Vibration Fact Sheet

How is Vibration Defined?

Vibration is the motion of the ground transmitted into a building that can be described in terms of displacement, velocity or acceleration. Vibration velocity is used in light rail transit (LRT) and freight rail and is defined by the following:

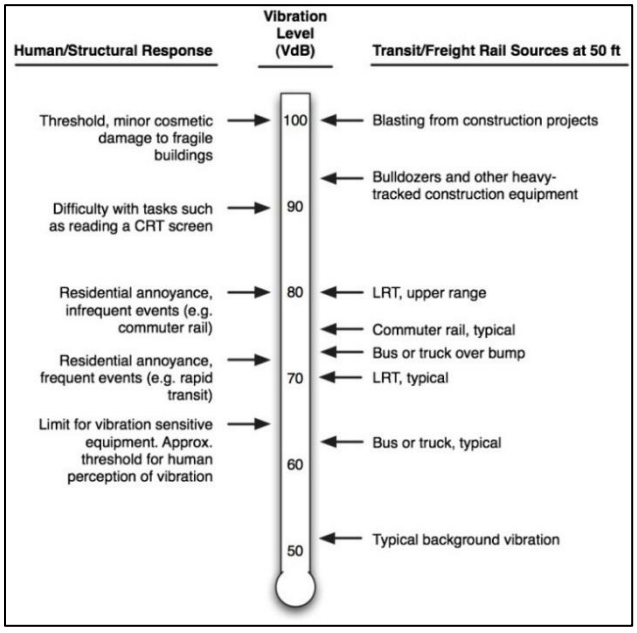
Level: Vibration is expressed in vibration decibels (VdB). The level of vibration represents how much the ground is moving. The threshold of human perception to LRT and freight rail vibration is approximately 65 VdB and annoyance begins to occur for frequent events at vibration levels over 70 VdB.

Frequency: Vibration frequency is expressed in Hertz (Hz). Human response to vibration is typically from about 6 Hz to 200 Hz.

Time Pattern: Environmental vibration changes all the time and human response is correlated to the number of vibration events during the day.

Vibration velocity (VdB) is used to describe LRT and freight rail vibration because it corresponds well to human response to environmental vibration. Vibration is defined by the maximum vibration level during a transit or freight rail event. Human sensitivity to vibration increases with increasing numbers of events during the day.

Vibration Levels from LRT and Freight Rail



Ground-borne noise (GBN) is also assessed. GBN is a form of low-frequency noise that radiates from building walls and ceilings due to vibration caused by LRT or freight rail operation. Because airborne noise typically masks GBN for above ground (at-grade or elevated) transit systems, GBN is only assessed for operations in a tunnel (where airborne noise is not a factor) or near locations such as recording studios that are well insulated from airborne noise.

How much Vibration is Created by LRT and Freight Rail?

Vibration levels from LRT and freight rail depend on the type of vehicle, track conditions, soil type, and train speed. Vibration levels also decrease with increasing distance from the tracks. Vibration levels based on typical LRT and freight rail operations and speeds are shown below.

Vibration and GBN Levels (VdB) at 45 mph

	LRT		
Distance	Vib	GBN	Freight Rail
50 feet	71	39	88
100 feet	66	34	82
200 feet	58	26	76

Light Rail Transit (LRT) Vehicle

How is Vibration Impact Assessed?

Vibration and GBN impact from LRT and freight rail projects are assessed by comparing the levels predicted to be generated by the project with the appropriate criteria.

The vibration and GBN criteria use by the Federal Transit Administration (FTA) take into account the sensitivity of the receiver by land use category, including:

Category 1: Highly vibration sensitive, such as manufacturing facilities

Category 2: Residences and other places where people sleep

Category 3: Schools, churches and other places with daytime use

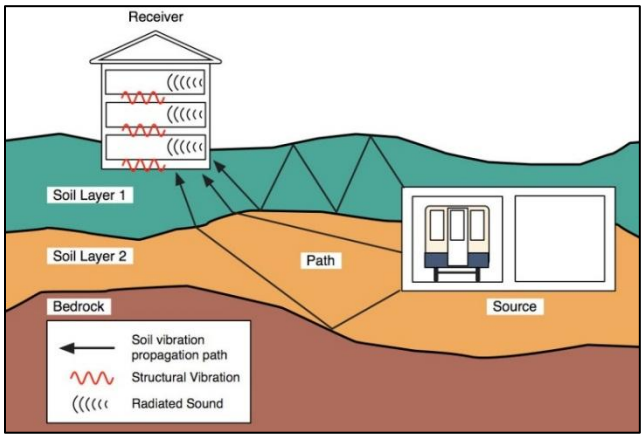
A vibration and GBN assessment is broken down into three pieces:

Source: What is generating the vibration or GBN (such as a transit vehicle or freight train)?

Path: How far and over what type of ground does the vibration or GBN travel?

Receiver: Who or what is experiencing the vibration, such as a residence or a school?

The Source – Path – Receiver Concept



Vibration and GBN impact assessments are based on applicable FTA and Federal Railroad Administration (FRA) models, and are assessed using the source-path-receiver framework. Some of the key components of a vibration impact assessment include:

Source

Vibration levels of LRT and freight trains

Number and speed of LRT and freight trains

Track type, including elevated tracks, a tunnel, or at-grade track

Special trackwork including crossovers

Path

Distance to vibration sensitive locations

Soil and bedrock characteristics

Building foundations

Receiver

Type of land use (Category 1, Category 2, or Category 3)

Sensitivity of the land use, including highly sensitive locations such as manufacturing facilities, residences or parks

Vibration and GBN impact is primarily assessed to determine the potential for human annoyance. However, vibration is also assessed for activity interference at highly sensitive sites, and in very rare cases, damage to fragile structures, usually during construction. Vibration assessments also address the potential for impacts from maintenance facilities and stations.

Typical Output of a Vibration Impact Assessment

The output of a vibration or GBN impact assessment includes locations with vibration or GBN impact (purple). This information is used to determine the location and extent of any potential vibration mitigation.

How is Vibration Mitigated?

Vibration or GBN mitigation is applied at locations where impact is identified. Vibration impacts generally require mitigation where reasonable and feasible. Because mitigation is highly dependent on engineering details, specific mitigation measures are usually identified during the design of a project.

Vibration or GBN mitigation is most commonly applied at the source (in the tracks), but can also be applied along the path or at the receiver. Examples include:

Source: Rail grinding, wheel truing, resilient fasteners, ballast mats, floating track slabs

Path: Trenches, buffer zones

Receiver: Building modifications, isolated tables, floating floors

Example Vibration Mitigation: Resilient Fasteners