PROCEDURES FOR MEASURING FREEWAY NOISE LEVELS

The following information provides an overview of what to expect when the Arizona Department of Transportation measures freeway noise levels. ADOT utilizes the procedures outlined below consistently in all locations.

Noise measurements are taken by the ADOT Noise Analysis Team, which is part of the ADOT Environmental Planning Group. In some instances, the ADOT team might include support from a qualified consultant who works under the direction of ADOT supervision.

ADOT utilizes a one-hour, A-weighted equivalent sound level [Leq (h)] descriptor. This is required when validating the Federal Highway Administration Traffic Noise Model pursuant to 23 CFR 772 ("Procedures for Abatement of Highway Traffic Noise and Construction Noise.") A-weighting reflects the human ear's response to sounds of lower pressure level. Unless otherwise stated, noise descriptors for transportation-related activity are assumed to be A-weighted.

Three, 10-minute readings are taken in each location.

The following equipment and procedures are utilized for all tests:

INSTRUMENTATION

For model validation measurements, the key instrumentation and accessories include the following:

- Integrating sound level meter, including microphone and preamplifier.
    - *Sound level meters (SLM) and sound level analyzers measure sound levels. Section 772.11(d) (3) of 23 CFR 772 calls for the use of an integrating sound level meter which automatically measures Leq. The accuracy of an SLM is characterized by its "class." Class 1 SLMs are designed for precision field measurements and research. Either class 1 or class 2 SLMs are acceptable for use in traffic noise analyses for federal-aid highway projects. Components of an SLM include a microphone with preamplifier, an amplifier, frequency weighting, input gain control, time averaging, and an output indicator or display.*
- Calibrator
    - *An acoustic calibrator provides a means of checking the entire acoustic instrumentation system's sensitivity by producing a known SPL (referred to as the calibrator's reference level) at a known frequency, typically 94 dB or 114 dB at 1 kHz. The acoustic instrumentation system includes a microphone, cables and recording instrumentation.*
- Windscreen
- Tripod
- Anemometer or handheld wind speed and direction instrument (online weather sites applications may be used to provide data on temperature and humidity data).
- Data sheets, clipboard, pen, pencil or electronic data-logging device.

- Still camera and optional video camera
- Vehicle-speed detection unit
- Traffic-counting device

ON-SITE SET UP AND DATA COLLECTION PROCESS

The process follows the FHWA Measurement of Highway-Related Noise – Report (FHWA-PD-96-046) and ADOT's Instruction on Determination on Existing Noise levels. In compliance with these guiding documents, *"Noise measurements should use three sampling periods that are 10-15 minutes long when determining the Leq(h); in low traffic volume areas, the sampling period should be increased to 30 minutes in length."* This process allows for noise measurements to be taken in one location per hour.

The steps below describe what is done upon arrival at the testing site through the successful collection of data. This is ADOT's standard process for taking noise measurements in all locations:

1. Determine the exact point(s) to place the microphone prior to setting up for data collection. Evaluate the presence or likelihood of localized noise sources (e.g. intermittent sources such as vehicle backfire, an airplane flying over, a loud motorcycle) that will cause levels to increase momentarily, and other sources such as air conditioning units, pool pumps, landscaping care, local traffic on neighborhood streets, social activities, pets, residential construction) and adjust the location accordingly.
    a. Locations are to be aligned with the request of residents.
    b. For ADOT purposes, locations are to correspond to the receiver placed in the noise model.
2. Attach the microphone and preamp to the tripod head, typically at a height of five (5) feet above the ground. Ensure the tripod is level and secure; weighing it down on slopes may be needed, especially if breezy conditions are expected.
3. Check all equipment settings, including use of the A-weighting filter network and measurement of Leq. Synchronize the time clocks on the instruments to each other and to all operators' time-keeping devices. Check battery strength.
4. Calibrate the entire acoustical instrumentation system.
5. Document wind speed and direction, temperature, humidity and cloud cover prior to and after data collection, and whenever substantial changes in conditions are noted during the measurement.
    a. Wind data should be site-specific and contemporaneous with the sound level measurements. For model validation measurements, wind should be calm. Discontinue or pause sampling if wind is not calm (or mark those one-minute periods as contaminated for post-measurement deletion).
    b. Temperature and humidity can be determined though online weather sites or applications on mobile devices. Ensure weather data from online sources is from weather stations near to the measurement site and that weather conditions from the online source match conditions observed in the field.
    c. For model validation purposes, ideal conditions are calm, overcast days. Observe cloud cover.

6. Begin filling out the field data sheet, including measuring distances to landmarks, making a site sketch, or taking photographs to document the location. Obtain latitude and longitude. Ensure documentation is thorough and completed so another person could return to the site at another time and set up at the same measurement point. Brief video recordings before or during the measurement can prove useful (possibly including voice narration or the sound level display in a portion of the video screen).
7. Deploy traffic-counting and speed detection equipment and personnel.
8. Measure sound levels for the needed duration registering intermittent sources (such as a vehicle backfire, an airplane flying over, a loud motorcycle or heavy truck passing by) that will cause the levels to increase momentarily, or any other source that may contaminate the data.
9. Collect the traffic count and speed data simultaneously with the sound level data. Record traffic in the field by video and perform counts later; video recording requires time synchronization between the acoustical instrumentation and the video camera.
10. Obtain as many speed samples as possible during the relatively short duration of a validation noise measurement; attempt to gather roughly equal numbers in each direction.
11. After sampling is completed, record the result(s) on the field data sheet. Save data to a file for download to a computer. Save any data files associated with the traffic counts or speeds to a computer either on site or after completing the day's measurements.
12. Recheck the sound level instrument's calibration (with the extension cable still in place, if used).
13. Documentation is an essential part of every measurement.
    a. In the field and after data analysis, complete data sheets in the field while at the site. Ensure documentation is sufficient for another person to return to that same microphone location and repeat the measurement with the same equipment and settings, and under the same conditions.
    b. Use the following parameters to document using data sheets:
        - Name of person conducting measurement
        - Project name and location
        - Site location and description, including address (if applicable), and possibly a site number that was assigned by the individual who is taking the measurement or preassigned by the measurement study planner.
        - Model and serial number of the sound level instrument, microphone and calibrator, and sound level instrument settings (e.g., A-weighting).
        - Site sketch (including distances to landmarks), ground surface characterization (including pavement), and terrain features (all of which would be useful information when the site is modeled with FHWA Traffic Noise Model).
        - Measurement date, start and stop time, and duration.
        - Pre- and post-measurement calibration results.
        - Measured Leq, and other descriptors, if measured.
        - File name for the measurement, if applicable.
14. Draft a technical memorandum.