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Tutorial on Sound Level Meters: Conducting a Noise Survey with an SLM

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ABSTRACT

Selecting an appropriate sound level meter (SLM) and knowing how it is set up, maintained and operated are all important to understand, but conducting a successful noise survey requires more. This tutorial focuses on the important additional steps required to properly plan, execute, and document a professional noise survey. These will include a discussion of the different types of surveys, understanding what resulting data will be required, planning for proper equipment, instrumentation, and field conditions, avoiding common pitfalls in survey execution, proper documentation of the survey conditions and results, and implementation of proper quality checks.

1 INTRODUCTION

This tutorial session on Sound Level Meters (SLMs) has covered topics as on the different types of SLMs available and how they are different, understanding how they work, appropriate settings and analysis features, and how to conduct basic sound level meter readings. This part of the tutorial takes the last step and discussing the planning, execution and documentation of a sound survey using one or more SLMs.

2 WHAT IS A SOUND SURVEY?

So, what exactly is a sound survey? Generally, a survey would include gathering multiple data points to examine, describe or define something. This may be applied to surveying a piece of property, asking a number of potential voters who they plan to vote for, or asking a talent show studio audience which contestant should advance to the next round. For the sake of this discussion we will assume that a sound survey includes collecting acoustical measurement data for a variety of locations, durations, operational conditions, or other comparative parameters. These may include indoor surveys, such as at workplaces, businesses, schools or hospitals, or outdoor settings including communities near transportation, commercial, industrial, or power generation/transmission sound sources, or in natural or recreational settings.

3 PLAN AHEAD

As simple as preparing a noise survey plan may seem, it is surprising how often this simple step of is skipped or forgotten. However, failure to create a plan is an open invitation for failure.

3.1 Know What Data You Need to Collect, and Where

As part of developing a sound survey plan, it is important to review any specific requirements for the data that you will need to collect and document. If the survey is intended to show compliance with a local noise ordinance, ensure that you are collecting the right measurement metrics (Leq, Lmax, L10, L90, etc.), appropriate measurement durations, and that the measurements are being

conducted at the proper location and conditions as specified in the regulation (such as at the property line of the subject property or nearest noise-sensitive property, etc.), as well as whatever other operational data or observations may be required. If the purpose of the survey is primarily to collect data for a highway noise model validation, make sure that in addition to collecting the acoustical data in the proper acoustical metrics and durations, you are also collecting the simultaneous traffic data required for the validation, otherwise the acoustical data by itself is worthless. When conducting a sound survey to characterize the acoustical properties of an interior space, product or equipment noise characteristics, be sure to research and incorporate the requirements from any applicable technical standards that may need to be followed.

3.2 Make a Plan

Once the basic requirements are understood, you can develop an appropriate sound survey work plan document. This does not need to be complicated but should include most or all of the following components:

- Name and location of the project;
- Names and contact information of the staff conducting the survey and who is in charge;
- Any significant travel/lodging arrangements (flight numbers, hotels, etc.), if appropriate
- Names and contact information for any local contacts (client or local agency staff who you may need to contact during the survey);
- Map or diagram of planned measurement locations;
- A preliminary schedule for when and where planned sound measurements will take place, (especially important for larger, or multiday surveys);
- A description of measurements to be carried out (short or long-term measurements, locations, durations, metrics, key SLM settings, anticipated sound events, number of iterations, etc.);
- Complete list of instrumentation, equipment and supplies required;
- A description of any special or non-standard instrumentation settings or measurement techniques that will be required;
- Reference any special procedure or standards to be followed;
- Any meteorological requirements or limitations for the sound survey (such as: moderate temperatures and wind speeds, no precipitation, dry roads, no or limited snow cover, etc.);
- A safe work plan, including mitigation plans for any special safety issues associated with the survey area and directions to the closest urgent care center in case of an emergency (this may be required by your employer or client); and,
- Any special safety or procedural training that might be required for the survey staff by the client or overseeing agency. Note: this is not uncommon when the scope of work includes working in an industrial facility, construction site, or within the right-of-way of a transportation facility, and failure to complete required training could result in the survey being canceled at the last minute (or even being banned from the project site).

It is often a good idea to have your client review your draft sound survey work plan. This will allow them to suggest any revisions or modifications, eliminate any confusion or miscommunication regarding what you will and will not be doing, and will also let them know that you are planning ahead.

One should also be aware that if any of your planned measurement locations are on private property not owned by your client, or not publicly accessible, you may need to arrange permission to access the property in advance, perhaps through the client or overseeing agency. This may

result in a "request to enter" letter or some other kind of documentation that you can carry in the field or contact information for local agency staff to help arrange access.

3.3 Check Your Equipment and Supplies

As part of your sound survey plan, you should create a detailed list of the instruments, equipment and supplies that will be required for your survey (or use an existing standardized list). Use the list as a packing list for your equipment both heading out and coming back, to make sure that you have not forgotten anything important (because nothing is more frustrating than driving four hours to the survey site only to discover that you forgot to pack windscreens). Your list may include the following:

- SLMs, including associated microphones and pre-amps;
- Field calibrators;
- Any specialized instrumentation (artificial noise sources, tapping machines, etc.)
- Windscreens, tripods, microphone clips, microphone extension cables, if applicable;
- Environmental cases (including locks and security cables), if required;
- Weather meters (hand-held, or free-standing station);
- Field data sheets (blank forms);
- Camera, video recorder, GPS transponder (or a smart phone which includes all);
- Digital sound recorders (if appropriate);
- Extra batteries, electrical tape, a small tool kit; and,
- Project documentation, copy of contract, permission to enter letters, etc.

Before leaving for the field, conduct a quick check on your key equipment, such as SLMs, to make sure that they are working properly, are within their manufactures' recommended laboratory calibration period, and can successfully pass a field calibration test.

3.4 Check Weather and Contacts

For exterior sound surveys, weather counts, and bad weather can be deal breaker. Generally, it is desirable to avoid extreme weather or active precipitation since these can negatively influence sound measurements. Therefore, it is a good idea to keep an eye on the 5 to 10 day weather forecasts for the measurement location to ensure that you will have reasonably good weather while you are there, especially if travel is required. Once you have confirmed appropriate weather conditions and finalized any travel plans check in with your client and local contacts to ensure that they know when you will be arriving on the project site (if appropriate).

4 EXECUTION

Execution is where proper preparation and planning pays off. Observe the following steps to maximize your chances for a successful sound survey.

4.1 Follow the Plan

Make sure that all members of the field team have a copy of the sound survey measurement plan and understand their role, and who to contact in case something goes wrong or a change in plans is required. Start each day in the field with a quick meeting to review the plan, each member's assignments and any updates or changes.

4.2 Work Safe

Working away from the office always carries some added risk, even if it only includes driving to a local survey location. Whether your sound survey plan includes a formal safe work plan or not, safety issues should be discussed and planned for. Safety issues to consider and address could include any or all of the following:

- When driving to and from the survey site, obey all traffic laws, practice defensive driving, reduce distractions while driving (such as eating or using the phone while behind the wheel);
- Identify potential on-site hazards, which could include operating near heavy machinery, potential outdoor environmental hazards such as snakes, insects, other animals or prolonged exposure to heat, cold or sun, or aggressive or uncooperative people, and provide appropriate strategies to deal with each;
- When working in potential high crime areas, how to avoid conflicts or request help if needed;
- Provide the address and directions to the nearest urgent care facility; and
- Conducting sound surveys with at least two people, if practical. This allows survey team members to share the work and provide some immediate back-up if a health or safety issue may arise.

4.3 Proper Documentation

A common and costly error often made by inexperienced individuals conducting a sound survey is missing or incomplete documentation. A bunch of numbers downloaded from an SLM are meaningless if they are not backed up with detailed documentation that adequately describes when and where the measurements were conducted and what the environmental and operational conditions were at the time of the measurement. It is highly recommended to use a preprinted field survey form when documenting any type of sound survey. A good general-purpose field data sheet should include sections to document the following for each measurement conducted as part of the survey.

- Name and general location of the project;
- Location, ID number and date of individual measurement;
- Name of the person conducting the measurement;
- Model, serial number and calibration due date for SLM and field calibrator being used;
- SLM settings (weighing network, response setting, measurement intervals, etc.);
- Field calibration check results;
- A description of the sound measurement environment, including site diagram and GPS coordinates of SLM placement, description of terrain and existing sound environment;
- Meteorological observations (temperature, wind speed, barometric pressure, % cloud cover);
- Table or list of sound pressure level measurement results data with corresponding notes and observations (may include just interval equivalent sound level (L_{eq}) values for each measurement interval, with other metrics downloaded or calculated later);
- Area to include observed traffic counts or other significant acoustical sources.
- A separate field data sheet should be completed for each measurement location and iteration.

Photo documentation is also highly recommended, typically using a good smart phone, digital camera or video recorder. The primary recommendation is to include at least two photos for each measurement location set-up, preferably one showing the SLM in the foreground and the primary noise source (highway, power plant, noisy machine, etc.) in the background, and another with the

SLM in the foreground and the primary noise-sensitive receptor location (residence, work station, outdoor use area, etc.) in the background. If possible, try to include some distinctive referenceable landmark (building, streetlamp, large tree) somewhere in the photo, to help place the measurement location in case the measurement may need to be repeated in the future. Additional photos can be included to help identify additional sound sources, receivers, or other elements that may influence the acoustical characteristics of the sound measurement environment, such as acoustical absorption, shielding or reflections.

For surveys that include long-term noise measurements where an SLM is left unattended for 24 hours or more in an environmental case, it may make sense to use an SLM with an internal event sound recording feature, or include a small digital recorder, which can be used to help identify individual transient sound events during post-processing.

4.4 Professionalism

An important but often overlooked aspect of conducting a good sound survey is professionalism. In most cases the survey team will come into contact with others. These may include clients, client's employees, public agency staff, homeowners, other members of the public, and maybe even law enforcement. Therefore, it is always important for the sound survey team to present and conduct themselves in a highly professional manner. This starts with wearing professional and appropriate attire (clean and presentable work shoes, long pants, long-sleeve shirt, etc.). Wearing a high-visibility safety vest and hard hat is often a good idea whenever working in an outdoor environment and especially when working anywhere near a roadway, rail line, or moving equipment.

Always carry proper personal identification and professional business cards, and if possible, some sort of official project documentation, such as a copy of a work order, contract, or request to enter letter in case you need to provide some justification for being there.

However, unless interacting with the public is part of your official project responsibilities (and usually it is not), interaction with the public should be minimized or avoided. If you are approached by an inquiring member of the public while conducting a sound survey, it is best to avoid divulging any significant project information and politely refer them to the appropriate client or agency person in charge of the project (who should be identified in the sound survey work plan) for additional information.

5 WRAP UP AND COMPLETION.

Even after the last measurement in the survey is completed, you still have a few items to cross off your list before you are done, as outlined below:

5.1 Check and Save Documentation

Before leaving the site, double check that all documentation, including field data sheets, have been completed and organized. For field data sheets, make sure that all appropriate data fields are completed and legible, and that the recorded data values are reasonable. Remember that neatness and legibility count! Field data sheets are frequently scanned and included as appendix to the formal report and as part of the permanent record of the project.

Recheck your equipment against the original packing list to make sure that nothing has been left behind. Review photos to make sure that you have at least two good photos of each measurement location. If time allows, consider backing up the SLM data files to a laptop or portable data device in the field.

5.2 Check and Restock Equipment

Upon return to the office or lab, see that all equipment is properly downloaded and returned to its proper place. Make note of any equipment that did not operate properly for maintenance or repair, making sure that the equipment is clearly identified as needing repair to avoid you or someone else inadvertently taking the equipment back out on subsequent assignments until the problem has been corrected. Process any equipment billing that may be required. All data and documentation, including field data sheets, should be scanned and saved to a project directory.

5.3 Prepare a Preliminary Sound Survey Report

Upon return, consider creating a preliminary sound survey report, this can be based on the noise measurement plan updated with revised or actual measurement locations and data, and can eventually be incorporated into the technical memo or report. A Sound Survey Report could include any or all of the following elements:

- A brief narrative description of the overall project and project area;
- A basic map or diagram of the noise measurement locations;
- A description of the measurements taken at each location (including a description of the land use and general activity during the measurement, time of day and duration, typical equipment settings, general noise sources observed, etc.);
- A summary table of the sound measurement results with relevant metrics;
- A graph or chart of long-term data measurements;
- A photo log with figures and captions for photos taken at each measurement locations;
- Any other details or observations that may be relative to the project or interpretation of the noise measurement data.

Once completed, have a coworker or associate do a quality assurance check of your sound survey report, cross-referencing the summary data with photos, field data sheets and downloaded data files, and inspecting the results for clarity, reasonableness and completeness. Some documentation of this quality check may be required by your organization or client.

Please note that some additional data analysis, calculations, or more detailed graphical representation of the data collected during your survey may be required as part of your overall project, but those details would be project specific and are not covered here.

6 CONCLUSIONS

Knowing how to select, set up and operate a sound level meter is a great start, but that's not all you need to know to conduct a successful and professional sound survey. The approach of proper planning, execution and follow up presented here should help to reduce potential problems and failures, and result in a successful, safe and high-quality sound survey.