Controlling Noise on Construction Sites

Controlling Construction Noise

Controlling construction noise can pose special problems for contractors. Unlike general industry, construction activities are not always stationary and in one location. Construction activities often take place outside where they can be affected by weather, wind tunnels, topography, atmosphere and landscaping. Construction noise makers, e.g., heavy earth moving equipment, can move from location to location and is likely to vary considerably in its intensity throughout a work day

High noise levels on construction worksites can be lowered by using commonly accepted engineering and administrative controls. This booklet is filled with tips other contractors and have used to lower the noise levels on construction worksites. Normally, earplugs and other types of personal protective equipment (PPE) are used to control a worker's exposure to noisy equipment and work areas. However, as a rule, engineering and administrative controls should always be the preferred method of reducing noise levels on worksites. Only, when these controls are proven unfeasible, earplugs as a permanent solution should be considered.

Engineering Controls

Engineering controls modify the equipment or the work area to make it quieter. Examples of engineering controls are: substituting existing equipment with quieter equipment; retro-fitting existing equipment with damping materials, mufflers, or enclosures; erecting barriers; and maintenance.

Administrative Controls

These are management decisions on work activities, work rotation and work load to reduce workers' exposure to high noise levels. Typical management decisions that reduce worker exposures to noise are: moving workers away from the noise source; restricting access to areas; rotating workers performing noisy tasks; and shutting down noisy equipment when not needed.

Personal Protective Equipment

Earplugs are the typical PPE given to workers to reduce their exposure to noise. Earplugs are the control of last resort and should only be provided when other means of noise controls are infeasible. As a general rule, workers should be using earplugs whenever they are exposed to noise levels of 85 dB (A) or when they have to shout in order to communicate.

Construction sites can be quieter

Although many in the construction industry believe that construction sites are inherently noisy, there are many ways in which they can be made quieter.

- Sometimes a quieter process can be used. For example: Pile driving is very loud. Boring is a much quieter way to do the same work.

- New equipment is generally much quieter than old equipment. Some equipment manufacturers have gone to great lengths to make their equipment quieter. Ask equipment manufactures about the noise levels of their equipment and consider these levels when making your purchase. For example, noise-reducing saw blades can cut noise levels in half when cutting masonry blocks.

- Old equipment can be made quieter by simple modifications, such as adding new mufflers or sound absorbing materials.

- Old equipment is also much quieter when it is well maintained. Simple maintenance can reduce noise levels by as much as 50%.

- Noisy equipment can be sited as far away as possible from workers and residents. Noise levels drop quickly with distance from the source.

- Temporary barriers/enclosures (e.g. plywood with sound absorbing materials) can be built around noisy equipment. These barriers can significantly reduce noise levels and are relatively inexpensive.

The Major Noise Sources on Construction Worksites

On construction worksites there are many different noise sources and these sources exhibit many differing types of noise such as background noise, idling noise, blast noise, impact noise, rotating noise, intermittent noise, howling, screeches and squeals that need to be controlled.

Fortunately, the noise levels of common construction noise sources are well-known. Below are the noise levels of common construction.

Equipment	Sound Level at Operator	
	Average	**Range**
*Background**	86	
Earth Moving:		
Front End Loader	88	85-91
Back Hoe	86.5	79-89
Bull Dozer	96	89-103
Roller	90	79-93
Scraper	96	84-102
Grader	<85	
Truck	96	89-103
Paver	101	100-102
Material Handling:		
Concrete Mixer	<85	
Concrete Pump	< 85	
Crane	100	97-102
Derrick	<85	
Power Units:		
Generators	<85	
Compressors	<85	
Impact:		
Pile Driver (diesel and pneum.)	98	82-105
Pile Driver (gravity, bored)	82.5	62-91
Pneumatic Breaker	106	94-111
Hydraulic Breaker	95.5	90-100
Pneumatic chipper	109	
Other Equipment:		
Poker Vibrator	94.5	87-98
Compressed Air Blower	104	
Power Saw	88.5	78-95
Electric Drill	102	
Air Track Drill	113	
Noise Standards		**Noise Level**
OSHA (at workers ear)		90 dB (A)
Day Time Community (at property line)		65 dB (A)

*British Columbia, "Construction Noise," Workers Compensation Board of BC

Bystander exposure to worksite noise is common in construction. Workers are as likely to be exposed from noise generated by other workers or trades, as they are to be exposed to noise generated by their own work. Society of Automotive Engineers* ranked the basic construction equipment in order of noise severity and ranked the equipment by noise severity and proximity to workers and people. The noise levels were measured 50 feet from the equipment. The results of SAE's noise impact ranking (NIR) are presented below. Ranking of 1 is more hazardous than 2.

Reviewing the tables, *Impact* equipment was the biggest noise hazard to operators and workers nearby while *Earth Moving* equipment exposed a greater number to noise hazards.

NIR by Noise Level & Proximity to People

Equipment	Ranking
Trucks	1
Scrapers	1
Tractors	1
Back Hoes	1
Front End Loaders	2
Graders	2
Compactors	2
Cranes	3
Generators	3
Pumps	3
Compressors	3
Concrete Pumps	3
Pavers	3

*SAE, Noise Abatement techniques for Construction Equipment, Cambridge 1979.

Effective Practical Solutions to Controlling Noise on Construction Worksites

Every construction project is different and constantly changing. Therefore, noise control solutions have to be tailored for the situation. Fortunately, there are a variety of ways by which construction equipment and worksite noise can be controlled. The following is a list of ways to control noise level your worksites.

- **Quieter Equipment**
- **Modifying Existing Old Equipment**
- **Barrier Protection**
- **Maintenance**
- **Noise Perimeter Zones**
- **Work Activity Scheduling**

Quieter Equipment

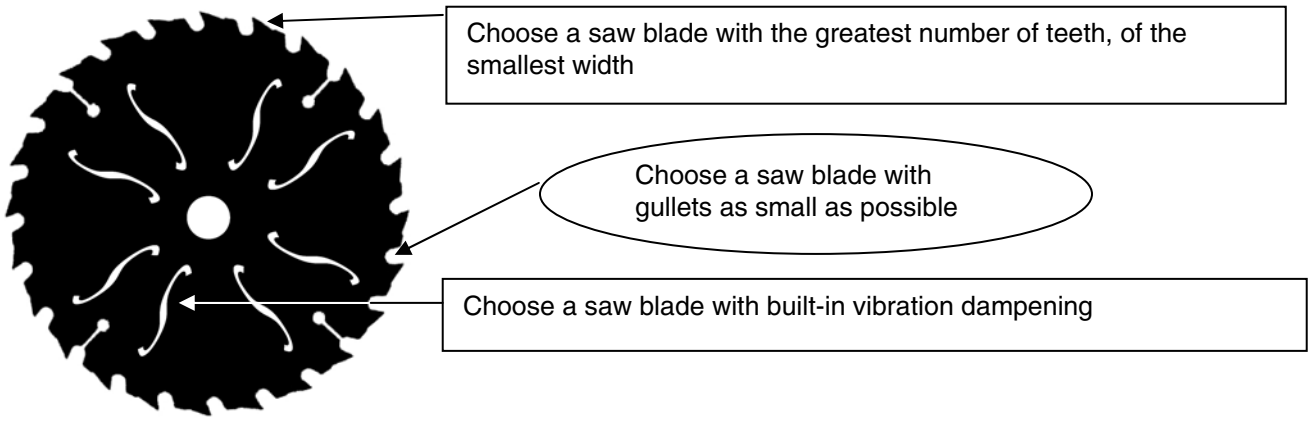
A cost-effective way to reduce noise at a construction worksite is to buy quiet equipment. When buying equipment always ask if there is a quieter way of doing the job. All things being equal most contractors would choose a quieter machine or process. Quieter machines or processes can cost more. Manufacturing tolerances are tighter, gears mesh better, quieter cooling fans are used, etc. Because of this, when contractors buy quieter equipment the final determination often depends on whether the noise reduction justifies the extra expense. Looking at this decision another way, if the quieter machine costs $100 more and is 5 dB quieter, the extra cost of $20 per decibel reduced can be considered cheap noise control when compared to cost of establishing a hearing conservation program or medical cost associated with noise induced hearing loss.

In addition, equipment in use should be the most suitable for the job. Avoid using equipment that is over-powered and, conversely, avoid using under powered equipment. Whenever possible the quietest equipment alternative should be used. In general, electronic powered equipment is quieter than diesel powered equipment and hydraulically powered equipment is quieter than pneumatic power. Below are examples of ways quieter construction equipment can be introduced into the worksite to reduce noise levels.

Buying Quiet Saw Blades

Problem:
Sound level tests on different saw blades under comparable conditions reported sound levels at the operator position between 91 and 97 dB (A).

Solutions:



Results:

Sound level tests on different saw blades under comparable conditions	**Sound Level -dB(A) at Operator Position**
Tooth Number and Size	
Cutting lengths of aluminum	
• 350mm dia. TCT blade, 84 teeth, 3.5mm wide	**97**
• 350mm dia. TCT blade, 108 teeth, 3.2mm wide	**91**
Decibel Reduction	**6**
Vibration Dampening	
Cutting bricks	
• 350mm dia. "standard" masonry blade, 20 teeth	**94**
• 350mm dia. "damped" masonry blade, 20 teeth	**84**
Decibel Reduction	**10**
Air Noise	
"Dummy cut" (run up to 3400 rpm, run down), without cutting	
• 350mm dia. TCT blade, 84 gullets, 10mm x 7mm	**91**
• 350mm dia. TCT blade, 108 gullets, 8mm x 4mm	**84**
Decibel Reduction	**7**

Reference:
WorkSafe Western Australia Engineering Noise Control Reports No's. ENC-2-93, ENC-4-93

Buying Quieter - Diesel Generators

Problem:

Compressors and generators rank second behind trucks of all onsite construction equipment in terms of daily sound energy produced.

Newer heavy duty diesel generators are designed to emit low noise and vibration. Some units are up to 15 dB (A) quieter than older diesel-powered generators and quieter than most gasoline sets. The units are totally enclosed and damped, including cooling, exhaust and intake systems.

Built-In Solutions:

- Improved intake/muffler system
- Suitable enclosure with damping cladding
- Improved cooling fan

Benefits:

- Up to 15 dB(A) noise reduction

Reference:

OR-OSHA, “Guide for Controlling Hazardous Noise on Construction Jobsites,” 1/03

Modifying Existing Old Equipment

The most common way to reduce the noise levels of common construction equipment is through worksite modifications. Some common worksite modifications consist of retro-fitting existing equipment with damping materials and mufflers. Below are examples of ways common construction equipment and worksites can be modified to reduce noise levels.

Modifying - Front End Loader

Problem:

Typical noise level of 95-102 dB(A) (at operator position with no noise control cab)

Not actual vehicle from study

Solutions:	Benefits:	Costs:
• Noise control cab w/ air conditioning	• 82-90 dB(A)	• $12-15,000, 60-140 h
• Add sound suppression to existing cab	• 82-90 dB(A)	• $500-1000, 30-80 h
• Replace exhaust system	• 90-100 dB(A)	• $200-400, 2 h

Acoustically Treated Noise Level:

- 82-90 dB(A) for the operator

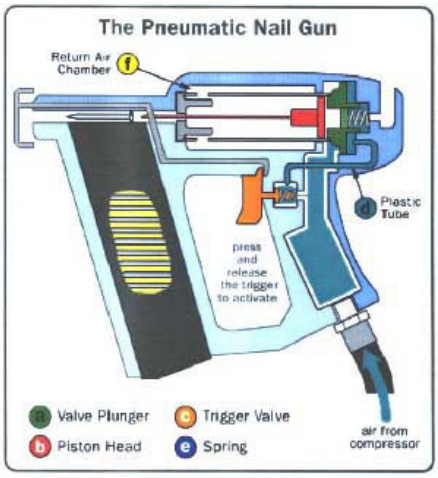
Reference:

U.S. Bureau of Mines, Mining Machinery Noise Control Guidelines, 1983

Modifying - Pneumatic Nail Gun

Problem:

Sound level from pneumatic nail guns 94.5 dB(A) (at muffler)



Solutions:

- Improving the existing muffler
- Incorporating some type of "return" or exhaust line

Acoustically Treated Noise Level:

- Avg. Sound Pressure Level With Treatment - **75.5 dB**
- Avg. Sound Pressure Level Without Treatment - **94.5 dB**

Costs:

Item	Retail Cost ($)	Number Required	Cost per Unit ($)
Viton O-Ring	6.50	0.02	0.13
PVC Housing	1.15	1.0	1.15
8mm Bolt	1.07	1.0	1.07
Hose Plug	1.26	2.0	2.52
		Total Goods	4.87
		Mass Production (1/3 Retail Cost)	1.62
		Estimated Production Cost per Unit	0.50
		Total Cost per Unit	2.12

Reference:

NIOSH, “Student Presentations - Pneumatic Nail Guns,” 2002, http://www.cdc.gov/niosh/topics/noise/CollegeStudents/nailgun/index.html

Excavator

Problem:

A Warner and Swasey excavator, equipped with a Detroit Diesel 4-53 engine (115 hp@ 2400 rpm) had a overall noise level of 80.5 dB (A) at 50 feet.

Not actual vehicle from study

Solution:

In the quietest configuration, with improved exhaust and intake muffling, fan disengaged, and three sound panels around the engine, the overall level was reduced to **71. 5 dB (A**).

Costs:

- Approximately $200-400.00

Reference:

U.S. Bureau of Mines, “Noise Abatement Techniques for Construction Equipment,” August 1979

Barrier Protection

An effective way of reducing noise is to locate noisy equipment behind purpose-built barriers. The barriers can be constructed on the work site from common construction building material (plywood, block, stacks or spoils) or the barriers can be constructed from commercial panels which are lined with sound absorbing material to achieve the maximum shielding effect possible. To be effective, the length of the barrier should be greater than its height. The noise source should not be visible and barrier should be located as close as possible to either the noise source or the receiver.

Decibel level at noise source (dB)	Distance from noise receiver to noise source (feet)	Decibel level at noise receiver (dB)
105	5	102
105	10	96
105	20	90
105	40	84

The distance between a noise source and noise receiver can be considered a barrier as well. Doubling the distance from the noise source lowers the noise level by 6dB. Notice in the table above, that as the distance doubles the noise level at the receiver decreases 6 dB (A). Below are examples of ways barriers and enclosures of construction equipment and can reduce noise levels.

Creating Noise Barriers

Problem:

Power pack produced noise levels of 98 dB(A) at 1m

Solutions:

- Portable screen built with common construction material was placed around a power pack

Benefits:

- Reduced the noise levels from **98 dB(A) to 90 dB(A) at 1 m**

Reference:
Worksafe Western Australia
www.safetyline.wa.gov.au/pagebin/pg000150.htm

Work Activity Scheduling

Work activity scheduling are administrative means to control noise exposure. Planning how noise sources are sited and organized on a work site can reduce noise hazards. Whenever possible, stationary noise sources like generators and compressors should be positioned as far as possible from noise sensitive receivers (workers, schools, residential buildings). When possible, stacks, spoils, and other construction material can be placed or stored around noise sources to reduce the hazard to receivers. Advantage should be taken of the screening effect any nearby object, such as cooling tanks, trailers or temporary site offices.

Jobs can be rotated so that exposure time is limited. Transferring workers from a high exposure task to a lower exposure task could make the employee's daily noise exposure acceptable. Administrative controls include activity planning, for example, scheduling pavement breaking operations so as to reduce the number of work site workers exposed. In addition noisy equipment should not be run for periods longer than necessary and should be switched off when not in use.

Maintenance

Increased attention to maintenance of tools and equipment will reduce worksite noise levels. Maintaining your plant and equipment in good order not only increases its life, but makes it safer to use and quieter. In many cases, a noise hazard will be created or made worse by a lack of maintenance. Parts may become loose, creating more noise because of improper operation or scraping against other parts. Grinding noises may also occur as the result of inadequate lubrication. It is especially important to provide proper maintenance of noise control devices which are added or built into machinery. Loose and worn parts should be fixed as soon as possible.

Always check and see if there are any problems starting to appear with a machine or equipment. Check for signs of wear or if the machine's performance is down. Some problems will appear as looseness or increased vibration. Listen for new noises, especially tonal ("whining") sounds, repeated impacts, or high frequency ("screech") sounds. Also, slipping belts will cause a screech at start-up, while a damaged bearing may appear as a "clunk" during run-down.

Ideally, the worksite should have a system in place for checking and servicing the various machines and power tools. Below are examples of ways maintenance and servicing can make equipment safer and quiet.

Why machines get noisier with use:

1. Worn or chipped gear teeth – will not mesh properly. The shiny wear marks are often visible on the teeth.

2. Worn bearings - bearing wear creates vibration and noise, as flat spots or cracks appear in the balls.

3. Slackness between worn or loose parts – causes rattling noises, squealing from slack drive belts, "piston slap" in motors, air leaks, etc.

4. Poor lubrication – causes squeaking noises due to friction or impact noise in dry and worn gears or bearings.

5. Imbalance in rotating parts – imbalances with fan impellers or motor shaft will show up as excess vibration.

6. Obstruction in airways - a build-up of dirt or a bent/damaged piece of metal in an airway or near a moving part, e.g., a bent fan guard, can cause whistling or other "air" type noises.

7. Blunt blades or cutting faces - blunt or chipped saw teeth, drill bits, router bits etc, usually make the job noisier as well as slower.

8. Damaged silencers - silencers for air-driven machines or mufflers for engines may become clogged with dirt, rusted out or damaged, so losing their ability to absorb noise.

9. Removal of a noise-reducing attachment - mufflers, silencers, covers, guards, vibration isolators etc. which reduce noise should never be removed except during maintenance, and then must be replaced

Maintenance

Problem:

A common type of reciprocating air compressor produced 94 dB (A) at 1m

Solutions:

- Regrinding the valves to improve the seal resulted in a significant noise reduction of approximately 7 dB (A).
- Introducing an oil additive gave an extra 1 dB(A) reduction

Benefits and Costs:

The overall noise reduction due to the re-seating of the valves and the introduction of the oil additive is therefore estimated to be approximately 8 dB (A). This is significant, in that the reduction was achieved at minimal cost, using methods which could be adopted by any skilled maintenance trades person.

Acoustically Treated Noise Level:
86 dB(A) at 1m

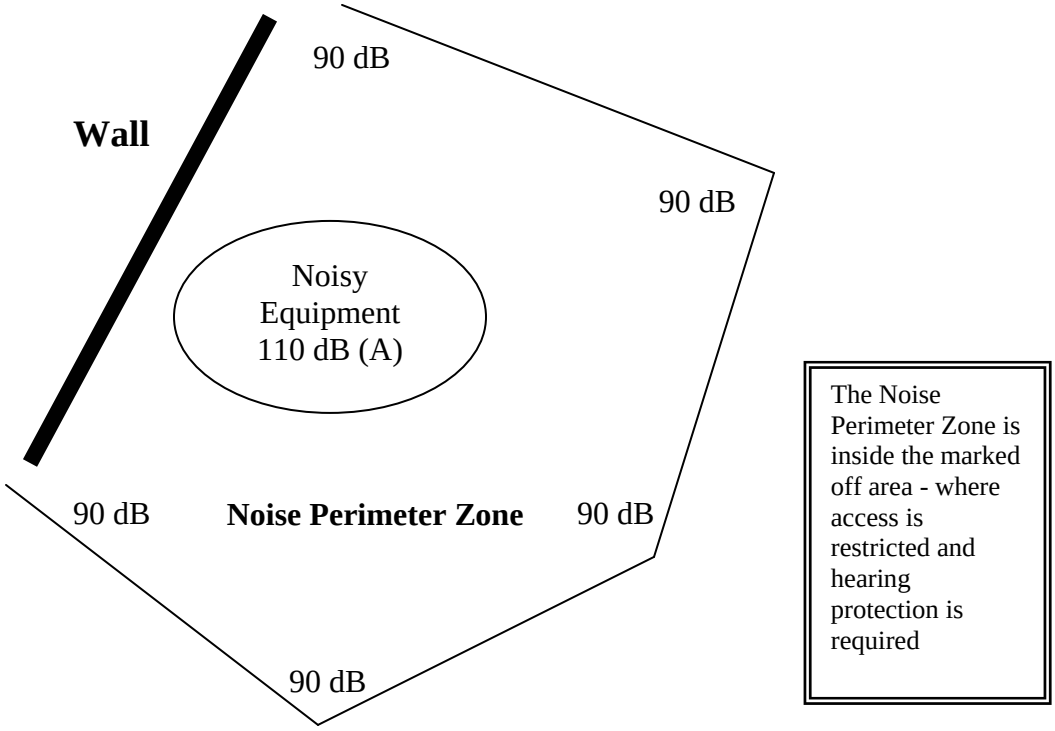
Reference:

WorkSafe Western Australia, “Noise Control Case Study: - Reduction of Noise from a Reciprocating Compressor through Maintenance,” 1999.
http://www.safetyline.wa.gov.au/pagebin/pg000153.htm

Noise Perimeter Zones

Noise perimeter zones (NPZ) are another administrative control to limit exposure to noisy processes or equipment to as few workers as possible. NPZ are areas where noise levels of 90(85?) dB (A) or more are roped off and marked to keep out all workers who don't have to be there.

NPZ can be set up using a sound level meter to find the safe distance from the source (90 dB (A)) and the NPZ can be set up at that distance. Noise does not radiate from the source at the same level in all directions. Noise from machinery can be higher in one direction than another because the noise can also be either absorbed or reflected from surfaces it contacts, such as the ground or a wall. Therefore, measurements should be taken at several points in an area where people might be working. Once noise levels that are 90 dB (A) or more are determined, rope off this area as the Noise Perimeter Zone. Exclude all workers who do not need to be in that zone. All workers who need to work within the zone must wear hearing protection. The area can be marked "Noisy Area - Hearing Protection Required" in the same way that a "Hard Hat Area" is marked off.



Of course, the entire site can be inside a Noise Perimeter Zone. Then everyone on site must wear hearing protection.

Another way for the employer to set up a NPZ is to measure the sound pressure level, using a sound level meter, at a distance from a noise source. Then measure the distance between the noise source and measurement point. Convert the sound pressure to the estimated sound power using the tables below and insert in second table to determine safe distances from the noise source.

Table 1: Converting sound pressure measurement to sound power

Measured Sound Pressure Level with SLM in dB	Estimated Sound Power Level (dB) at distance from source				
	At 5 ft	At 10 ft	At 15 ft	At 20 ft	At 30 ft
80	95	101	104	107	110
82	97	103	106	109	112
84	99	105	108	111	114
86	101	107	110	113	116
88	103	109	112	115	118
90	105	111	114	117	120
92	107	113	116	119	122
94	109	115	118	121	124
96	111	117	120	123	126
98	113	119	122	125	128
100	115	121	124	127	130

Table 2: Calculating the Noise Perimeter Zone from the sound power

Estimated Sound Power Level (dB)	80 dB at distance from source	Noise Perimeter Zone for Target Control Levels (dB)	
		85 dB at distance from source	90 dB at distance from source
90	3 ft	2 ft	1 ft
95	5 ft	3 ft	2 ft
100	9 ft	5 ft	3 ft
105	16 ft	9 ft	5 ft
110	29 ft	16 ft	9 ft
115	52 ft	29 ft	16 ft
120	92 ft	52 ft	29 ft
125	164 ft	92 ft	52 ft
130	292 ft	164 ft	92 ft

Conclusion

Construction work is inherently noisy. This publication explains why high noise levels on construction worksites are a serious issue that can be controlled. Many of the straight forward controls for common construction activities presented herein can be easily applied because contractors and workers do not have to have an extensive acoustical technical background to quiet equipment. Most often, construction worksite noise problems can be solved by contractors and workers together.

Resources

Web

- Blue Angel Program – www.blauer-engel.de/e-prod/uz/
- Laborers Health and Safety Fund of North America – www.lhsfna.org
- MSHA Surface Equipment Noise Control – www.msha.gov/1999noise/Surface/noisesurface.htm
- NIOSH Noise Page – www.cdc.gov/niosh/noisepg.html
- Noise Pollution Clearinghouse – www.nonoise.org/
- Noise Conference Website – www.lhsfna.org/html/noise_home.html
- Noise Management for the Building Industry – www.adfa.edu.au/amec/avu/
- OSHA Noise Page – www.osha-slc.gov/SLTC/noisehearingconservation/index.html
- Sound Alert – www.soundalert.co.uk
- WISE EARS Campaign – www.nidcd.nih.gov/health/wise/index.htm
- WorkSafe Western Australia SafetyLine - www.safetyline.wa.gov.au