OSHA’s Approach to Noise Exposure in Construction

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Objectives

• Provide technical information on construction noise and hearing conservation

• Explain current expectations

• Review 8/5/2002 OSHA Hearing Conservation for Construction Workers Advance Notice of Proposed Rulemaking

• Sell you on this program so you can sell to management and employees
Presentation Outline

• Construction Noise Levels
• Noise-Induced Hearing Loss
• Prevention
  – Noise Measurements
  – Hearing Protectors
  – Audiometric Testing
  – Noise Control

• Current and Future OSHA Standards
• Benefits of Hearing Conservation Programs
Construction Noise Levels
## Current OSHA Standards

- 1926.52 Occupational Noise Exposure  
  - **TABLE D-2 - PERMISSIBLE NOISE EXPOSURES**

<table>
<thead>
<tr>
<th>Duration per day, hours</th>
<th>Sound Level dBA slow response</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>92</td>
</tr>
<tr>
<td>4</td>
<td>95</td>
</tr>
<tr>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
</tr>
<tr>
<td>1 1/2</td>
<td>102</td>
</tr>
<tr>
<td>1</td>
<td>105</td>
</tr>
<tr>
<td>1/2</td>
<td>110</td>
</tr>
<tr>
<td>1/4 or less</td>
<td>115</td>
</tr>
</tbody>
</table>
Sound Pressure Level

• Pressure wave traveling in air or water

• Expressed in decibels (dB)
  – It is the perceived loudness

• Analogy: surface wave made when you throw a stone into a calm pool of water
Sound Pressure Level

- Logarithmic scale
- Small dB increase represents large increase in sound energy.
- 3 dB increase is a doubling of sound energy
- 10 dB increase represents a 10-fold increase
- 20 dB increase represents a 100-fold increase
Noise Levels for Common Tools

Source: NIOSH
## Construction Noise Levels

<table>
<thead>
<tr>
<th>Equipment</th>
<th>dB Level</th>
<th>Equipment</th>
<th>dB Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic chip hammer</td>
<td>103-113</td>
<td>Crane</td>
<td>90-96</td>
</tr>
<tr>
<td>Jackhammer</td>
<td>102-111</td>
<td>Hammer</td>
<td>87-95</td>
</tr>
<tr>
<td>Concrete joint cutter</td>
<td>99-102</td>
<td>Gradeall</td>
<td>87-94</td>
</tr>
<tr>
<td>Skilsaw</td>
<td>88-102</td>
<td>Front-end loader</td>
<td>86-94</td>
</tr>
<tr>
<td>Stud welder</td>
<td>101</td>
<td>Backhoe</td>
<td>84-93</td>
</tr>
<tr>
<td>Bulldozer</td>
<td>93-96</td>
<td>Garbage disposal (at 3 ft.)</td>
<td>80</td>
</tr>
<tr>
<td>Earth Tamper</td>
<td>90-96</td>
<td>Vacuum cleaner</td>
<td>70</td>
</tr>
</tbody>
</table>

Source: Center To Protect Worker’s Rights
<table>
<thead>
<tr>
<th>DECIBEL - dB(A)</th>
<th>EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double protection recommended above 105 dB(A)</td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>Pile driver</td>
</tr>
<tr>
<td>110</td>
<td>Air arcing gouging</td>
</tr>
<tr>
<td>108</td>
<td>Impact wrench</td>
</tr>
<tr>
<td>107</td>
<td>Bulldozer - no muffle</td>
</tr>
<tr>
<td>102-104</td>
<td>Air grinder</td>
</tr>
<tr>
<td>102</td>
<td>Crane - uninsulated cab</td>
</tr>
<tr>
<td>101-103</td>
<td>Bulldozer - no cab</td>
</tr>
<tr>
<td>97</td>
<td>Chipping concrete</td>
</tr>
<tr>
<td>96</td>
<td>Circular saw and hammering</td>
</tr>
<tr>
<td>96</td>
<td>Jack hammer</td>
</tr>
<tr>
<td>96</td>
<td>Quick-cut saw</td>
</tr>
<tr>
<td>95</td>
<td>Masonry saw</td>
</tr>
<tr>
<td>94</td>
<td>Compactor - no cab</td>
</tr>
<tr>
<td>90</td>
<td>Crane - insulated cab</td>
</tr>
<tr>
<td>87</td>
<td>Loader/backhoe - insulated cab</td>
</tr>
<tr>
<td>86</td>
<td>Grinder</td>
</tr>
<tr>
<td>85</td>
<td>Welding machine</td>
</tr>
<tr>
<td>60-70</td>
<td>Speaking voice</td>
</tr>
</tbody>
</table>

Table 1: Some typical noise levels found on construction sites

Source: Construction Safety Association of Ontario
Graph 1: Average dB(A) For Some Construction Trades / Activities

Source: Construction Safety Association of Ontario
### Average Daily Noise Exposure Levels (8-hour TWA) of Heavy Equipment and Associated Laborers
(adapted from Legris and Poulin, 1998)

<table>
<thead>
<tr>
<th>Operator and Task</th>
<th>Range in dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy-duty bulldozer</td>
<td>97-107</td>
</tr>
<tr>
<td>Vibrating road roller</td>
<td>91-104</td>
</tr>
<tr>
<td>Light-duty bulldozer</td>
<td>93-101</td>
</tr>
<tr>
<td>Asphalt road roller</td>
<td>85-103</td>
</tr>
<tr>
<td>Laborers</td>
<td>78-107</td>
</tr>
<tr>
<td>Crawler crane &lt; 35 ton (non-insulated cab)</td>
<td>93-101</td>
</tr>
<tr>
<td>Crawler crane &gt; 35 ton (non-insulated cab)</td>
<td>90-98</td>
</tr>
<tr>
<td>Crawler crane &gt; 35 ton (insulated cab)</td>
<td>80-89</td>
</tr>
<tr>
<td>Rubber-tired crane &gt; 35 ton (non-insulated cab)</td>
<td>78-90</td>
</tr>
<tr>
<td>Rubber-tired crane &gt; 35 ton (insulated cab)</td>
<td>59-87</td>
</tr>
<tr>
<td>Tower Crane</td>
<td>70-76</td>
</tr>
</tbody>
</table>
Presumed Noise Levels
British Columbia Standard

- Presumes specific construction occupations are routinely overexposed to noise
  - Carpenters - Sandblasters
  - Plumber pipefitters - Drillers
  - Sprinkler installers - Electricians
  - Mobile equipment oprs - Steel erectors
  - Welders/fabricators
  - Concrete workers (pumps, vibrators, jackhammers)
  - Drywallers shooting tracks or boarding
OSHA Inspection Data

- Chipping Concrete Floor
  96 dBA (TWA) at 4.5 hours

Source: OSHA Madison case file
OSHA Inspection Data

• Abrasive Blasting with Sponge-Jet Material
  105 dBA (TWA) at 6 hours

(3.5 X PEL for silica)

Source: OSHA Madison case file
OSHA Inspection Data

- Vermeer Saw Operator
  95 dBA (7 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

- Jackhammering - 102 dBA (7.5 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

- Bobcat Operator Breaking Pavement
  112 dBA  (7 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

- Lateral Drilling - 97 dBA (6.5 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

- Lateral Drilling - 104 dBA (7 hour sample)

Source: OSHA Chicago North case file
OSHA Inspection Data

- Partner Saw - 98 dBA (7 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

• 36” Wall Saw - 100 dBA (4.5 hour sample)

Source: OSHA Aurora case file
OSHA Inspection Data

- Tuckpoint Grinding - 99 dBA (2.5 hour sample)

Source: OSHA Chicago North case file
OSHA Inspection Data

- Sandblasting – 125 dBA (4 hour sample)
  Inside hood – 109 dBA

Source: OSHA Aurora case file
High Noise Exposures
Rules of Thumb

• Above 90 dBA when you have to raise your voice to be heard standing next to a person

• Need protection:
  – When using electric, gasoline, or air powered tools
  – When sitting in an open cab of dozers, rollers, some cranes, earth moving or road building equipment
Noise-Induced Hearing Loss

NIHL
Brief Overview – How Ears Work

- A-weighted response simulates the sensitivity of the human ear at moderated levels.
How Does Excessive Noise Damage Your Ears?

- Microscopic hair cells of the cochlea are exposed to intense noise over time.

- Hair cells become fatigued and less responsive, losing their ability to recover.

- Damage becomes permanent resulting in noise-induced permanent threshold shift.
Risk of Hearing Loss

- Estimated Risk of Incurring Material Hearing Impairment as a Function of Average Daily Noise Exposure Over a 40-year Working Lifetime (source: NIOSH)

- Average Exposure 90 dBA 29%
- Average Exposure 85 dBA 15%
- Average Exposure 80 dBA 3%
Audiometric Testing
What Is The Purpose of Having a Hearing Test on a Regular Basis?

• An audiometric testing program is used to track your ability to hear over time.
  – Baseline and annual

• Test records provide the only data that can be used to determine whether the program is preventing noise-induced permanent threshold shifts. It is an integral part of the hearing conservation program.
Case Study 1. Teenage Girl

From the American Academy of Family Physicians website, Rabinowitz article

FIGURE 1. Audiogram findings in the patient in case 1.

The area below the curves represents sound levels that the patient could still hear. (X = left ear; O = right ear)
Case Study 1  Conclusion

• “Temporary threshold shift“ example
• Common in persons exposed to high noise
• Represents transient hair cell dysfunction
• Complete recovery can occur
• Repeated episodes of such shifts causes permanent threshold shifts because hair cells in the cochlea are progressively lost.
Case Study 2  Factory Worker Age 55

From the American Academy of Family Physicians website, Rabinowitz article

FIGURE 2. Audiogram findings in the patient in case 2.

The area below the curves represents sound levels that the patient could still hear. (X = left ear; O = right ear)
Case Study 2  Conclusion

• Noise Induced Hearing Loss
  – Speech discrimination and social function interference
  – Difficulty in perceiving and differentiating consonant sounds
  – Words "run together"
  – Sounds such as a baby crying or a distant telephone ringing, may not be heard at all.

• Tinnitus
  – Common symptom of noise overexposure
  – Further interferes with hearing acuity, sleep and concentration.

• These impairments have been associated with social isolation, depression and an increased risk of accidents.
Carpenter Hearing Losses by Age

Source: NIOSH
Audiometric Test Services

• Mobile Testing Services

• Fixed Site (Occ Health Clinics, Hospitals)
  – Make sure they have a booth or partitioned area, not a noisy room!

• How To Find
Noise Measurements
Noise Measurements

• Sound level meters
  – A device that measures the intensity at a given moment
  – Spot check
Noise Measurements

• Noise dosimeters
  – A dosimeter is like a sound level meter except that it stores sound level measurements and integrates the measurements over time, providing an average noise exposure reading for a given period of time, such as an 8-hour workday.
Hearing Protection
Hearing Protection

- Ear Plugs
- Ear Muffs
- Dual protection
- Active noise cancellation
- Amplification devices
- NRR calculations
### What Hearing Protective Devices Will Work Best?

<table>
<thead>
<tr>
<th>Type</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Formable Ear Plugs (foam) | - Cooler, more comfortable under hot conditions  
                          - Can readily dispose of after each use  
                          - Lightweight | - Irritation to outer ear (for some people)  
                          - Sometimes fit problems |
| Reusable Ear Plugs (plastic) | - Cooler, more comfortable under hot conditions  
                          - Can be reused if cleaned properly  
                          - Lightweight | - Irritation to outer ear (for some people)  
                          - Sometimes fit problems |
| Ear Muffs                 | - Easy to use no fit problems                                               | - Not as effective if anything (even glasses) breaks the seal  
                          - Heavier/Warmer than plugs |
Noise Reduction Rating

• A hearing protector's ability to reduce noise is its Noise Reduction Rating (NRR).
• The greater the NRR, the better the noise attenuation.
• The NRR is usually listed on the hearing protector box.
Noise Reduction Rating Calculation

- For A-weighted readings don’t simply subtract NRR from exposure level 1910.95 Appendix B

- \((\text{dBA} - (\text{NRR}-7 \text{ dB}))\)
  
  - Example (plugs or muffs):
    
    \[
    \text{TWA} = 109 \text{ dBA}, \text{ NRR} = 29
    \]
    
    \[
    109 - (29-7) = 109 \text{ dBA} - 22\text{dB} = 87 \text{ dBA}
    \]

- Suggest you shoot for 80 dBA as a protection factor for poor fit/use
NIOSH NRR Calculation

http://www.cdc.gov/niosh/98-126f.html

- Earmuffs - Subtract 25% from the mfr's NRR
- Formable earplugs - Subtract 50% from the mfr’s NRR
- All other earplugs - Subtract 70% from the mfr’s NRR

- Formula
  \[ \text{Noise level} = \text{dBA} - (\text{derated NRR} - 7) \]
**Dual Protection**

- Using plugs and muffs simultaneously
- Actual attenuation depends on many factors
- Reduction is not near what you would expect

- NRR calculation:
  - Take the higher NRR and add 5 to the field adjusted NRR
Active Protection

• May help but not recognized by OSHA in NRR calculations

• Active headphones use destructive interference to cancel low-frequency noise while still allowing the wearer to hear mid- and high-frequency sounds such as conversation and warning sirens.

• Used extensively by pilots, active headphones are considered indispensable in helicopters and noisy propeller-driven aircraft.
Hearing Protection: Problems

- Undue reliance on protection without steps to reduce noise exposure at source
- Poor choice of protector
- Incorrect fitting
- Inadequate maintenance
- Inconsistent use negates most of the protective effect
Noise Control
# Noise Controls for Construction Equipment

(Schneider et al., 1995)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Noise Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pile Driver</td>
<td>Enclosure, muffler</td>
</tr>
<tr>
<td>Stone saw cutting</td>
<td>Noise control pad with water</td>
</tr>
<tr>
<td>Handheld impact drills</td>
<td>Reduction of reflected sound</td>
</tr>
<tr>
<td>Circular saw blades</td>
<td>15º tooth angle, new tooth configuration, slotted saw blades, viscoelastic damping</td>
</tr>
<tr>
<td>Pneumatic tools</td>
<td>Muffler</td>
</tr>
<tr>
<td>Pavement breaker/ Rock drill</td>
<td>Muffler, enclosure of cylinder case and front head, moil damping</td>
</tr>
<tr>
<td>Portable air compressor</td>
<td>Muffler, acoustic enclosures</td>
</tr>
</tbody>
</table>
# Noise Controls for Construction Equipment

(Continued from Schneider et al., 1995)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Noise Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulldozer</td>
<td>Cab-liner material, enclosure, sound absorption in canopy, sealing of all openings</td>
</tr>
<tr>
<td>Wheeled loader</td>
<td>Absorption of sound cooling air route</td>
</tr>
<tr>
<td>Vibratory roller</td>
<td>Flexible mounting for pump compartment</td>
</tr>
<tr>
<td>Joint Cutter</td>
<td>Anti-vibration mounting fixtures</td>
</tr>
</tbody>
</table>
Noise Control

• Replace worn, loose, or unbalanced machine parts that cause vibration.
• Keep machine parts well lubricated to reduce friction.
• Acoustical enclosures and barriers around generators
• Sound absorbing material and vibration isolation systems on hand tools
• Quiet work practices - use rubber mallets to erect and dismantle formwork.
Current/Proposed OSHA Hearing Conservation Standards
Current Expectations

• 1926.52(d)(1) Implement hearing conservation programs for employees exposed to 90 dBA average and above

• Audiograms
  – Season long employees
  – Long term year after year employees
  – One year mobile testing van exception per 1910.95(g)(5)(ii)
  – Don’t forget exposed shop employees

• Training

• 1926.101 Hearing Protection
Proposed Standard

• Apply general industry standard to construction, 85 dBA average and above
  – Monitoring
  – Audiograms
  – Hearing Protection
  – Training
  – Recordkeeping

• Modifications proposed by the public under the rulemaking process
Benefits of a Hearing Conservation Program
## Worker’s Compensation Claim Statistics in Wisconsin - 2000

<table>
<thead>
<tr>
<th>Condition</th>
<th>Claims</th>
<th>Lost Wage Compensation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of Hearing</td>
<td>725</td>
<td>$4,855,750</td>
</tr>
<tr>
<td>Hernia</td>
<td>1,267</td>
<td>$2,292,408</td>
</tr>
</tbody>
</table>
Worker’s Compensation Claim Statistics in Wisconsin - 2001

Loss of Hearing
• 696 claims
• Lost wage compensation $5,727,122

Hernia
• 1,179 claims
• Lost wage compensation $2,270,330
Hearing Loss Affects Safety Program

• Workers with NIHL may not hear audible warnings and safety signals.
• Hearing impairment jeopardizes not only affected employees but others who work with them.
• NIHL may interfere with daily life, especially during social activities in noisy settings.
• High incidence of fatalities from being struck by objects, transportation incidents, and frequency of fatal accidents from moving machines—especially pedestrians.

• Break down in communication
Hearing Loss Affects Safety Program

- Increased effort to listen may lead to fatigue, anxiety, and stress.
- Those affected may feel increasingly isolated from family and friends.
- Some people with NIHL also suffer from tinnitus, causing them to hear ringing, buzzing, rushing, whistling, or hissing when there are in fact no sounds to be heard.
Contractor Comments

Hearing Conservation Programs

- “Audiogram cost was minimal”
- “Cost is the easy part.”
- “Was not hard to do except the time to do dosimetry”
- “Insurance companies will often do monitoring”
- “Program was easily accomplished using a safety consultant”
Contractor Comments (continued)

- “Transient workforce is an issue”

- “Not a big problem to get employees to use hearing protectors. Machine operators are good about it, others maybe not so good.”

- “Have got to sell the program and get buy-in”
Contractor Comments
(continued)

• Some of the unions could step up to the plate and offer audiograms as a service to contractors.”

• “It would be good to have an audiogram card for workers to carry from job to job. Having a guy get 4-5 audiograms a year will make him mad and discredit the program.”
What You Can Do Now

- Monitoring
- Equipment noise labels
- Purchase equipment with noise in mind
- Sell employees on hearing protector use
- Audiometric testing program
Contact Information

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• Charlie Shields 630-896-8700
  charlie.shields@osha.gov


Extensive use of NIOSH, The Center To Protect Workers Rights, and the Construction Safety Association of Ontario materials was made. We thank those organizations for the use of their information in the advancement of hearing conservation.