

# Community and Environmental Noise: A Guide for Military Installations and Communities



Noise Management and the Department of Defense



**Cover photo:**

U.S. Marines fire the M777-A2 Howitzer down-range during Integrated Training Exercises at Twentynine Palms, California. (U.S. Marine Corps photo by Lance Cpl. Aaron S. Patterson/Released)

*This document is a product of the Department of Defense (DoD) Noise Program's Defense Noise Working Group (DNWG). The DoD Noise Program and the DNWG are the Department's mechanism to ensure that Department policies are in place to protect both installations and communities, as well as track and manage common noise-related issues across all Military Services. This primer is a collaborative product of the DNWG, prepared by representatives in the Office of the Secretary of Defense, Army, Navy, Marine Corps, and Air Force. This primer serves as an initial outreach tool and resource for supporting the Military Services, installations, and their communities.*



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# Foreword

## *Department of Defense Community and Environmental Noise Primer—*

Department of Defense (DoD) policy is to reduce adverse effects from noise associated with military testing and training operations. DoD implements this policy by promoting noise education and training for DoD and the public; leveraging resources to ensure coordination among the DoD and other federal agencies; and promoting outreach to those affected by noise from military activities. The DoD Noise Program and the Defense Noise Working Group (DNWG) are the mechanisms for implementing DoD's noise policy in a manner that is consistent with maintaining military readiness and preserving the ability to conduct critical testing and training requirements. DoD established its Noise Program and the DNWG to address the far-reaching effects of noise generated by military activities, understanding that proactive communication and collaborative land use planning can reduce or prevent impact on the military's ability to carry out its testing and training missions.

Noise generated from military operations and long-term noise exposure on surrounding communities are the most persistent and costly **encroachment** challenges for DoD. The presence of noise can extend far beyond the fenceline and tends to be more apparent to the public than other visual or environmental factors. As a result, noise generates many complaints from communities and is often the most prominent discussion point and decision-making factor in land use planning surrounding military installations. Noise-related factors are also the most common issue at installations and ranges that request funding through the DoD's Readiness and Environmental Protection Integration (REPI) Program to protect land in the vicinity of installations and ranges from further incompatible development.

Representatives from the DoD Noise Program, DNWG, and the Military Services have developed this primer to communicate with military installations, neighboring communities, and partnering organizations about military noise and the basic noise management activities that DoD uses to engage and inform the public. Through effective communication, education, and cooperation, DoD and the Military Services will continue to manage noise exposure while protecting its mission.



## Understanding Community and Environmental Noise

Population growth and urbanization trends have resulted in communities that are closer to military installations, airfields, and ranges. As a result, DoD is now competing for use of airspace, land, and seaspace previously dedicated to military activities. While nearby incompatible development poses a variety of issues for the military training for communities. Noise is defined as unwanted sound that disturbs routine daily activities and may be an **annoyance**. Planes, helicopters, artillery, tanks, and small arms are standard equipment for the military. The sound this equipment generates during testing and training activities often reaches neighboring communities, sometimes rattling windows, disturbing sleep, and affecting people's daily lives.

Communities and the military must consider how changes to both community development and military operations can impact **community exposure** to military noise. Communities near installations and ranges must consider military noise as they grow and change. Failure to consider noise in community plans can lead to greater community exposure and impacts to the military mission in response to complaints. Changes to military operations such as realignment of military units, use of new **tactics** and weapons, and increases or changes in night operations can also lead to increased noise exposure if DoD does not consider current and future community plans. Two-way communication and collaborative planning between the military and its neighboring communities can reduce community noise exposure while protecting the military mission and prevent future challenges with noise.

### *The Military Services' Perspective*

Success on the battlefield depends on realistic training that produces skilled warfighters who have confidence in themselves, each other, and their equipment. To prepare soldiers, sailors, marines, and airmen for combat, the Military Services

#### **Unresolved noise problems can result in restrictions on military activities that impact effectiveness and realism, including:**

- reduction in available flight/training hours (e.g., limited or no night training, seasonal delays for training, modification of **military training routes**);
- restrictions or curtailment of airfield operations;
- higher altitudes for flight operations; and
- relocation or closing of firing points and ranges.

need to conduct high-quality testing and training throughout the year. Negative community reactions to military noise are often a challenge to this essential training. As a result, the Military Services focus a significant amount of time and resources on studying, communicating, and addressing noise generated by military activities to protect essential testing and training.



*2nd Armored Brigade Combat Team, 1st Cavalry Division M1 Abrams tank during gunnery training at Fort Hood, Texas. (U.S. Army photo by Maj. Adam Weece)*

Public and political pressure, legal action, and damage claims against military installations have had significant consequences for military operations. For example, the Army Assistant Chief of Staff for Installation Management determined noise impacts the ability to conduct training and other mission activities at 49% of active Army installations.

### ***The Community Perspective***

While the sound of military activities evoke thoughts of safety and national security in some people, others find these sounds a nuisance. People can be startled by unexpected military sounds and may not understand why such noise is necessary. Communities often question the need for night training or even any live-fire training at all.

The number of people expected to be “highly annoyed” by noise is a metric used by the DoD and federal agencies to identify and address long-term noise exposure, noise impacts, and **land use compatibility** recommendations.



**The individual response of a community member to noise depends on many noise factors:**

- intensity, or loudness of the sound;
- duration, or length of time they can detect the sound;
- **frequency**, or pitch of the sound;
- repetition of the sound source;
- time of day the sound occurs;
- abruptness of onset or cessation of the sound;
- fear of personal danger from the sound sources; and
- the extent to which people believe that DoD can control the noise.

Annoyance is largely subjective. In a modern environment of constant natural and manmade sounds, an individual's response to military **sound sources** and perception of noise will vary depending on many factors. However, annoyance levels can be quantified and qualified. Recent studies and community surveys suggest a growing public intolerance for noise associated with military activities, expressing concerns about:

- interruption at work and school;
- diminished privacy and quiet at home;
- interrupted entertainment and conversation;
- sleep disturbance;
- property damage including broken windows; and
- disturbance of wildlife, livestock, and pets.

***Finding Common Ground***

Efforts to manage and mitigate noise, both on and off an installation, help reduce community exposure to noise while protecting the military mission. This Primer addresses the many ways DoD works with communities to find common ground and protect communities from noise exposure.

There are many opportunities for military installations and neighboring communities to reach mutually beneficial solutions to address noise-related concerns. Service- and Installation-specific noise management programs help

**How does the DOD quantify noise and predict annoyance?**

*While it is difficult to directly measure annoyance, studies have found that sound levels can help to predict how communities will react to different noises. Decades of community surveys and scientific studies have produced and validated an internationally recognized relationship between transportation sound levels and community annoyance. This relationship is used to develop land use recommendations for all federal, state, and local agencies. DoD also applies this relationship to noise generated by military activities. DoD and communities use these land use recommendations as part of their decision-making.*

### **What is the DoD doing to reduce annoyance?**

Community and environmental noise management programs are specifically designed to help military installations work with their civilian neighbors to address the impacts of military noise. These programs guide noise management efforts both on and off a base/installation and often include the following elements:

- noise assessment;
- noise education;
- complaint management;
- noise mitigation; and
- vibration information

installations work with their neighbors to address the impacts of **military noise**. Cooperative problem solving improves the likelihood of successful noise management.

**Education and outreach** are the first step in developing cooperative relationships between installations and communities. Informed communities are often the most engaged. It is very important for communities to understand the noise challenge, how to communicate with the installation, and participate in community and installation planning efforts. Establishing and maintaining a connection between installation and community is essential.

**Planning and prevention** can go a long way to achieving success and mutual benefit for the military and surrounding communities. Military activities and community development are in a constant state of change. For the military, noise management is always a part of the planning process. As close neighbors, coordinating planning activities and identifying compatible land uses can minimize or eliminate unnecessary community noise exposure.

Adequate mechanisms for **responding to and mitigating noise exposure** are also important components to any noise management program, especially for communities already exposed to or impacted by military noise. Complaint management systems and procedures help address community concerns while also allowing the installation to identify the source and determine whether adjusting testing and training operations to minimize or prevent further impact.

# What Is Noise and How Do We Talk About It?

While noise itself is something that everyone has experienced and recognizes, the technical concepts applied in noise management can be difficult for installation personnel and communities to understand. Establishing a basic and common understanding of noise concepts helps military installations and surrounding communities work together to address noise issues more effectively.

## Decibels and Weighting

The standard for the loudness of sound or noise levels is a quantity known as the “**decibel (dB)**.”

The human ear is not uniformly sensitive to all frequencies of sound. Most common sound sources are measured using **A-weighted decibels (dBA)**.

The A-weighting corresponds to the ear’s sensitivity and deemphasizes very high and low sound frequencies to only reflect the frequencies that people actually hear. The military typically uses A-weighting to describe sound from generators, aircraft, and general transportation. For reference, a normal voice has a sound level of approximately 60 dBA, and a busy highway can have a noise level of over 85 dBA.

**C-weighted decibels (dBC)** quantify sounds containing large amounts of low-frequency energy. Although people cannot hear low frequencies well, they may feel vibrations that low-frequency energy generates. As a result, large caliber weapons firing, and detonations are assessed with C-weighted dBs to better describe the sound and vibrations that people may experience.

## Cumulative vs. Single Event Sound Levels

Federal, state, and local agencies use a set of common **metrics** and measurements to describe noise when assessing land use compatibility and conducting noise studies and noise management. Each metric or measurement is used differently depending on the source or type of sound to ensure community

**Common Sounds and Noise Levels**  
(A-weighted)

Noise Source (at a given distance)	Typical Reaction
	<b>140</b>
Civil Defense Siren (100 ft)	<b>130</b>
Jackhammer (50 ft)	<b>120</b>
Pile Driver (50 ft)	<b>110</b>
Ambulance Siren (100 ft)	<b>100</b>
Motorcycle, Power Lawnmower (25 ft)	<b>90</b>
Garbage Disposal, Alarm Clock (3 ft)	<b>80</b>
Vacuum Cleaner (3 ft)	<b>70</b>
Normal Conversation, Dishwasher (5 ft)	<b>60</b>
Light Traffic (100 ft)	<b>50</b>
Bird Calls (Distant)	<b>40</b>
Soft Whisper (5 ft)	<b>30</b>
	<b>20</b>
	<b>10</b>
Human Breathing	<b>0</b>

### Noise and Vibration

While artillery firing or explosives activities may seem to shake the ground, the vibration felt in neighbors’ homes is typically caused by airborne sound waves that act on external surfaces of a home, causing it to vibrate. This vibration may cause annoyance and concern; however, it is very unlikely that vibration from normal military activities will result in structural damage to homes.

### Day-Night Average Sound Level (DNL)

DNL is a 24-hour average sound level that includes a 10-dB adjustment, or “penalty”, for activity occurring between 10 p.m. and 7 a.m. The 10-dB penalty considers that people are more sensitive to noise during these hours, when sounds are more noticeable and may be considered more intrusive.

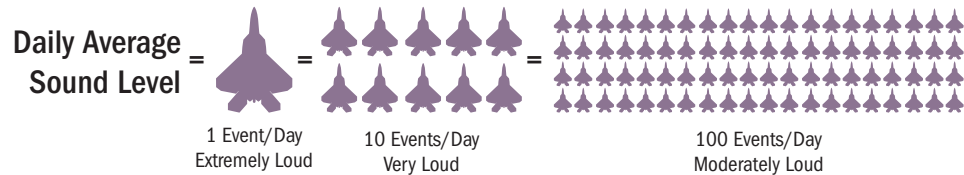
### Community Noise Equivalent Level (CNEL)

For military installations located in the State of California, CNEL is used in place of DNL as the primary metric for describing long-term noise exposure. CNEL, like DNL, applies a 10-dB penalty for activities occurring between 10 p.m. and 7 a.m., as well as an additional 5-dB penalty for activities occurring between 7 p.m. and 10 p.m.

exposure is appropriately measured and addressed. The differences in these metrics often confuse both installation personnel and communities, who may not realize that different types of noise are assessed in different ways.

## Day-Night Average Sound Levels

“**Day-night average sound level**” (DNL) is the most widely-used metric to describe, assess, and predict long-term noise exposure. The military uses DNL as the basis for determining land use compatibility for noise associated with aviation, demolition, and large caliber weapons. As with the decibel, DNL can also be weighted to better describe sound based on the type of the source. A-weighted DNL (ADNL) is used to describe noise from sound sources such as aircraft or transportation. C-weighted DNL is used to describe low-frequency sources such as large caliber weapons and detonations. DNL represents an average of all noise activities conducted throughout the day, and is usually averaged over an extended period of time. For land use planning, DNL is usually averaged over a year to include days of light and heavy training loads, as well as periods with no activity. DNL is most often used to describe and plan for persistent military activities, which is the best-known method for assessing and predicting long-term community exposure.



## Understanding the Concept of Average Sound Levels

The concept of daily average sound level can be difficult to explain to communities and stakeholders. It is important to understand that an average daily sound level accounts for all periods of activity, as well as inactivity, in a 24-hour period. As depicted, a measured daily average sound level for a small number of loud events may be equivalent to a large number of quieter events. Similarly, several relatively quiet events may not increase overall daily average sound levels.

## Peak or Maximum Sound Levels

Although DNL is an effective metric for assessing land use compatibility or the average of all noise events in a day, DNL may not be the best method of describing community annoyance associated with occasional loud events and their potential impact on communities. DNL accounts for the total noise exposure a community experiences over a period of time. The DoD often uses supplemental metrics such as “**unweighted**” peak sound levels and maximum sound levels to assess noise levels of **impulsive and single events**. This is necessary because the DNL (average) noise metric may understate the intensity of the impulsive events (small arms, artillery, tank gun, explosive detonations) since DNL averages noise peaks with **ambient** quiet times. For example, the average noise level is irrelevant to a mother upset about a child awakened from naps by aircraft

operations or tank firing. **Supplemental metrics** are sometimes a better predictor than DNL for determining noise impacts and likelihood of complaints.

### Aircraft Noise

A good predictor of annoyance at airfields with 50–200 operations per day is the maximum level (Lmax) of the three noisiest events.\*

#### Percentage of population highly annoyed from aircraft noise

Maximum level (dBA)	Percent Highly Annoyed (%)
70	5
75	13
80	20
85	28
90	35
95	43

### Blast Noise

Complaint potential from low-frequency sound (impulsive noise) that is caused by activities such as detonating explosives and artillery firing is low when levels are below 115 Peak dB.\*\*

Peak Decibels (dB)	Audibility
<115	May be Audible
115 – 130	Noticeable, distinct, may notice vibration/rattle
>130	Very loud, may startle

### Small Arms Noise

Mean unweighted peak sound pressure level around 85 **peak sound level** is a reasonable criterion for land-use planning. At this level, approximately 10% of a residential population would be expected to be affected. Small arms noise is unique in that the Services base land use recommendations on unweighted peak levels rather than DNL.\*\*\*

#### Percentage of population highly annoyed from small arms range noise

Peak Decibels (dB)	Percent Highly Annoyed (%)
80	4
85	10
90	13
95	21
100	29
105	38

\*Rylander, et al., 1974, "Re-Analysis of Aircraft Noise Annoyance Data Against the dBA Peak Concept," *infrequent*, Vol. 36, 399–406.

\*\*Pater, 1976, "Noise Abatement Program for Explosive Operations at NSWC/DL," presented at the 17th Explosives Safety Seminar of the DoD

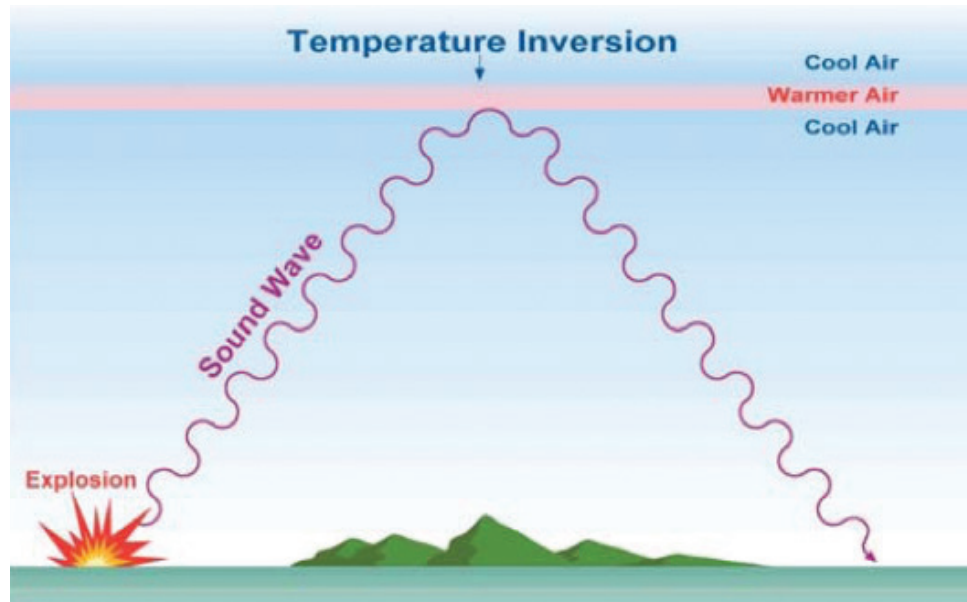
\*\*\*Sorenson and Magnusson, 1979, "Annoyance Caused by Noise from Shooting Ranges," *infrequent*, Vol. 62, 437–442.

### Single-Event Noise

DNL does not provide a clear depiction of maximum and peak noise levels from loud, single events. When planning specific noisy activities, the DoD compares the expected noise level to standard guidelines. It also factors in and analyzes weather and other elements that influence how sound travels. Information in the following tables can be compared with expected noise levels to determine whether there is a risk for adverse impacts on the community.

## ***Influences on Sound Propagation***

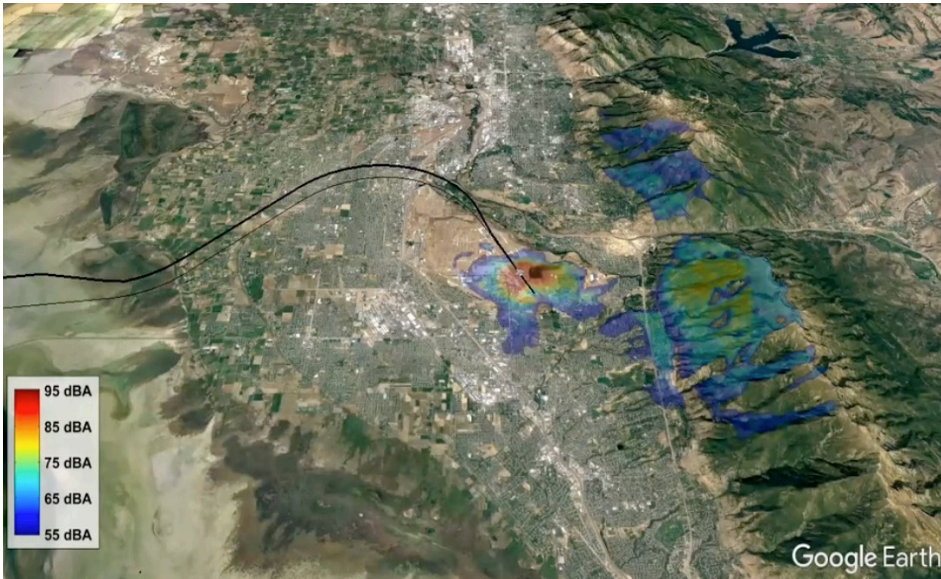
One of the more challenging aspects of managing noise is the way sound travels and **propagates** under different weather, wind, terrain, and even temperature conditions. Under the changing weather conditions, it is possible that a sound source can be barely detectable one day, but very loud and annoying the next.



### **Temperature Inversion**

*The image illustrates how temperature inversions bends (refracts) the sound created by a typical explosion. The sound waves from the explosion initially travel upward, but the inversion reflects the sound back down toward the ground, generating high noise levels many miles away. Noise levels at that distance would otherwise be much lower.*

Weather conditions have the largest influence on sound and significantly affect sound propagation. Wind, temperature, and cloud cover influences how far sound travels and how loud it will be at the **receiver's** location. Sound levels are typically higher downwind than upwind from the source. Temperature variations can also make distant sounds much louder and be heard at further distances than normal. In certain conditions, variations in temperature can act as a boundary for sound, trapping it close to the ground. This can create areas of high intensity sound far from the source. For example, on most days it may be possible to conduct military activities without disturbing neighboring communities. On another day, cloud cover and temperature variation can result in significantly increased noise levels from the same activities at the same location. In the case of blast noise, sound levels can vary by over 40 decibels at the receiver over the course of hours for the same activity.



## Noise Modeling and Sound Propagation

The DoD uses acoustic modeling tools to assess and predict noise in planning. The example above models a full-power takeoff of an F-35 from Hill Air Force Base. The extent of the engine noise from the aircraft is depicted as a color gradient. In this example, terrain effects can also be observed where the Wasatch Mountains act as a sound barrier.

**Terrain** also affects how sound travels. Hills and mountainous terrain can be both a barrier for sound as well as an instrument of sound propagation, especially when complex weather systems come into play. **Ground cover** or type of surface also influences sound levels. Bodies of water such as lakes, rivers, and oceans are very effective at allowing sound to travel over long distances when compared to soil or vegetative ground covers.

When assessing noise at military installations, DoD relies on **acoustic modeling** software that can accurately simulate the effects of sound propagation and determine sound levels under varying conditions. Noise modeling tools can help DoD and communities with land use planning and optimize the timing of activities to minimize community impacts.

## Noise and Compatible Use Zones Studies

The Military Services develop comprehensive **noise studies** to support communities, compatible land use planning, and DoD basing efforts by conducting detailed analysis of military activities, operations, and the sounds they produce. These studies use noise modeling software to account for all known activities and operations at the installation or range, as well as projected conditions which may affect or change sound levels throughout surrounding communities.

Noise studies are a comprehensive look at a community's exposure to installation and range noise from current or future military activities. These studies produce maps that depict noise exposure levels (usually in DNL) that align with a common set of land use **compatibility guidelines** adopted by federal, state, and local governments. The studies recommend land uses for surrounding areas based on current and future military activities. Land use compatibility guidelines for noise provide agencies with the maximum recommended exposure for specific land uses and activities. For example, recommended maximum exposure levels for industrial land use are higher than recommended sound levels for residential areas or where schools and childcare facilities may be present.



*Naval Air Station Meridian partnered with Lauderdale County to post signs near areas exposed to higher levels of aircraft noise from nearby military training activity. Location of the signs were determined based on noise studies conducted at the installation. The signs have helped inform new home buyers, lessees, and realtors of areas that are exposed to higher levels of long-term aircraft noise exposure.*

The noise study results and land use recommendations within noise studies are used to support planning, decision-making, and outreach for communities and DoD. These studies and noise management efforts help installation personnel provide information, recommendations, and assistance as communities develop and implement land use controls, such as zoning, special permits and projects, subdivision regulations, capital improvement programs, building codes, noise disclosure, establishment of easements, and public land acquisition. Working together, the military and its neighboring communities can prevent incompatible development around an installation, such as residential development in high noise zones or near installation boundaries.



The military incorporates the results of noise studies in its noise reduction efforts, **Joint Land Use Study (JLUS)** Program, and other compatible land use programs including the including the **Air Installations Compatible Use Zones (AICUZ)** Program, the **Navy Range Air Installations Compatible Use Zones (RAICUZ)** Program, and the **Marine Corps Range and Compatible Use Zones (RCUZ)** Program. These programs promote outreach between installations and local communities that will help protect public health and safety, as well as preserve the operational utility of the installation. DoD also uses the results of noise studies to identify potential REPI projects and support funding decisions that prevent incompatible development around ranges and airfields. Noise studies are also used during strategic basing decisions and **National Environmental Policy Act (NEPA)** analysis.



*An engineering student from California Polytechnic State University at San Luis Obispo, Calif., sits on Rogers Dry Lake Bed to record the noise footprint of the C-17 Globemaster III, during a noise mitigation study being conducted by NASA. (U.S. Air Force photo by Tom Tschida)*

#### **An effective community involvement program:**

- builds trust and enhances relationships;
- educates and informs;
- increases the likelihood of public acceptance; and
- reduces potential impacts to missions.

## **Improving Noise Management Through Community Involvement**

An effective community involvement program is proactive and demonstrates a commitment to preserving public trust. Community involvement activities can be implemented to encourage community input and minimize the effects of military noise on the community with the support of the installation commander and installation personnel.

### ***Have a Community Involvement Strategy***

Noise-related community involvement techniques and strategies best suited to address noise-related issues are integrated with an installation's overall community engagement strategy. Community involvement is not a one-time occurrence; it is an ongoing part of public engagement. The installation's Public Affairs Officer (PAO), **Community Planning and Liaison Officers (CPLOs)**, and/or community involvement staff are strategic partners in noise-related community involvement efforts, helping integrate and coordinate efforts with the installation's overall community engagement and communication efforts. For example, the PAO often shares information through social media, including public notifications of training events, and arranging tours, briefings and meetings with elected officials.

#### **Matching communication tools to the situation**

DoD conducts outreach and communication activities to involve and educate the public. Involving the public through the noise management program lets all stakeholders express their views and provides the military with information to influence training activities to minimize noise impacts. Which communications tools are most effective depends upon available resources, the amount of interest, and the communities' preferred methods of receiving information.

### ***Know Your Stakeholders***

The foundation of effective community involvement and communication is an understanding of the people and the issues. In noise management, stakeholders are those specifically concerned with noise issues. Stakeholders will likely include local government representatives (elected officials as well as staff) and community representatives (residents from communities adjacent to the installation, civic leagues, and business interests). On the installation, the PAO and CPLOs coordinate with various installation staff, range managers, and airfield operators to address noise complaints and issue press releases in advance of loud training events.

### **Building lasting relationships with stakeholders:**

- Participation in community meetings (Kiwanis, Chamber of Commerce, etc.), taking public questions, and fostering one-on-one conversations with community members.
- Meeting with the editorial boards of local newspapers.
- Telephone local officials; Establish contact and availability if they have any questions about the facility.
- Seek out community leaders or groups in the community who are interested in the process.
- Provide contact information to the public. Set up an email list to consistently communicate to many stakeholders simultaneously.

On-installation communities are also included in the stakeholder group. On-installation communities often provide input concerning the noise management program and have opportunities and outlets to express concerns related to the effects of training on their quality of life. On-base housing, schools, and day-care facilities can be impacted by military noise. Military installations strive to understand their neighboring communities, including military personnel and dependents who may live on base.

### ***Integrating Community Involvement Activities Into Your Installation's Day-to-Day Business***

Continuous and effective communication and coordination with the local community can sustain a positive relationship between the installation and its neighbors. Community noise management programs, community involvement activities, and **complaint management systems** are integrated into installation plans (e.g., training, land management, and master planning) that support installation operations. Noise is considered in all installation planning activities, such as the siting of new facilities and ranges. For the military, participation in regional planning meetings or establishing local installation-and-town advisory groups keeps the communication lines open. Many installations also have noise complaint hotlines and locations on the installation website where the community can report noise issues and concerns.

Informal opportunities to interact with the public are also beneficial. Frequent dissemination of noise-related information helps to maintain or improve relations with the public. The military sometimes uses advance notification of significant noise events to the public. Experience shows warning of activities that might cause annoyance seems to lessen, rather than increase annoyance.

## Noise Reduction Strategies and Complaint Management

**Noise mitigation** can take place at the sound source, along the path that the sound travels, or at the receiver. However, these mitigation techniques are limited, and their effectiveness and feasibility are often dependent on the type of sound source and location. At the source, the DoD employs tools such as using **inert ammunition** and constructing specially designed buildings to quiet jet engine noise associated with maintenance and testing. Establishing distance, maintaining vegetative cover, and building barriers or berms can mitigate sounds along the path. Noise levels can be mitigated at the receiver through construction incorporating noise level reduction features. Although these physical measures can help reduce community exposure to noise when properly implemented, the most effective means of mitigating impacts is through compatible land use planning. DoD conducts a detailed environmental assessment, including analysis of noise, safety, and land use compatibility, before siting any new testing or training activities. It can also be effectively used by neighboring communities through comprehensive plans and land development regulations.

While DoD's approach to noise management is largely focused on preventative action and mitigation prior to escalation, DoD also addresses noise through complaint resolution. For neighboring communities already significantly impacted by noise, complaint management and frequent communication are essential components of a noise management program and being a good neighbor. The goal of a complaint management program is to handle neighbors' complaints in ways that will prevent further concern from communities and improve communication. Handling noise complaints is a reactive noise management technique and can involve high-stress communication. Having a detailed communications plan, responding to complaints in a timely manner, and maintaining direct contact with range control, air traffic control, and flight line operations all ensure quick and effective resolution.

Typically, only a small percentage of people who are bothered by noise lodge complaints. The interaction between the military and the complainant can often be positive, especially when the military uses the opportunity to educate the complainant about the importance of the installation's mission and open up a dialogue. For the installation, a detailed complaint log can provide useful information about noise impacts and help in planning future mitigation activities. By asking specific questions of the complainant, the installation can identify the sound source, the conditions that resulted in the complaint, and other information to support decisions that can reduce future exposure.

## Conclusion

The military and neighboring communities can work together to address mutual noise challenges surrounding military installations and ranges. Reducing complaints and concerns from communities without modifying or constraining operations is DoD's ultimate goal. DoD understands that, by their nature, military activities are noisy events. The military strives to lessen effects of noise on communities by educating and conducting outreach with community members, establishing a common understanding of noise, and addressing noise through appropriate planning and response.

For more information on the DoD Noise Program, the DNWG, or individual Military Service noise programs, please contact:

### **Department of Defense Noise Program**

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Washington, DC 20301-3400

***[osd.noiseprogram@mail.mil](mailto:osd.noiseprogram@mail.mil)***

***<http://dodnoise.org>***

## Common Questions from Communities About Exposure to Noise

### ***What are the adverse effects of noise exposure?***

Noise affects people differently. Some people are more affected by noise, while others are less so. Adverse effects of noise may include annoyance, sleep disturbance, decreased scholastic performance, and speech interference.

### ***How will noise affect children if a school is located in a high-noise zone?***

In buildings without adequate sound insulation, aircraft noise may impact how well school-age children learn. **Noise level reduction (NLR)** incorporated into building design can help significantly. For example, it is strongly discouraged to construct schools in areas with outside noise levels of 65–75 dB. However, sound-proofing the building can reduce the amount of noise reaching the students. The building should provide enough NLR so that indoor classroom levels do not exceed 45 dB.

### ***How can I reduce noise in my house?***

Building material can reduce outdoor noise by 15–25 dB, depending on whether the windows are open or closed. Greater noise reduction may be achieved by caulking and filling exterior openings, installing sound-insulating windows and doors, and adding thermal insulation to outer walls and ceilings.

### ***Will living in a noise zone affect the value of my property?***

Property values are determined by a combination of neighborhood characteristics (e.g., the quality of local schools, local property taxes, access to transportation, and the crime rate) and individual housing characteristics (e.g., age of the house, number of rooms, and amenities such as garages). There are no definitive federal standards for quantifying the impact of noise on property values.

### ***How can noise shake my home?***

Structural vibrations from military activities are typically caused by airborne sound waves (impulse noise). An airborne sound wave is a force that acts on the external surfaces of a home, causing it to vibrate. This vibration is transmitted through the structure of a home to shelves, dishes, and loose windows, which may cause annoyance and concern.

### ***Will vibrations from military noise damage my home?***

It is very unlikely that vibration from military noise will result in structural damage to your home. Common events such as a gust of wind, children running through a house, a door slamming, or typical fluctuations in temperature and atmospheric pressure create strains on buildings that are comparable to or greater than those resulting from military activity.

The military sets procedures and limitations for testing and training operations to prevent such damage from occurring. These limitations are based on various studies that include data on the amount of vibration that would damage a house. According to these studies, sound levels reaching a home or other structure must be greater than 137 dB (peak) to cause any minor cosmetic damage. Even then, there is only a 1-in-10,000 chance that damage will occur—glass and plaster cracks being the most common.

# Definitions

## A

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<b>Acoustic Modeling</b>	A process using computer software to emulate an existing or future state of the sound environment or soundscape; a typical noise model displays noise contours so that levels of equal decibels are connected by lines.
<b>Air Installation Compatible Use Zones (AICUZ) Program</b>	A DoD Program that promotes long-term compatible land use on and in the vicinity of air installations by encouraging State and local governments to adopt enabling legislation and compatible land use regulations into their land use planning and control processes and by partnering with communities and other eligible entities to protect land through restrictive use and conservation easements.
<b>Ambient Noise</b>	The total of all noise in the environment, other than the noise from the source of interest. Also known as background noise.
<b>Annoyance</b>	An emotional and attitudinal reaction from a person exposed to noise used as primary indicator of community response. Annoyance attempts to account for all negative aspects of effects from noise, e.g., increased annoyance due to being awakened the previous night by aircraft, and interference with everyday conversation.
<b>A-Weighted Decibels (dBA)</b>	Sound level in decibels that closely corresponds with the human ears sensitivity to medium range frequencies by de-emphasizing low and high frequencies. This weighting helps quantify a noise with a wide range of frequencies into a single number representing the sound pressure level. A-weighting is appropriate for transportation noises such as aircraft overflight and vehicle traffic noise. See also "C-weighted Sound Level." (See ANSI S1.1 for scientifically agreed upon definition)

## C

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<b>C-Weighted Decibels (dBC)</b>	Sound level in decibels where weighting is applied to intense low-frequency noise that can cause vibrations. C-weighting does not apply adjustments to noise signals over most of the audible frequencies, but does apply small adjustments to the very low and very high frequencies. C-weighting is appropriate for impulsive sounds, such as sonic booms and the deployment of large caliber weapons. When experienced indoors, impulsive sounds can create secondary noise from rattling and vibrations of the building (see also CSEL and CDNL). (See ANSI S1.1 for scientifically agreed upon definition)
<b>Compatibility Guidelines</b>	Recommendations for land use compatibility within Noise Zone areas on and surrounding military installations, ranges, and airfields based on the specific type of land use and a range of sound exposure levels. Land use guideline recommendations vary based on the type of noise source (i.e. aircraft, traffic, weapons and explosives).
<b>Community Involvement Program</b>	A carefully designed program that uses a variety of techniques, and that, in addition to informing the public of possible decisions and their potential consequences, provides opportunities for consultation with the public, and considers the public's views before making decisions and taking actions.
<b>Community Planning and Liaison Officers (CPLOs)</b>	An individual representing a military installation or range that serves as a bridge between the installation and the community, local governments, and private stakeholders with regards to compatibility of development projects. The CPLO represents the installation commanding officer by meeting with elected officials, regional and community planners, zoning and code enforcement staffs, school board members, utility district managers, local Chamber of Commerce directors and staff, and non-profits groups including environmental, conservation, and natural resources organizations. The CPLO manages installation encroachment management programs which include Air Installations Compatible Use Zones (AICUZ) and the Range Air Installations Compatible Use Zones (RAICUZ) programs.

## C, continued

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### **Complaint Management Systems**

A program designed to input, track, and respond to noise complaints which typically include toll-free complaint hotlines, a complaint webpage, and mechanisms for follow-up and investigation of complaints. A well-organized noise complaint management program at an installation can affect negative attitudes towards the offending noise as well as try to reduce the noise exposure.

## D

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### **Day-Night Average Sound Levels (DNL)**

A 24-hour average sound level for a given day after the addition of a 10 dB weighting is added to account for the increased sensitivity of people to noise from such things as aircraft operations, for sound levels that occur between the hours of 10 p.m. to 7 a.m., because ambient sound levels at night are typically lower than during the daytime hours. (See ANSI S1.1 for scientifically agreed upon definition)

### **Decibel (dB)**

A logarithmic unit of measure used to describe the intensity or loudness of sound

## E

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### **Encroachment**

Incompatible land uses and habitat loss near and adjacent to installations, ranges, and operating areas which threaten the military's ability to provide the most realistic training.

## F

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### **Frequency**

Number of complete oscillation cycles per unit of time. The unit of audio frequency is the Hertz (Hz), which represents one cycle per second.

## I

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### **Inert Ammunition**

Ammunition used for military training and weapons function testing which contains no explosive charge.

### **Impulsive Sound**

Noise of short duration (typically less than one second), especially of high intensity, abrupt onset and rapid decay, and often rapidly changing spectral composition. Impulse noise is characteristically associated with sources such as explosions, target impacts, the discharge of firearms, sonic booms, and many industrial processes.

## J

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### **Joint Land Use Study**

A cooperative planning effort conducted as a joint venture between an active military installation, surrounding jurisdictions, state and federal agencies, and other affected stakeholders to address all compatibility around military installations.

## L

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### **Land Use Compatibility**

Ensures land-uses on and off an installation are compatible with the current or anticipated military noise environment. In some cases, the annual sound exposure level may be too high to support noise-sensitive land uses such as schools, daycare centers, or residential development. Thus, compatible land uses such industrial, commercial, or agricultural are encouraged. DoD works closely with states, counties, and communities in cooperative land use planning efforts to ensure land use compatibility and limit noise exposure.



## M

**Metrics** Industry standard units of measure and methods of describing noise that ensure all federal, state, and local agencies as well as industry have a standard approach to describing and addressing noise.

**Military Noise** Unwanted sound generated from the operation of military vehicles, weapons or weapons systems (e.g., aircraft, small arms, tank guns, artillery, missiles, bombs, rockets, mortars, and explosives).

**Military Training Route (MTR)** Corridors of defined airspace used by military aircraft to maintain proficiency in tactical flying.

## N

**National Environmental Policy Act (NEPA)** A federal law that requires federal agencies to assess the environmental effects of their proposed actions prior to making decisions. The range of actions covered by NEPA is broad and includes making decisions on permit applications, adopting federal land management actions, and constructing facilities. Using the NEPA process, agencies evaluate the environmental and related social and economic effects of their proposed actions. Agencies also provide opportunities for public review and comment on those evaluations.

**Noise** Noise is any unwanted sound. The issue of noise is very subjective, and is typically influenced by an individual's experiences and sensitivity. Both terms, noise and sound, are used in this instruction, depending on the context of the discussion.

**Noise Exposure** The cumulative acoustic stimulation reaching the ear of a receiver, over a specified period of time (e.g., a work shift, a day, or a lifetime).

**Noise Level Reduction (NLR)** The difference, measured in decibels, between the A-weighted sound level outside a building and the A-weighted sound level inside a designated room in the building. The NLR is dependent upon the transmission loss characteristics of the building surfaces that are exposed to an exterior noise source, the particular noise characteristics of the exterior noise source, and the acoustic properties of the designated room in the building

**Noise Mitigation** These are measures that can be taken to reduce or avoid noise exposure. For example, mitigating the effects of aircraft noise on sensitive land uses such as schools, residential areas, and churches can take many forms, including modification to time of day or frequency of use, flight path parameters (location, altitude, etc.), or changes to the listener's environment (building insulation).

**Noise Study** A comprehensive analysis of noise associated with specific or multiple military activities at a given installation, range, or airfield.

## P

**Peak Sound Level** Peak is a single-event (instantaneous) sound pressure level without weighting.

## R

**Range Air Installations Compatible Use Zones (RAICUZ)** A Navy-specific compatible land use program similar to the DoD AICUZ program that includes air-to-ground ranges and airspace in the vicinity of naval range installations, in addition to air installations.

**Range Compatible Use Zones (RCUZ)** A Marine Corps-specific program designed to protect the public health, safety, and welfare, and to prevent encroachment from degrading the operational capabilities of Marine Corps Range and Training Areas (RTAs), to encompass air-to-ground, ground-to-ground, and laser ranges. Like AICUZ and RAICUZ, the RCUZ provides compatible land use recommendations for noise contours and range compatibility zones (RCZs).

## S

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<b>Single Event Sound</b>	Sounds from single events such as the passby of a truck, the flyby of an airplane, or an explosion are all examples of single-event sounds.
<b>Sound Propagation</b>	The process by which sound travels through space or material; may be affected by such things as weather, terrain, and barriers.
<b>Sound Receiver</b>	The individual, community, animal, or object being exposed to a given sound
<b>Sound Source</b>	The origin of a sound or sound producing activity
<b>Supplemental Metrics</b>	Supplemental metrics and tools are additional units of measure and methods of describing noise that can be used to better communicate noise exposure and address the specific concerns to stakeholders.

## T

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<b>Tactics</b>	Military activities or skills, based on specific warfighting goals or strategies, that involve the organized movement of equipment, personnel, or vehicles as conducted in the field of battle.
<b>Terrain</b>	The physical features of a stretch of land or geographic area, including but not limited to elevation, slope, and geology. Terrain or topographic features can influence sound propagation characteristics.



