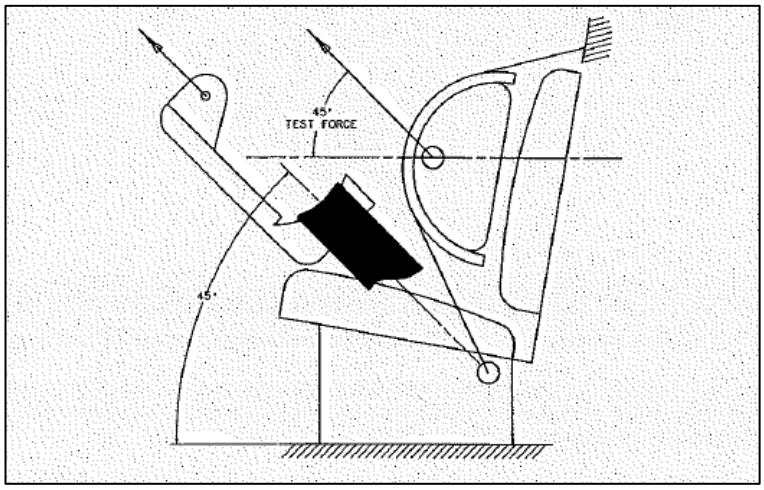

Figure 3 Construction and general-purpose test procedure

3.2.2.2 For an occupant restraint system with a mass greater than 70 kg, an additional load shall be applied at the center of gravity or at any point above and behind the planes defined as a horizontal plane through the center of gravity and 45 degree incline from the horizontal, passing through the axis that is horizontal and perpendicular to the direction the occupant faces and passes through the occupant restraint system center of gravity (reference cross hatched zone in Figure 6). The force applied at the center of gravity shall be calculated as follows: 10 times 0.0098 kN/kg multiplied by any mass (kg) of the seat system greater than 70 kg. The center of gravity load will be applied in the direction the occupant faces with an initial force application of 45 ±10 degrees above the horizontal. The center of gravity load shall be applied simultaneously with the restraint loads.

NOTE: Addition of the seat mass load to the pelvic body block load is permissible if the seat belt mounting point is in the cross hatched region of Figure 4.

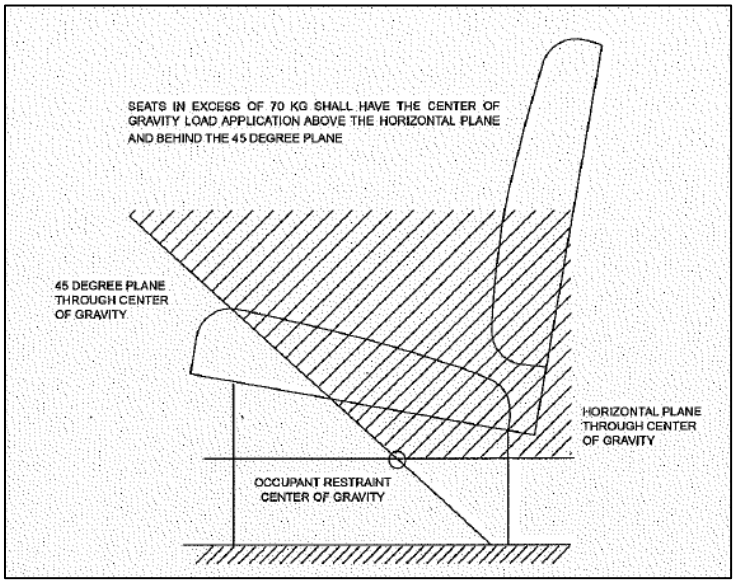

Figure 4 Range of center of gravity load application

3.2.2.3 Performance requirements

There shall be no rupture, release, or other failure of any element in the occupant restraint system. Permanent deformation shall not constitute failure.

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UNDER

CENTRAL MOTOR VEHICLES RULES - TECHNICAL STANDING COMMITTEE

SET-UP BY

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

GOVERNMENT OF INDIA

7th August 2024

Amendment No. 5 (04/2024)

To

AIS-160: Safety Requirements for Construction Equipment Vehicle(s)

1.0 **Part 2, Clause 3.8**

Substitute following text for existing text:

3.8 Physical Dimension of Operator and Minimum Operator Space shall be as per IS / ISO 3411:2007

Note:

1. Physical Dimension of Operator and Minimum Operator Space is not applicable for Roller fitted with cab.
2. All Earth moving machinery minimum space envelope height R1 as defined in IS/ISO 3411:2007 shall be ≥1000 mm and for compact machine ≥ 920mm.

2.0 **Part 2, Clause 3.12**

Substitute following text for existing text:

3.12 Zones of Comfort and Reach for Controls shall be as per ISO 6682:1986/IS 11252:1993. A steering wheel control shall be approximately centered in front of operator's seat with at least 180 degrees of its arch located within the zone of comfort as defined in IS / ISO 6682:1986 or IS 11252: 1993.

Note:

1. Zone of comfort and reach for controls as per IS/ISO 6682:1986 or IS 11252:1993 is not applicable for Rollers fitted with cab

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SET-UP BY

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)

GOVERNMENT OF INDIA

4th April 2024

Amendment No 4 (07/2023)

To

AIS-160: Safety Requirements for Construction Equipment Vehicle(s)

1.0 Add following Part 3 after Part 2

Part 3

Criteria for Extension of approval for Construction Equipment Vehicles type approved as per Part 1 and Part 2 above.

1.0 All test agencies shall follow Criteria for Extension of approval as per Annex G, for Construction Equipment Vehicles type approved as per Part 1 and Part 2 above

2.0 Add following new Annex G after Annex F

ANNEX – G

Criteria for Extension of approval for Construction Equipment Vehicles type approved as per Part 1 and Part 2 above.

1.0 SCOPE

1.1 This Annexure specifies the procedure to be followed for evaluating the Construction Equipment Vehicle model, its variant(s), Type & Version (s) for issue of a Certificate of Compliance as notified by Rule No. 126 of the CMVR from time to time and the Criteria for extension of approval for selection of test vehicle during Extension of Type approval certification. While deciding criteria for extension of approval, Table 1 shall be taken in to consideration.

2.0 DEFINITION

For the purpose of this standard, in addition to the definitions given in AIS-017, AIS-053 and AIS-160, the following definitions shall apply.

2.1 **'Criterion for Extension of Approval (CEA)**' is the guidelines to be followed:

a) For considering whether a change in the Technical Specifications affects the compliance adversely or not, and

b) If the change affects the compliance adversely, to decide the tests to be carried out for establishing compliance.

2.2 **Criterion for Extension of Approval is also to be used for:**

a) Selection of the base model(s) for establishing compliance from a number of models/variants at the time of Type Approval

b) Deciding on the extension of Type Approval when changes are made in the Technical Specification.

c) Deciding on approval for new variant (s) /version (s)

3.0 CRITERIA FOR EXTENSION OF APPROVAL

3.1 **General Guidelines:**

3.1.1 In general, when changes in Technical Specifications of a model / variant do not affect the performance adversely, and are still within the stipulated limits /tolerances, the Type Approval (CMVR compliance) can be extended without further verification. If the changes affect some of the performance parameters, tests shall be carried out only for those parameters.

3.1.2 The changes in parameters, with respect to an CEV's tested, as declared in the Technical Specifications that are deemed to affect the performance in respect of various provisions/notified standards and the tests to be performed, if any, for extending the Type Approval are given below.

3.1.3 Decision on any such parameter shall be informed by that Testing Agency to other Testing Agencies, ICEMA, and other AISC members giving the logic for such a consideration.

4.0 GUIDELINES FOR APPLYING CEA:

4.1 If the manufacturer has indicated a range of models/variant(s) to be certified, at the time of initial type approval, necessary model shall be selected from this range to represent the entire range, considering the CEA of each of the provisions.

4.2 It may be necessary to have more than one representative test sample to represent the entire range and all the provisions.

4.3 The details of tests to be carried out on each of these models and the provisions for which each of features / variant(s) /model can be certified, shall also be worked out.

4.4 If there is not a range of models / variant(s) to be certified, at the time of initial type approval, the model tested initially shall be treated as the base model.

4.5 When the validity of the certificate is to be extended for changes in the Technical Specifications, the manufacturer shall declare the changes and the base models to be considered and the details to given in the appropriate tables of AIS-007. The Testing Agency shall evaluate changes in the system and CEV related parameters with respect to the test results of the applicable base model based on CEA, and where applicable, decide the new base model(s), and tests to be carried out on them which are required to establish compliance.

4.6 If tests are carried out, they shall be also treated as those of a Base model, for future evaluations.

4.7 Any changes related to statutory/regulatory requirements shall be acceptable in the base model and variants. Extension approval for these requirements shall be done on the basis of submission of required compliance certificates of components / Assemblies & completion of required inspection/tests on base model and variants, if applicable

5.0 METHODS OF ESTABLISHING COMPLIANCE:

5.1.1 Depending upon the provision, the compliance can be established by the following methods:

a) Documents verification

b) Check fitment

c) Testing

5.1.2 For new or existing rules/ standards /provisions where no specific guidelines are mentioned in this standard, testing agency in discussion with manufacturer can decide for method of establishing compliance, necessary supporting documents, undertakings etc. to ensure that requirements of notified standards / provisions under CMVR fulfilled.

5.1.3 **Document Verification (DV)**

5.1.3.1 It involves verification of declarations / specifications / installations /drawings submitted by manufacturer with suitable undertaking, if applicable only & Comparison of details given in the documents submitted with those specified in the provisions. Physical sample inspection/ submission is not required if Document verification c is used as method of establishing compliance

5.1.3.2 Typical examples where this method is applicable are:

a) Provision for display of vehicle registration mark on Front & Rear.

b) Overall Dimensions for Construction Equipment Vehicle.

c) Size & Ply rating of tires.

d) All components, systems which involves type approval / COP conformity of verification like fuel tanks ,head lamps installation, emission , horn fitment, other safety components mentioned under rule 124 A.

e) Those which are so specified in the notified standard.

For detailed guidelines refer Table 1 of this annexure for identification of provisions / rules against which document verification can be used for establishing compliance for type approval.

5.1.4 **Check fitment (CF)**

5.1.4.1 This is applicable where the provision requires fitment of certain devices (Component or STU*).

*Separate technical unit' (STU) means a device subject to the requirements of a provision and intended to be part of a vehicle, which may be type-approved separately, but only in relation to one-or more specified types of vehicle where the provision makes express permission for doing so.

5.1.4.2 It involves verification of fitment / installation on test sample, comparison with specifications as submitted by manufacturer, general Operational checks / Functioning verification etc.

5.1.4.3 While checking fitment of STU's, where applicable, verification that details on vehicle are within the range of such parameters for which the component has been verified.

5.1.4.4 Guidelines mentioned in Table 1 of this annexure be referred for identification of provisions / rules against which "fitment checking" can be used for establishing compliance for Type approval.

5.1.5 **Test (T)**

5.1.5.1 Provisions, where performance parameters are specified in CMVR provisions /standards notified there in, shall be established by testing.

5.1.5.2 The tests may be carried out either at the premises of the Testing Agencies or at the manufacturer's premises. When the tests are carried out at the manufacturers' premises, the manufacturer shall demonstrate the adequacy of the test facilities for carrying out the tests as per the provisions.

5.1.5.3 The Testing Agency may also, at the request of the manufacturer, certify, in advance, the adequacy of the test facilities at his premises, in such cases manufacturer shall demonstrate routine calibration of the equipment etc. at the time of testing.

Table 1

Criteria for Extension of approval for Construction Equipment

S. No	Rule No	Test / Activity Description	Compliance Via	General Guidelines for Test sample selection as per CEA
1	93	Overall dimensions	DV+ T	1. Vehicle with maximum dimensions may be submitted for measurement & variants may be extended with verification of drawings / inspections.
2	95	Size & Ply rating of tyres	DV	1. Manufacturer's declaration for tyre size, ply rating, rolling radius and their maximum permissible load may be accepted.
3	96A	Brake performance	DV + T (As applicable)	1. Maximum Speed if increases above 5 % 2. Increase in Unladen weight more than 10 % for machine up to 20 T and 5 % for machine with above 20 T 3. Any Change in make of brake systems including brake liner / pad 4. Any Change in brake circuit drawing for service and secondary brake 5. Increase in Front / Rear unladen weight Ratio more than 10 % 6. Any decrease in wheel base 7. Any change in minimum hydraulic / pneumatic operating pressure 8. Any decrease in reservoir & compressor capacities

				9. Any decrease in brake effective area 10. Decrease in Engine rpm more than 8%. 11. Changes which reduce the engine braking effect (Changes such as decrease in swept volume, decrease in compression ratio). 12. Increase in rolling radius in excess of 10 %.
4	98A	Steering Performance	DV + T (As applicable)	1. Increase in width of front tyre and / or increase in load on front axle (5%) and / or any decrease in steering wheel diameter which may be verified through analytical method 2. Each unique steering system to be tested (Hydraulic /electric / Mechanical) 3. Hydraulic steering: - Any decrease in operating pressure and / or increase number of joints/ cylinders 4. Mechanical steering: - Any increase in number of linkages involved. 5. Steering gear box: -Any Change in steering gear ratio and / or wheel lock angle and / or type of steering gear box. 6. Any Increase in tyre size 7. Any Addition of emergency steering and / or additional steering control
5	98-A	TCD & TCCD	DV + T (As applicable)	1. Any Increase in width of front tyre 2. Any increase in machine dimensions (Length and width) 3. Any Increase in tyre size 4. Any decrease in number of turns (lock to lock)
6	117	Speedometer	T+CF	1. Decrease in unladen weight more than 20% for axle in which speedometer is mounted. 2. Any Change in the major/minor markings 3. Change in the type of speedometer (Digital to Analog and vice versa) 4. Any change in speedometer ratio / Pulse per RPM
7	120	Noise	T+DV	1. Operator Ear Level (OEL) a. Any Change in the forced

				ventilation (Fan/AC) speeds (no of speeds) b. Any increase in rated RPM 2. Pass By Noise (PBN) a. If engine power among variants varies more than 5 % highest horse power CEV shall be verified. b. Any increase in rated RPM. c. Any change in intake or exhaust system. d. d. Decrease in Unladen weight more than 10 % for machine up to 20 T and 5 % for machine with above 20 T. e. In case of Increase in radiator fan speed/ dimensions / no. of blades f. Any decrease in basic length which decreases measurement sphere radius as per ISO 6393: 2008. g. Any change in type of Radiator cooling fan.
8	124-C	Operator Controls & displays	DV + CF	1. For the variants, manufacturer's declaration may be accepted with suitable drawings etc
9	124-C	Machine Safety Labels	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc.
10	124-C	Visual Display requirements	DV + CF	1. Manufacturer's declaration may be accepted with suitable drawings etc.
11	124-C	Operation station & Maintenance areas	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc.
12	124-C	Fuel tanks (Non-metallic)	DV	1. Type approval validity of each unique Non-Metallic fuel tank shall be checked. 2. Manufacturer's declarations may be accepted for variants / versions
13	124-C	Minimum access dimensions	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc.
14	124-C	Access	DV +CF	1. Manufacturer's declaration may be accepted with suitable drawings etc.,

		systems		including variants / versions 2. Compliance may be done with installation drawings & undertaking.
15	124-C	Guards	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc, including variants / versions 2. Compliance may be done with installation drawings & undertaking.
16	124-C	Visual Display requirements	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc. including variants/versions
17	124-C	Forward horns and machine mounted travel alarms	DV +T	1. Any Change in location of alarm and horn positions. 2. Any Change in entire cabin. 3. Any Increase in overall length and / or width of machine. 4. Any Change in type of alarm or horn. 5. Any Change in Engine RPM.
18	124-C	Operator Controls	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc. including variants/versions
19	124-C	Performance requirements of articulation frame locks	DV + T	1. Manufacturer's declaration may be accepted with suitable drawings etc. including variants/versions
20	124-C	Lift arm support device	DV + CF	1. Manufacturer's declaration may be accepted with suitable drawings etc. including variants/versions
21	124-C	EMI/EMC	DV + T (As Applicable)	1. If the vehicle model is with one or more variants, then the variant with fully loaded version (variant fitted with maximum electronic systems including optional ones) shall be selected for base type approval. 2. Change in engine power is more than 10% 3. For ESA changes, compliance to be established with submission of component test reports complying to IS / ISO 13766 (Part 1) / AIS-004 (Part 3) extension of type approval may be granted to vehicle based on component approval

22	124-C	Seat Belt & Seat Belt Anchorages	DV +T (As Applicable)	1. Highest webbing width to be tested 2. Test in case of variant is not necessary if the length of strap on an adjustable portion of a seat belt type does not vary by more than 150mm and/or the buckle side of a seat belt type does not vary by more than 50mm of an approved. 3. The shape, dimensions and materials of the seat structure; the type and dimensions of the adjustment systems and all the locking systems; and the type and dimensions of the belt anchorages on the seat, of the seat anchorage and of the affected parts of the vehicle structure, shall be treated as same type.
23	124-C	ROPS	DV + T (As Applicable)	1. CEV Model with ROPS to be verified. Results to be extended for other models and Variants /versions if the tested ROPS is common and meets maximum mass criteria and Loads. 2. For Sample/variants ROPS Minor design changes on load carrying members shall be verified through analysis method as defined under ROPS standard. 3. Testing Data to be simulated ≥ 90% correlation for a. ROPS in all applicable loading b. baseline simulation to be compared with modified ROPS simulation and cross check for deflection and load magnitudes. c. The changes on load & deflection should not exceed by >5% compared to base line test data. d. If changes on load & deflection exceeds more than 5%, then Retest to be call up. 4. DLV will be set at design SIP position & incase of multiple SIP positions DLV will be set at nearest position of loading points in each test if possible.
24	124-C	ROPS (For WEXC)	DV + T (As Applicable)	
25	124-C	TOPS (For WEXC)	DV + T (As Applicable)	
26	124-C	Braking (Rubber Track)	DV + T (As Applicable)	1. Increase in Maximum Speed above 20 % 2. Increase in Unladen weight more than 10 % for machine upto 20 T and 5 % for machine with above 20 T

<table>
<tr><td></td><td></td><td></td><td></td><td colspan="3">3. Any Change in make of brake systems
4. Any Change in brake circuit drawing for service and secondary brake
5. Any decrease in track length
6. Any change in Minimum hydraulic / pneumatic operating pressure
7. Any Decrease in reservoir & compressor capacities
8. Changes which reduce the engine braking effect (Changes such as decrease in swept volume, decrease in compression ratio).</td></tr>
<tr><td>27</td><td>124-C</td><td>Minimum Operator Space</td><td>DV (As Applicable)</td><td colspan="3">1. Manufacturer’s declaration may be accepted with suitable drawings etc including variants/versions</td></tr>
<tr><td>28</td><td>124-C</td><td>FOPS</td><td>DV + T (As Applicable)</td><td colspan="3">1. Any Change related to roof and load carrying member simulation results with respect to Deflection Limited Volume (DLV) shall be submitted to the testing agency.
2. FOPS is applicable only for CEVS with cabin.</td></tr>
<tr><td rowspan="4">29</td><td rowspan="4">124-C</td><td rowspan="4">Operator Field of View</td><td rowspan="4">DV (As Applicable)</td><td>Sr. No.</td><td>Parameter and Change</td><td>Criteria for extension OR applicable test required</td></tr>
<tr><td>1</td><td>Change in Machine family type according to ISO 6165</td><td>Visibility tests on Visibility Test Circle (VTC) and on Rectangular Boundary (RB) are to be conducted. or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation</td></tr>
<tr><td>2</td><td>Change in operating mass range according to ISO 6016.</td><td>Visibility tests on Visibility Test Circle (VTC) and on Rectangular Boundary (RB) are to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation</td></tr>
<tr><td>3</td><td>Increase in machine dimensio</td><td>Visibility tests on Visibility Test Circle (VTC) and on Rectangular Boundary</td></tr>
</table>

					ns includin g equipme nt and attachme nts. (e.g. Overall length, width, height)	(RB) are to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation
				4	Any change in Seat Index Point Co-ordinates	Visibility performance criteria on both Visibility Test Circle (VTC) and on Rectangular Boundary (RB) to be verified or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation
				5	Change of mountin g position of mirror or rear view camera position.	Visibility performance criteria for Indirect Visibility only to be tested on Visibility Test Circle (VTC) and on Rectangular Boundary (RB) or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation
				6	Type of Device	Visibility performance criteria for Indirect Visibility only to be tested on Visibility Test Circle (VTC) and on Rectangular Boundary (RB).
30	124-C	Mirror Installation	DV	**Sr. No.**	**Paramet er and Change descript ion**	**Criteria for extension OR applicable test required**
				1	Change in Machine family type accordin g to ISO 6165	Applicable Field of Vision tests to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation

				2	Maximum Width of machine (vehicle)	Field of vision test to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation, if there is an increase in width.
						If decrease, no vehicle level test is required
				3	Type of Device (Mirror to rear view camera or vice versa)	Applicable Field of vision tests to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation.
				4	Deletion of mirror to the machine (vehicle)	If optional mirror is deleted or removed, no test is required, or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation.
				5	Change of mounting position of mirror with respect to Operator seat index point or vice versa	All field of vision tests to be conducted or simulation report shall be submitted along with comparison with the base type approved test and simulation correlation
				6	Use of alternate make of rear-view mirrors	If dimensions of reflecting surface are same or increased, no vehicle level test is required.
31	124-C	Zone of comfort and reach of controls	DV	1. Manufacturer's declaration may be accepted with suitable drawings etc including variants/versions		

CF	=	Check fitment
DV	=	Document verification
T	=	conducting test as per respective standard notified in CMVR.

Guidelines mentioned in the table below are only for reference for test agency and manufacturer to decide for selection of test samples require for test, however test agency in consultation with manufacturer can formulate worst case criteria supported by earlier test results, change in specification & accordingly can select the test sample for CMVR verification.. It's in discretion power of test agency that in consultation with manufacturer it can further extend the test results to any variants / versions if change content does not affect the test parameters adversely or where there is sufficient margins in the test results with respect to requirements & change content criticality..

As & when new requirement / standards will be notified in CMVR, until this standard covers the CEA criteria for new requirements, test agency in consultation with manufacturer can apply worst case criteria for these new requirements also based on change content in aggregates among different models.

Earlier test results/reports wherever available can also be used for consideration to finalizes WCC for selection of test samples.

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SET-UP BY

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)

GOVERNMENT OF INDIA

13th July 2023

Amd 3 (11/2022)

To

AIS-160 : Safety Requirements for Construction Equipment

Vehicle(s)

1.0 Part 2, Clause 3.2

Substitute following text for existing text:

3.2 Seat Belt and Seat Belt Anchorages shall be as per IS/ISO: 6683: 2005 (This requirement is not applicable to Tracked Asphalt Pavers with maximum design speed up to 5 km/h)

2.0 Part 2,

Add following new clause 3.17 after clause 3.16

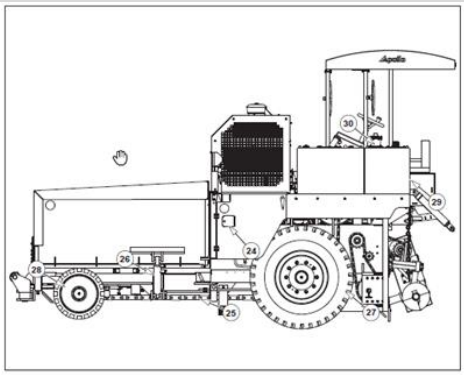
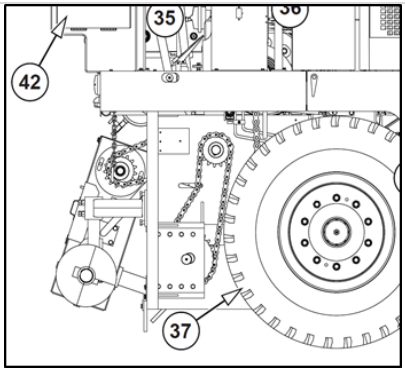
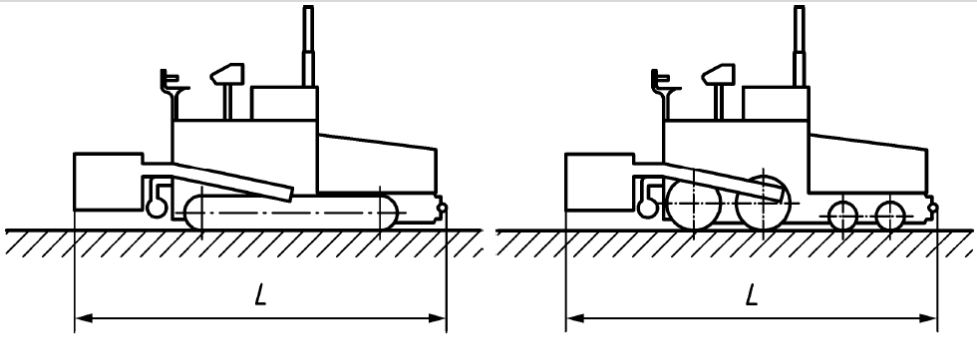
3.17 Static and Dynamic noise of Pavers, Mobile / Pick & Carry Cranes, Self-loading Concrete Mixer, Self-propelled Boom Pump, Tele Handler and Fork Lift shall be measured as Annex A, Annex B, Annex C, Annex D, Annex E and Annex F respectively.

3.0 Add following Annexes and renumber subsequent annexes.

Annex A

Noise Measurement Procedure for Pavers-Stationary test

0.0	**Definition**
0.1	**Paver Finisher** is a construction equipment used to lay Asphalt, WMM (Wet Mix Macadam) or Portland cement concrete on roads, bridges, parking lots and other such places. It lays the material flat and provides minor compaction. Pavers are classified into Wheeled & Tracked Paver. Wheeled Pavers are further classified into Mechanical Paver & Hydrostatic Sensor Paver
0.2	**Mechanical Paver** is a construction equipment wherein sub-systems like conveyor, spreaders / augers, Travel are operated through mechanical gearbox & chain drives. Tamper & vibrators are hydraulically operated

		
	Typical Mechanical Paver	**Mechanical Gear Box**
1.0	**Determination of A-weighted sound power level**	
1.1	**Measurement surface**	
1.1.1	A hemispherical test area shall be used for measurement.	
1.2	**Size of the measurement surface**	
1.2.1	The radius shall be calculated from the basic length *L* of the machine. The basic length includes the main body of the machine plus working units, such as screed. The width of the machine shall be the basic width of the paver-finisher.	
	 **a) basic length of crawler-mounted paver finisher A.** **b) basic length of rubber-tyred paver finisher** **Figure A.1 Basic length of the machine**	
1.2.2	The radius shall be:	
	• 4 m when the basic length L of the machine to be tested is less than or equal to 1,5 m. • 10 m when the basic length L of the machine to be tested is greater than 1,5 m but less than or equal to 4 m. • 16 m when the basic length L of the machine to be tested is greater than 4 m.	
1.3	**Microphone positions on the hemispherical measurement surface**	
1.3.1	Six microphone positions (i.e., positions 1, 2, 3, 4, 5 and 6) shall be arranged according to below figure.	

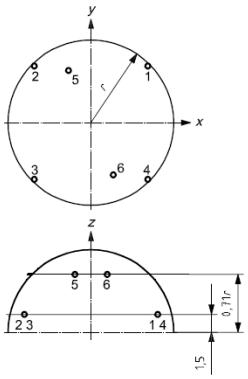


Table 1 — Co-ordinates of microphone positions

Microphone position	x/r	y/r	z
1	0,7	0,7	1,5 m
2	–0,7	0,7	1,5 m
3	–0,7	–0,7	1,5 m
4	0,7	–0,7	1,5 m
5	–0,27	0,65	0,71 *r*
6	0,27	–0,65	0,71 *r*

1.4	**Positioning of the machine**
1.4.1	The center of the machine shall coincide with the center of the hemisphere, which is the intersecting point of the *x*-axis and *y*-axis. The front (direction of travelling) of the machine shall point towards the microphone positions 1 and 4. For positioning the machine, the middle of the basic length *L* shall be regarded as the central point.
1.5	**Repetition of the test**
1.5.1	The A-weighted sound power level shall be determined at least three times. If at least two of the determined values do not differ by more than 1 dB, further measurements will not be necessary. Otherwise, the measurements shall be continued until 2 values differing by no more than 1 dB are obtained. The A-weighted sound power level to be used for calculating the sound power level to be declared is the arithmetic mean of both highest values that do not differ by more than 1 dB. The total duration of each measurement at each microphone position shall be at least 15 s.
2.0	**Determination of A-weighted emission sound pressure level at the operator's position**
2.1	**General**
2.1.1	This Annex A specifies additional requirements for the determination of the A-weighted sound pressure level at the operator's station of paver-finishers according to ISO 6396:2008
2.2	**Enclosed operator's positions**
2.2.1	When equipped with a cabin, all doors and windows shall be closed during measurement. The operator station air circulation fan speed shall be set to mid-position.
2.3	**Quantities to be determined**
2.3.1	If more than one operator's station is provided, the emission sound pressure level at the operator's station is the highest emission value determined at the operator's stations.
2.4	**Repetition of the test**
2.4.1	The sound pressure level shall be measured at least three times at each microphone position. If at least two of the measured values do not differ by more than 1 dB, further measurements will not be necessary. Otherwise the

	measurements shall be continued until 2 values differing by no more than 1 dB are obtained. The A-weighted emission sound pressure level to be used is the arithmetic mean of the two highest values that do not differ by more than 1 dB.
2.4.2	The duration of each measurement at each microphone position shall be at least 15 s.
2.5	**Microphone position(s)**
2.5.1	Should more than one operator's position be provided, then measurement shall be carried out for all positions.
3.0	**Operation conditions**
3.1	**General**
3.1.1	The machine shall be equipped as determined by the manufacturer, i.e. that all working units such as conveying systems, spreading systems, compacting systems and screed shall be fitted.
3.2	**Fan speed**
3.2.1	If the engine of the equipment or its hydraulic system is fitted with (a) fans(s) it (they) must operate during the test. The fan speed is, in accordance with one of the following conditions, stated and set by the manufacturer of the equipment and must appear in the test report, this speed being used in further measurements.
3.2.1.1	**Fan drive directly connected to the engine**
3.2.1.1.1	If the fan drive is directly connected to the engine and/or hydraulic equipment (e.g. by belt drive) it must operate during the test.
3.2.1.2	**Fan drive with several distinct speeds**
3.2.1.2.1	If the fan can work at several distinct speeds the test shall be carried out either
	- at its maximum working speed, or - in a first test with the fan set at zero speed and in a second test the fan set at maximum speed.
3.2.1.2.2	The resulting sound pressure level LpA shall then be calculated by combining both test results using the following equation:
	$$L\text{pA} = 10 \log \{0{,}3 \times 10^{\,0.1\,L\text{pA},0\,\%} + 0{,}7 \times 10^{\,0.1\,L\text{pA},100\,\%}\}$$
	where:
	LpA,0 % is the sound pressure level determined with the fan set at zero speed;
	LpA,100 % is the sound pressure level determined with the fan set at maximum speed.
3.2.1.3	**Fan drive with continuous variable speed**
3.2.1.3.1	If the fan can work at continuous variable speed, the test shall be carried out either according to option 3.2.1.2 or with the fan speed set by the manufacturer at no less than 70 % of the maximum speed.

<table>
<tr><td>4.0</td><td>Operating conditions for working units</td></tr>
<tr><td>4.1</td><td>The engine of the machine shall operate at the nominal speed indicated by the manufacturer. All working units shall be activated and operate at the speeds indicated in below Table.</td></tr>
<tr><td>4.2</td><td>The screed shall, across its basic width, be placed on a base made of cellular rubber (natural rubber basis) with a total thickness of at least 50 mm. Resonance effects should be avoided.</td></tr>
<tr><td>4.3</td><td>Settings for simulation to determine noise emission of a paver-finisher while paving</td></tr>
<tr><td>a</td><td>Pavers other than Mechanical Pavers
<table>
<tr><td>Conveying System (Speed)</td><td>at least 10% of maximum value</td></tr>
<tr><td>Spreading System (Revolutions)</td><td>at least 40% of maximum value</td></tr>
<tr><td>Tamper (Speed & Stroke)</td><td>at least 50% of maximum value</td></tr>
<tr><td>Vibrators (Speed, unbalanced moment)</td><td>at least 50% of maximum value</td></tr>
<tr><td>Pressure Bars (Frequency, Pressure)</td><td>at least 50% of maximum value</td></tr>
<tr><td colspan="2">Note: Figure indicated in table refers to the paving</td></tr>
</table></td></tr>
<tr><td>b</td><td>For Mechanical pavers
<table>
<tr><td>Conveying System (Speed)</td><td>Off</td></tr>
<tr><td>Spreading System (Revolutions)</td><td>Off</td></tr>
<tr><td>Tamper (Speed & Stroke)</td><td>NA</td></tr>
<tr><td>Vibrators (Speed, unbalanced moment)</td><td>With 50% of maximum value</td></tr>
<tr><td>Pressure Bars (Frequency, Pressure)</td><td>NA</td></tr>
<tr><td colspan="2">Note: Figure indicated in table refers to the paving</td></tr>
</table></td></tr>
<tr><td>5.0</td><td>Uncertainty of measurement</td></tr>
<tr><td>5.1</td><td>Uncertainty of measurement shall be as per 10.2 of ISO 6396:2008</td></tr>
</table>

Annex B

Noise Measurement Procedure for Mobile Cranes/ Pick & Carry Cranes

1.0	**Machine set-up**
1.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008.
1.2	All actuating movement shall be carried out at maximum velocity but without activating relief valves or contacting the end of travel barriers.
1.3	Measuring surface shall be as specified in 5.3.2 of ISO 6395:2008.
2.0	**Machine Operation**

2.1	**General**
2.1.1	The dynamic cycle is a combination of travel & stationary work cycle modes.
3.0	**Sound power level for Pass by**
3.1	Travel mode
3.3.1	Operation mode
3.3.1.1	The mode of operation of the machine shall be as specified in Clause 7 of IS/ISO 6395:2008.
3.3.1.2	Travel speed shall be as specified in 7.4. of IS/ISO 6395:2008. If the travel speed as specified in 7.4 cannot be achieved, the maximum speed in the first gear shall be used.
3.3.1.3	For machine having two engines, the machine shall be operated with travel engine alone at maximum governed engine speed (high idle), the auxiliary engine shall be kept off.
3.3.2	**Calculation for travel mode**
3.3.2.1	Since forward and reverse are two distinct modes of operation, both the time and sound pressure level shall be measured as separate entities for each travel direction. Calculate the time averaged A-weighted sound pressure level, LpA,3 in decibels for a combined travel cycle using Equation below.
	$$L_{pA,3} = 10 \lg \frac{1}{T_1 + T_2} \left(T_1 \times 10^{0,1 L_{pA,1}} + T_2 \times 10^{0,1 L_{pA,2}} \right) \text{ dB}$$
	Where
	T1 is the time interval for forward travel mode over the specified travel path
	T2 is the time interval for reverse travel mode over the specified travel path
	LpA1, LpA, 2 are the quantities determined during the T1 and T2 time intervals
3.3	**Stationary Work cycle mode**
3.3.1	Operating conditions during test.
3.3.1.1	Mounting of equipment
3.3.1.1.1	If the crane is equipped with outriggers in both front and rear end, they shall be fully extended and the crane shall be levelled on its pads in mid position of possible support height.
3.3.1.1.2	The mobile crane to be tested shall be presented in its standard version as described by the manufacturer. The engine power considered for determination noise limit is the nominal power of the engine used for crane motion. The crane shall be equipped with its maximum permitted counterweight.
3.3.1.1.3	Before carrying out any measurement, the engine and the hydraulic system of the mobile crane shall be brought to their normal working temperature following the instruction of the manufacturer and all relevant safety-related

	procedures given in the instruction handbook shall be carried out.
3.3.1.1.4	If the mobile crane is equipped with several engines, the engine used for the crane's function shall be run. The carrier engine shall be turned off.
3.3.1.1.5	If the engine of the mobile crane is fitted with a ventilator, it shall run during the test. If the ventilator can be operated at several speeds, the test shall be carried out with the ventilator running at the highest speed.
3.3.1.1.6	The mobile crane shall be measured under the following three ((a) to (c)) or four ((a) to (d)) conditions For all working conditions the following shall apply:
3.3.1.1.7	- Engine speed at 3/4 of maximum speed specified for crane operation mode with a tolerance of ± 2 %. - Acceleration and deceleration should be without dangerous movements of the the hook block. - motions at maximum possible speed as given in the instruction manual under the conditions given.
	(a) Hoisting
	The test consists of hoisting without load and the immediately following lowering to the starting position. The length of the boom shall be chosen so that the full test lasts 15 to 20 seconds.
	(b) Slewing (if applicable)
	With the boom adjusted to an angle of 40° to 50° to the horizontal and without load the upper carriage shall be slewed 90° to the left immediately followed by slewing back to the starting position. The jib shall be at its minimum length. The observation period shall be the time needed to carry out the working cycle.
	(c) Derricking
	The test starts with raising the short jib from the lowest working position immediately followed by the lowering of the jib to its original position. The movement shall be executed without load. The duration of the test shall be at least 20 seconds.
	(d) Telescoping (if applicable)
	With the jib adjusted to an angle of 40° to 50° to the horizontal without load and the jib fully retracted, the telescoping cylinder shall be extended together with the sections up to 50% to 75% and immediately retracted together.
4.0	**The resulting sound pressure level is calculated by:**
4.1	if all operations are applicable
	$LpA4 = 10 \log (0.4 \times 10^{0.1LpA5} + 0{,}25 \times 10^{0.1LpA6} + 0.25 \times 10^{0.1LpA7} + 0.1 \times 10^{0.1LpA8})$
4.2	if only telescoping is not applicable
	$LpA4 = 10 \log (0.4 \times 10^{0.1LpA5} + 0.3 \times 10^{0.1LpA6} + 0.3 \times 10^{0.1LpA7})$

4.3	if only Slewing is not applicable
	$LpA4 = 10 \log (0.4 \times 10^{0.1LpA5} + 0.4 \times 10^{0.1LpA7} + 0.2 \times 10^{0.1LpA8})$
4.4	if Slewing & Telescoping is not applicable
	$LpA4 = 10 \log (0.6 \times 10^{0.1LpA5} + 0.4 \times 10^{0.1LpA7})$
	where
	LpA5 is the sound pressure level for the hoisting cycle
	LpA6 is the sound pressure level for the slewing cycle (if applicable)
	LpA7 is the sound pressure level for the derricking cycle
	LpA8 is the sound pressure level for the telescoping cycle (if applicable)
5.0	**Calculation for combined travel and stationary work cycle modes**
5.1	Calculate the time-averaged A-weighted sound pressure level, LpA, T, in decibels, for a combined travel and stationary work cycle using equation below
	$LpAT = 10 \log (0.5 \times 10^{0.1LpA4} + 0.5 \times 10^{0.1LpA3})$ dB
	Where
	LpA 3, is the quantity determined in travel mode over the specified path
	LpA 4 is the quantity determined with stationary work cycle mode
6.0	**Sound pressure level at the operator's ear position**
6.1	Sound pressure level at the operator's ear position under dynamic test conditions shall be in accordance with IS/ISO 6396:2008 and the procedure listed above.

Annex C

Noise Measurement Procedure for Self-loading Concrete Mixer

1.0	**Sound power level for Pass by**
1.1	All the terms, definitions & procedures given in ISO 3744, IS/ISO 6395:2008 & IS/ISO 6396 :2008 & the following shall apply.
2.0	**Measuring surface and machine positioning**
2.1	The machine shall be positioned as specified in IS/ISO 6395:2008, 6.3.1 for travel mode and 6.3.2 for stationary work cycle.
2.2	The measuring surface shall be as specified in IS/ISO 6395:2008, 5.3.2 for self-loading concrete mixers.
3.0	**Machine set-up**
3.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008.
3.2	All actuating movement shall be carried out at maximum velocity but without activating relief valves or contacting the end of travel barriers.

3.3	For self-loading concrete mixers having two engines where one engine intended for vehicle mobility & other for auxiliary operations, the two engines shall be operated at different instances as specified in 4.2 and 4.3.
4.0	**Machine Operation**
4.1	General
4.1.1	The dynamic cycle is a combination of travel & stationary work cycle modes.
4.2	Travel mode
4.2.1	Operation mode
4.2.2	The mode of operation of the machine shall be as specified in Clause 7 of IS/ISO 6395:2008**.**
4.2.3	For self-loading concrete mixers having two engines, the machine shall be operated with travel engine alone at maximum governed engine speed (high idle), the auxiliary engine shall be kept off.
4.2.4	Calculation for travel mode Since forward and reverse are two distinct modes of operation, both the time and sound pressure level shall be measured as separate entities for each travel direction. Calculate the time averaged A-weighted sound pressure level, $L_{pA,3}$ in decibels, for a combined travel cycle using Equation
	$$L_{pA,3} = 10 \lg \frac{1}{T_1 + T_2} \left(T_1 \times 10^{0,1\, L_{pA,1}} + T_2 \times 10^{0,1\, L_{pA,2}} \right) \text{ dB}$$
	Where
	T1 is the time interval for forward travel mode over the specified travel path
	T_2 is the time interval for reverse travel mode over the specified travel path
	$L_{pA,1}, L_{pA,2}$ are the quantities determined during the T_1 and T_2 time intervals
4.3	**Stationary Work cycle mode**
4.3.1	The engine shall be operated at its maximum governed speed (high idle). The transmission control shall be set at neutral. At the beginning of the cycle, raise and hold the loading arm from the material grabbing position without touching the ground, then raise the arm to 75% of the maximum lift height and then return to material grabbing position three times without touching the ground. This sequence of actions is considered to be a single cycle for the stationary work cycle mode.
4.3.2	For self-loading concrete mixers having two engines, the travel engine shall be kept off, the machine shall be operated with auxiliary engine alone at maximum governed speed (high idle). The sequence of actions shall be as per 4.3.1.
4.3.3	Calculation for combined travel and stationery work cycle modes.
4.3.4	Calculate the time averaged A-weighted sound pressure level, $L_{pA,T}$, in decibels, for a combined travel and stationary work cycle using equation
	$$L_{pA,T} = 10 \lg \left(0,5 \times 10^{0,1 L_{pA,3}} + 0,5 \times 10^{0,1 L_{pA,4}} \right) \text{ dB}$$

	Where,
	$L_{pA,3}$ is the quantity determined in travel mode over the specified path.
	$L_{pA,4}$ is the quantity determined with the self-loading concrete mixer in stationary work cycle mode.
5.0	**Sound pressure level at the operator's ear position**
5.1	Sound pressure level at the operator's ear position under dynamic test conditions shall be in accordance with IS/ISO 6396:2008 and the procedure listed above.

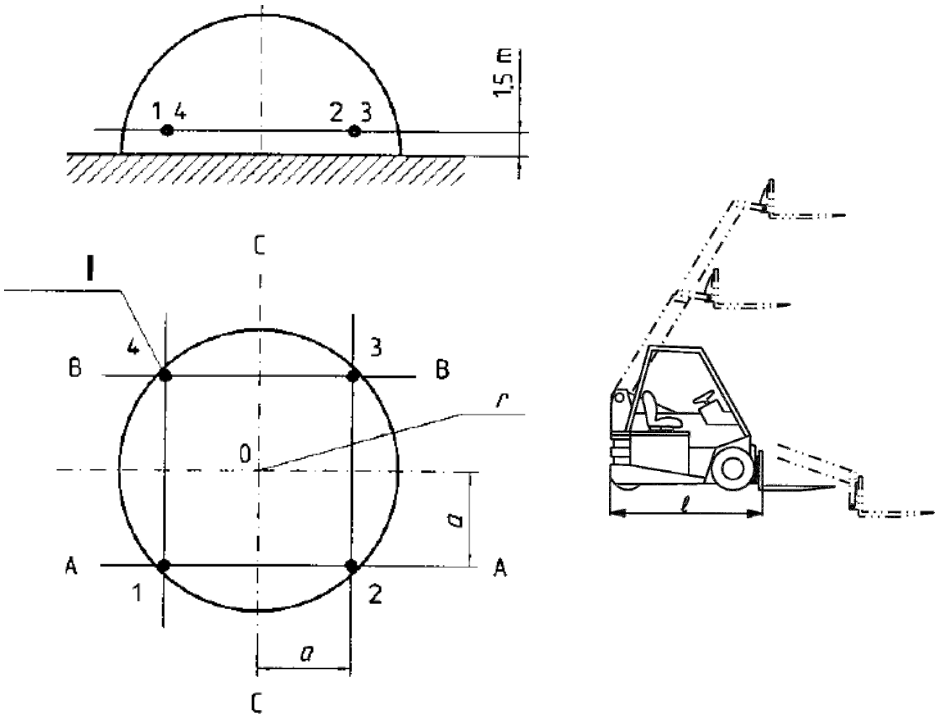
Annex D

Noise Measurement Procedure for Self-propelled Boom Pump

1.0	**Sound power level for Pass by**
1.1	All the terms, definitions & procedures given in ISO 3744, IS/ISO 6395:2008 & IS/ISO 6396 :2008 & the following shall apply.
2.0	**Measuring surface and machine positioning**
2.1	The machine shall be positioned as specified in IS/ISO 6395:2008, 6.3.1 for travel mode and 6.3.2 for stationary work cycle.
2.2	The measuring surface shall be as specified in IS/ISO 6395:2008, 5.3.2 for self-propelled boom pump.
3.0	**Machine set-up**
3.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008.
3.1.1	All actuating movement shall be carried out at maximum velocity but without activating relief valves or contacting the end of travel barriers.
3.1.2	For self-propelled boom pump having two engines where one engine intended for vehicle mobility & other for auxiliary operations, the two engines shall be operated at different instances as specified in 4.2 and 4.3.
4.0	**Machine Operation**
4.1	General
4.1.1	The dynamic cycle is a combination of travel & stationary work cycle modes
4.2	**Travel mode**
4.2.1	Operation mode
4.2.1.1	The mode of operation of the machine shall be as specified in Clause 7 of IS/ISO 6395:2008
4.2.1.2	Travel speed shall be as specified in 7.4. of IS/ISO 6395:2008. If the travel speed as specified in 7.4 cannot be achieved, the maximum speed in the first gear shall be used.
4.2.1.3	For self-propelled boom pump having two engines, the machine shall be operated with travel engine alone at maximum governed engine speed (high

	idle), the auxiliary engine shall be kept off. The sequence of actions shall be as per 4.2.1.1.
4.2.2	Calculation for travel mode
4.2.2.1	Since forward and reverse are two distinct modes of operation, both the time and sound pressure level shall be measured as separate entities for each travel direction. Calculate the time averaged A-weighted sound pressure level, $L_{pA,3}$, in decibels, for a combined travel cycle using Equation :
	$$L_{pA,3} = 10 \lg \frac{1}{T_1 + T_2}\left(T_1 \times 10^{0,1\, L_{pA,1}} + T_2 \times 10^{0,1\, L_{pA,2}}\right) \text{ dB}$$
	Where
	T_1 is the time interval for forward travel mode over the specified travel path
	T_2 is the time interval for reverse travel mode over the specified travel path
	$L_{pA,1}$, $L_{pA,2}$ are the quantities determined during the T_1 and T_2 time intervals
4.2.3	**Stationary Work cycle mode**
4.2.3.1	The engine shall be operated at application intended set speed. The transmission control shall be set at neutral. At the beginning of the cycle, the booms shall be adjusted so as to place maximum close to the rest position but not touching it, then raise the booms to 75% of the maximum lift height and then return to rest position as close as possible but not touching the rest position, repeat the operation three times. This sequence of actions is considered to be a single cycle for the stationary work cycle mode.
4.2.3.2	For self-propelled boom pump having two engines, the travel engine shall be kept off, the machine shall be operated with auxiliary engine alone at application intended set speed. The sequence of actions shall be as per 4.2.3.1.
4.2.4	Calculation for combined travel and stationary work cycle modes
4.2.4.1	Calculate the time-averaged A-weighted sound pressure level, $L_{pA,T}$, in decibels, for a combined travel and stationary work cycle using equation:
	$$L_{pA,T} = 10 \lg\left(0{,}5 \times 10^{0,1 L_{pA,3}} + 0{,}5 \times 10^{0,1 L_{pA,4}}\right) \text{ dB}$$
	Where
	$L_{pA,3}$, is the quantity determined in travel mode over the specified path
	$L_{pA,4}$ is the quantity determined with the self-propelled boom pump in stationary work cycle mode
5.0	**Sound pressure level at the operator's ear position**
5.1	Sound pressure level at the operator's ear position under dynamic test conditions shall be in accordance with IS/ISO 6396:2008 and the procedure listed above.
5.0	Note: Sound pressure level at the operator's ear position for stationary work cycle mode is not applicable to self-propelled boom pump.

Annex E
Noise Measurement Procedure for Tele Handler

1.0	**Definition**
	Telehandlers, a wheeled, internal combustion-engine driven with counterweight and lifting equipment (mast, telescopic arm or articulated arm).
2.0	**Measuring surface and positioning of machine**
2.1	The test environment, test site, climatic condition, measuring surface background and environment corrections shall be as per IS/ISO 6395 clause 5.0.
2.2	The machine shall be positioned as follows.
2.2.1	Travel mode - The vehicle's longitudinal axis remains as close as possible to line C-C
2.2.2	Lift cycle mode - Position the vehicle with its longitudinal axis on line C-C and with its centre *l/2* over point "O".
	
3.0	**Machine set-up**
3.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008.
3.2	All actuating movement shall be carried out at maximum velocity but without activating relief valves or contacting the end of travel barriers.
4.0	**Machine Operation (Sound power level —Dynamic test conditions)**
4.1	General
	The dynamic cycle is a combination of the travel and lift cycle modes.

4.2	Travel mode
4.2.1	Operation mode
	The mode of operation of the machine shall be as specified in Clause 7 of IS/ISO 6395:2008.
4.2.2	Calculation for travel mode
4.2.2.1	Drive the vehicle, without load, at full acceleration from standstill over a distance of three times its length (*l*), to reach line A-A, continue driving the truck at maximum acceleration to line B-B.
4.2.2.2	If the vehicle has a multi-geared transmission, select the gears that ensure the highest possible speed over the measurement distance. The period of measurement for this operation condition begins when the vehicle's centre crosses line A-A and ends when its centre reaches line B-B.
4.2.2.3	The sound pressure level shall be determined at least three times. If at least two of the determined values do not differ by more than 1 dB, further measurements will not be necessary. otherwise, the measurements shall be continued until two values differing by no more than 1 dB are obtained. The A-weighted surface sound pressure level to be used for calculating the sound power level is the arithmetic mean of the two highest values that do not differ by more than 1 dB.
	$$\text{LPAc} = 10 \lg \left[\frac{1}{N_M} \sum_{i=1}^{N_M} 10^{0,1\, L'_{pi(ST)}} \right] \text{dB}$$
	Lpi (ST) is the frequency-band or A-weighted time-averaged sound pressure level measured at the *i*th microphone position
	*N*M is the number of microphone positions.
	$$\text{LWAc} = \text{LPAc} + 10 \log (S/S0) \text{ dB}$$
	where
	S is the area, in square metres, of the measurement surface
	$S0 = 1\ m^2$
4.2.3	Calculation for Lift mode
4.2.3.1	With the vehicle stationary, the boom shall be lifted, from the lowered position, at maximum speed to the standardised lift height declared for that vehicle by the manufacturer. The lift height shall be listed in the test report.
	$$\text{LPAa} = 10 \lg \left[\frac{1}{N_M} \sum_{i=1}^{N_M} 10^{0,1\, L'_{pi(ST)}} \right] \text{dB}$$
	Lpi (ST) is the frequency-band or A-weighted time-averaged sound pressure level measured at the *i* th microphone position
	*N*M is the number of microphone positions.

	$LWAa = LPAa + 10 \log (S/S0)$ dB
	where
	S is the area, in square metres, of the measurement surface.
	$S0 = 1\ m^2$
	The resulting sound power level
	$L_{WA} = 10 \log (0{,}7 \times 10^{0{,}1\ LWAc} + 0{,}3 \times 10^{0{,}1 LWAa})$.
	Where superscript 'a' indicates 'lifting mode' and superscript 'c' indicates 'driving mode'
5.0	**Sound pressure level at the operator's ear position** Sound pressure level at the operator's ear position under dynamic test conditions shall be in accordance with IS/ISO 6396:2008 and the procedure listed in 4.0 of this annexure

Annex F

Noise Measurement Procedure for Forklift

1.0	**Definition**
1.1	Stacking lift truck fitted with fork arms (or with the fork arms replaced by another device) on which the load, either palletized or not, is put in a cantilever position in relation to the front wheels and balanced by the mass of the truck.
2.0	**Measuring surface machine positioning**
2.1	The machine shall be positioned as specified in IS/ISO 6395:2008, 6.3.1 for travel mode and 6.3.2 for stationary work cycle.
2.2	The measuring surface shall be as specified in IS/ISO 6395:2008, 5.3.2 for Fork lift.
3.0	**Machine Setup**
3.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008. All actuating movement shall be carried out at maximum velocity but without activating relief valves or contacting the end of travel barriers.
4.0	***Sound power level for Pass by***
4.1	**Machine set-up**
4.1.1	The machine set-up shall be as specified in Clause 7 of IS/ISO 6395:2008 All actuating movement shall be carried out at maximum velocity but

	without activating relief valves or contacting the end of travel barriers
4.2	**Machine Operation**
4.2.1	General
4.2.1.1	The dynamic cycle is a combination of travel & stationary work cycle modes
4.3	**Travel mode**
4.3.1	Operation mode
4.3.1.1	The mode of operation of the machine shall be as specified in Clause 7 of IS/ISO 6395:2008
4.3.2	Calculation for travel mode
4.3.2.1	Since forward and reverse are two distinct modes of operation, both the time and sound pressure level shall be measured as separate entities for each travel direction. Calculate the time averaged A-weighted sound pressure level, $L_{pA,3}$, in decibels, for a combined travel cycle using Equation below
	$$L_{pA,3} = 10 \lg \frac{1}{T_1 + T_2} \left(T_1 \times 10^{0,1 L_{pA,1}} + T_2 \times 10^{0,1 L_{pA,2}} \right) \text{ dB}$$
	Where
	T1 is the time interval for forward travel mode over the specified travel path
	T_2 is the time interval for reverse travel mode over the specified travel path
	L_{pA1}, $L_{pA\,2}$ are the quantities determined during the T_1 and T_2 time intervals
4.4	**Stationary Work cycle mode**
4.4.1	The engine shall be operated at its maximum governed speed (high idle). The transmission control shall be set to neutral. Raise the forks from the carry position to 75 % of maximum lift height and then return to carry position three times. This sequence of actions is considered to be a single cycle for the stationary hydraulic mode.
4.5	Calculation for combined travel and stationery work cycle modes
4.5.1	Calculate the time averaged A-weighted sound pressure level, $L_{pA,\,T}$, in decibels, for a combined travel and stationary work cycle using equation below:
	$$L_{pA,T} = 10 \lg \left(0,5 \times 10^{0,1 L_{pA,3}} + 0,5 \times 10^{0,1 L_{pA,4}} \right) \text{ dB}$$
	Where,

	$L_{pA\ 3,}$ is the quantity determined in travel mode over the specified path
	$L_{pA\ 4}$ is the quantity determined with the Forklift in stationary work cycle mode.
5.0	**Sound pressure level at the operator's ear position**
	Sound pressure level at the operator's ear position under dynamic test conditions shall be in accordance with IS/ISO 6396:2008 and the procedure listed above**.**

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P. B. NO. 832, PUNE 411 004

ON BEHALF OF

AUTOMOTIVE INDUSTRY STANDARDS COMMITTEE

UNDER

CENTRAL MOTOR VEHICLES RULES - TECHNICAL STANDING COMMITTEE

SET-UP BY

MINISTRY OF ROAD TRANSPORT & HIGHWAYS

(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)

GOVERNMENT OF INDIA

30th November 2022

Amendment No. 2 (07/2022)
to
AIS 160 Safety Requirements for Construction Equipment Vehicle(s)

1.0 Part 2, Page No. 3/6, Clause No. 3.1

Substitute following text for existing text:

3.1 Electro Magnetic Compatibility (EMC) shall be as per IS / ISO 13766 (Part 1):2018.

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

20th July 2022

Amendment No. 1 (02/2022)
To
AIS-160: Safety Requirements for Construction Equipment Vehicle(s)

1.0 Page 2/6, Part 1

Add following new clause 3.17 after clause 3.16

3.17 Compliance given conforming to AIS-012 (Part 1 to 10), AIS-010 (Part 1 to 5), as applicable shall be deemed to be comply with requirements of SS. 15.1

2.0 Page 3/6, Part 2

Add following new clause 2.5 after clause 2.4

2.5 For Construction Equipment Vehicles (CEVs), other than those defined in IS/ISO 6165:2012, performance of Lighting and light-signaling devices fitted on such Construction Equipment Vehicle (CEV) shall be tested as per Table 1 of AIS 062 (Rev-1) and installation of such lights and light signaling devices shall be as per CMV Rules.

3.0 Page 3/6, Part 2

Add following new clause 3.14 and 3.15 after clause 3.13

3.14 For Construction Equipment Vehicles (CEVs) as defined in IS/ISO 6165:2012, performance of Lighting and light-signaling devices fitted on such Construction Equipment Vehicle (CEV) shall be tested as per Table 1 of AIS 062 (Rev-1) and installation of such lights and light signaling devices shall be as per IS / ISO 12509.

3.15 Retro-reflective tape fitted on Construction Equipment Vehicle (CEV) shall comply with performance requirement laid down in AIS-090 as amended from time to time.

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UNDER

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MINISTRY OF ROAD TRANSPORT & HIGHWAYS

(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)

GOVERNMENT OF INDIA

10th February 2022

AUTOMOTIVE INDUSTRY STANDARD

SAFETY REQUIREMENTS FOR CONSTRUCTION EQUIPMENT VEHICLE(S)

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
(DEPARTMENT OF ROAD TRANSPORT & HIGHWAYS)
GOVERNMENT OF INDIA

September 2020

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.

This standard covers requirements for safety components of Construction Equipment Vehicles (CEV). These requirements are proposed to be regulated for the first time in the country. Accordingly, this standard is divided in two parts. The requirements covered in part 1 will be mandated in first phase and the part 2 will be mandated subsequently.

The AISC panel and the Automotive Industry Standards Committee (AISC) responsible for preparation of this standard are given in Annex-A and Annex-B respectively.

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AIS-160: Safety Requirements for Construction Equipment Vehicle(s)

PART 1

1.0 SCOPE:

1.1 This AIS is applicable for Construction Equipment Vehicle (CEVs) as defined in CMVR "2", sub rule "cab".

1.2 Requirements as specified in Clause Nos. 3.8 to 3.16 of this part, shall only be applicable for CEV's which are covered under IS/ISO: 6165:2012.

1.3 Requirements as specified in Clause Nos. other than those specified in 1.2, shall be applicable to all CEV's.

1.4 In addition to the safety provisions listed in Cl. No. 3 of this part, other technical and safety requirements shall be as per Central Motor Vehicle Rule (CMVR), 1989 as amended from time to time

2.0 GENERAL REQUIREMENTS :

2.1 Basic Types, Identification and Terms and Definitions of Construction Equipment's Vehicles shall be as per IS/ISO: 6165:2012 and Rule 2 of CMVR, as amendment from time to time.

2.2 Units for dimensions, performance, capacities and measurement accuracies used in testing and certification of Construction Equipment's Vehicles may be as per IS/ISO: 9248:1992, as amendment from time to time.

2.3 Definition of dimensions and codes for the base machine of all type of Construction Equipment's Vehicles may be as per IS: 11114-2:2006 /ISO6746-1:2003, as amendment from time to time.

2.4 Definition of dimensions and codes of the equipment and attachments of all type of Construction Equipment's Vehicles may be as per IS: 11114-3:2006 / ISO 6746-2:2003, as amendment from time to time.

3.0 PROVISIONS ON SAFETY:

3.1 External rear view mirror of the vehicle shall be as per AIS-001 (Part 1) or (Part 2) (Rev.1):2011.

3.2 Internal Mirror (if fitted) shall be as per AIS-001 (Part 1) or (Part 2)(Rev.1):2011.

3.3 Common / Specific Symbols for operator controls and other displays shall be as per IS/ISO: 6405-1: 2017 and IS/ISO: 6405-2: 2017. The mandatory requirements shall be as per AIS-071 (Part 1).

3.4 Machine Safety Labels shall be as per IS/ISO: 9244:2008.

3.5 Visual Display Requirements shall be as per AIS-071 (Part 1 and 2) except for CEV's covered under the scope of IS/ISO: 6165:2012, which will be as per clause 3.13 of this part.

3.6 Operator Station and Maintenance Areas shall be as per IS/ISO: 12508:1994.

3.7 Non-metallic Fuel Tanks shall be as per IS/ISO: 21507:2010.

3.8 Minimum Access Dimensions shall be as per IS: 10689:1993/ ISO: 2860:1992, as applicable.

3.9 Access Systems for steps, primary access, alternate exit path and opening, maintenance opening, handrail and handholds shall be, as per IS/ISO: 2867:2011, as applicable.

3.10 Guards - Barrier Guards, Fenders, Fan Guards, Thermal Guards, and Hose Guards shall be as per IS/ISO: 3457:2003.

3.11 Visual Display Requirements shall be as per IS/ISO: 6011:2003.

3.12 Machine mounted audible travel alarms and forward horn shall be IS/ISO:9533-2010.

3.13 Operator Controls shall be as per IS/ISO: 10968:2004.

3.14 Performance requirements for Articulated Frame Lock shall be as per as per IS/ISO: 10570:2004.

3.15 Lift Arm Support Device shall be as per IS/ISO: 10533:1993/Amd 1:2005.

3.16 Dimensions and requirements for Operator's Seat shall be as per IS/ISO: 11112:1995.

PART 2

1.0 SCOPE:

1.1 This AIS is applicable for construction equipment vehicle (CEVs) as defined in CMVR rule "2", sub rule "cab".

1.2 Requirements as specified in Clause Nos. 3.3 to 3.13 of this part, shall only be applicable for Construction Equipment Vehicles which are covered under IS/ISO: 6165:2012.

1.3 Requirements as specified in Clause Nos. other than those specified in 1.2, shall be applicable to all Construction Equipment Vehicles.

1.4 In addition to the safety provisions listed in Cl. No. 3 of this part, other technical and safety requirements shall be as per Central Motor Vehicle Rule (CMVR), 1989 as amended from time to time

2.0 GENERAL REQUIREMENTS :

2.1 Basic Types, Identification and Terms and Definitions of Construction Equipment's Vehicles shall be as per IS/ISO: 6165:2012 and Rule 2 of CMVR, as amendment from time to time.

2.2 Units for dimensions, performance, capacities and measurement accuracies used in testing and certification of Construction Equipment's Vehicles may be as per IS/ISO: 9248:1992, as amendment from time to time.

2.3 Definition of dimensions and codes for the base machine of all type of Construction Equipment's Vehicles may be as per IS: 11114-2:2006 /ISO6746-1:2003, as amendment from time to time.

2.4 Definition of dimensions and codes of the equipment and attachments of all type of Construction Equipment's Vehicles may be as per IS: 11114-3:2006 / ISO 6746-2:2003, as amendment from time to time.

3.0 PROVISIONS ON SAFETY:

3.1 Electro Magnetic Compatibility (EMC) shall be as per IS / ISO 13766 (Part 1):2018 and IS / ISO 13766 (Part 2):2018.

3.2 Seat Belt and Seat belt anchorages shall be as per IS/ISO: 6683:2005.

3.3 Roll over Protective Structure (ROPS) shall be as per IS/ISO 3471:2008 as applicable.

3.4 Roll Over Protective Structure (ROPS) which shall be provided for excavators shall be as per IS/ISO 12117-2:2008 as applicable.

3.5 Tip over protection structure (TOPS) for compact excavators shall be as per ISO 12117:1997, as applicable.

3.6 Performance and Tests of Rubber Tracked / Padded Crawler Machines for Braking Systems shall be as per IS/ISO10265:2008.

3.7 Seat Index Point shall be as per IS 11113:1999 / ISO 5353:1995.

3.8 Physical Dimension of Operator and Minimum Operator Space shall be as per IS/ ISO 3411:2007.

3.9 Falling Object Protective Structure (FOPS) shall be as per IS/ISO 3449:2005 as applicable.

3.10 Operator Field on View shall be as per IS/ISO 5006: 2017.

3.11 Installation requirement of rear view mirrors shall be as per ISO:14401-1:2009 and IS/ISO:14401-2:2009.

3.12 Zones of Comfort and Reach for Controls shall be as per ISO 6682:1986/IS 11252:1993.

3.13 Evaluation of Operator Seat Vibrations for suspended seats if fitted, shall be as per IS/ISO 7096:2000.

ANNEX- A

(See Introduction)

COMPOSITION OF AISC PANEL ON SAFETY REQUIREMENTS FOR CONSTRUCTION EQUIPMENT VEHICLE(S)*

Convener	
Shri A. A. Badusha	The Automotive Research Association of India (ARAI)
Members	**Representing**
Shri K. B. Patil	The Automotive Research Association of India (ARAI)
Shri Sagar Babar	The Automotive Research Association of India (ARAI)
Shri K. V. Krishnamurthy	ICEMA
Shri Saurabh Dalela	JCB India Ltd.,
Shri Karthik Kaliappan	John Deere India Pvt. Ltd.
Shri K.Vijay	Ajax Fiori Engineering (I) Pvt. Ltd
Shri K. Reji Jose	Caterpillar India Ltd.
Shri Bhaskaran Venkataramani	Caterpillar India Ltd.
Shri Vivek Rawat	JCB India Ltd.,
Shri Suresh Kumar M.	Larsen & Toubro Limited
Shri Rajeev Shalia	Case Construction Equipment
Shri G. Rajendra.	Mahindra & Mahindra Construction Equipment Division
Shri M. Rajendran	Komatsu India Pvt. Ltd.
Shri R. Ashok	Volvo Construction Equipment Ltd.
Shri S. G. Roy	Indian Earthmoving & Construction Industry Association Ltd.

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

ANNEX - B
(See Introduction)

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 Heavy Industries and Public Enterprises (Department of Heavy Industry), 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	Global Automotive Research Centre
Director	International Centre for Automotive Technology, Manesar
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
Shri K. V. Krishnamurthy	Indian Construction Equipment Manufacturers Association

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)