

Thank You for Attending Today's Webinar:

TSI - Advanced Sound Measurement Using the TSI SoundPro



Your Host

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Content



- **Workplace Noise Fundamentals**

- Noise Standard
- Exchange Rate
- Noise Dissipation

- **Noise Sampling and common mistakes**

- Noise Range
- Weighing network: A,C, Z
- Calibration

- **Time response**

- Slow, Fast
- Impulse vs Peak

- **Octave Band Analysis**

- 1/1 vs 1/3
- Applications

- **Community noise sampling**

- Criterion curves
- Background noise

Key Steps And Best Practices



Preparation

- Placement of your instrument
- Disrupting the space with your setup
- Location survey
- Planning

Survey Application

- Noise Dosimeter vs Sound Level meter
- Instrument Setting

Octave Band Analyzer

- Combine an OBA to your broadband measurement.

Instrument Setting

- Frequency response
- Time response
- Instrument range
- Operating temperature

Calibration

- Pre-Cal
- Post-Cal
- Annual-Cal

Noise Regulations and Standards



OSHA HC (Hearing Conservation)

- "A" Weighting
- Slow response
- 5 dB ER
- 90 dB CL
- 80 dB Threshold

OSHA PEL (Permissible Exposure Level)

- "A" Weighting
- Slow response
- 5 dB ER
- 90 dB CL
- 90 dB Threshold

MSHA HC (Hearing Conservation)

- "A" Weighting
- Slow response
- 5 dB ER
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- 80 dB Threshold

MSHA PEL (Permissible Exposure Level)

- "A" Weighting
- Slow response
- 5 dB ER
- 90 dB CL
- 90 dB Threshold

ACGIH

- "A" Weighting
- Slow response
- 3 dB ER
- 85 dB CL
- 80 dB Threshold

200310EC (EU Directive)

- "A" Weighting
- Slow response
- 3 dB ER
- 85 dB CL
- No Threshold

Workplace Noise Level Exposure Limits



Duration per Day (h)	OSHA Permissible Exposure Level	European Union Directive 2003/10/EC
8	90 dB	85 dB
4	95 dB	88 dB
2	100 dB	91 dB
1	105 dB	94 dB
0.5	110 dB	97 dB
0.25	115 dB	100 dB

OSHA's Noise standard (29 CFR 1910.95) requires employers to have a hearing conservation program in place if workers are exposed to a time-weighted average (TWA) noise level of 85 decibels (dBA) or higher over an 8-hour work shift.

Instrument Range



Underload: UL

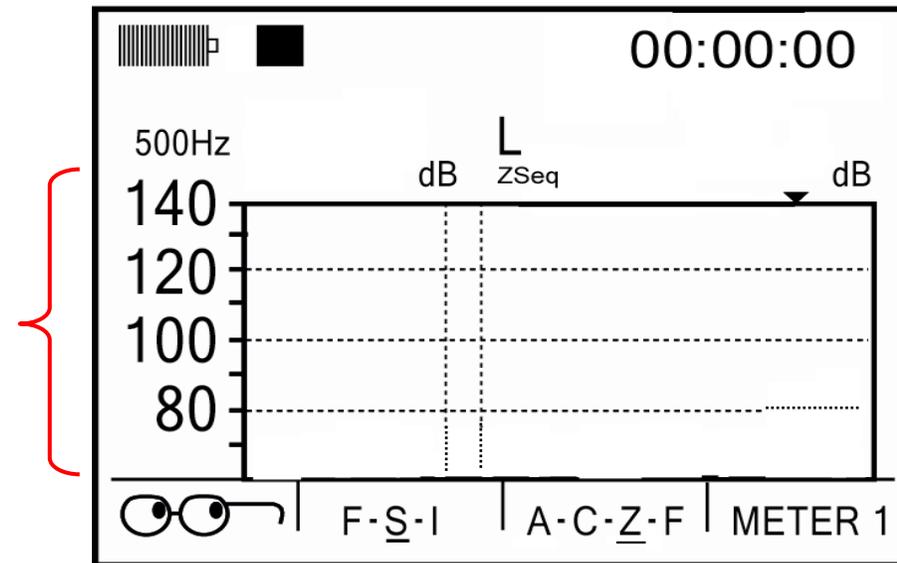
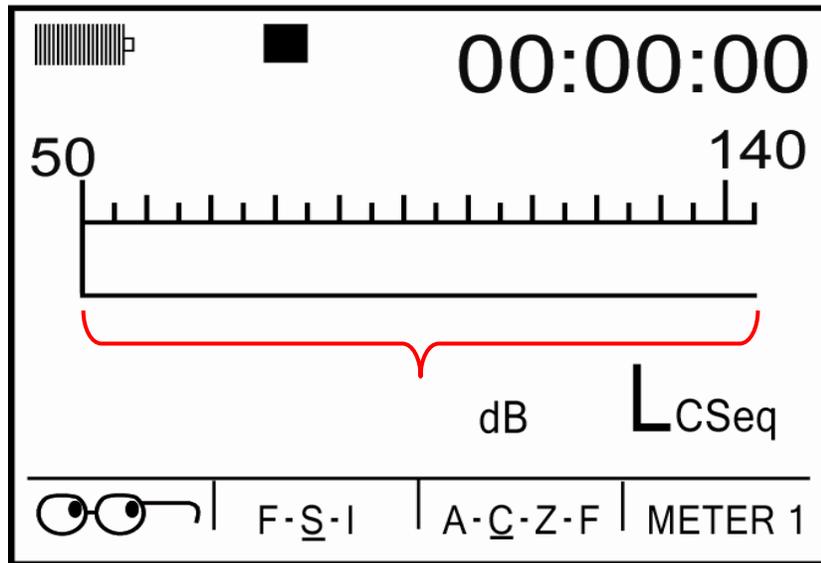


Overload: OL



Optimal

SoundPro Range

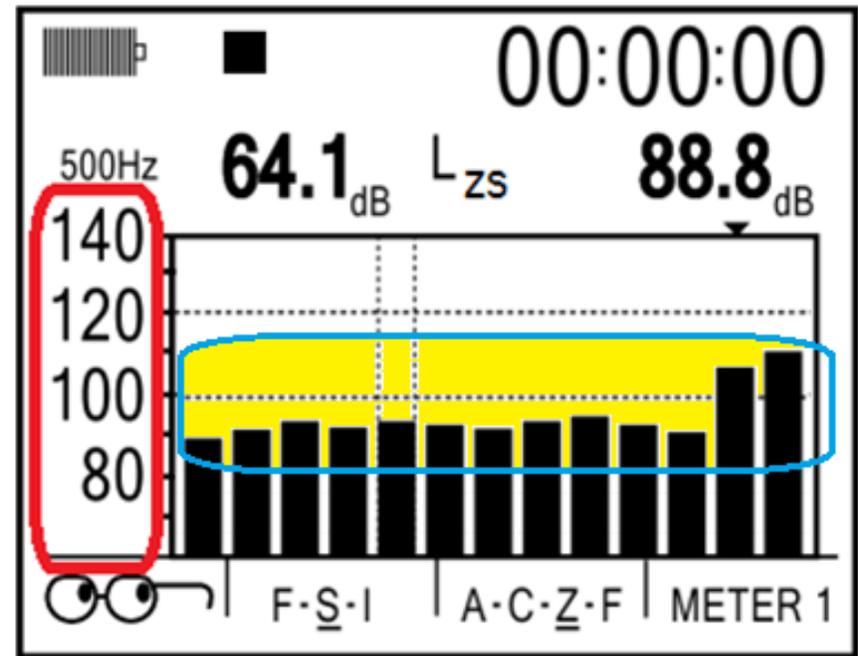


Press ▲/▼ arrows to adjust the range

How to Set the Range



- ❑ The numbers on the Y-axis (circled red) indicate the range.
- ❑ Use the Up or Down arrows as needed to select an appropriate range. The goal is selecting a range so the bars are near the center of the display. (bleu, yellow area)



Range Selection by Application



Industrial / Hearing Conservation: range is often 80 to 140 dB range.

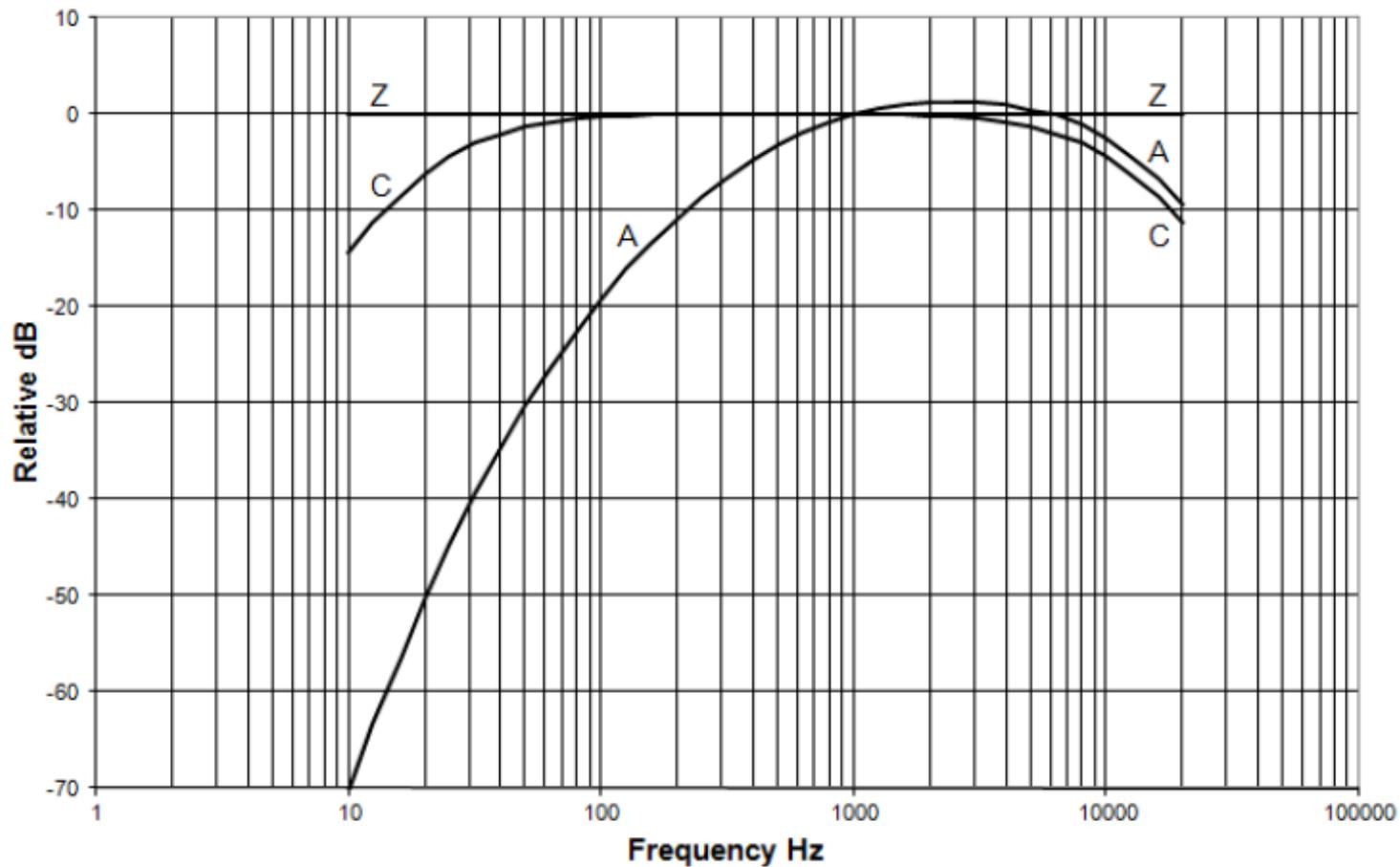
General work place (office / hospital): range of 40 to 80 dB.

Community Noise: ranges often in the 55 to 90 dB range.

Background Noise: ranges as low as 20 or 30 dB.

		07:30:30	
MAX	89.9 dB	DOSE	90.2 %
AVG	85.5 dB	PDSE	100.0 %
TWA	95.0 dB	PTWA	101.5 dB
OL	.05 %	SEL	60.0 dB
EXP 150.5 p2s			
U.L. 00:00:03			
	F·S·I	A·C·Z·F	METER 1

Frequency Response & Weighting



Time Response



Slow: 1 second rise and fall

- For typical occupational noise measurements, including extremely elevated short-term noise

Fast: 125 milliseconds rise and fall

- For rapidly fluctuating sound

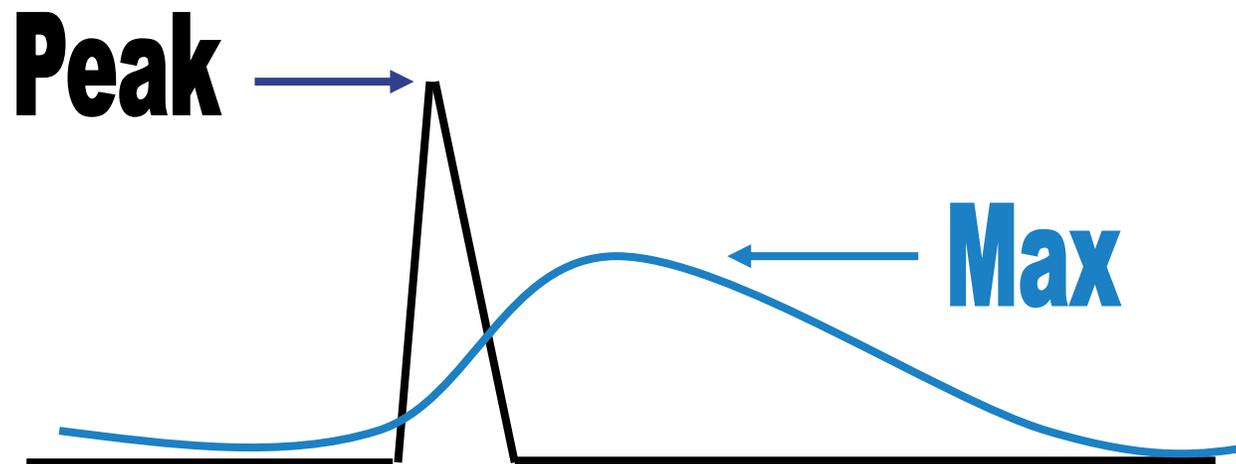
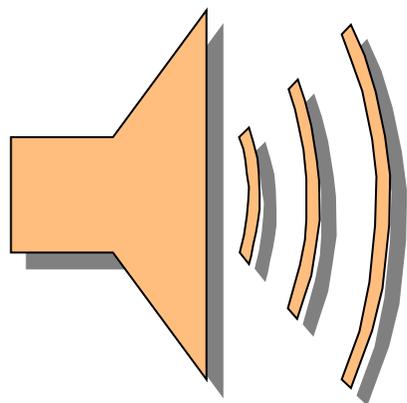
Impulse: 35 millisecond rise 1.5 s fall

- For measuring transient sounds (sounds that decay or pass with time)

Peak: 50 microsecond rise and fall

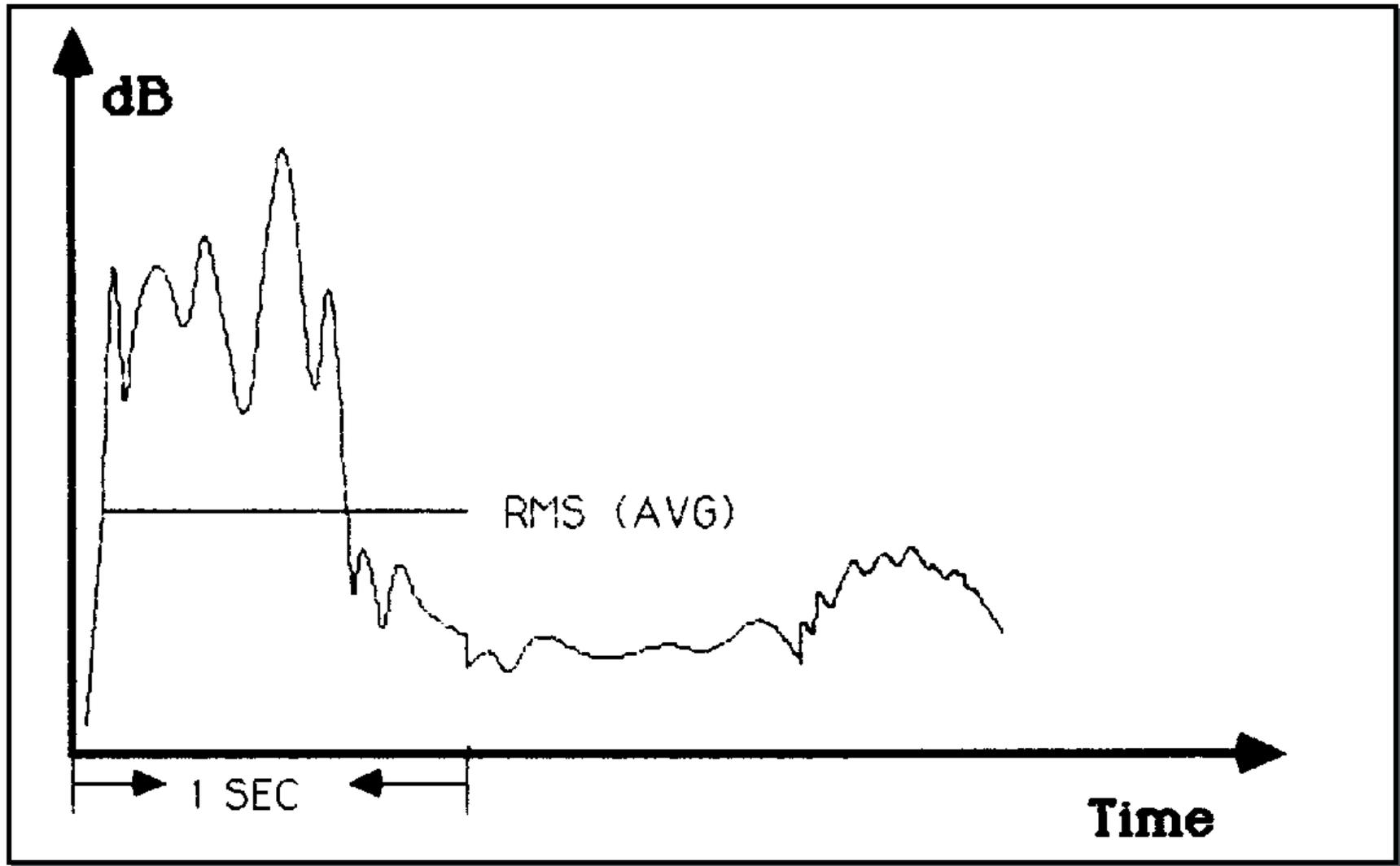
- For measuring the highest sound pressure level available

RMS vs Peak

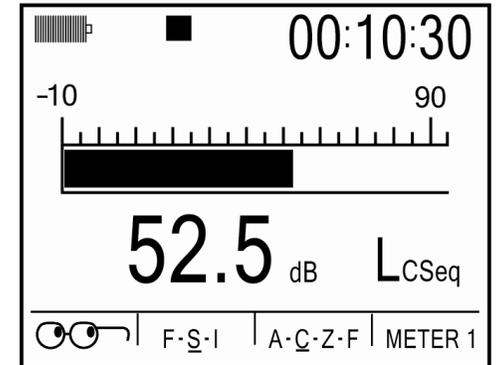
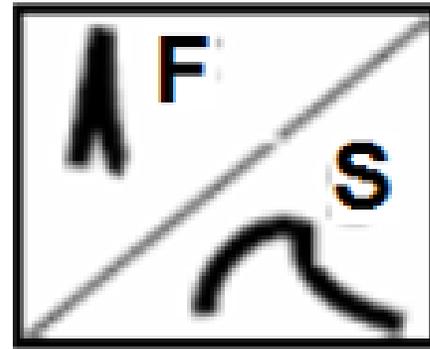
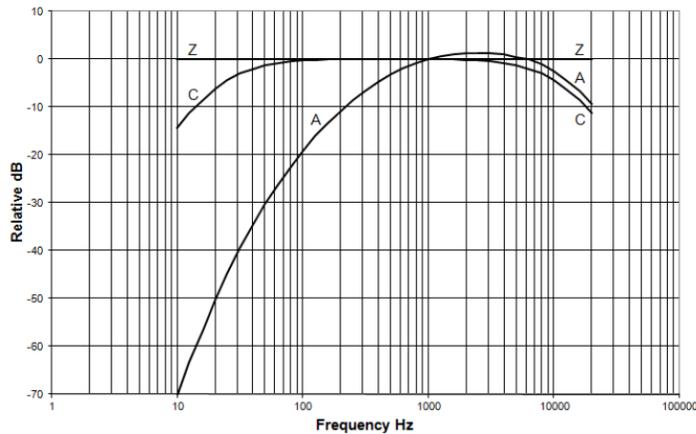


More Detail

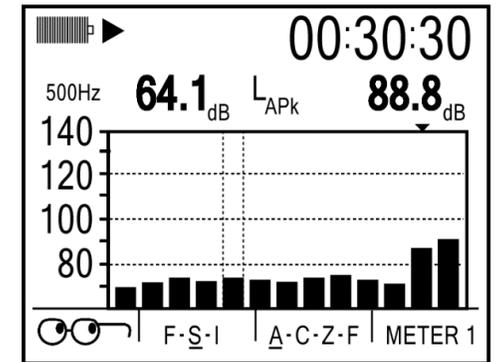
RMS (Root-Mean-Square)



What is octave Band?



Broadband



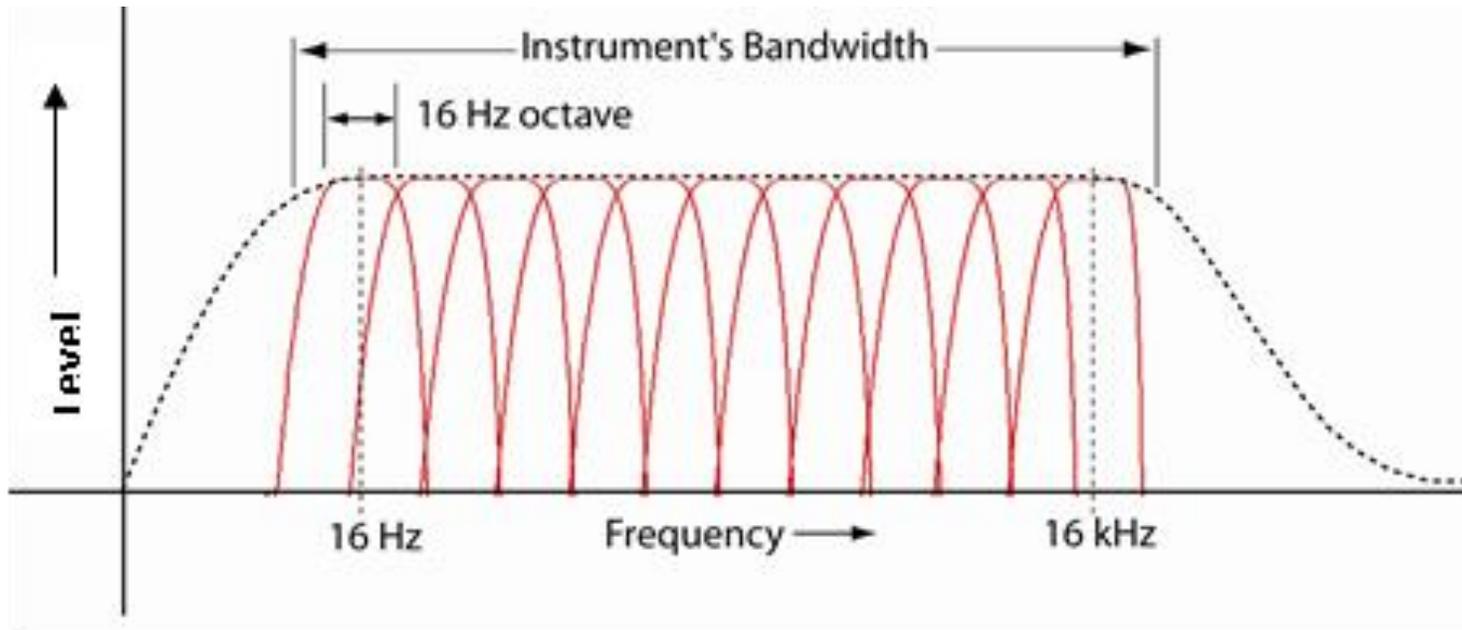
Octave Band

Octave Band Analysis



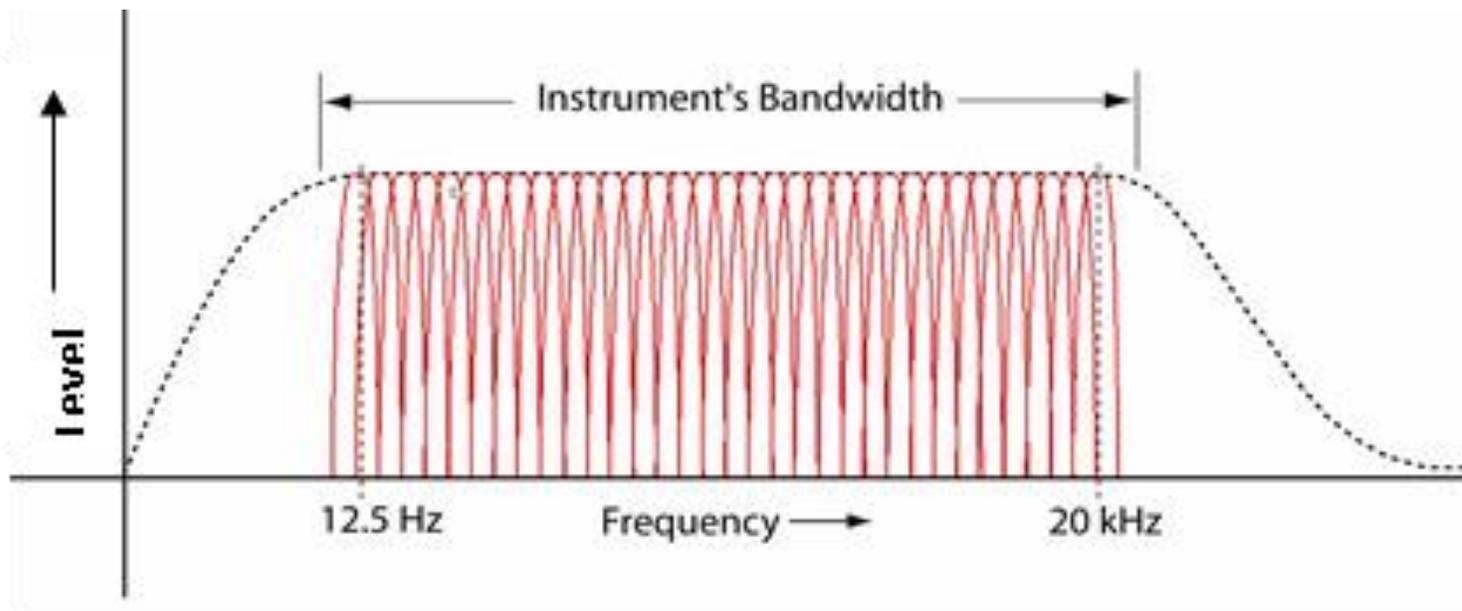
1/1 vs 1/3

1/1 Octave



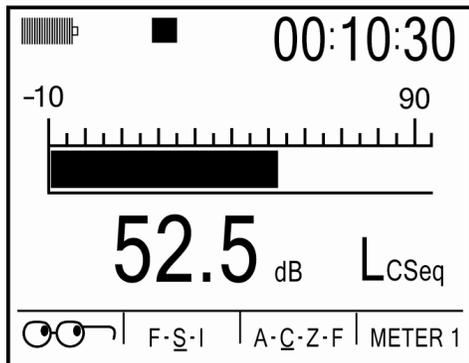
- 31.5 Hz
- 63 Hz
- 125 Hz
- 250 Hz
- 500 Hz
- 1.00 kHz
- 2.00 kHz
- 4.00 kHz
- 8.00 kHz

1/3 Octave

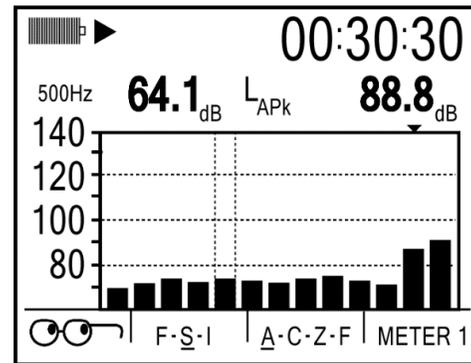


- 12.5 Hz
- 16 Hz
- 20 Hz
- 25 Hz
- 31.5 Hz
- 40 Hz
- 50 Hz
- 63 Hz
- 80 Hz
- 100 Hz
- 125 Hz
- 160 Hz
- 200 Hz
- 250 Hz
- 315 Hz
- 400 Hz
- 500 Hz
- 630 Hz
- 800 Hz
- 1.00 kHz
- 1.25 kHz
- 1.60 kHz
- 2.00 kHz
- 2.50 kHz
- 3.15 kHz
- 4.00 kHz
- 5.00 kHz
- 6.30 kHz
- 8.00 kHz
- 10.00 kHz
- 12.50 kHz
- 16.00 kHz
- 20.00 kHz

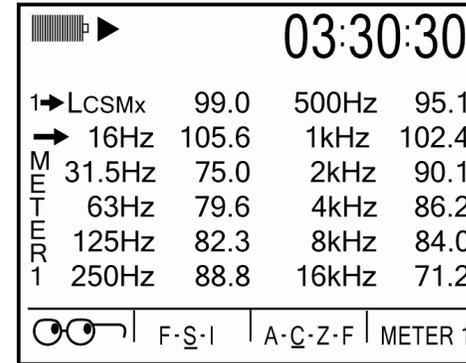
Octave Band Analysis



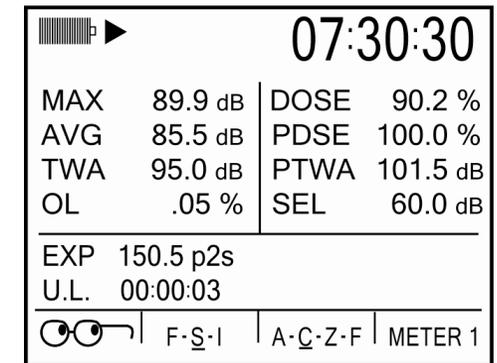
This is Broadband



1/1 Octave Band Chart



1/1 Octave Band Table



1/1 Octave Band Table

Octave Band Analysis



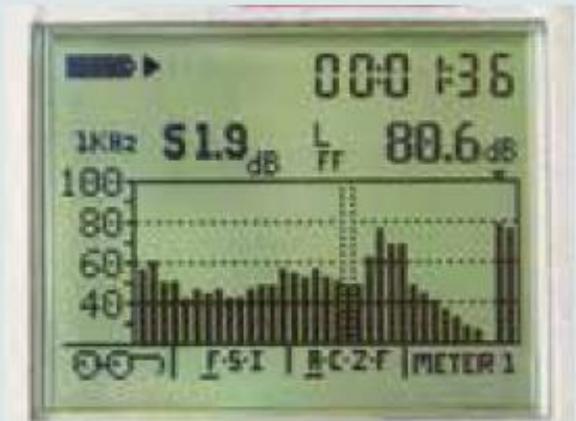
Sound Pressure Level Display

Displays the current Sound Pressure Level (SPL) with selected time response and filter weightings. The amplitude of the displayed measurement is shown both graphically by the length of the bar and numerically below the bar.



1/1 Octave Band Bar Chart Screen

Displays 1/1 octave analysis measurements in filter band and broadband values for both meters 1 and 2. This screen contains 13 bars with 11 filter bands and two for broadband.



1/3 Octave Band Bar Chart Screen

Displays 1/3 octave-band analysis measurements in filter band and broadband values for both meters 1 and 2. This screen contains 35 bars with 33 filter bands and two for broadband.

Octave Band Applications



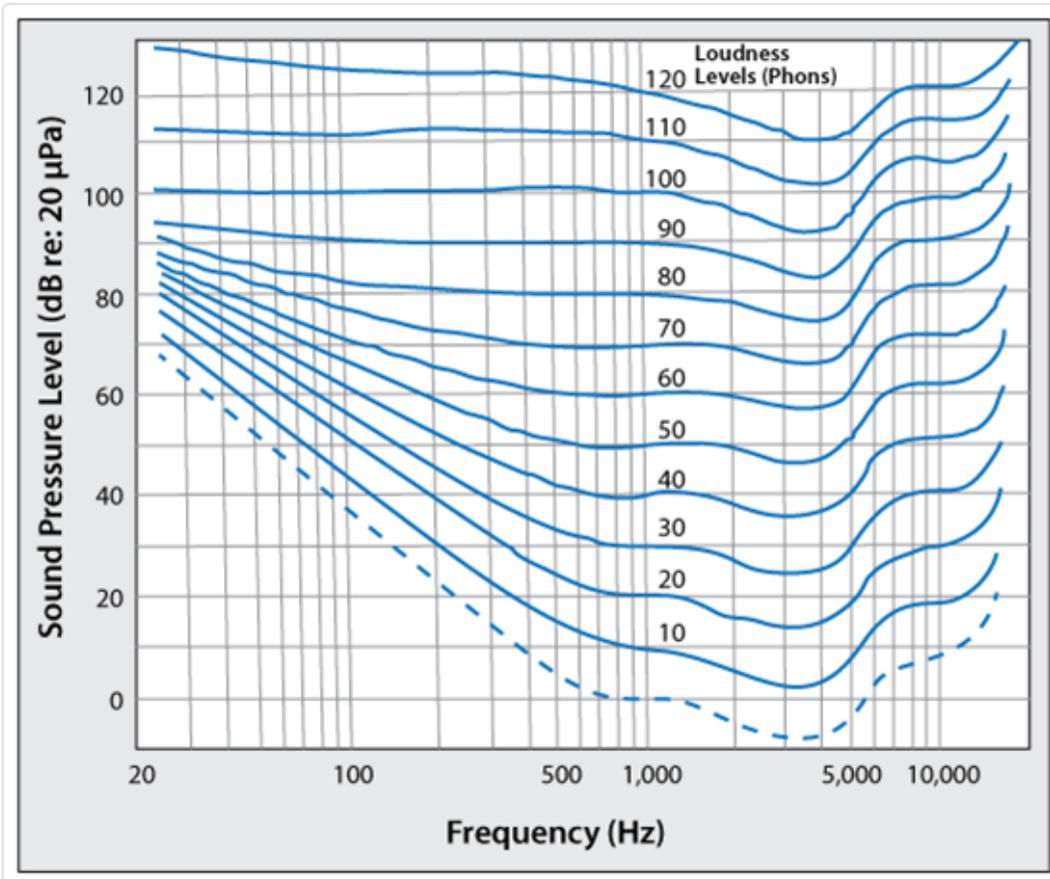
1/1 Octave Band Application

- Industrial / Hearing Conservation
- General work place (office / hospital)
- Community Noise
- Environmental Noise
- Criterion Curves /HVAC/Background Noise
- Audiometric Booth Testing
- STIPA

1/3 Octave Band Application

- Industrial / Hearing Conservation
- General work place (office / hospital)
- Community Noise
- Environmental Noise
- Criterion Curves /HVAC/Background Noise
- Audiometric Booth Testing
- STIPA

Loudness and Hearing loss



For High Frequencies, adding:

- 1 dB not noticeable
- 3 dB just perceptible
- 5 dB noticeable
- 10 dB twice as loud
- 20 dB four times as loud

For Low Frequencies, adding:

- 3 dB noticeable
- 5 dB twice as loud
- 10 dB four times as loud

Hearing Protector Attenuation Methods



**Good - Better -
Best**

- **NRR:** Noise Reduction Rating (SNR in Europe)
- **HML:** High Medium Low Lc – La
- **Octave Band**

Hearing Protector Attenuation



European Standard EN 352-2:2002
Attenuation data

(1) Frequency Hz	63	125	250	500	1000	2000	4000	8000
(2) Mean Attenuation dB	23.7	22.0	21.6	19.0	23.8	31.9	39.6	39.6
(3) Standard Deviation dB	4.0	2.9	4.7	4.3	3.6	4.0	2.7	3.7
(4) Assumed Protection dB (APV)	19.7	19.1	16.9	14.7	20.2	27.9	36.9	35.9

CE
EN 352
SNR: 24 dB
H: 27 dB
M: 19 dB
L: 18 dB

Model	NRR	CSA Class		Frequency (Hz)									
				125	250	500	1000	2000	3150	4000	6300	8000	
X1A	22 dB	A	Mean (dB)	16.0	18.3	27.7	37.6	35.1	42.2	41.4	39.4	39.3	
			SD (dB)	5.2	3.1	3.0	3.5	2.8	2.8	2.6	2.6	3.8	
X2A	24 dB	A	Mean (dB)	14.9	21.6	31.8	41.0	36.7	39.1	38.5	39.0	39.0	
			SD (dB)	4.2	3.3	2.3	2.5	3.0	2.4	2.0	2.8	3.4	
X3A	28 dB	AL	Mean (dB)	23.4	27.7	29.4	42.5	38.8	39.3	42.3	39.5	39.5	
			SD (dB)	3.0	2.1	3.1	2.6	2.7	4.0	3.3	2.6	2.8	
X4A	27 dB	AL	Mean (dB)	20.5	24.1	32.8	40.7	37.6	44.5	45.4	42.4	42.3	
			SD (dB)	4.6	3.4	1.9	2.8	2.9	3.1	2.5	3.1	3.0	
X5A	31 dB	AI	Mean (dB)	23.9	30.5	41.1	43.0	38.0	43.1	44.0	41.1	40.3	
			SD (dB)	4.1	2.2	2.8	2.9	2.7	2.9	2.4	2.6	2.2	

Applications – Octave Band Analysis



- Noise control engineering
- Choosing an adequate hearing Protection device
- Audiometric Booth Testing
- Product design – For example: automotive design, airplane cabins, etc.
- Criterion Curves – For use in room and building acoustic measurements. Also used in HVAC.
- Reverberation time – Used to evaluate and measure sound decay in a specific space, tailored to speech or music. Used in spaces such as classrooms, auditoriums, gymnasiums, concert halls/theaters, etc.
- STI-PA testing – used to determine if a building mass notification system is intelligible or unintelligible

Community Noise



❑ LDN: Level Day Night

A day–night 24-hr average noise level (L_{DN}).

10-dBA “penalty” applied to nighttime levels between 10 p.m. and 7 a.m.

❑ CNEL: Community Noise Exposure Level

The average equivalent sound level measured over a 24-hour period.

10-dBA “penalty” applied to nighttime levels between 10 p.m. and 7 a.m.

5-dBA “penalty” applied to evening levels between 7 p.m. and 10 p.m.

		07:30:30	
L01	99.0 dB	L10	85.1 dB
L50	82.9 dB	L90	---.- dB
LDN	---.- dB	CNEL	85.0 dB
OL	.05 %	TK3	90.0 dB
Lc-a	---.- dB		
<hr/>			
	F-S-I	A-C-Z-F	METER 1

Exceedance Level (Ln)



- Exceedance levels represent the percent of the run time that was spent above a certain decibel level. For example, an **L40 equal to 73 dB** means that for **40% of the run time**, the **decibel level was higher than 73 dB**.

		07:30:30	
L01	99.0 dB	L10	85.1 dB
L50	82.9 dB	L90	---.- dB
LDN	---.- dB	CNEL	85.0 dB
OL	.05 %	TK3	90.0 dB
Lc-a	---.- dB		
	F-S-I	A-C-Z-F	METER 1

Room Acoustic Quality



Too Quiet

VS

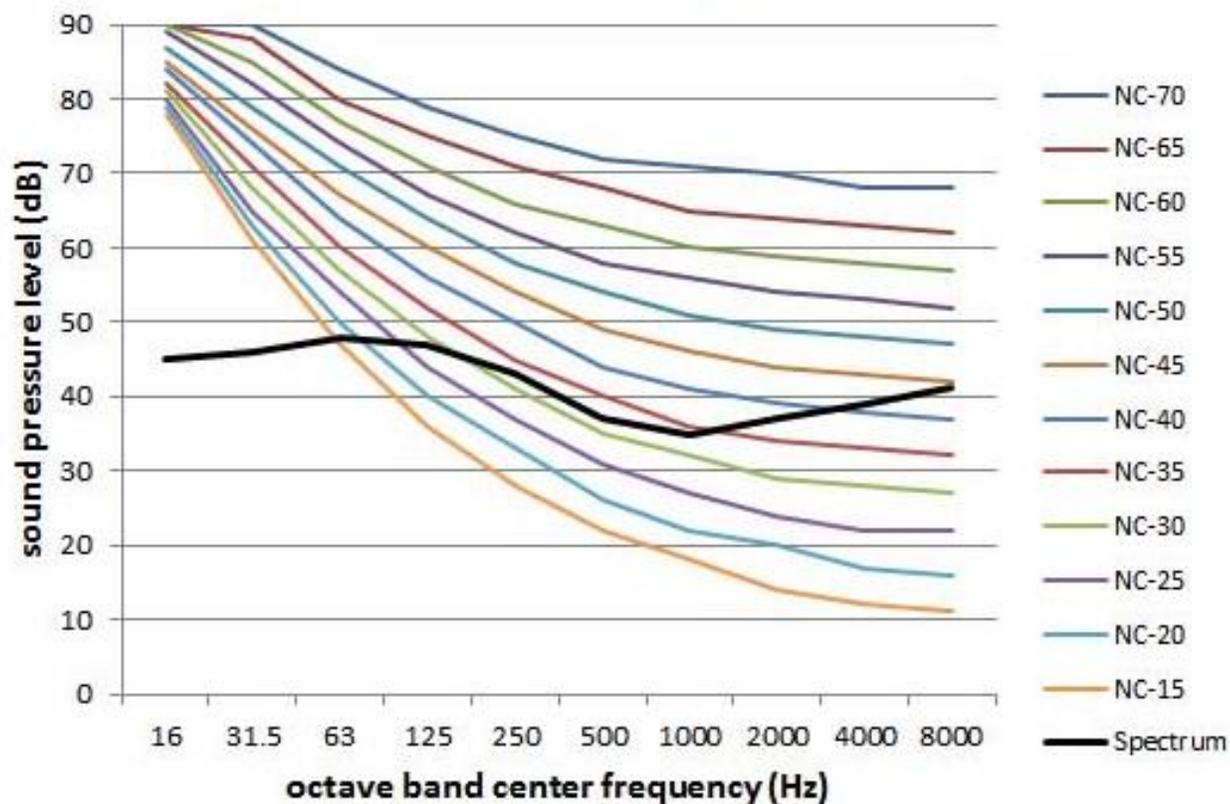


Too Loud

NC Curves



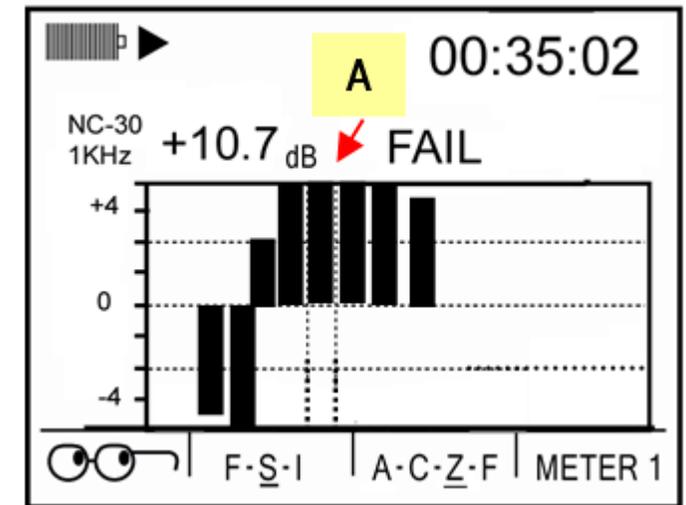
Noise Criteria (NC) Curves



Background, HVAC, Equipment Room Noise

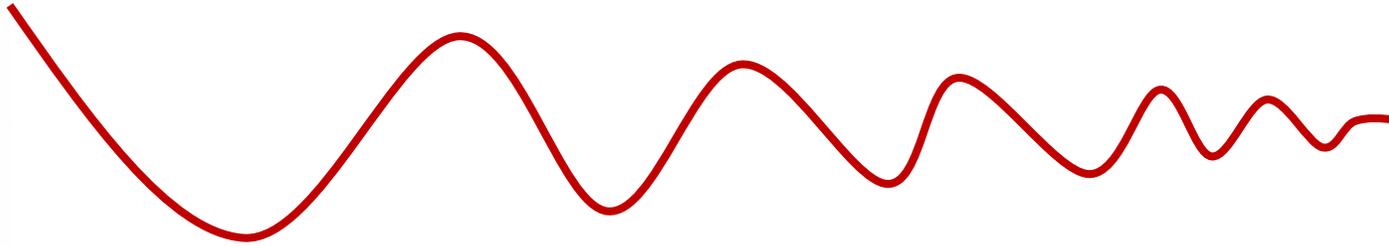


- ❑ **Noise Criterion Curves (NC)** 63 to 8,000 Hz
 - ❑ HVAC room or building acoustic comparisons.
- ❑ **Preferred Noise Criterion Curves (PNC)** 31.5 to 8,000 Hz.
 - ❑ Accounts for lower frequencies compared with the NC method.
- ❑ **Room Criterion Curves (RC)**
 - ❑ Determine noise in offices/room acoustics any interference such as hissing, rumbling, speech or vibration.
- ❑ **Balanced Noise Criterion Curves (NCB)** 16 to 8,000 Hz.
 - ❑ One of the newer methods that indicate interference from rumble, rattle, and hiss.
- ❑ **Noise Rating Curves (NR)** 31.5 to 8,000 Hz.
 - ❑ used primarily in Europe, Australia, for HVAC studies,



A: Select each band to see the NC-30 score +10.7 dB means value exceeded by 10.7dB.

Sampling strategies and Equipment Spacing



- Sound Pressure wave is generated with a *frequency* and *intensity*
- Sound pressure levels decay over *distance*
- To measure sound as it effects workers, measure at the ear **NOT** the source

Noise Dissipation



- As a general rule of thumb, when the distance between a source and receiver doubles, the sound pressure level decreases by 6 dB.
- Use this as a helpful guide for determining safe distances from noise sources:
 - Examples:
 - Selecting the placement of an equipment control station
 - Determining the location of designated walkways through a manufacturing site

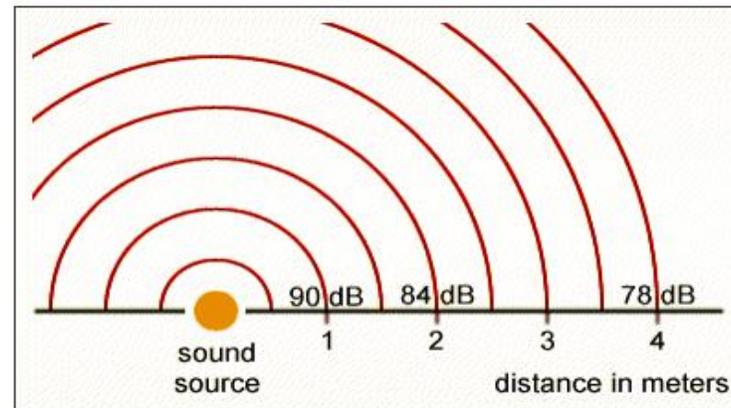
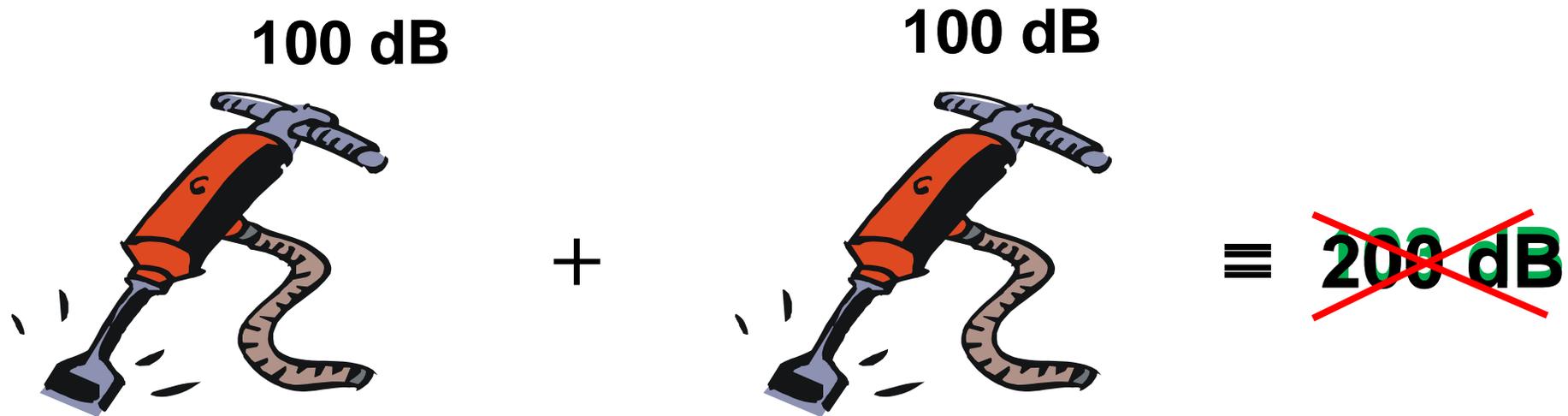


Figure 4: Inverse Square Law Concept in Free Field (OSHA, 2015)

Doubling Sound Source



Because the decibel is logarithmic, it can not be added together like other numbers



- Two sound sources of equal amplitude combined , increase the total by 3dB.
- This is also referred to as doubling rate or Exchange Rate of 3dB, 4dB or 5dB depending on the standard.

Noise Math



If the difference between two levels to be added is:

- ❑ 0 to 1dB, Then add 3dB to the higher number
- ❑ 2 to 3dB, Then add 2dB to the higher number
- ❑ 4 to 7dB, Then add 1dB to the higher number
- ❑ 8dB or more, Then add 0dB to the higher number

If more than 2 levels are to be added they must be added in pairs as follow:

- ❑ (92 dB + 90 dB = 94 dB dif. = 2, add 2dB)
- ❑ (94 dB + 89 dB = 95 dB dif. = 5, add 1dB)
- ❑ (95 dB + 88 dB = 96 dB dif. = 7, add 1dB)
- ❑ (96 dB + 79 dB = 96 dB dif. = 8, add 0dB)

Calibration



□ Pre- and Post-calibrations

- **Pre-calibration** is performed prior to any data being recorded by the meter. During a pre-calibration, the meter level may be adjusted to match the calibrator output level.
- **Post-calibration** is a simple verification that the instrument has remained in calibration throughout the measurement period.

		00:00:15
\CAL		
CALIBRATE		
CALIBRATION HISTORY:		
PRE-CAL	114.0 dB	
11:54:19		30-JAN-2009
POST-CAL	114.0 dB	
06:22:18		30-JAN-2009

NEW EDGE 7 and 8 Dosimeter



New TSI Quest 7&8 Dosimeters

- Voice Note
- Event Recording
- Four internal meters
- Pause Function
- ½ " MEMS microphones
- Intrinsically safe (**EG8**)
- Compatible with DMS software
- Bluetooth vs Non-Bluetooth





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