



GUIDELINE FOR RAIL NOISE ASSESSMENT CRITERIA FOR RAPID RAIL TRANSIT SYSTEMS



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PREFACE

The Ministry of Megapolis and Western Development is in the process of planning and constructing Rapid Rail Transit System focusing to achieve the effective public transport system for the country and providing effective solution for traffic congestion in metropolis targeting improvement of the social well-being while achieving the sustainable development goals of the country.

Noise emanating from especially construction and operation of rapid rail systems is well known environmental problem worldwide because it is continuously affected and created nuisance to nearby human settlements, generally. Though Sri Lanka has no previous experiences in constructing and operating such a system, issues are expected to be sharp and complicated when railway lines pass through dense human settlements.

It was a requirement to have a set of standards which could be used for designing of environmental friendly and sustainable expressways, preparation of proper environmental management plan, monitoring to get understand the exact noise levels, using for legal requirements. This guideline aims to fulfill the requirements in scientific and systemic manner.

Mr A S Pannila, Additional Director General (Technical Services) of the Industrial Technology Institute and a leading Acoustic Scientist with hands full of practical experiences in the field provided excellent technical consultancy for preparation of the guideline, and the Central Environmental Authority would like to acknowledge his invaluable service for preparation of the Guideline. Stakeholder organizations supported for the preparation of the guideline are acknowledged and names of the stakeholder organizations are listed in the Appendix.

The Central Environmental Authority is in the view of upgrading this guideline into regulations, once acquiring hands on experience on implementation of the assessment criteria and limits set out in the guideline.

Any constructive comment, opinion or review on the guideline or a component of the guideline is welcomed and be kindly requested to send such comment, opinion or review to the following address for future developments.

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Guideline for Rail Noise Assessment Criteria for Rapid Rail Transit Systems

1. Scope

This document presents guidance and recommendation for rail noise assessment criteria for planning, construction and operation of Rapid Rail Transit Systems.

1.1. Definition of Rapid Rail Transit System

For the purpose of this guideline the Rapid Rail Transits System is defined as follows:

Rapid Rail Transit system (RTS) refers to an urban rail transit system providing rapid public transport operates with lower passenger capacity on a localized shorter network compared to heavy rails. It uses Rapid Rail Vehicles (RRV) operating in multiple units powered by electricity mostly on a shared Right of Way (ROW) with other road vehicles on designated structure.

Note:

However, provided that the ministry or government institute of the subject of Rapid Rail Transit Systems could have the right to regulate the definition and any valid revision to be made by the ministry or the institute shall be affected thereof.

1.2. Definition of Rapid Rail Transit Project

For the purpose of this guideline, the Rapid Rail Transit Project is defined as follows:

A project that shall be planned, constructed and implemented a Rapid Rail Transit System.

2. The purposes of this guideline are:

- 2.1. Planning purposes typically by government authorities, projects proponents, and consultants
- 2.2. Carrying out noise measurements, monitoring, modeling and prediction in rapid rail systems
- 2.3. Application in noise impact assessments and, pre & post compliance verification for Environmental Impact Assessments or Initial Environmental Examinations of rapid rail projects
- 2.4. Determining noise disturbance on a quantitative manner and for regulatory requirements
- 2.5. Offering an introductory treatise on noise control in rapid rail systems

3. Validity of the rail noise assessment criteria

- 3.1. This guideline only applies to rapid rail projects which were evaluated after year 2017 for environmental compliance
- 3.2. Noise assessment criteria which are given in this guideline can be applied only for existing noise sensitive receivers at the time of announcement of the new light rail project. The time of announcement of the new rapid rail project means the date of the final approval of the Environmental Impact Assessment or Initial Environmental Examination, unless otherwise specified by the ministry or the government institute of the subject of the rapid rail systems
- 3.3. This guideline could not be applied to new noise sensitive development, which has gained development consent after announcement of new rapid rail project
- 3.4. It is the developer's responsibility to ensure the new development is designed with appropriate consideration of noise impacts due to existing rapid rail system operation

Note:

However, provided that the ministry of subject or the government institute of the subject of RTS can voluntarily assess complaints receiving against to any RTS evaluated in prior to 2017 using the criteria and permissible levels specified in this guideline.

4. Noise Limits

Noise assessment limits are based on either of followings, depending on circumstances.

- 4.1. An absolute limit is given in the guideline is based on the average level of noise which should not be exceeded in a specified time period.
- 4.2. A relative limit is based on the permitted increase in noise level with respect to the background noise level.

Noise Assessment Criteria for Rapid Rail Transit Systems

Table 1. Airborne rapid rail noise assessment criteria for residential land use

Assessment criteria dB (A) - External	
Day (06.00 am - 10.00 pm)	Night (10.00 pm - 06.00 am)
60 L_{Aeq} (16h) and 85 L_{AFmax}	50 L_{Aeq} (8h) and 85 L_{AFmax}

Table 2. Airborne rapid rail noise assessment criteria for commercial land use

Assessment criteria dB (A) - External	
Day (06.00 am - 10.00 pm)	Night (10.00 pm - 06.00 am)
65 L_{Aeq} (16h) and 85 L_{AFmax}	55 L_{Aeq} (8h) and 85 L_{AFmax}

Table 3. Airborne rapid rail noise assessment criteria for sensitive land uses other than residential and commercial land uses

Other sensitive land users	Assessment criteria dB (A) (when in use)	
	Internal level	External Level
Schools & Educational institutions (class rooms), authorized centers for child care, aged care, physically/mentally handicap care	45 L_{Aeq} (1h)	63 L_{Aeq} (1h)
Buddhist Temples, Hindu Temples, Churches, and Mosques	45 L_{Aeq} (1h)	60 L_{Aeq} (1h)
Hospital Wards	40 L_{Aeq} (1h)	63 L_{Aeq} (1h)
Courthouse and Library	45 L_{Aeq} (1h)	63 L_{Aeq} (1h)
Open space – Passive use (e.g. Parkland, forest reserves)	-	65 L_{Aeq} (16h)
Open space – Active use (e.g. Sports ground, golf course, walking track)	-	65 L_{Aeq} (16h)

Note:

In case of background noise is higher or marginal to relevant noise level assessment, adding +3 dB (A) is allowed subject to following conditions:

- a) External level should not be higher than 70 L_{Aeq} (1 hour)
- b) Internal level should not be higher than 55 L_{Aeq} (1 hour)

Technical Notes to Table 1, Table 2 and Table 3

1. Specified noise assessment levels refer to noise at the receiver location
2. Noise assessment levels refer to noise from rail transport only. It should not be included ambient noise from other sources
3. The noise levels are external levels except where otherwise stated
4. $L_{Aeq,T}$ (where T is the relevant time period) refers to the equivalent continuous noise event and is measured using the ‘fast’ response setting on a sound – level meter. The purpose of the L_{Amax} assessment level is to capture the potential noise impact associated with individual pass-by events
5. Noise from safety warning devices such as horns and bells should not exceed the L_{Amax} assessment level

5. Background noise level correction

- 5.1. Background correction should be done in the case of background noise level is between 3 dB (A) and 10 dB (A) below the measured noise level of a single passing event
- 5.2. Background noise level should be measured by using L_{A90} descriptor before and after single passing event
- 5.3. Decibel subtraction can be used to calculate the actual noise level of a single passing event
- 5.4. Corrected single passing event noise level should be used to calculate the time average noise level ($L_{Aeq,T}$)

6. Locations where noise assessment criteria apply

The designated locations for assessment against the criteria are described in Table 4.

Table 4. Assessment locations for existing land use

Assessment Type	Assessment Location
External noise levels at residencies	The noise level should be assessed at 2.5 meters from the façade/room and at a height of 1.5 meters from the floor (Note 1)
Noise levels at multi-level residential buildings	The external point of reference for measurement is the floor of the building that is most exposed to rapid rail vehicle noise. This point should be selected at the height of selected floor and 3 meters from the building (Note 2)
Internal noise levels	Noise level at the centre of the habitable room that is most exposed to the rapid rail vehicle noise with openable windows being opened sufficiently to provide adequate ventilation
External noise levels for other noise sensitive land users	External points should be selected considering area where the typical activities of the land used is being taken in place (Note 3)
Open space: Passive or active use	The noise level is to be assessed at the time(s) and location(s) regularly attended by people using the space. In this regard, regular attendance at a location means at least once a week

Note 1:

The position has been adopted to provide a relatively accessible measurement location, and will protect the acoustic amenity of both the internal space in the dwelling and external space near the respective façade/room. In case such location is not accessible point inside the building could be selected for the assessment with windows open condition. However external level should be considered for assessment criteria.

Note 2:

Incase this point is not accessible for noise measurement; point inside the same floor can be selected with the condition of openable windows being opened sufficiently to provide adequate ventilation. In such a situation assessment is based 5 dB (A) less than the relevant external level.

Note 3:

This does not mean that noise levels over the entire property will also meet the assessment criteria.

7. Measurement Equipment

- 7.1. The measurement shall be made with a precision sound level meter which comply with the requirements of the IEC publications, IEC 60942:2017 and IEC 61672-1:2013 or thereafter for the type of meters in class 1.
- 7.2. The “A” weighting network and ‘fast’ time weighting response shall be used for sound pressure level measurements for equivalent L_{eq} and statistical centile readings.
- 7.3. Measurement for statistical centile levels (L_{90}) and maximum level (L_{max}) shall be made using a sound level meter which is installed with statistical analysis functions, or alternatively computed from continuously monitored instantaneous sound pressure levels using data acquisitions system for the stipulated time period.
- 7.4. The calibration of sound level meter shall be checked and adjusted according to the manufacturer’s instructions using standard sound source. (Sound level meter calibrator or pistonphone) at the beginning and end of each series of measurement.
- 7.5. A wind shield approved by the microphone manufacturer shall be used. Measurements cannot normally be made if the wind speed exceeds 5 m/s. For continuous remote monitoring the wind speed shall be monitorial concurrently with sound levels.

8. Calibration of Equipment

- 8.1. Sound level meters and sound level calibrators which are used for noise measurement should have valid calibration certificate with international traceability.
- 8.2. Maximum valid period for calibration report for sound level meter is 4 years and sound level meter calibrator is 2 years.

9. Requirement of Accreditation

The organization/Institute who measures/monitors the rapid rail noise levels should have valid ISO 17025 accreditation status for measurement of environmental noise and background noise.

10. Software for Noise Predictions

Internationally accepted software package should be used in prediction of noise levels.

Any accepted software which is used for prediction of noise level, must be validated with respective in-field measurement in order to noise prediction reflect the actual situation as closely as possible and any difference between the model output and measurement value are known.

Note:

A number of software packages which implement various suits of calculation methods are available including:

Sound PLAN	- Braunstein +Berndt
Cadna A	- Datakustik
Type 7810/Pradiator	- B & K
Traffic noise model	- US Federation Highway Administration

The above software packages can accurately implement calculation methods as specified by their developers. This is not an exhaustive list and there are other software as well.

11. Applying the noise assessment criteria for new rapid rail project

Steps should be taken in the following order to apply noise assessment criteria for actual noise mitigation.

11.1. During the planning stage of the project

Step 1:

Identify the study area, comprising noise sensitive assessment locations within 200 meters from the centre line of the outermost rail track on each side of the proposed rail track.

Step 2:

Predicted noise levels (with estimated vehicle count for 5 years & 10 years) at the identified noise sensitive receivers should be calculated using internationally accepted noise prediction software. (Noise prediction should be done using a validated software within Sri Lanka).

Step 3:

For each assessment location in the study area where exceedances are identified in step 2, identify feasible and reasonable mitigation measures in following order of priority.

- i. In-corridor noise barriers
- ii. Localized noise barriers or at-property treatment

Step 4:

Calculate the predicted noise level in step 2 again with the proposed mitigation and make sure the predicted noise levels are within the assessment criteria.

Note:

In some locations In-corridor noise barriers are not effective or not economical. In such situation localized noise barriers or at property treatment could be considered. Localized noise barriers or at property treatment should be designed in consultation with the land user(s) and consent for design should be taken.

11.2. During the operation of the project**Step 5:**

Actual noise measurements should be carried out after one year time from the date of operation of the rail track. Additional noise receivers (if any) should be identified using this actual noise measurement.

Step 6:

Suitable mitigation method should be applied for the receivers who were identified in step 5.

Step 7:

Repeat step 5 and step 6 in three year and five year time interval after the date of operation of the rail track.

Note:

Existing land users before the announcement of the rail track only be considered for step 1 to step 7.

Appendix A

Stakeholder organizations supported for preparation of the Guideline

1. Ministry of Transport and Aviation
2. Ministry of Megapolis and Western Development
3. National Engineering Research and Development Centre
4. Industrial Technology Institute
5. National Building Research Organization
6. Road Development Authority
7. Urban Development Authority

Appendix B

Example for calculation of $L_{Aeq,T}$ and L_{AFmax}

This example demonstrates how to calculate $L_{Aeq,T}$ and L_{Amax} noise levels from a series of measurement results at a specific location.

Example set of measurement results

Measurement	Time	Pass-by duration (seconds)	Measured noise levels, dB(A)	
			$L_{Aeq,T}$ (for pass-by)	L_{Amax}
1	6.22 am	33	70	77
2	6.51 am	31	71	79
3	7.30 am	30	71	78
4	7.43 am	30	69	78
5	7.51 am	35	72	81
6	8.12 am	31	67	75
7	8.50 am	33	72	82
8	9.47 am	32	71	80
9	11.25 am	30	69	77
10	1.50 pm	28	70	79
11	2.31 pm	34	69	77
12	3.49 pm	33	71	82
13	4.35 pm	29	70	78
14	5.14 pm	30	68	76
15	5.29 pm	31	73	86
16	5.37 pm	32	72	80
17	5.54 pm	31	70	79
18	7.38 pm	30	71	79
19	8.50 pm	34	67	76
20	10.24 pm	33	71	81

To calculate the $L_{Aeq,T}$ for a period based on measurements of all pass-by during that period the following equation should be used:

$$L_{Aeq,T} = 10 \times \log_{10} \left(\frac{\sum P_i \times 10^{0.1 \times L_i}}{T_P} \right)$$

Where:

- P_i is the duration of each pass-by, in seconds
- L_i is the L_{Aeq} noise level of the pass-by over that duration
- T_P is the duration of the total assessment period (T) in seconds.

So the $L_{Aeq,15hr}$ from 7 am to 10 pm for the above set of measurements would be:

$$L_{Aeq,15hr} = 10 \times \log_{10} \left(\frac{30 \times 10^{7.1} + 30 \times 10^{6.8} + \dots + 34 \times 10^{6.7}}{15 \times 60 \times 60} \right) = 50 \text{ dB(A)}$$

In situations where not all pass-by noise levels during an assessment period have been measured, then the $L_{Aeq,T}$ for the period is able to be conservatively approximated by assuming a typical worst-case pass-by noise level and duration. For example, the set of measurements only contains three pass-bys during the night time period. If there were actually ten pass-bys during the night-time period, then the $L_{Aeq,9hr}$ for the night time period could be approximated by assuming a typical worst-case pass-by level of 72 dB(A) and duration of 34 seconds (based on all measurements taken). The $L_{Aeq,9hr}$ level can then be calculated by time correcting the pass-by noise level:

$$L_{Aeq,9hr} = 72 + 10 \times \log_{10} \left(\frac{10 \times 34}{9 \times 60 \times 60} \right) = 52 \text{ dB(A)}$$

The worst-case $L_{eq,1hr}$ for the example set of measurements could be for either the 7.30 am to 8.30 am period or for the 5 pm to 6 pm period as in both periods there were four pass-bys. The measured $L_{Aeq,1hr}$ levels are:

$$L_{Aeq,1hr(07:30 \text{ to } 08:30)} = 10 \times \log_{10} \left(\frac{30 \times 10^{7.1} + 30 \times 10^{6.8} + 35 \times 10^{7.2} + 31 \times 10^{6.7}}{1 \times 60 \times 60} \right) = 56 \text{ dB(A)}$$

$$L_{Aeq,1hr(17:00 \text{ to } 18:00)} = 10 \times \log_{10} \left(\frac{30 \times 10^{6.8} + 31 \times 10^{7.8} + 32 \times 10^{7.2} + 31 \times 10^{7.0}}{1 \times 60 \times 60} \right) = 57 \text{ dB(A)}$$

Based on the set of measurements, the worst-case $L_{Aeq,1hr}$ level is 57 dB (A) during the period from 5 pm. to 6 pm.

The relevant L_{Amax} level for comparison with the criteria is the L_{Amax} level not exceeded for 90% of rail pass-by events. For the presented set of measurements it would be 82 dB (A).



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