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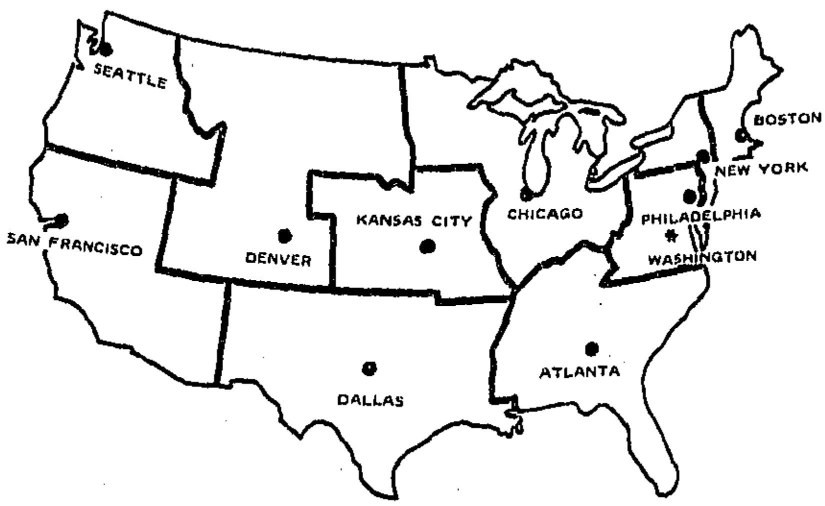
HANDBOOK FOR REGIONAL NOISE PROGRAMS



APRIL 1974

OFFICE OF NOISE ABATEMENT AND CONTROL
WASHINGTON, D.C. 20460

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SECTION 1

INTRODUCTION

This handbook is intended as a working reference manual for Environmental Protection Agency region program managers and staff personnel. It provides an overview of the noise problem and EPA's regional noise program. Its contents should be useful to non-technically oriented as well as technically oriented personnel. A loose leaf format is utilized, thereby allowing for periodic update.

No information is contained herein which has not been previously disseminated to the regions in a different format. Furthermore, no attempt has been made to delineate all activities of the EPA Office of Noise Abatement and Control (referred to as ABN); this information is available to the regions in the work plans and reports which are forwarded periodically.

This guide contains eleven sections. Bibliographic references are given throughout; appendices include a glossary of terms, a list of EPA noise documents, a compilation of ordinances, and a schedule of EPA noise workshops.

Many different sources were utilized in the preparation of this guide. Among the most important were the various EPA technical documents and the manual, prepared by Dr. W.S. Gatley and Mr. E.F. Frye, entitled "Regulation of Noise in Urban Areas."

SECTION 2

ACOUSTIC PRINCIPLES AND TERMINOLOGY

2.1 INTRODUCTION

In order to understand the characteristics of sound and the meaning of acoustical terms, a foundation of basic principles, definitions, and techniques is essential. Since it is possible for a discussion in acoustics to easily become comprehensive and technical, only the basic fundamentals are presented in this section.

2.2 CHARACTERISTICS OF SOUND

Basically, the sound we experience in our everyday lives can be a result of objects or bodies being set into vibration. More specifically, when a vibrating surface imparts its motion to the surrounding air, a minute time variation in atmospheric pressure called sound pressure results. In addition, the air itself can vibrate (turbulence) and generate sounds. The word "minute" is obviously a relative term and is used in designating just how small the sound pressure quantity really is.

In order to adequately describe the magnitude of the sound pressure, the metric units of Newtons per square meter (N/m^2) are used. Figure 2-1 shows the wide range of sound pressures associated with some commonly encountered noise conditions in terms of this system of units.

The sound source and the medium surrounding the source vibrate in a similar fashion, and the resulting disturbance propagates outward from the source. When the pressure variations occur regularly, a definable number of repetitions occur each second and this is called the frequency of the sound. The units previously applied to frequency were cycles per second (cps); now the Hertz (Hz) is used (in honor or Heinrich Hertz who discovered the means of generating radio waves). The units are equivalent.

Since air can be compressed and rarefied, a "wave motion" occurs and a "sound wave" tends to propagate outward and away from its source. The speed of propagation is about 344 meters/sec under normal atmospheric conditions. If the sound source is confined to a small region in space (the point source), the wave front will diverge so that the sound energy passing through a unit of area will diminish with increasing distance, implying that the sound pressure will diminish with distance.

The sound energy passing through a unit of area per unit of time is called the sound intensity. It can be shown from the study of acoustics that, in the case of a small sound source, the intensity

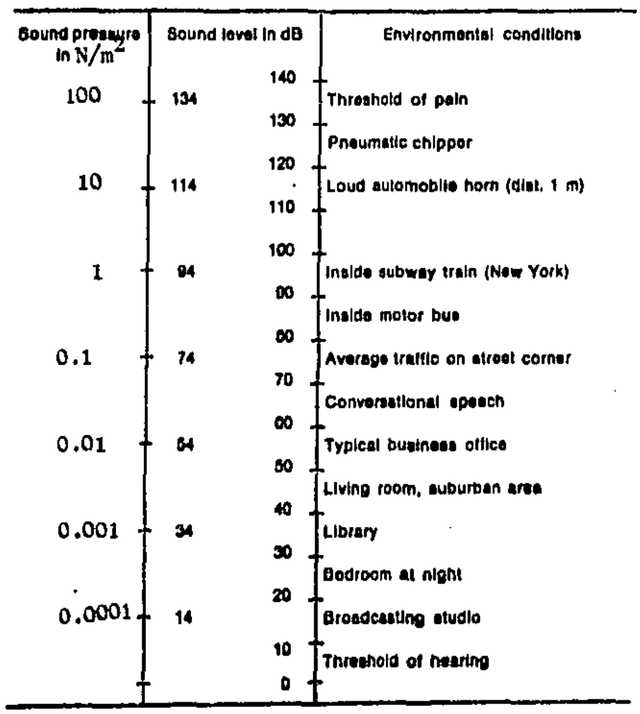


Figure 2-1. Commonly Encountered Noise Levels

varies inversely as the square of the distance from the sound source. This is called the inverse square law.

As a final comment on the characteristics of sound, it is important to realize that sound pressure is normally presented in terms of its root-mean-square value. This is because the average fluctuation of the pressure variations in compression and rarefaction about the equilibrium pressure level is zero. Consequently, the pressure values during a time interval are squared, then the time average is obtained, followed by taking its square root value. The notation Prms is used to represent this quantity.

In conclusion, the minute pressure disturbances designated as sound waves have the following characteristics:

1. The magnitude of the sound pressure is given in N/m^2 and is normally the root-mean-square value.
2. The frequency of the sound wave is given in Hertz.
3. Sound waves move at 344 meters/sec under normal atmospheric conditions in air.
4. The sound pressure of the wave almost always decreases with increasing distance from its source.
5. For a freely propagating spherical wave the intensity decreases with the inverse of the distance squared.

2.3 ACOUSTIC TERMINOLOGY

One of the more difficult quantities to define is the decibel. What exactly is it? How is it used and applied?

The decibel (dB) is used universally to describe the relative magnitude of sound. It is a dimensionless measure of the logarithm of the ratio between two values (i.e., a measured quantity and a reference quantity). The decibel has been applied to the acoustics field for the following reasons:

1. If one used the almost unbearable roar of a jet engine at close range and the barely audible whisper to describe the range of the human ear, the corresponding sound pressures would have a ratio of 1,000,000 to 1. By employing the logarithmic feature inherent in the decibel's definition, this tremendous pressure range is resolved into a condensed and more meaningful scale that ranges from 0 dB (by definition) to approximately 120 dB (Figure 2-1).
2. The ear tends to respond in a logarithmic manner. The human auditory response to a given increase in sound pressure is approximately proportional to the ratio of the increase in sound pressure to the sound pressure already present. (For example, the ear is capable of detecting a very small increase in sound pressure when the ambient level is low; with high ambient level, a much larger increase is necessary to give the ear the same sensation.)[1]

Under ideal laboratory conditions, the average ear can detect a minimum sound pressure level change of 1 dB. In everyday encounters, a 3 dB change in sound pressure level is barely perceptible, whereas a 5 dB change is clearly noticeable.[2]

2.4 DECIBEL LEVELS

The following are the mathematical definitions of the sound power level, the intensity level, and the sound pressure level. Note that the term "level" refers to a logarithmic measure and is expressed in decibels. Also note that the term log is a logarithm to the base 10.

$$\text{Sound Power Level} = PWL = 10 \log \left(\frac{W}{Wo}\right), \text{ dB relative to Wo}$$

where

W = source power in watts
Wo = reference power = 10^{-12} watts

$$\text{Intensity Level} = IL = 10 \log \left(\frac{I}{Io}\right), \text{ dB relative to } I_o$$

where

I = intensity in watts/meter^2

I_o = reference intensity = 10^{-12} watts/meter^2

$$\text{Sound Pressure Level} = SPL = 10 \log \left(\frac{p^2}{p_o^2}\right), \text{ dB relative to } p_o$$

where

p^2 = mean-square pressure in $(N/m^2)^2$

p_o = reference pressure = 0.00002 N/m^2 = 20 micro N/m^2

From the above definitions for the decibel, it is first noted that for a 3 dB drop, the power, the intensity, and the mean-square pressure must be halved. By way of example, consider intensity I_1 with intensity level IL_1 and intensity I_2 with intensity level $IL_2 = IL_1 - 3$. Thus, by definition,

$$IL_1 = 10 \log \left(\frac{I_1}{I_o}\right)$$

$$IL_2 = 10 \log \left(\frac{I_2}{I_o}\right)$$

Subtracting the second equation from the first,

$$IL_1 - IL_2 = 10 \log\left(\frac{I_1}{I_o}\right) - 10 \log\left(\frac{I_2}{I_o}\right)$$

Now, using the given relationship between IL_1 and IL_2 on the left side of the equation, we get

$$3 = 10 \log\left(\frac{I_1}{I_2}\right)$$

so that by rearranging and taking the antilog of both sides, we obtain

$$\frac{I_1}{I_2} = 2$$

and

$$I_2 = \frac{1}{2} I_1$$

This proves that for a 3 dB drop, the intensity is halved.

Another interesting observation is that the intensity level decreases by 6 dB for each doubling of distance from the source producing a freely propagating spherical wave. This latter observation is a consequence of the inverse square law[3], which is given mathematically as

$$I = \frac{W}{4\pi r^2}$$

where r is the distance between the source center and the point of observation. Thus, for a given sound power W, let the intensity level at distance r_1 be given as

$$IL_1 = 10 \log\left(\frac{I_1}{I_o}\right) = 10 \log\left(\frac{W}{4\pi r_1^2 I_o}\right)$$

Suppose the distance is doubled, so that $r_2 = 2r_1$.

Then, at this distance, the intensity level is

$$IL_2 = 10 \log \left(\frac{W}{4\pi r_2^2 I_o} \right)$$

$$= 10 \log \left(\frac{W}{4\pi r_1^2 I_o 4} \right)$$

$$= 10 \log \left(\frac{W}{4\pi r_1^2 I_o} \right) - 10 \log 4$$

$$= IL_1 - 6$$

Since it can be shown[3] that under normal atmospheric conditions

$$SPL \approx IL$$

then, from the above derivation, the SPL also decreases by 6 dB for each doubling of distance from the source.

An important point here is that at a particular location the sound pressure level due to a sound source will, in general, vary with a change of the local surroundings. A typical example would be parking a car in a garage. The sound level we hear inside the garage is different from that which we hear while parked on the driveway even while standing in the same location relative to the car. Another example is the household vacuum cleaner. From experience we know that this appliance appears to produce different levels of sound when used in a carpeted living room and in the tiled recreation room.

To obtain a better appreciation for the sound pressure levels of typical noise sources, refer to Figure 2-1. These sound pressure levels can be considered to be representative, although it must be remembered that sound pressure level readings are dependent upon local surroundings and distance from the noise source. The sound pressure level readings given are those that would be typically present in the environments specified.

2.5 COMBINATION OF SOUNDS

The total sound energy at a given location is usually a combination of the sound energy arriving at the given point from many different sources. For example, the listener may be exposed simultaneously to the sounds from a barking dog, a power mower, a garbage disposal, and a ringing telephone. What is the total sound that the listener hears? For most types of sounds, the total is obtained by summing the acoustical energies produced by each source that arrive at the listener's ear in a given time interval. This combination yields an effective sound pressure that can be easily converted to SPL. In fact, a sound level meter is an instrument that performs this operation automatically and displays the result on a meter.

Let us now consider what happens when two sources produce identical sound pressure levels at the location of a sound level meter. This means that the same amount of acoustic energy is arriving per unit time from each source. If the SPL from either one of the sources is, say, 80 dB, what does the meter read when both sources are operating? Because SPL values are logarithmic, the answer is *not* 160 dB. Combining the two sounds on an energy basis shows that the total SPL is 83 dB.

This result is obtained since it is shown in acoustics that the quantity p^2 is additive.[3] For the above example, if the SPL is 80 dB, then from the definition of SPL,

$$SPL = 10 \log \left(\frac{p^2}{p_o^2}\right)$$

Substituting the given value in the left side of the equation, we obtain

$$80 = 10 \log \left(\frac{p^2}{p_o^2}\right)$$

Therefore, rearranging and taking the antilog of both sides,

$$\left(\frac{p^2}{p_o}\right) = \text{antilog } 8 = 10^8$$

Thus, for the two sources operating simultaneously, since p^2 is additive,

$$\left(\frac{p^2}{p_o}\right) = 2 \times 10^8$$

Consequently, the SPL for the two sources is

$$\begin{aligned} SPL &= 10 \log (2 \times 10^8) \\ &= 10 \log 2 + 10 \log 10^8 \\ &= 3 + 80 = 83 \text{ dB} \end{aligned}$$

2.6 SOUND POWER

Since the sound pressure level is a function of the environment, a characteristic of a sound source that is absolute and independent of its surroundings would be useful. One such characteristic is the sound power output of a source. The sound power output of a source (at specified operating conditions) is a measure of the acoustic work it produces per unit time, a fixed value which is independent of source location. The measuring unit that is applied is the watt. Like sound pressure, sound power has an overwhelming range of values. Typical values for the very soft whisper and jet engine are .000,000,0001 and 100,000 watts respectively. Again, the logarithmic character of the decibel is advantageous to compress this large range of numbers into a more manageable range. The sound power and corresponding sound power level of some typical noise sources are shown in Figure 2-2.

If sound power output is a non-variant with respect to source location, one might ask: "Why do we measure the sound pressure level of a source instead of the sound power level?" There are at least two reasons for doing so:

1. Sound power levels, at the current state of the art, cannot be measured directly, but must be calculated from sound pressure measurements.
2. Measurements to calculate the sound power output require special test conditions and environments (anechoic chambers, reverberation rooms, etc.) that often are not available on location.

The primary purpose of determining the sound power output of a source is that once this value is known, the sound pressure level can be estimated, knowing the acoustic qualities of the proposed or actual surroundings. An example might be to estimate the increase in the sound pressure level if an air-conditioner is added to an already noisy office.

2.7 FREQUENCY ANALYSIS

As was shown earlier, one of the important characteristics of sound is its frequency or frequency content. The spectrum (or range) of frequencies of interest to us is the human auditory range. This spectrum typically extends from approximately 20 to 20,000 Hz, but for most persons the range is about 40 - 13,000 Hz, and decreases with age. This spectrum can be viewed as a contiguous band of frequencies, each 1 Hz wide.

The simplest of all sounds are those composed of a single frequency. These sounds are called pure tones, or simple harmonic sound waves. However, the sounds to which we are usually exposed are much more complex than pure tones. These sounds are composed of many frequencies, each occurring simultaneously at its own sound pressure level. The striking of a chord on the piano or guitar are examples. Often, the sound does not appear to have any tonal quality. Examples of this category would be ventilating duct noise or the sound produced by escaping steam. The important point to remember is that our world of sound is composed of many frequencies, each at a given sound pressure level, occurring simultaneously and generally changing with time. In

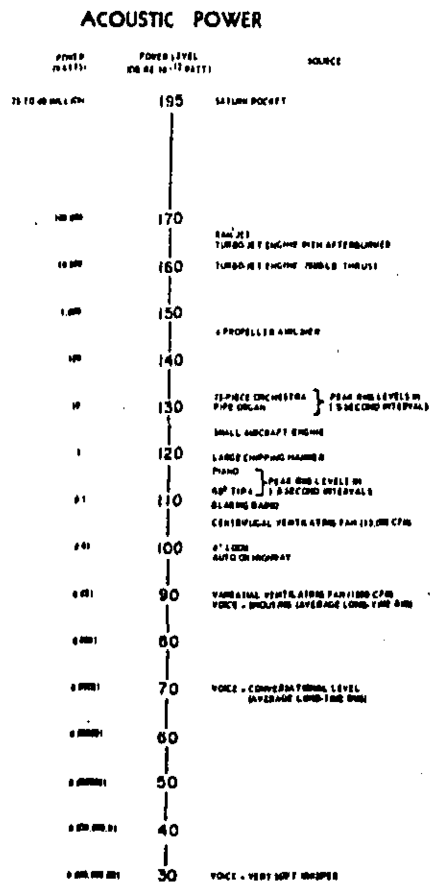


Figure 2-2. Typical Power Levels for Various Acoustic Sources

order to investigate the frequency content of a sound, a procedure known as a frequency analysis can be performed. This procedure enables us to obtain a sound pressure level versus frequency picture or spectrum of a sound source.

When a frequency analysis is performed, the sound spectrum is electronically divided into adjoining frequency bands and the SPL is computed for each band, called band level. The basic scheme employs octave bands to divide the spectrum into continuous and adjoining frequency bands (Figure 2-3). The upper frequency of each band f_u is twice the lower frequency f_l, and the center frequency of each band $f_c = \sqrt{f_u f_l}$, that is, the geometric frequency of the adjoining frequency bands. The precision instrument which divides the spectrum and measures the SPL for each octave band is known as an octave band analyzer. It is noted that narrower band analyzers such as the one-third octave band analyzer are also available for those cases where more detailed frequency data are required.

Instead of naming the upper and lower frequencies of each band it has become standard practice to specify a center frequency within each band. Center frequencies in use today (the preferred octave bands) are as follows: 31.5, 63, 125, 250, 500, 1000, 2000, 4000, 8000, 16,000 Hz. An older series of octave bands is sometimes encountered in noise standards and codes. This older series is comprised of the following frequency bands: 37.5-75, 75-150, 150-300, 300-600, 600-1200, 1200-2400, 2400-4800, and 4800-9600 Hz. It is important to note that the band levels for these two series of octave bands cannot be interchanged. In other words, the 75-150 Hz band level cannot be substituted for the preferred 125 Hz band level.

In summary, a frequency analysis defines two characteristics of a sound source:

1. The frequency distribution of the sound
2. The amount of sound energy concentrated in the various frequency bands.

2.8 AMBIENT NOISE

Ambient noise or background noise is defined as the total of all the noise in a system or situation, independent of the presence of the desired signal. When noise emitted by a source is measured, we may justifiably question whether the resulting decibel value is truly due to the source alone or is possibly the source plus ambient noise. A simple rule-of-thumb has become accepted and is quite accurate: "If the sound pressure level in all octave bands (with the source operating) is 10 dB SPL or greater than the ambient level, the contribution due to the ambient noise is negligible." The decibel values thus obtained are essentially those due to the source. Otherwise, the ambient effect should be subtracted from the sound pressure levels for the source plus ambient noise. (This subtraction should be performed on an energy basis analogous to the addition process for combining sources described in Subsection 2.5).

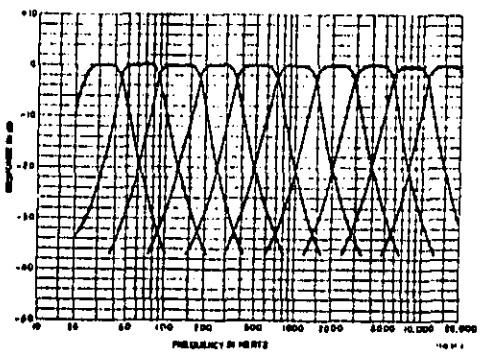


Figure 2-3. Typical Octave Band Filter Characteristics

REFERENCES

1. Randall, *An Introduction to Acoustics*, Addison-Wesley, 1951.
2. Yerges, *Sound, Noise and Vibration Control*, Van Nostrand, 1969.
3. Beranek, *Noise and Vibration Control*, McGraw-Hill, 1971.

SECTION 3

EFFECTS OF NOISE ON PEOPLE

3.1 INTRODUCTION

This section summarizes the main points of the EPA Noise Technical Information Document 300.7 "Effects of Noise on People." The NTID should be consulted for greater detail and for an extensive list of references. Since the section was written, the Criteria Document on the effects of noise has been published by the Office of Noise Abatement and Control. This document should also be consulted for further details on the effects of noise on people, including the effects of infrasound and ultrasound.

* * * *

It has not been demonstrated that many people have had their lives shortened by noise. While undoubtedly serious accidents have occurred when auditory warning signals were misunderstood or not heard due to intrusive noise, their prevalence has not been evaluated. Perhaps the stress of continued exposure to high levels of noise can produce disease or make one more susceptible to disease, but there is no definitive evidence. There are only hints of relations between exposure to noise and the incidence of disease. In other words, the effects of noise on people have not been successfully measured in terms of "excess deaths" or "shortened lifespan" or "days of incapacitating illness". The most well-established effect of noise on health is that of noise-induced hearing loss.

There is clear evidence to support the following statements about the effects on people of exposure to noise of sufficient intensity and duration:

- Noise can permanently damage the inner ear, with resulting permanent hearing losses that can range from slight impairment to nearly total deafness.
- Noise can result in temporary hearing losses, and repeated exposures to noise can lead to chronic hearing losses.
- Noise can interfere with speech communication and the perception of other auditory signals.
- Noise can disturb sleep.
- Noise can be a source of annoyance.

- Noise can interfere with the performance of complicated tasks and, of course, can especially disturb performance when speech communication or response to auditory signals is demanded.
- Noise and other acoustical considerations can reduce the opportunity for privacy.
- Noise can adversely influence mood and disturb relaxation.

In all of these ways, noise can affect the essential nature of human life – its quality.

3.2 AUDITORY EFFECTS

An understanding of the auditory effects of noise requires a brief explanation of how the ear functions. When sound enters the ear, the waves pass through the ear canal to the eardrum which vibrates in response to the sound stimulus. The eardrum conducts these vibrations to three tiny bones called ossicles – the three smallest bones in the body. The ossicles conduct sound into the inner ear and in so doing, tend to modify (attenuate) the loudness of the signal to some extent. Normal action of the ossicles may amplify soft sounds or dampen loud sounds by a mechanism known as the acoustic reflex.

Although the acoustic reflex protects the inner ear by reducing the intensity of low-frequency sounds similar to the way in which the eye protects itself from bright light by contracting the pupil, the acoustic reflex provides only partial protection to the ear. First, the reflex occurs in response from the brain a few hundredths of a second after the loud sound is first perceived. So, when impulsive sounds (such as those associated with explosions) occur, they reach the inner ear at full impact, with little adaptation. Also, the muscles tend to relax after a few minutes, so their sound-dampening capacity is limited when loud sounds are sustained.

When loud sounds enter the inner ear, the ossicles transmit the vibrations to a fluid contained in a tiny, snail-shaped structure called the cochlea. Within the cochlea are microscopic hair cells that move back and forth in response to the sound waves. Neural impulses are created by the movement of these crucial hair cells that go to the brain where they are interpreted as sound. These delicate hair cells can be damaged by too intense sound waves.

When intense sound waves occur only briefly, the damage may be temporary. But if loud noises are frequent or sustained, the damage may be permanent, and such noise-induced hearing loss cannot be restored through surgical procedures or by medication.

The number of people in the United States exposed to potential hearing loss directly caused by noise was estimated at 40 million by the EPA "Report to the President and Congress on Noise." Moreover, permanent loss tends to occur initially in frequencies above the range of speech. Thus, by the time a person realizes he is suffering hearing loss, that loss may have spread and become permanent. People whose hearing has been impaired from noise exposure do not live in an auditory world that is merely muffled. Sounds that are heard may be distorted; and, while hearing aids can amplify sound, they cannot correct the distortions caused by noise-induced injury to the ear.

The occupational and non-occupational causes of noise-induced hearing loss are many and varied, but noise-induced hearing loss and ear damage can be eliminated if exposures to noise are:

1. Held to sufficiently low levels.
2. Held to sufficiently short durations.

* * * *

Another important auditory effect of noise is called masking or noise caused interference with the perception of wanted sounds or signals. In some cases, the masking of a signal such as that of an approaching vehicle can lead to property damage, personal injury, or even death.

Masking also has considerable implications for normal speech communication. For adults, free and easy speech communication is probably essential for full development of social relations. Additionally, especially for children, there is the problem that masking caused by a transportation noise source may interfere with the learning process. Since speech perception deteriorates with age, the elderly population is even more susceptible to the masking of speech by noise than are young adults. Thus, background noise can crucially influence the important role that speech communication plays in our society.

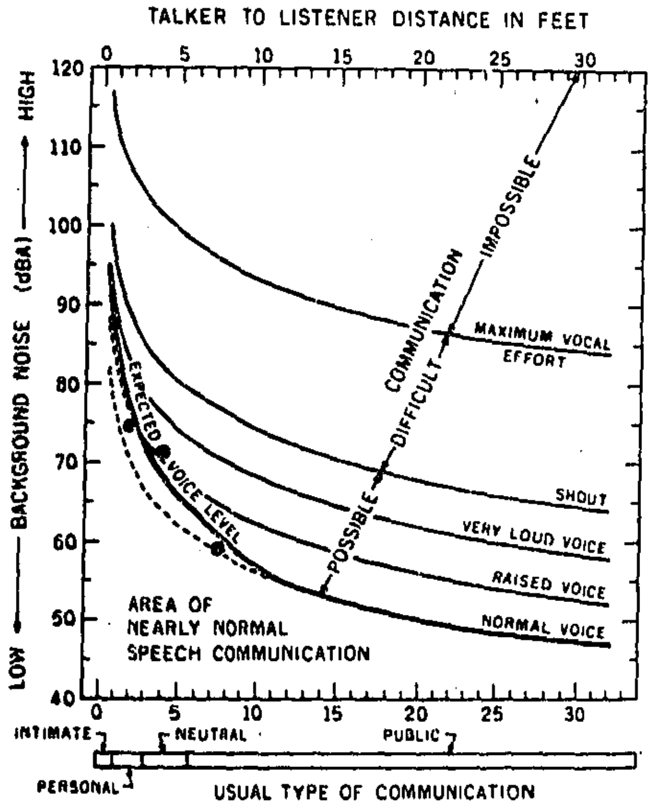
Figures 3-1 and 3-2 demonstrate graphically the relationship of speech communication to background noise and the distance between the talker and listener. It can be seen that at 15-20 feet, distances not uncommon to many living rooms and classrooms, A-weighted sound levels of the background noise must be below 50 decibels if speech communication is to be nearly normal.

3.3 GENERAL PSYCHOLOGICAL AND SOCIOLOGICAL EFFECTS

3.3.1 Effect on Sleep

Noise not only has direct effects on auditory function as described above, but it also produces other behavioral effects of a more general nature. As is evident from everyday experience, noise can interfere with sleep. It takes longer to fall asleep under noisy conditions, and noise of sufficient intensity and duration can be disturbing throughout the sleep period. Women tend to awaken to noises of lower levels than do men, and persons over 60 years of age are much more likely to have their sleeping disturbed by noise than are younger people.

While the adverse effects of sleep disturbance are not completely known, one can tentatively assume that sleep disturbance by excessive noise will reduce one's feelings of well-being. Furthermore, when noise conditions are so severe as to disturb sleep on a regular, unrelenting basis, then such sleep disturbance may constitute a hazard to one's physical and mental health. (See Figure 3-3 for the sleep pattern of young adults and Figure 3-4 which charts awakenings to sound from laboratory and questionnaire studies.)



NOTE: Heavy data points represent scores of 90% correct with tests done with phonetically balanced lists of one-syllable words (Waltzman and Levitt, 1971). Types of speech communication typical of various talker-listener distances are based on observation (Hall, 1959).

Figure 3-1. Quality of Speech Communication as Dependent on A-weighted Sound Level (dBA) of Background Noise and Distance between Talker and Listener. (Modified from Webster, 1969.)

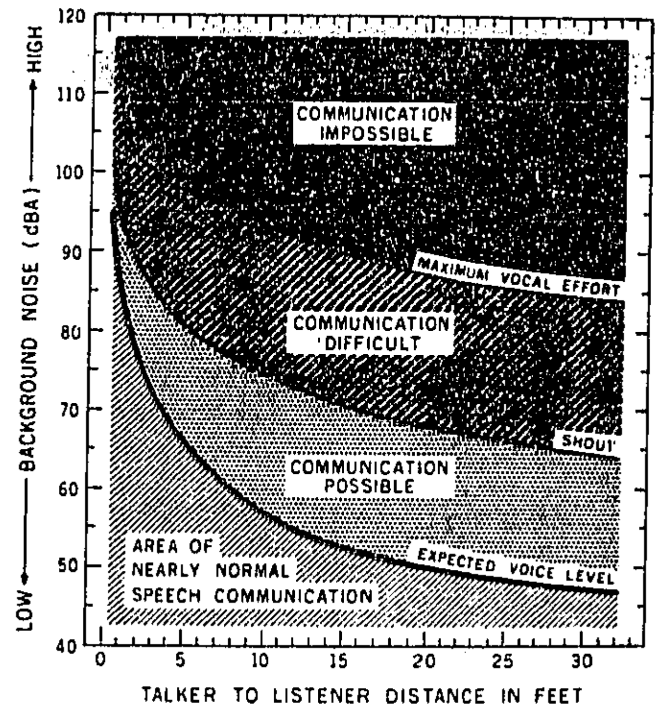
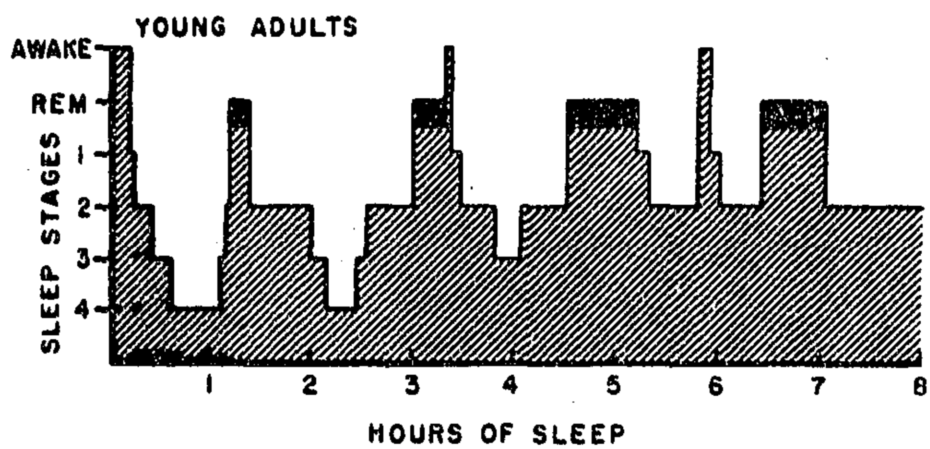
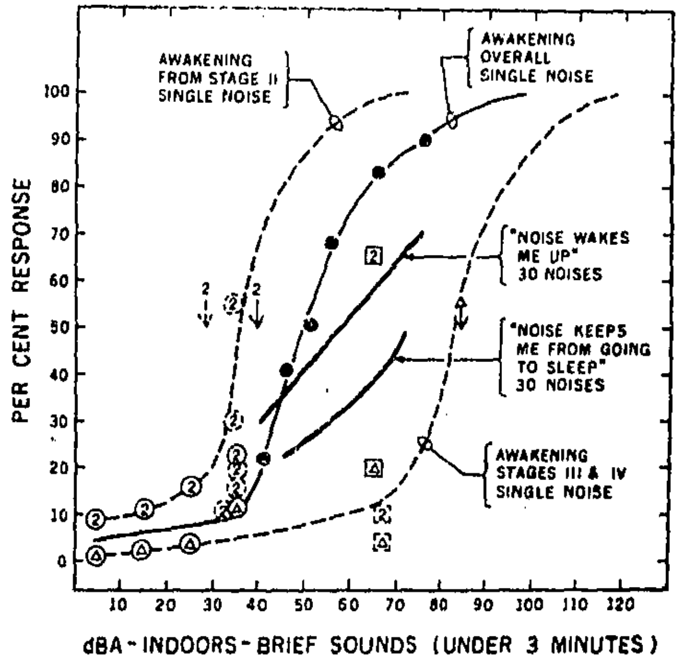


Figure 3-2. Simplified Chart Showing Quality of Speech Communication in Relation to A-weighted Sound Level of Noise (dBA) and Distance between Talker and Listener.



NOTE: Stage IV is absent during later part of sleep period, and more time is spent in Stage II and REM. Notice the two brief periods that sleeper spontaneously awoke. (From Berker, 1969, in *Sleep: Physiology and Pathology*, A. Kales, Editor, with the permission of the author, editor, and the J.B. Lippincott Company.)

Figure 3-3. Nocturnal Sleep pattern of Young Adults.



NOTE: Horizontal axis gives approximate A-weighted sound level (dBA) of the noise. Curves labelled "awakening" are from normally rested young adults sleeping in a laboratory and moderately motivated to awake in response to sound. Percentage of awakening responses will depend on intensity of sound and also on definition of "awakening," motivation of the subject to awake in response to sound, and sleep stage when stimulus is presented. Questionnaire results, "Noise wakes me up," and "Noise keeps me from going to sleep," are derived from the Wilson Report (1963) for the case of 30 brief noises distributed throughout the night. Laboratory results are from various studies. Filled circles were gathered throughout the night without regard to sleep stage (Steinicke, 1957). Data from sleep stage II are represented by *2's*; those from sleep stages III and IV by deltas, Δ's. Circles with unbroken borders are from Williams *et al.* (1964). Circles with broken borders are from Williams *et al.* (1965). Boxes with solid borders are from Rechtshaffen *et al.* (1966). Boxes with broken borders are from Lukas and Kryter (1970). Broken arrow is from Watson and Rechtshaffen (1969). Solid arrows are from Kryter and Williams (1970).

Figure 3-4. Awakenings to Sound from Various Laboratory and Questionnaire Studies.

3.3.2. Annoyance

A great many instances of annoyance produced by sound may be due to the masking effects of sound, to particular responses to the message content of the sound, or to physiological responses to the sound (such as a startle reaction to a sudden noise). Despite wide variations in human responses among members of a community with regard to the intensity of their reactions and the specific noises that they find objectionable, well-defined trends have emerged. On the average, there are relations between the physical characteristics of noises and the amount of annoyance, irritation, distraction, and disturbance. Physical measurements of sounds can be weighted in such a manner as to enable one to generally predict judgments of noisiness. The resulting decibel values are said to be perceived noise levels (PNLs), and they are expressed as PNdB.

3.3.3 Community Responses

Certain generalizations can be made concerning community response. For exposure to fixed noise sources, instances of annoyance, disturbance and complaint are greatest for rural areas, followed by suburban, urban residential, commercial and industrial areas, in decreasing order. Similarly, a given noise will be more disturbing at night than during the day and cause greater annoyance in summer than in winter. Moreover, there is little evidence that annoyance due to community noise decreases with continued exposure. Rather, the annoyance may increase the longer one is exposed to it.

As Figures 3-5 and 3-6 indicate, community responses to noise can range from indifference and mild annoyance to highly-organized group action. Those who complain about aircraft noise (the most thoroughly studied group) cannot be identified as having a special set of psychological and sociological characteristics. Those who complain about aircraft noise, contrary to the beliefs of some, are not highly sensitive to noise. Nevertheless, total numbers of complaints of community anti-noise action are correlated with measures of the severity of the noise exposure.

3.3.4 Other Possible Psychological and Sociological Effects

It is difficult to assess the effects of noise on human performance. However, the belief is that noise can reduce the accuracy of work, particularly that of complex tasks requiring mental output. Also, when a task requires the use of auditory signals, speech or nonspeech, then noise at any intensity level sufficient to mask or interfere with the perception of these signals will interfere with the performance of the task. Environmental noise alone probably does not produce mental illness, but the continual bombardment of noise on an already psychologically sensitive or predisposed population cannot be helpful. Clearly, the facts of speech interference, hearing loss and annoyance support the contention that noises can act as a source of psychological distress.

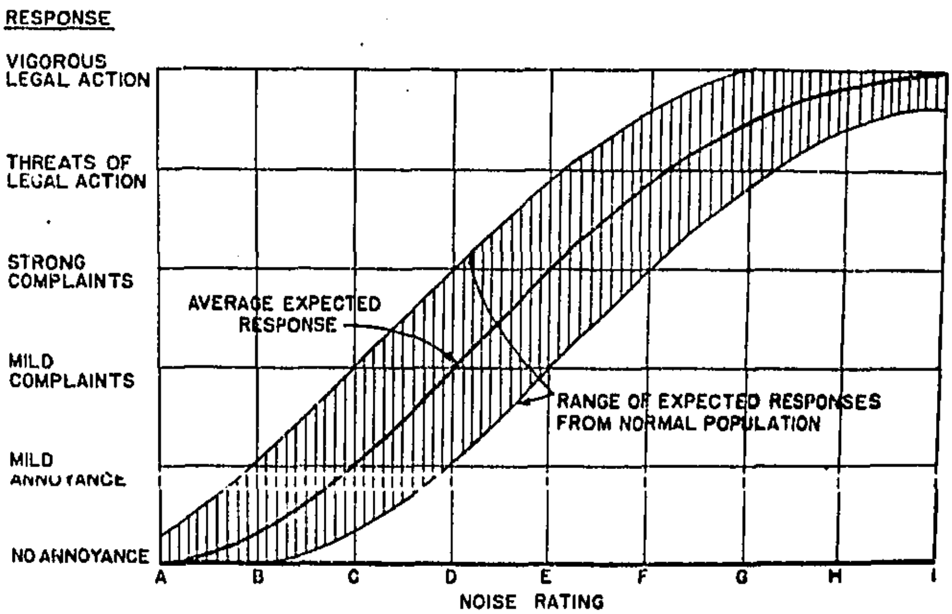


Figure 3-5. Relation between Community Response and Noise Exposure. Noise Exposure Increases from A to I. (From Rosenblith *et al.*, 1953.)

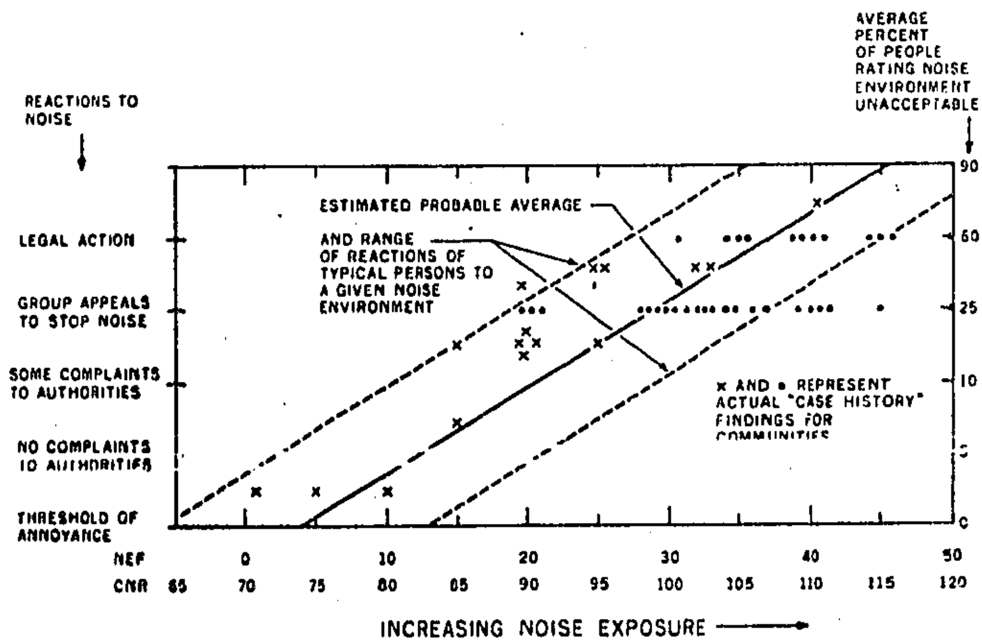


Figure 3-6. Relations between Community Noise Levels (Measured in CNR or NEF), Judgments of Unacceptability, and Community Responses. (After Kryter *et al.*, 1971.)

3.4 GENERAL PHYSIOLOGICAL EFFECTS

Sound produces transient physiological responses in the muscular and neuro-endocrine systems. It has been proposed that frequent repetition of these responses may lead to *persistent* pathological changes in non-auditory bodily functions. Also, it has been proposed that frequent repetition of these transient physiological responses might aggravate existing physiological disorders. These proposals have not been verified, but evidence consistent with them has been gathered by Messrs. Karl Kryter, Henning von Gierke and others. While these claims of noise-induced pathology of non-auditory bodily functions merit further research and investigation, as of now, they are unproven.

However, the evidence suggests that, if noise control sufficient to protect persons from hearing loss were instituted, it is *unlikely* that the noise of lower level and duration resulting from this effort could directly induce non-auditory disease.

3.5 SUMMARY

In summary, noise can have various adverse effects on people. There is the danger of permanent hearing loss from excess noise and interference with speech communication, sleep and daily activities. Moreover, it appears that noise may be a contributing factor to mental stress and psychological disorders. As the noise levels continue to rise in our cities, homes and places of work we can expect these adverse effects of noise to become more prevalent unless effective implementation of comprehensive noise regulations is achieved.

SECTION 4

CRITERIA FOR RATING SOUNDS

4.1 INTRODUCTION

The only objective characteristics of sound that present acoustical equipment can measure are the sound pressure level and the frequency content. Thus, the subjective response of the public to various sounds and noise sources must be correlated in some manner to these two quantities, as well as other factors (e.g., number of occurrences within a given period, the time of day, etc.).

Much work has been done in this area; although the optimum method has yet to be contrived, numerous methods of approach have become acceptable and are widely used. As will become evident in the discussion which follows, it seems that there is no single measuring method which accurately describes or correlates well with the public's reaction to *all* sounds and noise sources. Thus, several methods have been devised, each with its own refinements and proposed area(s) of application. To the uninitiated it might appear that acousticians have devised noise measuring methods that are too limited in application, and that they have lost sight of the ultimate goal. Actually, all of their efforts have a common purpose: to produce reliable measuring or rating methods which correlate well with the subjective response of the public to the various classes of urban noise.

All rating methods are based upon the sound pressure level and frequency content of the noise. Some also include effects from pure tones, duration of the noise, number of occurrences, and time of day.

4.2 RESPONSE CHARACTERISTICS OF THE HUMAN EAR

Before delving into the various measuring methods it would be best to investigate the response characteristics of the human ear.

The perception of the loudness of pure tones of different frequencies was first investigated by Fletcher and Munson almost 40 years ago. Basically, their procedure was to place an observer in a very quiet room and subject him to a 1000 Hz reference pure tone. The sound pressure level of another pure tone of a different frequency was then adjusted until it was judged "equally loud" by the observer. The results of their research were a set of curves similar to those in Figure 4-1. These contours have been verified and internationally standardized and are called equal loudness level contours for pure tones.

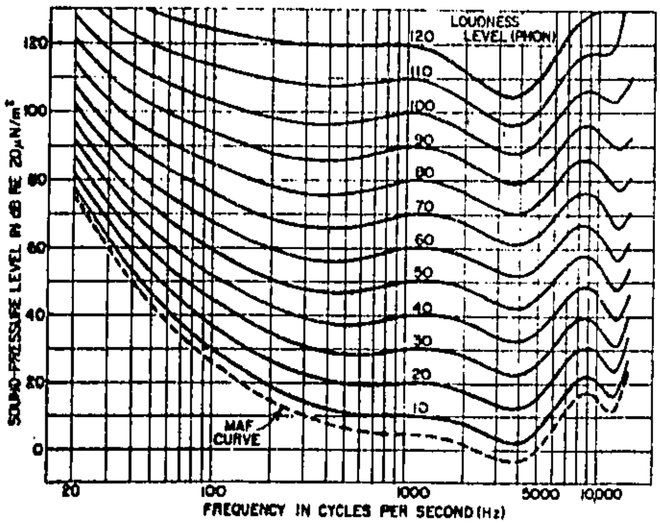


Figure 4-1. Equal Loudness Contours for Pure Tones

Each contour is given a value in phons which corresponds to the sound pressure level in decibels of the 1000 Hz reference tone. These contours illustrate that the response of the human ear is dependent upon not only the frequency of a tone, but also the sound pressure level. Two examples of the use of the contours are:

1. An observer would nominally judge a 30 dB SPL, 125 Hz, pure tone to be equally loud as a 200 dB SPL, 1000 Hz, pure tone. Thus the 30 dB tone has a "loudness level" of 20 phons.
2. An observer would nominally judge an 80 dB SPL, 31.5 Hz pure tone to be equally loud as a 50 dB SPL, 1000 Hz pure tone. The 80 dB tone has a loudness level of 50 phons.

It can be seen that the response of the human ear is complex and nonlinear. At lower sound pressure levels, the ear is not as responsive to low frequencies as at higher frequencies. However, as the sound pressure level increases, the response of the ear become flatter.

As was mentioned earlier, the sounds we experience rarely consist solely of pure tones. To take this into account, equal loudness level contours for narrow bands of noise have been developed and are similar in appearance to those for pure tones. (Figure 4-2.)

If the sounds one is exposed to are composed of pure tones or narrow bands of noise, a phon value for these sounds can be obtained directly from eighter Figure 4-1 or 4-2. If the sounds are complex (i.e., broadband with or without pure tone components), an equivalent phon value can be calculated from an octave band analysis of the noise.

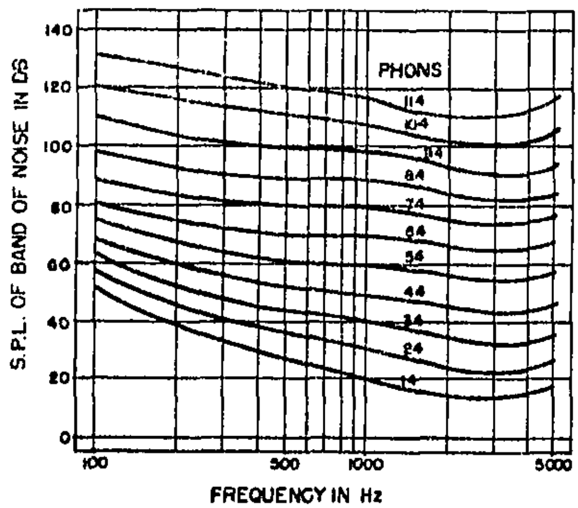


Figure 4-2. Equal Loudness Contours for Relatively Narrow Bands of Random Noise

Although the phon scale covers the large dynamic range of the ear, it does not fit a subjective loudness scale. Doubling the number of phons does not correspond to a subjective loudness increase of two. For loudness levels of 40 phons and greater, an increase of 10 phons corresponds to a subjective doubling of loudness. To obtain a quantity proportional to loudness, a scale has been defined in which the unit is called a sone. This loudness scale (in sones) corresponds quite closely to our subjective sensation of loudness. Using this scale, we can say that a jet aircraft at takeoff is approximately 50 times as loud as normal conversation. Stating that jet aircraft generate 120 phons in contrast to 60 phons for ordinary conversation probably conveys less meaning. Table 4-1 gives some typical loudness levels in phons and loudness in sones.

4.3 SINGLE–NUMBER RATINGS FOR NOISE

The simplest sound measuring technique is to measure the sound level using a sound level meter. This instrument includes frequency weighting networks referred to as the A, B, or C scales.* The frequency characteristics of these scales have become internationally standardized and are shown in Figure 4-3.

As shown in the figure, the A scale attenuates those frequencies below approximately 500 Hz. In other words, frequencies above 500 Hz are weighted more heavily in an attempt to parallel the

*On some sound level meters, a D weighting network has been added to provide an indication of perceived noise decibels (PNdB) which is defined later in this chapter.

TABLE 4-1
REPRESENTATIVE VALUES OF LOUDNESS LEVEL AND LOUDNESS

LOUDNESS LEVEL (PHONS)		LOUDNESS (SONES)
140	Threshold of pain	1024
120	Jet aircraft	256
100	Truck	64
80	Orator	16
60	Low conversation	4
40	Quiet room	1
20	Rustling of leaves	
3	Hearing threshold	

response characteristics of the human ear. Careful comparison of the A weighting network and the equal loudness level curves will reveal that the A weighting approximates an inverted 40 phon contour. Likewise, the B weighting network approximates an inverted 70 phon contour. The C network is essentially flat and approximates the response of the ear to intense sound pressure levels.

When a sound is measured with a sound level meter, the weighting network must always be stated. For example, if a measurement was made using the A scale, the results should be specified as dB (A) or dBA. Noises can also be measured without using a weighting network. When this is done, all frequencies are admitted unattenuated to the sound level meter, and what is termed an overall SPL results. When an overall reading is taken, it can be described correctly three ways: The noise is 50 dB SPL (overall), 50 dB overall SPL, or 50 dB OSPL.

A similar situation occurs when we obtain octave band data. The measured values we obtain from each band are SPL's, since all frequencies within each band are admitted unattenuated and are called the octave band sound pressure levels. Thus we can conclude by saying that when a weighting network is employed, the resulting decibel values are "sound levels" and the appropriate weighting must be specified. When no weighting is employed, the decibel values are either overall SPL for sound level meters or just sound pressure levels for octave band data.

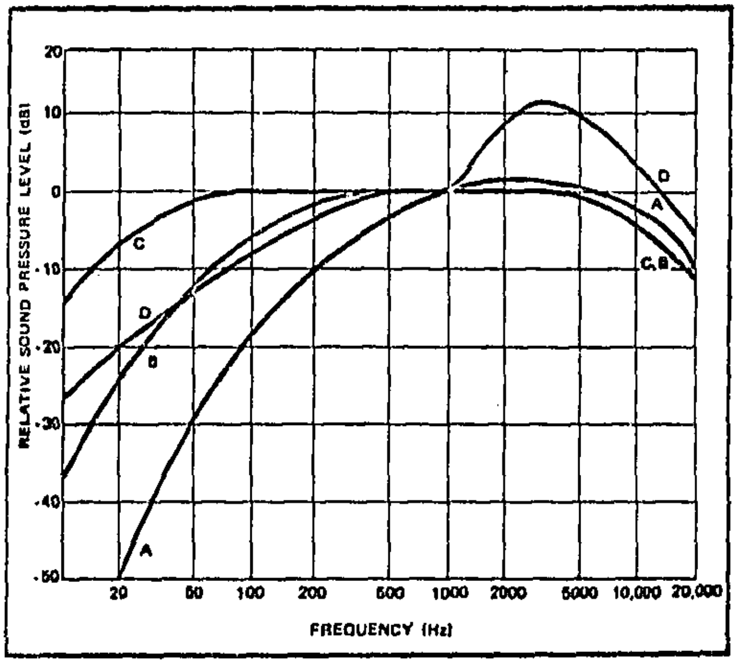


Figure 4-3. International Standard A, B, and C Weighting Curves for Sound Level Meters

Before we continue to other noise measuring methods, two important points concerning overall SPL and A, B, or C weighted sound levels must be presented.

1. It is possible for two different noise sources to produce identical overall SPL's or identical dBA values, since different frequency distributions can produce identical overall sound levels. This phenomenon is demonstrated by two examples in Figure 4-4. Thus when we specify a limiting OSPL or dBA level we really have no knowledge of the frequency distribution of the sound. A given distribution of octave band levels does, however, significantly restrict the frequency distribution of the sound.
2. The OSPL, by definition, provides no indication as to the frequency content of the sound. The weighted sound levels, on the other hand, are designed to closely approximate the response characteristics of the human ear to pure tones. Thus the weighted sound levels provide additional qualitative information that the OSPL does not.

The remaining noise measuring methods require octave band or 1/3 octave band data in order to be evaluated. A brief description of some of these methods follows.

4.4 CALCULATED LOUDNESS

The calculated loudness method is used for obtaining a sone value for complex sounds and primarily applies to steady, wide-band noise. Two methods of performing calculated loudness are currently in use, the Stevens procedure and the Zwicker procedure. A detailed treatment of these procedures can be found elsewhere.[1] However, to provide an introduction to one of these methods, Figure 4-5 shows the curves for obtaining the sone value of a noise according to the Stevens method when its octave band sound pressure levels are known. The sone value for each center frequency is obtained from the figure. The equivalent sone value is then calculated by the following equation:

$$S_{eq} = (\Sigma 0.3 S_n) + 0.7\, S_{max}$$

Where S_{eq} = equivalent sone value

S_n = octave band sone value

S_{max} = maximum octave band sone value

The equivalent phon value can be obtained from the conversion chart supplied with Figure 4-5.

One advantage of the calculated loudness method is that some people tend to identify more readily with the sone unit rather than the decibel. They grasp the concept of one sound being twice or three times as loud as another more easily than that of the decibel scale.

4.5 PREFERRED SPEECH INTERFERENCE LEVEL (PSIL)

The Preferred Speech Interference Level (PSIL) predicts the masking effect of noisy environments. The inability to converse or to hear adequately at normal distances is a common occurence

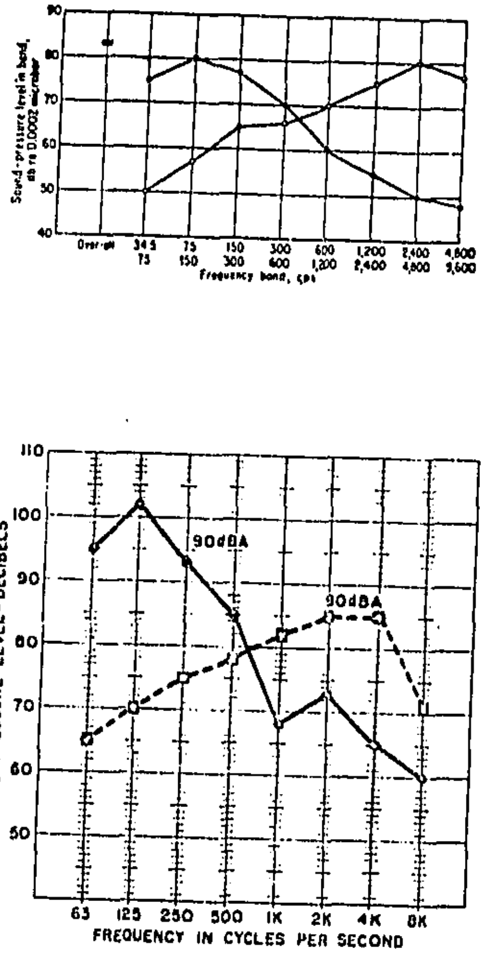


Figure 4-4. Frequency Spectra for Identical Overall Sound Levels

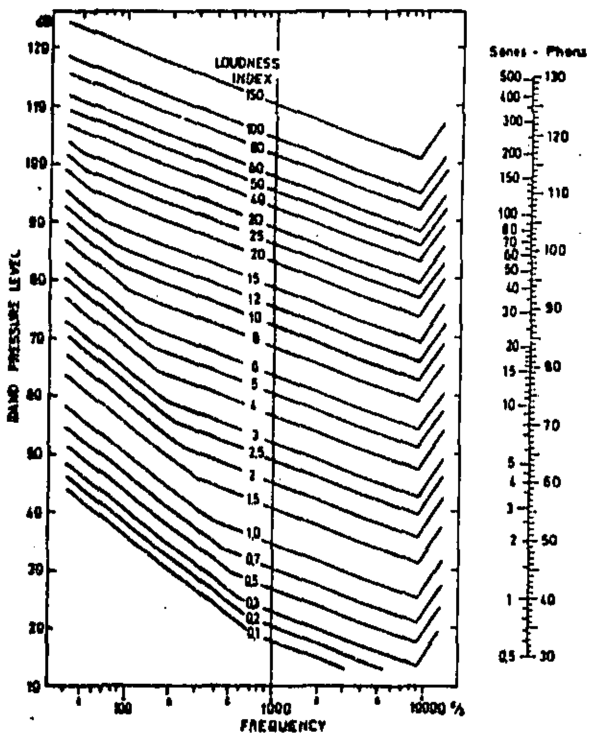


Figure 4-5. Equal Loudness Contours

at cocktail parties or conventions. Also the inability to hear telephone conversations is characteristic of many office and/or industrial work areas.

"The region of intelligibility for the human voice is roughly from 300 to 3000 Hz."[2] Thus, the PSIL is defined as the arithmetic average of the 500, 1000, and 2000 Hz octave band levels, since noise in these bands interferes with (masks) effective speech communication more than the rest of the spectrum. When this averaged number (in decibels, SPL) exceeds a certain value, speech comprehension becomes difficult or impossible as shown in Figure 4-6. For example, a PSIL of 66dB would require a very loud voice level for reliable conversation at a distance of 6 ft.

4.6 NOISE RATING NUMBER (N)

The noise rating method is based on a set of curves as shown in Figure 4-7. This family of curves is similar to the equal loudness contours and attempts to approximate the subjective characteristics of the ear to various types of sounds. These curves are used to judge the acceptability of noises for different environments with primary emphasis on the annoyance character of the noise. The method of approach is to plot the octave band sound pressure levels on the family of curves. The noise rating number (N) of the noise is the number of the curve that lies just above the plotted spectrum. Specific noise rating criteria for various environments have been established and are shown in Figure 4-7. A sample spectrum also has been plotted in Figure 4-7; its N value is 45.

The corrected noise rating is an N number that has been corrected for specific environments or circumstances. Corrections for dwellings are indicated in Figure 4-7. An illustration of this procedure follows.

Suppose, for example, that a municipal maintenance crew was removing a diseased or dying tree from your immediate neighborhood. The maximum corrected noise rating that should be allowed in your living room under this criterion would be:

N	=	30 for living rooms
	+	5 correction for assuming removal work occurred during the daytime
	+	5 correction for assuming removal work occurred 25% of the time (of each hour)
	+	5 correction for assuming a residential urban neighborhood
		45 = corrected noise rating number

4.7 NOISE CRITERION NUMBER (NC)

The noise criterion method is almost identical to the noise rating procedure but applies mainly to ". . . the steady, continual ambient levels within a space or neighborhood, as opposed to specific noises or intermittent activities occurring there."[3] The family of curves shown in Figure 4-8, however, is slightly different. The NC contours are more lenient from the 500 Hz octave band up through the 8000 Hz octave band. The process of plotting the local noise spectrum on the family of curves is identical for both NR and NC ratings. Representative NC values for different spaces are shown in Table 4-2. For the spectrum plotted in Figure 4-8, NC=49.

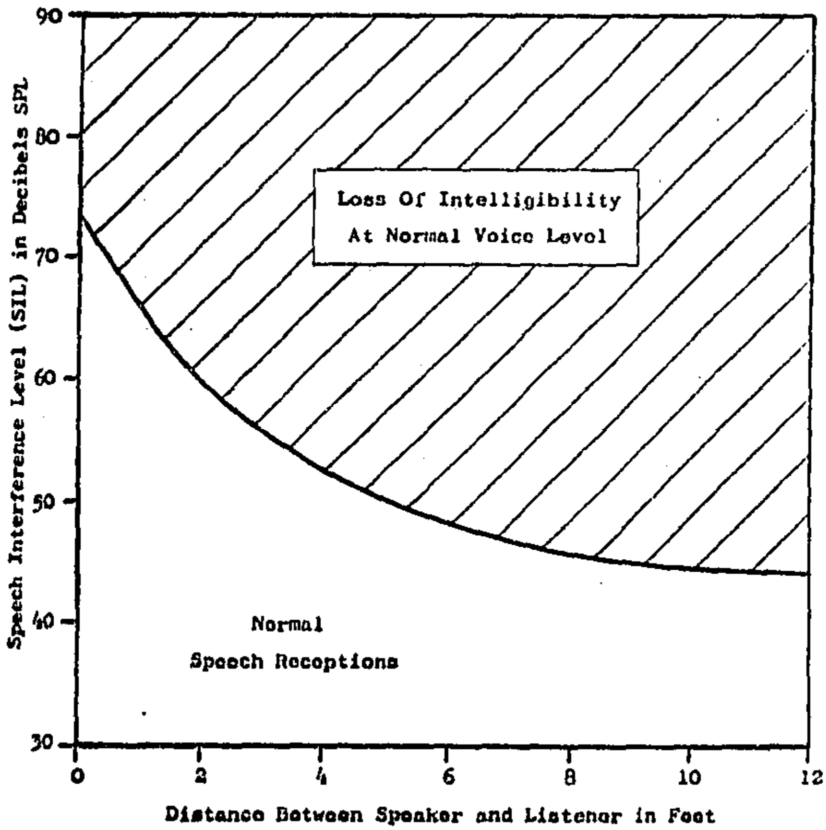
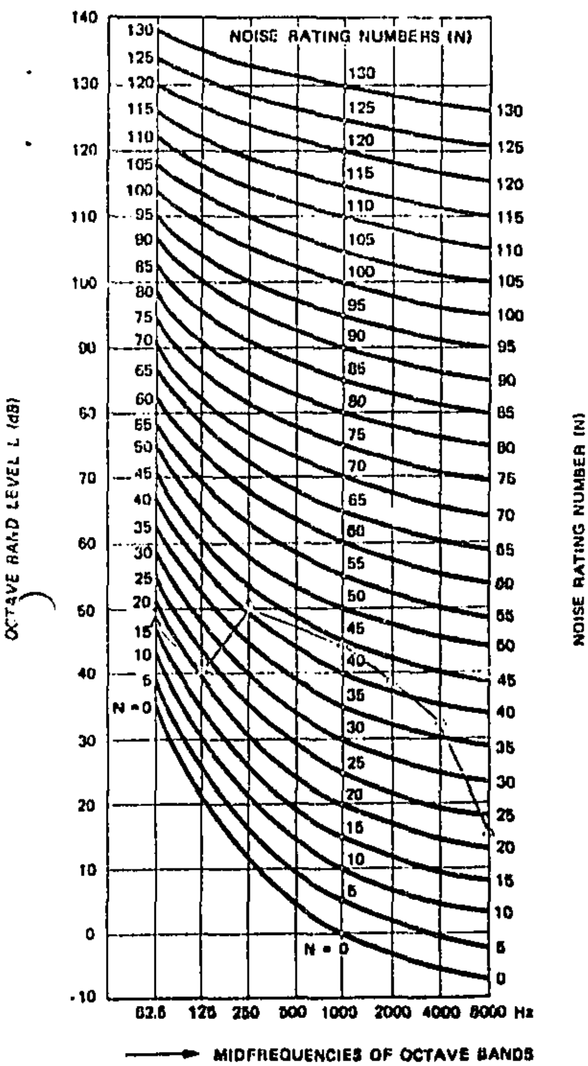


Figure 4-6. Speech Interference Effects of Noise



	Criterion
broadcasting studio	15
concert hall, legitimate theatre 500 seats	20
class room, music room, TV studio, conference room, 50 seats	25
sleeping room (see corrections below)	25
conference room 20 seats or with public adress system, cinema, hospital, church, courtroom, library	30
living room (see corrections below)	30
private office	40
restaurant	45
gymnasium	50
office (type writers)	55
workshop	65
Corrections for dwellings a) Pure tone easily perceptible	-5
b) Impulsive and/or intermittent	-5
c) Noise only during working hours	+5
d) Noise during 25 % of time	+5
6 %	+10
1.5 %	+15
0 %	+20
0.1 %	+25
0.02 %	+30
e) Very quiet suburban	-5
suburban	0
residential urban	+5
urban near some industry	+10
area of heavy industry	+15

Estimated Community Reaction	*Corrected Noise Rating*
No Observed Reaction	Less than 40
Sporadic Complaints	40 50
Widespread Complaints	45 55
Threats of Community Action	50 60
Vigorous Community Action	Above 65

Figure 4-7. Noise Rating Number Curves and Criteria

TABLE 4-2
REPRESENTATIVE NOISE CRITERIA (NC) VALUES FOR DIFFERENT SPACES

SUBJECTIVE CLASSIFICATION	FUNCTION	SPACE	NC LEVEL
Quiet	Sleeping	Bedrooms	30
		Hospital Rooms	30
Critical Hearing And Listening	Music	Concert and Recital Halls	25-30
Normal	Discussion	Classrooms	30
		Conference Rooms	25-30
	Mental And Creative Tasks	Executive Offices	30
		Study Rooms	35
Noisy	Dining	Restaurants	45
		Kitchens	55
	Clerical	Stenography And Duplicating	50
Very Noisy	Sports	Stadiums	55
	Transportation	Railroad Stations	55-65
	Computing And Calculating	Computer Rooms	70
	Production	Factories And Shops	50-75

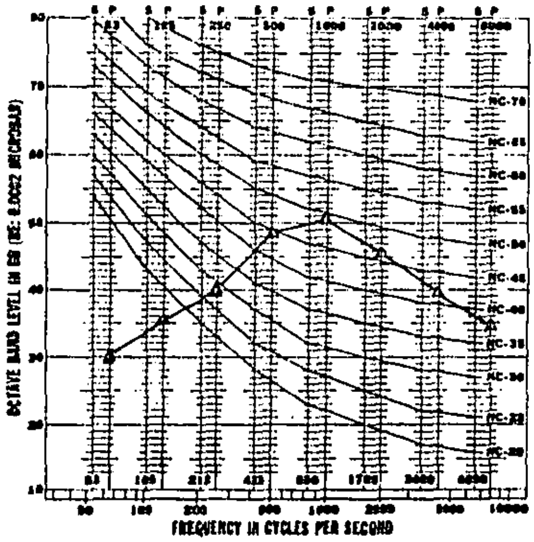


Figure 4-8. Noise Criterion Curves

4.8 PERCEIVED NOISE LEVEL (PNL)

Kryter followed a procedure similar to that used for loudness, but he asked the observer to compare noises on the basis of their acceptability on their noisiness. The judgments were found to be similar to those for loudness, but enough difference was observed to give a somewhat different rating for various sounds. On the basis of these results, Kryter has set up a calculation procedure for perceived noise level (PNL). In essence, then, the PNL concept accounts for the noisiness or intrusiveness rather than the loudness. The perceived noise level is registered in perceived noise decibels, PNdB. It has found particular use in gauging response to aircraft noise.

The calculation procedure for PNdB is identical to that used for calculating loudness, except that curves of constant noy values shown in Figure 4-9 are used. The effective noy value is given by:

$$N_t = (\Sigma 0.3 N_n) + 0.7 N_{max}$$

Where N_t = Effective noy value

N_n = noy value corresponding to each octave band SPL

N_{max} = maximum octave band noy value

An equivalent PNdB value is obtained by using the conversion chart provided in Figure 4-9.

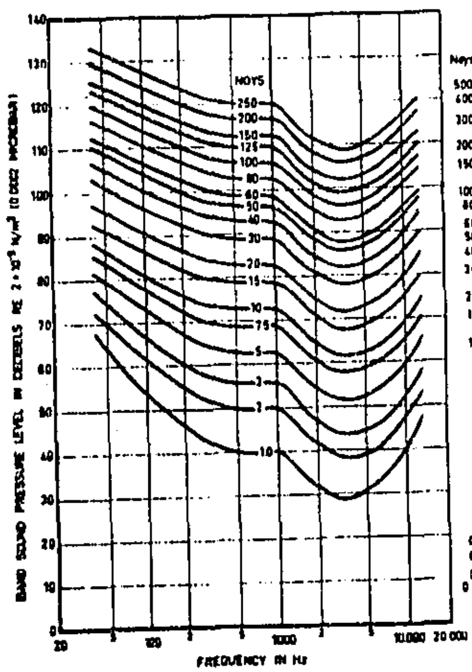


Figure 4-9. Equal Noisiness Contours

If 1/3 octave band data are used, the constants 0.3 and 0.7 are replaced by 0.15 and 0.85, respectively.

On some sound level meters, the 40 noy curve has been incorporated into an additional weighting network (D weighting) to provide a direct approximation to PNL. The proposed D weighting curve is shown in Figure 4-3. The measured sound pressure level from the D-network, L_D, is approximately related to the PNL as follows: $PNL = L_D + 7$, PNdB.

4.9 NOISE AND NUMBER INDEX (NNI)

Several single-number ratings include corrections for number of events and in some cases, time of occurence. One example of these is the noise and number index (NNI), which is based upon surveys and sociological investigations made near London's Heathrow Airport and is used for measuring aircraft noise. Conceivably it could also be used to gauge the response to other transient noise sources such as trains. Essentially, the NNI takes an average peak PNL and adjusts it in relation to the number of events that occur, day or night; i.e. number of aircraft flyovers. Since this method was conceived for use in a particular geographical area with possibly unique air traffic densities and flight patterns, it may not be universally applicable to other airport situations.

4.10 ENERGY EQUIVALENT NOISE LEVEL (L_{eq})

Fluctuating noise levels such as noise from highway traffic is sometimes represented in terms of a steady noise having the same energy content as the fluctuating noise. Using the definition of the sound pressure level, it can be shown that the energy equivalent steady noise level (L_{eq}) is given by:

$$L_{eq} = 10 \log \left[\frac{1}{t_2 - t_1} \int_{t_1}^{t_2} 10^{SPL/10} \, dt \right]$$

where SPL is the measured sound pressure level as a function of time and t_1 and t_2 denote the times at the beginning and ending of the measurement period, respectively.

4.11 DAY–NIGHT AVERAGE SOUND LEVEL (L_{dn})

The day-night average sound level (L_{dn}) is a measure of the average A-weighted sound level during a 24-hour time period, with a 10 decibel penalty applied to nighttime sound levels. Thus, the L_{dn} is essentially an energy equivalent noise level, L_{eq}, evaluated over a 24-hour period except for the nighttime penalty.

4.12 NOISE POLLUTION LEVEL (L_{NP})

The noise pollution level (L_{NP}), attempts to deal with fluctuating noise by accounting for the L_{eq} along with the range of variation of the noise. Thus:

$$L_{NP} = L_{eq} + 2.56\,t \quad \text{dB(NP)}$$

where L_{eq} and t are the energy equivalent noise level and standard deviation, respectively, of the measured A-weighted SPL.

4.13 NOISE EXPOSURE FORECAST (NEF)

A method currently in wide use for making noise exposure forecasts (NEF) of aircraft noise utilizes a perceived noise level scale with additional corrections for the presence of pure tones. Two time periods are used to weight the number of flights.[4]

The single event noise level is defined in terms of effective perceived noise level (EPNL) which can be specified approximately by:

$$EPNL = PNL_{max} + 10 \log \frac{t10}{20} + F, \text{ EPNdB}$$

Where

PNL_{max} = maximum perceived noise level during flyover, in PNdB,

t10 = 10 dB down duration of the perceived noise level time history, in seconds,

and

F = pure tone correction. Typically, F = + 3 dB

Community noise exposure is specified by the term, "noise exposure forecast" (NEF). For a given runway and one or two dominant aircraft types, the total NEF for both daytime and night-time operations can be expressed approximately as:

$$NEF = \overline{EPNL} + \log N_f - 88.0$$

Where

$\overline{EPNL}$ = energy mean value of EPNL for each single event at the point in question

$N_f = (N'_d + 16.7\, N_n)$ or

$= (15\bar{n}'_d + 150\bar{n}_n)$

N'_d, $\bar{n}_d$ = total number and average number per hour, respectively, of flights during the day period 0700 to 2200.

N_n, $\bar{n}_n$ = the total number and average number per hour, respectively, of flights during the night period 2200 to 0700.

The constant (-88.0) dB includes an arbitrary -75 scale-changing constant and a reference number of daytime flights of 20. The constant 16.7 accounts for the 10-to-1 weighting factor for flights during the 9-hour night period.

4.14 COMPOSITE NOISE RATING METHOD (CNR)

The original method for evaluating land use around civil airports is the composite noise rating (CNR). It is still in wide use by the Federal Aviation Administration, the Department of Housing and Urban Development, and the Department of Defense for evaluating land use around airfields.[5] This noise exposure scale may be expressed as follows:

The single event noise level is expressed (without a duration or tone correction) as simply the maximum perceived noise level (PNL_{max}) in PNdB.

The noise exposure in a community is specified in terms of the composite noise rating (CNR), which can be expressed approximately as follows:

$$CNR = \overline{PNL}_{max} + \log N_f - 12$$

Where

$\overline{PNL}_{max}$ = approximate energy mean maximum perceived noise level (PNL) at a given point

N_f = same as defined for NEF. The actual method for accounting for the number of flights and time periods uses discrete interval correction factors. These have been approximated by the use of the equivalent continuous weighted number of flights, N_f.

4.15 COMMUNITY NOISE EQUIVALENT LEVEL (CNEL)

The following simplified expressions are derived from the exact definitions in the report, "Supporting Information for the Adopted Noise Regulations for California Airports." They can be used to estimate values of CNEL where one type of aircraft and one flight path dominate the noise exposure level.

Single event noise is specified by the single event noise exposure level (SENEL) in dB and can be closely approximated by:

$$SENEL = NL_{max} + 10 \log_{10} t_{ea}, \text{ dB}$$

Where

NL_{max} = maximum noise level as observed on the A scale of a standard sound level meter

and

t_{ea} = effective time duration of the noise level (on A scale) in seconds

The effective duration is equal to the energy of the integrated noise level (NL), divided by the maximum noise level (NL_{max}) when both are expressed in terms of antilogs. It is approximately 1/2 of the 10 dB down duration, which is the duration for which the noise level is within 10 dB of NL_{max}.

A measure of the average integrated noise level over one hour is also utilized. This is the hourly noise level (in dB), defined as:

$$HNL = \overline{SENEL} + 10 \log n - 35.6, \text{ dB}$$

Where

$\overline{SENEL}$ = energy mean value of SENEL for each single event,

and

n = number of flights per hour

The total noise exposure for a day is specified by the community noise equivalent level (CNEL) in dB, and may be expressed as:

$$CNEL = \overline{SENEL} + 10 \log N_c - 49.4, \text{ dB}$$

Where

$$N_c = (N_d + 3N_e + 10N_n)$$

or

$$= (12\bar{n}_d + 9\bar{n}_e + 90\bar{n}_n)$$

$N_d, \bar{n}_d$ = total number and average number per hour, respectively, of flights during the period 0700 to 1900

$N_e, \bar{n}_e$ = total number and average number per hour, respectively, of flights during the period 1900 to 2200

and

$N_n, \bar{n}_n$ = total number and average number per hour, respectively, of flights during the period 2200 to 0700

An alternative form of Community Noise Equivalent Level ($CNEL_2$) employs the time period weighting factor from the Noise Exposure Forecast method. It is approximated as:

$$CNEL_2 = \overline{SENEL} + 10 \log N_f - 49.4 \text{ dB}$$

Where

N_f was given previously for NEF calculation.

4.16 COMPARISON OF COMPOSITE RATING SCALES FOR SPECIFYING COMMUNITY NOISE EXPOSURE

The basic expressions previously defined for specifying community noise exposure are summarized:

Noise Exposure Forecast	NEF	$= \overline{EPNL} + 10 \log N_f - 88$, dB
Composite Noise Rating	CNR	$= \overline{PNL_{max}} + 10 \log N_f - 12$, dB
Community Noise Equivalent Level	CNEL	$= \overline{SENEL} + 10 \log N_c - 49.4$, dB
and	$CNEL_2$	$= \overline{SENEL} + 10 \log N_f - 49.4$, dB

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SECTION 5

SOURCES OF NOISE

5.1 INTRODUCTION

A characterization of the sources of environmental noise and an assessment of their impact on the quality of life is central to the formulation of a balanced environmental noise abatement program. Clearly, such a program must be predicated on a quantitative understanding of the contribution of each of the broad array of noise-producing devices. Most people are aware, at least qualitatively, of the impact of aircraft noise on airport communities, and many are aware of the noise from the numerous diesel trucks presently on our roads. But noise from other types of vehicles, construction and industrial operations, and appliances are also problems in various segments of society. People assess the relative and absolute impact of these sources differently. Such impressions are generally closely tied to an individual's life style and experience and cannot be used as the basis for the establishment of national policies. An objective and quantitative description of noise sources and effects is needed to establish priorities and to cast the problem of environmental noise in proper perspective. It is even more important to determine the average cumulative noise exposure of typical individuals in our complex society.

Sources may be characterized individually and in the aggregate. To assess relative importance and to serve as a basis for impact evaluation, it is generally adequate to determine a simple measure of the noise level (e.g., dBA) of a source at a particular distance. For example, by comparing the A-weighted sound levels of appliances at a 3-foot measuring distance, one can tentatively conclude that the noise from refrigerators at 42 dBA is less likely to be a serious problem than noise from vacuum cleaners at 72 dBA. Further, noise levels at other distances and in other situations characteristic of personal exposure may be estimated by accounting for changes in level as sound propagates through the air and structures.

Characterizing noise levels in a more collective sense is also of use in assessing impact. People tend to respond differently to the noise characteristics of a distant highway or construction site than to a readily identifiable single incident such as a passing truck. Highways, for example, are typically characterized by a nearly continuous background level, with fluctuations owing to vehicle spacing and the various source levels of each vehicle. Single events are different in that they may intrude excessively in otherwise quiet environments, and annoyance is strongly related to both the peak level and duration of exposure.

One step further than aggregating vehicles is to consider the noise generation in the community. This means the combination of all sources creating a total noise environment. The value of considering community noise as a whole, rather than evaluating each source in isolation, is twofold. First, human behavior is not arithmetically additive, reactions to individual acoustic stimuli do not provide a simple measure of the reaction to concurrent stimuli. Secondly, the myriad sources around us make the synthesis of community noise profile difficult. To acquire an indication of realistic community situations, it is more useful to have a total noise picture, established from actual field measurement.

As with noise source levels, the community impact must be treated quantitatively and in terms that can be readily interpreted. It is not necessarily of great interest that a piece of construction equipment may generate noise levels as great as 95 dBA to 50 feet. It is of interest that this noise level will contribute to the hearing loss of construction workers and other people exposed daily for several hours, that it will prevent intelligible conversation, and that it could affect the sleep of people living nearby. The number of people disturbed in these ways and the extent of their disturbance is important. In a sense, the magnitude of the noise problem is proportional to the number of people whose lives are significantly degraded by noise.

It is neither practical nor desirable to identify and characterize all sources of environmental noise. Every piece of machinery, from a jet aircraft to an electric clock, produces sound; but not all of these sounds are of sufficient significance to merit study. Furthermore, the appropriate depth of treatment varies with the significance of the source. The following sources of environmental noise have been identified and analyzed in references:[1,2,3]

1. Transportation systems.
2. Devices powered by internal combustion engines.
3. Industrial plants.
4. Construction equipment.
5. Household appliances and building equipment.

5.2 DESCRIPTION OF THE OUTDOOR NOISE ENVIRONMENT

A physical description of a sound must account for its frequency characteristics, magnitude, and temporal pattern. A sound level meter, when used with the A-weighting characteristic, accounts for the frequency characteristics of a noise and the magnitude of outdoor noise by weighting the amplitude of the various frequencies approximately in accordance with a person's hearing sensitivity.

To complete the description of the outdoor noise environment at a specific location, it is necessary to account for the temporal pattern of the A-weighted noise level. The temporal pattern is most easily observed on a continuous graphic-level recording, such as the two samples illustrated in Figure 5-1. The first striking feature of these two samples is that the noise level varies with time over a range of 33 dB, which is greater than an eightfold range of noisiness.*

The second major feature of the samples is that the noise level appears to be characterized by a fairly steady lower level, upon which are superimposed the increased levels associated with discrete single events. This fairly constant lower level is termed the residual noise level. The continuous noise heard in the backyard at night when no single source can be identified, and which seems to come from all around, is an example of residual noise. Distinct sounds that are superimposed on the residual noise level, such as aircraft overflight, cars, and dogs barking (Figure 5-1), are classified as intrusive noises. They can be separated both into intrusive noises from outside the neighborhood, such as aircraft and the cars on boulevards, and local neighborhood noises, such as dogs barking and local cars passing by.

Both direct reading and statistical methods have been applied to 24-hour recordings of the outdoor noise level at a typical suburban residential location.[4] The results are illustrated in Figures 5-2 and 5-3. The variation of the hourly and the day, evening, and nighttime values of the various statistical measures, together with the minimum and maximum values read from a continuous recording, are summarized in Figure 5-2. The period histograms showing the percentage of time that the level was in any stated level interval are shown in Figure 5-3.

All of the statistical measures in Figures 5-2 and 5-3 show the typical daytime-nighttime variation in noise level. In this example, the residual noise level drops sharply after midnight, reaching a minimum value between 4:00 and 5:00 a.m. Between 6:00 and 8:00 a.m. it rises to almost constant daytime value. This time variation of the noise is generally well correlated with the amount of ongoing activity. It is particularly well correlated with the amount of vehicular traffic in urban areas, which is generally considered to be the basic source of the residual noise. For this report, L_{90}, the level which is exceeded 90 percent of the time, will be used as the statistical measure of residual noise where there are no identifiable steady-state noises present. The median noise level (L_{50}) is a useful measure of the average noise environment in the sense that one-half of the time it is quieter and one-half of the time it is noisier than L_{50}. The dashed line in Figure 5-2 is the energy equivalent noise level (L_{eq}) affected by both the duration and the magnitude of all the sounds occurring in the time period. Its value equals that of a steady-state noise that has the same energy during the period analyzed as that of the actual time-varying noise. The energy equivalent noise level is one of the most important measures of the outdoor noise environment for the purpose of correlating noise and community reaction.

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*A change of approximately 10 dB represents a doubling, or halving of perceived loudness or noisiness of a sound. Thus, a 33-dB range of variation represents more than 2x2x2, or eightfold, range of possible variation in loudness or noisiness.

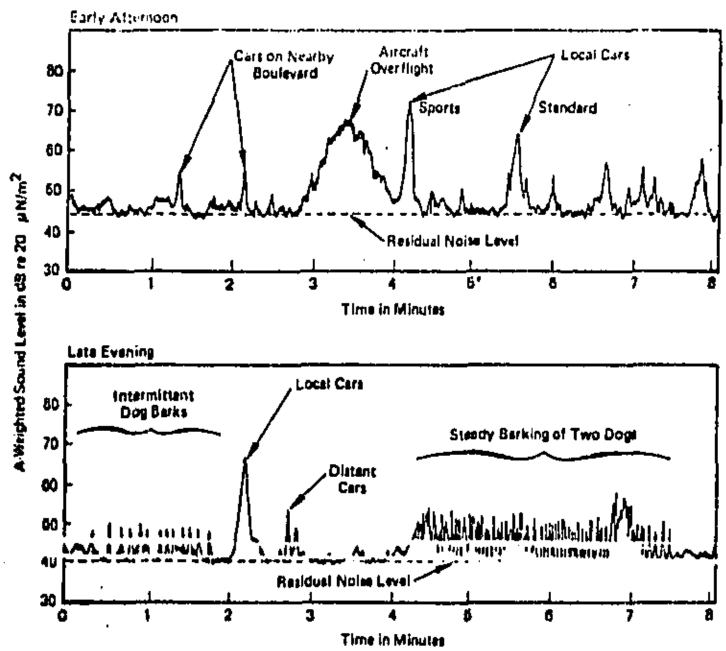

Figure 5-1. Two Samples of Outdoor Noise in a Normal Suburban Neighborhood with Microphone Located 20 Feet from Street Curb.

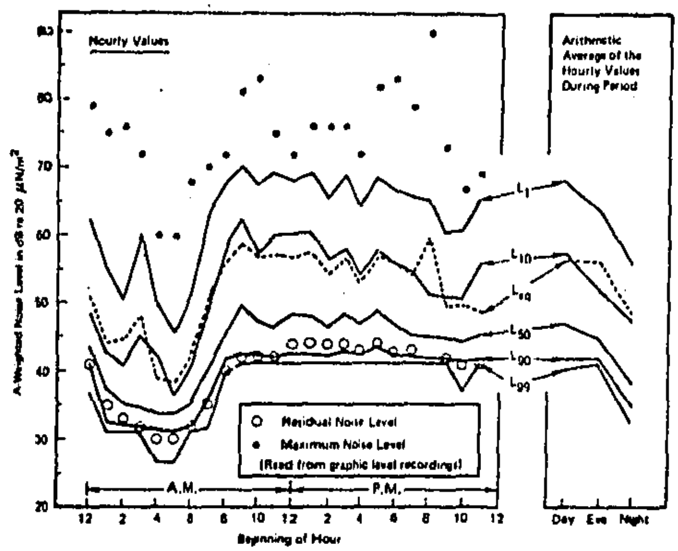

Figure 5-2. Various Measures of Outdoor Noise Level

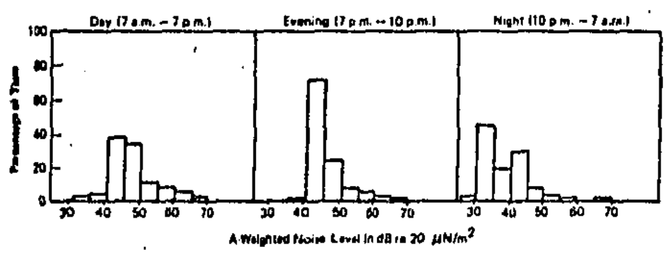

Figure 5-3. Histograms of Percentage of Time Noise Was in Each 5-dB Interval for Three Time Periods.

5.3 INTRUDING NOISES AND COMMUNITY REACTION

There are two basic types of identifiable intruding noises that increase the outdoor noise level above the residual noise level—steady or quasi-steady-state noises and intermittent single-event noises. A steady or nearly constant level noise intrusion may result from a nearby freeway, industry, or air conditioner. The intermittent single-event noise is exemplified by the noise from an aircraft flyover, a single car passby, or a dog barking.

5.4 CONSTANT-LEVEL NOISE INTRUSIONS

One of the best known examples of constant-level noise intrusion is the noise environment within a busy city. The high daytime noise levels within the city make it difficult to have an outdoor conversation at normal voice levels. For example, if the outdoor noise level is 76 dBA, a condition commonly encountered in cities, it is necessary to talk in a raised voice to achieve intelligibility at a 2-foot distance.

Similar data show that the maximum distance for normal voice conversation outdoors in a noisy urban residential area is 3 to 5 feet, according to the range of noise levels for this category in Table 5-1.* Also, the noise associated with the "very noisy urban residential" area of Table 5-1 is sufficiently high to restrict the amount by which doors and windows can be opened if one is to retain a desirable indoor noise environment.**

The noise levels associated with the "quiet suburban residential" area of Table 5-1 permit barely intelligible normal voice conversation at distances ranging between 30 and 50 feet.* However, if the noise level is so low that the distance for intelligible conversation in normal voice approaches the distances between neighbors, it becomes difficult to have a private conversation. For example, with a 50-foot distance between neighbors, the median noise level required to obtain privacy would have to be on the order of 46 to 50 dBA, depending upon orientation of the talker relative to the neighbor and assuming no barriers exist. This median noise level range is approximately that of the normal suburban community.

The considerations of speech intelligibility and privacy suggest that there are both maximum and minimum bounds to the outdoor noise levels that are compatible with reasonable enjoyment and full use of patios, porches, and yards. The upper bounds for speech intelligibility appear to be in the range of the very noisy urban residential category of Table 5-1, and the lower bound for speech privacy is a function of the distance and shielding between neighbors.

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*See Reference 4 for the criteria basis.

**A general estimation of building interior noise levels could be made on the basis of a reduction of exterior levels by about 7 dBA with windows open and 15 dBA with them closed, in the direction facing the noise source, and assuming average residential structures.

TABLE 5-1

QUALITATIVE DESCRIPTORS OF URBAN AND SUBURBAN DETACHED HOUSING RESIDENTIAL AREAS AND APPROXIMATE DAYTIME RESIDUAL NOISE LEVEL (L_{90})

DESCRIPTION	TYPICAL RANGE dB(A)	AVERAGE dB(A)
Quiet Suburban Residential	36 to 40 inclusive	38
Normal Suburban Residential	41 to 45 inclusive	43
Urban Residential	46 to 50 inclusive	48
Noisy Urban Residential	51 to 55 inclusive	53
Very Noisy Urban Residential	56 to 60 inclusive	58

5.5 INTERMITTENT SINGLE-EVENT INTRUDING NOISES

At many points in typical communities, the noise environment is made up of a series of transient noise events, such as that caused by vehicular traffic. Many of these single-event noises interfere with speech and other activities for brief intervals of time. However, their impact is not as easily quantified in terms of speech interference as are constant level noise intrusions.

One method for estimating the magnitude of the intrusion for single-event noises is to have people rank the acceptability of a series of noises at different levels. One of the most comprehensive recent studies of the subjective judgment of single-event noises was performed using vehicle traffic noises. The results are summarized in Figure 5-4. This data is consistent with the apparent general acceptance of maximum levels that result from standard passenger automobiles driven on residential streets.

5.6 COMMUNITY REACTION TO NOISE

The advent of commercial jet aircraft initially increased the maximum noise levels at some locations around major airports by 10 to 20 dBA. These increases in noise caused widespread complaints and various forms of legal action from citizens living in neighborhoods near these civil airports. This situation paralleled the earlier history of military jet operations by the Air Force after World War II, although only a few Air Force operational bases were close to cities and towns. Unfortunately, the civil airports, which accounted for the majority of the early commercial jet operations, were located near the major cities they served. Further, they were becoming surrounded by homes constructed in the post-World War II building boom. As jet thrust ratings, jet aircraft operations, and airports continued to increase, the airport noise problem tended to spread through the wider areas of the community and to more communities.

The U. S. Air Force and other governmental agencies began to investigate the effects of aircraft noise on people in communities in the early 1950's. This early research resulted in a proposed model for relating aircraft noise intrusion and the probable community reaction. This model, first published by the U. S. Air Force[5] accounted for the following seven factors:

1. Magnitude of the noise with a frequency weighting for hearing response.
2. Duration of the intruding noise (10 times the logarithm of the relative duration).
3. Time of year (windows open or closed).
4. Time of day noise occurs.
5. Outdoor noise level in community when the intruding noise is not present.
6. History of prior exposure to the noise source and attitude towards its owner.
7. Existence of pure tone or impulsive character in the noise.

Corrections for these factors were generally made in 5-dB intervals, since many of the initial relationships were based solely on the intuition of the authors (Rosenblith and Stevens), and it was considered difficult to assess the response to any greater degree of accuracy. This method was incorporated in the first Air Force Land Use Planning Guide in 1957[6] and was later simplified for ease of application by the Air Force and the Federal Aviation Administration (FAA).

Many other methods have been proposed for describing repeated single-event type noise, with primary application to airport noise problems. Most of those methods represent an evolution of the community noise reaction model and consider at least some of its principal factors. Three of the methods for calculating the magnitude of noise intrusion are summarized in Table 5-2.

The Composite Noise Rating (CNR) was introduced in the early 1960's and has been widely used by Federal agencies. The Noise Exposure Forecast (NEF) is a recent evolution of the CNR and is proposed as its successor by the FAA. It essentially updates the CNR by substitution of the tone- and duration-corrected Effective Perceived Noise Level (EPNL) scale used for aircraft certification, instead of the Perceived Noise Level (PNL) scale of the earlier CNR. Thus, the NEF accounts for both duration and pure tone content of each single-event sound, whereas the CNR accounted for neither.

The Community Noise Equivalent Level (CNEL) was recently introduced by the State of California for monitoring purposes. It is based on the A-weighting to avoid the complexity of the computer calculations required to obtain ENPL and, thus, cannot contain a pure-tone weighting. It also differs from the NEF by inclusion of the evening time period weighting, in addition to daytime and nighttime. However, despite these structural differences, the difference between the absolute values of CNEL and NEF for specific locations near airports is approximately constant at 35+2 dB. Thus NEF-30 is approximately equivalent to CNEL-65.

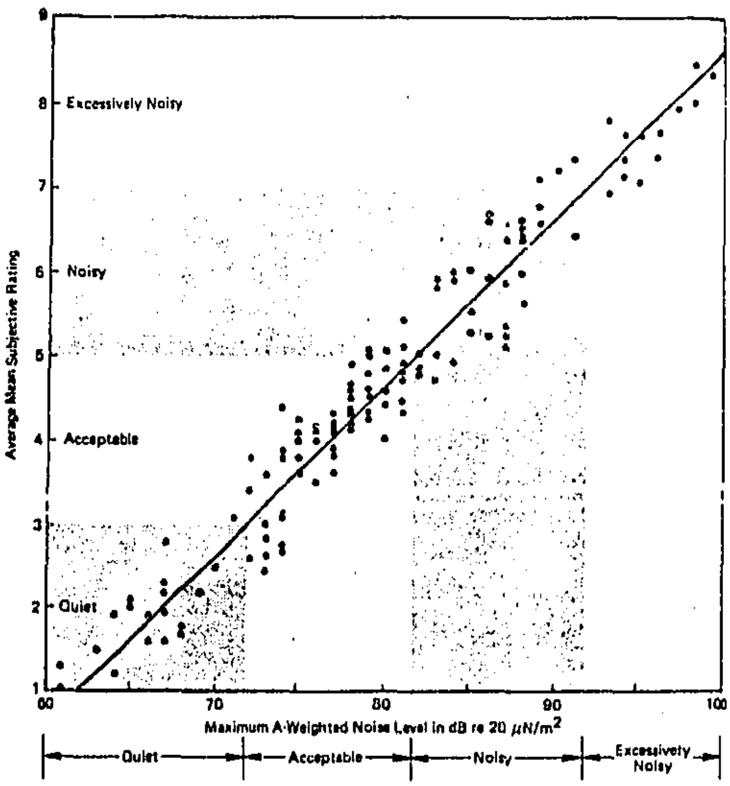


Figure 5-4. Average Mean Subjective Rating as a Function of Maximum Noise Level in dBA for British Experiment at Motor Industry Research Association Proving Grounds

TABLE 5-2

FACTORS CONSIDERED IN EACH OF THREE METHODS USED FOR DESCRIBING THE INTRUSION OF AIRCRAFT NOISE INTO THE COMMUNITY

FACTOR	COMPOSITE NOISE RATING (CNR)	NOISE EXPOSURE FORECAST (NEF)	COMMUNITY NOISE EQUIVALENT LEVEL (CNEL)
Basic measure of single event noise magnitude	Maximum perceived noise level	Tone-corrected perceived noise level	A-weighted noise level
Measure of duration of individual single event	None	Energy integration	Energy integration
Time periods during day	Daytime (7 AM-10 PM) Nighttime (10 PM-7 AM)		Daytime (7 AM-7 PM) Evening (7 PM-10 PM) Nighttime (10 PM-7 AM)
Approximate weighting added to noise of single event which occurs in indicated period	Daytime 0 dB Nighttime 12 dB		Daytime 0 dB Evening 5 dB Nighttime 10 dB
Number (N) of identical events in time period	10 log N		10 log N
Summation of contributions	Logarithmic		Logarithmic

REFERENCES

1. *Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines*, NTID 300.13
2. *Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances*, NTID 300.1
3. *Noise from Industrial Plants*, NTID 300.2
4. *Community Noise*, NTID 300.3
5. *Handbook of Noise Control*, vol. 2, "Noise and Man." WADC TR 52-204
6. "Procedures for Estimating Noise Exposure and Resulting Community Reaction from Air Base Operations," WADC TN 57-10

SECTION 6

NOISE REDUCTION

6.1 INTRODUCTION

Noise reduction encompasses a rather broad technical area of acoustics. Consequently, this section is intended to be only an introduction to the subject matter. Should the reader require more detailed information, it can be found elsewhere (References 1-3).

Nevertheless, a basic principle in noise reduction can immediately be offered. This principle applies well to simple problems as well as complex ones. It can be simply stated that to have effective noise reduction, the noise level of the noisiest component (or components) should first be reduced. The principle indirectly implies that efforts of noise reduction on components of lesser noise level may be wasteful as shown in the following example: suppose there are three sources in a certain noisy situation of sound pressure levels 70 dB, 75 dB and 80 dB. By adding these levels as shown in Subsection 2.5 or from Figure 6-1, the overall sound pressure level will be 81.6 dB. If noise control efforts are devoted to decreasing the sound pressure level of the loudest noise by 10 dB from 80 dB to 70 dB, the overall sound pressure level will become 77.1 dB (from Figure 6-1) giving a reduction of 4-5 dB in sound pressure level. On the other hand, if the sound pressure level of the 70 dB noise is reduced by the same amount of 10 dB to 60 dB, the overall sound pressure levels will be 81.2 dB giving a reduction of only 0.4 dB. Thus the measure of noise control in the second case is much less effective than the first case. It is interesting to note that a noise reduction of 4.5 dB will also result if 5 dB reduction is achieved for each of the 75 dB and 80 dB noise.

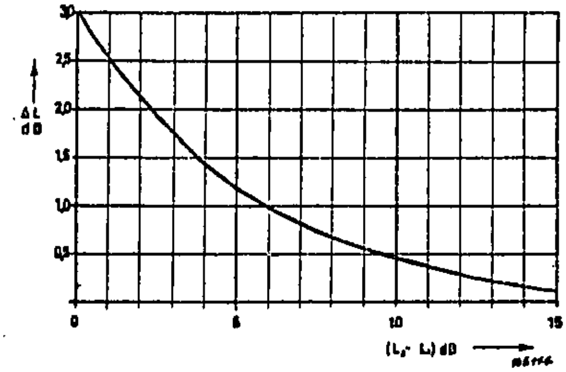
Normally, when a noise problem exists, the acoustic system may be viewed as consisting of three major components:

1. The *source* from which the acoustic energy emanates.
2. The *path* along which the acoustic energy travels.
3. The *receiver* upon which the acoustic energy impinges.

We wish, therefore, to introduce methods and examples of reducing the noise for each component of the source-path-receiver model.

6.2 NOISE REDUCTION OF THE SOURCE

The most effective approach to treating a noise problem is to reduce the noise at its source. In some cases, the solution to the problem may be straightforward and inexpensive; other problems



NOTE: To use the chart the level difference (in dB) between the two noise levels, L_1 and L_2 to be combined is calculated (X-axis). From the chart a dB-value (ΔL) is then found which should be added to the highest of the levels, L_1 or L_2, to give the combined noise level.

Figure 6-1. Noise Level Addition Chart.

involving complex forces acting simultaneously may require sophisticated analysis and treatment which, in turn, will be expensive. The following discussion outlines some approaches which have been found useful in industrial noise control[4] and which can be extended to general noise control problems.

1. Substitution Method—This approach considers using quieter equipment, a quieter process, or introducing different material. For example, high velocity turbojet engines are being replaced by lower velocity fanjet engines resulting in substantial reduction in aircraft noise. In the case of impacting bodies consisting of metal on metal, a reduction of the impact noise can be achieved by replacing the metal with some other material such as rubber, should the process allow it.
2. Modification of the Noise Source—
   A. Reduce the driving force on the vibrating surface by maintaining the dynamic balance of rotating bodies, minimizing the rotational speed, increasing the duration of the work cycle, or decoupling the driving force. The feasibility of these approaches naturally depends upon the overall function of the vibrating body.
   B. Reduce the response of the vibrating surface by adding damping materials to the surface, changing the structural support of the surface, or increasing the mass of the surface.

C. Reduce the area of the vibrating surface by reducing the overall dimensions or perforating the surface.

D. Make use of the directionality of the source by positioning the noise source in such a way that the receiver is exposed to minimum noise levels.

E. Whenever possible, try to reduce the speed of moving objects both solid or fluid, as on an assembly line in a bottling plant.

F. Introduce streamline surfaces to minimize turbulence associated with fluid flow.

G. Use mufflers to reduce noise due to exhaust gases.

6.3 NOISE REDUCTION OF THE PATH OF SOUND

If it is not possible or economical to reduce the noise at the source, the next step is to consider treating the path along which the sound energy flows. The following methods may be used to reduce noise along the path of sound:

1. Introduce vibration isolation mounts.
2. Place a baffle between the source and receiver.
3. Place sound absorbing material on existing surfaces. An example showing the effect of each of these approaches on the speech interference level (SIL) is shown in Figure 6-2.
4. Place a rigid sealed enclosure around the source. Varying degrees of such treatment on the SIL for a given example are shown in Figure 6-3.
5. Use sound absorbing materials such as acoustic tile, heavy draperies, plush carpeting, etc. to change the acoustic environment inside rooms. It is important to realize that should the receiver be close to the sound source in the same room, such treatment will have little effect in reducing the noise level experienced by the receiver. This is due to the fact that the direct sound field will not be affected by the sound absorbing materials.
6. Figure 6-4 is an illustration of techniques employed to abate highway noise levels. Such techniques include landscaping (which must be dense to be effective), wall barriers, and depressing the highway.

6.4 NOISE REDUCTION AT THE RECEIVER

One obvious approach to reducing noise between a source and receiver is to increase the distance between them. Such an approach allows the noise intensity to decrease with the distance traveled by the freely progressing sound waves. Again, referring to Figure 6-4, we see that where there is no barrier next to the highway, the sound level is decreased with the distance from the right-of-way. (It is sometimes assumed that a decrease in the sound level occurs at a rate of 4.5 dB as the distance is doubled).

The concept of decaying sound levels with distance from the source is useful for proper land use zoning. For example, land areas close to airports could be reserved for industrial or commercial use only, so that residential areas would be suitably removed from high levels of aircraft noise.

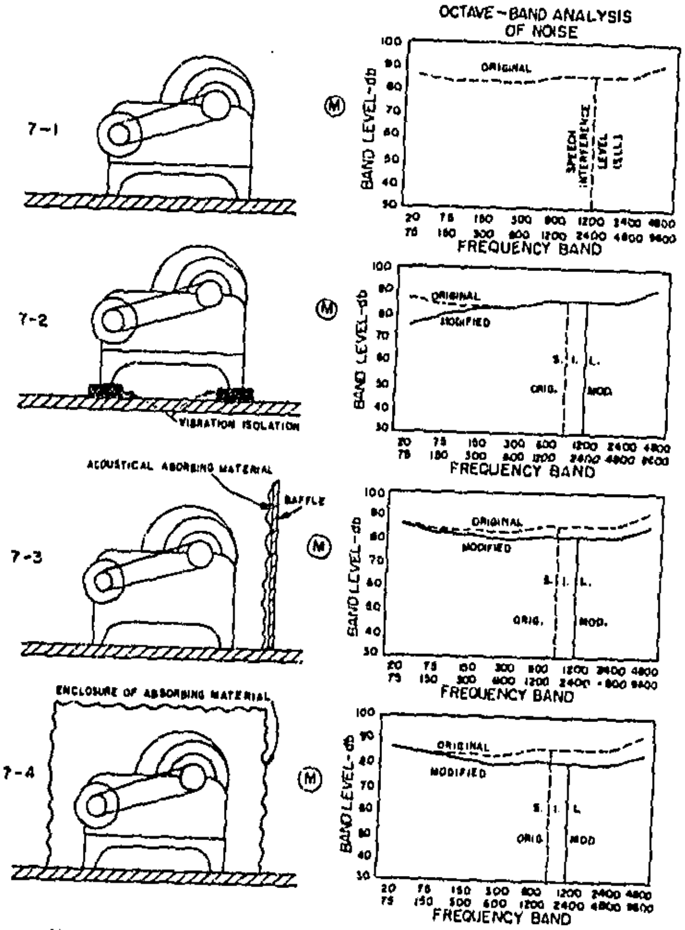


Figure 6-2. Possible Noise Reduction Effects of Some Noise Control Measures (From *Handbook of Noise Measurement*, General Radio Company)

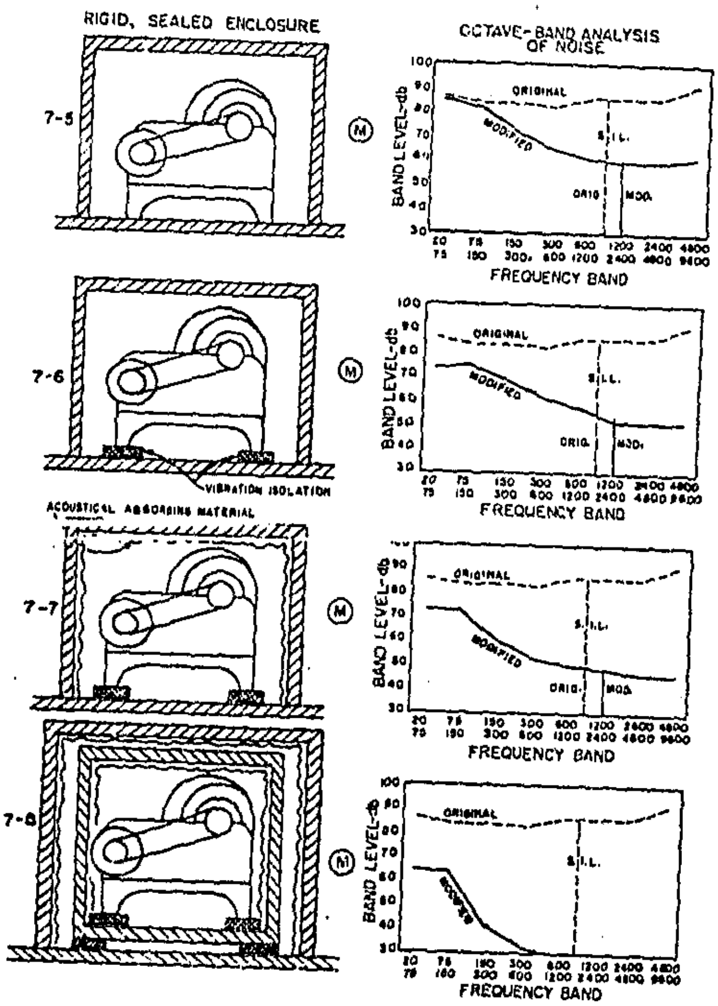


Figure 6-3. Noise Reduction Possible by the Use of Enclosures. (From *Handbook of Noise Measurement*, General Radio Company)

HIGHWAY NOISE (dBA, L_{10}) AT VARIOUS DISTANCES FROM EDGE OF 4-LANE HIGHWAY

TRAFFIC: 5,000 VEHICLES PER HOURS, 5% TRUCKS, 53 MPH

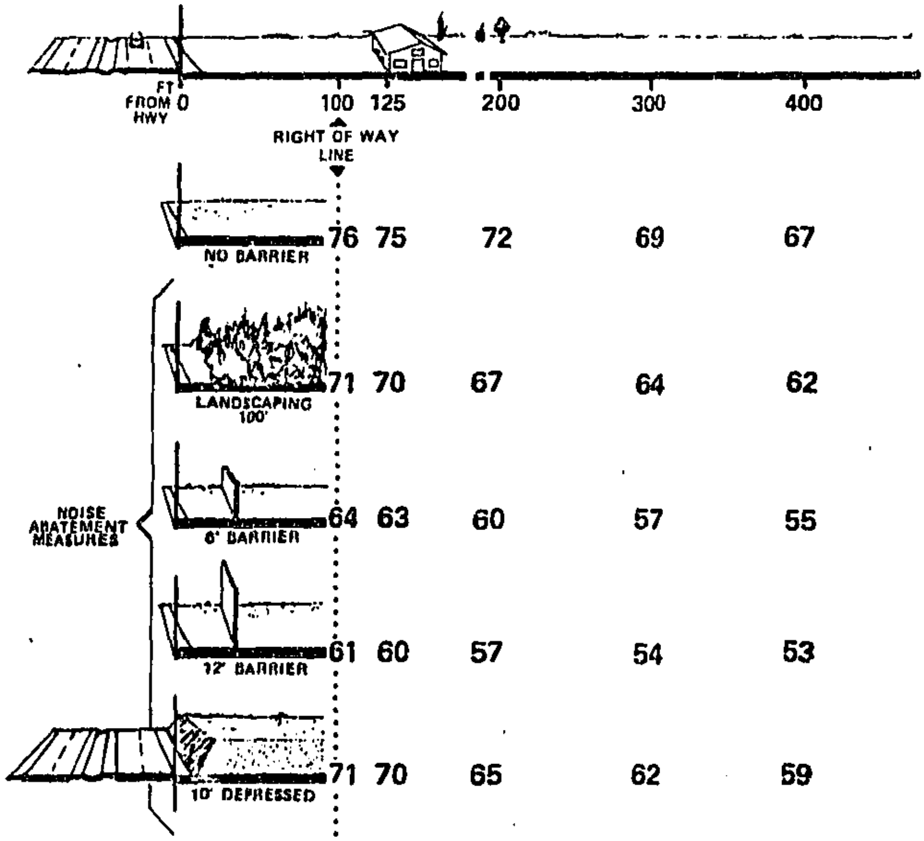


Figure 6-4. Highway Noise (dBA, L_{10}) at Various Distances From Edge of 4-Lane Highway

An approach such as land use planning, when utilized by local jurisdictions, would block expansion of existing residential areas into acoustically undesirable land areas.

When industrial noise levels cannot be reduced to acceptable occupational noise levels, the receiver may be rotated in job locations to meet allowable time exposures. In some cases the receiver may require hearing protection devices such as earplugs.

REFERENCES

1. Beranek, L. L., (ed.), *Noise Reduction*, New York, McGraw-Hill, 1960.
2. Yerges, L., *Sound, Noise and Vibration Control*, Van Nostrand, 1969.
3. Beranek, L. L., (ed.), *Noise and Vibration Control*, New York, McGraw-Hill, 1971.
4. *Industrial Noise Manual*, 2nd ed, Detroit: American Industrial Hygiene Association, 1966

SECTION 7

MEASURING AND MONITORING NOISE

7.1 INTRODUCTION

Measurement is essential for developing intelligent appraisals of environmental noise.

The accuracy of the data derived from environmental noise measurements depends upon many important factors. Foremost, the equipment used for the measurement must be standardized. Standardization implies that the results are accurate within specified tolerances, repeatable under the same environmental conditions, and that the results can be correlated with the results of other instruments. Likewise, the measurement methodology must be a standard one since it too will affect the outcome of the measurement. An important procedure is the calibration process which accurately sets the read-out scales of the measurement equipment subjected to known, standardized inputs. It is the process which establishes the validity of the measured data within the limitations of the equipment. Quite often, appropriate measurement procedures include sketching the physical layout, showing the measurement stations with respect to nearby walls and other reflecting objects. Most equipment, operational characteristics, measurement methods, and procedures are contained in recommended specifications and procedure promulgated by national and international organizations. These specifications and procedures must be followed in the measurement and monitoring of noise.

7.2 COMMON NOISE MEASURING EQUIPMENT

The following list sets forth some commercially available acoustic measuring equipment with which regional personnel should be familiar:

- Sound Level Meter/Microphone.
- Calibrator.
- Octave Band Filters.
- Tape Recorder.
- Graphic Level Recorder.
- Statistical Analyzer
- Spectrum Analyzer.
- Impulse Meter.
- Dosimeter.
- Real Time Analyzer.

7.2.1 Sound Level Meter/Microphone

This is the most important instrument of all sound measuring equipment. Commercially available units are self-contained, battery operated, and portable. Usually a microphone is supplied with the sound level meter.

Most manufacturers supply two different damping levels to the meter indicating mechanism (needle); thus, the meter can be read in fast or in slow setting. Generally, on the fast setting, the needle indicates the sound level within a fraction of a second after a steady signal is first applied. The overshoot is generally not greater then 1 dB. The slow setting averages the sound level for a greater time period.

The weighting networks, designated A, B, and C, were originally designed to approximate the human reception of sound at different loudness levels as discussed in Section 4 (Subsections 4.3 and 4.4). In some newer sound level meters, a D weighting network provides measured levels which are related to the perceived noise level due to aircraft noise (Subsection 4.8).

Depending on the tolerance of the weighting network, sound level meters can be classified as Type 1-Precision, Type 2-General Purpose, Type 3-Survey, and Type S-Special Purpose. The Type 2-General Purpose meter gives the sound level within a few decibels of the meter reading. Type 2 is generally satisfactory for most measurements in compliance with noise ordinances (i.e., the results are usually acceptable in a court of law).

The microphone of a sound level meter is generally of the omni-directional, random-incident type and is suitable for most sound measurements. In addition, other accessories may include a wind screen, random incident corrector, tripod, etc.

7.2.2 Calibrator

Commercially available sound pressure level calibrators are portable, battery operated units which, when fitted to a microphone, supply a specified sound pressure level within a fraction of a decibel. The calibration procedure involves only a battery check and the setting of the sound level meter control knobs. It is good practice to calibrate the sound level meter both prior to making a survey and afterwards. For monitoring projects, occasional calibration is very desirable. For a more complicated survey involving the use of recorders, it is important to feed the calibration signal to the recorders for reference purposes.

7.2.3 Octave Band Filters

The octave band filter set is an analyzer that indicates at what frequency range the sound energy is concentrated. For this reason, the instrument is particularly useful in noise control assignments.

Portable units conforming to ANSI and IEC specifications [2, 3] are commercially available as accessories to the sound level meter over the frequency range between 31.5 Hz to 31,500 Hz in eleven octave bands.

7.2.4 Tape Recorder

A tape recorder is required for more elaborate surveys where a permanent record of the acoustic environment is desired or where more detailed analysis in the laboratory is anticipated. The unit with a DC option is particularly useful for field survey since the powering of the unit may be tapped from a car battery. Depending upon the type of survey, the sound level meter is set on the A-weighting network (community noise studies) or on the linear weighting network (noise control).

In selecting a recorder for noise measurement, care should be exercised to assure that the unit has good sound reproduction capability in the audible range. Quality tape should always be chosen for the recording.

7.2.5 Graphic Level Recorder

This is basically a recorder which gives a temporal trace of the sound pressure level on paper for visual examination. Commercial units are AC operated. Both linear and logarithmic (dB) displays of the signal can be obtained.

7.2.6 Statistical Analyzer

The statistical analyzer provides a histogram of recorded noise. One commercial unit divides the sound level into ten equal intervals of 5 dB each with ten windows indicating the time lapse for each interval. Two additional windows indicate the time when the sound is above and below the 50-dB sound level intervals. The sampling time varies from 0.1 second to 10 seconds. This unit is coupled to a compatible level recorder.

7.2.7 Spectrum Analyzer

This AC operated, laboratory instrument is desirable for detailed analysis of a steady sound signal measured directly or on tape. For virtually all tasks performed by regional personnel, an octave/third octave analyzer is sufficient. Commerical units having filter sets conforming to national and international standards can provide an octave or third octave analysis of a signal automatically when coupled to a level recorder.

7.2.8 Impulse Meter

This is generally a precision sound level meter with the additional capability of measuring signals with a high crest factor such as impulse sound or blast. A specially designed "hold" circuitry enables the operator to read the maximum rms or maximum peak values of the impulsive signal.

7.2.9 Dosimeter

This noise exposure meter provides a reading which can be related to the percentage of a predetermined period when the noise environment exceeds a set level. Commercially available units are designed for compliance with the Occupational Safety and Health Act regulations (Chapter 8). A noise exposure meter for community noise monitoring is being developed through and ABN-National Bureau of Standards interagency agreement.

7.2.10 Real Time Analyzer

This is an analyzer which displays the energy spectrum on a fluorescent screen in a vacuum tube. This analyzer, capable of providing 1/3 octave spectra in the order of a few milliseconds, may be used in measuring PNdB values associated with aircraft noise. It can also be used to analyze impulsive sound.

7.3 CONSIDERATIONS IN MEASURING AND MONITORING

7.3.1 Understanding the Problem

First, the problem must be clearly understood, whether it is a comprehensive law enforcement program or a telephone complaint of a single offensive source.

7.3.1.1 Locality of the Problem

It is necessary to determine if measurements are to be taken indoors or outdoors. The demographic setting should also be known.

7.3.1.2 Nature of the Noise

It is necessary to determine whether the noise is steady, fluctuating or impulsive and whether any pure tone exists.

7.3.1.3 Operational Characteristic of the Noise

It is necessary to determine whether the noise occurs continuously or periodically in the day, and also whether it occurs in daytime or nighttime.

7.3.1.4 Physical Characteristics of the Noise

It is necessary to determine the sound pressure level, the frequency and directivity of the noise.

7.3.2 Methodology

Once the problem is understood, a program can be planned based on the available resources. Several considerations are important in formulating the measurement program.

7.3.2.1 Location and Frequency Requirements

The planner must decide how many measurement stations are sufficient and how often data are taken at these stations.

7.3.2.2 Manpower Requirement

The planner must also estimate the required number of technical and non-technical personnel and in what way they are to be used.

7.3.2.3 Equipment Requirement

This concerns the assembly of suitable equipment for the execution of the program. Careful planning such as the rotation of the equipment and personnel is necessary. Auxiliary equipment such as power supplies, cable connections, etc. should not be neglected.

7.3.2.4 Data Requirement

The planner must decide what type of results (rms, peak, dBC (A), etc.) are to be recorded, what degree of accuracy is acceptable, and what type of permanent record is required.

7.3.3 Measurement and Monitoring

7.3.3.1 Visual Inspection

Upon arriving at the measurement site, it is advisable to study the area and listen to the noise so that any necessary adjustments to the program can be made immediately. Most of the time, it is necessary to have permanent records of the physical layout of the site including the measurement stations.

7.3.3.2 Calibration

The batteries of the equipment should be checked and the equipment should be calibrated in accordance with standards specifications and procedures.

7.3.3.3 Background Noise Survey

If the offending noise can be turned off, it is advisable to obtain a measurement of the background noise.

7.3.3.4 Operation

For recorded data to be useful, published procedures must be followed strictly. These procedures are contained in manufacturer manuals, standards specifications and applicable laws and ordinances. Any deviation should be noted in the permanent record.

Sometimes erroneous data are obtained due to environmental elements such as humidity, temperature, and atmospheric changes. The errors can be eliminated by making corrections in accordance with the procedures recommended by the manufacturers. Wind errors can be minimized by windscreens.

7.4 DATA REDUCTION, ANALYSIS AND PRESENTATION

In data manipulation, the manufacturers' manuals and standards specifications should be consulted for corrections and calculation procedures.

The analysis and the presentation of the data depend on the nature of the survey. Several commonly encountered situations are given below.

7.4.1 Complaints, Noise Control

For noise of a steady nature such as that from a stationary source, sound level meter results in dB(A) and dB(C) at the property boundary are often sufficient to determine if compliance of a local noise ordinance is met. If the readings are about the same, the noise has high frequency characteristics (i.e., the energy is concentrated in frequency ranges of about 500 Hz and above); otherwise the noise is low frequency in nature. For more elaborate analysis, a portable octave set is incorporated or attached to a sound level meter. Examples are given in Figure 4-2.

7.4.2 Community Noise Survey and Monitoring

For community noise survey and monitoring activities, it is sometimes best to record the temporal sound pressure level in dB(A) with a recorder (Figure 5-1). Histograms (Figure 5-3) can be presented from the results taken from the statistical analyzer to provide statistical sound levels.

7.4.3 Impulsive Noise Measurement

An impulse sound level meter will give the peak and the rms sound pressure levels. Sometimes it is desirable to record the noise on tape which can be analyzed in an oscilloscope for the waveform, and other times in a real time analyzer for the spectra.

7.4.4 Aircraft Noise

This fluctuating noise can best be recorded on tape for further analysis. In the most sophisticated arrangement, a real time analyzer is coupled to a computer to calculate aircraft noise ratings.

REFERENCES

1. "American National Standard Specifications for Sound Level Meters," ANSI S1.4-1971.
2. "American Standard Specification for Octave, Half-Octave, and Third-Octave Band Filter Sets," ASA S1.11-1966.
3. "Octave, Half-Octave and Third-Octave Band Filters Intended for the Analysis of Sounds and Vibration" (1966), IEC Recommendation, Publication 225.
4. *Noise and Vibration Control*, Chapter 4, Beranek, L. L., ed., McGraw Hill Book Company, 1971
5. *Tutorial Papers on Noise Control*, Chapter 12, Inter-Noise 72, Crocker, M. J., ed., Institute of Noise Control Engineering, 1972.
6. *Handbook of Noise Measurement*, Seventh Edition by Peterson, A. P. G., Gross, E. E., Jr., General Radio Company, 1972.
7. *Acoustic Noise Measurements* by Broah, J. T., Bruel & Kjaer, 1971.

SECTION 8

LAWS AND ORDINANCES

8.1 NOISE ABATEMENT REGULATIONS

8.1.1 General Policy for Federal Noise Abatement and Control

The National Environmental Policy Act of 1969 has required, since January 1, 1970, that Federal agencies use an interdisciplinary approach to integrate the environmental design arts into the decision making process [Section 102(2) (A&B)]. Initially, this new approach to decision making has taken the form of environmental impact statements required pursuant to Section 102 (2) (C) on all Federal actions significantly affecting the human environment. Noise was not specifically mentioned but the Council of Environmental Quality chose to consider noise as an influence on the quality of the environment. Such statements should, therefore, include consideration of environmental noise. Section 102(2) (A&B) is intended to bring about the synthesis of an environmental awareness within Federal agency decision making processes.

The Noise Pollution and Abatement Act of 1970 was the first legislation to provide a central focus for overall environmental noise abatement at the Federal level. This Act required that an Office of Noise Abatement and Control be established in the Environmental Protection Agency (EPA) to carry on research and investigations into environmental noise. The act further directed in Section 402(c) that, following a determination by the Administrator of EPA that noise related to a Federal agency's activity or its sponsored activities is a public nuisance or is otherwise objectionable, the Federal department or agency sponsoring such activity must consult with the Administrator of EPA to determine possible ways of abating such noise. Previous Federal legislation had been directed to noise abatement with respect to specific noise sources (such as aircraft noise) or in regard to special environmental situations (such as occupational exposure or transportation planning).

The Noise Control Act of 1972 represents the first major Federal attempt to eliminate excess noise at the design stage of a wide variety of new consumer products. Major provisions of the Act include the following:

- EPA is directed to develop and publish information on the limits of noise required for protecting public health and welfare as well as a series of reports to identify products that are major sources of noise and to give information on the techniques for controlling noise from such products.

- Using the criteria thus developed, the EPA Administrator is required to set noise emission standards for products that have been identified as major sources of noise and for which standards are deemed feasible. The law requires such standards to be set for products in the categories *of construction equipment, transportation equipment* (except aircraft), *all motors and engines, and electrical and electronic equipment.* It also grants authority to set for other products, standards deemed feasible and necessary to protect public health and safety.
- EPA has authority to require the labeling of domestic or imported consumer products as to their noise-generating characteristics or their effectiveness in reducing noise. Manufacturers or importers of nonconforming or mislabeled products are subject to fines of up to $25,000 per day for each violation and to imprisonment for up to one year. Manufacturers must issue warrants that their regulated products comply with Federal standards at the time of sale. They are also required to maintain records and provide information, including production samples, if requested by EPA.
- The EPA Administrator also is to prescribe noise emission standards for the operation of *equipment* and *facilities* of *interstate railroads, trucks,* and *buses.*
- All Federal agencies are directed to use the full extent of their authority to insure that purchasing and operating procedures conform to the intent of the law. EPA may certify low-noise-emission products for purchase by the Federal Government.
- As required by the Noise Control Act of 1972, EPA completed and submitted to the Congress on July 27, 1973, a comprehensive study of aircraft noise and cumulative noise exposure around airports. Using this information, EPA will submit to the FAA proposed regulations to control aircraft noise and sonic booms. After a hearing and further consultation with EPA, the FAA may adopt or modify the proposed regulations. The FAA may reject the proposals if it believes they are unsafe, technologically or economically infeasible, or inapplicable to certain aircraft. However, it must publicly explain its specific reasons for rejection. A continuing review and consultation role is provided for EPA.

It is apparent that the Noise Control Act of 1972 has mandated a strong leadership role in noise emission control at the Federal level. However, while certain preemptive powers do exist (see Appendix E) it is important for State and local governments to realize that a quiet environment can be achieved only through a partnership with the Federal government.

8.1.2 Aircraft Noise

The Department of Transportation (DOT) Act of 1966 was the first statutory authority relevant to aircraft noise. Section 4(a) of the Act directed the Secretary of Transportation to "promote and undertake research and development relating to transportation, including noise abatement, with particular attention to aircraft noise". Although some efforts were undertaken by the Federal Aviation Administration (FAA) as early as 1960, it was not until the 1968 enactment of Section 611 (PL 90-411), relating to Control of Aircraft Noise and Sonic Boom, as an amendment to the Federal Aviation Act of 1958, that the Federal government undertook an active program of civil aircraft noise abatement.

In November 1969, the FAA published in the *Federal Register* the Federal Aviation Regulation (FAR) Part 36 – Noise Standards: Aircraft Type Certification. This far-reaching rule applies to certain subsonic jet aircraft (see reference 3 for a complete discussion). The rule defines noise limits which aircraft must meet at certain locations with respect to the airport runway during takeoff and landing operations. Additional restrictions are imposed by the FAR-36 to insure that aircraft become progressively quieter at flight positions further from the airport.

In the Airport and Airways Development Act of 1970, the FAA has a valuable tool that could be used to abate noise with respect to airports, since the Act declares the "national policy that airport development projects authorized pursuant to this part shall provide for the protection and enhancement of the natural resources and the quality of environment of the Nation". The airport certification provisions of Section 51(b)(1) direct the Administrator of the FAA to set minimum operational safety standards for airports served by Civil Aeronautics Board (CAB) certified air carriers, but do not apply to the regulation of airport noise levels. The Act is applicable to all projects involving new airports and runways or extension of existing runways; thus, relatively few airport developments that might create additional noise escape consideration.

The FAA issued FAR Part 91 -- General Operating and Flight Rules: Civil Aircraft Sonic Boom in April 2, 1973. The purpose of the rule is to afford the public protection from civil aircraft sonic boom by prohibiting supersonic flights of civil aircraft, except under terms of an authorization to exceed Mach 1.

8.1.3 Highway Noise

Beginning in 1965, the Secretary of Commerce (duties transferred to the Secretary of Transportation since 1966) was required to "cooperate with the States . . . in the development of long range highway plans . . . which are formulated with due consideration to their probable effect on the future development of urban areas of more than fifty thousand population." The first active consideration of highway noise at the Federal level was contained in the Policy and Procedures Memorandum 20-8 of the Bureau of Public Roads, issued January 14, 1969. Environmental effects, which must be considered by the State or local sponsor seeking Federal aid, are defined to include "noise, air, and water pollution."

A 1970 amendment to the Federal-Aid-Highway Act (PL 91-605) required the Secretary of Transportation to develop and promulgate standards for highway noise levels compatible with different land uses. Such standards were issued in April 1972 by the Federal Highway Administration (FHWA) as Policy and Procedure Memorandum (PPM) 90-2.

8.1.4 Occupational Noise Abatement and Control

The Occupational Safety and Health Act of 1970 mandated the Department of Labor to promulgate regulations to protect employees of all firms affecting interstate commerce. Limitation of noise at the employee's work place, based on necessity to protect against permanent hearing handicap, has been established by regulation. Section 18 of the Act permits a state to assume responsibility for administering and enforcing the Occupational Safety and Health Program within the state.

The Atomic Energy Commission (AEC), in AEC Manual 0550-01 OS, February 25, 1970, and the Department of Interior, pursuant to the Coal Mine Health and Safety Act of 1969, have also adopted the OSHA standards for occupational noise programs. The AEC program is intended, ". . . for the protection of AEC and AEC contractor employees, the general public, and the environment . . . ." The Department of the Interior, through the Bureau of Mines, applies the standards to some 1900 licensed underground coal mines. The Bureau of Motor Carrier Safety, Department of Transportation has extrapolated the OSHA standards for maximum allowable in-cab noise levels for 10-hour periods. These proposed regulations were published in the *Federal Register* on January 4, 1973.

8.1.5 Acoustic Characteristics of Buildings

Regarding acoustical characteristics of buildings, the Department of Housing and Urban Development (HUD) has issued Policy Circular 1390.2, August 4, 1971, concerning acoustical acceptability of new sites and existing buildings to be aided by HUD monies. This circular applies noise standards to programs where none existed previously and replaces the standards of the Federal Housing Administration (FHA), which is under HUD, to the extent that programs, ". . . have less demanding noise exposure requirements."

The General Services Administration (GSA), under PBS P3410.5, June 12, 1968; PBS P 3460.1C, June 12, 1968; PBS 4-0950, November 1970; PBS 4-1021, February 1970; and PBS 4-1515-71, April 1971, has established certain objective standards to be met in various segments of government buildings constructed under GSA contract. These standards are designed to reduce the impact of noise by providing a buffer between the noise source and the receiver. Furthermore, under PBS 4-01100, August 1972, GSA set allowable decibel levels for the purchase of construction equipment.

8.1.6 Other Noise Sources Controlled at the Federal Level

The Federal Power Commission, acting under the authority of the Natural Gas Act of 1938 (15 U.S.C. §717), has directed in 18 C.F.R. §2.69, 1971 (first appearing on July 16, 1970 in 35 Fed. Reg. 11389) that compressors, when used above ground in connection with gas pipelines, must be located and treated so as to reduce the noise impact on the environment.

8.2 STATE NOISE ABATEMENT REGULATIONS

Many States are entering the noise control field in earnest, as demonstrated by the large number of recently enacted or proposed State laws in this area. (To date, approximately 20 States have some objective type of noise law.) It is increasingly common for States to establish environmental departments to deal with noise and other pollutants, and the number of noise sources being regulated by any single State is growing. The States are also becoming more sophisticated in the writing of noise laws and are beginning to specify noise limits in terms of decibels instead of the subjective and inexact terms previously used, such as "unnecessary" and "unreasonable," although such standards have by no means disappeared. A growing number of states are also setting standards for noise from new vehicles and equipment, forbidding the sale of any that fail to conform to the standards.[1]

8.2.1 Trends and Gaps in State Legislation

The trend in the area of state regulation is toward more comprehensive, objective laws covering more noise sources and enforced by environmental agencies. States tend to adopt laws that set progressively stricter standards over specified time periods and often direct their laws at the manufacturers.

Despite these encouraging signs, there are still gaps in State regulation. Aircraft noise is not restricted except in California. Colorado has taken steps in the direction of control of railroad and construction site noise.

With some exceptions, States have not been experimenting with new methods of regulating noise. In particular, there has been a noticeable failure to employ land use policies to limit the effects of noise. To date, Minnesota and New York are the only States to have passed such laws. (Five other States are currently considering similar legislation.)

8.3 REGIONAL NOISE ABATEMENT REGULATIONS

One significant regional regulation of noise sources is the limit on aircraft takeoff noise imposed by the Port of New York Authority, which operates Kennedy, La Guardia, Newark, and Teterboro Airports in the New York City vicinity. Takeoffs are not permitted if atmospheric conditions and operating procedures would cause a limit of 112 PNdB to be exceeded at certain measuring points near the airport.*

Other examples of regional efforts in noise abatement include the Minneapolis-St.Paul regional zoning for airports as well as a similar scheme for the Dallas-Fort Worth Regional Airport.

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*The suitability of these rules as effective measures has been challenged by nearby communities.

8.4 LOCAL NOISE ABATEMENT REGULATIONS

Appendix C is a compilation[2] of municipal (i.e., a city and not a borough, township, or county jurisdiction) noise regulations currently enacted, covering the categories of nuisance, zoning (land use), buildings, vehicles, and aircraft. These are over 175 noise related regulations involving approximately 43 million people, which is equivalent to 23 percent of the total U.S. population. Nearly 85 percent, or 148, of these laws contain nuisance provisions and are classified as "nuisance type ordinances." They typically prohibit unreasonably loud, disturbing, or unnecessary noise but fail to define noise quantitatively. The remaining laws are "performance type ordinances." This smaller group, incorporating acoustical criteria, is more objective in nature. These criteria include overall sound level measurements, usually expressed in decibels on the A-weighted scale (dBA). However, many ordinances include octave band provisions in addition. Examples of local ordinances employing performance type standards can be found elsewhere.[1]

8.4.1 Trends and Gaps in Local Legislation

Noise has traditionally been regulated more often at the local level, beginning in Boston in 1850. The first quantifiable noise ordinances adopted at the local level included Seattle (1952), Cincinnati (1953), and Chicago (1955). However, with the increase in the general environmental noise levels of American cities in recent years, local governments have begun to adopt more comprehensive laws to deal with a variety of noise sources. These laws are tending to include more stringent standards and are often directed at manufacturers. Although the major noise sources are regulated at the local level, any one city does not have laws governing noise from every type of noise source. More cities must expand the number of regulated noise sources if local control of noise is to be more effective. They must also increase local expenditure for personnel and equipment to implement existing laws.

8.5 RECOMMENDATIONS FOR STATE ENABLING LEGISLATION

At its April meeting, 1973, the Council of State Governments adopted a model bill for noise control legislation at the State level. Briefly, the bill attempts to give the states maximum authority to regulate noise pollution consistent with the preemptive provisions of the Federal Noise Control Act of 1972.

The model bill contains the following provisions, many of which are patterned on their Federal counterparts:

1. Policy—a declaration of policy of noise control to better the public health and welfare.
2. State agencies are obliged to follow that policy and to obey all Federal, State, and local noise laws.
3. The State is to adopt a comprehensive program of noise control including:
   a. Control of environmental noise.
   b. Control of product noise.

c. Labeling requirements for noisy and noise reducing products.
d. Notice to purchasers of real property of the noisiness of the area.
e. Setting of ambient standards.
f. Adoption of a plan for achieving those standards.
g. Noise insulation standards for new construction.
h. Regulation of noise at places of work.
i. Regulation of airport and aircraft noise.

4. Standards–The basis of the standards for the above regulations is consideration of the public health and welfare, taking into account the magnitude and conditions of use of the product or activity involved, degree of noise reduction available through the operation of the best available technology, and the cost of compliance.
5. The State also is to:
   a. Conduct studies.
   b. Comment on noise impact of environmental impact statements.
   c. Give technical and legal drafting assistance to local governments.
   d. Procure low noise emission products.
   e. Give variances.
   f. Submit annual reports.
6. Local Governments are to develop a noise control plan and implementing mechanisms.
7. Enforcement provisions are geared to each State's usual procedures but may include civil remedies and criminal penalties.
8. Provision is made for citizen suits with a simplified version of the Federal act.

REFERENCES

1. *Noise Source Regulation in State and Local Noise Ordinances*, NTID 73.1, March 1, 1973.
2. Bragdon, Clifford, "Community Noise Ordinances: Their Evolution, Purpose and Impact," presented at the 74th National Meeting of the American Institute of Chemical Engineers, New Orleans, March 13, 1973.
3. *Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines*, NTID 300.13, December 31, 1971.

SECTION 9

HEADQUARTERS-REGIONAL INTERFACE

9.1 INTRODUCTION

The EPA regional noise abatement effort was given impetus by the Office of Noise Abatement and Control's first summer intern program, which began in June 1971 with the assignment of one intern to each region. Prior to that time, the regions had virtually no personnel with even limited expertise in the noise field. (ABN, itself, was not established until April 1971 as a result of the Clean Air Act Amedments, passed in December 1970.) The interns' work involved initiating various projects to bring the noise problem to the attention of both public and private groups.

Since that time, the regions, with varying degrees of involvement and often with ABN assistance, have been performing certain noise related tasks. These tasks have included:

- Review of environmental impact statements, with noise control as a consideration.
- Response to public inquiries and complaints.
- Collection of information pertaining to the particular region (e.g., ordinances, projects, contacts, etc.)
- Consultation with State and local officials regarding noise ordinance development and noise programs.
- Workshops, etc.

Regional involvement in these activites as well as in many others has established the framework for a truly effective national noise abatement program.

9.2 PRESENT REGIONAL CAPABILITIES IN NOISE PROGRAMS

9.2.1 Personnel and Funding

Although no formal noise control program existed in the regions until FY'74, from inception, ABN endeavored to upgrade the personnel capability in the regions.

In November 1971, the regions sent representatives to an ABN funded, one-week, noise training course at Pennsylvania State University. The course provided the regions with the capability to deal with noise problems on a limited basis.

By March 1972 both Region IV and Region VIII, with ABN encouragement, were utilizing part-time ABN funded noise control consultants. (These regions had completed arrangements prior to the imposition of a freeze on hiring consultants.) The other regions will be able to draw upon contractor furnished technical assistance during FY'74.

In January 1973 the Assistant Administrator for Hazardous Materials Control proposed granting a temporary position to each region from the Office of Hazardous Materials Control for FY'74 if the region would actively request and support this position being made permanent in FY'75.

Also, ABN decided to utilize, beginning in FY'74, another method of staffing the regions which is provided for in the Intergovernmental Personnel Act of 1970, (Mobility of Federal, State and Local Employees). The number of IPA personnel in each region will depend upon the funding available for this program in ABN. Approximately $22,000 is budgeted for each region in FY'74.

Specifically, the act permits the temporary assignment of personnel among the Federal Government and State and local governments and institutions of higher education to perform assignments mutually beneficial to the organizations involved. Assignments may be initiated by the State or local government or by the Federal agency concerned. Each assignment is implemented by a written agreement that must be consented to by the Federal agency, the State or local government or institution of higher education, and the employee to be assigned.

9.2.2 Technical Assistance from Laboratories and Other Organizations

9.2.2.1 U.S. Air Force 6570th Aerospace Medical Research Laboratory (AMRL).

Since July 1972, ABN has made available to the regions technical consulting services from AMRL. This consultation is intended to include, but not be restricted to, impact statements, advice on noise surveys, complaint follow-ups, application of noise criteria, etc. The appropriate AMRL contacts are:

Mr. John Cole
Chief, Biodynamic Environmental Branch
(513/255-3675)

Dr. Charles Nixon
Chief, Biological Acoustics Branch
(513/255-3607)

Since it is necessary for ABN to maintain an accounting of services rendered by AMRL for cost reimbursement, regions should notify the coordination and technical assistance staff whenever AMRL has been requested to provide a specific service.

9.2.2.2 CHABA (the NAS-NRC Committee on Hearing, Bioacoustics and Biomechanics)

This important interagency group may be utilized by the regions if requests are coordinated through ABN. Sponsored by the National Academy of Sciences, the CHABA includes representatives from academia, industry and government. The government organizations represented are:

- Department of the Army
- Department of the Navy
- Department of the Air Force
- NASA
- FAA
- EPA
- NIH
- DOT (highway Safety Council).

Services and activities of CHABA include:

- Literature reviews
- Reports on special problem areas
- Evaluations of research proposals
- On-going research projects
- Opportunity for interaction among the various agencies.

9.2.2.3 Industrial and Professional Associations

Interest in noise related problems is demonstrated by the activities of over 100 professional/industrial organizations. Some of these organizations, of course, have a direct interest while others have a more tangential one. The Institute of Noise Control Engineering and the Acoustical Society of America are two of the larger professional societies that are directly engaged in a broad spectrum of noise problems. These two organizations are among those which have been most cooperative with ABN. Addresses are:

Acoustical Society of America
c/o Mr. Eugene Kone
American Institute of Physics
335 East 45th St.
New York, New York 10017

Institute of Noise Control Engineering
P.O. Box 1758
Poughkeepsie, New York 12601

A discussion of these and other organizations is contained in the EDP Noise Technical Information Document 300.9.

9.2.2.4 Citizens Groups

There are many citizens groups interested in noise pollution; such groups can send support to a number of regional programs. Among the most well known are:

- National Organization to Insure a Sound-Controlled Environment (N.O.I.S.E.)
  Executive Building
  1 West Street
  Mineola, New York 11501

- Citizens Against Noise
  2729 West Lunt
  Chicago, Illinois 60645
  Attn: Mr. Ted Berland

- Citizens for a Quieter City, Inc.
  P.O. Box 7777, Ansonia Station
  New York, New York 10023
  Attn: Mr. Robert A. Baron

- Sierra Club Headquarters
  1050 Mills Tower
  222 Bush Street
  San Francisco, California 94104

9.2.2.5 Universities

In over 90 institutions of higher learning, courses are being offered in noise related subjects. Research, covering a variety of subjects, is also being conducted.

University programs are discussed in detail in the EPA Noise Technical Information Document 300.9.

9.2.2.6 Other Federal Agencies

Regional offices of the other Federal agencies involved in noise may be a valuable resource to the regional noise program office.

Federal activities in the noise area are discussed in a separate section of this planning guide.

9.2.3 Instrumentation and Supporting Equipment

9.2.3.1 Sound Measuring Equipment

Each region has the following ABN supplied equipment in addition to any it may have purchased on its own:

General Radio	Item Number
1. 1565-9702,	1565-B Sound Level Meter
2. 1560-9667,	Cable
3. 1562-9701,	1562-A Calibrator
4. 1560-9570,	1560-9570 Microphone
5. 1560-9606,	1560-P6 Microphone
6. 1560-9642,	1560-P42 Pre-amplifier
7. 1560-9580,	Tripod
8. 1560-9521,	Windscreen Pack
9. 1521-9833,	Graphic Level Recorder
10. 1521-9423,	Chartpaper

9.2.3.2 Computer Services

ABN is currently making available to the regions its own noise library, known as NOISE, which is on the EPA computerized retrieval system (ENVIRON). Accessible from remote terminal, it is an on-line system containing abstracts and other bibliographic information on noise-related topics.

The Management Information and Data Systems Branch in the region leases the remote terminal. Arrangements for the use of the terminal may be made through that branch. (Cost is assumed by the regional office.)

9.2.3.3 Sound Demonstration Kit/Movies/Visual Aids

Each region received a noise control demonstration kit in 1972 designed to teach people how to reduce noise. The effectiveness of basic noise control methods can be demonstrated acoustically with this apparatus. Each region was also provided the National Bureau of Standards film "Noise Presentation." Various other movies and visual aids are available from ABN.

9.3 REGIONAL PROGRAMS

9.3.1 ABN Priorities

ABN, in providing guidance and support to the regions, identified three regional output priorities for FY'74:

1. Establishment of mechanisms and relationships for coordination of all activities of Federal agencies in the region which impact the generation of noise by the private sector.
2. Regional assesment of the needs of States and local governments. These assessment statements should include an evaluation of existing legislation, regulations, and noise

control programs as well as a discussion of recognized problem areas. This will enable ABN to determine the resources required for State and local ambient control programs.

3. Structure and conduct, with ABN guidance of the initial phase, an environmental noise monitoring program. Base line data on environmental noise levels will be obtained from representative land use areas within the regions.

These output priorities are consistent with the Office of Hazardous Materials Control's *primary objective of regional program activities* which is to establish a basis for expansion to full scale operations through FY'78.

In addition to these priorities, ABN also has listed the activities which are necessary and/or desirable for accomplishment (although not all in FY'74).

9.3.1.1 Public Awareness Program

Develop and implement a public awareness program on the effects of noise and the measures needed for abatement and control:

- Workshop - a 2-day program for State and local officials to inform them on the assessment of noise problems and the implementation of noise control programs. (Since May 1972, when Region X conducted a two-day workshop in Seattle, Washington, ABN has been actively encouraging and supporting the regional involvement in this area. For a schedule of workshops conducted, see Appendix D.
- Conference - a 1 to 2 day program for citizens groups, etc.
- Information - promulgate information and data on noise and its effects via literature, radio/T.V. media, demonstrations, speeches, etc.
- Educational Institutions - promote curriculum consideration for noise courses, seminars, etc., at the high school and college level.

9.3.1.2 Technical Assistance

Provide technical assistance to State and local governments to implement noise control programs:

- Ordinances - assist in the drafting and review regarding content, dB levels, types of controls, enforcement techniques, etc.
- Resources - advise on the selection of personnel, equipment, supporting services, etc.
- Training - advise on the nature of training required for program officials, survey technicians, etc. Provide training where possible.
- Noise control programs - collect and review existing State and local regulations to establish a base line of noise control activities within the region.
- Surveys - Provide survey equipment and/or conduct surveys to determine ambient noise levels in response to requests from Federal installations and local governments.

9.3.1.3 Other areas

- Identify research requirements.
- Review and evaluate environmental impact statements.
- Reply to inquiries (letter, calls, etc.)
- Provide testimony for public hearings, etc.
- Plan for future compliance and enforcement strategies.
- Support ABN in standard setting and criteriadevelopment, as appropriate.
- Provide information to ABN about the kinds of programs needed at the regional level to implement intent of NCA'72.

9.3.2 General description of regional tasks in support of FY'74 goals

The following chart indicates the three priority areas with the tasks and milestones set forth in detail.

TASK	DATE START	DATE COMPLETE	
1) *Establish Region Interagency Coordination*			
Explore possibility of using Federal Regional Councils as a coordinating device.	July 1973		Region
Review regulations and major policies of each of the major agencies.	August	On-going	Region
Choose 1 or 2 major policies and investigate their application in the Region.	October	On-going	Region
Recommend to Hq. any initiatives for Hq. to take with other Federal Agencies' Hq's.	Any	—	Region
2) *Data Base for State and Local Assistance Planning*			
Distribute draft assessment format and instructions to regions for review and comment.	7/15/73		Head-quarters
Final outlines and instructions provided.		12/15/73	Head-quarters
Assessments of States completed and submitted to Hq.	1/30/74	—	Region
Assessments of other jurisdictions completed and submitted to Hq.	1/30/74	On-going	Region

TASK	DATE START	COMPLETE
3) *ENVIRONMENTAL IMPACT STATEMENT REVIEW*	On-going	Regions
4) *TECHNICAL ASSISTANCE TO STATES AND LOCAL GOVERNMENTS*	On-going	Regions

Output of regional programs will in part be measured through a series of reports to be submitted to headquarters.

9.4 REGIONAL/ABN COMMUNICATION

9.4.1 Current EPA Regional Contacts.

Region			
1	John F. Kennedy Bldg. Rm. 2203 Boston, Mass. 02203	Mr. Earl Anderson Mr. Alan Hicks	617-223-5775 617-223-5708
2	26 Federal Plaza New York, New York. 10007	Mr. Conrad Simon Ms. Jan Pawlak Dr. Roy Sullivan Mr. Emilio Escaladas	212-264-2301 212-264-2110
3	Curtis Building 6th & Walnut Sts. Philadelphia, Pa. 19106	Mr. Gordon Rapier Dr. Rocco DiTaranto	215-597-9872 215-597-9869
4	Suite 300 1421 Peachtree St., N.E. Atlanta, Ga. 30309	Mr. Asa Foster Dr. Clifford Bradgon* Mr. Lawrence Jefferson Dr. Kent Williams	404-526-5289 404-526-5861
5.	1 NW Wacker Drive Chicago, Ill. 60606	Mr. James Conlon	312-353-5248
6	1600 Patterson St. Dallas, Texas 75201	Mr. George Putnicki Dr. Hal Watson Mr. Charles Riddel	214-749-3971
7	Room 249 1735 Baltimore St. Kansas City, Mo. 64108	Mr. Donald A. Townley Mr. Vincent Smith	816-374-3307

Region			
8	Room 916 Lincoln Tower 1860 Lincoln St. Denver, Colo. 80220	Mr. David Wagoner Mr. Robert Simmons Dr. Robert Chanaud* Mr. James West	303-837-2407 303-837-2222
9	100 California St. San Francisco, Calif. 94102	Mr. Clyde Eller Dr. James Channell Ms. Marla Brenner Dr. Richard Procunier	415-556-1406 415-556-4606
10	1200 Sixth Ave. Seattle, Washington 98101	Mr. Douglas Hansen Ms. Deborah Humphrey	206-442-1253

* ABN supported consultants

9.4.2 ABN Personnel

The following is a list of ABN personnel who should be contacted by EPA Regional noise officials who require information and/or assistance in the specialty areas as noted:

Rudy Marrazzo 703-557-7750	Susan Absher 703-557-7760 Nancy Braymer 703-557-2126	Casey Caccavari 703-557-7749 Arnold Konheim 703-557-7604 Tom Gutmann 703-557-7604
Program Plans Budget Activities Policy Matters Resources Regional Visits & Meetings	Reports on Consultants Intergovernmental Personnel Act Interagency Agreements Regional Workshops Training Programs Regional Reporting System Public Information	Ordinances and Laws Model Noise Legislation EIS Process Noise Complaints re: Federal Installations Technical Assistance Monitoring

9.4.3 Regional Reporting System

A formal system of reporting to ABN was established in February 1973 (although ABN has been communicating regularly with the regions since June 1971). The regions were requested to report according to the following schedule:

Report Received by ONAC	*Regions*
Tuesday-First Week of Month	V, VII
Tuesday-Second Week of Month	VI, IX
Tuesday-Third Week of Month	I, II, X
Tuesday-Fourth Week of Month	III, IV, VIII

In turn, the regions are provided information regularly on ABN's activities, including the weekly action summary, the monthly status report and the noise program work plans as they are revised.

9.4.4 Meetings

ABN visited nearly every regional office during FY'73. Various regions are being invited on a periodic basis to participate in ABN's program reviews.

In March 1973, ABN sponsored a Regional Planning Workshop in Denver, Colorado, for development of regional plans and programs. Two full days were devoted to discussions of noise program strategy and planning. The program was structured so that ABN staff personnel and regional noise representatives could have ample time to discuss various problems in the areas of resources, communications, and technical assistance.

ABN plans to hold other mettings of this type (perhaps on an annual basis). In the meantime, ABN welcomes visits by regional personnel to headquarters.

9.5 OUTLOOK FOR THE FUTURE

The following chart graphically illustrates the general noise control strategy of EPA for FY 73-78. It shows relative resource commitment as a function of time among the major tasks to be accomplished by the EPA noise program. The chart is based upon the following premises:

a. that all statutory deadlines are to be met effectively and on time.

b. that establishment of effective State/local programs of noise control, coordination of Federal agency research and control programs, and initiation of EPA noise research and enforcement programs should begin at a relatively low level and expand after all initial regulatory deadlines have been met.

Therefore, a heavy resource commitment expectedly will not be undertaken on the regional level until after 1976. This increased commitment will be concurrent with the rising commitment of resources for enforcement and research activities.

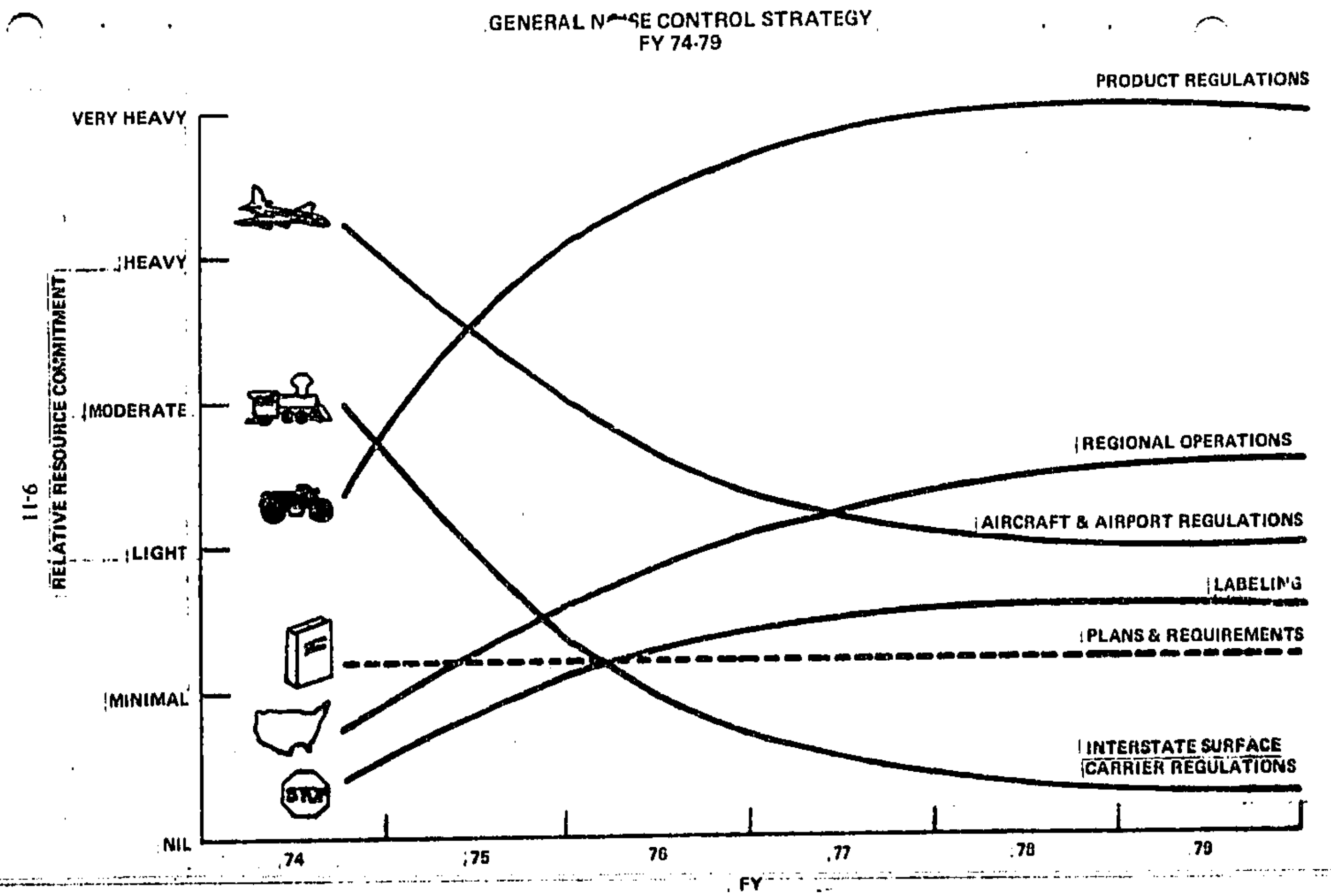

Figure 9-1. General EPA Noise Control Strategy FY 74-79

SECTION 10

INTERAGENCY COORDINATION

10.1 AUTHORITY

Prior to October 1972, EPA's authority for coordinating Federal agency noise programs was contained in three laws:

1. Title IV, Section 402(c) of the Clean Air Act Amendments of 1970.
2. Section 309 of the Clean Air Act.
3. National Environmental Policy Act of 1969 (NEPA, PL 91-190).

The first of these, Title IV of the Clean Air Act Amendments of 1970, provides that:

> In any case where any Federal department or agency is carrying out or sponsoring any activity resulting in noise which the Administrator determines amounts to a public nuisance or is otherwise objectionable, such department or agency shall consult with the Administrator to determine possible means of abating such noise.

In 1972, ABN utilized this authority in successfully abating noise from naval training flights in the San Diego, California area. The situation was reviewed thoroughly with Department of Defense officials, and the naval training flight patterns were subsequently altered to alleviate the problem.

Section 309 of the Clean Air Act provides general authority for EPA to review proposed environmental regulations of other Federal agencies. Pursuant to this authority, ABN reviewed, from the standpoint of noise impact, certain proposed regulations of other Federal agencies, such as the FHWA's noise standards and procedures, PPM 90-2.

Finally, the National Environmental Policy Act of 1969 established the environmental impact statement process. ABN's role with regard to this law is discussed in detail in Chapter 11.

In October 1972, the Noise Control Act of 1972 (PL 92-574, hereafter referred to as NCA '72) was signed into law, granting EPA broad authority in the area of interagency coordination for noise programs. Section 4 of the act directs EPA to coordinate all Federal agency noise standards and regulations and to develop a report on the status of the Federal Government's overall efforts to control noise. (NCA'72 is discussed in depth in Section 8.)

NCA '72 also requires all Federal agencies to execute their programs in such a manner as to "promote an environment for all Americans free from noise that jeopardizes their health or welfare". In addition to the general policy to be followed by Federal agencies in the management of their noise programs, the act specifies that Federal agencies shall comply with all applicable Federal, State, interstate, and local requirements regarding noise.

10.2 PRESENT INVOLVEMENT

At present, ABN is utilizing the extensive capabilities of other Federal agencies to enhance those of EPA's own noise program. ABN, through the use of interagency agreements, has established working relationships with the U.S. Air Force Aerospace Medical Research Laboratory (AMRL) at Wright-Patterson AFB, Ohio, the Committee on Hearing, Bioacoustics, and Biomechanics (CHABA) of the National Academy of Science-National Research Council, the U.S. Air Force Academy, and the National Bureau of Standards. Through these agreements, ABN has drawn upon highly skilled technical resources to assist in various programmatic areas. (The capabilities of AMRL and CHABA are discussed in Section 9.)

ABN is gathering information for effective coordination of the Federal Government's noise programs. Data has been acquired and analyzed for the first report on Federal agency noise programs, which should be published in July 1974 and cover FY 73-74. The report will provide ABN the informational base line necessary for decision making regarding redirection of effort, resource commitment, and elimination of overlapping areas. Included in the report will be a summary of Federal noise research and control programs.

10.3 FUTURE PROGRAMS

On December 17, 1973, the President signed Executive Order 11752, entitled "Prevention, Control, and Abatement of Environmental Pollution at Federal Facilities." This order revised Executive Order 11507 to provide a strong management role by the EPA in insuring compliance by Federal facilities with environmental pollution standards. The new order also added noise, pesticides, radiation and solid waste to the list of pollutants covered. (E.O. 11507 had covered Federal Facility compliance with only air and water quality standards.)

The EPA Office of Federal Activities has developed a strategy to implement the new order. Although the bulk of the actual effort (inspections, assigning budget priorities to various projects, etc.) will be made on the regional level, ABN will provide necessary guidance for projects involving noise control. It should be noted that the order is in essence a mechanism for accomplishing the compliance mandate specified in Section 4b of the Noise Control Act of 1972 (PL92-574). However, efforts by EPA to act in the Federal facility compliance area are not dependent upon the order.

The ABN noise control strategy chart (see Section 9) shows the relative resource commitment accorded to the various areas of the noise program for fiscal year 1973-1979. Although the overall level of regional activity will be relatively low until FY'76, ABN intends to give development of activities in the interagency coordination area as much support as possible.

SECTION 11

ENVIRONMENTAL IMPACT STATEMENT PROGRAM

11.1 INTRODUCTION

The National Environmental Policy Act of 1969 (PL 91-190) directs all Federal agencies to "identify and develop methods and procedures which will insure that presently unquantified environmental amenities and values are given appropriate consideration in decision making along with economic and technical considerations." The Council on Environmental Quality (CEQ), in furthering this act, has established guidelines for preparation of the required environmental impact statements (EIS).

Practically speaking, an industry contemplating new construction or major expansion or modification should seriously consider the advisability of preparing an environmental impact statement to meet applicable Federal and State requirements.

All Federal agencies must submit EIS's for any Federal action affecting the environment. The different requirements of each Federal agency make uniformity in the preparation of statements difficult. Many states have now adopted legislation covering environmental impact statements at the local level.

Generally an EIS contains the following:

- Description of the proposed action.
- Probable impact of the proposed action on the environment, including impact on ecological systems.
- Probable adverse environmental effects which cannot be avoided.
- Alternatives to the proposed action.
- The relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity.
- Any irreversible and irretrievable commitments of resources.
- Problems and objections raised by other Federal, State, and local agencies and by private organizations and individuals in the review process and in the disposition of the issues involved.

11.2 STATUS OF NOISE IMPACT DISCUSSION

Prior to January 1972, noise impact generally was not considered in the preparation of most EIS's. This was due to the following reasons:

- Lack of information on behalf of applicants.
- Inadequate review by EPA on noise impact.
- Lack of noise criteria for use in noise impact assessment.

EPA's review was inadequate for various reasons, the primary one being the absence of the technical capability to perform such an analysis. Prior to January 1972, most EIS's having an obvious noise implication (i.e., airports, highways, etc.), were sent to EPA headquarters in Washington. In some cases, limited manpower and the time needed to assess the statements restricted adequate review.

After the establishment of regional noise contacts (See Section 9) and the associated noise training and assistance provided by ABN, the regions began evaluating their respective impact statements. Presently the evaluation of the noise impact in EIS' varies in each regional office depending upon the location for the programmatic responsibility.

Preliminary findings in an EPA contracted study, conducted by George Washington University, to evaluate the treatment of noise impact by the applicant and reviewer indicated shortcomings in both the preparation and assessment stages of the EIS process. This caused ABN to carefully evaluate its own performance as well as that of others involved in the process. It was ABN's opinion that more guidance was needed regarding the types of criteria which should be utilized in the EIS preparation and evaluation.

11.3 GUIDELINES FOR EIS ASSESSMENT

Presently only two Federal agencies have acoustical guidelines to evaluate noise impact. The Department of Housing and Urban Development (HUD) published a policy Circular 1390.2 in 1971 on noise abatement and control together with a *HUD Noise Assessment Guideline* to be used in considering financing proposals sent to HUD.

The Department of Transportation, Federal Highway Administration (FHWA), issued noise standards for the design of new highways and modification of existing highways in January 1973. Many FHWA regional offices as well as State highway offices use the Highway Research Board's Report #117 as a guide in preparing highway EIS's.

At this time, the only guidelines for assessing EIS's to be set by EPA are those for highways. ABN recommends that its regional counterparts utilize certain accepted guides such as HUD's Circular 1390.2, the Highway Research Report #117, DOT Highway Noise Computer Program, the Noise Exposure Forecast (NEF) or Composite Noise Rating (CNR) for airport evaluations, and other rating scales such as speech interference levels, sleep interference criteria, etc., as necessary. These are to be viewed as surrogates until such time as EPA develops and publishes additional recommended guidelines to be used in the EIS process.

11.4 FUTURE EIS GUIDANCE

Much information is still needed for guidance in the assessment of EIS's. ABN's aim is to provide this guidance by:

1. Publishing the Levels Document as required by the Noise Control Act of 1972 (PL 92-574).
2. Obtaining a better working definition of what is meant by noise impact through the National Academy of Sciences/National Research Council (Committee on Hearing, Bioacoustics and Biomechanics.)
3. Working with other segments of EPA, especially the Office of Federal Activities, to develop guidelines for EPA's EIS review. (OFA published guidelines for review of highway impact statements in September 1973.)

Until these efforts are realized it will be the responsibility of each region and ABN to use the best available information for EIS assessment.

REFERENCES

1. National Environmental Policy Act of 1969. (NEPA) (PL 91-190)
2. Executive Order #11514. This order sets forth general requirements for agencies to implement NEPA, and directs the Council on Environmental Quality to issue guidelines to Federal Agencies for the preparation of impact statements.
3. CEQ Guidelines/April 23, 1971. These guidelines establish the EIS process.
4. CEQ Guidelines/May 16, 1972. These guidelines supplement the earlier ones, and a number of questions on procedure and content are addressed which arose in the first year's experience of implementing NEPA.
5. *Federal Register*/December 11, 1971, Implementation of the National Environmental Policy Act. This gives all the Federal agencies regulations for implementing NEPA.
6. Clean Air Act Amendment of 1970, Section 309. This section requires the Administrator of EPA to review and comment in writing upon all those actions subject to the impact statement requirements of NEPA which relate to any of the authorities of the Administrator.
7. EPA Order 1640.1. This explains the policies and procedures to be followed in reviewing Federal agency actions and fulfilling EPA's responsibilities under Section 309 of the Clean Air Act Amendments.
8. *Federal Register*/January 17, 1973, Interim Regulation. This provides for Interim Guidance for EPA Environmental Impact Statements.

GLOSSARY

ACOUSTICS–(1) The science of sound, including the generation, transmission, and effects of sound waves, both audible and inaudible. (2) The acoustics of an auditorium or of a room, the totality of those physical qualities (such as size, shape, amount of sound absorption, and amount of noise) which determine the audibility and perception of speech and music.

AIRBORNE SOUND–Sound that reaches the point of interest by propagation through air.

AMBIENT NOISE–See background noise.

ANALYSIS–The analysis of a noise generally refers to the composition of the noise into various frequency bands, such as octaves, third octaves, etc.

ANECHOIC ROOM–A room whose boundary walls absorb almost completely sound waves incident upon them, with practically no sound being reflected.

ARTICULATION INDEX (AI)–A numerically calculated measure of the intelligibility of transmitted or processed speech. It takes into account the limitations of the transmission path and the background noise. The articulation index can range in magnitude between 0 and 1.0. If the AI is less than 0.1, speech intelligibility is generally low. If it is above 0.6, speech intelligibility is generally high.

A-WEIGHTED SOUND LEVEL (dBA)–A quantity, in decibels, read from a standard sound-level meter that is switched to the weighting network labeled "A". The A-weighting network discriminates against the lower frequencies according to a relationship approximating the auditory sensitivity of the human ear at moderate sound levels. The A-weighted sound level measures approximately the relative "noisiness" of "annoyance" of many common sounds.

AUDIO FREQUENCY–The frequency of oscillation of an audible sine-wave of sound; any frequency between 20 and 20000 hertz (Hz). See also frequency.

AUDIOGRAM–A graph showing hearing loss as a function of frequency.

AUDIOMETER–An instrument for measuring hearing sensitivity.

BACKGROUND NOISE–The total of all noise in a system or situation, independent of the presence of the desired signal.

BAND CENTER FREQUENCY–The designated mean frequency of a band of noise or other signal. For example, 1000 Hz is the band center frequency for the octave band that extends from 707 Hz to 1414 Hz, or for the third-octave band that extends from 891 Hz to 1123 Hz.

BAND PRESSURE (OR POWER) LEVEL–The pressure (or power) level for the sound contained within a specified frequency band. The band may be specified either by its lower and upper cut-off frequencies, or by its geometric center frequency. The width of the band is often indicated by a prefatory modifier; e.g., octave band, third-octave band, 10-Hz band.

CONTINUOUS SOUND SPECTRUM–A continuous sound spectrum is comprised of components which are continuously distributed over a frequency region.

C-WEIGHTED SOUND LEVEL (dBC)–A quantity, in decibels, read from a standard sound-level meter that is switched to the weighting network labeled "C". The C-weighting network weights the frequencies between 70 Hz and 4000 Hz uniformly, but below and above these limits frequencies are slightly discriminated against. Generally, C-weighted measurements are essentially the same as overall sound-pressure levels, which require no discrimination at any frequency.

CYCLES PER SECOND–See frequency.

DAMAGE-RISK CRITERIA (HEARING-CONSERVATION CRITERIA)–Recommended maximum noise levels that for a given pattern of exposure times should, if not exceeded, minimize the risk of damage to the ears of persons exposed to the noise.

DAMPING–The dissipation of energy with time or distance. The term is generally applied to the attenuation of sound in a structure owing to the internal sound-dissipative properties of the structure or owing to the addition of sound-dissipative materials.

DECIBEL–The unit in which the levels of various acoustical quantities are expressed. Typical quantities so expressed are sound pressure level, noise level, and sound power level.

DIFFUSE SOUND FIELD–The presence of many reflected waves (echoes) in a room (or auditorium) having a very small amount of sound absorption, arising from repeated reflections of sound in various directions.

DIRECTIVITY INDEX–In a given direction from a sound source, the difference in decibels between (a) the sound pressure level produced by the source in that direction, and (b) the space average sound pressure level of that source, measured at the same distance.

DUCT LINING OR WRAPPING–Usually a sheet of porous material placed on the inner or outer wall(s) of a duct to introduce sound attenuation and heat insulation. It is often used in air conditioning systems. Linings are more effective in attenuating sound that travels inside along the length of a duct, while wrappings are more effective in preventing sound from being radiated from the duct sidewalls into surrounding spaces.

EFFECTIVE PERCEIVED NOISE LEVEL (EPNL)--A calculated measure designed to estimate the effective noisiness of a single noise event, usually an aircraft flyover; it is derived from instantaneous perceived noise level values by applying corrections for pure tones and for the duration of the noise.

FAR FIELD–Consider any sound source in free space. At a sufficient distance from the source, the sound pressure level obeys the inverse-square law, and the sound particle velocity is in phase with the sound pressure. This region is called the far field of the sound source. Regions closer to the source, where these two conditions do not hold, constitute the near field. Now consider a sound source within an enclosure. It is also sometimes possible to satisfy the far field conditions over a limited region between the near field and the reverberant field, if the absorption within the enclosure is not too small so that the near field and the reverberant field merge.

FILTER–A device that transmits certain frequency components of the signal (sound or electrical) incident upon it, and rejects other frequency components of the incident signal.

FLUCTUATING NOISE–A noise whose sound pressure level varies significantly but does not equal the ambient environmental level more than once during the period of observation.

FREE SOUND FIELD (FREE FIELD)–A sound field in which the effects of obstacles or boundaries on sound propagated in that field are negligible.

FREQUENCY–The number of oscillations per second (a) of a sine-wave of sound, and (b) of a vibrating solid object; now expressed in hertz (abbreviation Hz), formerly in cycles per second (abbreviation cps).

HEARING DISABILITY–An actual or presumed inability, due to hearing impairment, to remain employed at full wages.

HEARING HANDICAP–The disadvantage imposed by a hearing impairment sufficient to affect one's efficiency in the situation of everyday living.

HEARING IMPAIRMENT–A deviation or change for the worse in either hearing structure or function, usually outside the normal range; see hearing loss.

HEARING LOSS–At a specified frequency, an amount, in decibels, by which the threshold of audibility for that ear exceeds a certain specified audiometric threshold, that is to say, the amount by which a person's hearing is worse than some selected norm. The norm may be the threshold established at some earlier time for that ear, the average threshold for some large population, or the threshold selected by some standards body for audiometric measurements.

HEARING LOSS FOR SPEECH–The difference in decibels between the speech levels at which the "average normal" ear and a defective ear, respectively, reach the same intelligibility, often arbitrarily set at 50%.

HERTZ–See frequency.

IMPACT INSULATION CLASS (IIC)–A single-figure rating which is intended to permit the comparison of the impact sound insulating merits of floor-ceiling assemblies in terms of a reference contour.

IMPACT SOUND–The sound arising from the impact of a solid object on an interior surface (wall, floor, or ceiling) of a building. Typical sources are footsteps, dropped objects, etc.

IMPULSIVE NOISE–Noise which is characterized by brief excursions of sound pressure which significantly exceed the ambient environmental sound pressure. The duration of a single impulse is usually less than one second.

INVERSE-SQUARE LAW--The inverse-square law describes that acoustic situation where the mean-square sound pressure changes in inverse proportion to the square of the distance from the source. Under this condition the sound pressure level decreases 6 decibels with each doubling of distance from the source.

ISOLATION--See vibration isolator.

LEVEL--The level of an acoustical quantity (e.g., sound pressure), in decibels, is 10 times the logarithm (base 10) of the ratio of the quantity to a reference quantity of the same physical kind.

LINE SPECTRUM--The spectrum of a sound whose components occur at a number of discrete frequencies.

LOUDNESS--(1) A listener's perception of the intensity of a strongly audible sound or noise, (2) The factor *n* by which a constant intensity sound or noise exceeds, in the judgment of a listener, the loudness of a 1000 Hz tone heard at a sound pressure 40 dB above threshold. The unit is the sone. See also loudness level.

LOUDNESS LEVEL--The number, attributed to a constant intensity sound or noise, of decibels by which a 1000 Hz pure tone, judged by listeners to be as loud as the sound or noise, exceeds the reference level 2×10^{-5} N/m^2. The unit is the phon. See also loudness.

MASKING--The action of bringing one sound (audible when heard alone) to inaudibility or to unintelligibility by the introduction of another, usually louder, sound. See masking noise.

MASKING NOISE--A noise which is intense enough to render inaudible or unintelligible another sound which is simultaneously present.

NEAR FIELD--See far field.

NOISE--Any sound which is undesirable because it interferes with speech and hearing, or is intense enough to damage hearing, or is otherwise annoying.

NOISE CRITERION (NC) CURVES--Any of several versions (SC, NC, NCA, PNC) of criteria used for rating the acceptability of continuous indoor noise levels, such as produced by air-handling systems.

NOISE EXPOSURE FORECAST (NEF)--A measure of the total noise exposure near an airport; it is derived from EPNL contours for individual aircraft by including considerations of mix of aircraft, number and time of operations, runway utilization, flight path, and operating procedures.

NOISE INSULATION--See sound insulation.

NOISE ISOLATION CLASS (NIC)--A single number rating derived in a prescribed manner from the measured values of noise reduction. It provides an evaluation of the sound isolation between two enclosed spaces that are acoustically connected by one or more paths.

NOISE LEVEL--See sound level.

NOISE AND NUMBER INDEX (NNI)--A measure based on perceived noise level and used for rating the noise environment near an airport.

NOISE POLLUTION LEVEL (L_{NP})--A measure of the total community noise environment regardless of the type of noise source; it is computed from the energy mean of the noise level and the standard deviation of the time variation of noise level.

NOYS–A unit used in the calculation of perceived noise level.

OCTAVE–Any two pure tones, whose ratio of frequencies is exactly two, are said to be an octave apart, or to be separated by an octave.

OCTAVE BAND–All of the components in a sound spectrum whose frequencies are between two sine-wave components separated by an octave.

OCTAVE BAND SOUND PRESSURE LEVEL–The integrated sound pressure level of only those sine-wave components in a specified octave band for a noise or sound having a wide spectrum.

OSCILLATION–The variation with time, alternately increasing and decreasing, (a) of some feature of an audible sound, such as the sound pressure, or (b) of some feature of a vibrating solid object, such as the displacement of its surface.

PEAK SOUND PRESSURE–The maximum instantaneous sound pressure (a) for a transient or impulsive sound of short duration in time, or (b) in a specified time interval for a sound of long duration.

PERCEIVED NOISE LEVEL (PNL)–The level in dB assigned to a noise by means of a calculation procedure that is based on an approximation to subjective evaluations of noisiness.

PHON–The unit of measurement for loudness level.

PITCH–A listener's perception of the frequency of a pure tone; the higher the frequency, the higher the pitch.

PRESBYCUSIS–The decline in hearing acuity that normally occurs as a person grows older.

PURE TONE–A sound wave whose waveform is that of a sine-wave.

RANDOM INCIDENCE–If an object is in a diffuse sound field, the sound waves that comprise the sound field are said to strike the object from all angles of incidence at random.

RANDOM NOISE–An oscillation whose instantaneous magnitude is not specified for any given instant of time. It can be described in a statistical sense by probability distribution functions giving the fraction of the total time that the magnitude of the noise lies within a specified range.

RESONANCE–The relatively large effects produced, e.g., amplitude of vibration, when repetitive sound pressure or force is in approximate synchronism with a free (unforced) vibration of a component or a system.

REVERBERATION–The persistence of sound in an enclosed space, as a result of multiple reflections, after the sound source has stopped.

REVERBERATION ROOM–A room having a long reverberation time, especially designed to make the sound field inside it as diffuse (homogeneous) as possible.

REVERBERATION TIME–The time required for the sound pressure level, arising from reverberation in a room or auditorium and measured from the moment at which the source of sound power is stopped, to die away (decay) by 60 dB.

ROOT-MEAN-SQUARE (RMS)–The root-mean-square value of a quantity that is varying as a function of time is obtained by squaring the function at each instant, obtaining the average of the squared value over the interval or interest, and taking the square root of this average.

SINE-WAVE–A sound wave, audible as a pure tone, in which the sound pressure is a sinusoidal function of time; sound pressure since of (2 × frequency × time).

SONE–The unit of measurement for loudness.

SONIC BOOM–The pressure transient produced at an observing point by a vehicle that is moving past (or over) it faster than the speed of sound.

SOUND–See acoustics (1).

SOUND-ABSORPTION COEFFICIENT (ABSORPTION COEFFICIENT)–The sound-absorbing ability of a surface is given in terms of a sound-absorption coefficient. This coefficient is defined as the fraction of incident sound energy absorbed or otherwise not reflected by the surface. Unless otherwise specified, a diffuse sound field is assumed. The values of sound-absorption coefficient usually range from about 0.01 for marble slate to about 1.0 for long absorbing wedges such as are used in anechoic chambers.

SOUND INSULATION–(1) The use of structures and materials designed to reduce the transmission of sound from one room or area to another or from the exterior to the interior of a building. (2) The degree by which sound transmission is reduced by means of sound insulating structures and materials.

SOUND LEVEL (NOISE LEVEL)–The weighted sound pressure level obtained by use of a sound level meter having a standard frequency-filter for attenuating part of the sound spectrum.

SOUND LEVEL METER–An instrument, comprising a microphone, an amplifier, an output meter, and frequency-weighting networks, that is used for the measurement of noise and sound levels in a specified manner.

SOUND POWER–Of a source of sound, the total amount of acoustical energy radiated into the atmospheric air per unit time.

SOUND POWER LEVEL–The level of sound power, averaged over a period of time, the reference being 10^{-12} watts.

SOUND PRESSURE–(1) The minute fluctuations in atmospheric pressure which accompany the passage of a sound wave; the pressure fluctuations on the tympanic membrane are transmitted to the inner ear and give rise to the sensation of audible sound. (2) For a steady sound, the value of the sound pressure averaged over a period of time. (3) Sound pressure is usually measured (a) in dynes per square centimeter (dyn/cm^2), or (b) in newtons per square meter (N/m^2). 1 N/m^2 = 10 dyn/cm^2 10^{-5} times the atmospheric pressure.

SOUND PRESSURE LEVEL–Is defined as 10 times the logarithm to the base 10 of the ratio of the pressure squared to a reference pressure squared.

SOUND TRANSMISSION CLASS, (STC)–The preferred single figure rating system designed to give an estimate of the sound insulation properties of a partition or a rank ordering of a series of partitions. It is intended for use primarily when speech and office noise constitute the principal noise problem.

SOUND TRANSMISSION COEFFICIENT–The fraction of incident sound energy transmitted through a structural configuration.

SOUND TRANSMISSION LOSS (TRANSMISSION LOSS) (TL)–A measure of sound isolation provided by a structural configuration. Expressed in decibels, it is 10 times the logarithm to the base 10 of the reciprocal of the sound transmission coefficient of the configuration.

SPECTRUM–Of a sound wave, the description of its resolution into components, each of different frequency and (usually) different amplitude and phase.

SPEECH INTERFERENCE LEVEL (SIL)–A calculated quantity providing a handy guide to the interfering effect of a noise on speech. The speech interference level is the arithmetic average of the octave-band sound pressure levels of the noise in the most important part of the speech frequency range. The levels in the three octave-frequency bands centered at 500, 1000, and 2000 Hz are commonly averaged to determine the speech interference level.

SPEED (VELOCITY) OF SOUND IN AIR–The speed of sound in air is 344 m/sec or 1128 ft/sec at 78°F.

SPHERICAL WAVE–A sound wave in which the surfaces of constant phase are concentric spheres. A small (point) source radiating into an open space produces a free sound field of spherical waves.

STANDING WAVE–A periodic sound wave having a fixed distribution in space, the result of interference of traveling sound waves of the same frequency and kind. Such sound waves are characterized by the existence of nodes, or partial nodes, and antinodes that are fixed in space.

STEADY-STATE SOUNDS–Sounds whose average characteristics remain constant in time. Examples of steady-state sounds are a stationary siren, an air-conditioning unit, and an aircraft running up on the ground.

STRUCTUREBORNE SOUND–Sound that reaches the point of interest, over at least part of its path, by vibrations of a solid structure.

THIRD-OCTAVE BAND–A frequency band whose cut-off frequencies have a ratio of 2 1/3, which is approximately 1.26. The cut-off frequencies of 891 Hz and 1123 Hz define a third-octave band in common use. See also band center frequency.

THRESHOLD OR AUDIBILITY (THRESHOLD OF DETECTABILITY)–For a specified signal, the minimum sound pressure level of the signal that is capable of evoking an auditory sensation in a specified fraction of the trials.

THRESHOLD SHIFT–An increase in a hearing threshold level that results from exposure to noise.

TRAFFIC NOISE INDEX (TNI)–A measure of the noise environment created by highways; it is computed from measured values of the sound levels exceeded 10 percent and 90 percent of the time.

TRANSDUCER–A device capable of being actuated by waves from one or more transmission systems or media and supplying related waves to one or more other transmission systems or media. Examples are microphones, accelerometers, and loudspeakers.

TRANSIENT SOUNDS–Sounds whose average properties do not remain constant in time. Examples are an aircraft flyover, a passing truck, a sonic boom.

TRANSMISSION LOSS (TL)—See sound transmission loss.

VIBRATION ISOLATOR—A resilient support for machinery and other equipment that might be a source of vibration, designed to reduce the amount of vibration transmitted to the building structure.

WAVEFORM—A presentation of some feature of a sound wave, e.g., the sound pressure, as a graph showing the moment-by-moment variation of sound pressure with time.

WAVEFRONT—The front surface of a sound wave on its way through the atmosphere.

WAVELENGTH—For a periodic wave (such as sound in air), the perpendicular distance between analogous points on any two successive waves. The wavelength of sound in air or in water is inversely proportional to the frequency of the sound. Thus, the lower the frequency, the longer the wavelength.

APPENDIX A

LIST OF EPA PUBLICATIONS ON NOISE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

The following "Noise" technical documents are for sale by the *Superintendent of Documents, U.S. Government Printing Office, Washington, D. C. 20402 (Phone: Area Code 202/541-3311 or 541-3712)*

EPA DOCUMENT NO.	TITLE	GPO STOCK NO.	CATALOG NO.	POST-PAID	BOOK-STORE
Senate 92-63	Report to the President and Congress Noise	5500-0040	92-2:5.Doc 63	$ 2.75	
NTID300.1	Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances	5500-0044	EP1.2:N69/4	3.45	$ 3.00
NTID300.2	Noise from Industrial Plants	5500-0042	EP1.2:N69/5	2.50	
NTID300.3	Community Noise	5500-0041	EP1.2:N69/6	2.60	2.25
NTID300.4	Laws and Regulatory Schemes for Noise Abatement	5500-0046	EP1.2:N69/7	6.05	5.50
NTID300.5	Effects of Noise on Wildlife and Other Animals	5500-0055	EP1.2:N69/8	.95	.70
NTID300.6	An Assessment of Noise Concern in Other Nations	5500-0043 5500-0052	EP1.2:N69/9/V.1 EP1.2:N69/9/V.2	3.50 .75	 .50
NTID300.7	Effects of Noise on People	5500-0050	EP1.2:N69/10	2.10	1.75
NTID300.8	State and Municipal Non-Occupational Noise Program		Available at NTIS Only		
NTID300.9	Noise Programs of Professional/Industrial Organizations, Universities and Colleges	5500-0053	EP1.2:N69/12	1.00	.75

EPA DOCUMENT NO.	TITLE	GPO STOCK NO.	CATALOG NO.	POST-PAID	BOOK-STORE
NTID300.10	Summary of Noise Programs in the Federal Government	5500-0061	EP1.2:N69/13	3.75	
NTID300.11	The Social Impact of Noise	5500-0047	EP1.2:N69/14	.50	.35
NTID300.12	The Effects of Sonic Boom and Similar Impulsive Noise on Structures	5500-0048	EP1.2:N69/15	.30	
NTID300.13	Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines	5500-0045	EP1.2:N69/16	4.30	3.75
NTID300.14	Economic Impact of Noise	5500-0049	EP1.2:N69/17	1.00	
NTID300.15	Fundamental of Noise: Measurement, Rating Schemes, and Standards	5500-0054	EP1.2:N68/18	1.25	
*VOL I	Construction Noise - Atlanta, Georgia July 8-9, 1971	5500-0037	EP1.2:N69/3/V.1	.75	
*VOL II	Manufacturing and Transportation Noise (Highway and Air) Chicago, Illinois July 28-29, 1971	5500-0085	EP1.2:N69/3/V.2	2.10	1.75
*VOL III	Urban Planning, Architectural Design: and Noise in the Home Dallas, Texas August 18-19, 1971	5500-0062	EP1.2:N69/3/V.3	1.25	

EPA DOCUMENT NO.	TITLE	GPO STOCK NO.	CATALOG NO.	POST-PAID	BOOK-STORE
*VOL IV	Standards and Measurements Methods, Legislation and Enforcement Problems San Francisco - September 27-29, 1971	5500-0036	EP1.2:N69/3/V.4	2.25	
*VOL V	Agricultural and Recreational Use Noise - Denver, Colorado September 30 - October 1, 1971		Available at EPA Only		
*VOL VI	Transportation Noise (rail and other); Urban Noise Problems and Social Behavior - New York, New York, October 21-22, 1971	5500-0038	EP1.2:N69/3/V.6	1.50	
*VOL VII	Physiological and Psychological Effects - Boston, Massachusetts October 28-29, 1971	5500-0056	EP1.2:N69/3/V.7	2.00	
*VOL VIII	Technology and Economics of Noise Control; National Programs and their Relation with State and Local Washington, D.C. - November 9-12, 1971	5500-0039	EP1.2:N69/3/V.8	2.00	
**NTID 73.1	Noise Source Regulation in State and Local Noise Ordinances - March 1, 1973	5500-0095	EP1.2:N69/22	35	.25

EPA DOCUMENT NO.	TITLE	GPO STOCK NO.	CATALOG NO.	POST-PAID	BOOK-STORE
**Senate 93-8	Report on Aircraft-Airport Noise	5270-01936	93-1:S: doc 8	1.25	
**550/9-73-002	Public Health and Welfare Criteria	5500-00103	EP1.2:N69/23/973	1.95	

Noise Facts Digest – Out of stock – will be available at NTIS only in the near future

*EPA Public Hearings
**Current Technical Documents

In addition to the mail-order service provided by the Office of the Superintendent of Documents, Government Printing Office, Washington, D.C. 20402, there are also GPO retail bookstores in other locations as indicated below:

Department of Commerce
14th & E Streets, N.W. – Room 1098
Washington, D.C. 20230
Telephone: AC 202/967-3527

Department of State Building
21st & C Streets, N.W. – 1st Floor
Washington, D.C. 20520
Telephone: AC 202/632-1437

Forrestal Bookstore
James H. Forrestal Building
Room 1-J001
1000 Independence Avenue, S.W.
Washington, D.C. 20407
Telephone: AC 202/426-7973

Government Printing Office
710 North Capitol Street
Washington, D.C. 20402
Telephone: AC 202/783-3238

Pentagon Building
Main Concourse, South end
Washington, D.C. 20310
Telephone: AC 202/541-2998

USIA Building
1st Floor
1776 Pennsylvania Avenue, N.W.
Washington, D.C. 20547
Telephone: AC 202/632-9668

Atlanta Bookstore
Federal Building -- Room 100
275 Peachtree Street, NE
Atlanta, Georgia 30303
Telephone: AC 404/526-6947

Birmingham Bookstore
2121 Building – Room 102A
2121 Eighth Avenue North
Birmingham, Alabama 35203
Telephone: AC 205/325-6056

Boston Bookstore
John F. Kennedy Federal Building -- Room G25
Sudbury Street
Boston, Massachusetts 02203
Telephone: AC 617/223-6071

Canton Booksotre
Federal Office Building
201 Cleveland Avenue Southwest
Canton, Ohio 44702
Telephone: AC 216/455-4354

Chicago Bookstore
Everett McKinley Dirksen Building
14th Floor – Room 1463
219 South Dearborn Street
Chicago, Illinois 60604
Telephone: AC 312/353-5133

Cleveland Bookstore
Federal Office Building – 1st Floor
1240 East 9th Street
Cleveland, Ohio 44114
Telephone: AC 216/522-4922

Dallas Bookstore
Federal Building–U.S. Courthouse
Room 1046
1100 Commerce Street
Dallas, Texas 75202
Telephone: AC 214/749-1541

Denver Booksotre
Federal Building–U.S. Courthouse
Room 1421
1961 Stout Street
Denver, Colorado 80202
Telephone: AC 303/837-3965

Detroit Bookstore
Federal Building – Room 229
231 W. Lafayette Boulevard
Detroit, Michigan 48226
Telephone: AC 313/226-7816

Kansas City Bookstore
Federal Office Building – Room 144
601 East 12th Street
Kansas City, Missouri 64106
Telephone: AC 816/374-2160

Los Angeles Bookstore
Federal Office Building – Room 1015
300 North Los Angeles Street
Los Angeles, California 90012
Telephone: AC 213/688-5841

Milwaukee Bookstore
Federal Building – Room 190
517 East Wisconsin Avenue
Milwaukee, Wisconsin 53202
Telephone: AC 414/224-1304

New York Bookstore
26 Federal Plaza – Room 110
New York, New York 10007
Telephone: AC 212/264-3825

Philadelphia Bookstore
Federal Office Building – Room 1214
600 Arch Street
Philadelphia, Pennsylvania 19106
Telephone: AC 215/597-0677

Pueblo Sales Outlet, PDDC
Pueblo Industrial Park
Pueblo, Colorado 81001
Telephone: AC 303/544-2301

San Francisco Bookstore
Federal Office Building – Room 1023
450 Golden Gate Avenue
San Francisco, California 94102
Telephone: AC 415/556-6657

Seattle Bookstore
Federal Office Building – Room 1056
909 First Avenue
Seattle, Washington 98104
Telephone: AC 206/442-4270

As of 10/25/73

The following "Noise" technical documents are for sale by the *National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22151 (Phone: Area Code 703/321-8543):*

EPA DOCUMENT NO.	TITLE	NTIS DOCUMENT NO.	PRICE
NCR500.1	Report to the President and Congress on Noise	PB-206716	$ 6.00
NTID300.1	Noise from Construction Equipment and Operations, Building Equipment, and Home Appliances	PB-206717	6.00
NTID300.2	Noise from Industrial Plants	PB-206718	6.00
NTID300.3	Community Noise	PB-207124	3.00
NTID300.4	Laws and Regulatory Schemes for Noise Abatement	PB-206719	9.00
NTID300.5	Effects of Noise on Wildlife and Other Animals	PB-206720	3.00
NTID300.6	An Assessment of Noise Concern in Other Nations	PB-206721 (Vol I) PB-206722 (Vol II)	6.00 3.00
NTID300.7	Effects of Noise on People	PB-206723	3.00
NTID300.8	State and Municipal Non-Occupational Noise Programs	PB-208659	3.00
NTID300.9	Noise Programs of Professional/Industrial Organizational, Universities and Colleges	PB-207125	3.00
NTID300.10	Summary of Noise Programs in the Federal Government	Available at GPO Only	
NTID300.11	Social Impact of Noise	PB-206724	3.00
NTID300.12	The Effects of Sonic Boom and Similar Impulsive	PB-206725	3.00
NTID300.13	Transportation Noise and Noise from Equipment Powered by Internal Combustion Engines	PB-208660	6.00
NTID300.14	Economic Impact of Noise	PB-206726	3.00
NTID300.15	Fundamental of Noise: Measurement, Rating Schemes, and Standards	PB-206727	3.00

EPA DOCUMENT NO.	TITLE	NTIS DOCUMENT NO.	PRICE
*AMRL-TR-73-53	Relation Between Daily Noise Exposure and Hearing Loss Based on the Evaluation of 6,835 Industrial Noise Exposure Cases	AD-767204	3.00
*EPA/550/9-73-001-A	A Basis for Limiting Noise Exposure for Hearing Conservation	AD-767274	4.75
*EPA/550/9-73-001-B	Predition of NIPTS Due to Continuous Noise Exposure	AD-767205	3.00
**NTID 73.7	Military Aircraft and Airport Noise and Opportunities for Reduction Without Inhibition of Military Missions	PB-223637	5.25
**NTID 73.6	Review and Analysis of Present and Planned FAA Noise Regulatory Actions and Their Consequences Regarding Aircraft and Airport Operations	N/A at this time	
**NTID 73.5	Noise Source Abatement Technology and Cost Analysis Including Retrofitting	N/A at this time	
**NTID 73.4	Impact Characterization of Noise Including Implications of Identifying and Achieving Levels of Cumulative Noise Exposure	N/A at this time	
**NTID 73.3	Operations Analysis Including Monitoring, Enforcement, Safety, and Cost	N/A at this time	
**NTID 73.2	Legal and Institutional Analysis of Aircraft and Airport Noise and Apportionment of Authority Between Federal, State, and Local Governments	N/A at this time	
	Noise Facts Digest	Out of Stock – Will be available in the near future	

*Current "Noise" technical documents by contracts

**Current EPA "Noise" technical documents

NOTE: *Documents are obtainable faster from NTIS than GPO*

APPENDIX B

MUNICIPAL NOISE CONTROL REGULATIONS

(January, 1973)

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
ALABAMA											
1 Birmingham	300,910		X'								
ALASKA											
2 Anchorage	48,081							X			
3 Juneau	6,050		X								
ARIZONA											
4 Flagstaff	26,177		X						X		
5 Phoenix	581,562		X						X		
6 Tucson	262,933	X		X							
ARKANSAS											
7 Little Rock	132,483		X								
CALIFORNIA											
8 Alhambra	62,125	X									
9 Anaheim	166,704		X								
10 Beverly Hills	33,416	X									
11 Burbank	88,871										X
12 El Segundo	15,620	X		X							
13 Freemont	100,869		X								
14 Hemet	12,252		X	X							
15 Inglewood	89,985	X		X						X	
16 Los Altos Hills	6,865							X			
17 Los Angeles	2,816,061		X	X		X			X		
18 Sacramento	254,413		X								
19 San Clemente	17,063		X								
20 San Diego	696,769	X									
21 San Francisco	715,674		X	X				X			
22 San Jose	445,779										X
23 Santa Barbara	70,215		X							X	
24 Santa Monica	88,289										X
25 Torrance	134,584			X							X

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
COLORADO											
26 Aspen	2,404	X		X				X			
27 Boulder	66,870		X	X							
28 Denver	514,678		X	X							
29 Dillon	182								X		
30 Lakewood	92,787		X	X				X			
CONNECTICUT											
31 Hartford	158,017		X				X				
32 New Haven	137,707		X	X							
DISTRICT OF											
33 COLUMBIA	756,510		X	X				X			
DELAWARE											
34 Wilmington	80,386		X						X		
FLORIDA											
35 Coral Gables	42,494		X	X							
36 Fort Lauderdale	139,590		X		X		X				
37 Madeira Beach	4,342		X								
38 Jacksonville	528,865			X							
39 Miami	334,859		X		X						
40 Orlando	97,565									X	
GEORGIA											
41 Atlanta	497,421		X								
42 College Park	18,203		X	X						X	
43 Macon	122,423		X		X						
44 Waycross	18,996		X								
45 Lake City	2,306		X								
IDAHO											
46 Pocatello	40,036	X		X				X			

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
ILLINOIS											
47 Chicago	3,369,359		X	X							
48 Des Plaines	57,239			X				X			
49 Park Ridge	42,466	X		X						X	
50 Peoria	126,963	X						X			
51 Northbrook	27,297					X					
52 Urbana	32,800	X		X							
53 Decatur	90,397		X						X		
INDIANA											
54 Indianapolis	745,739	X					X				
IOWA											
55 Des Moines	200,587		X						X		
KANSAS											
56 Wichita	276,534		X				X		X		
KENTUCKY											
57 Covington	52,535	X									
58 Louisville	361,472	X		X				X			
LOUISIANA											
59 New Orleans	593,471		X		X						
MARYLAND											
60 Baltimore	905,759	X		X							
MASSACHUSETTS											
61 Acton	14,770		X								
62 Boston	641,070		X	X				X			
63 Pittsfield	57,020		X	X				X			
64 Springfield	163,905		X	X							

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
MICHIGAN											
65 Ann Arbor	99,797		X	X			X	X			
66 Detroit	1,512,893		X								
67 Grand Rapids	197,649	X									
68 Wyoming	56,560	X									
MINNESOTA											
69 Bloomington	81,970			X		X					
70 Minneapolis	434,400		X	X			X				
MISSISSIPPI											
71 Jackson	153,968		X								
MISSOURI											
72 Independence	111,662			X							
73 Kansas City	507,330		X	X				X			
74 St. Louis	622,236		X								
MONTANA											
75 Billings	61,581		X								
76 Helena	22,730					X			X		
77 Missoula	29,497								X		
NEBRASKA											
78 Scottsbluff	14,507		X						X		X
NEVADA											
79 Las Vegas	125,787		X						X		
NEW JERSEY											
80 Absecon	6,094		X								
81 Asbury Park	16,533		X								

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
NEW JERSEY											
82 Bayonne	72,743		X								
83 Belleville	34,643	X		X							
84 Bloomfield	52,059		X								
85 Boonton	9,261	X		X							
86 Bordentown	4,490		X								
87 Brigantine	6,741		X								
88 Burlington	11,991		X								
89 Camden	102,551		X								
90 Cape May	4,392		X								
91 Clifton	82,437	X		X							
92 Clinton	1,742		X								
93 Corbin	258		X								
94 Dover	15,039		X								
95 E. Orange	75,471		X								
96 Elizabeth	112,654		X	X							
97 Fairlawn	37,975		X	X							
98 Gloucester	14,707		X	X							
99 Guttenberg	5,754		X								
100 Hammonton	11,464		X	X							
101 Hanover	10,700			X							
102 Harrison	11,811		X								
103 Hawthorne	9,173			X							
104 Hoboken	45,380			X							
105 Irvington	59,743			X							
106 Jersey City	260,545		X								
107 Long Branch	31,774		X								
108 Margate	10,576		X								
109 Morristown	17,662		X								
110 Newark	382,417		X								
111 Newton	7,297		X								
112 N. Wildwood	3,914		X								
113 Nutley	32,099		X								
114 Ocean City	10,575		X								
115 Orange City	32,566		X								
116 Paterson	144,824		X								
117 Perth Amboy	38,798		X								

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria Yes	NUISANCE Acoustical Criteria No	ZONING Acoustical Criteria Yes	ZONING Acoustical Criteria No	BUILDING Acoustical Criteria Yes	BUILDING Acoustical Criteria No	VEHICLE Acoustical Criteria Yes	VEHICLE Acoustical Criteria No	AIRCRAFT Acoustical Criteria Yes	AIRCRAFT Acoustical Criteria No
NEW JERSEY											
118 Plainfield	46,862		X								
119 Pleasantville	13,778		X								
120 Princeton	12,311	X		X							
121 Rahway	29,114		X	X							
122 Ridgefield Park	14,453		X	X							
123 Salem	7,648		X								
124 Secaucus	13,228		X								
125 S. Amboy	9,338		X	X							
126 Summit	23,620		X								
127 Trenton	104,638		X								
128 Vineland	47,399		X								
129 Westfield	33,720		X								
130 W. Orange	43,715		X								
131 Wildwood	4,110		X								
132 Woodbridge	78,846	X									
NEW HAMPSHIRE											
133 Manchester	87,754		X						X		
NEW MEXICO											
134 Albuquerque	243,751		X		X				X		
NEW YORK											
135 Albany	115,781				X						
136 Binghamton	64,123	X									
137 Buffalo	462,768		X						X		
138 New York	7,895,563		X	X	X						
139 Rochester	296,233		X								
140 White Plains	50,125		X						X		
141 New Rochelle	75,385		X						X		

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
NORTH CAROLINA											
142 Greensboro	144,076		X						X		
143 Raleigh	123,793		X								
NORTH DAKOTA											
144 Bismark	34,703		X								
OHIO											
145 Akron	275,425		X								
146 Cincinnati	452,524		X					X			
147 Cleveland	750,903		X						X		
148 Columbus	540,025		X	X							
149 Dayton	243,601		X	X							
150 Toledo	383,818		X								
151 University Heights	17,055		X								
OREGON											
152 Medford	28,454		X						X		
153 Portland	380,620		X		X					X	
OKLAHOMA											
154 Oklahoma City	368,856		X	X							
PENNSYLVANIA											
155 Philadelphia	1,950,098		X								
156 Pittsburgh	520,117		X						X		X
157 Scranton	103,564								X		
RHODE ISLAND											
158 Warick	83,694			X							

LOCATION	1970 POPULATION	NUISANCE Acoustical Criteria		ZONING Acoustical Criteria		BUILDING Acoustical Criteria		VEHICLE Acoustical Criteria		AIRCRAFT Acoustical Criteria	
		Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
SOUTH CAROLINA											
159 Columbia	113,542		X								
SOUTH DAKOTA											
160 Sioux Falls	72,488				X				X		
TENNESSEE											
161 Memphis	623,530		X								
162 Nashville	448,003			X					X		
TEXAS											
163 Dallas	844,401			X							
164 El Paso	322,261		X						X		
165 Houston	1,232,802		X								
166 Irving	97,457			X		X					
167 Killeen	35,507		X						X		
168 San Antonio	654,153		X								
UTAH											
169 Ogden	69,478								X		
170 Salt Lake City	175,885	X									
VIRGINIA											
171 Norfolk	307,951		X								
172 Richmond	249,621		X		X						
WASHINGTON											
173 Seattle	530,831		X					X			
WISCONSIN											
174 Madison	173,258		X						X		
175 Milwaukee	717,372		X			X					
TOTAL											
175	47,208,593	24	124	53	9	8	4	15	27	7	6

Appendix C
NOISE WORKSHOPS
for
PUBLIC OFFICIALS

NOISE WORKSHOP FOR PUBLIC OFFICIALS

	1. REGION X, SEATTLE	MAY 19-20, 1972
	2. "PILOT," KANSAS CITY	SEPTEMBER 11-12, 1972
	3. REGION IX, SAN FRANCISCO	DECEMBER 10, 1972
	4. REGION IV, ATLANTA	DECEMBER 19-20, 1972
*	5. REGION VIII, DENVER (Held Salt Lake City)	APRIL 24-25, 1973
	6. REGION II, NEW YORK CITY (Albany)	JUNE 20-21, 1973
*	7. REGION VIII, DENVER (Helena, Montana)	JULY 24-25, 1973
	8. REGION I, BOSTON (Waltham, Mass.)	OCTOBER 23, 1973
	9. REGION II, NEW YORK CITY	NOVEMBER 28-29, 1973
*	10. REGION VIII, DENVER (North Dakota)	FY'74
*	11. REGION VIII, DENVER (Denver)	FY'74
	12. REGION II, SAN JUAN, P.R.	JANUARY 23-25, 1974
	13. REGION III, PHILADELPHIA	FY'74
	14. REGION VI, DALLAS	FY'74
	15. REGION IX, SAN FRANCISCO	FY'74
	16. REGION X, SEATTLE	FY'74
	17. REGION IV, ATLANTA	FY'74
	18. REGION VII, KANSAS CITY	MARCH 20, 1974

*CONDUCTED WITHOUT ABN SUPPORT

APPENDIX D

EPA GENERAL COUNSEL MEMORANDUM OF AUGUST 24, 1973 RE:

PREEMPTION UNDER THE NOISE CONTROL ACT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

SUBJECT: Preemption Under the Noise Control Act DATE: August 24, 1973

FROM: Anthony O. Garvin, Attorney
Air Quality & Radiation Division

TO: Dr. Alvin Meyer
Deputy Assistant Administrator
Office of Noise Abatement and Control

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Question

What is the preemptive effect of regulations issued under the regulatory sections of the Noise Control Act?

Answer

Section 6:

Once a noise emission regulation has been promulgated by EPA pursuant to §6 of the Noise Control Act, the authority of states and local governments to adopt or enforce limits on noise emissions for new products is preempted, unless the state or local regulation is identical to that adopted by the Administrator. States and localities may control environmental noise by regulating the use of any product, including a product covered by Federal noise emission regulations. However, state restriction on use which is so broad as to be effectively a restriction on the sale of a new product probably would be invalid.

Section 7:

The authority of states and localities to control aircraft noise through their police power has been completely preempted by the Federal Aviation Act and the Noise Control Act. There is still some question regarding the extent to which airport operators can regulate airport noise through their proprietary authority.

Section 8:

After the effective date of Federal labeling regulations adopted under § 8, states are only prohibited from regulating labeling in a manner which conflicts with Federal requirements.

Section 17 and 18:

On their effective dates, the noise emission regulations adopted by EPA pursuant to § § 17 or 18 preempt the authority of states and local governments to regulate noise emissions resulting from the operation of interstate railroads or interstate motor carriers, unless the state or local regulation is identical to that adopted by EPA. States and localities may, however, regulate the levels of environmental noise or control the use of any product if the Administrator determines the state or local regulation is necessitated by special local conditions and is not in conflict with regulations promulgated under §§17 or 18.

Discussion

Section 6:

Section 6(a) of the Noise Control Act directs EPA to prescribe noise emission standards applicable to new products which are major sources of noise, for which noise standards are feasible and which fall into one of the following categories: 1) construction equipment; 2) transportation equipment (including recreational vehicles and related equipment); 3) any motor or engine (including any equipment of which an engine or motor is an integral part); 4) electrical or electronic equipment.

Section 6(b) authorizes the Administrator to adopt regulations for other products for which noise emission standards are feasible and necessary to protect public health and welfare.

Section 6(e) (1) provides that the noise emission regulations adopted under §6 shall have the following preemptive effect:

> No State or political subdivision thereof may adopt or enforce--
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> (A) with respect to any new product for which a regulation has been prescribed by the Administrator under this section, any law or regulation which sets a limit on noise emissions from such new product and which is not identical to such regulation of the Administrator; or
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> (B) with respect to any component incorporated into such new product by the manufacturer of such product, any law or regulation setting a limit on noise emissions from such component when so incorporated.
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> (2) Subject to sections 17 and 18, nothing in this section precludes or denies the right of any State or political subdivision thereof to establish or enforce controls on environmental noise (or one or more sources thereof) through the licensing, regulation, or restriction of the use, operation, or movement of any product or combination of products.

It is clear from the Act that after the promulgation of Federal regulations, no State or city may adopt or enforce any noise emission regulation applicable to any new product unless such regulation is identical to the Federal regulation. Prior to the promulgation of Federal regulations by EPA there is no restriction on State or local regulation. Even after promulgation of EPA regulations covering a product, States and municipalities retain wide authority to control noise resulting from the use of the same product. Techniques available for this purpose include: speed and load limits, curfews on the use of noisy products, zoning restrictions, boundary line restrictions and similar restrictions.

There are still unresolved questions concerning the extent of State authority under the Act. For example, it is not clear to what extent States and municipalities can prescribe decibel limits on the use of products once they are in the hands of consumers. Although § 6(e) (2) of the Act seems to leave the States with unlimited authority to regulate use of products, a decibel limit on use of a product is effectively a prohibition on the sale of such a product with higher decibel emissions when the noise emitted is not within the control of the user. For example, consumers will be reluctant to purchase a snowmobile that emits more than 85 decibels in a State which prohibits the use of any snowmobile which emits more than 85 decibels. A similar effect would result from State regulations that prohibited the use of a product meeting Federal noise standards in a way or at the times such a product is ordinarily used, unless the product met lower noise levels.

Unfortunately, the legislative history of § 6(e) is somewhat ambiguous regarding the propriety of use regulations which have the practical effect of emission limitations. The preemption provision of § 6 was proposed in approximately its final form as § 6(d) of the House Bill, H.R. 11021. The House Report explained the preemptive operation of that section as follows:

> Section 6 of the Committee's bill affects the authority of States and political subdivisions over noise emissions only in one respect: States and local governments are preempted from prescribing noise emission standards for new products to which Federal standards apply, unless their standards are identical to the Federal standards. A similar provision applies to component parts. For products other than new products to which Federal standards apply, State and local governments attain exactly the same authority they would have in the absence of the standards setting the provisions of the bill. The authority of State and local government to regulate use, operation, or movement of products is not affected at all by the bill.
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> Nothing in the bill authorizes or prohibits a State from enacting State law respecting testing procedures. Any testing procedures incorporated into the Federal regulations must, however, be adopted by the State in order for its regulations to be considered identical to Federal regulations.
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> Localities are not preempted from the use of their well-established powers to engage in zoning, land-use planning, curfews and other similar plans. For example, the recently enacted Chicago Noise Ordinance provides that heavy equipment for construction may not be used between 9:30 p.m. and 8:00 a.m. within 600 feet of a hospital or residence except for public improvement or public service utility work. The ordinance further provides that the motor of a vehicle in excess of 4 tons standing on private property and within 150 feet within residential property may not be operated for more than two consecutive minutes unless within a completely enclosed structure. Such local provisions would not be preempted by the Federal government by virtue of the purported bill. H. Rep. No. 92-842, 92nd Cong., 2d Sess., at 8-9.

The reference in the House Report to the Chicago ordinance indicates that States and localities are free to prohibit the use of noisy products during specified hours.

Although the report does not indicate whether States can completely prohibit all uses of a noisy product, a statement made by Congressman Rogers in response to a question raised by Congressman Eckhardt indicates that a total prohibition is permissable. Congressman Rogers is chairman of the subcommittee which held hearings on the noise legislation. The following exchange took place:

> Mr. Eckhardt. Now suppose the State of Texas should attempt to accomplish essentially the same thing as the [hypothetical] New York statute concerning pile drivers was intended to accomplish, but suppose the Texas statute controlled use instead of production or assembly. Thus, Texas provides that no pile driver shall be used within the confines of the State of Texas which has a noise emission level above a certain number of decibels. Could the State so regulate?
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> Mr. Rogers. Yes. Though a noise emission limit is provided, it is not applied in the area this bill is designed to control; that is, primarily the manufacture of equipment with a certain noise potential. The preemption provision in section 6(d) (1) [now 6(e) (1)] applies only to State regulation of "new products" and "new product" is defined in section 3.
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> Of course, we do know all of this would have to bear any constitutional overview as to the commerce clause and requirements that statutes be reasonable and not a burden on interstate commerce. (Cong. Rec., p. H1515, February 29, 1972).

This discussion supports the proposition that States can prohibit the use of products regardless of the effect on sales of new products.

On the other hand, the legislative history of the preemption provision in the Senate provides some support for the opposite position. Section 408(d) of the Senate bill prohibited, after the effective date of a Federal standard, any State or local standard on noise emissions of a product which was "enforceable against the manufacturer". (See 118 Cong. Rec. S17745-46, October 12, 1972). The prohibition of only those local regulations which are "enforceable against the manufacturer" suggests that States may set use limits which discourage the sale of new products which emit noise in excess of the local regulation. However, in the report of the Senate Committee on Public Works which accompanied the bill to the Senate floor, the Committee stated:

> Subsection 408(d) of the bill deals with the responsibilities of the Federal government and State and local governments in controlling noise. For any product manufactured after the effective date of an applicable Federal standard, authority to establish noise emission standards for the manufacturer is preempted. States and cities, however, retain complete authority to establish and enforce limits on environmental noise through the licensing, regulations, or restriction of the use, operation, or movement of a product, or concentration or combination of products.
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> It is the intention of the Committee to distinguish between burdens which fall on the manufacturers of products in interstate commerce and burdens which may be imposed on the users

of such products. In the judgment of the Committee, noise emission standards for products which must be met by manufacturers, whether applicable at the point of introduction into commerce or at any other point, should be uniform.

. . . .

At a minimum, States and local governments may reach or maintain levels of environmental noise which they desire through (a) operation limits or regulations on products in use (such as speed or load limits or prohibitions of use in given areas or during given hours); (b) quantitative limits on environmental noise in a given area which may be enforced against any source within the area, including zones adjacent to streets and highways; (c) regulations limiting the environmental noise which may exist at the boundary of a construction site; (d) nuisance laws; or (e) other devices tailored to the needs of differing localities and land uses which do not amount to a burden manufacturers must meet to continue in business. Sen. Rep. No. 92-1160, 92nd Cong., 2d Sess., at 7-8.

The references in the Senate report to preemption of standards enforceable "indirectly against the manufacturer" and of standards "which must be met by manufacturers, whether applicable at the point of introduction into commerce or at any other point" suggest that the Senate did not intend to permit the States to set standards which would discourage or eliminate the sale of new products meeting Federal standards.

The preemptive language of § 6(e) as finally adopted reflects the broad language of the House bill. Unfortunately, there was no discussion of the meaning of the final preemptive language. The incorporation of the broad language of the House bill implies that the section should be given an interpretation that is consistent with the statement made by Congressman Rogers. On the other hand, the deletion of the language in § 6(e) (1) of the Senate bill which had limited preemption to State regulations "enforceable against the manufacturer" suggests that the final Act preempts use regulations which would *indirectly* eliminate or discourage sales of new products.

Since the legislative history of § 6(e) is somewhat ambiguous it is difficult to predict with any certainty how the courts would construe the preemptive provisions. However, a case which will undoubtedly influence the determination is *Allway Taxi, Inc. v. City of New York*, 340 F. Supp. 1120 (S.D. N.Y. 1972). In that suit several corporations challenged a New York City ordinance which required taxicabs to be equipped with emission control devices. The ordinance was challenged on the ground that it violated § 209 of the Clean Air Act which prohibits States from regulating exhaust emissions for new motor vehicles. Section 209(c), however, expressly authorized State use regulations in language very similar to § 6(e) (2) of the Noise Control Act:

(c) Nothing in this part shall preclude or deny to any State or political subdivision thereof the right otherwise to control, regulate, or restrict the use, operation, or movement of registered or licensed motor vehicles.

Moreover, § 213(3) of the Clean Air Act defined the term "new motor vehicle" as a motor vehicle "the equitable or legal title to which has never been transferred to an ultimate purchaser". (The definition of "new product" in §3(5) (A) of the Noise Control Act is identical). Even though the city emission limitation may have indirectly discouraged the sale of new motor vehicles as taxicabs, the court held that the ordinance was not preempted by §209 of the Clean Air Act. However, the court warned that the imposition of State emission standards immediately after a new car is bought and registered "would be an obvious circumvention of the Clean Air Act and would defeat the Congressional purpose of preventing obstruction to interstate commerce." On the other hand, the court stated that State emission requirements "upon the resale and reregistration of the automobile" or "for the licensing vehicles for commercial use within that locality" would not be preempted.

Thus the Court in *Allway Taxi* recognized that a restriction which does not apply before or at the sale may have such an adverse effect upon sales as to be invalid under the preemption provisions relating to "new motor vehicles." Yet the Court found no such effect even when all taxicabs in New York City were subject to the local restriction. Other cases have tended to construe preemptive provisions narrowly.*

We conclude that broad State and local use restrictions are permissible under §6, but that use restrictions which effectively discourage the sale of all new products covered by Federal regulations would probably be invalid. Because the practical effect of a use restriction rather than the "nature" of the restriction will probably be determinative, the validity of such restrictions will have to be considered in light of the extent of the restriction, the ordinary use of the product, the effect of the restriction on interstate commerce, and related facts. No general rule is possible.

Section 7:

Section 7(b) of the Noise Control Act, which amends § 611 of the Federal Aviation Act, provides that the FAA, after consulting with EPA, shall provide "for the control and abatement of aircraft noise and sonic boom, including the application of such standards and regulations in the issuance, amendment, modification, suspension or revocation of any certificate authorized by [the Federal Aviation Act]." Although §611 of the Federal Aviation Act does not contain any preemptive language, the Supreme Court of the United States in the City of *Burbank v. Lockheed Air Terminal, Inc.*, U.S. 93-S.Ct. 1854 (1973), held that the pervasive nature of Federal regulation of aircraft noise preempts the authority of States and local jurisdictions to adopt or enforce regulations controlling aircraft noise under their police power. At issue in that suit was the validity of an ordinance of the City of Burbank which prohibited jet aircraft from taking off between the hours of 11 p.m. and 11 a.m. from an airport owned by Lockheed. Although the Court recognized that the control of noise has traditionally been within the police power of the States, the Court held that the pervasive control vested in EPA and the FAA under the Noise Control Act "seems to us

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*See, e.g., *Askew v. American Waterways Operators, Inc.*, ___ U.S. ___, 93 S. Ct. 1590 (1973); *Chrysler Corp. v. Tofany*, 419 F.2d 499 (2d Cir., 1969); *Exxon Corp. v. City of New York*, ___ F.Supp. ___, Civ. No. 73-1093 (S.D.N.Y. 1973).

to leave no room for local curfews or other local controls." The opinion further declared that a uniform and exclusive system of Federal regulation is necessary because of the interdependence of safety and the control of noise pollution.

In light of the recent decision in *City of Burbank v. Lockheed Air Terminal, supra,* it is clear that State and local governments are completely preempted from adopting or enforcing regulations to control aircraft noise under their police power. The authority of States and local governments is preempted whether or not the Federal government has in fact adopted any regulations controlling aircraft noise.

However, in a footnote to the majority opinion, Justice Douglas suggested that localities may have proprietary authority as airport owners to control airport noise.* Since Justice Douglas failed to indicate the types of measures that could be taken by airport operators under their proprietary authority, it is impossible at this time to determine whether the police power-proprietary distinction is really meaningful. The fact that Justice Douglas reserved the right to rule upon "what limits if any apply to a municipality as a proprietor" suggests that the proprietary authority may also be held in the future to have been preempted by the pervasive nature of Federal airport noise regulations.

Section 8:

Section 8 authorizes Federal noise labeling requirements for products which emit noise capable of adversely affecting the public health or welfare or which are sold on the basis of their effectiveness in reducing noise. Section 8(c) provides:

> This section does not prevent any State or political subdivision thereof from regulating product labeling or information respecting products in any way not in conflict with regulations prescribed by the Administrator under this section.

Section 8 thus leaves the States with considerable power in the area of labeling. Prior to the promulgation of Federal labeling requirements, States and municipalities may regulate labeling in any manner desired. After the effective date of Federal regulations, States are only prohibited from regulating labeling in a way which conflicts with Federal requirements. Thus, for example, a Federal regulation requiring manufacturers to place a label on the product specifying the noise emission level of the product in decibels would not preclude a State regulation requiring manufacturers to indicate that the high noise level might impair the buyer's hearing after a specified amount of time near the product. The States, therefore, have wide authority in this area.

Sections 17 and 18:

Sections 17 and 18 direct the Administrator to promulgate noise emission regulations for interstate railroads and interstate motor carriers. Noise emission regulations adopted by EPA pursuant to § § 17 and 18 must include limits on noise emissions that are based upon "best available technology, taking into account the cost of compliance."

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*_____ U.S. _____, 93 S.Ct. 1854, at 1861 n. 14.

Section 17(c) (1) provides for Federal preemption in the following language:

> . . . . After the effective date of a regulation under this section applicable to noise emissions resulting from the operation of any equipment or facility of a surface carrier engaged in interstate commerce by railroad, no State or political subdivision thereof may adopt or enforce any standard applicable to noise emissions resulting from the operation of the same equipment or facility of such carrier unless such standard is identical to a standard applicable to emissions resulting from such operation prescribed by any regulation under this section.

The preemptive provision of § 18(c) (1) is nearly identical to that of § 17(c) (1) except that § 18(c) (1) prohibits state and local regulations "applicable to the same operation of such motor carrier" while § 17(c) (1) forbids the adoption of regulations "applicable to noise emissions resulting from operation of the same equipment or facility of such carrier." Since the legislative history does not indicate whether the use of different phrases was intentional, the words of each section should be construed literally.

Section 17(c) (1), therefore, preempts only regulations that apply to "operation of the same equipment or facility." However, this leaves open the question whether local regulation of greater or smaller units of equipment or facilities than are covered by Federal regulations would be preempted. For example, if Federal standards exist for locomotives, can local governments regulate brake noise or noise from the entire train?

Section 18(c) (1) applies to all State and local regulations applicable to the "same operation" covered by Federal regulations. The question here is what is the "same operation" of a motor carrier? For example, it is not clear whether EPA, by the adoption of noise emission standards for those trucks with a gross vehicle weight rating over 10,000 pounds, has preempted the States from regulating the operation of trucks weighing less than 10,000 pounds.

In our opinion, the question of what is the "same operation" or "operation of the same equipment or facility" will be influenced greatly by EPA statements concerning what it believes its regulations cover. Therefore, EPA should state [when promulgating regulations] what particular operation or equipment it intends to cover by its regulation. For example, if EPA promulgates a regulation under § 18 limiting noise emissions only from trucks over 10,000 lbs., it should state the reason it did not regulate noise emissions from trucks under 10,000 lbs. EPA should indicate whether it believes that such trucks do not need regulation, in which case there should be preemption, or whether noise from such trucks is essentially a local problem, in which case there should not be preemption.

The position that EPA's statements will be controlling is supported by *Chrysler Corporation v. Tofany*, 419 F. 2d 499 (2d Cir. 1969). In *Tofany*, the U. S. Court of Appeals had to interpret the preemptive language of the Federal Motor Safety Act, which is similar to §§ 17(c) (a) and 18(c) (1). Section 1392(d) of the Federal Motor Vehicle Safety Act provides:

> Whenever a Federal motor vehicle safety standard established under this subchapter is in effect, no State or political subdivision of a State shall have any authority either to establish,

or to continue in effect, with respect to any motor vehicle or *item of motor vehicle equipment* any safety standard applicable to the *same aspect of performance* of such vehicle or item of equipment which is not identical to the Federal standard. (emphasis added.)

The Court interpreted the phrases "item of motor vehicle equipment" and "same aspect of performance" narrowly. The court concluded that Federal regulation of lighting generally did not preclude State regulation of a specific type of auxiliary lighting. In reaching this conclusion, the court heavily relied on the fact that the Federal Highway Administration never intended to deal with that specific type of auxiliary lighting. The court quoted the decision of the U.S. Supreme Court in *Thorpe v. Housing Authority of Durham,* 393 U.S. 268, 276, 89 S.Ct. 518, 523 (1969), for the proposition that the administrative interpretation of a regulation is controlling unless plainly erroneous. *Tofany and Thorpe* thus indicate that EPA's statements regarding the preemptive effect of regulations implementing § § 17 and 18 will be controlling. However, EPA's statements will not be dispositive if a court believes that the State or local regulations impose an undue burden upon interstate commerce.

Assuming that a State or local regulation would be preempted by the terms of § § 17(c) (1) or 18(c) (1), a State or locality may apply for an exemption under § § 17(c) (2) or 18(c) (2). Sections 17(c) (2) and 18(c) (2) provide in identical language as follows:

> Nothing in this section shall diminish or enhance the rights of any State or political subdivision thereof to establish and enforce standards or controls on levels of environmental noise, or to control, license, regulate, or restrict the use, operation, or movement of any product if the Administrator, after consultation with the Secretary of Transportation, determines that such standard, control, license, regulation, or restriction is necessitated by special local conditions and is not in conflict with regulations promulgated under this section.

The term "not in conflict" must be construed in accordance with the purpose of §17(c) and §18(c), *i.e.* to avoid undue burdens on interstate commerce.* Thus § § 17(c) (2) and 18(c) (2) determinations will have to be made by balancing local needs against the impact local regulation will have on interstate commerce. In view of recent judicial decisions affecting EPA actions, we believe that any reasonable determination by the Administrator which takes both of these factors into account will be sustained *if* the Administrator clearly articulates his reasoning.

*Congress' intent in enacting the preemption sections was clearly to minimize the burden on interstate commerce. See 118 Cong. Rec. S17777, S18002-03 (October 12 and 13, 1972).

Thus, EPA can to a great extent control the preemptive effect of its regulations under § § 17 and 18 by (1) explaining the preemptive effect EPA believe its regulations should have and (2) granting exemptions under § § 17(c) (2) and 18(c) (2).

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