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EPA

Noise and its Measurement

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Breaking Noise Into Parts

The noise abatement engineer may need to analyze the noise from a particular source so that he can identify its origin and eliminate the cause.

Using the example of a jet engine, the engineer may determine that the high-pitched whine comes from one part of the engine while learning that other, less bothersome frequencies come from another part. He will then concentrate his work on the part of the engine that makes the most trouble.

To solve the problem, the engineer may use a sophisticated noise analyzer together with a graphic sound level recorder to break the noise down into its individual ingredients.

Summary

With new methods like these, we are coming to grips with the problem of noise and how to reduce it. Accurate noise measuring instruments have made it possible to replace arguments over what is too loud with statements of scientific fact.

These new instruments are proving invaluable to manufacturers who want to make quieter equipment, and to State and local officials who want to reduce noise.

The Environmental Protection Agency, through its ten Regional Offices, offers equipment and technical assistance to State and local governments with noise problems. EPA technicians also consult with manufacturers.

By using noise monitoring equipment of simple design and moderate cost, we can now go a long way toward reducing noise pollution and benefit the health and well-being of all Americans.

The tools are there. It is up to us to use them effectively.

Hearing Protectors

In today's mechanized world it is virtually impossible for an active person to avoid exposure to potentially harmful sound levels.

For this reason, hearing specialists now recommend that we get into the habit of wearing protectors, not only to guard against hearing loss but to reduce the annoying effects of noise.

There are two basic types of hearing protectors: muffs worn over the ears and inserts worn in the ear. Well-fitting protective muffs are more effective, but inserts also do a good job if properly fitted. Since ear canals are rarely the same size, inserts should be separately fitted for each ear. Cotton plugs are virtually useless.

Protective muffs should be adjustable to provide a good seal around the ear, proper tension of the cups against the head, and comfort.

Both types of protectors are available at many sports stores and drugstores. They are well worth the small inconvenience they cause for the wearer.

Hearing protectors are recommended for the following:

At work: Construction, Lumber, Mining, Steel, Textiles.

During recreational and home activities: Target shooting and hunting, Power tool use, Lawn mowing, Snowmobile riding.

Note: These are only some of the jobs and activities where hearing protectors are beneficial. Protectors are also helpful when concentration is necessary in the home or office.

The decibel scale is logarithmic (based on powers of ten), not linear like a ruler. Therefore, a small increase in decibels represents a great increase in intensity. For example, while 10 decibels is 10 times more intense than one decibel, 20 decibels is 100 times more intense (10 x 10, rather than 10 + 10), 30 decibels is 1000 times more intense (10 × 10 × 10) and so on. The sound intensity multiplies by 10 with every 10-decibel increase. The reason for such a scale is simply that the human ear is sensitive over such a wide range of acoustic energy that the numbers involved had to be compressed for convenience.

In some ways, the decibel scale resembles the Richter scale for earthquakes. A small numerical increase represents a great increase in intensity.

The ear can detect a very slight change in noise intensity. Even a small reduction in decibels then can make a difference.

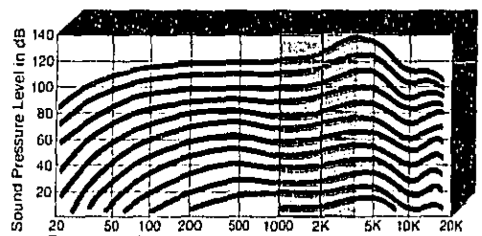
Measuring Noise Scientifically

In response to mounting public concern over environmental noise, new and better ways of measuring it have been developed. In the past, typical sound level meters were the size of TV sets. Now they are no larger than pocket transistor radios and measure noise with laboratory accuracy. In addition, their use requires no special scientific training.

This means that the average citizen or city employee can reliably monitor noise, making possible new opportunities for noise abatement and control. Prices for good sound level meters start around $200, a cost within the reach of most municipal budgets.

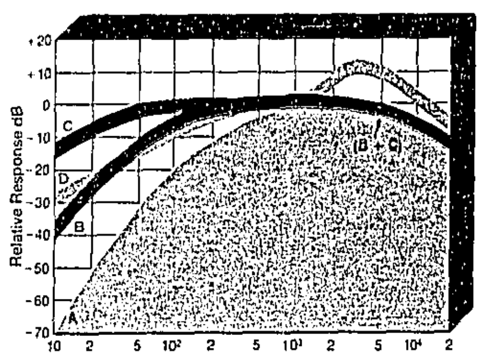
How Meters Work

Sound level meters have three or four scales for measuring noise. The A scale is used most often to measure neighborhood noise. It electronically filters the low and high frequencies and responds to sounds much the same as the human ear. The graph below shows that the ear is most sensitive to sounds in the 1000-4000 Hz range.



Human response to pure tones of equal Sound Pressure Level.

The B, C and D scales on noise meters are used for more specialized noise readings. The D scale, for instance, is the one being considered for use in measuring the noise of jet engines at airports.



The Weighting Curves A, B, C and D

While jet engines generate a great concentration of high frequency noise, diesel locomotives generate noise that is heavily weighted in the lower frequencies, so a different scale may be used to measure their noise, usually the C scale.

The damage done by the pollution of our air and water is widely recognized. The evidence is right before our eyes, in contaminated water, oil spills and dying fish, and in smog that burns the eyes and sears the lungs.

Noise is a more subtle pollutant. Aside from sonic booms that can break windows, noise usually leaves no visible evidence, although it also can pose a hazard to our health and well-being. An estimated 14.7 million Americans are exposed to noise that poses a threat to their hearing on the job. Another 13.5 million of us are exposed to dangerous noise levels without knowing it from trucks, airplanes, motorcycles, hi-fi's, lawnmowers, and kitchen appliances.

Recent scientific evidence shows that relatively continuous exposures to sound exceeding 70 decibels—expressway traffic, for instance—can be harmful to hearing. More than that, noise can cause temporary stress reaction which includes increases in heart rate, blood pressure, blood cholesterol levels and effects in the digestive and respiratory systems. With persistent, unrelenting noise exposure, it is possible that these reactions become chronic stress diseases such as high blood pressure or ulcers.

Knowing the damage that noise is doing, what can we do about reducing it?

First we must identify the noise source and measure its output. Accurate analysis and measurement are the first steps in controlling noise.

What Is Sound?

Sound travels in waves through the air like waves through water. The higher the wave, the greater its power. The greater the number of waves a sound has, the greater is its frequency or pitch.

The strength of sound, or sound level, is measured in decibels (dB). The frequency is measured in Hertz (Hz) (cycles per second). However, the human ear does not hear all frequencies. Our normal hearing ranges from 20 Hz to 20,000 Hz or, roughly, from the lowest note on a great pipe organ to the highest note on a violin.

The human ear also does not hear all sounds equally. Very low and very high notes sound more faint to our ear than 1000 Hz sounds of equal strength. This is the way our ears function.

The human voice in conversation covers a median range of 300 to 4000 Hz. The musical scale ranges from 30 to 4000 Hz.

Noise in these ranges sounds much louder to us than very low or very high-pitched noises of equal strength.

Loudness and Decibels

Because hearing also varies widely between individuals, what may seem loud to one person may not to another. Although loudness is a personal judgment, precise measurement of sound is made possible by use of the decibel scale. This scale, shown below, measures sound pressure or energy according to international standards.

Sound Levels and Human Response

Common Sounds	Noise Level (dB)	Effect
Carrier deck jet operation Air raid siren	140	Painfully loud
	130	
Jet takeoff (200 feet) Thunderclap Discotheque Auto horn (3 feet)	120	Maximum vocal effort
Pile drivers	110	
Garbage truck	100	
Heavy truck (50 feet) City traffic	90	Very annoying Hearing damage (8 hours)
Alarm clock (2 feet) Hair dryer	80	Annoying
Noisy restaurant Freeway traffic Man's voice (3 feet)	70	Telephone use difficult
Air conditioning unit (20 feet)	60	Intrusive
Light auto traffic (100 feet)	50	Quiet
Living room Bedroom Quiet office	40	
Library Soft whisper (15 feet)	30	Very quiet
Broadcasting studio	20	
	10	Just audible
	0	Hearing begins

This decibel (dB) table compares some common sounds and shows how they rank in potential harm to hearing. Note that 70 dB is the point at which noise begins to harm hearing. To the ear, each 10 dB increase seems twice as loud.