



Developing a Comprehensive Construction Noise Specification

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ABSTRACT

As acoustical engineers, we are often asked to develop community noise-related guidelines, regulations, laws, ordinances, and project specifications. This paper will describe the ingredients needed to develop a robust and defensible construction noise specification that is both enforceable and effective. It will be based on the author's past and current experiences developing such specifications, including those used for the Big Dig project in Boston, FHWA's construction noise handbook, the New York City construction noise regulation, as well as dozens of large-scale construction projects across the country. The goals of proactive and reactive noise control and the difference between a performance-based versus a prescriptive-based specification will be explained, community noise criteria will be suggested, and examples will be provided for important clauses in such a specification. Lastly, a listing of "lessons learned" over the decades are provided.

1. INTRODUCTION

As acoustical engineers, we are often asked to develop community noise-related guidelines, regulations, laws, ordinances, and project specifications with respect to construction noise. The public and our clients rely on our experience and expertise to make sure these noise control guidelines are fair and effective. In this case, "fair" can mean striking a balance between the contractor's need to perform and advance the work with the community's need for peace and quiet. And "effective" can mean the specification actually achieves its intended outcome in an enforceable and defensible manner.

Decades of evolution and improvements in writing such noise specifications are available to all projects now that wish to adopt them. Fortunately, Federal and State sponsoring agencies have learned that it is better to proactively control construction noise than to lose the public's trust by abusing it. Experience has also shown that if a project does not adequately deal with construction noise, then the public can and will turn to their elected officials, the news media, and the legal system to put tremendous pressure on the project to comply. This, in turn, can lead to weeks, months, or years of expensive construction delays.

For credibility information, the author developed the Construction Noise Control Specification 721.560 for the Big Dig project in Boston⁽¹⁾; developed the original FHWA Roadway Construction Noise Model (RCNM) and related sections of the FHWA handbook⁽²⁾; the New York City construction noise regulation Section 24-219, Title 15, Chapter 28⁽³⁾; as well as project-specific construction noise control specifications for dozens of projects across the country.

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2. PURPOSE OF SPECIFICATIONS

A balance must be struck between the noise producer (i.e. contractor) and the noise receiver (i.e. community). The purpose of the construction noise control specification is to (1) protect the community from excessive noise, (2) ensure that the contractor can actually perform the required work, (3) place the responsibility for compliance on the contractor, and (4) protect the project from liability. If the specification is too restrictive or the noise limits are unachievable, then contractors will not bid on the project due to the risk that it might be “unbuildable”. This introduces the important differences between a performance-based versus a prescriptive-based specification. In short, a *prescriptive* specification tells the contractor what they *must do*, where a *performance* specification tells the contractor what they *cannot do*.

The vast majority of projects should include a *performance* noise specification. Such a specification sets allowable performance limits (criteria) and restrictions on the contractor. But it allows the contractor to determine whatever means and methods they wish to get the job done within the acceptable limits. Experience has shown that contractors are remarkably clever and innovative at finding solutions to keep their project work moving forwards. In contrast, a *prescriptive* noise specification is one that directs the contractor exactly what noise control measures must be taken in the field, rather than setting noise criteria limits. While this approach might work in certain pre-analyzed circumstances, it unfortunately places the liability for success on the project, not the contractor! If the prescribed noise control measures do not work well enough, then the contractor can demand additional compensation to perform any additional noise mitigation. Thus, a prescriptive-based specification puts the liability for success on the project, where a performance-based specification puts the liability for success on the contractor.

In any case, the construction noise control specification needs to be prepared ahead of time complete with project-specific limitations so that it can be included in the bid documents that the sponsoring agency will send out to perspective construction contractors for proposals. This is the best time for specifications to be distributed because once a contractor proposes to perform the job and wins, then they are contractually obligated to adhere to the noise specification. Thus, the sponsoring agency gets the benefit of competitive bidding pressures to keep the cost of implementing the noise control program to a minimal. However, if a contractor is selected and awarded a project to construct and then a change is made later in the noise control requirements, then the contractor is free to ask for additional compensation to perform the “out of scope” work and new schedule delays could occur.

3. KEY COMPONENTS OF SPECIFICATIONS

Construction noise specifications needs to clearly and unambiguously inform the contractor as to their responsibilities and obligations, as well as to how their compliance with stated noise limits shall be measured. *Simply put, noise control does not help increase the contractor’s production schedule or profit margin.* Any ambiguities or confusion in the specification will likely be ruled in favor of the contractor during claims adjudications for additional funding. Here are the suggested sections for a construction noise specification:

- **General** – This section lays out the purpose and applicability of the specification, as well as referencing any other related codes or regulations incorporated by reference that the contractor must follow.
- **Definitions** – This section defines any import terms used in the specification, particularly any and all acoustical definitions.

- **Submittals** – This section informs the contractor as to what submittals will be required of them before and during the construction phase. Submittals such as noise control plans, acoustical engineer’s qualifications, noise measurement data, etc., all serve to keep the contractor involved and focused on the noise control mission. Moreover, once accepted by the reviewing sponsor agency, these submittals become contractual *obligations* for the contractor to comply with.
- **Limitations** – This section informs the contractor of the quantitative noise criteria limits that will be required in a performance-based specification, as well as any restrictions in time or equipment use applicable to the project (e.g. use of quieter backup alarms, avoiding night work, etc.). It is important to specify both individual equipment noise emission limits as well as receptor noise limits.
- **Qualifications** – This section defines the minimal qualifications expected of the contractor’s acoustical consultant who will be developing and performing most of the noise control deliverables. Being Institute of Noise Control Engineering (INCE) Board Certified is increasingly the requirement.
- **Noise Monitoring Plan** – This section describes the requirements for performing ambient baseline and/or construction phase compliance noise monitoring and reporting. The type of noise monitors, monitoring locations, and sound data to be collected are typically defined. Additionally, the means by which the contractor receives notifications of exceedances (e.g. text message or email) can also be specified to improve response time and minimize community disturbances.
- **Noise Control Plan** – This section describes the contractor’s obligation to prepare and submit a plan ahead of time for work anticipated over the next phase of project work. The plan should have a disclosure of equipment expected in the field and a computation of the anticipated noise levels affecting the nearby community (i.e. receptors). If noise levels are expected to exceed specified limits, then the plan must show how the contractor will proactively mitigate the noise to acceptable levels. Once accepted by the sponsoring agency, this plan becomes a *contractual obligation* that the contractor must implement in the field.
- **Materials** – This section describes the minimal requirements of any noise control materials the contractor might use, such as noise barriers, noise curtains, enclosures, backup alarms, equipment mufflers, etc. Acoustical properties such as Sound Transmission Class (STC) of Surface Density (SD) for barriers and enclosures, Insertion Loss (IL) for mufflers, Noise Reduction Coefficient (NRC) for absorption material, and several material properties such as tear strength, wind load capacity, fire retardancy, etc. all need to be fully specified. Typically specified STC values range from 25 – 35 STC, SD values range from 4 – 6 lbs/sq.ft, and NRC values range from 0.7 – 0.8 NRC. Note that this section does not specify how and where the materials must be used; that is the purpose of the Noise Control Plan.
- **Complaint Procedure** – This section describes how the contractor shall be required to accept, log and respond to noise complaints received from the public. Sometimes the contractor is entrusted with this complaint logging task, other times the sponsoring agency maintains the information. In either case, a description of how a timely and thorough investigation shall be performed is defined.

- **Payment Items** – This section describes how the contractor will be reimbursed for the costs incurred in purchasing and installing the required noise control measures. Most often, this section simply says it is the contractor’s obligation as part of the cost of performing work. However, occasionally there can be reimbursement rates based on unit prices for materials such as “per square foot” for noise barriers. Penalty fees and fines to be incurred by the contractor in the event of problematic noncompliance can also be listed in this section.

4. CONSTRUCTION NOISE CRITERIA LIMITS

It is recommended that construction noise criteria be specified for both the *noise sources* as well as the *noise receptors*. Construction noise limits that have worked well on other major projects contains both "relative" and “absolute” criteria limits at identified noise sensitive receptor locations, as well as "absolute" noise emission limits for any/all equipment used on site. It is important to note that *the noise limits apply only to the noise the contractor produces*. The contractor cannot be held accountable for other unrelated ambient noise sources. Examples of receptor and source noise criteria can be seen in Tables 1 and 2, respectively.

As shown in Table 1, the receptor limits restrict construction induced L10 noise levels to not exceed baseline (pre-construction) L10 noise levels (or Leq noise levels) by more than 5 dBA at identified noise sensitive receptor locations. This provides a “relative” limit to evaluate construction related noise. L10 (or Leq) noise limits are intended to address continuous or steady construction noise averaged over some time interval, of say 20-minute periods. Lmax noise limits also apply at the receptors and are intended to address loud impact-type noise events. Specifying an Lmax noise level provides an “absolute” limit at receptors.

Three types of receptor land-uses are recognized: (1) *Noise Sensitive Areas* - involving nighttime land-use such as residences, hotels, and hospitals, (2) *Commercial Areas* - such as businesses, retail, and office buildings, and (3) *Industrial Areas* - such as factories and large manufacturing or processing plants. The receptor criteria limits are more stringent for residential receptors than for commercial or industrial receptors in lieu of the more sensitive nature of residential land-use at night. In addition, there are different criteria limits depending on various times of day, with the most restrictive noise limits applied to the more sensitive nighttime period. *Daytime* is defined from 7:00 AM to 6:00 PM, *evening* is 6:00 PM to 10:00 PM, and *nighttime* is defined as 10:00 PM to 7:00 AM.

As shown in Table 2, contract specifications should also contain an *absolute* noise limit which is applied to generic classes of heavy equipment to restrict their noise emissions at the source. Equipment-specific Lmax noise limits in dBA evaluated at a reference distance of 50 feet are provided. These equipment emission limits are achievable but have been set conservatively as low as possible to require the equipment to be well maintained with modern noise control devices and materials applied to them if needed.

Table 1. Receptor Construction Noise Criteria Limits

Noise Receptor Locations and Land-Uses	Receptor Construction Noise Criteria Limits in dBA, RMS slow					
	Daytime (7 AM - 6 PM)		Evening (6 PM - 10 PM)		Nighttime (10 PM - 7 AM)	
	L10	Lmax	L10	Lmax	L10	Lmax
Noise-Sensitive: (Residences, Hospitals, Institutions, Hotels, etc.)	75 or Baseline + 5 <i>(Whichever is louder)</i>	85 (Steady) 90 (Impact)	Baseline + 5	85	Baseline + 5 <i>(If Baseline < 70)</i> Baseline + 3 <i>(If Baseline >= 70)</i>	80 80
Commercial: (Businesses, Offices, Stores, etc.)	80 or Baseline + 5 <i>(Whichever is louder)</i>	None	None	None	None	None
Industrial: (Factories, Plants, etc.)	85 or Baseline + 5 <i>(Whichever is louder)</i>	None	None	None	None	None

Table 2. Construction Equipment Noise Emission Criteria Limits

<u>Equipment Description</u>	<u>Lmax Noise Limit at 50 ft, dB(A), slow</u>	<u>Is Equipment an Impact Device?</u>	<u>Acoustic Usage Factor</u>
All other equipment > 5 HP	85	No	50 %
Auger Drill Rig	85	No	20 %
Backhoe	80	No	40 %
Bar Bender	80	No	20 %
Blasting	94	Yes	1 %
Boring Jack Power Unit	80	No	50 %
Chain Saw	85	No	20 %
Clam Shovel	93	Yes	20 %
Compactor (ground)	80	No	20 %
Compressor (air)	80	No	40 %
Concrete Batch Plant	83	No	15 %
Concrete Mixer Truck	85	No	40 %
Concrete Pump	82	No	20 %
Concrete Saw	90	No	20 %
Crane (mobile or stationary)	85	No	20 %
Dozer	85	No	40 %
Dump Truck	84	No	40 %
Excavator	85	No	40 %
Flat Bed Truck	84	No	40 %
Front End Loader	80	No	40 %
Generator (25 KVA or less)	70	No	50 %
Generator (more than 25 KVA)	82	No	50 %
Gradall	85	No	40 %
Grader	85	No	40 %
Horizontal Boring Hydraulic Jack	80	No	25 %
Hydra Break Ram	90	Yes	10 %
Impact Pile Driver (diesel or drop)	95	Yes	20 %
Insitu Soil Sampling Rig	84	No	20 %
Jackhammer	85	Yes	20 %
Mounted Impact Hammer (hoe-ram)	90	Yes	20 %
Paver	85	No	50 %
Pickup Truck	55	No	40 %
Pneumatic Tools	85	No	50 %
Pumps	77	No	50 %
Rock Drill	85	No	20 %
Scraper	85	No	40 %
Slurry Plant	78	No	100 %
Slurry Trenching Machine	82	No	50 %
Soil Mix Drill Rig	80	No	50 %
Tractor	84	No	40 %
Vacuum Excavator (vac-truck)	85	No	40 %
Vacuum Street Sweeper	80	No	10 %
Vibratory Concrete Mixer	80	No	20 %
Vibratory Pile Driver	95	No	20 %
Welder	73	No	40 %

Notes: "Impact" is equipment assumed to produce separate discernable sound pressure maxima.

"Acoustic Usage Factor" represents the percent of time that equipment is assumed to be running at full power while working on site.

5. PROACTIVE AND REACTIVE CAPABILITIES

A comprehensive construction noise control specification should contain both *proactive* and *reactive* capabilities. Proactive capabilities are intended to avoid excessive noise from being produced in the first place, while reactive capabilities are intended to allow for fast response times to complaints and implementation of additional noise control measures if required.

Proactive components of the specification are intended to avoid excessive noise by predicting/anticipating excessive noise in advance, to which the contractor must commit to implement suitable noise mitigation beforehand. Portions of the noise specification that address proactive efforts include the Limitations section in which certain particularly loud equipment or operations (e.g. blasting, pile driving, hoe ramming, etc.) might be restricted during certain times of day or night. Another example is the need for the contractor to develop and adhere to a Noise Control Plan in which noise levels are predicted at receptor locations. If excessive noise is anticipated in the plan, then suitable noise mitigation measures must be committed and installed beforehand by the contractor to reduce the noise to acceptable levels. This may also include notification of the public prior to excessively noise events, such as blasting or pile driving. Informing the community of particularly noisy activities will help minimize the disruptive nature of the noise, reduce complaints, and will help to build the public's confidence in the project.

Reactive components of the specification are intended to allow the project sponsor or the contractor to respond to excessive noise situations that inevitably occur during construction projects. Often times, these occasions will trigger noise complaints from the public, which as stated above, need to be addressed and resolved as quickly as possible to maintain the public's trust and to avoid the issue being elevated to elected officials and/or the local news media. Examples of reactive portions of the specification include the establishment of source and receptor noise criteria limits, a description of how noise compliance measurements will be performed, and an approved process in place to receive noise complaints and immediately react to investigate them.

With advancements in noise monitoring technology, it is much easier for construction projects to be reactive and reduce their community impact. Real-time noise monitoring capabilities with text and email notifications allow for quicker response time to exceedances. This makes it possible for modifications to be made to the noise generating activity while it is occurring, rather than addressing it days after it has already occurred.

6. ENFORCEMENT AND PENALTIES

Like any law or regulation, project specifications are only as effective as they are adhered to. Compliance with the terms and conditions in the noise specification must be measured in the field, and must be enforced if necessary. Again, for these reasons it is very important to use the *performance-based* approach in developing the construction noise specification. The types of proactive and reactive control measures described above need to be the responsibility and liability of the contractor to perform satisfactorily. In this manner, the contractor cannot seek additional funding if compliance is not achieved. It is the contractor's obligation to comply.

Moreover, penalties can be applied to the contractor if they fail to meet the requirements contained in the noise specification. Unfortunately, these penalties need to be somewhat punitive to ensure successfully achieving the contractor's cooperation. Otherwise, the contractor might simply accept and pay the penalties as a "cost of doing business" in which case the public suffers from excessive noise.

Penalties can take many forms; but must be clearly disclosed in the noise specification at the time the contractor bids to win the project. Example penalties could include withholding of contract payment, monetary fines, or even stop work orders. "Time is money" for contractors, so they will certainly move quickly to resolve the noise problem if their work site is shut down.

7. LESSONS LEARNED

The lessons learned by the author after 30 years of experience assessing and controlling construction noise, and in developing construction noise related regulations, guidelines, ordinances and project specifications include the following:

- *Construction noise is controllable!* It should not be viewed or dismissed as a temporary or an unfortunately but inevitably necessary aspect of construction projects.
- A comprehensive performance-based construction noise control specification is essential for controlling the contractor in the field and for protecting the project/sponsoring agency from liability.
- The noise specification must be “fair” to both the noise producer (i.e. contractor) and the noise receiver (i.e. community). It can be a difficult balance to strike. The project must get built, but people deserve peace and quiet for their quality of life.
- The noise specification can be restrictive (that’s its purpose), but it cannot be overly onerous to the point that the contractor cannot manage to perform the necessary work (i.e. an unbuildable project).
- The noise specification must be included with the project’s bid documents in order to inform contractors of the requirements and to receive the benefit of competitive bid prices from prospective contractors.
- Construction noise criteria should include community receptor and equipment source noise limits; take into account the noise sensitivity of different types of land-uses; account for sensitivity differences in time of day or night; and be based on a short enough timeframe (e.g. 20 minutes) to allow for effective real-time mitigation decisions to be made.
- All noise-related metrics and measurement conditions must be clearly defined in the noise specification. Any ambiguities will play in favor of the contractor.
- Penalties contained in the noise specification for noncompliance must be severe enough to adequately motivate the contractor to take swift corrective actions.

REFERENCES

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