Effects of Watercross Noise in Residential Area

Carl Mun

March 1, 2021

Abstract

The Nottingham Planning Board in the state of New Hampshire is reviewing an application for approval of a Watercross event to be held three (3) times a year starting in 2021, (Case #21-003-SIT). Noise levels from the event are estimated at 140 dB which far exceeds safe levels recommended by both OSHA and NIOSH. Any noise level above 90 dB are considered unsafe and may result in hearing loss. For safety, events should be located at least 1,000 feet from any residence. This distance would bring the attenuated noise level to 80 dB. The proposed location has a number of homes located less than 1,000 feet from the event, as such this application if approved would endanger those residents.

Table of Contents

Introduction 4

Methods

I. Safe Noise Levels 5

II. Snowmobile Noise Levels 7

III. Attenuation of Noise 8

IV. Conclusion 9

Abbreviations 10

References 11

About the Author 12

Additional Information 13

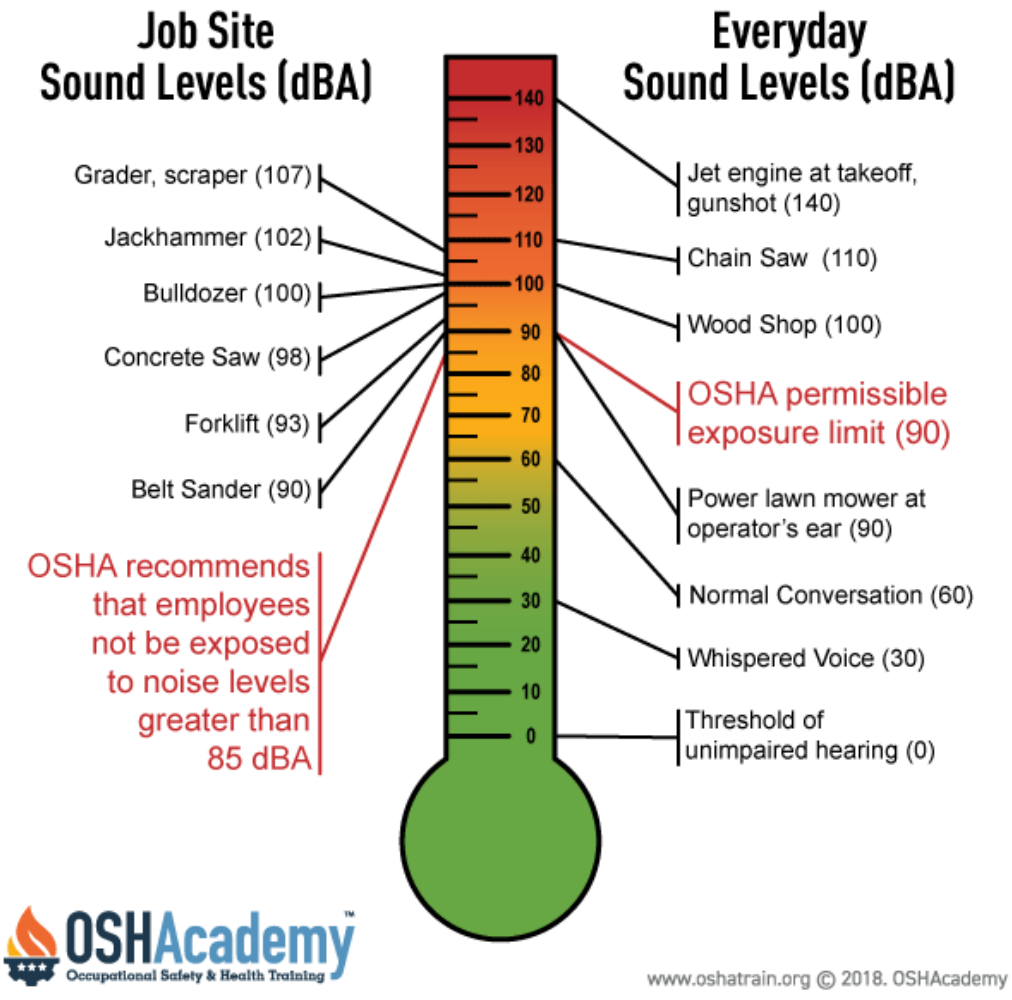
Introduction

Watercross events utilize modified snowmobiles to race across water. These snowmobiles are high performance machines built for speed and do not conform to any type of emission standards or required noise level suppression. This report reviews noise level standards, snowmobile noise levels, effects and attenuation to establish effects of residence located next to the proposed event pulling data and information from references listed at the end of this report.

Methods

I.) Safe Noise levels

As shown in the charts below, noise levels above 90 dBA are harmful. Noise levels have an additive effect when there is more than one noise source of similar intensity. This compounds the intensity of the sound pressure which both carries the noise level further and intensifies the noise level exponentially as noise is measured by sound pressure expressed in decibels on a logarithmic scale. A decibel (dB) is defined as 0.1-Del. The increase in sound pressure from 80 dB (8-Del) to 140 dB (14-Del) is 10^6 or 1,000,000 times the sound pressure. The maximum sound pressure on earth is estimated at 194 dB based at sea level 0 degrees C. This level would result in death.



From an article by Sengpiel Audio providing comparable government standards illustrating the safe time duration a person should be limited to at a given sound level.

Exchange Rates of NIOSH and OSHA Standards – National Institute for Occupational Safety and Health 1998; Occupational Safety and Health Administration 2009. According to each governing body, a person can safely be exposed to each decibel level for its corresponding time without risk of NIHL. For example, according to the OSHA standard, a person can withstand an environment with sound levels at 95 dBA for four hours. After four hours they are at risk for NIHL. NIOSH maintains that a person is safe in a 95 dBA environment for less than one hour.

NIOSH Standard	
Sound level (dBA)	**Duration (Hours: Minutes: Seconds)**
82	16:00:00
85	8:00:00
88	4:00:00
91	2:00:00
94	1:00:00
97	0:30:00
100	0:15:00
103	0:07:30
106	0:03:45
109	0:01:53
112	0:00:56
115	0:00:28
118	0:00:14
121	0:00:07
124	0:00:03
127	0:00:01

OSHA Standard	
Sound level (dBA)	**Duration (Hours: Minutes: Seconds)**
85	16:00:00
90	8:00:00
95	4:00:00
100	2:00:00
105	1:00:00
110	0:30:00
115	0:15:00
120	0:07:30
125	0:03:45
130	0:01:53
135	0:00:56
140	0:00:28
145	0:00:14
150	0:00:07
155	0:00:03
160	0:00:01

A graduate paper by Kiera Lynn Moore – University of Northern Colorado stated the problem of noise exposures of recreational snowmobiles very well. Pease note racing snowmobile produce *exponentially* higher noise levels.

Statement of the problem

Noise induced hearing loss (NIHL) is a preventable health risk that affects many individuals on a daily basis. Of the 28 million Americans who have some degree of hearing loss, as many as 10 million individuals in America suffer from hearing loss caused from hazardous noise exposure in the workplace or recreational activities (Rabinowitz, 2000). Hazardous sound levels damage fragile structures of the inner ear and can cause permanent hearing loss over time. Temporary auditory damage can occur but repeated exposure to dangerous levels of sound can cause cell death which leads to irreversible permanent hearing threshold shifts, also known as noise induced permanent threshold shifts.

There are numerous articles outlining the dangers of excessive noise levels and how increased levels dramatically reduce safe exposure limits.

General Health & Wellness 5-22-18

"The Science of Sound
The roar of the racetrack comes with a price.
"The damage comes to the ear from the volume of the sound," explains Matt Provenzano, MD, an otolaryngologist with Franciscan Physician Network in Michigan City. "The louder the volume, the higher energy of the sound. The more energy the ears deal with, the more potential for damage.
"Studies show the peak level in the pit exceeds 140 decibels," Dr. Provenzano said. "Even out in the stands and infield, you're still exposed to significantly high levels of noise."
For every 5 decibel increase in noise, the recommended time of exposure is cut in half. You can have eight hours of exposure at 90 decibels (think, the sound of a passing motorcycle), but only four hours at 95 decibels (think, the sound of a kitchen blender). Headed to Carb Day? That concert will likely rate over 112 decibels. Continued exposure is considered dangerous to hearing.

II.) Snowmobile Noise Levels

Below is the Abstract from an article on racing snowmobiles and hearing loss by Authors Fred H. Bess of Vanderbilt University and Robert E. Poynor. They measured racing snowmobiles as high as 137 dBA which far exceeds the standards set by OSHA and NIOSH. This level is even higher than a race car track noise level. At these levels OSHA's standard is less than one minute of exposure, NIOSH is less than one second exposure. Any longer exposure may result in hearing loss.

Snowmobile Engine Noise Level and hearing
Temporary threshold shifts (TTSs) were measured in 17 subjects (12 drivers and five riders) following 120 minutes of snowmobile noise exposure. All subjects were found to exhibit marked TTS at frequencies above 1,000 hertz. Predictably, the greatest amount of TTS occurred at 4,000 Hz. An acoustic analysis of the snowmobiles represented in this study revealed that the noise levels exceeded damage risk criteria for two hours exposure. One snowmobile was found to produce as much as 136 dBA at full throttle.

Do not let the size of the vehicle force you to assumptions on noise, Hypersports and other manufactures are producing 2- and 4-cylinder performance engines exceeding 600 hp at 9,400 rpm closing in on the much larger V8 NASCAR engines. Note: snowmobiles have much shorter exhaust systems which add to the noise levels as well as many are two-cycle engines instead of the four-cycle NASCAR, which due to the exhaust at the end of the ignition cycle, produce a much louder "pop". People who operate chain saws or two-cycle gas trimmers understand how loud small two-cycle engines can be. Also, NASCAR and INDY machines race on much longer tracks, proposed Watercorss will compete on a very small lake or pond concentrating the noise.

Noise Exposures of Recreation Snowmobilers – Kiera Lynn Moore 5-1-2015

"Engine types.
Snowmobile engines come in two types, two-stroke and fourstroke. A stroke is the movement of a piston in an engine. A two-stroke engine has a single piston stroke in each direction. A four-stroke engine has one exhaust stroke and one compression stroke followed by returning strokes. Two-stroke engines give the snowmobile significant power, less weight, and cost less, however four-stroke engines 20 produce less air and noise pollution. Krause (2003) reported that four-stroke engines had shown lower sound levels at a distance than two-stroke engines. Since four-stroke engines have to exert less energy for the same revolutions per minute (RPM), which is how many times the piston goes up and down in one minute, the noise exposures from four-stroke engines is often less."

III.) Attenuation of Noise – Danger Zone

Noise levels of racing snowmobiles have been measured at 135+ dB. With the additive effect of multiple machines racing sound pressure levels can easily reach 140 dB. Given the distance attenuation, at 1,000 feet the noise level would be 80 dB.

Geluid Lawaai - wwww.hoevelakenbereifbarr.nl 1-29-2012

"How do you add noise levels?
Sound pressure levels are expressed in decibels, which is a logarithmic scale. Therefore, we cannot simply arithmetically add noise levels. For example, 35 dB plus 35 dB does not equal 70 dB.
To add two or more noise levels, if the difference between the highest and next highest noise level is: 0–1 dB then add 3 dB to the higher level to give the total noise level
2–3 dB then add 2 dB to the higher level to give the total noise level
4–9 dB then add 1 dB to the higher level to give the total noise level
10 dB and over, then the noise level is unchanged (i.e. the higher level is the total level)
So, 35 dB plus 35 dB equals 38 dB."

Distance Attenuation Calculator – Bogna Szyk – 2-22-19

"The sound attenuation formula is as follows:
$SPL_2 = SPL_1 - 20 * \log (R_2 / R_1)$
where:

- **SPL_1** is the Sound Pressure Level at point 1,
- **SPL_2** is the Sound Pressure Level at point 2,
- **R_1** is the distance from the sound source to point 1
- **R_2** is the distance from the sound source to point 2."

IV.) Conclusion

Any type of racing activity, car, motorcycle or snowmobile should not be allowed in a residential area and provide adequate distance to any home due the excessive and dangerous noise levels emitted from these events. Minimum safe distance should be at least 1,000 feet with recommendations of one quarter of a mile to assure noise levels are far below dangerous limits.

Abbreviations

dB – Decibel

dBA – Decibel A – Weighted

OSHA – Occupational Safety and Health Administration

NIOSH – National Institute for Occupational Safety and Health

NIHL – Noise Induced Hearing Loss

TTS – Temporary Threshold Shift

References

Tontechnik–Rechner, Sengpiel Audio - Exchange Rates of NIOSH and OSHA Standards, http://www.sengpielaudio.com/PermissibleExposureTime.htm

Kiera Lynn Moore – University of Northern Colorado (5-1-2015) – Noise Exposures Of Recreational Snowmobilers

General Health & Wellness (5-22-18) - The Science of Sound, https://www.franciscanhealth.org/community/blog/hearing-indy-500

Fred H. Bess of Vanderbilt University and Robert E. Poynor (3-1972) - Snowmobile Engine Noise Level and hearing

Geluid Lawaai – (2012) How do you add noise levels? https://www.hoevelakenbereikbaar.nl/www2/MilieuZaken/Geluid_lawaai/Noise%20level%20calculations.pdf

Bogna Szyk (2-22-2019) – Distance Attenuation Calculator, https://www.omnicalculator.com/physics/distance-attenuation

Snowmobile technical committee. (2009). Measurement of exhaust sound levels of stationary snowmobiles (J2567_200901). Retrieved November 2, 2001, From: http://standards.sae.org/j2567_200401/

Occupational Safety and Health Administration (1983)- Occupational noise exposure; Hearing conservation amendment: Final rule. 29 CRF 1910.95 Fed. Reg., 48(46), 9738-9785.

National Institute for Occupational Safety and Health (1998) - Criteria for a recommended standard: Occupational noise exposure. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Krause, B. (2003) - Field analysis of snowmobile sounds pressure levels measured in Yellowstone National levels. Wild Sanctuary. 1-2

About the Author

Carl Mun – Bachelors of Science in Mechanical Engineering, Purdue University 1984

Started career in the Consulting Engineering field, obtaining Professional Engineering License (PE) in 1998. Later switching to the automotive industry OEM design, prototype, testing and manufacture of exterior vehicle lighting then continuing into the engine and transmissions systems. Responsibilities included working with manufacturing machines and equipment to assure OSHA noise levels were meet. Currently working on power modular cooling of next generation electric vehicles.

Additional Information

Additional informative articles of Watercross events and effect on wildlife and nature:

https://www.turtleguardians.com/2020/02/effects-of-watercross-on-widlife-and-turtles/

International Snowmobile Racing (ISR) Watercross rules require mandatory hearing protection.

http://www.isrracing.org/tempPDF/Watercross%20Competition.pdf

"5. Hearing protection is mandatory in all non-stock classes in all types of competition. Recommended for all stock class competition"