Issues and Answers
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AGENDA

- Terminology & Definitions
- Instrument setting explanations
- Standards & Ordinances
- What instrument for your ordinance
- Taking valid and defensible measurements
- Background (Ambient) Noise Issues
- Care, Use and Maintenance of equipment
- Use of Software
HUD HOUSING SURVEY  74,000

- Noise........................................24%
- Traffic.....................................14%
- Street Repair..............................13%
- Street Lighting............................9%
- Crime........................................8%
- Litter.........................................7%
- Deteriorating Bldgs.....................6%
- Abandon Bldgs.............................3%
- Odor..........................................3%
Noise and Health

- Irritability
- Stress
- Anxiety
- Anger
- Fatigue
- Sleep Disruption
- Confrontations
- Cardiovascular Problems

- Pregnancy & Children?
Weighting

Range
70-140
50-120
30-100

View

Response

Calibrate
Acoustical Calibrators

Fig. III-4  Typical Calibrator

1) Loudspeaker
2) ON/OFF switch
3) Battery indicator
4) Microphone adapter
5) ANSI Certification
Code enforcement Sound Level Meters and Calibrators must meet:

ANSI S1.4 – 1983 +

IEC 60651 – 1979 +
ANSI: American National Standards Institute

- A national body that establishes traceable standards for SLM accuracy and performance.
SOUND vs. Noise

Sound: Anything the ear hears
Noise: Unwanted sound
Sound Wave
Compression & Rarefaction of air molecules
Sound Pressure Level

Sine Waves with different sound pressures
Weighting

Range
70-140
50-120
30-100

Response

View

Calibrate
SPL

- **Sound Pressure Level**
- Is what SLMs measure
- Is the reading generated by a:

**SOUND LEVEL METER ( SLM )**

- In units of **decibels**
The loudest sound a human can tolerate is 100,000,000,000,000 (100 Trillion) times stronger than the weakest sound we can just barely hear.

A.G. Bell suggested using the logarithmic scale. Thus: 1-14 Bel’s (in honor of AG Bell)
Or: 1-140 decibels (the range of human hearing)
dB (decibel)

- SLM’s read out SPL in units of dB
- Designation used to express INTENSITY (Loudness)
- They are logarithmic values
- Can’t be added, subtracted, divided or averaged using standard math.
dB Example

- 80dB + 80dB = 83dB
- 83dB + 83dB = 86dB
- 86dB + 86dB = 89dB

- Double the sound wave strength = 3dB increase

- 71dB + 71dB = 74dB
- 54dB + 54dB = 57dB
- Etc…..
People estimate a sound to be twice as loud at 8 to 10dB increase.
Fig. 1-9  Typical sound levels, measured "A"/slow

140  Super siren. Jet airplane takeoff at 50 feet.
130  Approximate threshold of pain in the human ear.
120  Jet airplane takeoff at 200 feet.
110  Riveting machine. Chain Saw.
100  Area around electric furnace.
  90  Boiler room. OSHA permissible exposure level (PEL).
  80  Pneumatic drill at 50 feet.
  70  Speech at 1 foot.
  60  Background in large retail store. Speech at 3 feet.
  50  Private business office. Typical home.
  40  Quite residential area.
  30  
  20  Background in motion picture studio.
  10  
   0  Average threshold of hearing, 1 - 4kHz.
EPA 1974 Community Levels

24 Hr dB Average (Ldn)

- Rural: 45-50 dB
- Quiet Suburb: 50 dB
- Normal Suburb: 55 dB
- Urban Residential: 60 dB
- Noisy Urban: 65 dB
- Very Noisy Urban: 70 to 80 dB
## SOUND LEVEL LIMITS BY RECEIVING PROPERTY

<table>
<thead>
<tr>
<th>Receiving Property Category</th>
<th>Time</th>
<th>Sound Level Limit (dBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>7:00 a.m.—10:00 p.m.</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>10:00 p.m.—7:00 a.m.</td>
<td>55</td>
</tr>
<tr>
<td>Commercial</td>
<td>At all times</td>
<td>65</td>
</tr>
<tr>
<td>Industrial</td>
<td>At all times</td>
<td>70</td>
</tr>
</tbody>
</table>
How Loud is Too Loud?

- Complaints typically begin when the offending source is 5 or 6 dB louder than the ambient (surrounding) dB level.

- Complaints become vigorous when the source is 10 to 20 dB louder than the ambient dB level.

- The character of the noise is also a factor.
Character of Noise Source

- Noise can be divided into four groups:
  - Continuous
  - Variable
  - Impulsive (or impact)
  - Pure tones
Frequency (Hz)

1Hz and 10Hz Sine Waves
Frequency Characteristics

- Low Frequency, Long Wavelength
  - Makes for good propagation

- High Frequency, Short Wavelength
  - Reflective, dissipates easily

- Humans can hear 20Hz – 20 kHz
Frequency (Hz)

- 80 Hz  Kettle Drum..................14ft long
- 100Hz  A/C Compressor..........11ft long
- 400-500Hz  Male voice.........3ft long
- 8000Hz (or 8 kHz) “S” sound.......2in long
Weighting

Range
70-140
50-120
30-100

Response

View

Calibrate
The human ear is capable of responding to frequencies ranging from 20 Hz to 20 kHz.

The ear is less efficient at high and low frequencies.

A normal human ear is most sensitive from 500Hz to 4kHz.

Interestingly those are human speech frequencies.
Frequency Response & Weighting

“A” and “C” weighting curves

![Graph showing A and C weighting curves](image)
A Weighting

- Ear’s response to typical unamplified sounds.
- All ordinances require A weighting adjusted SLMs.

C Weighting

- Ears response to Typical low frequency dominated sounds (such as amplified music, construction or highway sounds)
- Some ordinances will discriminate against such sounds by allowing the use of C Weighted readings
Complaints

Most complaints are from sources with significant components of:

- LOW FREQUENCIES
- IMPULSE / IMPACT SOUNDS
- PURE TONE FREQUENCIES
Classification of Sound Level Meters

ือน Three types of SLM’s established by ANSI, and IEC Standards:

♦ Type 0
  • Laboratory grade instrument

♦ Type 1
  • Precision instrument

♦ Type 2
  • General purpose instrument
  ➢ For Community noise surveys a type 2 or better instrument is usually required
Instrument accuracy

- Type 0: Perfectly accurate
- Type 1: Accurate +/- 1dB
- Type 2: Accurate +/- 2dB
Type 2 Application +/- 2dB

- For Example: Your ordinance allowable dB level.....65dB
- And You read 67dB (+/- value 65 – 69dB)

- No violation recommended

- Rule of thumb: Violation should be 3dB or more above allowable dB level
**Type 1 Application (+/- 1dB)**

- **For Example:** Your ordinance allowable .................. 65dB
- **And You read........ 67dB (+/- value 66 - 68dB)**

**Violation**

**Rule of thumb:** Violator should be 2dB or more above allowable dB level.
SLM Reading

- Typical SLMs will display out to tenths of a dB

- Best Practice? Always use the highest full number shown on SLM (to avoid possible confusion)
**Weighting**
A or C

**Range**
- 70 to 140
- 50 to 120
- 30 to 100

**Response**
Fast or Slow

**Measurement**
SPL or MAX

*2100 Keypad/Control switches identified*
Example (Type 2)

- Ordinance allowable level: **65dB**

- Meter reads: **67.2dB**

- Violation: **.2** (2/10ths) of a dB

- That’s cutting it pretty thin for siting a violation
SLM Reading (Undamped)
SLM with Damping
SLOW & FAST RESPONSE

- SLOW RESPONSE (1sec)
  Damping of the SLM response to allow for more accurate reading in variable noise environments.

- FAST RESPONSE (125 milliseconds)
  Undamped SLM response for more accurate capturing of impulse/impact sounds and short duration sounds.
SLOW/FAST Application

- **SLOW** works well in steady or mildly variable environments.

- **FAST** works well when intermittent impulsive sounds are part of the noise source.

- Check your Ordinance!
Weighting

Range
70-140
50-120
30-100

View

Response

Calibrate
Range Setting

- Meter adjusted to correctly read the sound field under study
Proper Range setting
Improper Range setting
Improper Range Setting
Proper Range setting
Weighting

Range
70-140
50-120
30-100

Response

View

Calibrate
Leq (Level Equivalence)

- Leq can be thought of as AVERAGE dB Level

- A powerful feature that:
  1. Assures most accurate representation of noise source
  2. Removes/reduces challenges

- Highly advised for any enforcement SLM
The highest dB reading reached during measurement.

Many ordinances site a MAX dB limit that cannot be exceeded for any amount of time.

Can help to enforce limits on Impulse/Impact noises.
Some Impulse sounds can be clearly heard but do not exceed allowable levels.

Ordinances sometimes address this by allowing fast response setting in SLM.

Some ordinances actually increase the allowable level by 5 – 10dB (usually daytime levels).

MAXimum limit can also help resolve issues.
Exceedence Levels

• Some ordinances set a dB limit that cannot be exceeded more than 10% of the measurement time.

• Often, a minimum of 10 Minutes
Exceedence Levels

- L01 Maximum
- L10 Typically seen in Ord.
- L50 Half dB levels above, half below
- L90 Ambient (without Source)
Noise generated across real property lines. The noise from any activity or from any permissible use of property within the applicable zoning district classifications of shall be deemed to be excessive, unnecessary, offensive and unusually loud if the total noise level as measured on the A-scale due to both ambient noise, and the alleged source of the unnecessary, offensive or excessive noise, exceeds the noise levels which are herein prescribed in table I, the measurement of which is based upon decibels, i.e. 0.0002 microbar. All such measurements as well as the method employed shall be consistent with the regulations of the American National Standards Institute, Inc., and shall represent the A-weighted sound pressure level which is exceeded ten percent of the time (L10) during the observation period which shall be a minimum of 10 minutes.
Pure Tones

- A single frequency or closely associated frequencies
- Can result in complaints that do not exceed allowable dB levels
- Some ordinances reduce the allowable level by 5 – 10dB
Octave Band Analyzer

- Focus on the frequency content of the overall noise signal
- Important for noise control efforts
- Usually performed in the Z Weighting Band
In addition to the limits of table (2a), for any sound source which impacts residential property, the maximum allowable sound level limits for the individual octave bands whose centers are 31.5, 63 and 125 Hertz shall not exceed 65 dB.
SLM with OBA
SLM with OBA
OBA Screen

[Image of an OBA Screen showing frequency and level readings]
Weighting

Range
70-140
50-120
30-100

Response

View

Calibrate
ANSI Certified Calibrator
SLM Adjustment Review

- Range (adjust to noise field)
- Weighting (A or C)
- Response Time (Slow or Fast)
- Max
- Min
- L10 (as needed)
- Recording interval (data logging SLMs)
Conducting a Study

- Allow SLM to acclimate to weather environment.
- Calibrate (in the same environment)
- Positions yourself according to Ordinance.
- Set parameters on your SLM (weighting, response, etc.)
- Use wind-screen as needed.
- Hold SLM at comfortable reading angle.
- Run study for appropriate duration.
  - Minimum time required by Ordinance, or
  - Until you attain a representative sample.
- Review and Record (or store) results.
Violator Challenges

- Claims background noise invalidates your work.
- Refuses/Can’t deactivate noise source.
- Insults you; “your mother wears Klondike boots”
EFFECTS OF BACKGROUND NOISE

If the sound level from a particular source is to be determined, all surrounding sources of noise should be reduced or eliminated. Since that is not typically possible to do, the curve shown may be used to correct for the presence of such noise.

1. Find the difference between source noise and background noise.
2. If less than 4dB, ambient noise too high for accurate measurement.
3. If between 4dB and 9dB a correction will be necessary (see chart).
4. No correction necessary if the difference is greater than 9dB.

![Graph showing the effect of background noise on sound level determination.](image)
ADJUSTING FOR THE EFFECTS OF BACKGROUND NOISE

If AMBIENT (Background) noise levels are within 10dB of the source noise levels, an adjustment must be made to compensate for the background noise.

1. Subtract the AMBIENT dB level from the SOURCE dB level.

2. Adjust according to the following table.

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Background Example

Ordinance allowable dB Level (daytime)...65dB

- Source dB level..........................69dB
- Ambient dB level.......................64dB
- Difference................................5dB

- Adjustment...............................68dB
  - 2dB
- Adjusted Source Level..............67dB
ADJUSTING FOR THE EFFECTS OF BACKGROUND NOISE

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Ordinance allowable dB Level (daytime)... 65dB

- Source dB level (type 2)............. 69dB
- Ambient dB level.................. 64dB
- Difference............................ 5dB

- Adjustment............................ 69dB
  - 2dB
- Adjusted Source Level............ 67dB

Site a violation?
Ordinance allowable dB Level (daytime)...65dB

- Source dB level (type 2).........69dB
- Ambient dB level...................64dB
- Difference............................5dB

- Adjustment............................69dB
  - 2dB
- Adjusted Source Level...............67dB

Site a violation?

**NO** Because of type2 accuracy the actual level could possibly be 65dB
Environmental Effects

- Temperature Gradients
- Wind Gradients
- Wind over Microphone
- Humidity
- Trees & Shrubs
- Large Objects
- Water Surfaces
Temperature Gradients

- Temp. Inversion (often seen as cloud cover)
  - Keeps sound waves closer to the ground, thus further travel at ground level.
Wind Gradients

- Sound waves travel further DOWN WIND
- Much less distance UP WIND
Wind over Mic

- Heard as “noise” by the SLM

- A mic wind screen will eliminate wind noise
  BUT only up to 12 – 15 mph
  - Can be used indoors as well
Large Objects

- Sound waves can be reflected and/or redirected.
- Can cause increase in SLM reading.
- Stand at least 4-5ft from hard exterior walls.
  - 3ft in attached housing.
Trees & Shrubs

- Not as effective as some may think.

- Example:
  - ~100ft of typical tree & shrub growth to lower any given dB level by 5dB.
Water Surfaces

- Hard reflective surface
- Usually no large objects
- Sound often carries noticeably greater distances than on land.
Nuisance Ordinance

- Disorderly Conduct
- Disturbing the Peace
- Subjective Tests
  - (such as source heard at 50 or 100ft)
(a) Some sounds may be such that they are not measurable by the sound pressure level meter or may not exceed the limits of Table I but they may be excessive, unnatural, prolonged, unusual and are a detriment to the public health, comfort, convenience, safety, welfare and prosperity of the residents of the city. Such sounds are prima fascia evidence of a violation.

(b) Noises prohibited by this section are unlawful notwithstanding the fact that no violation of section 12-165 is involved, and notwithstanding the fact that the activity complained about is exempted in section 12-165(e).

(c) Any person making a complaint under this section shall be required to sign a sworn complaint prior to an arrest being made; otherwise no such complaint will be honored.
Instrument Care

- Always store SLM in instrument case and in reasonable temperature environment.
- Handle with care (particularly the microphone)
- Send out for required annual factory/laboratory recalibration (checked/adjusted/repaired).
- Keep all paperwork safely stored.
Conducting Studies

- Allow SLM & Cal. to stabilize in field environment.
- Calibrate.
- Set up in accordance with your ordinance.
- Hold SLM:
  - Away from your body.
  - At ~45degree angle
- NO talking during study.
- Avoid standing close to large reflective surfaces.
- Attain a representative sample (or Ord. specified time).
- Stop study.
- Recheck Calibration.
What To Record

- Dates and Times
- Instrument settings
- Model and Serial Numbers
- Pre Calibration and Post Cal. Check level
- Location Descriptions
- Task Descriptions
- Environmental Factors
- Unusual Conditions
- Test Results
Typical Ordinance Content

- Purpose
- Definitions
- Powers & Duties
- Measurement Procedures
- Limits
- Specifically Forbidden Acts
- Exceptions
- Enforcements Procedures
Ordinance Considerations

- Local acoustic environmental conditions.
  - What are your avg Daytime / Nighttime dB levels
  - What kinds of noises are typical.
  - What sources of noise typically trigger complaints.
  - What are community expectations.
Ordinance Considerations

- SLM weighting networks:
  - Always include A weighting.
  - Lots of low frequency complaints?
    - Optional A and/or C weighting authorization.
    - Use of OBA (i.e. designated frequency limits).
Ordinance Considerations

- Frequent impact/impulse complaints
  - Allow either F (fast) or S (slow) response settings.
Ordinance Considerations

- **Maximum dB limits**
  - **dB Levels** that cannot be exceeded for any amount of time.
  - Sometimes 5 to 10dB higher than Allowable Limits (usually daytime only).
Ordinance Considerations

Where to perform studies:

- Receiving Property.
- Nearest Property Line.
- At violators property line.
- Designated distance from Source.
Ideal Ordinance Inclusions?

- Leq
- A & C Weighting Option
- Slow and Fast Option
- Prima Fascia Option
- Max Limit Option
- Prima Fascia
- OBA (frequency specific limits)
Conclusion

• There is no substitute for:
  • Knowing ordinance
  • Knowing SLM operation
  • Good planning
  • Common sense
<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
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<tbody>
<tr>
<td>LASeq</td>
<td>57.3 dB</td>
</tr>
<tr>
<td>LAE</td>
<td>90.3 dB</td>
</tr>
<tr>
<td>LAS</td>
<td>32.0 dB</td>
</tr>
<tr>
<td>LASmx</td>
<td>77.2 dB</td>
</tr>
<tr>
<td>LASmn</td>
<td>31.4 dB</td>
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</table>

Date: 09-MAR-2018 17:01