ACENTECH

ACEC/MA Building Engineering Committee

Noise Compliance Basics

ACEC

Presented by
Michael Bahtiarian, INCE Bd. Cert.

January 17, 2020

How is Sound Quantified

- The “Decibel” is not a unit of measure!
- Terms often used interchangeably:
  - Sound Level
  - Noise Level
  - **Sound Pressure Level OR Sound Power Level**

Good

  - Sound
  - Noise

Ehh

  - dB Level
  - Decimal level

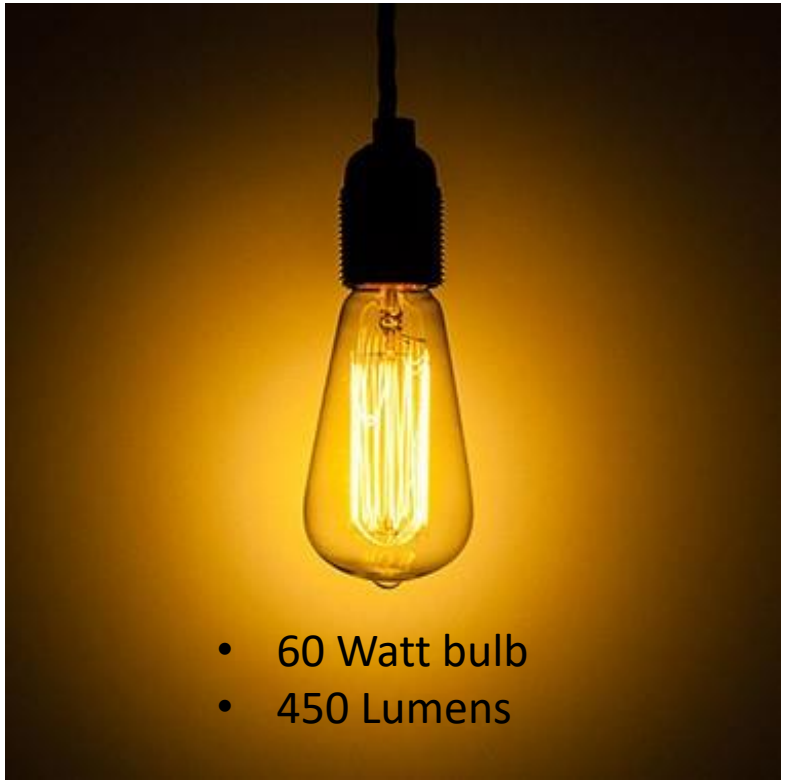
Bad

Sound Pressure vs. Sound Power

Parameter	Sound Pressure Level	Sound Power Level
Abbreviation	SPL	PWL
Symbol	L_p	L_w
Units	Pascals	Watts
Reference	20 micro-Pa (µPa)	1 pico-Watts (pW)
Uses	Sound measurements, sound limits, regulations, and many others	Quantifying the acoustical source level of sound sources (usually mechanical equipment)

Warning: Both can be reported as dB, but $L_p \neq L_w$!

Sound Power vs. Pressure



- Still a 60 Watt bulb
- Still outputs 450 Lumens
- But: much less bright at the receptor

Sound Power vs. Pressure

Sound Power Level

dB re: 1pW

Sound Pressure Level

70

10ft

64

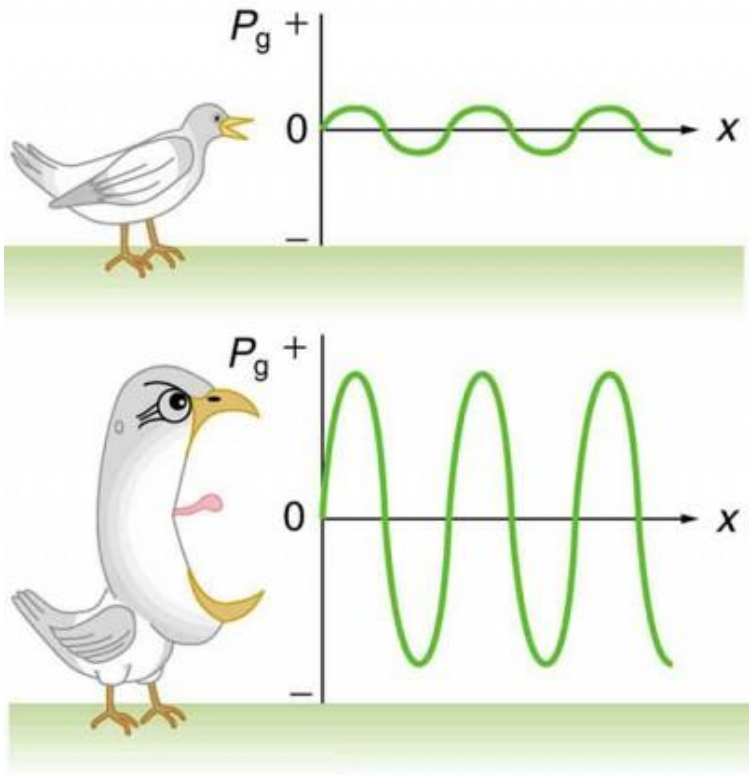
20ft

50

100ft

dB re: 20 µPa

Amplitude vs. Frequency

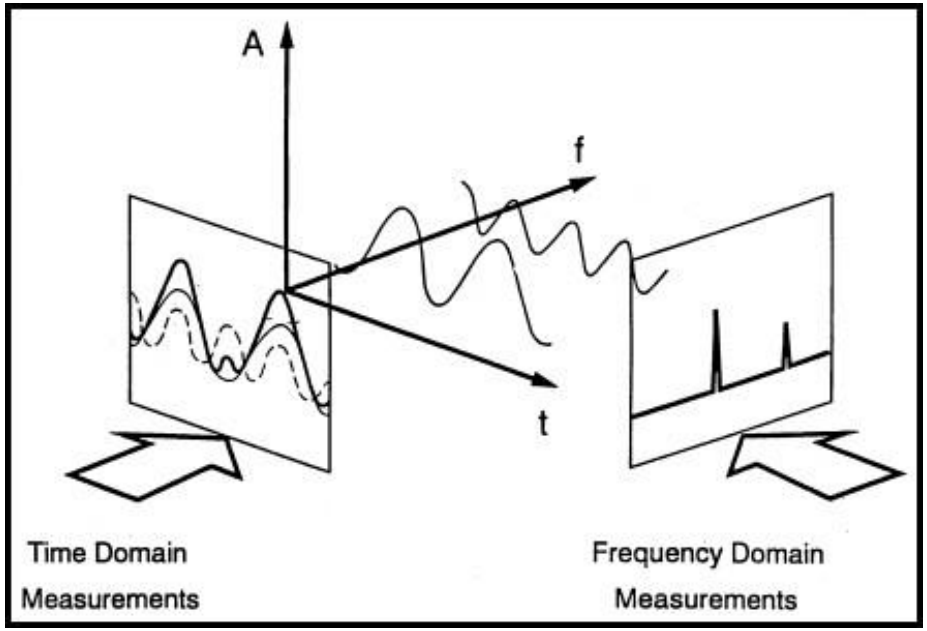


- Decibels always refer to amplitude of sound
- Amplitude = “Loudness”

Amplitude vs. Frequency

- Fourier transform allows for interpretation of sound in frequency domain

- Frequency = “Pitch”
- **Units of Hertz**



The “Color” of Sound

Sound levels need to be specified with both:
amplitude and **frequency**

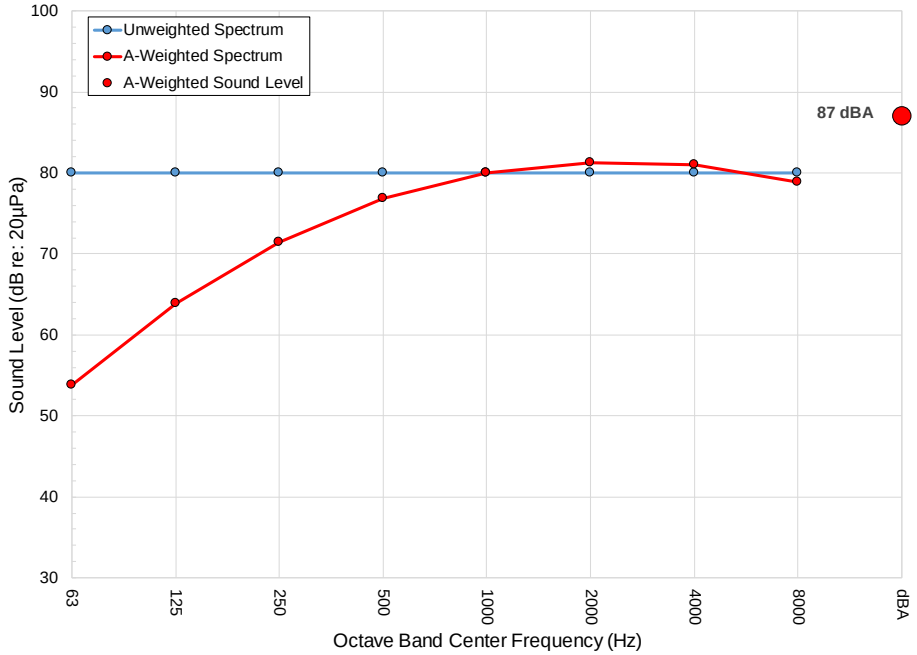
“Low”

“Mid”

“High”

A-Weighted Sound Level

Description	63	125	250	500	1000	2000	4000	8000
Unweighted Spectrum	80	80	80	80	80	80	80	80
A-Weighting Filter	-26	-16	-9	-3	0	+1	+1	-1
A-Weighted Spectrum	54	64	71	77	80	81	81	79
A-Weighted Sound Level	87 dBA							



- Frequency-dependent filter
- **Sum** across all weighted frequencies
- **dBA ≈ "Overall"**

Noise Codes & Regulations

- Federal
- State
- Local

Federal Noise Regulations

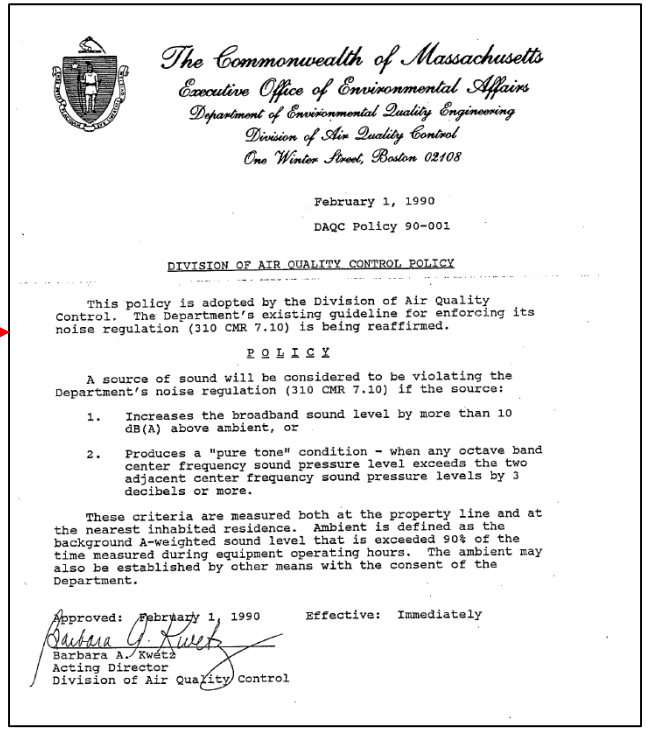
- Many U.S. noise regulations & guidelines:
  - HUD: Housing developments
  - FAA: Aircraft/airport operations
  - DOT: Highway & transit
  - NPS: Over-flights & snowmobiles
  - EPA: Ldn ≤ 55 dBA to protect health & welfare
  - DOD: Various requirements
  - OSHA: Hearing conservation

BUT, there are no Federal Regulations for Building Exterior or Interior Sound

Mass State Regulation (310 CMR 7.10)

Regulation 310 CMR 7.10: Noise

(1) No person owning, leasing or controlling a source of sound shall willfully, negligently, or through failure to provide necessary equipment, service, or maintenance or to take necessary precautions cause, suffer, allow, or permit unnecessary emissions from said source of sound that may cause noise.



The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
Department of Environmental Quality Engineering
Division of Air Quality Control
One Winter Street, Boston 02108

February 1, 1990

DAQC Policy 90-001

DIVISION OF AIR QUALITY CONTROL POLICY

This policy is adopted by the Division of Air Quality Control. The Department's existing guideline for enforcing its noise regulation (310 CMR 7.10) is being reaffirmed.

POLICY

A source of sound will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or

2. Produces a "pure tone" condition - when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. Ambient is defined as the background A-weighted sound level that is exceeded 90% of the time measured during equipment operating hours. The ambient may also be established by other means with the consent of the Department.

Approved: February 1, 1990 Effective: Immediately

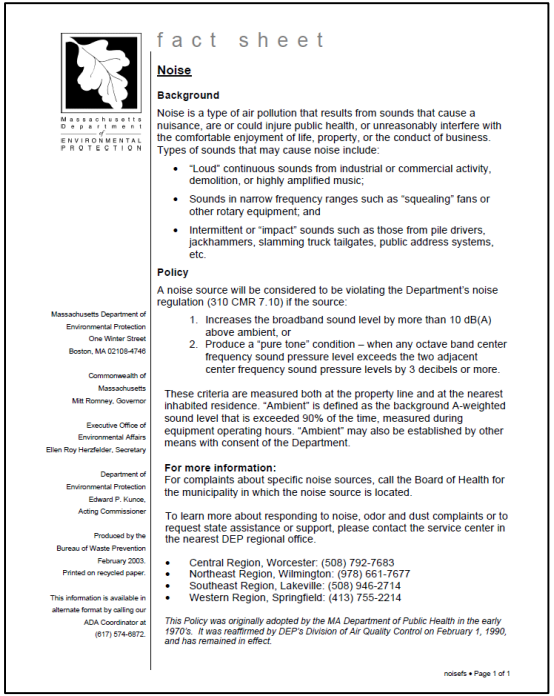
Barbara A. Kwetz
Acting Director
Division of Air Quality Control

State Reg Quick Read

- **Violation occurs if any source of sound**:
  - Increases the **Broadband SPL** by 10 dB (amplitude)

    or
  - Produces a **Pure Tone** (frequency)
- **Applies at either:**
  - Property Line

    and/or
  - Nearest Inhabited Residence



Massachusetts Department of Environmental Protection

fact sheet

Noise

Background

Noise is a type of air pollution that results from sounds that cause a nuisance, are or could injure public health, or unreasonably interfere with the comfortable enjoyment of life, property, or the conduct of business. Types of sounds that may cause noise include:

- "Loud" continuous sounds from industrial or commercial activity, demolition, or highly amplified music;
- Sounds in narrow frequency ranges such as "squealing" fans or other rotary equipment; and
- Intermittent or "impact" sounds such as those from pile drivers, jackhammers, slamming truck tailgates, public address systems, etc.

Policy

A noise source will be considered to be violating the Department's noise regulation (310 CMR 7.10) if the source:

1. Increases the broadband sound level by more than 10 dB(A) above ambient, or
2. Produce a "pure tone" condition – when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

These criteria are measured both at the property line and at the nearest inhabited residence. "Ambient" is defined as the background A-weighted sound level that is exceeded 90% of the time, measured during equipment operating hours. "Ambient" may also be established by other means with consent of the Department.

For more information:
For complaints about specific noise sources, call the Board of Health for the municipality in which the noise source is located.

To learn more about responding to noise, odor and dust complaints or to request state assistance or support, please contact the service center in the nearest DEP regional office:

- Central Region, Worcester: (508) 792-7683
- Northeast Region, Wilmington: (978) 661-7677
- Southeast Region, Lakeville: (508) 946-2714
- Western Region, Springfield: (413) 755-2214

This Policy was originally adopted by the MA Department of Public Health in the early 1970's. It was reaffirmed by DEP's Division of Air Quality Control on February 1, 1990, and has remained in effect.

noisefs • Page 1 of 1

Massachusetts Department of Environmental Protection
One Winter Street
Boston, MA 02108-4746

Commonwealth of Massachusetts
Mitt Romney, Governor

Executive Office of Environmental Affairs
Ellen Roy Herzfelder, Secretary

Department of Environmental Protection
Edward P. Kunce,
Acting Commissioner

Produced by the Bureau of Waste Prevention
February 2003.
Printed on recycled paper.

This information is available in alternate format by calling our ADA Coordinator at (617) 574-6872.

MADEP Definitions

*__Broadband SPL__ is the A-weighted overall sound pressure level.

**__Ambient SPL__ is defined as the background A-weighted sound pressure level that is exceeded 90% of the time measured during equipment operation. The ambient may also be established by other means with the consent of the Department.

**__Pure Tone__ is defined when any octave band center frequency sound pressure level exceeds the two adjacent center frequency sound pressure levels by 3 decibels or more.

How do you measure background noise?

- There is no detailed method from MADEP
- Consultants have done it many different ways and we held one meeting of the Boston Chapter of ASA on this topic
- Approaches will depend on noise source and environment

What we know from MADEP Fact Sheet:

- Need to measured A-weighted SPL
- Measure during equipment operating hours
- Need to measure level that is exceeded 90% of the time
- Ambient sound may be established by other means

How do you measure background noise?

What is not specified:

- Location of the Sound Level Meter
- Instrumentation Type(s) or Settings
- Noise Metrics
- Duration of Survey
- Sampling Periods
- Compilation of Data Sets

How do I measure background noise?

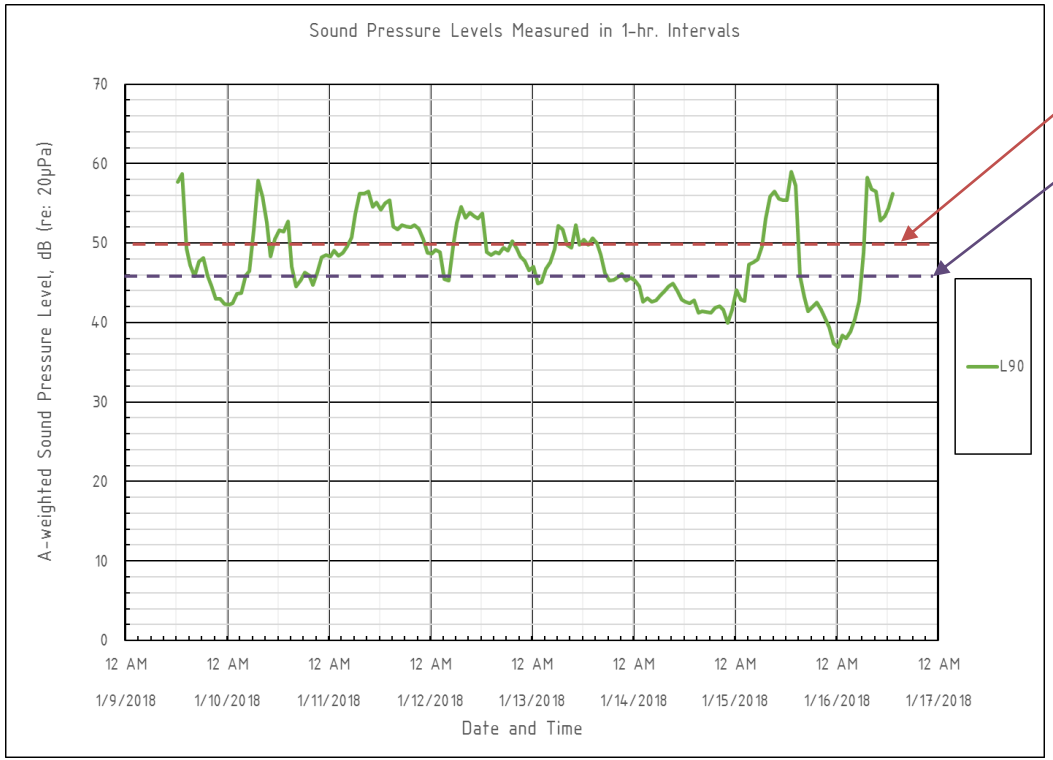
- Instrumentation: **Type 1 Logging Sound Level Meter**
- Noise Metrics: **L_{EQ}, L_{90}, L_{10} (sometimes others)**
- Time of Day for Measurement**:
  - **Daytime (7am to 7pm)**
  - **Evening (7pm to 10pm)**
  - **Nighttime (10pm to 7am)**
- Duration of Measurement
  - 20 minutes
  - 2 to 3 hours
  - 3 to 4 days
  - **1 week**
- Sampling Period: **1 hour** (but sometimes 5 minutes)

*These time periods were originally defined in the EPA "Levels Document" (1974) and more recently in ANSI S12.9-Part 1 (2013).

How do you compile background noise data?

- No guidance in MADEP Fact Sheet
- Extensive sampling offered by newer SLM's
- Longer sample periods should be divided
- Single Values:
  - Minimum
  - Average
  - Maximum
- Details could vary depending on situation

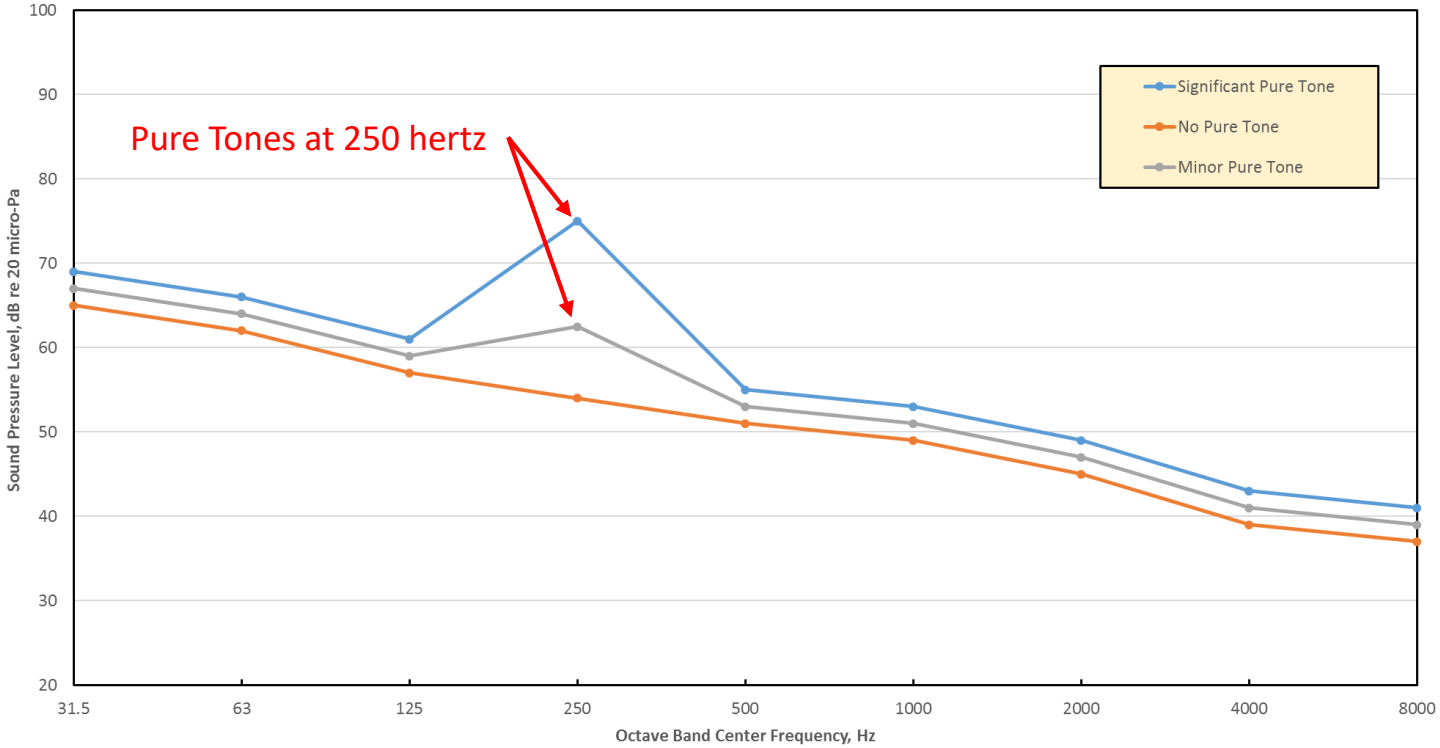
Which SPL is Background?



How do I compile background noise data?

- Compile L_{90} values by time of day
  - Daytime (7am to 7pm)
  - Evening (7pm to 10pm)
  - Nighttime (10pm to 7am)
- Sampling Period of 1 hour or 5 minutes
- Take Arithmetic Average L_{90} for each sample in each daytime period per above
- *To be extra conservative, some people take the 90th percentile of each L_{90} data set.*

What is a Pure Tone Look Like



Boston & Cambridge Code

- Both cities have similar code; absolute SPL:
  - A weighted SPL limit (below)
  - Octave band SPL limits (next slide)
  - Measured at receptor

PERIOD OF DAY	RESIDENTIAL ZONED	RES/INDUS. ZONED	COMM. ZONED	INDUSTRIAL ZONED
DAY	60 dBA	65 dBA	65 dBA	70 dBA
NIGHT	50 dBA	55 dBA	65 dBA	70 dBA

Octave Band Limits

2.5 Zoning District Noise Standards

Noise standards referred to in these Regulations for the several zoning districts of the City of Boston, as defined in and established pursuant to the Boston Zoning Code, are as established by the following table:

TABLE OF ZONING DISTRICT NOISE STANDARDS

Maximum Allowable Octave Band Sound Pressure Levels

Octave Band Center Frequency of Measurement	Residential		Residential / Industrial		Business	Industrial
(Hz)	Daytime	All Other Times	Daytime	All Other Times	Anytime	Anytime
31.5	76	68	79	72	79	83
63	75	67	78	71	78	82
125	69	61	73	65	73	77
250	62	52	68	57	68	73
500	56	46	62	51	62	67
1000	50	40	56	45	56	61
2000	45	33	51	39	51	57
4000	40	28	47	34	47	53
8000	38	26	44	32	44	50
Single Number Equivalent	60 dBA	50 dBA	65 dBA	55 dBA	65 dBA	70 dBA

Boston; APCC

TABLE 8.16.060E

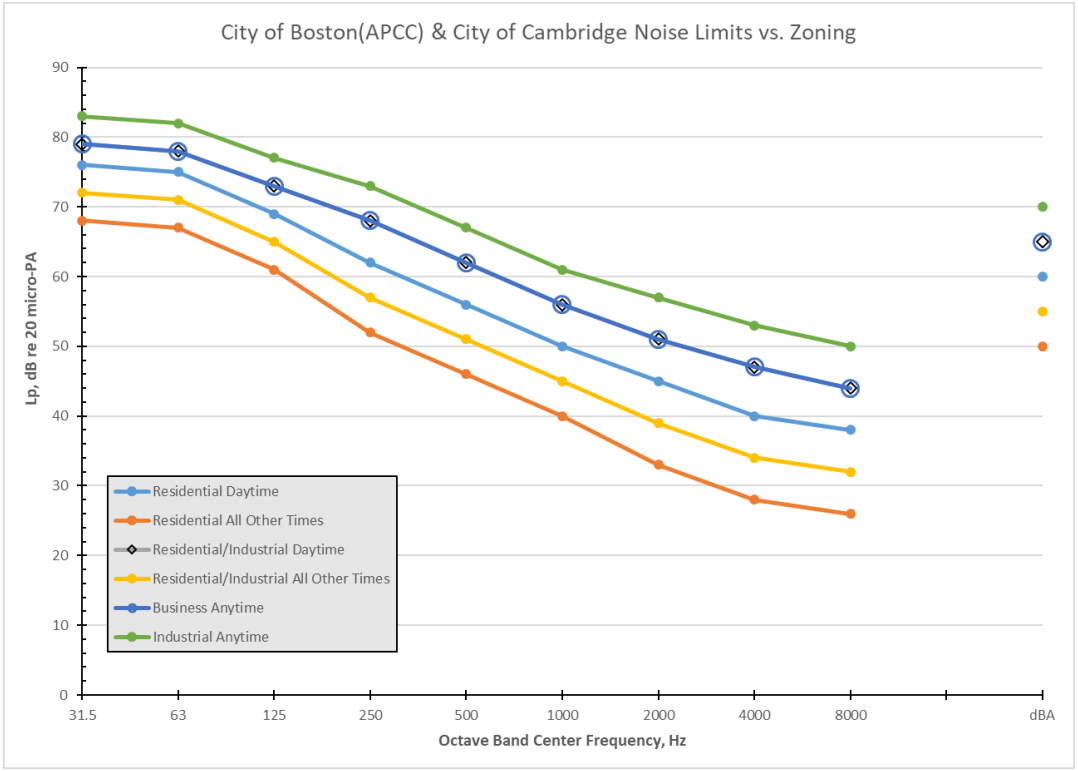
TABLE OF ZONING DISTRICT NOISE STANDARDS

Maximum Allowable Octave Band Sound Pressure Levels

Octave Band Center Frequency Measurement (Hz)	Residential Area		Residential in Industrial		Commercial Area	Industry Area
	Daytime	Other Times	Daytime	Other Times	Anytime	Anytime
31.5	76	68	79	72	79	83
63	75	67	78	71	78	82
125	69	61	73	65	73	77
250	62	52	68	57	68	73
500	56	46	62	51	62	67
1,000	50	40	56	45	56	61
2,000	45	33	51	39	51	57
4,000	40	28	47	34	47	53
8,000	38	26	44	32	44	50
Single Number Equivalent (dB(A))	60	50	65	55	65	70

Cambridge

Octave Band Graphed



City / Town Noise Regulations

- Local ordinances vary greatly by municipality
- Most Mass Cities/Towns have absolute limits which depend on time of day and zoning
- A few use the MADEP guideline
- All municipalities are authorized to use and enforce the MADEP noise guideline

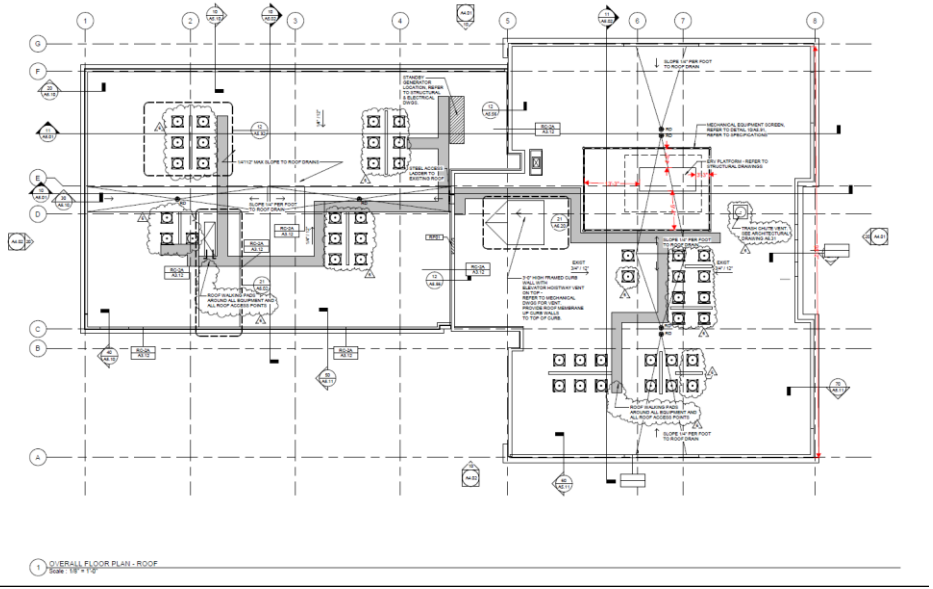
Summary of Largest New England Town Ordinances

New England Population Rank	City, State	Typical Noise Limit, dB(A)
1	Boston, MA	65
2	Worcester, MA	<10 dB above background
3	Providence, RI	75
4	Springfield, MA	“Plainly Audible”
5	Bridgeport, CT	62
9	Manchester, NH	65
29	Portland, ME	92
63	Burlington, VT	“no loud noise”

Code Compliance

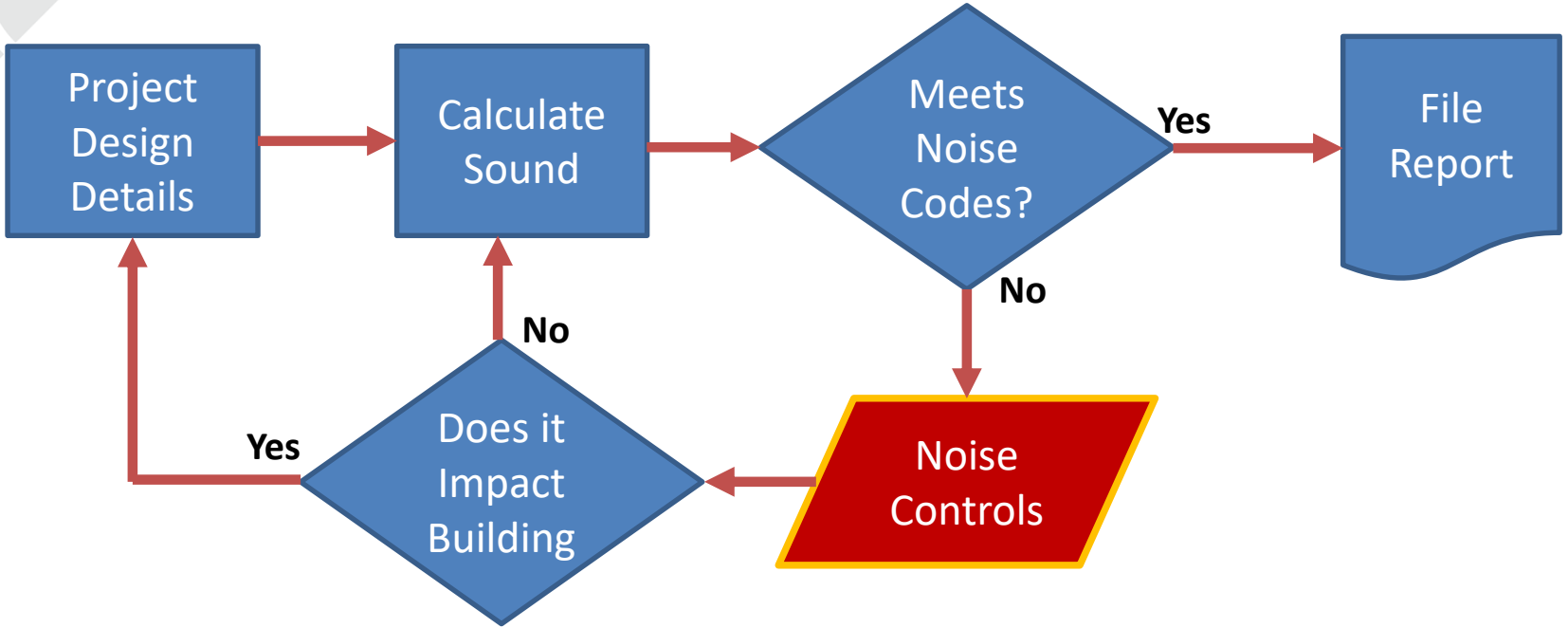
Know your applicable codes:

- Federal
- State
- Municipal
- Other



Will Your Project Meet Code(s)?

Steps in Conducting a Noise Study



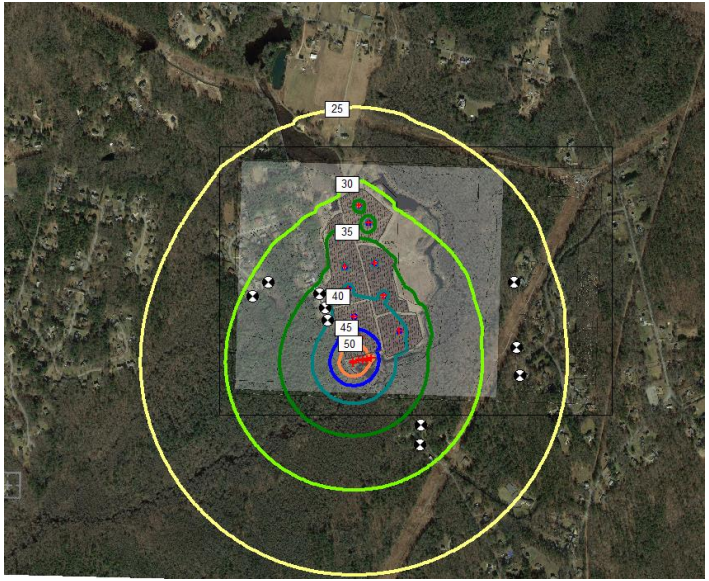
Design Information Needed

- Site Plan
- Building Floor Plan
- Mechanical Plan/Design location and specifications of:
  - Air Handling Units
  - Chillers
  - Condensing Units
  - Supply & Exhaust Fans

Need Sound Power

Acoustic Modeling Advantages

- More accurate, includes:
  - Reflections
  - Excess Attenuation (air, ground, & foliage)
- Sound Contours
- Large number of sources
- Many others



Noise Control (Treatment) Options

- Relocate Noise Equipment
- Quiet equipment
- HVAC Silencers
- Acoustic Louvers
- Noise Barriers (shown on right)
- Better Sound Insulation
- Sound Absorption

PMA Gravity Barrier. ArchMod Finish.

Summary/Questions

- How to quantify sound
- Noise control regulations
- Noise code compliance process

Contact us:

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Lets Hear from the Regulators:

- City of Cambridge
  - Andrea Boyer
  - Tyler Bubenik
- City of Boston/APCC
  - Lugardy Raymond

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