Noise Study

Noise Fundamentals and Terminology

Sound from highway traffic is generated primarily from a vehicle's tires, engine and exhaust and technically described in terms of the loudness (amplitude) of the sound and frequency (pitch) of the sound. The standard unit of measurement of the loudness of sound is the Decibel (dB). Decibels are based on the logarithmic scale, as opposed to the more common linear units such as that of temperature. In terms of human response, most observers perceive an increase or decrease of 10 dB in the sound pressure level as doubling or halving of the sound. For example, 70 dB will sound twice as loud as 60 dB. In addition, studies have shown that a 3 dB increase or decrease is barely perceptible by the human ear.

Noise has been defined as unwanted sound. Highway traffic noise is a major contributor to overall transportation noise and is considered to be a line source of energy from which the energy levels dissipate vertically and laterally from the roadway. Traffic noise is not constant. It varies as each vehicle passes a point. The time-varying characteristics of environmental noise are analyzed statistically to determine the duration and intensity of noise exposure.

Noise metrics (measurements) can be divided into two categories: single event and cumulative. Single-event metrics describe the noise levels from an individual event such as an aircraft fly over or perhaps an emergency vehicle pass-by. Cumulative metrics average the total noise over a specific time period, which is typically 1 or 24-hours typically applied in evaluating community noise. For this type of analysis, cumulative noise metrics were used. For traffic noise, since humans are not equally sensitive to all frequencies, noise is adjusted or weighted using an A-weighted scale. The A weighting scale is widely used in environmental analysis because it closely resembles the nonlinearity of human hearing. The unit of A-weighted noise is dB(A). Because highway traffic sounds fluctuate over time, an equivalent sound level is used to represent a single number to describe varying traffic sound levels. The noise standard used by the FHWA is related to the peak one-hour noise level and is described in terms of the Equivalent Noise Level (LEQ). The term Leq (h) refers to the energy-average noise level during the hour period, i.e., the average noise based on the acoustic energy of the sound. Peak hour noise refers to the hour with the highest Leq (h) whether or not it is the peak traffic hour. All traffic noise levels are expressed in dB(A) Leq (h).

Receptors are the "human ears" and the site location represents an area where frequent exterior human activity occurs. For residential dwellings, the receptor site location is generally the patio/backyard or front yard areas near the house structure.

Noise Impact Determination

The peak hour volumes and corresponding speeds for automobiles, medium trucks and heavy trucks result in the noisiest conditions. According to FHWA regulation and ODOT noise, policy, noise impacts occur when:

(1) Exterior noise levels are expected to reach 66 decibels (dB) for residential dwellings.

(2) Interior noise levels are expected to reach 51 dB for auditoriums, day care centers, hospitals, libraries, medical facilities, places of worship, public or nonprofit institutional structures, radio studios, recording studios, schools, and television studios.

(3) When there is an anticipated increase of future noise levels over existing noise levels of 15 dB or greater (interior and exterior).

What are the Federal standards for highway traffic noise?

The Federal noise regulation at 23 CFR 772 constitutes the official Federal noise standards. The standards include the Noise Abatement Criteria along with all other requirements of 23 CFR 772, such as prediction of noise levels, abatement, information for local officials and construction noise. The entire Part 772 is the Noise Standard. FHWA has given highway agencies flexibility in implementing the 23 CFR 772 standards which done per current ODOT Noise Policy dated July 13, 2010 to be applied uniformly and consistently to all federal aid projects throughout the state.

What is the focus of the FHWA Noise Abatement Criteria (NAC)?

The FHWA NAC focuses on levels where highway traffic noise could potentially interfere with speech communication in exterior areas. 23 CFR 772's primary focus is on determining traffic noise impacts and considering noise abatement for exterior areas of frequent human use.

How are existing noise levels determined?

Existing noise levels are determined by using one of the following methods:

(1) for highways on new alignment, utilizing a precision sound level meter, perform daytime ambient readings at remote receptor locations.

(2) Predict noise levels using the FHWA Traffic Noise Model version 2.5 (TNM 2.5); or,

(3) Use a combination of sound level measurements and prediction with a validated Traffic Noise Model. Measurements should occur during free flow traffic conditions and do not need to occur during the worst noise hour.

How are future noise levels determined?

As with all ODOT highway projects requiring a noise study, future noise levels are determined by using the FHWA TNM 2.5 being consistent with the methodology of TNM per 23 CFR 772.9(a).

What is TNM v 2.5?

The FHWA's TNM 2.5 is a computer software that calculates existing and future noise levels based on project design plans consisting of roadway geometry, traffic data, terrain lines, ground zones and receptor site locations. For this project, existing and future levels were determined using TNM 2.5.

How are noise impacts determined?

A traffic noise impact occurs when: (1) future predicted exterior or interior LEQ(h) traffic noise levels approach by one decibel, meet or exceed any of the FHWA Noise Abatement Criteria; or, (2) Impacts which occur when there is a substantial noise increase. A substantial increase is defined as when future noise levels exceed existing levels by 15 dB or greater and can occur even though the predicted noise levels may not exceed the NAC.

For this project, the primary receptors of concern are the residential dwellings and places of worship in which impacts occur when noise levels equal or exceed 66 dB(A) LEQ(h).

Where no exterior area of frequent human activity is apparent, analysis of interior noise levels is conducted by subtracting a noise reduction factor from the calculated exterior noise level, based upon the composition of the subject building. For this project, one place of worship was analyzed for interior noise levels by applying the noise reduction factor for a light frame, ordinary sash (closed) building type, which is 20 dB. An interior noise impact occurs for places of worship when the interior noise level meets or exceeds 52 dB(A) LEQ(h).

What is dB(A) LEQ(h)?

The decibel (dB) is a logarithmic unit, which expresses the ratio of the measured sound pressure level to a standard reference level. Sound is composed of various frequencies, but the human ear does not respond to all frequencies. Frequencies to which the human ear does not respond are filtered out when measuring highway traffic noise levels. Sound level meters are usually equipped with weighting circuits, which filter out selected frequencies. The A-scale on a sound level meter best approximates the frequency response of the human ear. The term LEQ (h) refers to an equivalent of an average sound level over an hour's time period that contains the same acoustic energy as the time-varying sound level during the same period. All traffic noise levels are typically expressed in dB(A) LEQ (h).

Are payments allowed for noise damages?

Per FHWA, State DOTs cannot use Federal-aid funds to compensate property owners for noise damages, but can use Federal-aid funds for noise abatement consisting primarily in the form of noise barrier walls placed within the highway right-of-way. In addition, per ODOT Noise Policy, the Department will not consider insulation of residences as noise mitigation.

Does vegetation reduce noise levels?

Studies have shown that vegetation must be a minimum of 100 feet thick, a minimum of 20 feet high and sufficiently dense (100% opacity) to provide at least a 5-dB(A) noise reduction. Since a substantial noise reduction does not occur until vegetation matures, the FHWA does not consider the planting of vegetation to be a highway traffic noise abatement measure for projects subject to the provisions of 23 CFR 772.

Results of the Analysis for the Muskogee Turnpike & SH-51 Connection Project

Noise Modeling
This noise analysis screening was conducted utilizing FHWA Traffic Noise Model version 2.5 (TNM 2.5) based on the following parameters: 1) no model validation measurements and 2) no ambient noise level recordings were conducted. The screening is for use in a conservative estimate of traffic noise impacts. A detailed noise study that includes model validation and field measurements will be conducted based on the selection of a preferred alternative.

A preliminary review led to the conclusion that at least one noise impact is anticipated as a result of both the Alternative 1 and Alternative 2 proposed designs. No such impacts were apparent from a preliminary review of the Alternative 3 proposed design. Therefore, a noise analysis screening using TNM 2.5 was first conducted for the Alternative 3 proposed design to determine whether further analysis of Alternatives 1 and 2 was necessary at this time.

Analysis of the Alternative 3 proposed design was conducted using the existing condition year (2020) and the future condition design year (2045) based on the respective roadway geometry, traffic volumes, terrain and receptor site locations. Thirty (30) single-family homes and two (2) places of worship were analyzed for noise impacts based on the Alternative 3 proposed design. For the places-of-worship, one included an exterior analysis at a playground area. For the other, an interior analysis was conducted consisting of building type described as a light frame with ordinary sash windows in which a 20 dB noise reduction factor was applied in TNM 2.5.

Noise Impact Determination
Based on the Alternative 3 proposed design and 2045 design year traffic volumes, future sound levels for all receptors evaluated are expected to range from 48.3 to 64.8 dB(A) Leq (h). No receptors are expected to experience traffic noise levels that approach, meet or exceed the respective FHWA Noise Abatement Criteria (66 dBA for exterior analysis or 51 dBA for interior analysis).

No substantial increases (+15 dB) in noise levels are anticipated, with the highest increase in future noise levels over existing levels being
+9.4 dB.

Based on the noise analysis screening of the Alternative 3 proposed design and 2045 design year traffic volumes, no receptors will experience traffic noise levels that constitute a noise impact. Although at least one (1) noise impact is anticipated for either Alternative 1 and Alternative 2 proposed designs, additional impacts would also be anticipated due to those residential dwellings being in close proximity with the improved roadways and interchange involved.

A detailed Traffic Noise Study will be completed once preliminary plans are available which will include model validation fieldwork.