

## The Emperor Is Naked and Annoyed by Airplanes Flying over His Castle

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"He's isn't wearing any clothes!," cried the little boy. "The emperor is as naked as the day that he was born." Sometimes we ignore the obvious, be it royal haberdashery or environmental sound metrics. Perhaps that is what has happened with the evaluation of community response to environmental noise.

For many years now, land-use planning has incorporated long-term average sound levels under the tacit assumption that:

1. There is a direct relation between community acceptance and average sound level, and
2. Annoyance is related to integrated sound level or sound exposure.

Ask any resident living in the vicinity of an active airport what produces the most annoyance: an individual flight, the total number of flights, or the background sound level. The answer is easily predicted. "It's the overflight, stupid!" Just as the little boy in the story, the public knows the real state-of-affairs.

So here we stand telling these people they shouldn't be upset about overflights from regional airports or noise from new highway projects because the average annual sound level doesn't exceed a certain criterion. Meanwhile, they argue with the bureaucrats, petition their representatives and tell anyone who will listen that it doesn't matter what the average sound level is – *the noise is unacceptable*. How did we get into this state of affairs?

The introduction to American National Standard S12.9-1996, Quantities and Procedures for Description and Measurement of Environmental Sound – Part 4: Noise Assessment and Prediction of Long-term Community Response, provides some of the answers. We are told in one paragraph that, "The 1978 seminal paper by T. J. Schultz demonstrated the efficacy of the day-night average sound level  $L_{dn}$  for predicting the annoyance response of a community as a result of noise from highway traffic, railroad, aircraft and some industrial sites." In the early 1970s, the Environmental Protection Agency adopted annual  $L_{dn}$  as a predictor of community response to (stationary) noise sources. The Agency recommended  $L_{dn} \leq 55$  dB in residential areas. Indeed, this approach has served well in many instances, particularly in the case of continuous noise sources. Comparison of sound emissions with ambient levels, especially using octave band inputs, has enabled acousticians to predict community response and to design sites which produce a minimal impact on surrounding residences. This scheme has not worked well, however, in instances where there are less stable noise sources contributing periodic excursions substantially above the background level.

This discrepancy was addressed in a recently published paper by Fields in the *Journal of the Acoustical Society of America* (1998; 104 (4)). Fields reexamined 363 community noise surveys

which provided the basis for previous conclusions regarding the relationship between annoyance and intruding sound. His reanalysis, based on the quality of the study, the quantification of background and intruding noise and the types of questions asked in the surveys, led him to conclude that there is little relationship between the annoyance of intermittent sounds and the background level in which they are heard.

This is consistent with public reaction around airports and other transportation noise sources. People do not react to the average sound level over a year but rather, they are affected by the interference with speech or other activities that occur during the single noise event. It seems appropriate at this juncture to incorporate single event metrics into criteria for annoyance and land use planning. In fact, Part 4 of ANSI standard S12.9 includes descriptors for single-event sounds. These include the peak frequency-weighted sound pressure level, the maximum exponential time-weighted sound pressure level and the sound exposure level. There may be other single-event metrics which are also be appropriate in certain situations.

I encourage the acoustical community to include measurement of single noise events when updating environmental and community noise standards and also encourage regulatory agencies as well to recognize their potential utility. **SV**

# Developing Rational Environmental Noise Standards

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**Environmental noise limit criteria for residential communities must serve the dual purposes of providing both a predictable and acceptable acoustical environment and feasible regulations for developers to follow. The development of such criteria for a residential township in New Jersey is presented and compared with State regulations.**

Noise control along interstate highway corridors has become an obvious acoustical issue due to increased highway traffic. Freeways have reduced commuting time and made it feasible for many people to live in rural areas yet still work in the city. Suddenly, noisy intrusions that were tolerated or, perhaps, not even noticed in a traditional suburban setting have become an annoyance.

Short noise events may be a distraction and continuous noise sources may be unacceptable. On the other hand, rural residents with long-standing needs continue activities such as farming which may require use of noise-producing equipment. The value of property with the potential for development also needs to be protected from arbitrary utilization restrictions. Guidance must be available which allows reasonable development while protecting other residents from unreasonable intrusions.

In New Jersey there are large differences in the acoustical environment from one part of the state to another. For many years, the State government has used a single limit compliance regulation as a *de facto* planning guide for new project approvals. This standard established daytime and nighttime limits for the level of noise that can be emitted to residential and to commercial (as distinct from industrial) land uses by commercial and industrial sound sources. All property is subject to the same daytime limits of 65 dB(A) and nighttime limit of 50 dB(A) for residential property without regard to ambient conditions. In theory, a commercial source may not produce more than 50 dB(A) near a residence alongside a heavily traveled highway at night but it could produce 50 dB(A) at a rural residence where the nighttime ambient is 30 dB(A).

To understand how different acoustical environments throughout the state can be, consider one township which encompasses several types of land uses – from farming to commercial and industrial. The Township recently undertook a survey to document sound levels prior to deciding whether to write a Township Noise Regulation. Typical background A-weighted sound levels found in the township and at an urban location are shown in Table 1. Differences in residential nighttime levels are about 20 dB, equivalent to a difference of four times in the loudness of the environment.

Noise regulation by the State has neither provided adequate guidelines for development nor protection of the diverse acoustical environments which exist throughout the State. The regulation is silent on the fact that the ambient sound levels differ throughout the State. For this reason, limits stipulated are over-protective of the urban resident while leaving rural residents open to development which conceivably could raise existing ambient levels by 20 dB.

## Reconciling the Positions

Defensible management of environmental noise depends on the capability to demonstrate that a proposed regulation is based on criteria that reflect the nature of the environment to be protected and that the chosen standards can be achieved. If a criterion is set too low, it may be difficult to enforce because

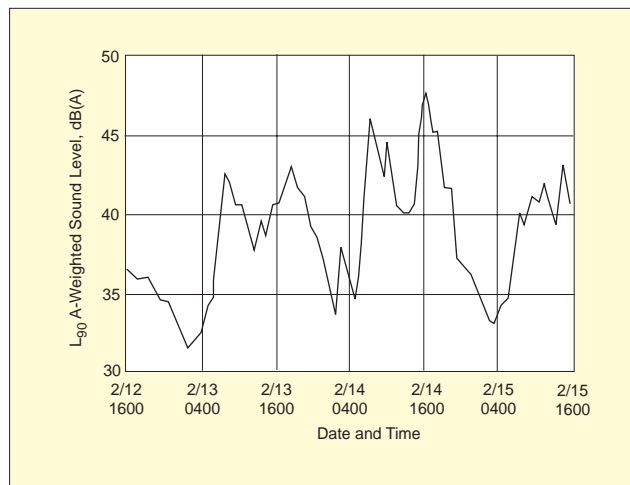


Figure 1. Typical ambient sound levels.

regulated emissions may be overwhelmed by the ambient noise environment. Therefore, low criteria are easily challenged. There are several steps to achieve reasonable criteria.

First, determine existing ambient sound levels at typical locations to be regulated. A sound survey will provide data to establish rational minimums. It should be designed to evaluate sound levels over a period of several days, preferably during the season in which they will be lowest to identify the lowest levels to be preserved. Typical data from an ambient noise survey are shown in Figure 1. These  $L_{90}$  data show sound levels that were exceeded 90% of the time during each observation period.

Second, select a criterion that either allows a minimal increase in the background level or one that is based on an absolute level that will allow for some acceptable increase in the ambient sound level. The acceptable change in ambient level could be chosen to be 'none.' Recognize, however, that this effectively sets the criterion emission to 10 dB below the ambient if  $L_{eq}$  is chosen as the metric upon which the criterion is based.

Third, recognize that there may be areas in which there are widely different noise environments. Activities in one, such as in the commercial section of town, must be accommodated while the quiet rural environment in other areas must be protected. Therefore, criteria must be established not only in terms of level but also in terms of region. Frequently, regions can be defined on the basis of existing zoning.

Fourth, anticipate noise sources that should be exempted because they are considered necessary or beneficial. Examples of such noise sources are fire warning signals, public parades, celebrations and public works to protect health and safety. Other common sources that may be the subject of special limitations are sources such as residential air conditioners.

Fifth, standards should incorporate measures of sound which can be quantified. Prohibiting "barking dogs which annoy a

Table 1. Typical background A-weighted sound levels.

Location	Night	Day
Urban Residential . . . . .	54 dB	60 dB
Township Commercial . . . . .	42 dB	51 dB
Township Residential . . . . .	35 dB	40 dB

reasonable person” depends on interpretation of “annoyance” and “reasonable person” by an adjudicating official. It is less as a design criterion. Limiting dog barking to a measurable level consistent with other regulated noise avoids these problems.

Finally, develop a plan for enforcing the regulation. Training and education of person(s) who would enforce the regulations must be stipulated.

### Township Solution

In the Township, a decision was made to adopt a somewhat complex criterion based on the realization that practical sound limits must recognize that there will be brief high-level events which, if infrequent, will not be disruptive to the environment. Disruptive, high-level noise events occurring frequently or for long duration, would not be allowable.

Three noise zones were established: rural residential – includes all residential property not in the village commercial area or in research office park areas; residential – includes all residential uses in the village, commercial, research or office park zones; and commercial/public service – includes village commercial areas, office park areas and research park areas. Both average sound levels over a 15 min period and  $L_{90}$  background sound levels are stipulated for each of the “noise zones.” To achieve this goal, the limits were addressed in three parts. Table 2 lists the overall background sound level limits  $L_{90}$  and average sound levels  $L_{eq}$  which further limit short duration sound levels. Impulsive sound limits  $L_{pk}$  were also adopted as shown in Table 3 to limit the maximum level of any sound no matter how brief.

An objective of the Noise Ordinance was not to penalize occasional sound in excess of the  $L_{90}$  criterion but to establish an absolute limit on how intense a sound could be. Therefore, the impulsive limits stipulate that no sound may exceed the levels shown in Table 3.

Comparison of the limits established for the Township with limits established by the State of New Jersey Regulation during the day are shown Figure 2. If a short, intensive sound existed for a brief duration, say 3 sec in 15 min, its average level would be quite low. As the duration of the sound increases, the level must decrease to keep the average level constant. This change with duration is shown in Figure 2 as the “ $L_{eq}$  Limit.” At approximately 30 sec duration, the  $L_{eq}$  limit and the New Jersey State limit are equal. As duration continues to increase, the allowable level decreases until 90 sec is reached. Because the Ordinance metrics are based on 15 min periods (900 sec) any sound level that exists for 90 sec determines the background level  $L_{90}$ . Therefore, the  $L_{90}$  limit governs the allowable sound level for durations greater than 90 sec. For this reason, there is a sharp decrease in the allowable sound level at this point. From 30 sec onward, the Township Ordinance is as much as 20 dB more restrictive than the New Jersey State Noise Regulation.

At night (Figure 3), 90 sec of the 15 min period in the rural zone is more permissive than the State noise regulation. Following these times, the levels permitted in the Township are

Table 2. Permissible sound levels in dB, A-weighted.

Receptor	Day		Night	
	$L_{90}$	$L_{eq}$	$L_{90}$	$L_{eq}$
Rural Residential . . . . .	45	50	40	45
Residential . . . . .	55	60	45	50
Noise Sensitive Commercial Public Service or Community Service . . . . .	60	65	60	65

Table 3. Permissible impulsive noise levels in dB linear.

Receptor	Impulsive Limit	
	Day	Night
Rural Residential . . . . .	75	70
Residential . . . . .	85	75
Commercial . . . . .	90	90

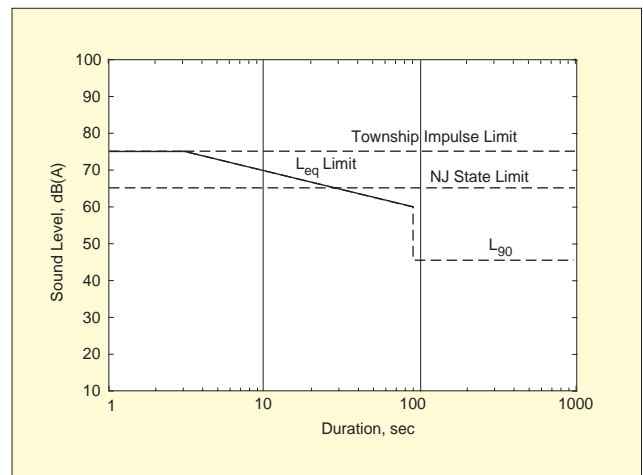


Figure 2. Permissible sound levels - township rural daytime.

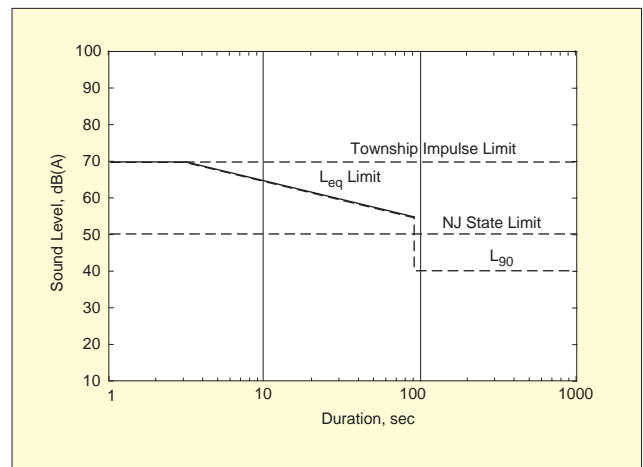


Figure 3. Permissible sound levels - township rural nighttime.

10 to 15 dB more restrictive than those permitted by the State.

### Consequences of Regulation

How then does the Ordinance preserve the acoustical environment? It maintains the average sound levels over a selected period of time (15 min) while providing for a few higher level excursions.

1. Permissible limits are based on a survey of existing ambient sound levels in the Township. During the daytime, the allowable levels are similar to existing levels for 97% of the time. The night limits are similar to or more restrictive than the existing levels for 90% of the time.

2. The Ordinance is more restrictive for background sound levels  $L_{90}$ , than the State of New Jersey limits. During the daytime, the Township limits are 20 dB more restrictive whereas at night they are 10 dB more restrictive. The New Jersey limits are 15 dB lower at night than they are during the day.

3. The Ordinance recognizes the practical aspects of regulating noise. For example, it allows for a truck to be moved from the road where it is unregulated to a property where noise can be controlled. Without the allowance of a short duration high-level noise omission from a property, this could not be accomplished without violating the noise regulation. This ordinance allows for such truck movement from the road to the property where it can be controlled without violating the law. However, it does not allow a continuous stream of trucks to transit from the road to the property.

Because the metrics used in the Ordinance differ in some respects from those of the State regulation, the training required for enforcement personnel is more extensive. The Rutgers Noise Control Course, on-the-job-training with the New Jersey DEPE (Department of Environmental Protection and Enforcement) or other equivalent experience provides the spe-

cialized training required to deal with statistical noise measurements. Essentially, this training is needed to develop an understanding that short measurement samples are unacceptable and to become proficient with sound level meters that can produce statistical noise measurements.

### Summary

Criteria for permissible noise levels must serve the dual purposes of providing both a stable acoustical environment and guidance regarding feasible regulations for developers to follow. These criteria should be based on existing noise levels at the sites to be impacted and should be viewed in terms of maintaining the tranquility of the place rather than as an impediment to development.

Establishing a single criterion to limit noise to the same level everywhere does not achieve these goals. Rather, it effectively protects a narrow segment of the population while overprotecting or underprotecting the majority. The part of the population

that is inadequately protected recognizes this fact and will vocally oppose projects that agreed to "meet the State limit." Effectively, a single level limit is, for this reason, an anathema to development and subject to reasonable challenge. In cases where the limit is overprotective, it cannot be defended.

Criteria for noise limits can be developed that are both protective and do not impede appropriate development, as demonstrated by the Township. Within the Township are three zones in which the acceptable noise limits vary according to existing uses and ambient levels. Accommodation of the needs of commercial activities is accomplished by allowing short duration excursions above the background sound level which provide time to move mobile noise sources between/to locations where the noise can be controlled. For this approach to be effective, each community must evaluate its goals for preserving the acoustical environment and must choose criteria accordingly. **SV**