Amd 3 to AIS-160 (11/2022)

To

AIS-16 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

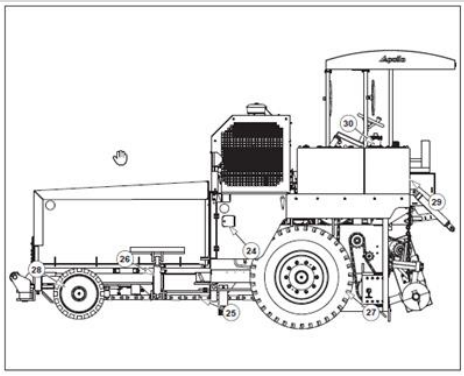
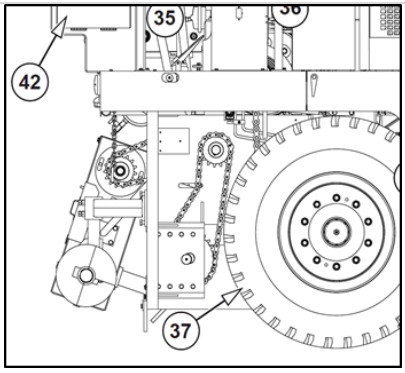
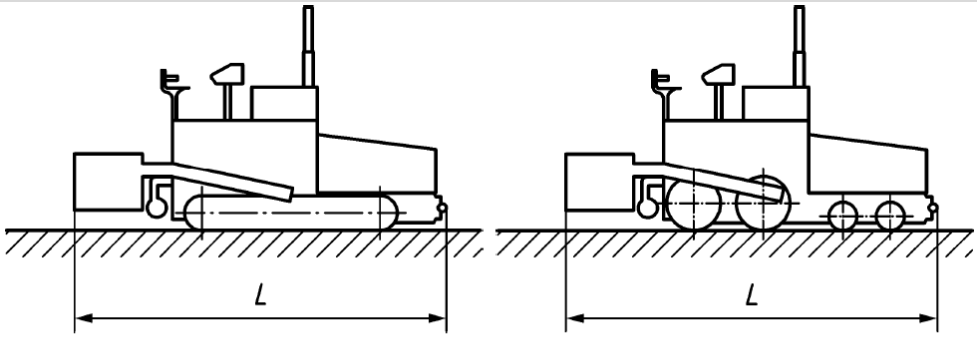
3.17 Static and Dynamic noise of Pavers, Mobile / Pick & Carry Cranes, Self-loading Concrete Mixer, Self-propelled Boom Pump, Tele Handler and Fork Lift shall be measured as Annex A, Annex B, Annex C, Annex D, Annex E and Annex F respectively.

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.	

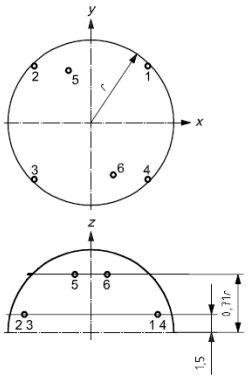


Table 1 — Co-ordinates of microphone positions

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.

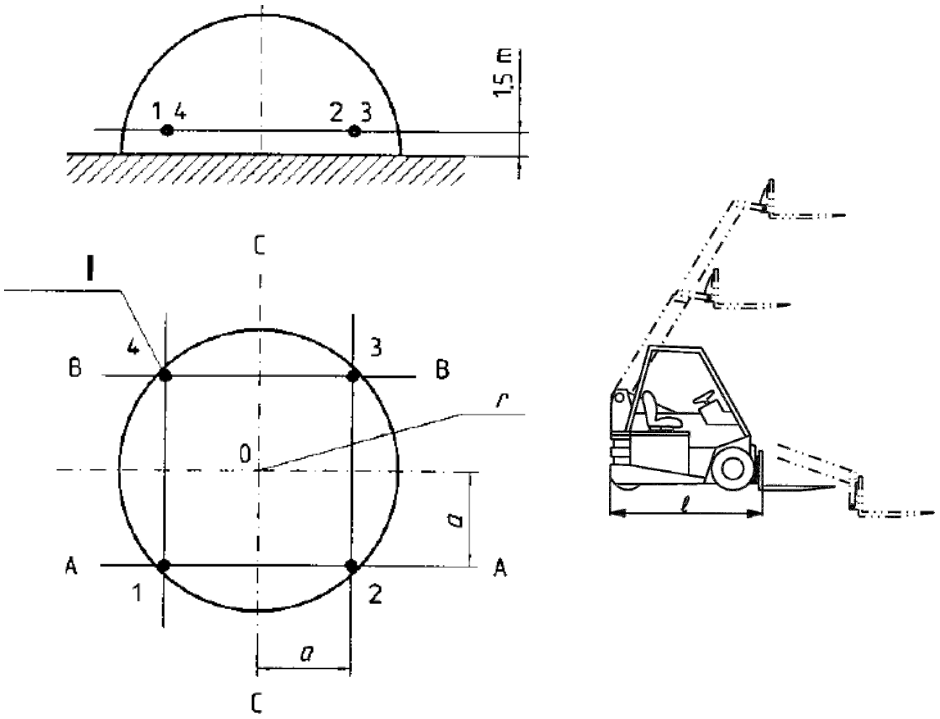
Annex D

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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(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.

CONTENTS

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.
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Shri K. Reji Jose	Caterpillar India Ltd.
Shri Bhaskaran Venkataramani	Caterpillar India Ltd.
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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)