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Recreational gun range noise – the price of freedom

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ABSTRACT

A growing source of community noise concern stems from the increasing number of civilian gun ranges that open or expand every year for recreational and business purposes. Outdoor shooting ranges typically offer a wide variety of sporting use of firearms including handguns, rifles and shotguns. While there are several ways to evaluate and control gunfire noise, it turns out that many of these gun ranges are specifically exempt from State or local noise regulations due in part to the significance Americans place in the 2nd Amendment. This paper will discuss these topics and describe (1) the types of firearms and competitive matches held throughout the United States, (2) various empirical and analytical means of predicting gunfire noise levels in the community, (3) control options to reduce gunfire noise levels, (4) shooter health risks and club liability issues, and (5) a detailed look at relevant noise regulations.

1. FIREARMS AND COMPITITIONS

BANG! The sound of freedom, or a community noise pollutant? It all depends on which end of the gun you are listening. The use of firearms for self defense, recreation and competition is “as American as apple pie”, yet private and commercial gun ranges are under constant pressure to close or curtail their operations due primarily to community objections over noise. As a result many States have adopted legislation specifically protecting the lawful operation of gun ranges against those who would prefer that the “bad noise” simply be prohibited.

Americans do love their freedoms, and first amongst equals are those afforded by the 2nd Amendment to the US Constitution. Words written in 1791, namely - “*A well regulated Militia, being necessary to the security of a free State, the right of the people to keep and bear arms, shall not be infringed.*” - have been interpreted and argued in many ways. Most recently the US Supreme Court ruled in the case of *District of Columbia v. Heller* that indeed the 2nd Amendment applies to all US citizens on an individual basis rather than solely to national defense or police organizations. This, along with hundreds of years of civilian ownership and use of firearms, has led to an ever increasing number of private civilian and commercial firearms ranges. But along with the recreational use of firearms comes an unwanted byproduct, namely community noise.

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Recreational use of firearms by civilians can take many forms. People may join and use a gun range in order to practice with their self defense or home defense weapons, or they may join a club to practice or compete in their sport of choice. Hunters may join a gun club simply to have a place to sight in their hunting rifles, or people may just want to use the range for casual “plinking” entertainment. Police departments, lacking a dedicated range of their own, may use a local civilian range to practice and perform their mandatory qualification tests. Table 1 summarizes many of the more popular types of recreational uses of firearms. But whatever the reasons, all of the shooting involves noise; noise that can be predicted, measured, evaluated and controlled.

Table 1. Various Forms of Competitive Shooting and Associated Organizations

<p>Shotgun Sports: Trap, Skeet, and Sporting Clays</p>	<p>Trap and Skeet are very common shotgun sports where flying clay targets (birds) are shot out of the air after being thrown by machines in known directions. Sporting Clays is an outdoor sport similar to trap & skeet, but which utilizes a variety of clay target configurations and launching positions intended to simulate hunting conditions. National Skeet Shooting Association - www.mynssa.com American Trap Shooting Association - www.shootata.com National Sporting Clays Association - www.mynsca.com</p>
<p>Rifle Sports: High Power Rifle</p>	<p>Competitive center fire rifle shooting encompassing various military style firearms including the AR15 in .223 cal/5.56mm and the M1 Garand in .30-06 caliber. NRA regulation high power competition is conducted at ranges of 200, 300 and 600 yards. NRA - http://www.nrahq.org/compete/highpower.asp</p>
<p>Pistol Sports: Action Pistol Steel Challenge USPSA/IPSC IDPA</p>	<p>Action pistol sports which involve the shooting of center fire handguns under the pressure of a timer. Steel Challenge is a speed shooting sport in which competitors try for the fastest time on target arrays of steel plates. International Practical Shooting Confederation (IPSC) shooters start with a holstered center fire handgun and run through courses of fire which simulates the defensive use of a sidearm. International Defensive Shooting Association (IDPA) is similar to IPSC except more emphasis is placed on concealed carry techniques. The most commonly utilized firearms are center fire pistols in 9 mm, 40 S&W, 45 ACP and 38 Super. <i>Steel Challenge Shooting Association</i> - www.steelchallenge.com <i>United States Practical Shooting Association</i> - www.uspsa.org <i>International Practical Shooting Confederation</i> - www.ipsc.org <i>International Defensive Shooting Association</i> - www.idpa.com</p>
<p>Cowboy Action:</p>	<p>This is a competitive discipline using "old west" style firearms. Cowboy shooting is a "lifestyle sport", where competitors are expected to dress the part and use period firearms, or modern replicas thereof. Common calibers include 12 Gauge, .38, .44 and .45 caliber in both modern and black powder loading. <i>Single Action Shooting Society</i> - www.sassnet.com</p>
<p>Three Gun Sport: Rifle Handgun Shotgun</p>	<p>Three gun events consist of an aggregate score of handgun, rifle and shotgun stages. The handguns are generally semi-automatics in 9 mm, 38 Super, 40 S&W or 45 ACP. The dominant rifle and shotgun calibers are .223/5.56 and 12 Gauge. <i>United States Practical Shooting Association</i> - www.uspsa.org <i>International Multigun Association</i> - www.3gunrules.com</p>
<p>Silhouette: Center fire handgun</p>	<p>Silhouette shooting involves knocking down steel silhouettes of chickens, pigs, turkeys and rams at long distances to simulate hunting conditions. High power, single shot handguns are typically used. <i>International Handgun Metallic Silhouette Association</i> - www.ihmsa.org <i>National Rifle Association</i> - http://www.nrahq.org/compete/silhouette.asp</p>
<p>Small Bore Rifle: .22 Caliber Rifle</p>	<p>Small Bore Rifle competition uses .22 caliber rimfire rifles and bullseye style targets. <i>National Rifle Association</i> - http://www.nrahq.org/compete/smallbore.asp</p>
<p>Black Powder Shooting:</p>	<p>Black powder shooting is characterized by firearms that use "black powder" rather than modern propellants. Black powder guns (or historic firearms) are typically granted additional time in the field during hunting seasons, or can be used during Revolutionary War or Civil War reenactment events. http://hunting.about.com/od/blackpowder/Muzzleloader_and_Black_Powder_Information.htm</p>
<p>Bench Rest Sport: Rifle</p>	<p>Precision rifle shooting, shot from a benchrest-supported position. Accuracy and precision sport. <i>National Benchrest Shooters Association</i> - www.nbrsa.org</p>

2. GUNFIRE NOISE PREDICTIONS

There are several methods available for predicting gunfire noise levels in community locations resulting from the recreational use of firearms at gun ranges. Like any noise source, gunfire noise levels affecting distant community receptors can be estimated based on some knowledge of the source strength or emissions of various firearms, the terrain conditions, distances and elevations between the firearms and the receptors, the presence of any intervening barriers, buildings or obstacles, and meteorological (i.e. wind) conditions.

Two prediction methods are available, (1) empirical, and (2) analytical. Often times a combination of the two methods is used to produce the most accurate results.

A. Empirical Gun Noise Model

The empirical method involves performing a series of measurements of live gunfire noise at specified locations relative to a gun range. Care should be taken to ensure that the noise measurement instrumentation is configured in a suitable manner to measure gunfire noise, such as with a “Peak” or RMS time constant of “fast” or “impulse”, and with Linear or C-weighting if the measurements are made in close proximity to the firearms for hearing conservation purposes, or A-weighting if the measurements are performed farther away in the community.

The measurement locations should be selected at known distances from the gun range using scale maps or GPS longitude and latitude coordinates for example. The distances should not, however, be selected too far away from the gun range as to compromise the signal-to-noise ratio by the time the gunshot noise reaches the sound level meter. Useful test distances are dependent on ambient noise conditions but distances within a few thousand feet should produce satisfactory results. The noise measurement itself should focus on sampling just the noise from the gunshot, ideally during a moment of low background noise, with results expressed in maximum (Lmax) noise levels.

The next step involves post-processing the data to find mathematical relationships between gunfire noise levels and distance. Spreadsheets such as MS Excel® have several “trend line” functions that allow for this type of analysis. The results, such as those shown in Figure 1 from a gun noise study performed on Nantucket Island in 2007 involving the test firing of several gun calibers, allows for the prediction of gunfire noise levels at any distance of interest¹.

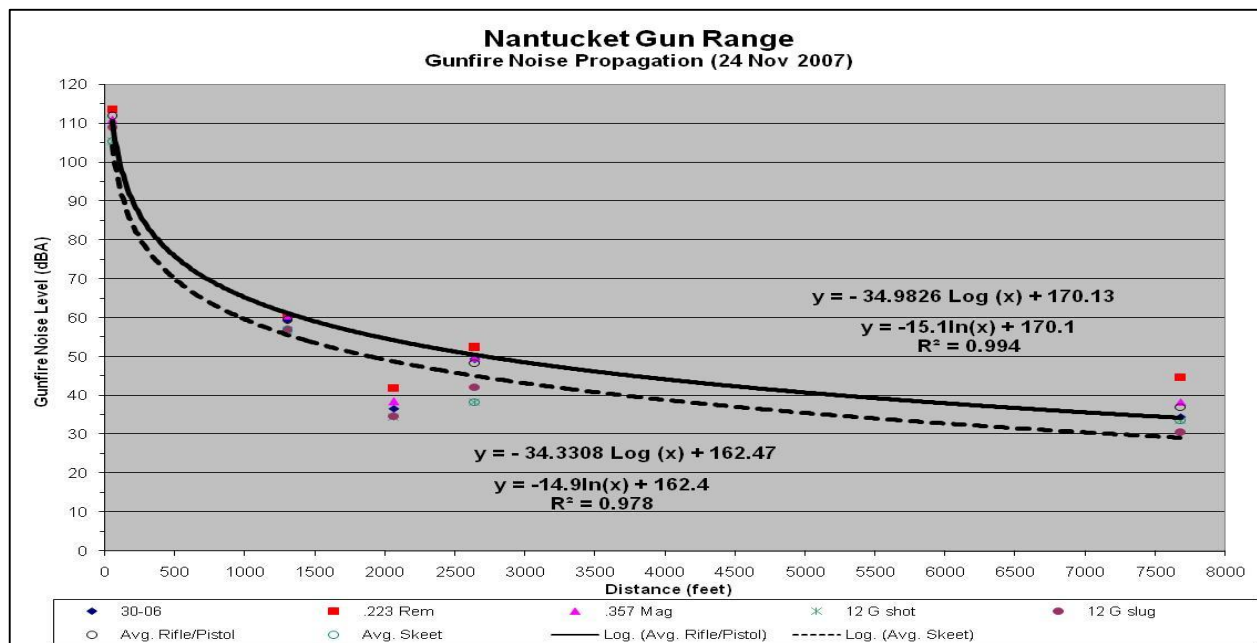


Figure 1: Empirical gunfire noise prediction model based on actual noise measurements¹

B. Analytical Gun Noise Model

Analytical methods involve the use of standard acoustical propagation equations to calculate how gunfire noise levels produced at a gun range will attenuate with distance. Important factors include distance loss, directivity, ground effects, foliage and forested areas, intervening barriers, buildings or obstructions, and wind effects. Distance loss uses the typical 20 Log (distance ratio) approach, but other factors are not so easily calculated. Firearms can be very directional noise sources with, not surprisingly, the loudest emission forward of and axial with the firearm's barrel. For semi-automatic firearms there can also be a second noise emission point out the breach-end of the barrel as the action opens to cycle the gun.

Frequency-dependent attenuation factors are more difficult to estimate because they vary for different ground cover conditions and obstacle types. Fortunately, ISO 9613 provides excellent guidance on how to estimate these other outdoor noise propagation factors. ISO 9613 is so widely applicable that it has been implemented in a commercially-available computer model called Cadna-A[®] available through DataKustik, GmbH. Providing the gunfire noise emissions levels can be estimated in terms of their sound power levels, then the Cadna-A model, or its competitors such as SoundPLAN[®] or ENM[®], can be very useful tools for estimating gunfire noise levels at more distant community receptor locations. For example, Figure 2 shows the results from a Cadna-A model prepared in 2008 for a newly proposed handgun, rifle and shotgun range in Bemidji, MN². There is also a model developed by the US Army called Small Arms Range Noise Assessment Model[®] (SARNAM)³ which is intended primarily for evaluating land use compatibility based on the Day-Night (Ldn) noise metric.

One factor that is critically important in using commercial-available models is to ensure that the input data is in the correct format and metric to compute resulting noise levels in accordance with relevant regulations. In this case the results shown in Figure 2 show isopleth noise contours in 5 decibel increments based on hourly A-weighted Leq levels. Care had to be taken to properly estimate the Leq sound pressure and sound power levels from the various firearms due to the need to average the gunfire noise levels over an entire hour. This process required estimating the number of rounds expected to be fired in a worst-case hour.

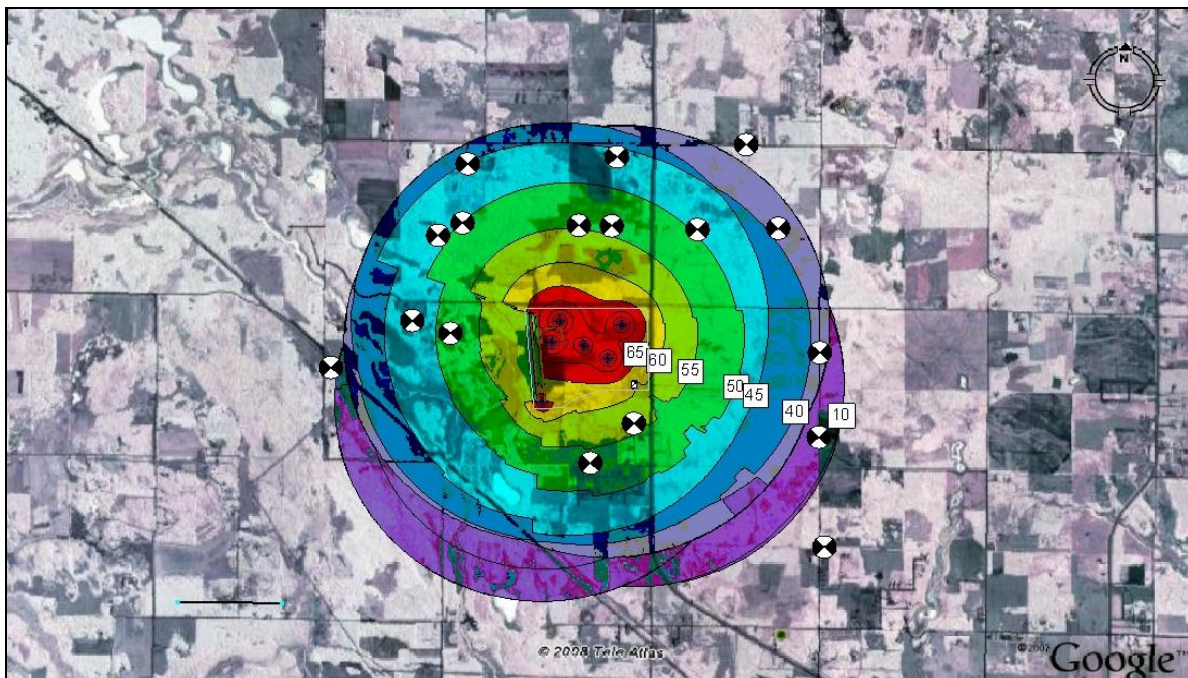


Figure 2: Analytical gunfire noise predictions per ISO 9613 using the Cadna-A model²

3. GUNFIRE NOISE CONTROL OPTIONS

Gunfire noise can be controlled, or at least reduced, by several means. Mitigation options could include (1) time restrictions, (2) restrictions on ammunition or firearm calibers, (3) firearm noise suppressors, (4) residential soundproofing, (5) shooting shed enclosures, and (6) the erection of noise barriers or earthen berms.

- 1.) Time restrictions typically allow shooting to only occur during daylight hours. If more specific operating permits or Memoranda of Understanding (MOU) are needed, then specific operation hours, such as 9:00 AM to 9:00 PM, can be specified. However, additional time restrictions could also be imposed to avoid shooting on holidays or weekends when neighbors may be more sensitive to noise intrusion. The process of establishing actual operating hours is usually a give-and-take compromise process between range owners and the affected community.
- 2.) Restrictions on ammunition and firearm calibers could be considered, but this can be very limiting for shooters and difficult to oversee for compliance. Smaller-caliber ammunition tends to be quieter than larger calibers, but there are notable exceptions to this rule. The key factor is the explosive pressure of the gunpowder used inside the cartridge, as reported by SAAMI⁴ in units of *crusher copper units of pressure* (cup) and more recently in units of *pounds per square inch* (psi). Lower pressure, and therefore quieter, ammo such as 22 LR, 38 Special, 45 ACP and black powder firearms produce chamber pressures of approximately 25,000 psi or less, whereas higher pressure rifle ammo such as 223 Remington and 500 S&W pistol ammo can produce internal chamber pressure levels of 50,000 psi or more. Also, some firearms are quieter than others due to their mechanical operation. For example, bolt action rifles, revolvers, and pump or hinged shotguns are generally quieter than their semi-automatic counterparts. This is because noise can escape out both the barrel as well as through the open action as a semi-automatic goes through its operating cycle.
- 3.) Law enforcement personnel using the range could be required to use suppressors (note: they are not called *silencers*) screwed onto the muzzle ends of their barrels, however civilian use of firearm noise suppressors is highly regulated (i.e. essentially prohibited) by Federal law through the National Firearms Act of 1934.
- 4.) Residential soundproofing could be considered including options such as new triple-glazed windows, solid exterior doors, new weather stripping, and air conditioning units. A less expensive option would be to install additional exterior or interior window sashes (i.e. storm windows) to augment the home's existing windows. Providing the windows are installed with at least a 4-inch air space and tight seals then an incremental noise reduction of 10 decibels, and perhaps an overall noise reduction of 35 to 40 decibels, can be expected. Homeowners' will likely appreciate this mitigation option because it reduces noise from all environmental and transportation sources, not just from gunfire. However, these mitigation measures are expensive (perhaps \$25,000 per dwelling) and do nothing to reduce noise outside the homes.
- 5.) Shooting enclosure sheds are useful for noise control purposes and improve shooter safety and comfort as well. Shooting sheds can be built with three sides and a roof, with the open side facing downrange for unimpeded shooting. Sheds can be made of

relatively inexpensive yet substantial construction such as concrete or CMU block. Shooting sheds provide shelter from the weather for shooters' comfort, allow for storage of range supplies, and act as enclosures to reduce noise propagation in all directions except downrange. The shed's walls should have a Sound Transmission Class (STC) rating of STC 40 or greater, and the interior walls/ceiling should be lined with a material with a Noise Reduction Coefficient (NRC) of 0.70 or greater to help reduce reverberant noise inside the shed itself. However, care should be taken to ensure that the sound absorptive material is suitable for outdoor use, and should be cleaned periodically in order to avoid the buildup of flammable unburned gunpowder residue.

- 6.) Noise barrier walls or earthen berms could be erected along the sides and backstop areas of each range. Earthen berms are inexpensive but may only have a practical height of about 20 feet tall. Engineered barriers with proper anchoring systems could approach 40 feet tall if necessary. Barriers can be made out of simple wood/timber, or pre-cast or cast-in-place concrete slabs with anchoring systems carefully designed to withstand wind loads on the barrier. Utility (telephone) poles are often used as the structural elements with one end planted in a drilled hole backfilled with concrete. Wooden tongue & groove or overlapping planks can be horizontally attached directly to the poles to the desired height. The limiting factor in a noise barrier's effectiveness is its height. The taller a barrier can be built the better its noise reduction performance will be. However, care must be taken to ensure that there are no air gaps between the planks that will allow noise to pass through the barrier. This is the reason why elevated deflector baffles, such as those erected above many new ranges to keep errant rounds from leaving the range (i.e. "no blue sky" design), provide relatively little benefit as noise barriers.

4. HEARING RISKS & FACILITY LIABILITY

When unprotected ears and high levels of sound energy are in proximity, whether in the same acoustic space (indoor range) or nearby in free field over a reflecting plane (outdoor range), there is risk of temporary and/or permanent hearing loss. And in the case when shooting is done for recreational purposes at a commercial range, the range owners face potentially liability as well.

A. Potential Risk to Hearing

The relation of noise exposure to damage risk/hearing loss associated with recreational small arms shooting is consistent with the classical pattern: sound level (peak pressure and/or energy), repetition/number of events, recovery period (mean time between events), and single substantial overpressure, may result in Noise Induced Temporary Threshold Shift (NITTS), and/or Noise Induced Permanent Threshold Shift (NIPTS). Rarely, acoustic trauma with catastrophic hearing damage and profound deafness can also occur. The risk to the "recreational" shooter is not much different than the risk to civilian "occupational" shooters such as law enforcement personnel or military personnel in some circumstances. Actually, the potential risk to casual or recreational shooters may be higher because of a lack of training that is afforded to occupational shooters by their employers in accordance with occupational safety and health regulations.

Several of the military and police small arms in various calibers are routinely owned and used by recreational shooters. One can measure and observe that the acoustic "report" from an AR-15 rifle is identical to that from an M-16 when firing the same ammunition. Likewise .38 caliber variants, 9 mm, 40 S&W, 45 ACP, and 12 Gauge buck shot and slug loads, are all routinely used by recreational, law enforcement, and military shooters alike.

Based on previous measurements and investigations, peak sound levels (L_{pk-lin} or A) from firing these guns, at a distance of 15 feet, are 151 to 153 ± 5 dB⁵. Sound levels of this magnitude are capable of causing NITTS, NIPTS, and further hearing damage if they are repeated often enough or without sufficient recovery time. A simple and effective preventive measure is the use of personal hearing protection such as ear plugs or ear muffs, or both as “double protection”.

If shooters, guests, or range personnel might have direct exposure to recreational gunfire noise during training, practice, competition, plinking, hunting or similar activities, then they must be aware of the potential risk to their hearing and should **wear personal hearing protective devices at all times when anywhere near the firing line**. Similar to the excellent gun safety practice of treating every gun as if it were loaded, one should also assume that a firearm may discharge close to you at any time! The best practice is to wear your hearing protection until you are in a protected space or have left the range.

B. Facility Liability

Because activities conducted at shooting ranges have the potential to cause personal injury, there is legal liability associated with shooting ranges and competitive shooting events. Notwithstanding “disclaimer” and “release of liability” forms, shooting range operators and event sponsors have been and will be sued for alleged personal injury whether it be from a trip and fall, exposure to airborne lead, an accidental gunshot wound, or claimed loss of hearing.

In one case, a spotter wearing insert hearing protectors and standing to one side of a shooter during the firing of two 9 mm rounds sued the indoor shooting range and the hearing protector’s manufacturer⁶. The suit alleged that the observer suffered hearing damage, yet the shooter and another spotter standing on the shooter’s other side reported no ill effects resulting from the two pistol shots. Based on forensic reconstruction, the unprotected sound level at the shooter’s ear, located 32 inches from the muzzle in standing offhand position, was 162 dB linear peak; and the reconstructed unprotected sound level at the adjacent spotter/observers’ near ears, located 57 inches from the muzzle, was 157 dB linear peak. The maximum acoustic energy of the two 9 mm gunshots was assumed to concentrate in the 10 kHz region based on US Army CERL³ data.

Based on the manufacturer’s noise reduction data for the protectors, the calculated sound level near the plaintiff’s ear drum was 144 dB at 500 Hz. Although this is below the damage risk criterion published by CHABA⁷ and others, the plaintiff still collected some (but substantially reduced) damages for the alleged hearing loss. Short of having every person at or near the firing line take a “before” condition audiogram, there is no irrefutable way to argue that hearing damage did not occur as a result of proximate exposure to firing line noise.

In a different case, damages were awarded to a plaintiff who alleged hearing loss from shooting range noise due to being sold a “defective” hearing protector by the range operator. This alleged loss was *some twenty-five years after serving as a helicopter machine gunner in Vietnam!* The Department of Defense Veteran’s Administration couldn’t or wouldn’t produce any of the plaintiff’s medical records including any pre- or post-service audiograms in response to a subpoena. Thus, no pre-existing condition of impaired hearing could be proven by the defendant range operator.

For these reasons, civilian and commercial gun ranges would be well advised to have more than adequate coverage of General Liability insurance, and aggressively post and enforce: **“High Noise Area – Hearing Protection Required”**.

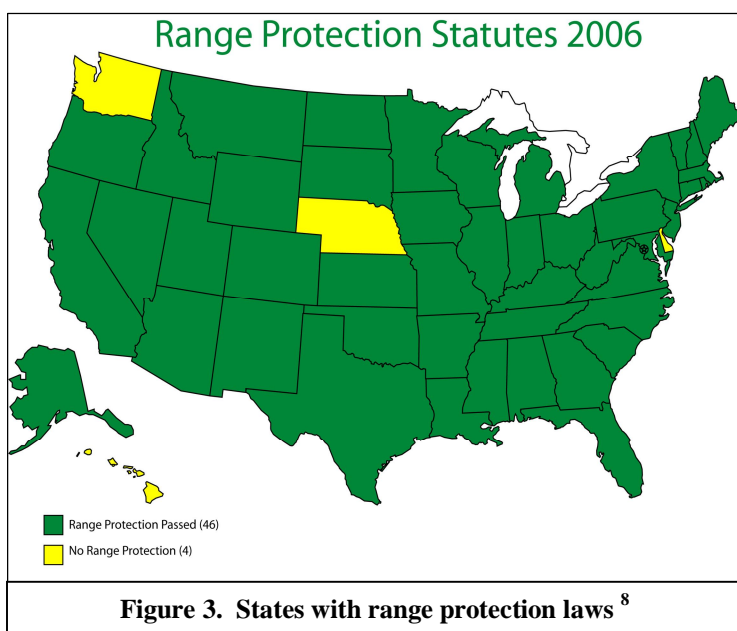
5. GUN RANGE NOISE REGULATIONS

Outdoor gun ranges may face opposition from nearby property owners who assert that the gun noise poses a public nuisance or violation of a local noise ordinance. Objections are sometimes

raised by homeowners who moved in and encroach after the range was already in operation or, in many cases, actually build a house near a pre-existing gun range and then complain about the noise.

Some people will consider any gun noise to be "excessive" because of the source, rather than level or duration of the sound. Persons who are "bothered by guns" may find range noise to be more disturbing than sounds from sources that do not offend their sensibilities on a non-acoustic basis. For example, measurements have confirmed that noise adjacent to gun clubs is frequently well below that of a nearby car door closing².

Protecting the rights of private property owners to engage in activity that was lawful at the time the property was purchased has become the attention of legislative focus in recent years. Numerous state legislatures have recognized that imposing a new noise requirement on an existing gun range is no different than ordering an existing business to cease operation because of a zoning change that would exclude its previously compliant use of the land.



As shown in Figure 3 and listed in detail in Table 2, at least 47 States currently have laws protecting ranges from adverse action for violation of community noise ordinance^{8,9}. The nearly universal standard states that the range cannot be held in violation for any noise ordinance that was enacted after the range was placed into initial operation. And while most State's gun noise laws do not contain specific noise limits, those that do generally provide for relatively high allowable noise levels comparable, for example, to that of traffic or aircraft noise. Gun noise limits are often expressed in hourly Leq criterion which, if they were to

be actually measured in the field, would be fairly easy to comply with given the time averaging nature of the Leq noise metric. Other regulations allow for relatively loud noise levels, such as 150 decibels, at the range's property lines.

Examples of specific mandates in range protection laws include:

- Exemption from State Regulation limits for noise from firearms and shooting ranges.
- Protection against new noise ordinances for ranges in operation before a specific date.
- Limits on hours of operation that are covered by the exemption.
- Extension of the protection to include any range relocation on the property that is required to comply with a government regulation.
- The prohibition of any property owner from building within certain distances of the range property line if the noise would exceed current limits unless the property owner (not the range) comes with, and pays for, a noise mitigation plan.
- Exemption from any lead pollution law if the range opened before a specific date.

Table 2. States Statutes Protecting Gun Ranges ⁹

Alabama – ALA. CODE § 6-5-341	Montana – MT. CODE ANN. § 45-8-111 & § 76-9-101 et seq
Alaska – AK STAT. § 34.75.010	Nevada – NEV. REV. STAT. § 40.140 & § 202.450
Arizona – ARIZ. REV. STAT. ANN. § 17-601 et seq.	New Hampshire – N.H. REV. STAT. ANN. § 159-B:1-3
Arkansas – ARK. CODE ANN § 16-105-502	New Jersey – N.J. STAT. ANN. § 13:1G-21.2. & 13:1G-21.3.
California – CAL. CIVIL CODE § 3482.1	New Mexico – N.M. STAT. ANN. § 17-8-1 et seq
Colorado – COL. REV. STAT. ANN. § 25-12-109	New York – N.Y. GEN. BUS. LAW § 150
Connecticut – CONN. GEN. STAT. § 22a-74a	North Carolina – N.C. GEN. STAT. § 14-409.45. et seq
Delaware – DEL. CODE ANN. tit. 10 § 8142	North Dakota – N.D. CENT. CODE § 42-01-01.1
Florida – FLA. STAT. ANN. § 823.16 & § 790.333	Ohio – OHIO REV. CODE ANN. § 1533.83 et seq
Georgia – GA. CODE ANN. § 41-1-9	Oklahoma – OKLA. STAT. ANN. tit. 63 § 709.2 et seq
Idaho – IDAHO CODE ANN. § 55-2602	Oregon – OR. REV. STAT. ANN. § 467.131
Illinois – 740 ILL. COMP. STAT. ANN. § 130/5	Pennsylvania – 35 PA. STAT. ANN. § 4501
Indiana – IND. CODE ANN. § 14-22-31.5-3	Rhode Island – R.I. GEN. LAWS § 11-47-62
Iowa – IOWA CODE ANN. § 657.9	South Carolina – S.C. CODE ANN. § 31-18-10 et seq
Kansas – KAN. STAT. ANN. § 58-3221 et seq.	South Dakota – S.D. CODIFIED LAWS § 21-10-28 et seq
Kentucky – KY. REV. STAT. ANN. § 237.200 et seq.	Tennessee – TENN. CODE ANN. § 39-17-316 et seq
Louisiana – LA. REV. STAT. ANN. § 30:2053	Texas – TEX. HEALTH & SAFETY CODE ANN. § 756.041
Maine – ME. REV. STAT. ANN. tit. 17 § 2806 & 30-A § 3011	Utah – UTAH CODE ANN. § 47-3-1 et seq
Maryland – MD. CODE ANN. ENVIR. § 3-105	Vermont – VT. STAT. ANN. tit. 10 § 5227
Massachusetts – MASS. GEN. LAWS ANN. ch. 214 § 7B	Virginia – VA. CODE ANN. § 15.2-917
Michigan – MICH. COMP. LAWS § 691.1541 et seq	West Virginia – W. VA. CODE ANN. § 61-6-23
Minnesota – Chapter 87A	Wisconsin – WIS. STAT. ANN. § 182.021
Mississippi – MISS. CODE ANN. § 95-13-1	Wyoming – WYO. STAT. ANN. § 16-11-101
Missouri – MO. REV. STAT. § 537.294	Hawaii, Nebraska, Washington – No range protections

6. CONCLUSIONS

Noise is an unfortunate byproduct of the recreational use of firearms. Civilian firearms ranges are under constant pressure to reduce or eliminate their operations stemming largely from community objection to noise. Fortunately, the noise generated from the lawful use of firearms can be measured, evaluated and controlled. Empirical and analytical models are available to predict the severity of gunfire noise levels in community locations, and control measures such as earthen berms, shooting sheds, caliber or time restrictions, and in extreme cases, residential soundproofing, can lessen neighboring community objections to the gunfire noise.

Americans love their freedoms, and first amongst equals are those afforded by the 2nd Amendment to the US Constitution. Gun noise will continue thanks to the freedoms Americans enjoy, but fortunately, neighboring communities and gun ranges can coexist in peace and quiet.

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