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25^a Semana de la Salud Ocupacional

Transformación
Social desde la
SST

XXXIX Congreso de Ergonomía, Higiene, Medicina y Seguridad Ocupacional.
18° Congreso Colombiano de Ergonomía: Perspectivas de la Ergonomía en el Trabajo Actual.

NIOSH Health Hazard Evaluation Program: Evaluating and Controlling Workplace Noise Exposure

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National Institute for Occupational Safety
and Health
Health Hazard Evaluation Program



Disclaimer: The findings and conclusions in this presentation are those of the author(s) and do not necessarily represent the views of the National Institute for Occupational Safety and Health (NIOSH). Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention (CDC), NIOSH.

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National Institute for Occupational Safety and Health



What does NIOSH do?

- Occupational health research
- Surveillance and epidemiology
- Health hazard evaluations (HHEs)
- Field studies
- Laboratory studies
- Control technology
- Personal protective equipment
- Respirator testing and certification
- Safety research
- Educational and reference materials
- Protect emergency response workers



What is the NIOSH Health Hazard Evaluation (HHE) Program

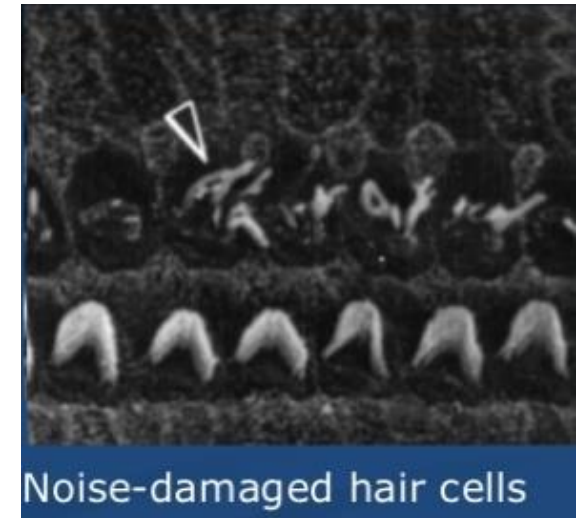
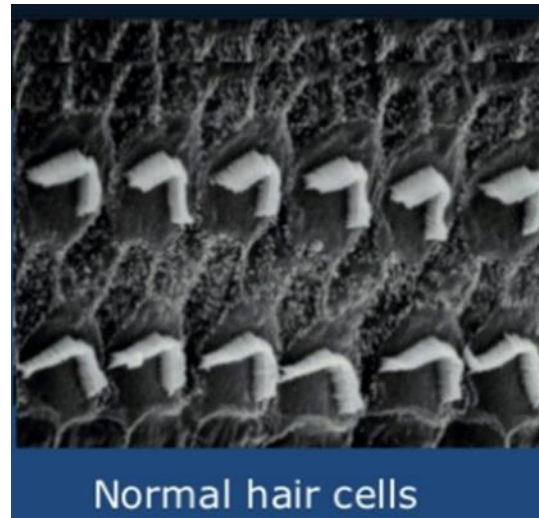
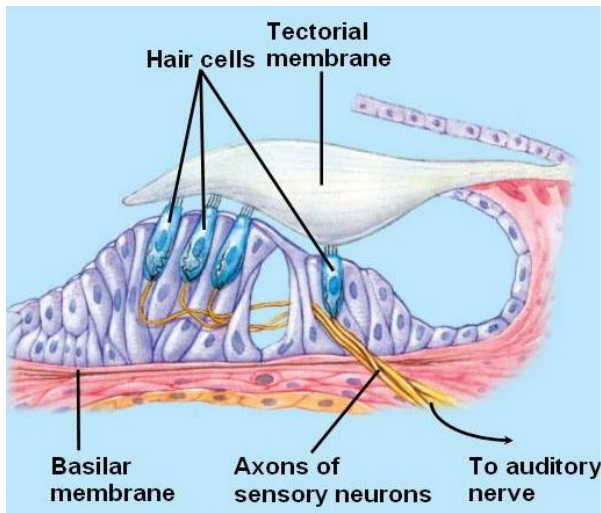
- Respond to requests from employers, employees, unions, and government agencies in the U.S.
- Evaluate chemical, physical, biological hazards, and psychosocial stressors
- Involve employees and employers throughout the process
- Provide a written report with specific recommendations to control identified hazards
- No cost

<http://www.cdc.gov/niosh/hhe/>

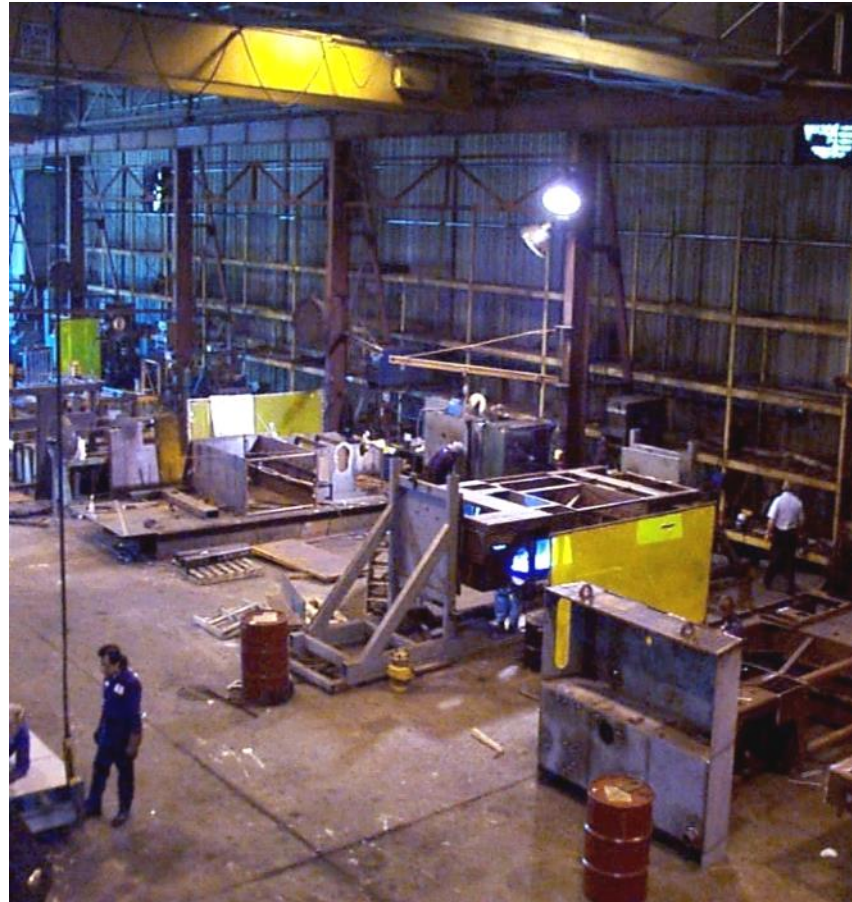


What Causes Noise-Induced Hearing Loss?

- Sound waves deflect hair cells (stereocilia) inside the cochlea which send nerve impulses to brain
- Repeated exposure to loud noise damages stereocilia or dislodges them from the tectorial membrane
- Damaged hair cells = hearing loss



Workplace Noise Evaluations



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Types of Workplace Noise



- Continuous – same noise levels throughout the work shift

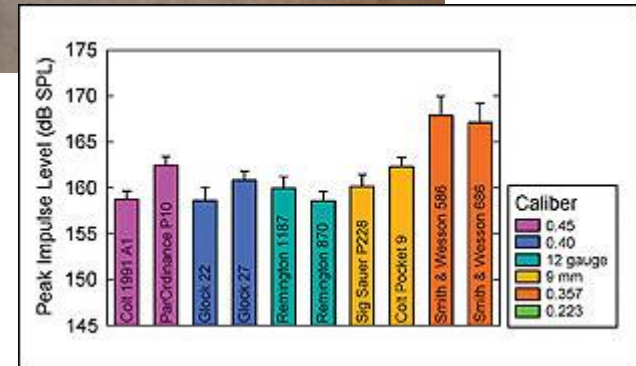


- Intermittent – periods of high and low noise during work shift

Types of Workplace Noise



- Impulse or Impact - steep rise in the sound level to a peak level, followed by a rapid decay; at least 1 second between peaks



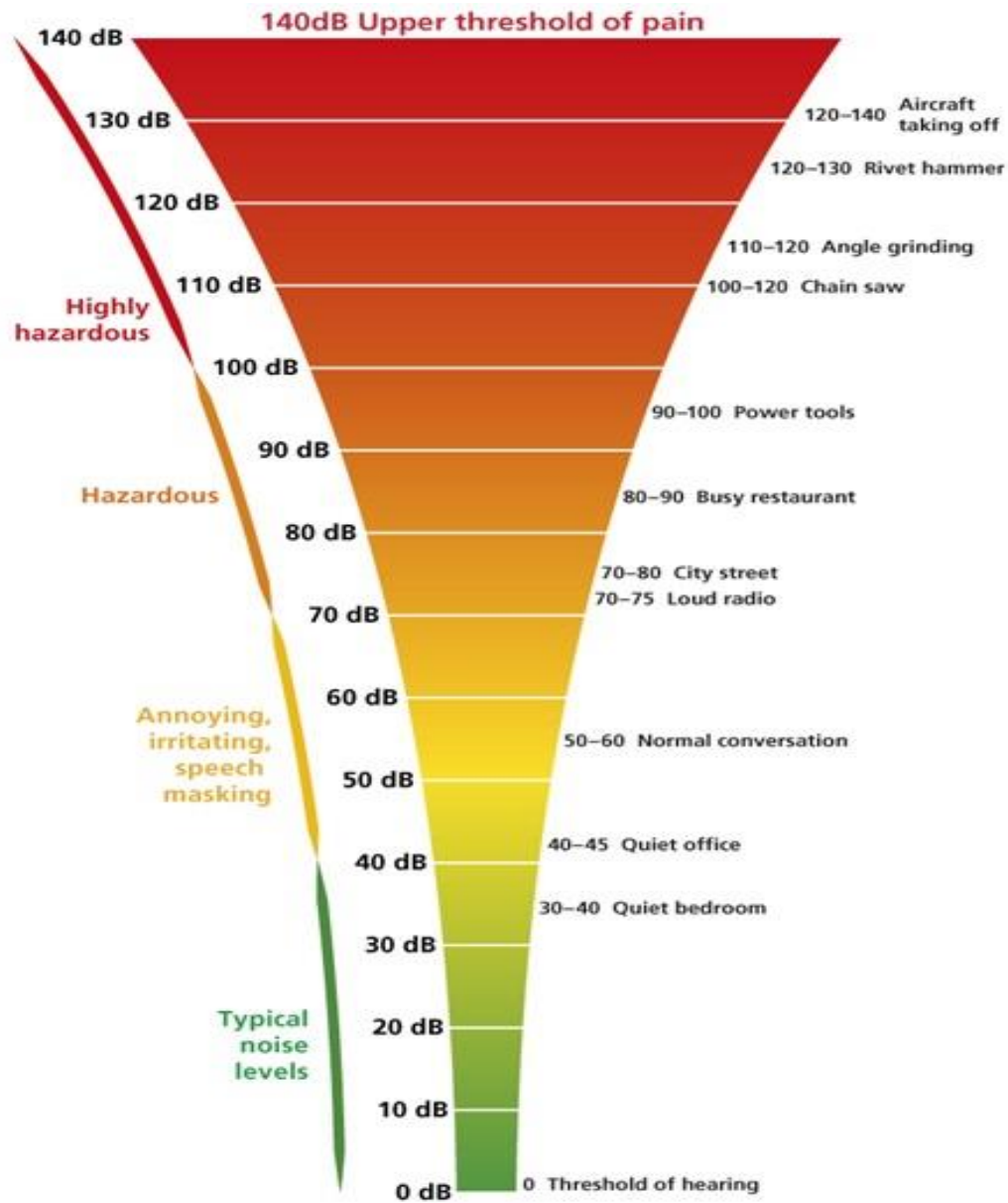
Types of Workplace Noise



- Combination - both continuous and impulsive noise

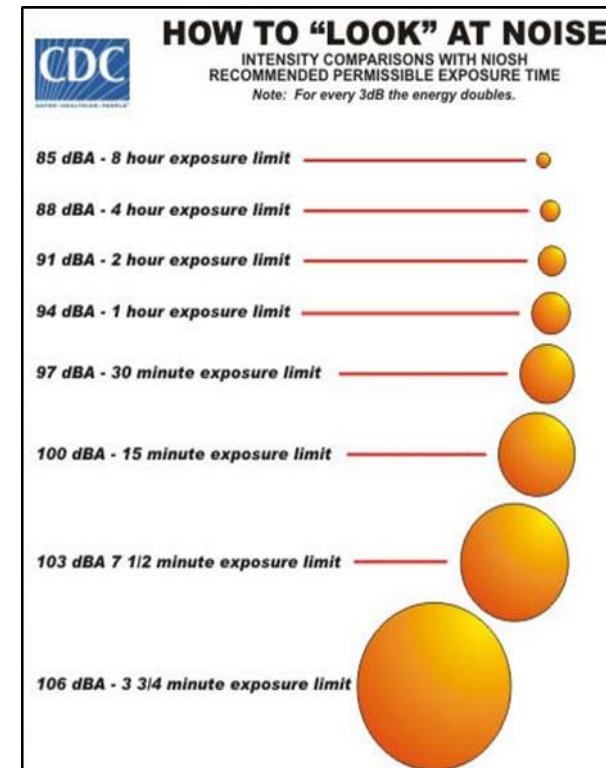
As a general guideline:

The work area is too noisy if a worker has to raise his or her voice to be understood by a co-worker 3 feet away.



NIOSH Recommended Exposure Limit (REL)

- 85 dBA, as an 8-hour time-weighted average (TWA)
 - This is equivalent to a noise dose of 100%
- If REL exceeded, NIOSH Recommends a hearing loss prevention program
 - *Use engineering, administrative, and/or work practice controls to reduce noise exposures*
 - *Provide hearing protection*
 - *Provide fitting and training on hearing protection*
 - *Provide baseline and annual audiometric testing*



Adjust Noise Exposure Limit for Longer Work Shifts

<u>Shift Length</u>	<u>Exposure Limit (dBA)</u>
8 hr	85.0
9 hr	84.5
10 hr	84.0
11 hr	83.6
12 hr	83.2

Noise Measurement Instruments

- Noise Dosimeter
- Sound Level Meter

Noise Dosimeter



- Personal monitoring
- Measure full-shift time-weighted average (TWA) noise exposures



Noise Dosimeter Settings

- Response rate: Slow
- Weighting scale: A-weighting
- Exchange rate: 3-dB (NIOSH)
- Threshold level: 80 dBA (NIOSH)
- Criterion level: 85 dB (NIOSH)

NOTE: always calibrate before and after using instruments

Sound Level Meter with Octave Band Analyzer

- Area noise monitoring
 - Assess where overexposures likely or noise controls needed
- Identify noise sources
- Task-based noise measurements
- Measure frequency specific noise levels to determine best type of noise control
- Accuracy:
 - Type 1 = ± 1 dB at 1000 Hz
 - Type 2 = ± 2 dB at 1000 Hz



Measuring Employees' Noise Exposures

- Best method
 - Use noise dosimeter to measure full-shift exposures
- What if we do not have a noise dosimeter?
 - Task-based noise monitoring
 - Area noise monitoring



Task-based Noise Monitoring

Department	Job Code	Job Function	Job Tasks	Time-At-Task (hrs)	Task Sound Level (dBA)
930	2882	Repair	Lunch and Break	1.0	74.8
			Weld Department Repairs	2.0	88.5
			Press Department Repairs	3.5	92.5
			Tool and Die Area Activity	1.5	83.2
TWA Noise Exposure for Job Code 2882 in Department 930				8.0	90.0

$$\text{Task based TWA } (L_{TWAi}) = q \log_{10} \left[\frac{1}{T} \sum_{i=1}^N t_i * 10^{L_{SLAi}/q} \right]$$

$$q = 10$$

T = 8 (hours worked during the work shift)

N = Total number of job tasks

t_i = Duration of the i th task (time-at-task)

L_{SLAi} = A-weighted sound level average for the i th task

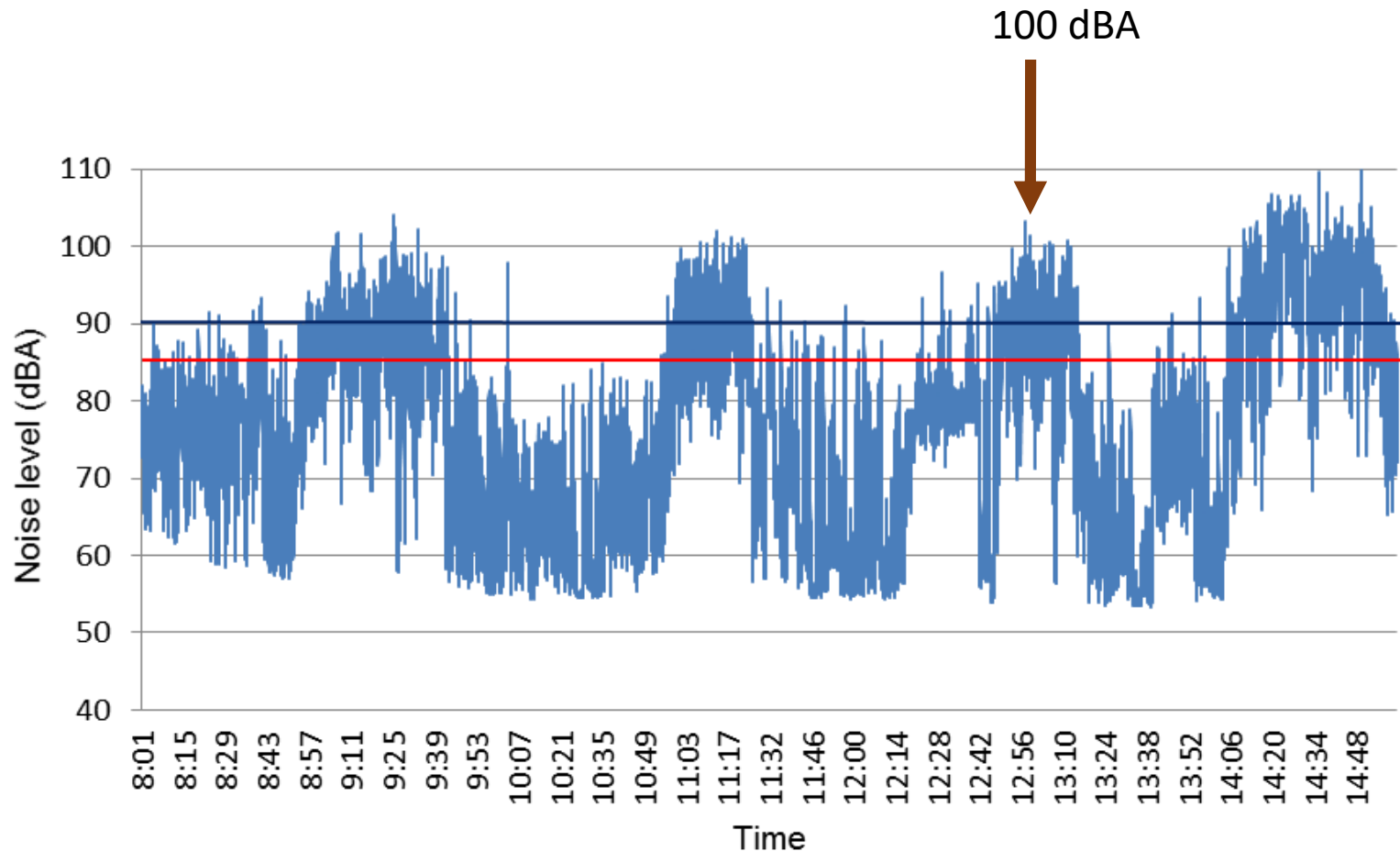
Area Noise Monitoring



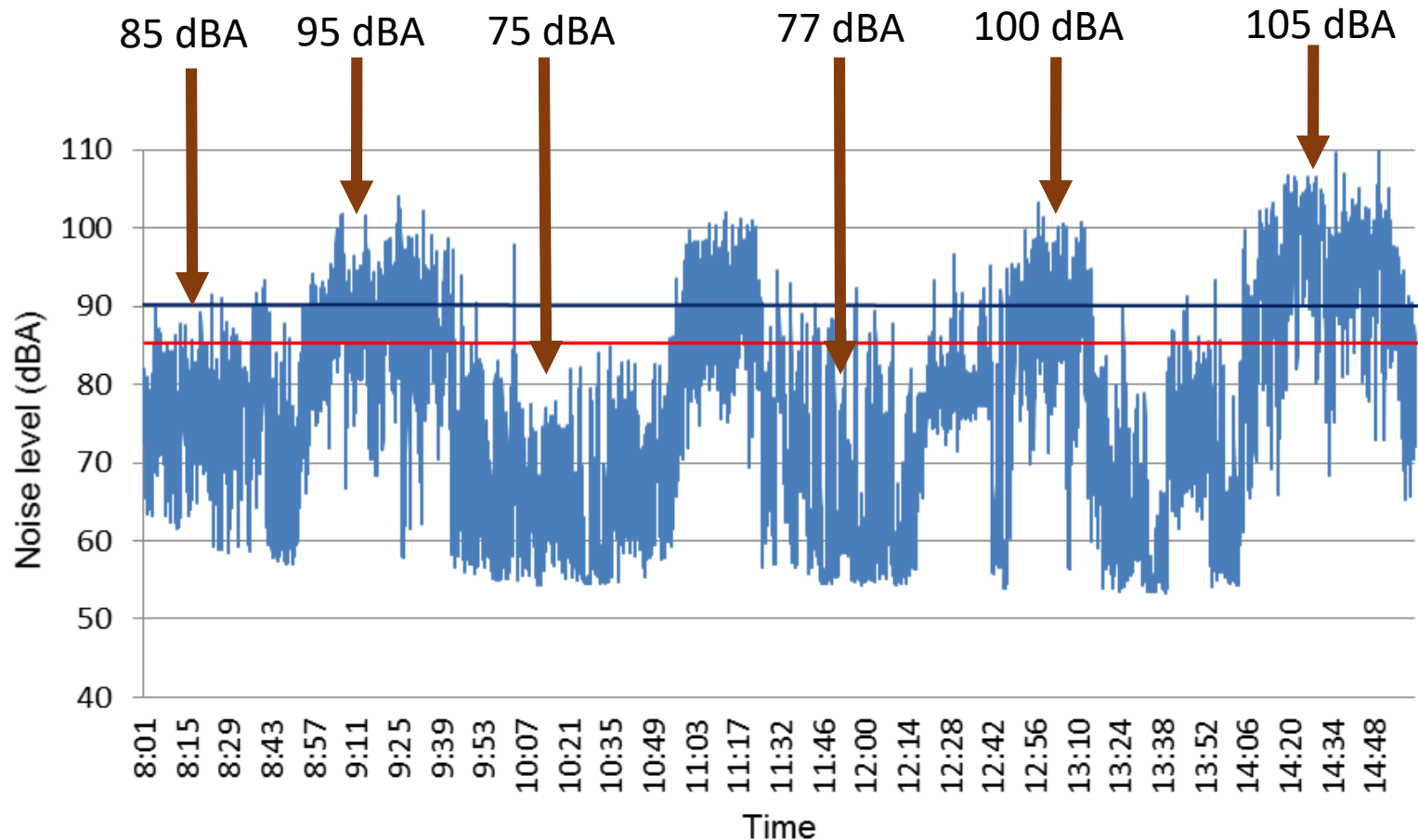
Area Noise Monitoring: What if we only took one measurement?



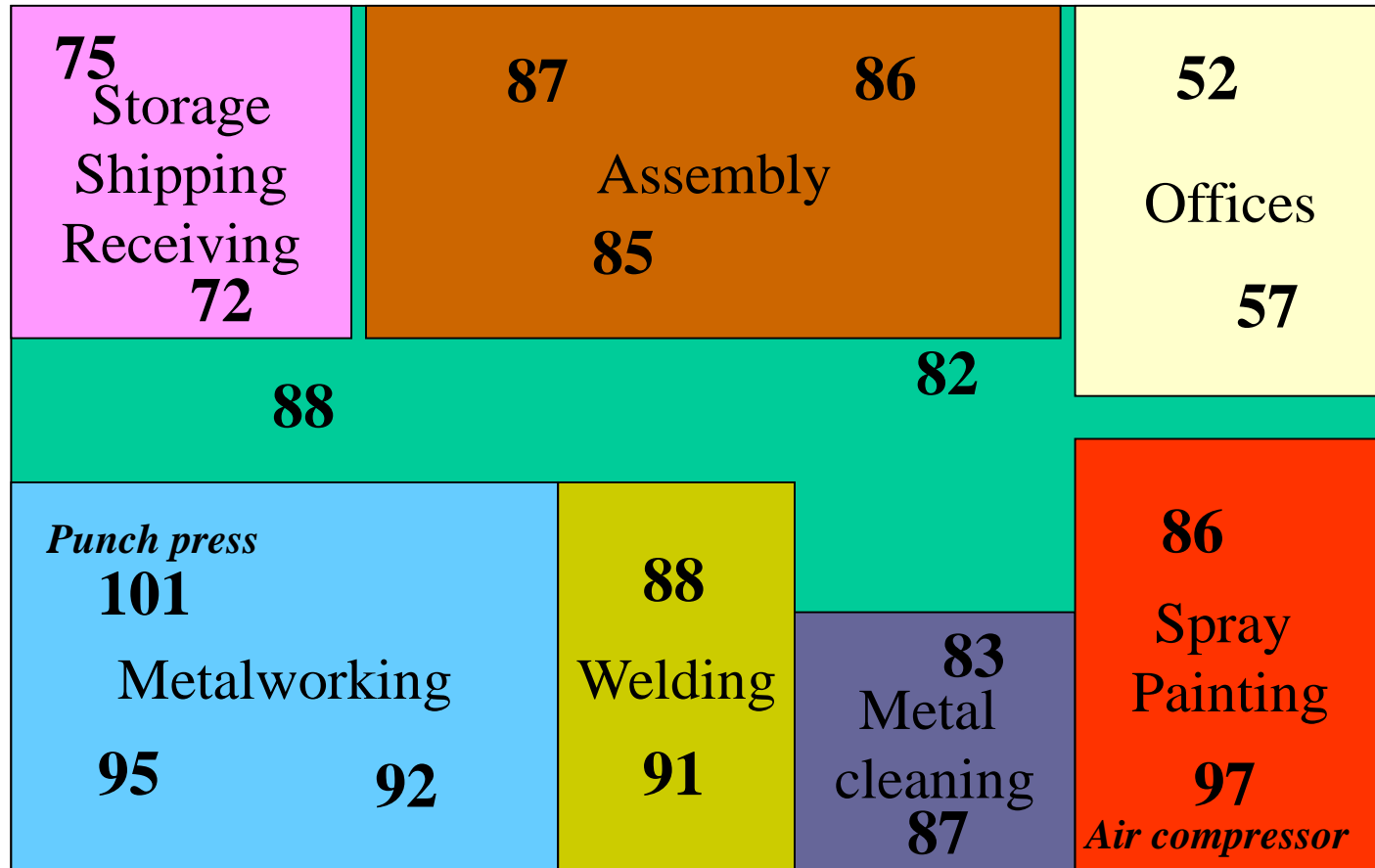
Area Noise Monitoring: What if we only took one measurement?



Area Noise Monitoring: Multiple measurements are better



Area noise mapping (dBA)



Noise Assessment Considerations

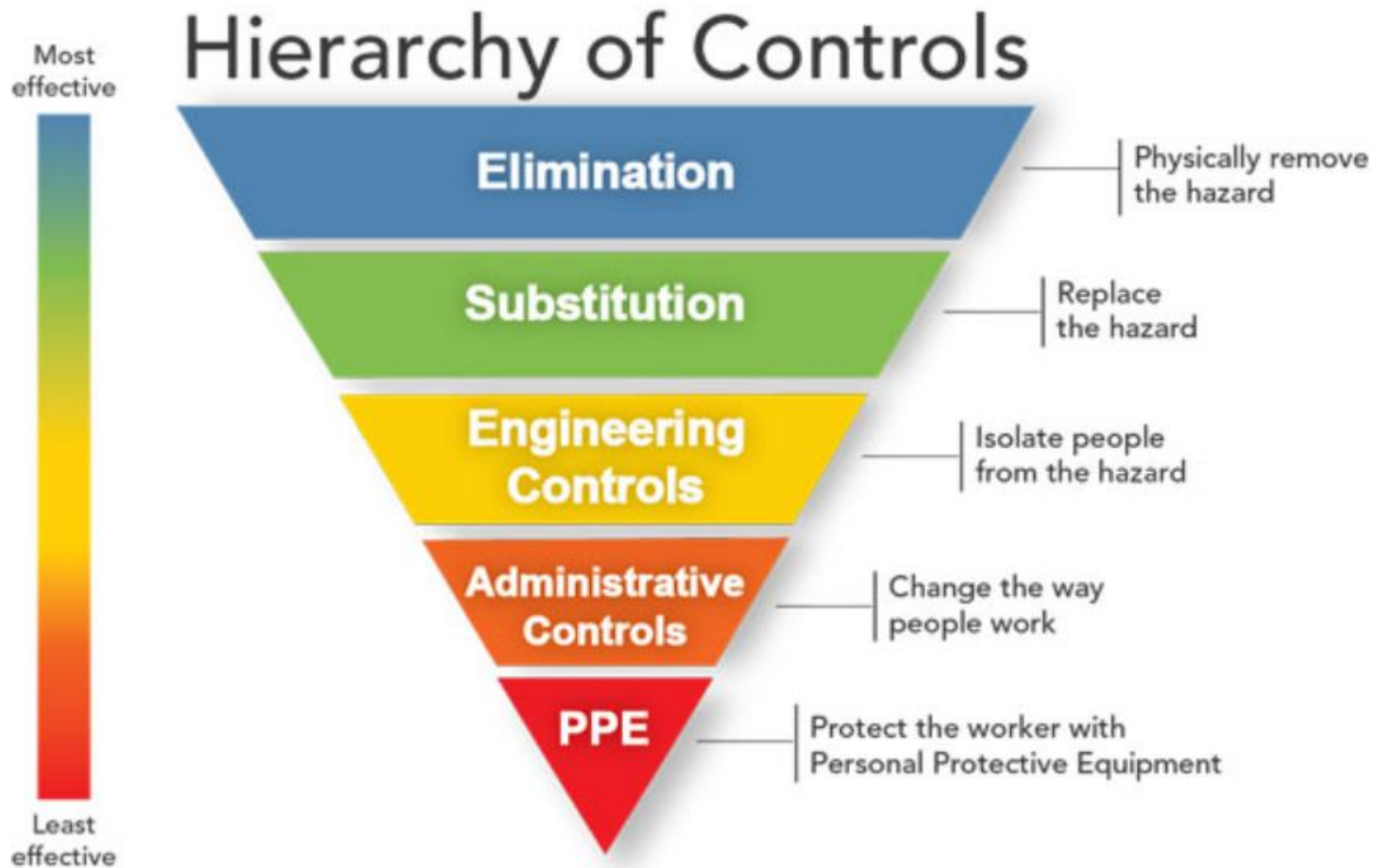
- Identify noise sources
 - Observe production processes, equipment, work activities, and work practices
- Identify and select workers from similar exposure groups (SEGs) for monitoring
 - Workers with similar exposure conditions, tasks, duration, equipment, and work processes
 - Rule of thumb – select 10%-25% from each SEG
- *When and where* to sample?
 - Shift differences (1st vs. 2nd vs. 3rd)
 - Differences within the shift (am vs. pm)
 - Task differences
 - Differences in equipment or processes
- Evaluate potential noise control options

Noise Control



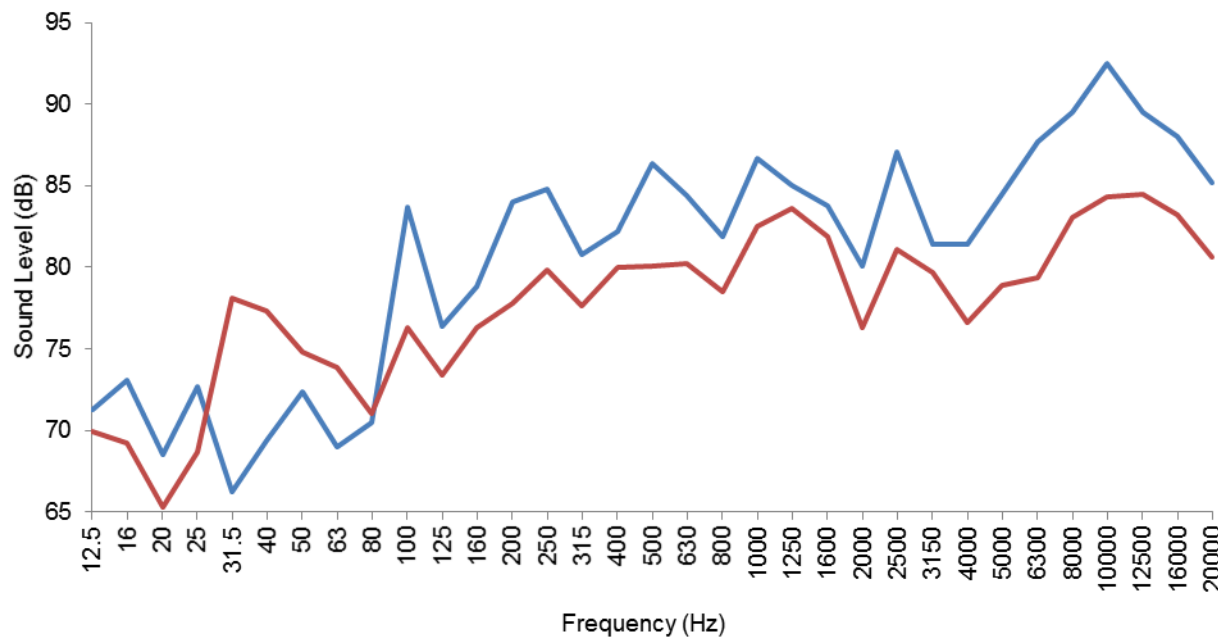
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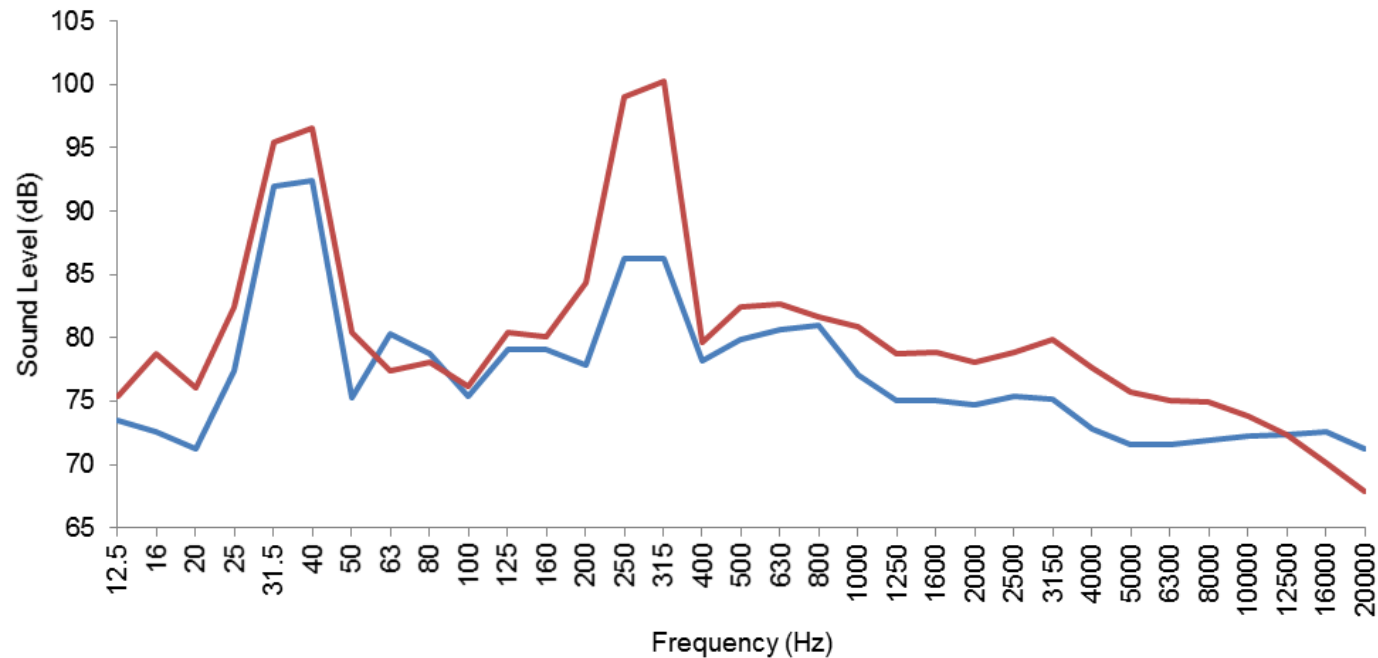
What does knowing noise frequency tell us about noise control?

- **High Frequency** noise is strongly **directional** and more easily reflected.
- Use enclosures, noise barriers, eliminate compressed air leaks

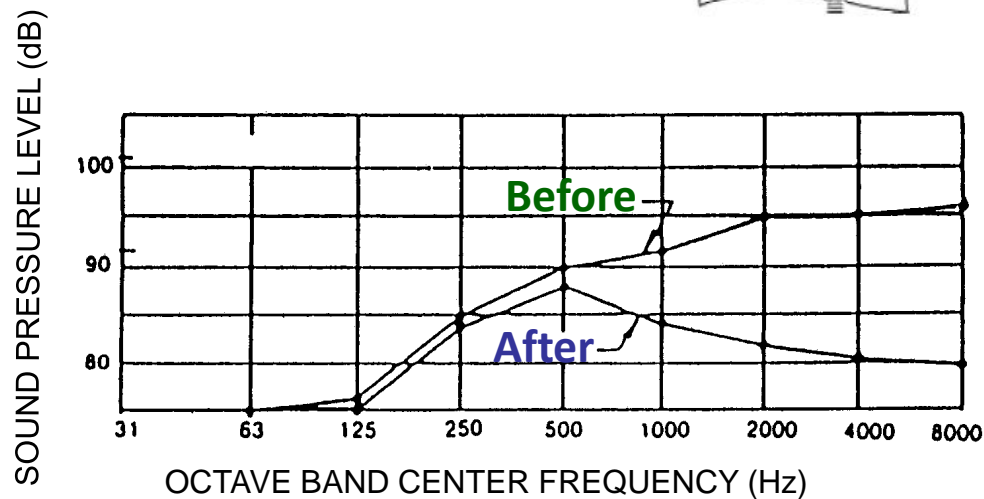
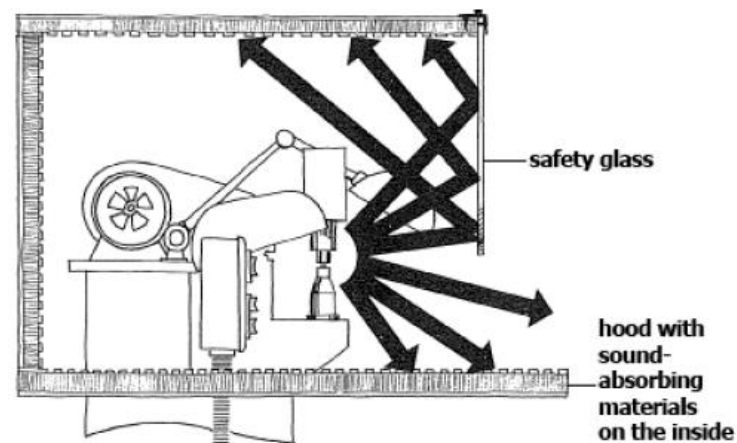
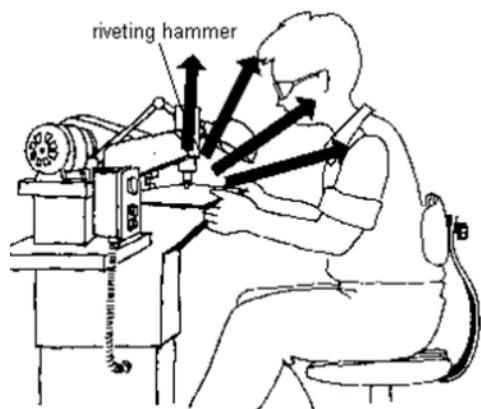


What does knowing noise frequency tell us about noise control?

- **Low Frequency** Noise travels in all directions ***around*** objects ***and through*** openings
- Use vibration isolation



Noise levels before and after installation of a partial enclosure and glass shield



Noise Enclosure Problem

Problem: Opening in side panel and on bottom of machine enclosure allows high frequency noise to escape

Solution: Reduce openings in enclosure



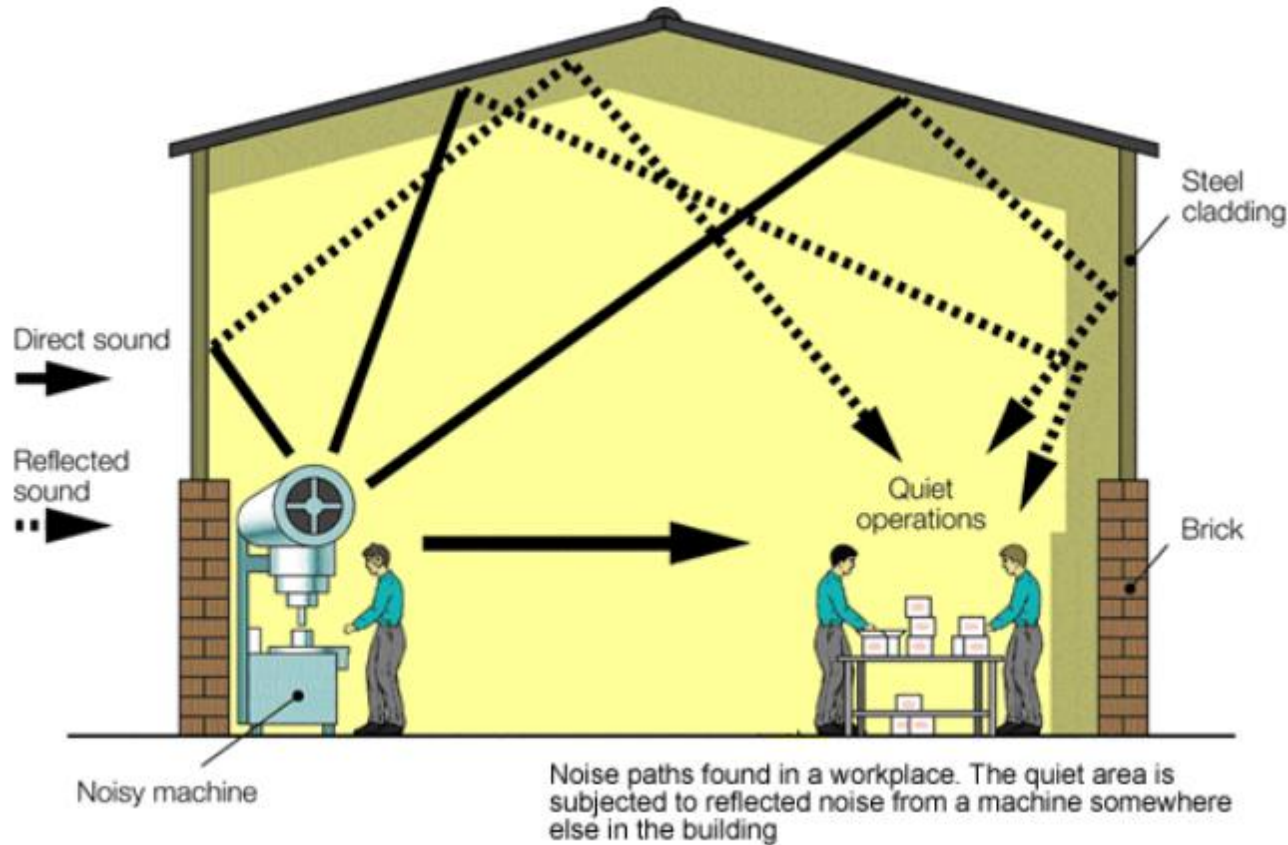
Separate Worker from Noise

Operator booth in high noise area of metal conduit manufacturing company

More than 15 dB noise reduction

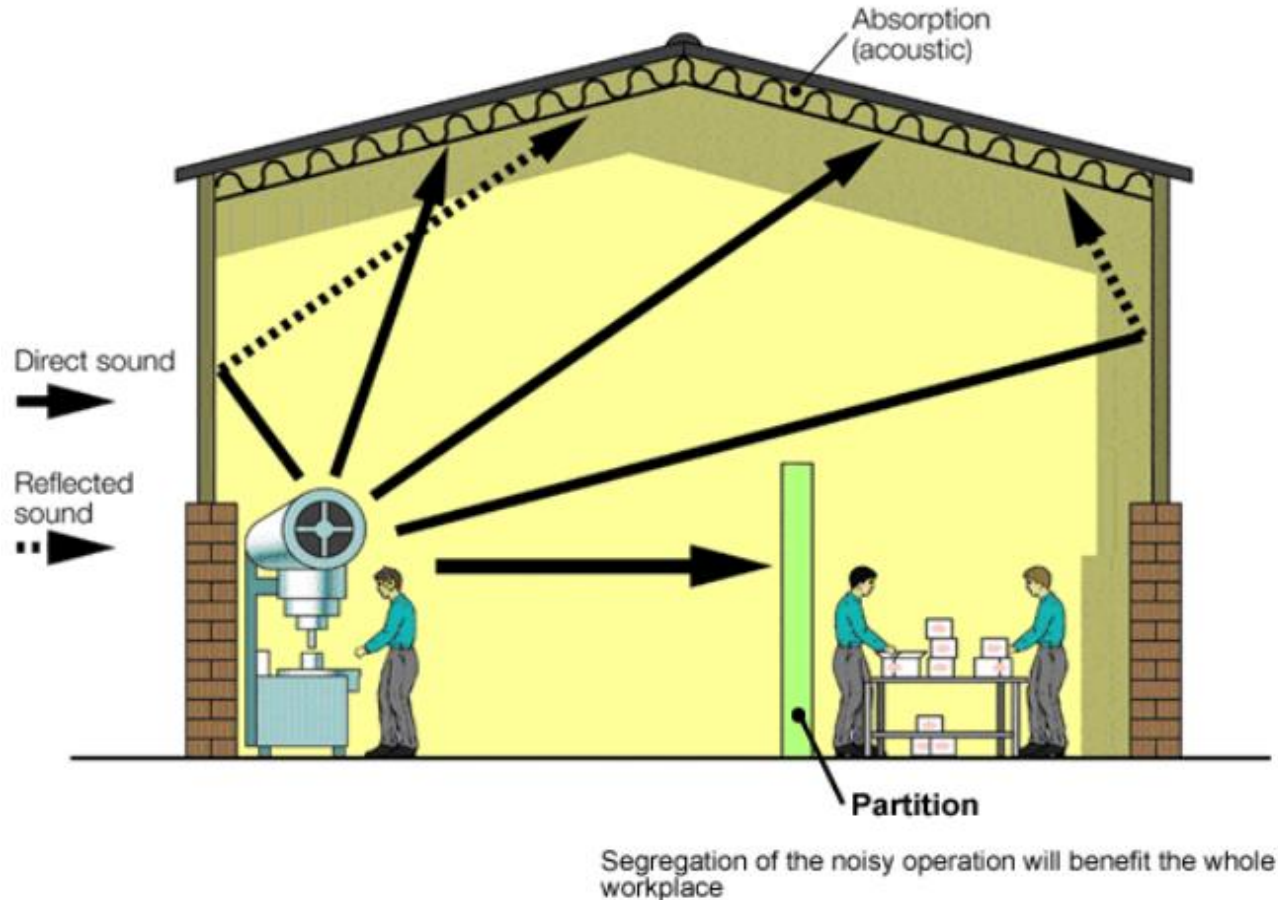


Noise paths for direct and reflected sound



<http://www.hse.gov.uk/noise/goodpractice/workplacedesign.htm>

Using absorptive treatment on ceiling and barriers to reduce direct and reflected sound



<http://www.hse.gov.uk/noise/goodpractice/workplacedesign.htm>

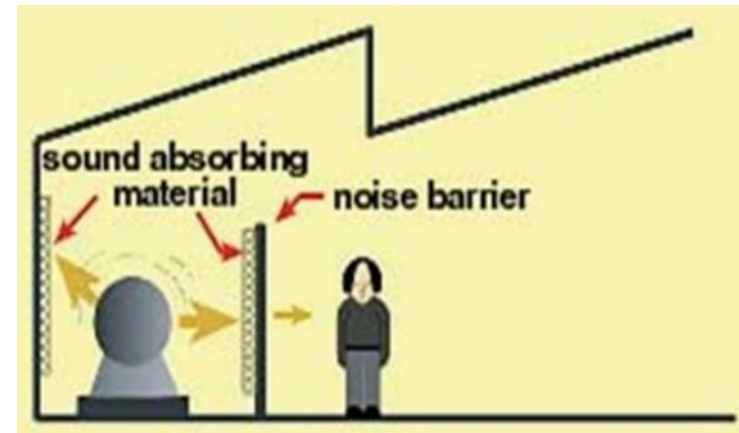
Sound absorption treatment

- Absorbent materials on walls only affect the reflected, reverberant sound – not the direct path of sound
- Can material withstand workplace environment (for example dust and moisture)

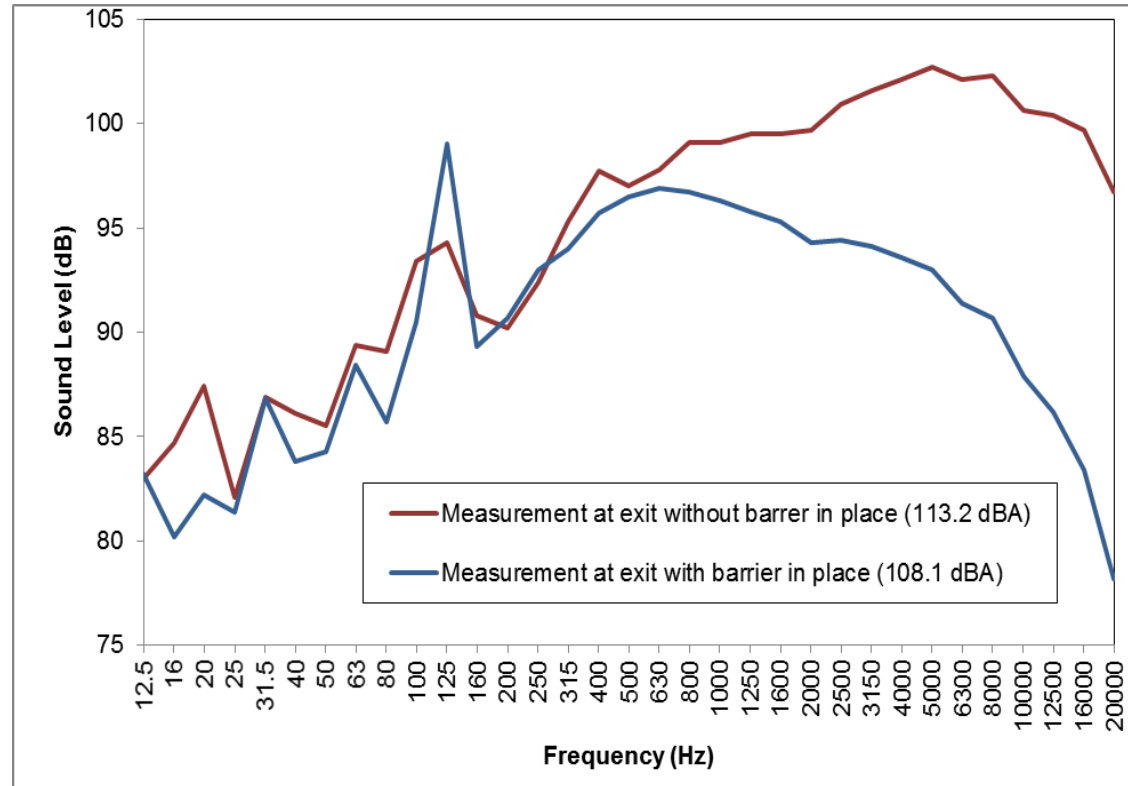


Sound Barriers

- Do not work well for low frequency noise
- Best at reducing direct noise, and may not affect reflected noise.
- Place barrier as close to the noise source or employee position as possible.
- Construct barrier of a dense material, and line it with absorptive material facing the noise source.



Sound Barrier



Noise Control of Baler Operation

- Recommendations:
 - Increase width and height of barrier wall
- OR
- Completely enclose baler operation



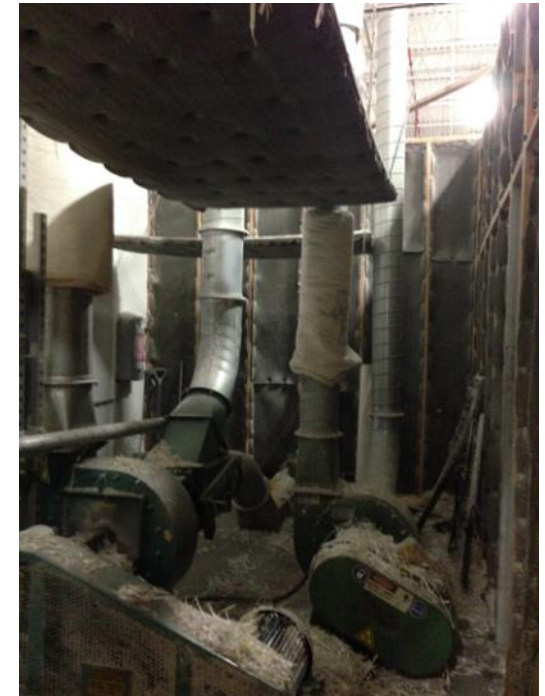
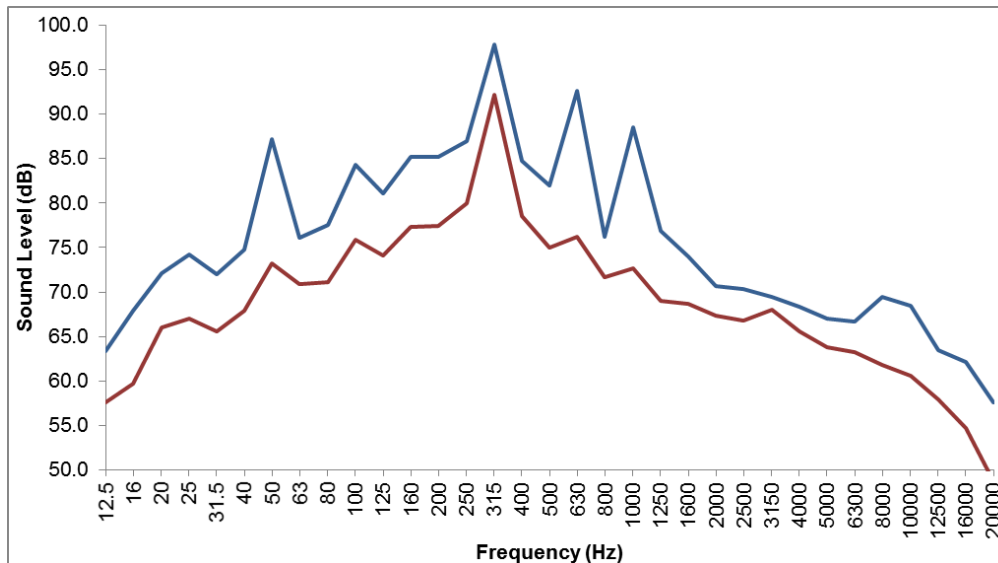
Noise Control of Baler Operation

HOWEVER

- Octave band measurements also show low frequency characteristics (barrier wall has little effect on low frequency noise)

Therefore

- Improve vibration isolation of baler and motors



Poor design and maintenance of noise barrier in foundry



Example noise control for impact noise from tool

- Hard Cap[®] chisel by Mayhew Tools
 - Polymer Cap
 - Hard cap delivers impact energy
 - Reduces noise
 - Damps ringing of the metal chisel

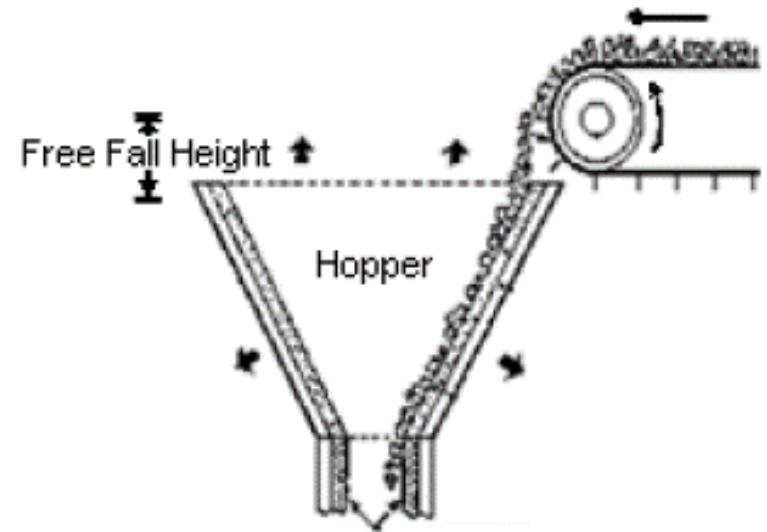
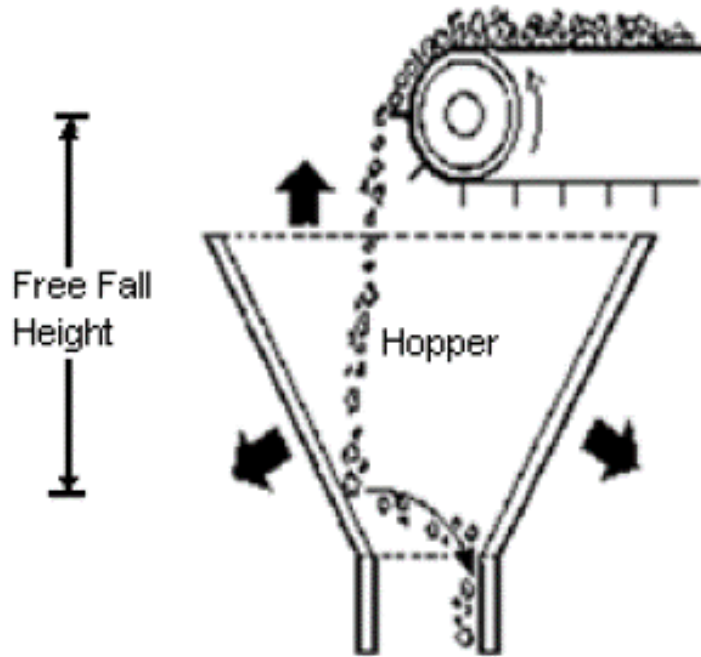
Higher
impact
noise

Lower
impact
noise



<http://www.mayhew.com/>

Reduce noise from falling objects



From: Noise Control, Principles and Practice, Bruel & Kjaer

Metal-to-metal noise

Problem: Noise from castings bouncing on metal shaker conveyor and falling into metal bins (sound levels = 103 dBA, peak levels: 128 dB)

Solutions:

- Reduce distance that casting fall
- Increase thickness of metal bins and conveyor surface with thicker metal or constrained layer damped metal
- Replace metal bins with durable plastic composite



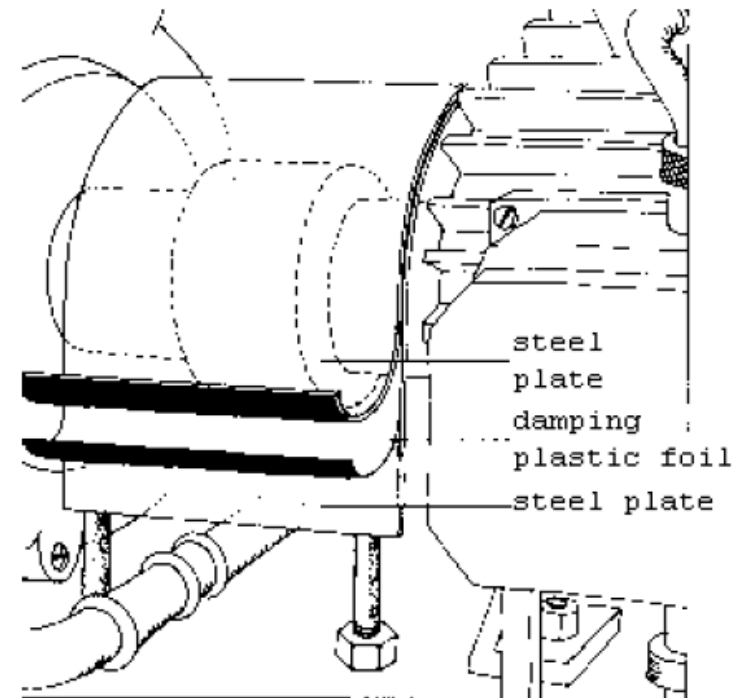
Metal-to-metal and equipment noise

Replacing steel flight bars with durable polyurethane coated flight bars on continuous mining machine achieved noise reduction of 5-7 dB



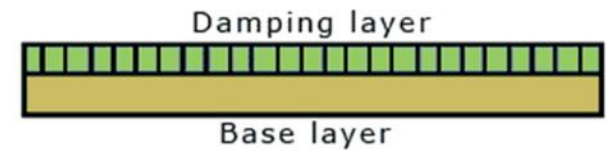
Apply damping material to vibrating surfaces

- Free layer
- Unconstrained layer
- Constrained layer



Unconstrained Layer Damping

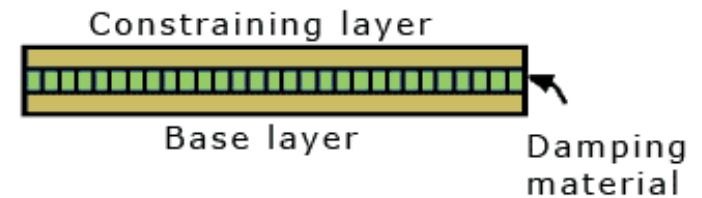
- Sheet metal with viscoelastic layer (Typically a stiff polymer)
- Stiff plastic with adhesive backing
- Stiff foam with adhesive backing
- Hard stiff rubber sheeting with adhesive backing



<http://www.megasorber.com/contact.html>

Constrained Layer Damping

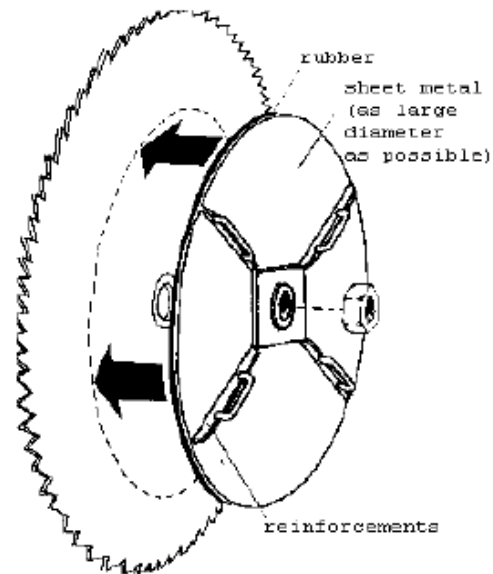
- Sheet Metal (Steel)
- Viscoelastic core (0.001 to 0.1 inches thick)
- Sheet Metal (Steel)



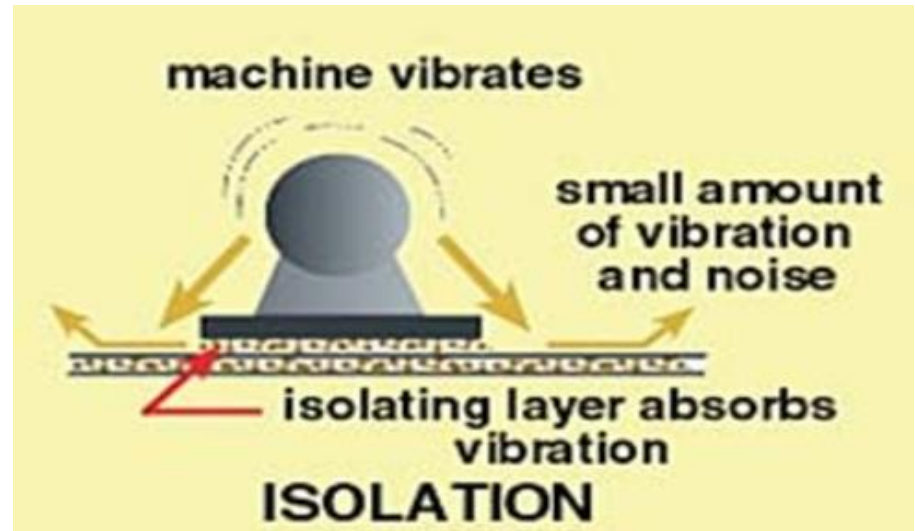
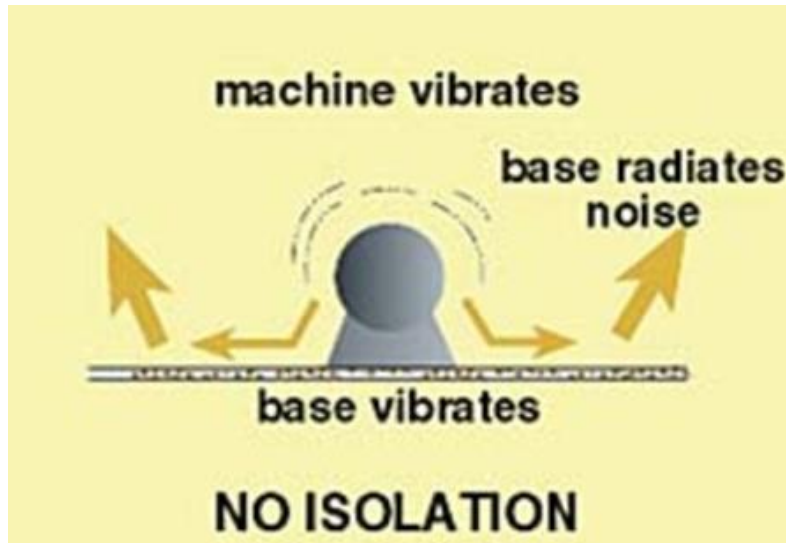
<http://www.megasorber.com/contact.html>

Reducing noise from sawblades

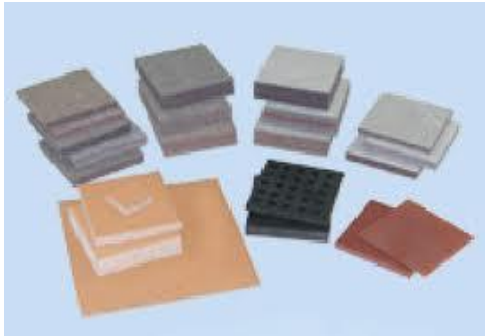
- Composite saw blades
- Quiet design blade
- Keep saw teeth sharp
- Adding noise damping collars to saw blades



Vibration Isolation

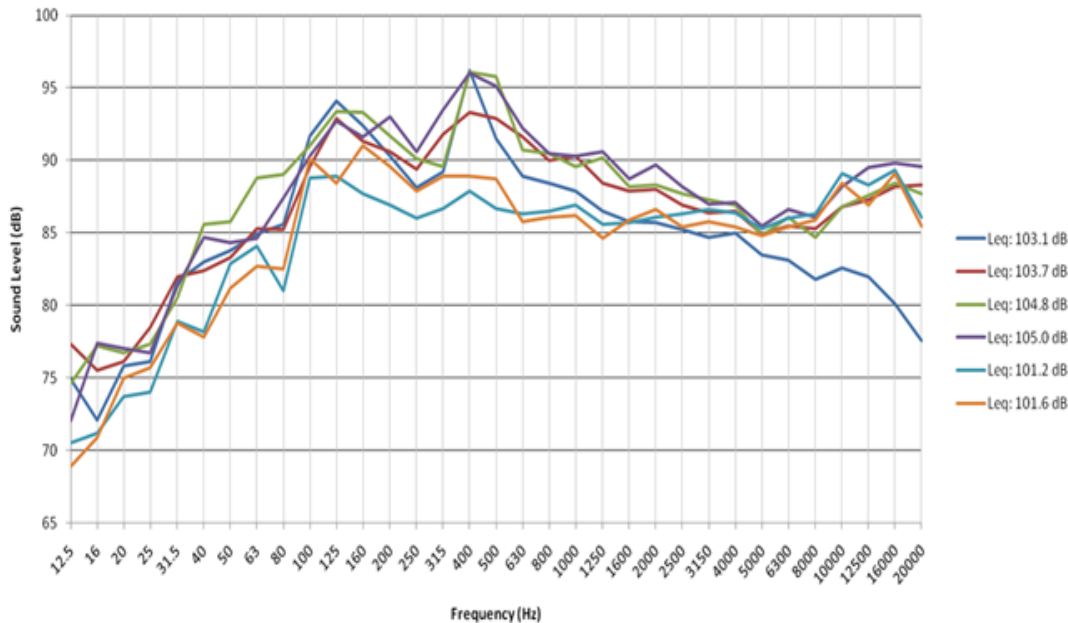


Example Vibration Isolation Mounts



Vibration Isolation

Recommendation: Install vibration isolation pads or springs to reduce vibration transmitted from operating equipment to surrounding surfaces



Stamping press mounted to concrete floor had no vibration damping

Vibration Isolation



No vibration isolation

Foundry shaker bolted directly to the concrete floor

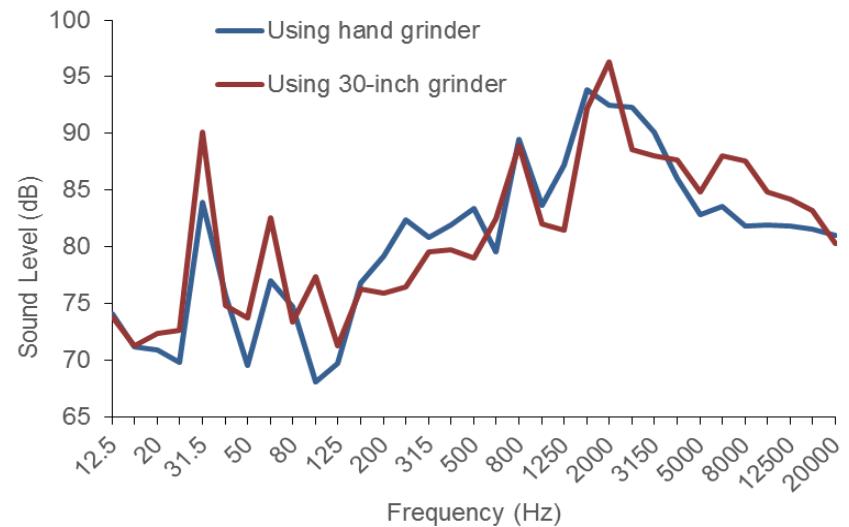


Vibration isolation

Barrel house shakeout mounted on heavy springs

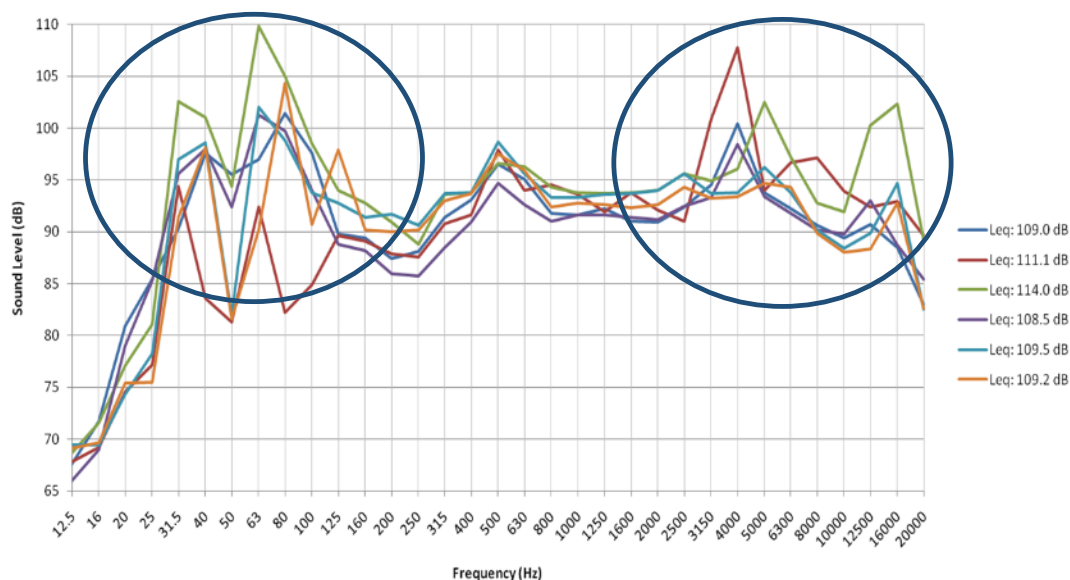
Noise from grinders

- Reduce noise
 - Contact the grinding wheel manufacturers to select grinding wheels that generate less noise.
 - Decreasing rotational speed of the grinding wheel
 - Mount large grinders on vibration isolation pads
 - Place castings on vibration isolation mats



Noise control for combination of high and low frequency

- Install acoustic enclosures or barriers on equipment to reduce high frequency noise components
- Install vibration isolation pads to reduce vibration transmitted from operating equipment to surrounding surfaces

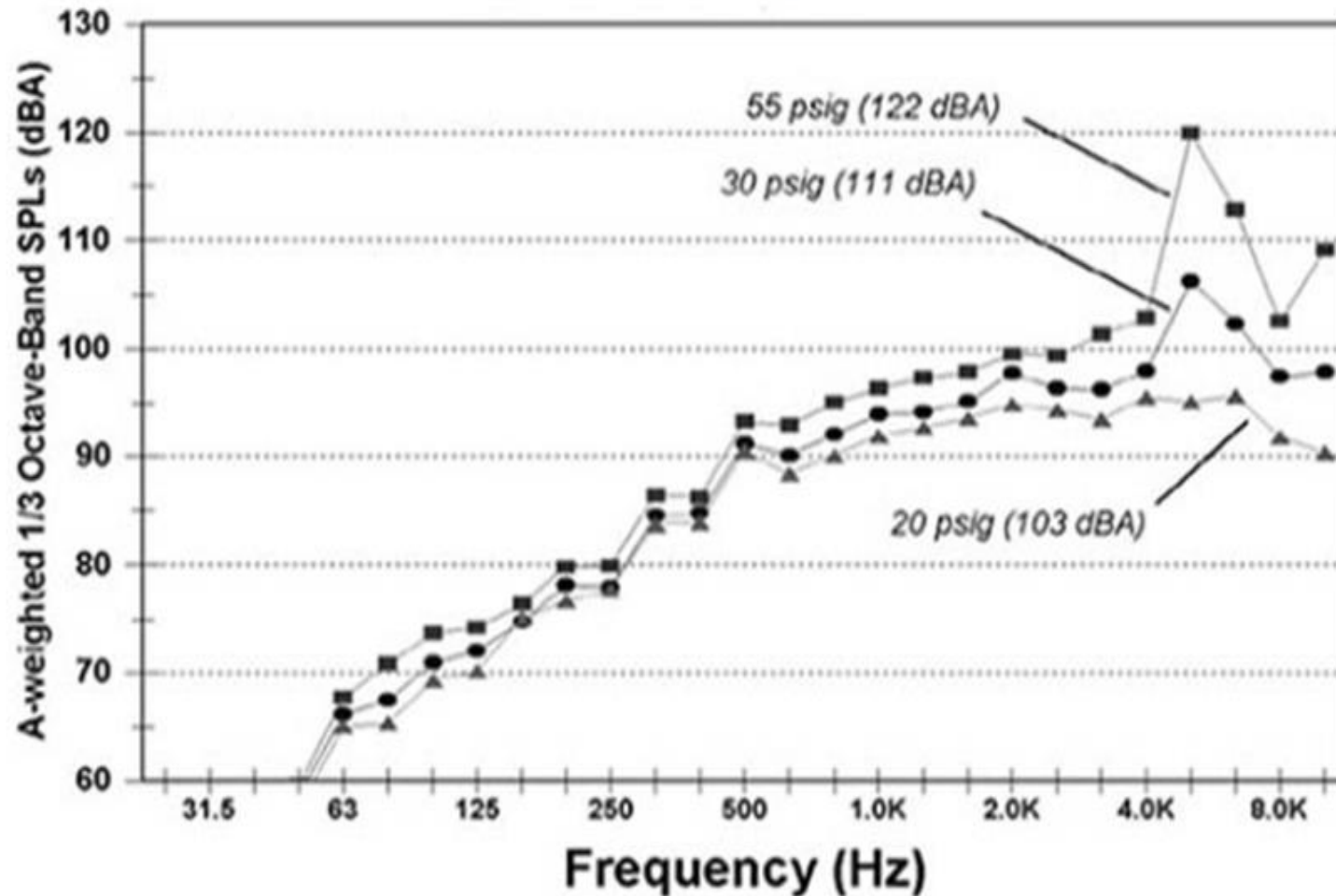


Motor and blower, without vibration isolation or noise enclosure, mounted directly to a metal platform

Pneumatic and compressed air noise

- Pneumatic or compressed air systems:
 - Operate equipment with devices such as air cylinders, air valves, and solenoids
 - Air jets, air nozzles, or hand-held air guns often used move parts/product, blow-off debris, close flaps on corrugated containers (boxes/cases)
- Compressed air can account for 25-33% of a plant's noise problems.
 - Noise from compressed air is caused by turbulence due to the mixing of air with widely different velocities
 - Additional turbulence and noise is created as the compressed air blows against objects, such as parts or sections of the machinery
- Compressed air noise is probably one of the easiest to control
- Reducing compressed air usage and noise can have significant financial and energy savings over time

Noise Reduction Resulting from Air Pressure Adjustments



Pneumatic and compressed air noise

Problem: Air turbulence and high noise caused by air exiting open ended nozzles of compressed air guns



Solution: Reduce air pressure and replace compressed air guns or tips with quiet-design nozzles



Pneumatic and compressed air noise

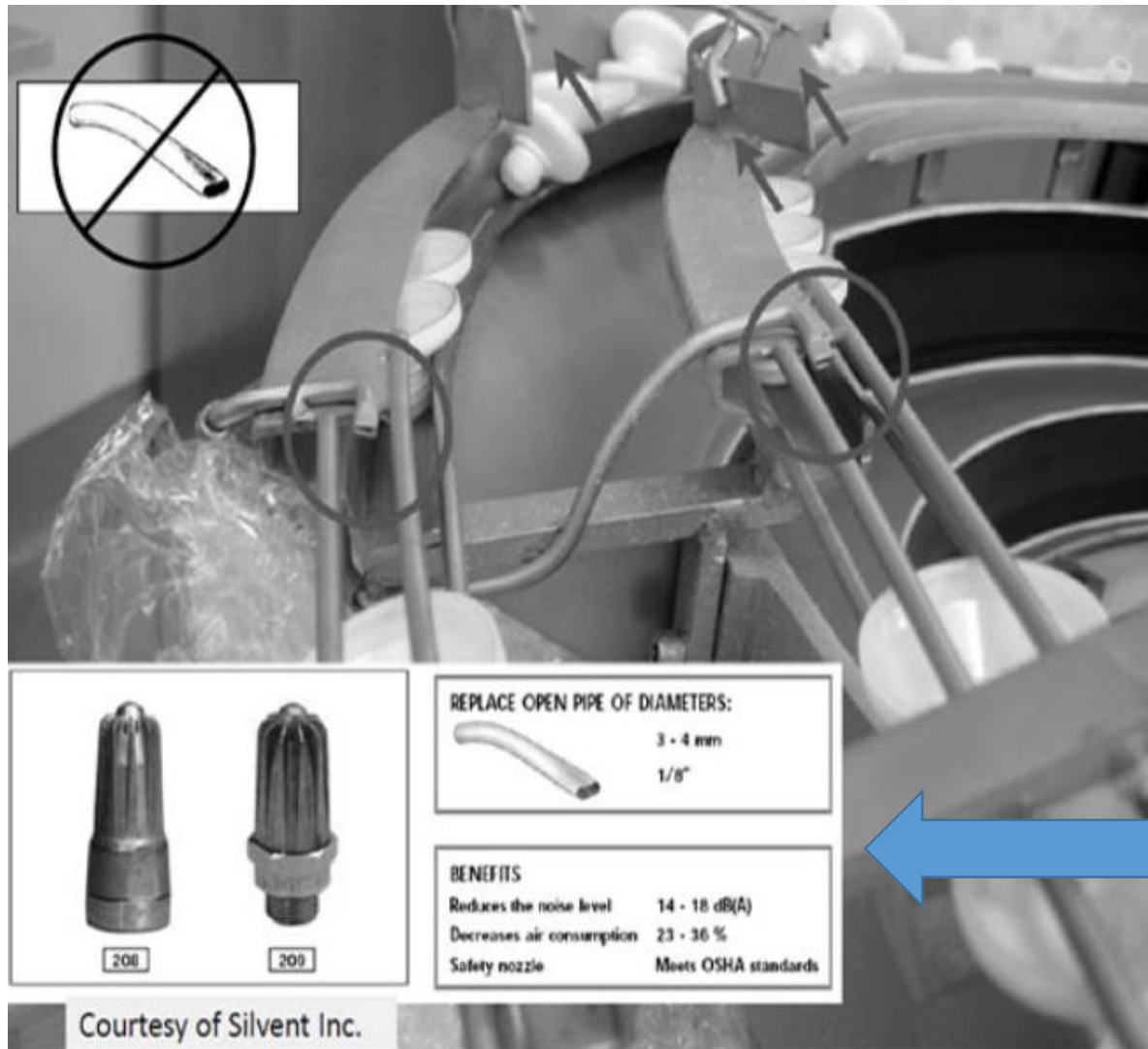
Problem: Exhaust ports of solenoid valve without silencing mufflers lead to high noise as air exits




Solution: Installing mufflers on exhaust port reduces noise



Pneumatic and compressed air noise



REPLACE OPEN PIPE OF DIAMETERS:

	3 - 4 mm
	1/8"

BENEFITS

Reduces the noise level	14 - 18 dB(A)
Decreases air consumption	23 - 36 %
Safety nozzle	Meets OSHA standards

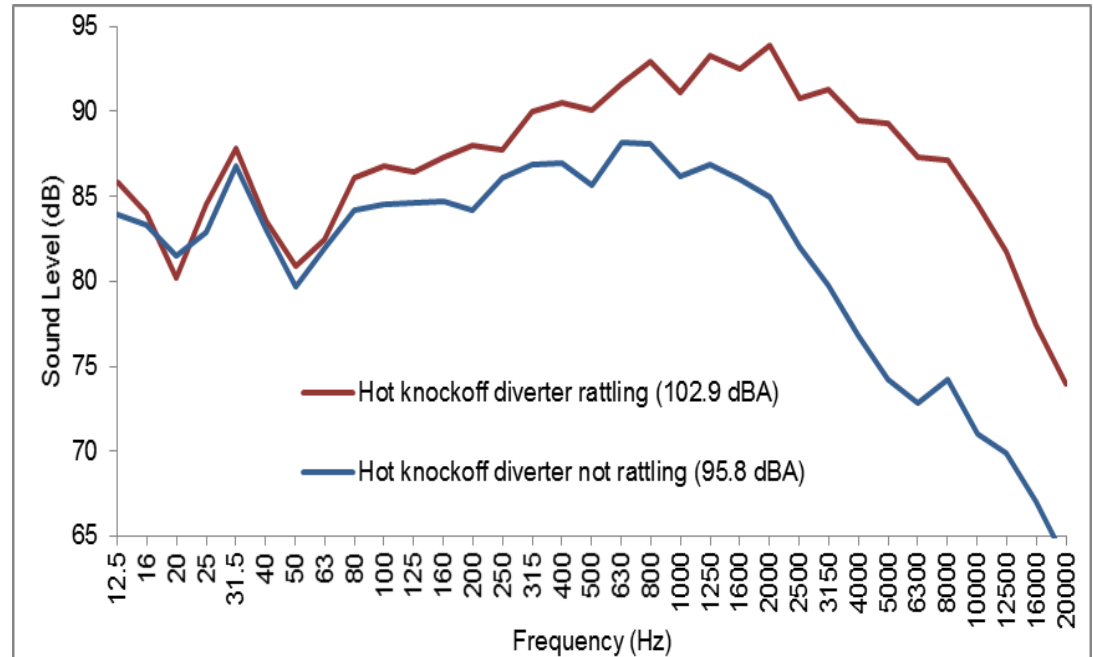
Courtesy of Silvent Inc.

Fix compressed air leaks

- Compressed air leakage is a widespread problem in industry
- In this example: more than 10 dB noise reduction by repairing leak



Noise from poor maintenance



Noise from poor work practices

Problem:

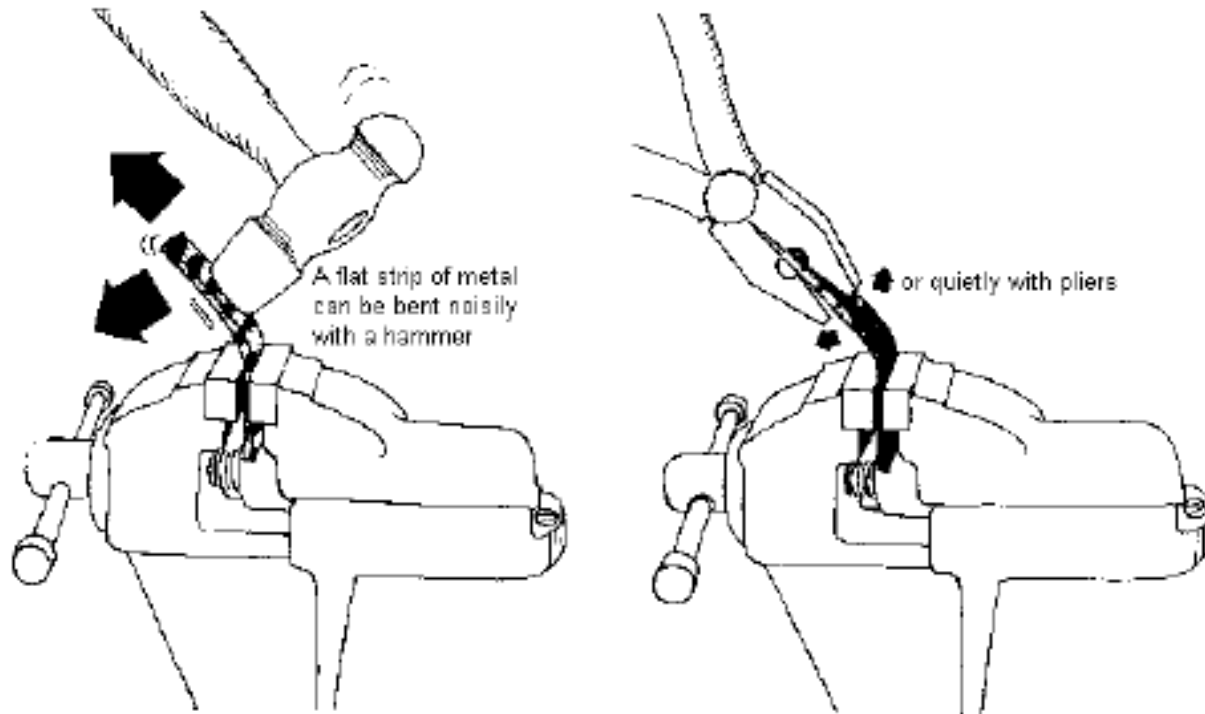
- Metal container into which employees tossed foundry scrap positioned 3 meters behind employee.

Solutions:

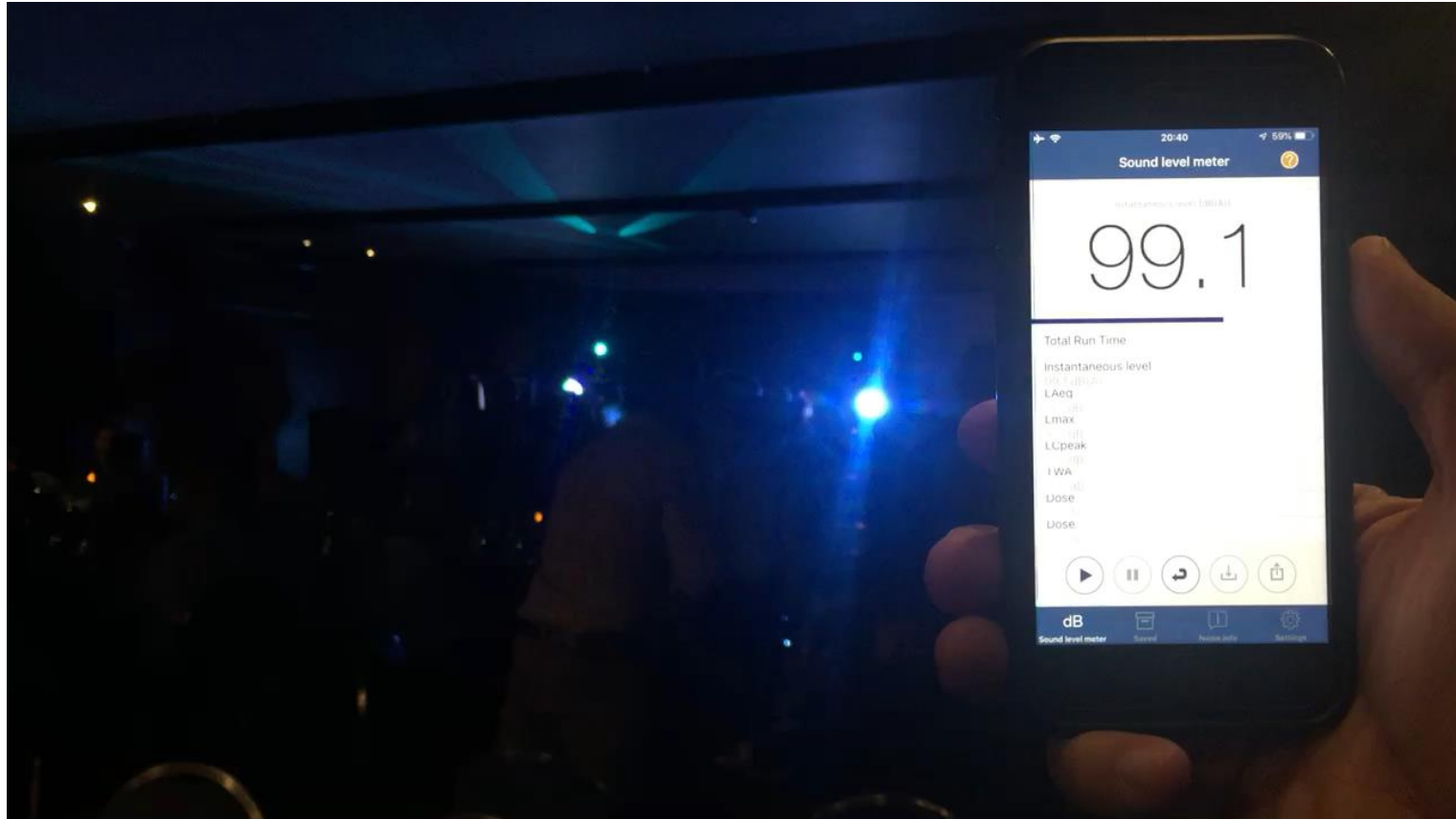
- Place bins close to work station
- Replace thin-walled metal bins
 - Thicker metal walls
 - Durable plastic polymer bins
- Modify work practices
 - Employees more gently drop pieces into bins



Changing work practices to reduce noise



What about noise here?



Buy Quiet Process

What You Can Do to Help

Buy Quiet is an occupational health and safety initiative which encourages companies to purchase or rent quieter machinery as older machinery is replaced in order to reduce worker exposure to noise. The program helps you comply with OSHA requirements, reduces the noise impact on the community, and encourages manufacturers to design equipment that is quieter. Most importantly, it reduces your risk of hearing loss.



1 Advocacy

Communicate to your employees and community the importance of Buy Quiet and the benefits of the program.

2 Policy

Develop policies to support your internal Buy Quiet initiative.

3 Research & Purchase

Research quieter tools and equipment with cost benefit analysis

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

SAFER • HEALTHIER • PEOPLE™
www.cdc.gov/niosh/topics/buyquiet

  
DHHS (NIOSH) Pub. No. 2014-127

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Hearing Protection



There is a hearing protector for every situation



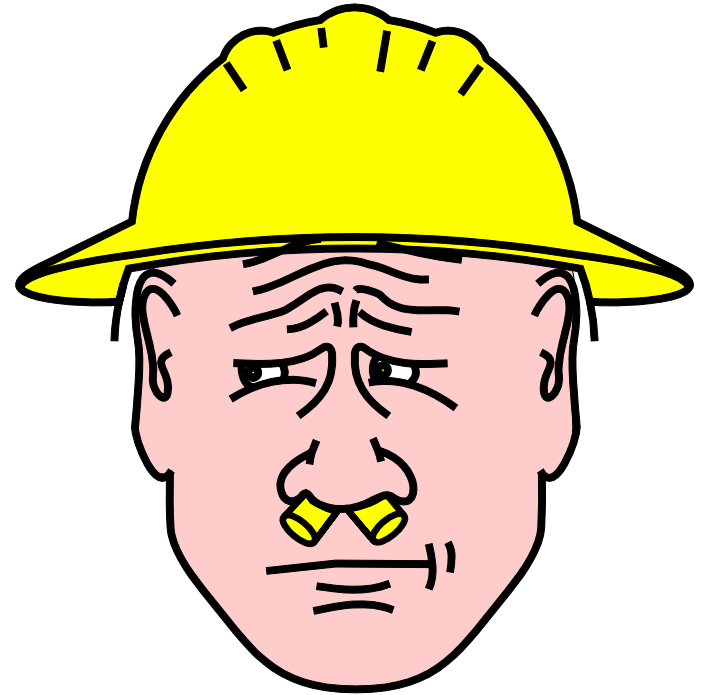
Over 300 models to choose from

Department of Health and Human Services
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health



Any hearing protector
that can be worn wrong
WILL be worn wrong!

Or won't be worn at all

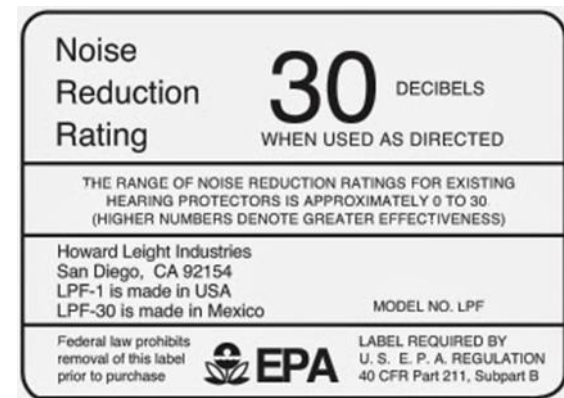


Barriers to HPD use



- Comfort
- Convenience
- Concern about communication or hearing important sounds
- Not understanding the importance of protecting hearing
- Cost
- Safety culture

Noise Reduction Rating (NRR)



1. Single number descriptor of protection attenuation.
2. Real-ear attenuation measured per ANSI S3.19-1974:
 - human subjects in lab setting each tested 3 times
 - each exposed to 9 narrow bands of diffuse noise
 - hearing thresholds measured with and without protector - difference is attenuation

Calculating HP Field Attenuation

Real World Example Calculation

1. Measures full-shift TWA exposure in dBA:

Exposure = 95 dBA

2. NRR of hearing protection used by employee:

NRR = 29

3. Calculate expected TWA exposure under HP:

= Measured TWA – ((NRR – 7)/2)

= 95 dBA – ((29 - 7)/2)

= 95 dBA – 11 = **84 dBA**

Dual Hearing Protection



- Recommended when full-shift noise exposures ***above 100 dBA***
- Field attenuation of dual HP
 - Calculated attenuation of the higher rated HP + 5 dBA

Proper insertion of earplugs

- Ensure that hands and plugs are clean before using
- Roll foam plugs into as small a cylinder as possible
- With opposite hand pull up on ear to straighten ear canal and insert the ear plug into the ear canal

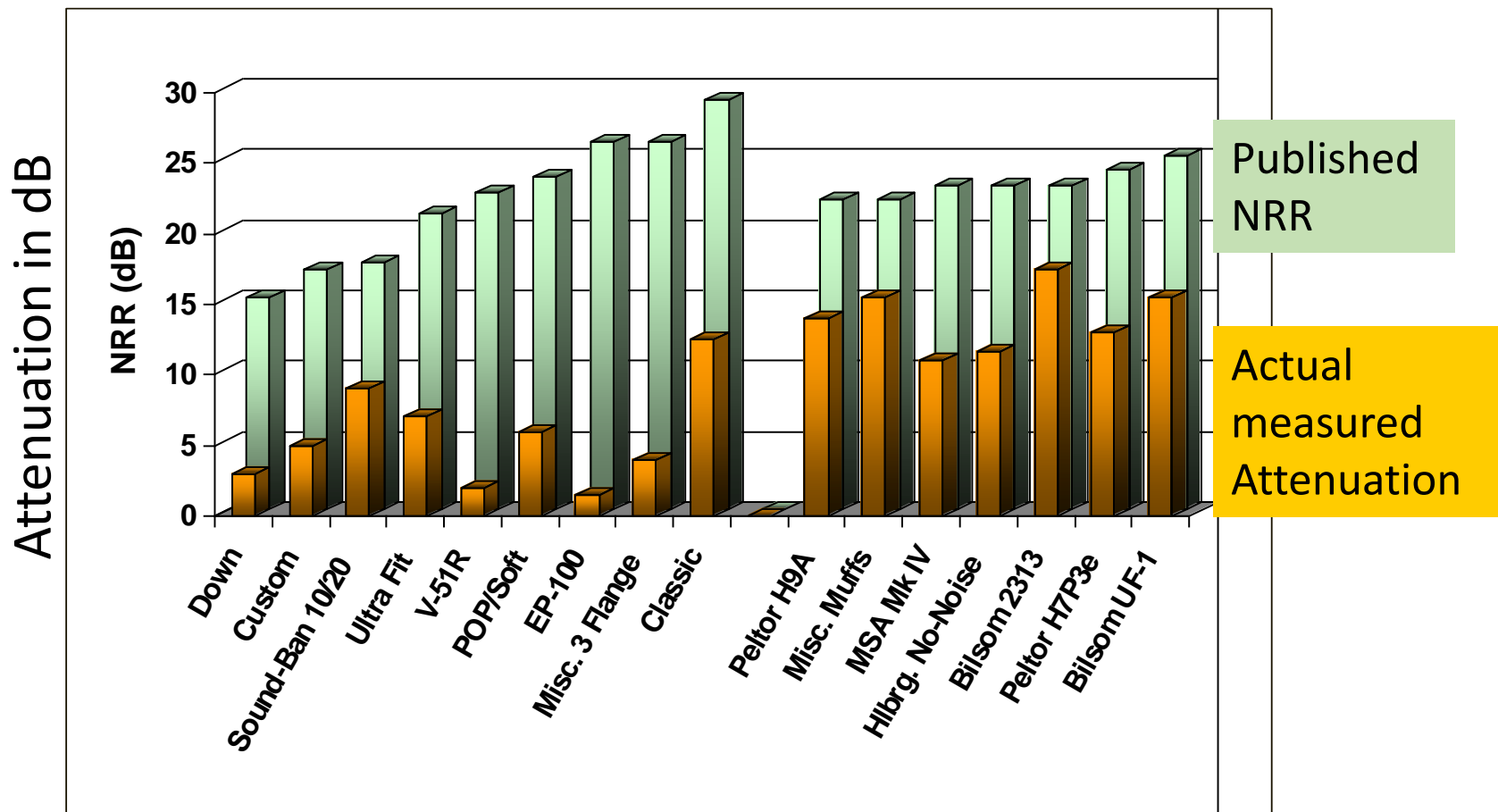


Hearing protector fit-testing

- Procedure to measure personal attenuation rating (PAR) of hearing protector used by employee
- Can be used as a tool to help achieve better fit of HPDs



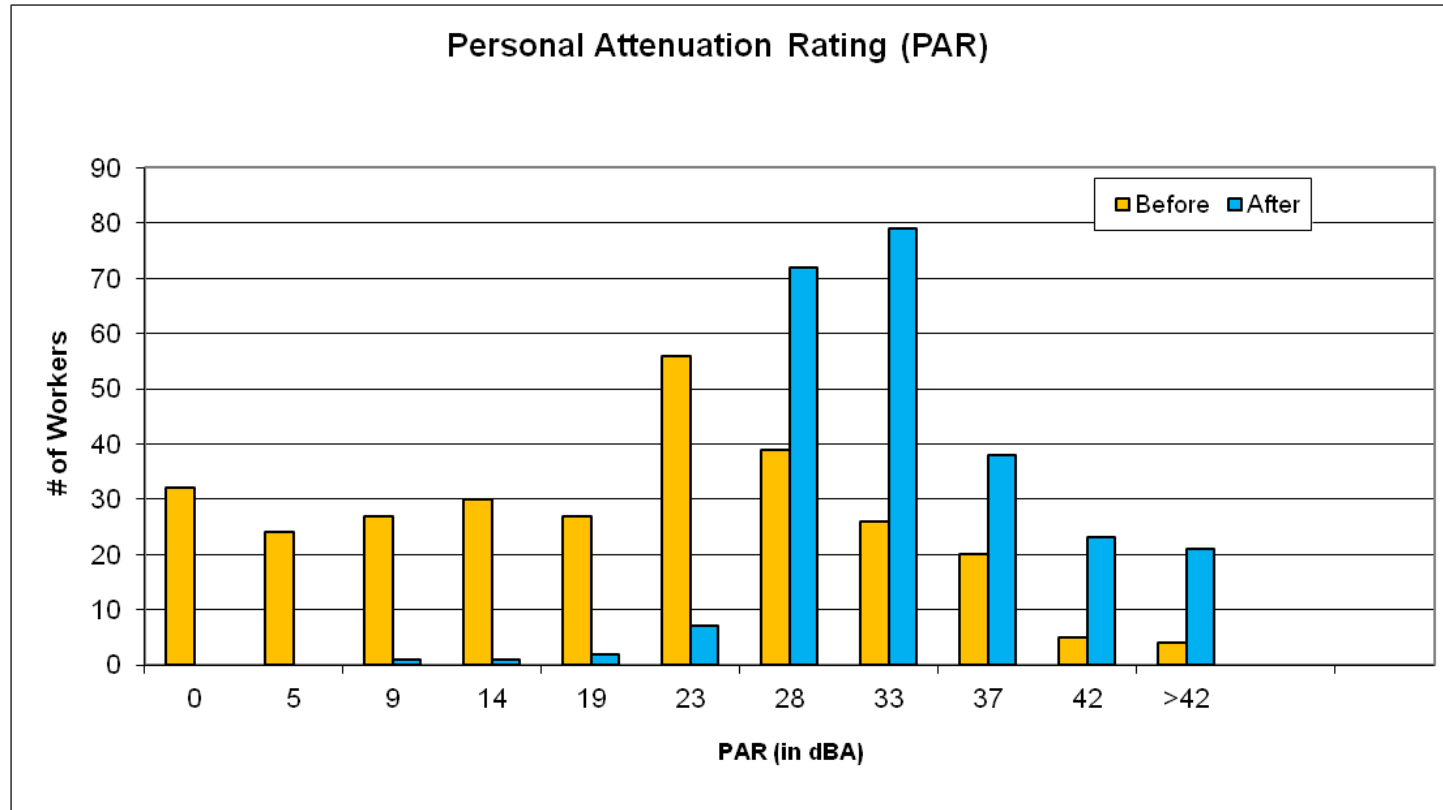
Why fit test?



www.e-a-r.com/pdf/hearingcons/earlog20.pdf

Why fit test?

Shift in personal attenuation rating (PAR) distribution pre-/post-training



Goal of > 25 dB of protection achieved by most workers

Several hearing protection fit testing systems are available:

- 3M E-A-Rfit™



- Phonak SafetyMeter



- Howard Leight VeriPRO



Several hearing protection fit testing systems are available:

- FitCheck™



- FitCheck Solo™



- INTEGRAfit



Ototoxic Chemicals

- Acrylonitrile
- Arsenic
- Carbon disulfide
- Carbon monoxide
- Cyanide
- Ethyl Benzene
- Fuels
- Heptane
- Mercury compounds
- Methyl ethyl ketone
- N-Hexane
- Organic tin
- Organophosphates
- Paraquate
- Lead compounds
- Perchloroethylene
- Stoddard solvent
- Styrene
- Toluene
- Trichloroethylene
- Xylene

Thank-you !

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