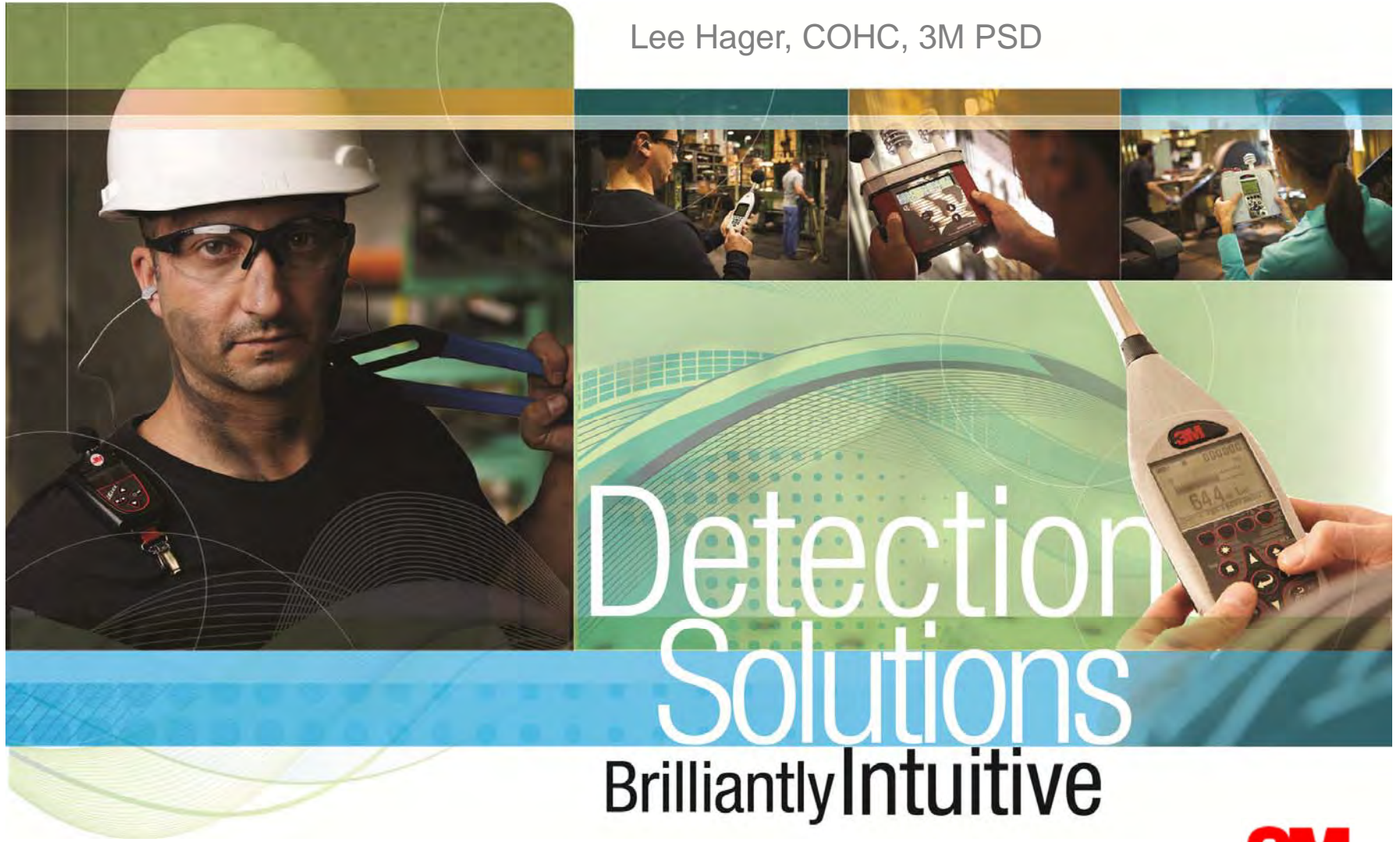


Community and Environmental Noise Measurement

How it differs from Occupation Noise Sampling

Lee Hager, COHC, 3M PSD

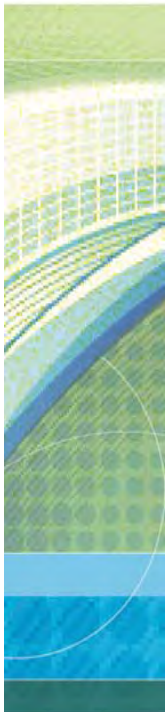


Detection
Solutions
Brilliantly Intuitive

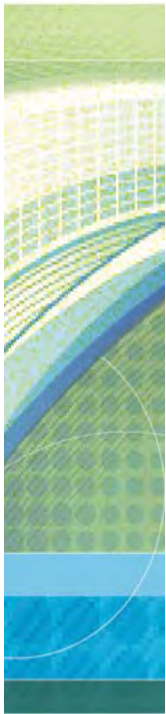


Today's Instructor

- Lee Hager
 - lhager@mmm.com
 - 517-290-1907
- Past
 - *Chair AIHA Noise Committee*
 - *President National Hearing Conservation Association*
- Current
 - *AIHA Fellow*
 - *CAOHC Council*
 - *SiS Expert Committee*

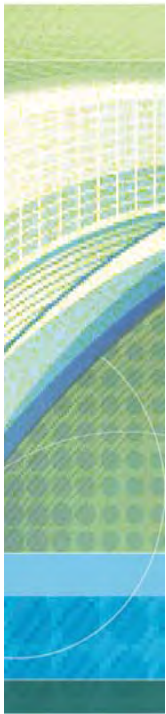


Community or Environmental Noise Measurement



- The Main Point to Understand – It isn't about hearing loss
- Regulations – sources & common elements
- Who's the Judge – which opinions matter
- Metrics – common units of measure
- Instrumentation - picking the tool for the job
- Property Line – an important concept to understand
- Annoyance Factors – why all noise isn't equal
- How the measurements can go wrong
- Some resources that may be helpful

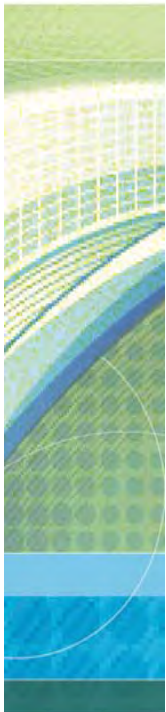
Typical Sources of Concern



- Fixed Sources
 - *Vehicle Traffic, especially trucks*
 - *Amplified Music*
 - *Nightclubs*
 - *Rail & Aircraft*
 - *Construction Activity*
 - *Heavy Equipment*
 - *Compressors & Pumps*
 - *Firing Ranges*
 - *Race Tracks*
- Mobile or Temporary Sources
 - *Vehicle Traffic, especially motorcycles*
 - *Amplified Music*
 - *Concerts*
 - *Construction Activity*
 - *Heavy Equipment*
 - *Compressors & Pumps*
 - *Parties, loud voices*

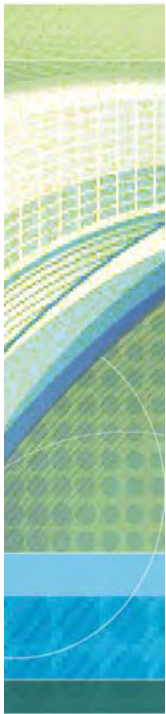
Human Factors

- Sleep Disturbance
- Annoyance
- Stress
- Fatigue
- Communication Interference



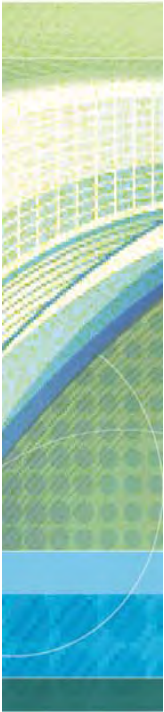
Mitigating Circumstances

- Expectations
- Time of Day
- Time of Year
- Duration of Signal
- Attitudes in General

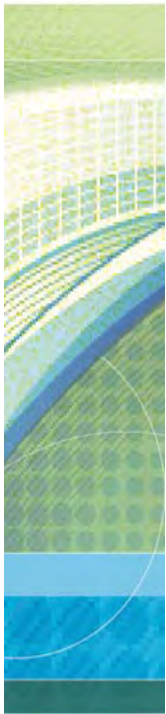


How Loud?

- Complaints begin typically when the offending source is 5 dB louder than the ambient
- Complaints become vigorous when the source is 20 dB louder than the ambient



Metrics - Ldn & Cnel



- Level day/night
10 dB penalty applied
10 pm to 7 am
- Assumes 24 hour sample
- $Ldn = 10 \log (1/24 (15 (10Ld/10) + 9 (10(Ln + 10)/10)))$ where
Ldn = day-night sound level (dB)
Ld = daytime equivalent sound level (dB)
Ln = nighttime equivalent sound level (dB)

- Community Noise Equivalent
Same as Ldn except 5 dB
penalty is applied from 7 pm to
10 pm
- Measure is unique to California

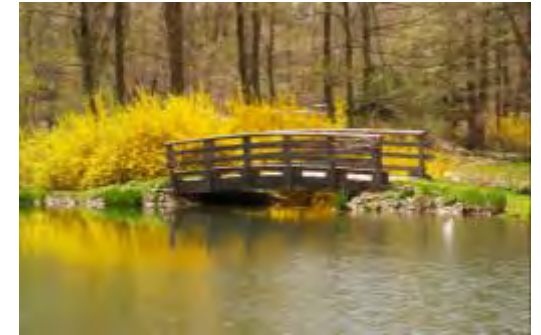


The Main Point to Understand – It isn't about hearing loss

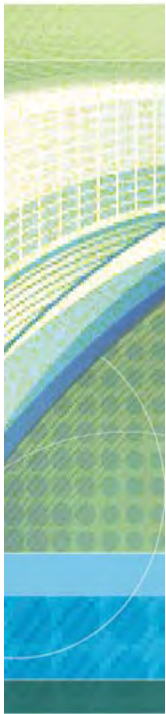
1974 EPA Community Noise Levels



■ Rural	35 to 50 dBA Ldn
■ Quiet Suburb	50
■ Normal Suburb	55
■ Urban Residential	60
■ Noisy Urban	65
■ Very Noisy Urban	70



Regulations – Sources & Common elements



The “Expert” Influence

Federal
State
City/Municipality

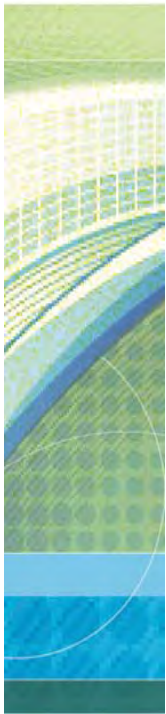


Gross estimation of threshold of
annoyance

$$Ldn = 26 + 10 \log(\# \text{ of people/km}^2)$$

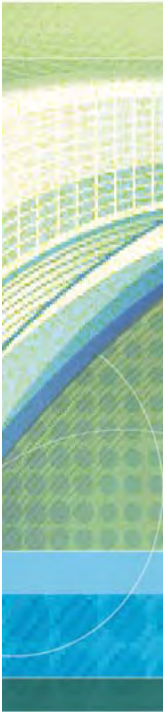
Regulations – Sources & Common elements

- Common Elements
 - *Authority*
 - *Purpose*
 - *Definitions*
 - *Metrics & Methods*
 - *Special Situations*
 - *Exemptions*



Who's the Judge – which opinions matter

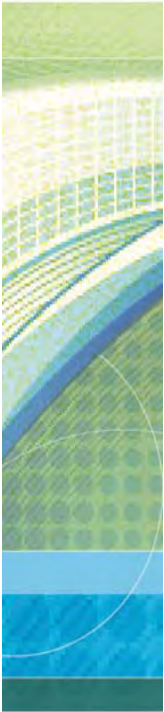
- *Beauty is in the ~~eye~~ ear of the beholder*



The annoyed
The enforcer
The accused



Metrics – Common Units of Measure Instrument Functions

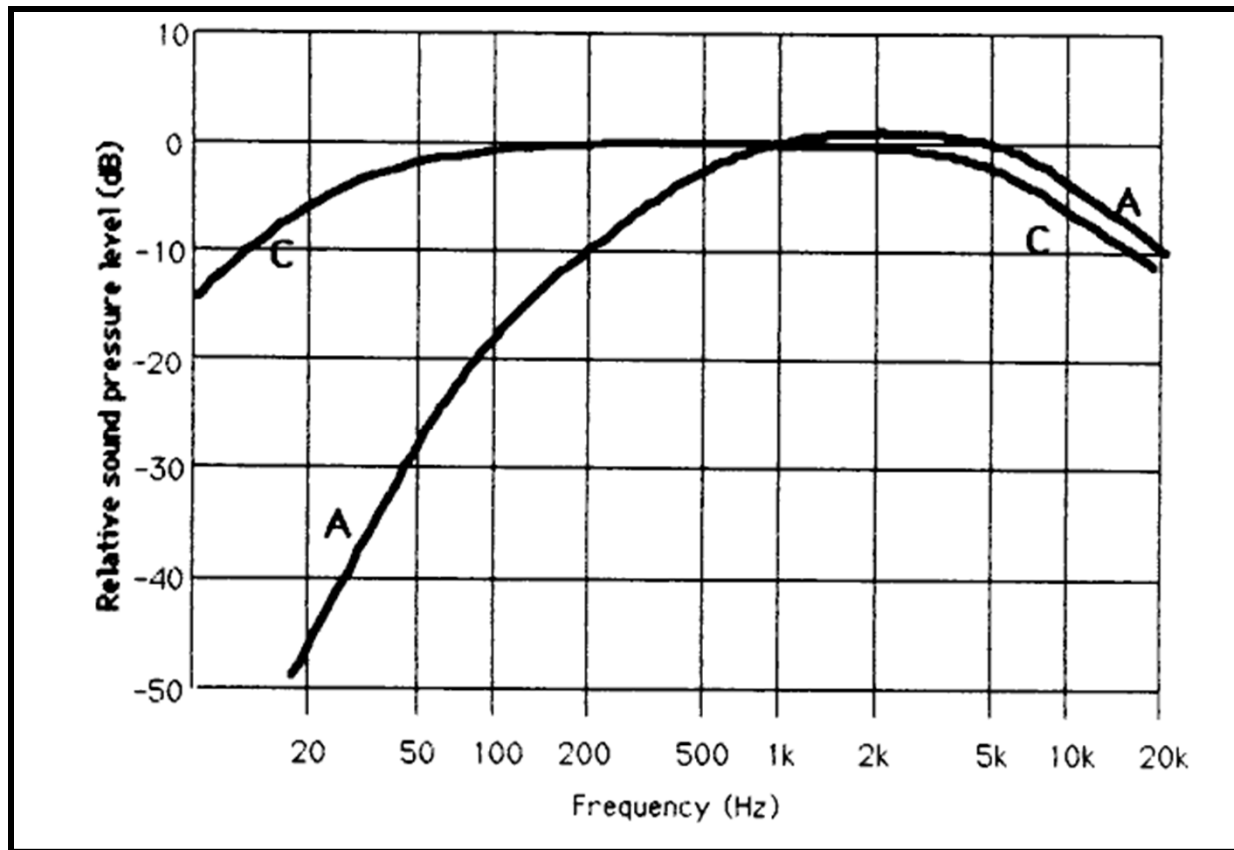
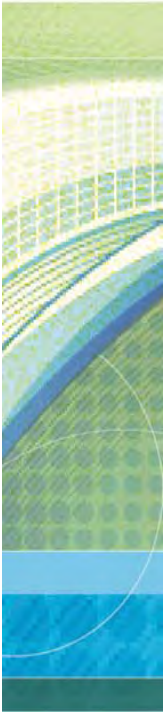


- Measurement Range – needs to go low enough and be wide enough
- Linear (Z), A or C weighting
- Fast and/or Slow Response
- Peak, Impulse
- Leq
- Ldn/Cnel
- L10, L50, L90
- 1/1 Octave Bands or 1/3rd Octave Bands
- Real Time Analysis

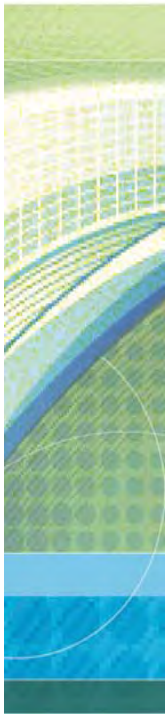


Metrics - Frequency Response & Weighting

- "A" and "C" Weighting Curves



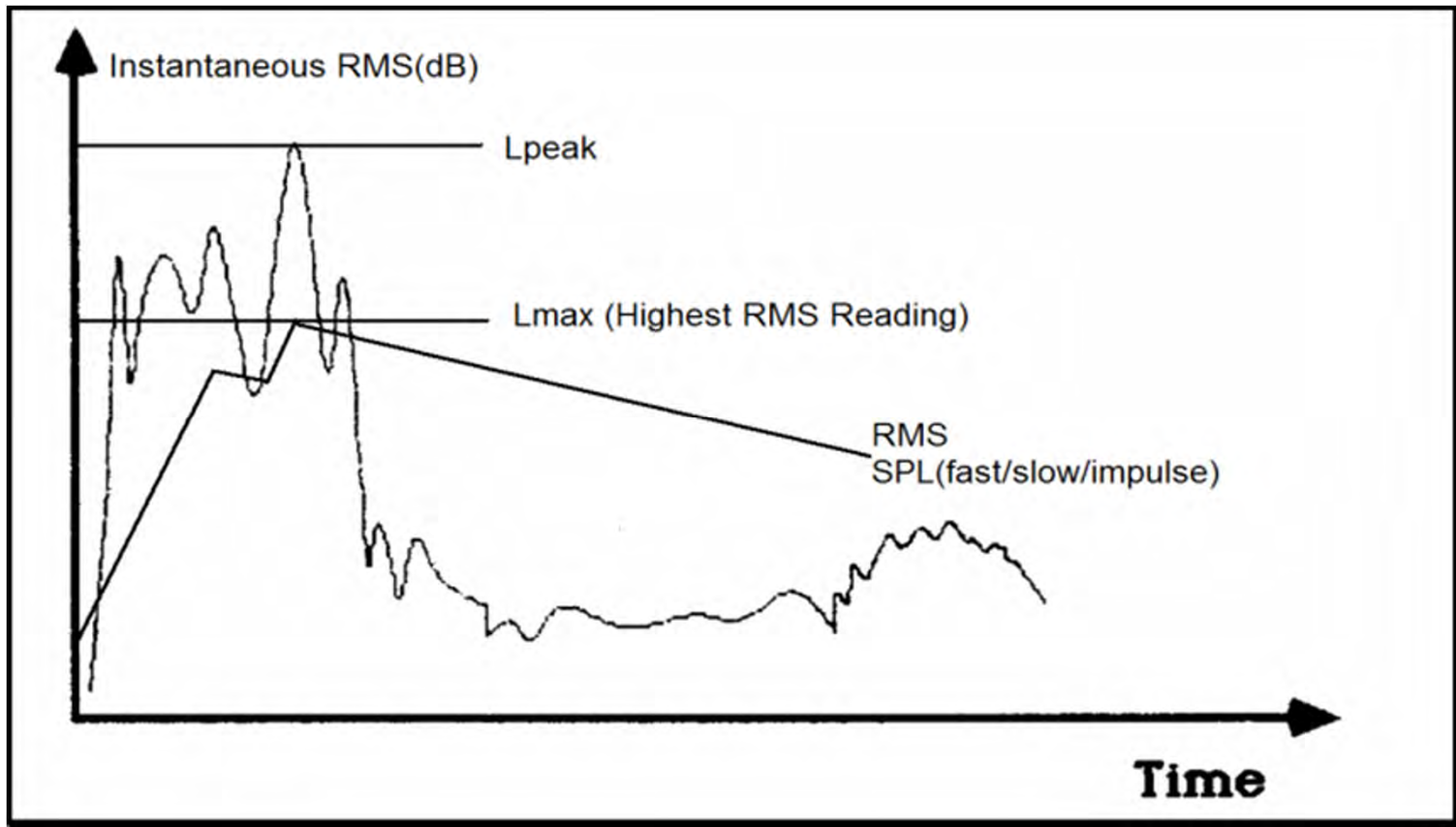
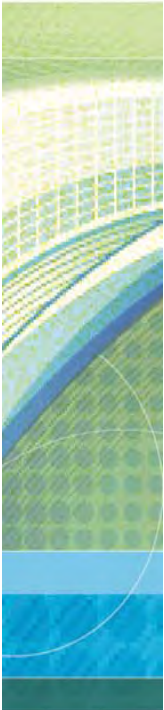
Metrics - Response Time



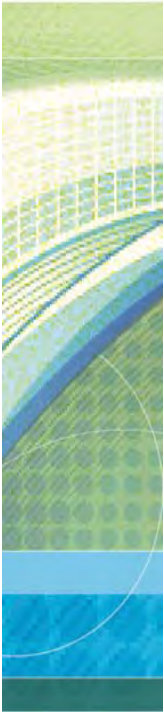
- Fast = 125 milliseconds
- Slow = 1 second
- Impulse = 35 millisecond rise, 1.5 second decay
- Peak = 50 microseconds



Metrics – Response Time

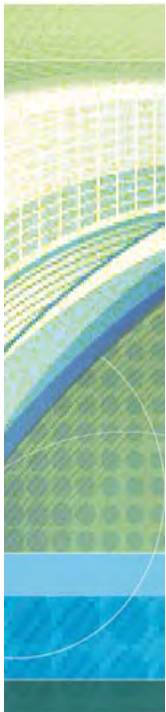


Metrics - Leq (Level Equivalent)



- 3 decibel exchange rate
- $Leq = 10 \log [(1/T) \int pA^2 dt / pref^2]$ where
Leq = equivalent sound level (db)
T = time period (s)
pA = sound pressure (Pa, N/m²)
pref = reference sound pressure (20 10⁻⁶ Pa, N/m²)

Metrics - Exceedance Levels

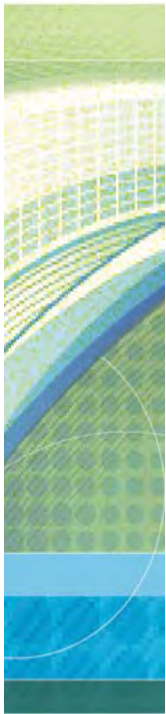


Such as L_1 , L_{10} , L_{50} , L_{90}

Indicates the percentage of time a level is exceeded... if the L_{90} is reported as 58 dB, then 58 dB is exceeded 90% of the time



Metrics - Octave Band Filters



<u>Center</u>	<u>Low</u>	<u>High</u>
31.5 Hz	22.4	44.7
63	44.7	89.1
125	89.1	178
250	178	355
500	355	708
1000	708	1410
2000	1410	2820
4000	2820	5620
8000	5620	11200

Session Report

1/5/2007

Information Panel

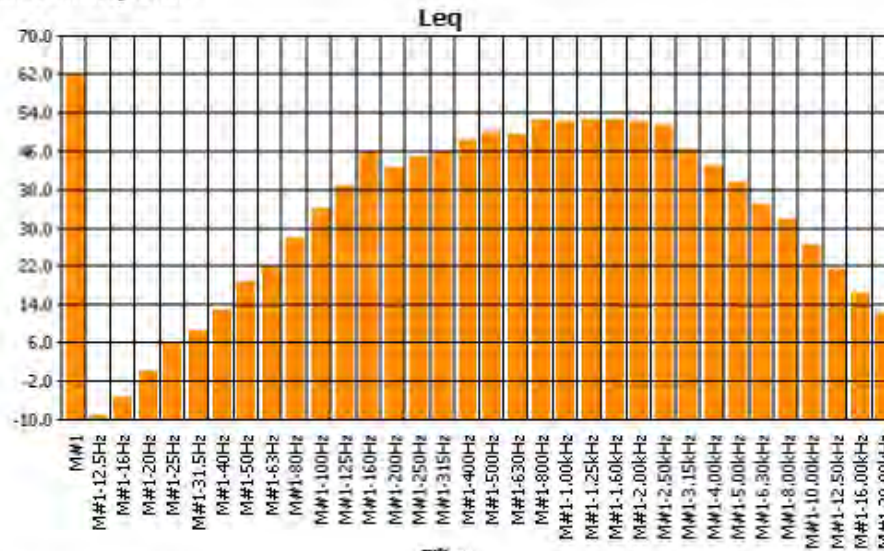
Company Name
Device Model Type
Device Name
Device Firmware Revision
Start Time
Stop Time
Comments

SoundPro DL
 Engineering Test Unit
 Tuesday, May 09, 2006 18:28:25
 Tuesday, May 09, 2006 18:31:48

General Data Panel

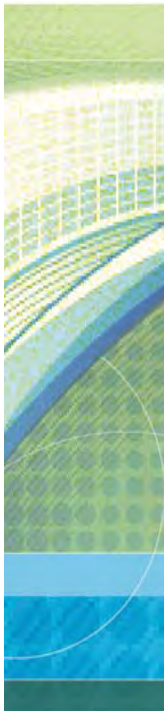
Description	Meter/Sensor	Value	Description	Meter/Sensor	Value
Exchange Rate	1	3 dB	Weighting	1	A
Bandwidth	1	1/3	Response	1	SLOW

Filter Summary Chart



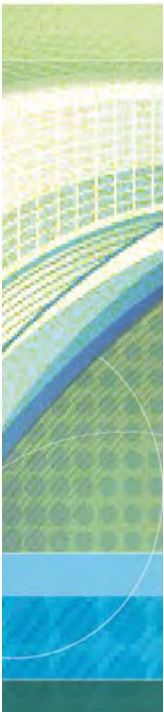
Filter Summary Table

MeterString	Summary Value
M#1	62
M#1-12.5Hz	-8.8
M#1-16Hz	-5
M#1-20Hz	0.4
M#1-25Hz	6.3
M#1-31.5Hz	8.7
M#1-40Hz	13.3
M#1-50Hz	19
M#1-63Hz	22.1
M#1-80Hz	28.2
M#1-100Hz	34.4
M#1-125Hz	39
M#1-160Hz	45.8
M#1-200Hz	49
M#1-250Hz	45.1
M#1-315Hz	46.7

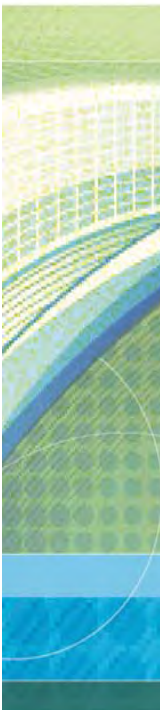


Instrumentation

- Sound Level Meter
- Integrating Sound Level Meter
- Some Noise Dosimeters
- Data Logging Devices
- Frequency Analyzers – Real Time Analyzers
- Recording Devices

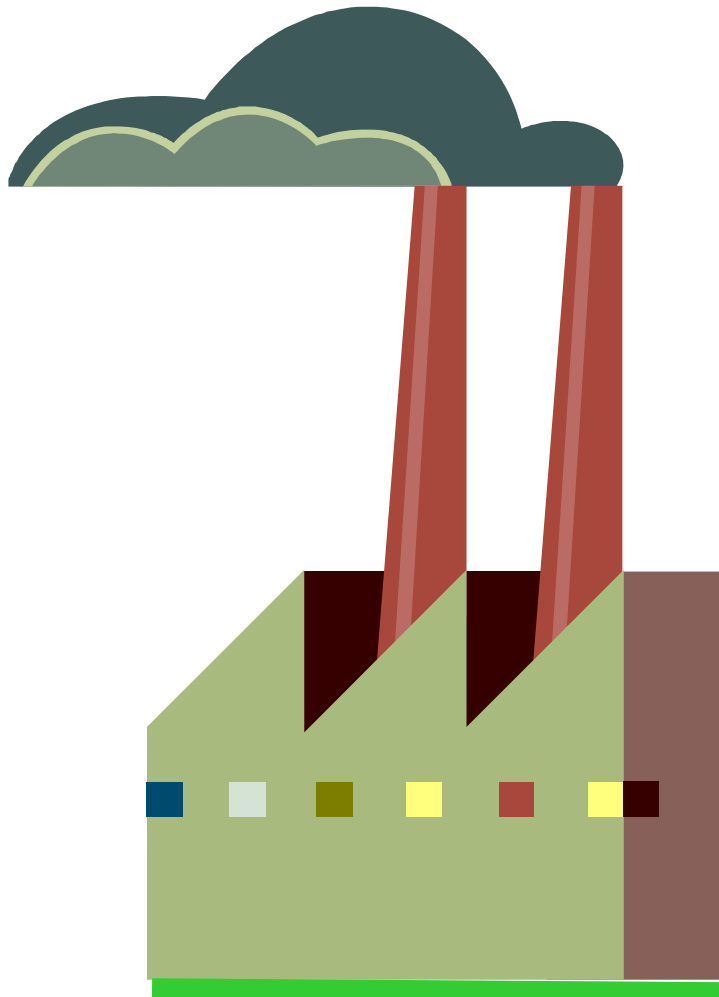
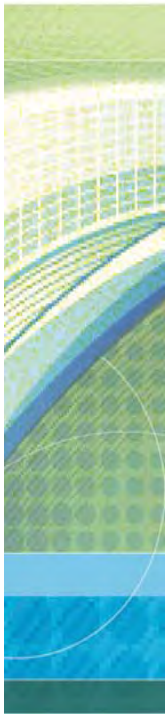


Instrumentation - Type 1 & Type 2

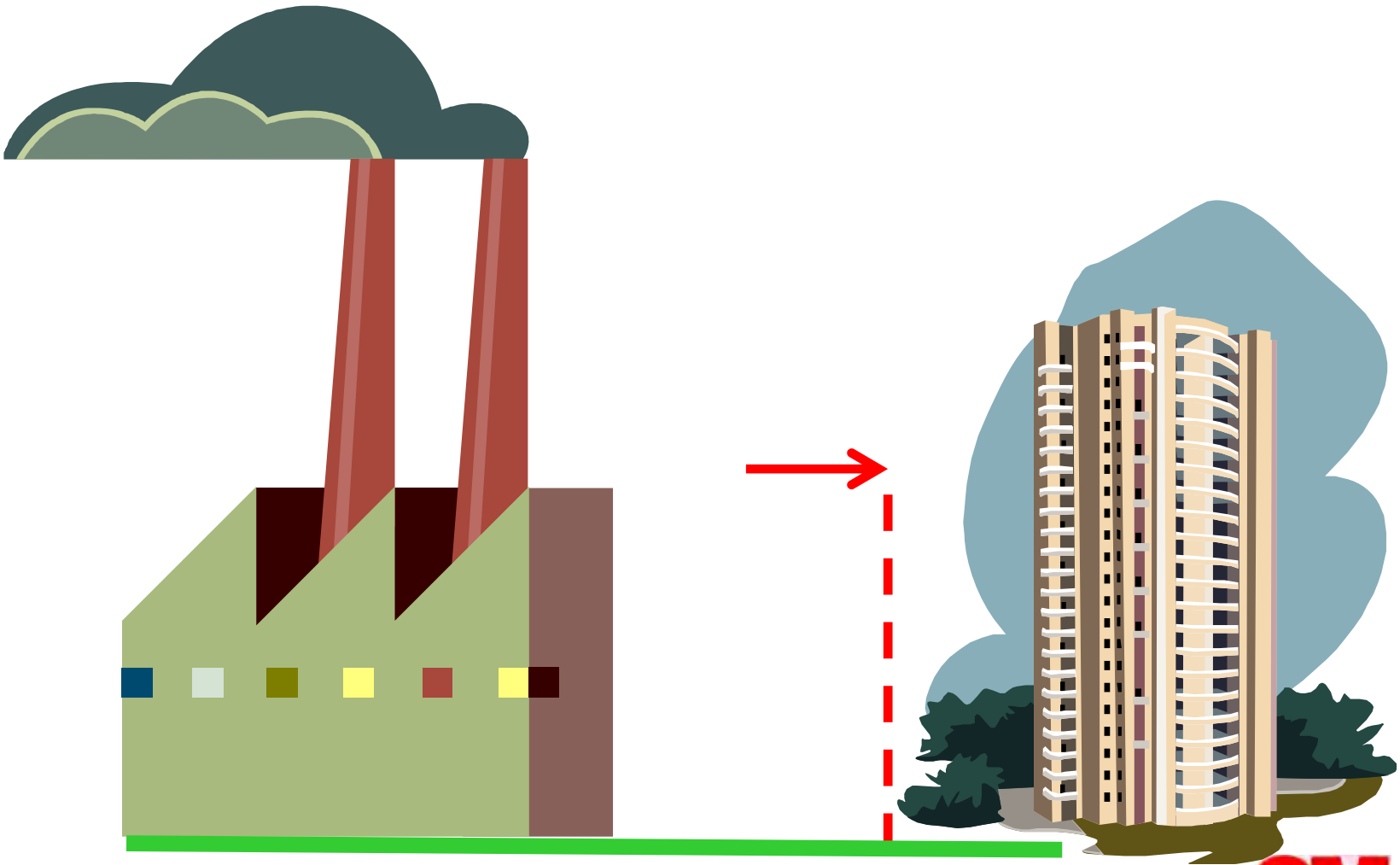
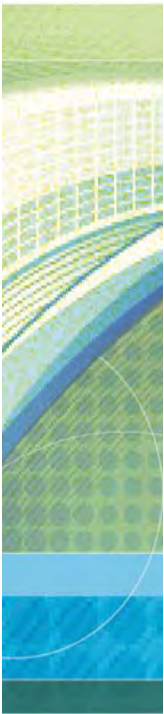


Freq. in Hz	T1	T2
31.5	+/- 1.5	+/- 3.0
63	+/- 1.0	+/- 2.0
125	+/- 1.0	+/- 1.5
250	+/- 1.0	+/- 1.5
500	+/- 1.0	+/- 1.5
1000	+/- 1.0	+/- 1.5
2000	+/- 1.0	+/- 2.0
4000	+/- 1.0	+/- 3.0
8000	+1.5/-3.0	+/- 5.0
10000	+2.0/-4.0	+ 5.0/- ∞

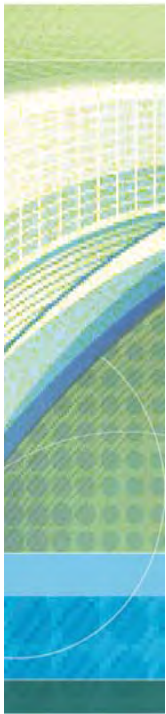
Property Line – an important concept to understand



Property Line – an important concept to understand



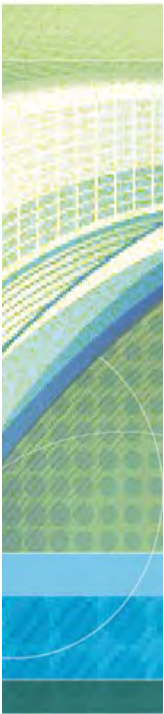
Annoyance Factors – why all noise isn't equal



- Low Frequency Signals
- Human Voice
- Pure Tones
- Dramatic sudden changes from ambient



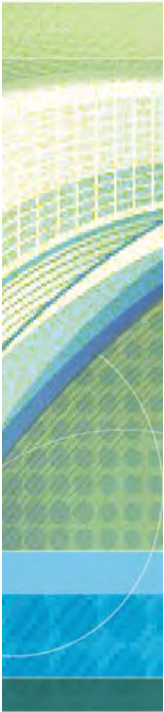
Ambient Noise



- The background noise level without the offending noise source
- L90
 - *Stop the source*
 - *Find a “like” location*

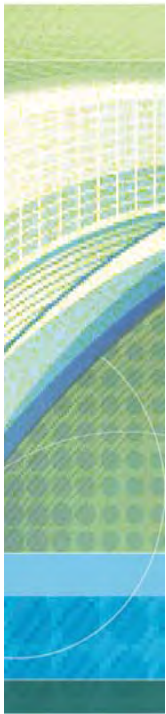


Ambient Noise and the Source

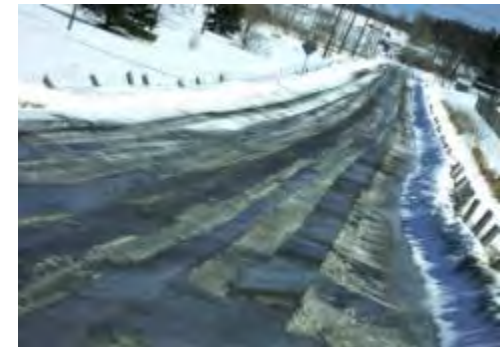


- If source is within 3 dB of the surroundings, the source is having little or no effect
- Between 4 and 10 dB there is mixed effect
- If the source is greater than 10 dB above the surroundings, then the surroundings are having little or no effect

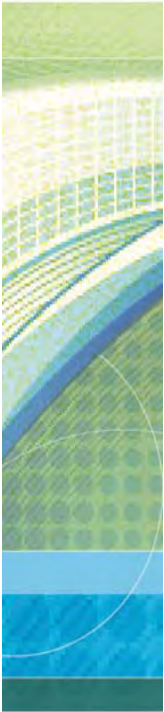
Annoyance Factors – why all noise isn't equal Perceptions



- Expectations -10 to +5 dB
- Seasonal (winter) -5 dB
- Tonal Quality 0 to +12 dB



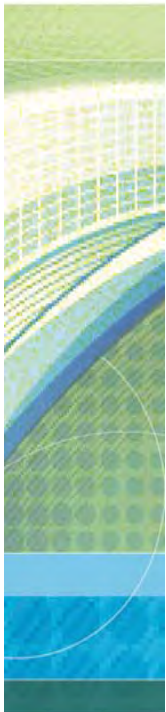
How the measurements can go wrong



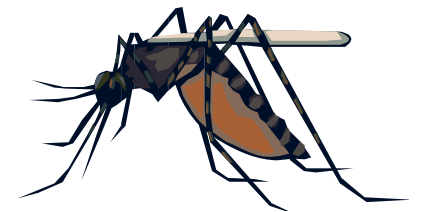
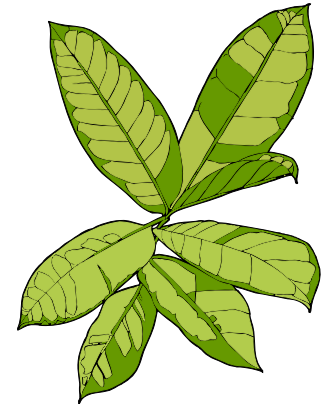
- Seasonal Factors
- Weather
- Measurement Location
- Source Operating Parameters



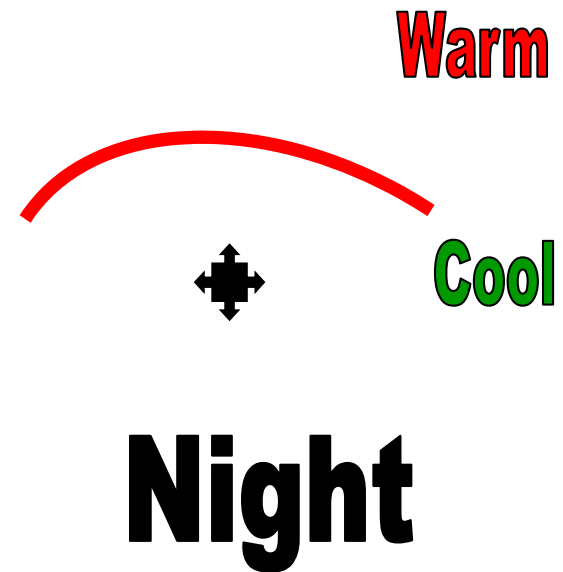
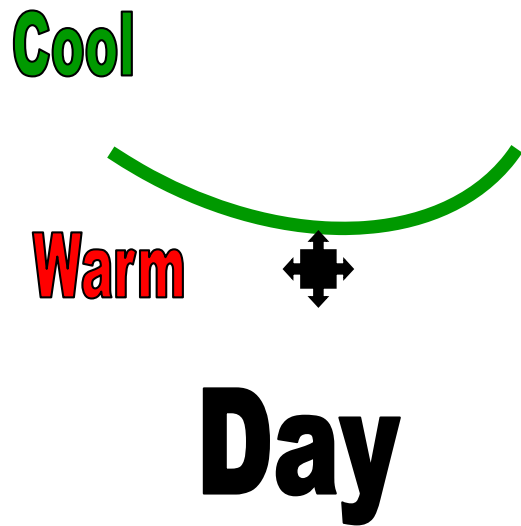
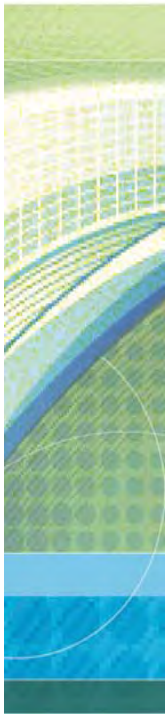
Seasonal Factors



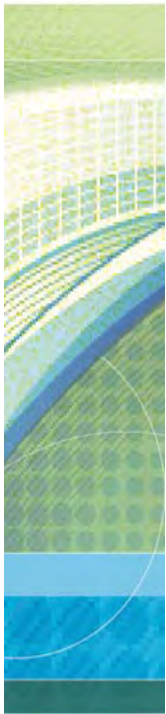
- Plant conditions (the green & growing type)
- Insect and Wildlife activities and prevalence
- Wind patterns
- Ground conditions



Sound Flow in Atmosphere



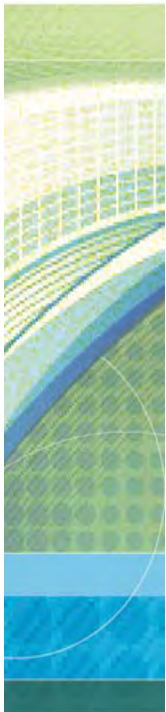
Meteorological Conditions



- Wind Speed and Direction at the site
- Ambient Air Temperature, Relative Humidity, Barometric Pressure and Cloud Cover
- Precipitation
- Snow, Ice or Rain Cover



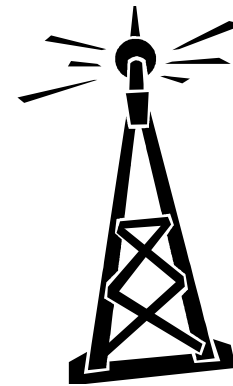
Weather Condition Measures



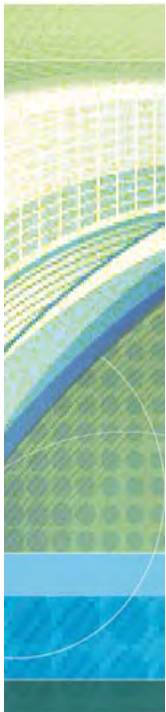
- Radio
- Internet

www.weather.com
www.noaa.gov
www.wunderground.com

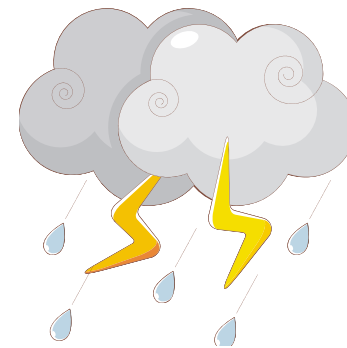
- Telephone
- Field Measure



Precipitation and Ground Condition



- Active Measureable Rainfall or Snowfall
- Condensation
- Thunder
- Wet, Snow, Ice

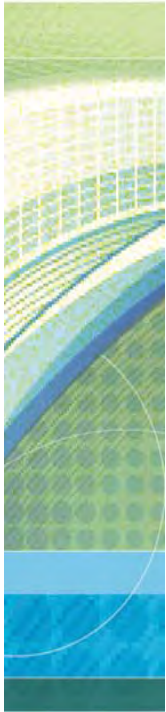


Measurement Location

- Directly influences measurement results and includes:
 - *Topography*
 - *Ground surface cover (grass, loose dirt, gravel, asphalt, concrete, etc.)*
 - *Reflective Surfaces*



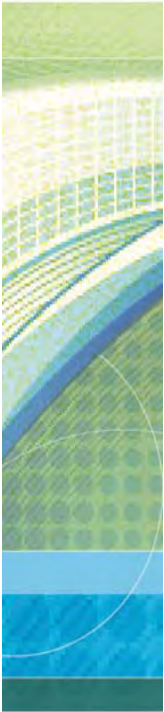
Source Operating Conditions



- Factors for consideration may include:
 - *Load rates*
 - *Timing*
 - *Cycling*
 - *Materials*
 - *Tools*
 - *Multiple Sources*
- Distance from source(s)

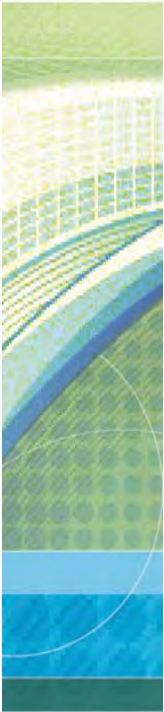


Site Selection



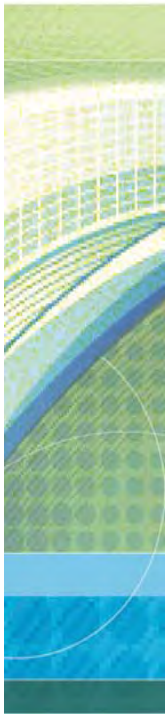
- Controlled by purpose of measurement
 - *Source*
 - *Recipient*
 - *Boundary line*
 - *"Specified location"*

Microphone Height

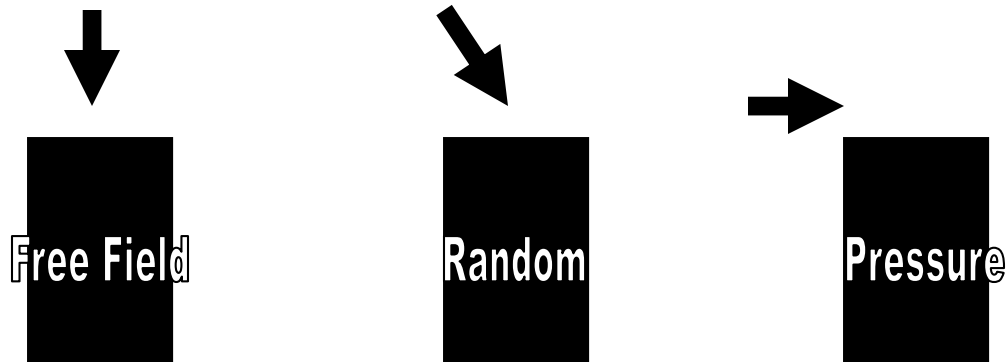


- Between 1.2 and 1.8 Meters (4 to 5 feet)
- Ordinance or standard may require a different height
- Remember line of sight and purpose of measurement – such as the effect of a noise signal on the occupant of an upper floor apartment

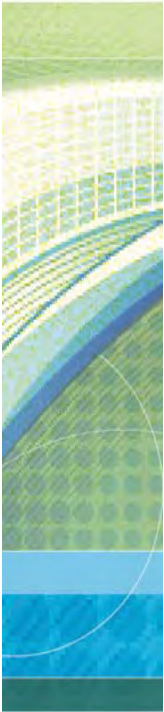
Know the Microphone



- Frequency response
- Sensitivity
- Directionality



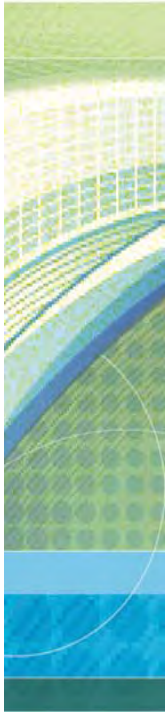
Calibration



- Includes the microphone, preamplifier, cables and meter.
- Field Calibration: before and after each set of measurements (daily)
- Factory or Laboratory calibration: suggest annual due to evidence expectations



Worksheet for Measurement Assignments



Date: _____

Time: _____ am/pm

Wind Speed: _____

Direction: ___ Source: _____

Sky: ___ Clear ___ Some Clouds
 ___ Cloudy

Precipitation: ___ None
 ___ Light Rain ___ Rain
 ___ Fog ___ Snow
 ___ Other: _____

Surface: ___ Hard ___ Soft
 ___ Very Soft
 ___ Mixed

Buildings, Walls, Geography

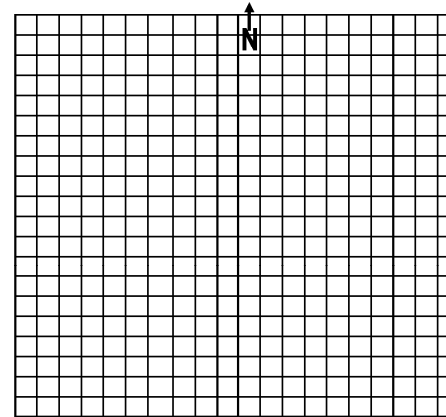
Instrumentation

Model: _____

Serial #: _____

Calibration: _____

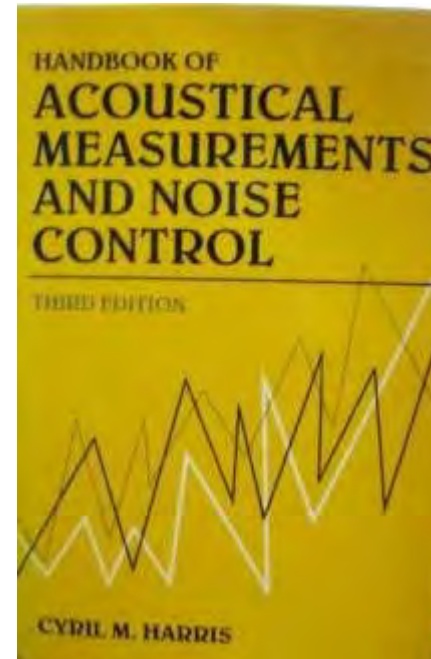
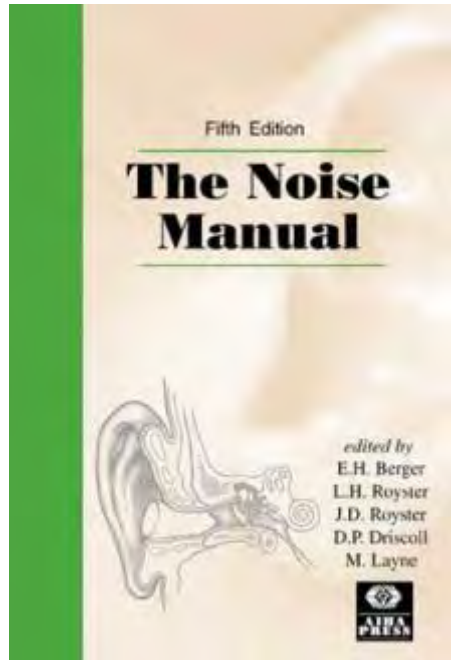
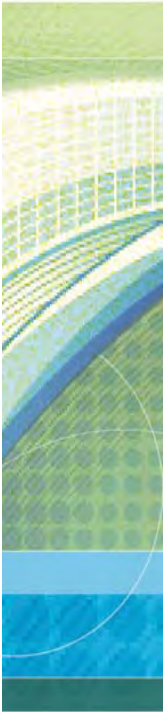
Other Notes:



	1	2	3	4
Leq A				
Leq C				
Lpk A				
Lpk C				
Lmx A				
Lmx C				
Lmn A				
Lmn C				
16				
31.5				
63				
125				
250				
500				
1000				
2000				
4000				
8000				
16000				
Ldn/Lcnel				
L10				
L50				
L90				



Resources



Noise Pollution Clearinghouse
www.nonoise.org

Questions?

