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PROACTIVE AND REACTIVE CONSTRUCTION NOISE CONTROL STRATEGY AT THE CENTRAL ARTERY/TUNNEL PROJECT

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ABSTRACT

The CA/T Project, by all accounts, is the most ambitious and grandest-scale urban construction project even undertaken in the United States. The challenges facing the Project's noise control program are to successfully control construction noise to avoid posing a hardship on abutting communities, while supporting construction milestones and ensuring environmental noise commitments contained the Project's Environmental Impact Report are fulfilled. The entire CA/T construction noise control program can be described in terms of its proactive and reactive strategies. Project officials have learned that by proactively predicting and anticipating loud construction noise conditions, many noisy situations can be completely avoided or at least significantly minimized. However, not all noisy conditions can be anticipated, so a strong and flexible reactive ability is necessary to mitigate unexpected excessive noise.

INTRODUCTION

The construction noise-related challenges facing the Central Artery / Tunnel Project (known as the Big Dig) are as immense as is the scope-of-work for this ambitious mega-project. This paper details the proactive and reactive construction noise control strategies employed by the CA/T Project to successfully manage this most politically charged issue.

The CA/T Project, by all accounts, is the most ambitious and grandest-scale urban construction project even undertaken in the United States. Construction in close proximity to thousands of residences and businesses may take 12 years to complete and cost upwards of $13.6 billion. Broadly stated, the challenges facing the Project's noise control program are to successfully control construction noise to avoid posing a hardship on abutting communities, while supporting construction milestones and ensuring environmental noise commitments contained the Project's Environmental Impact Report [1] are fulfilled. In general, the solution has been a willingness to use any and all reasonable and feasible noise control methods to

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mitigate construction noise at the source, along the intervening pathway, or at the receptor locations. While cost estimates for the entire 18-year noise control program (design and construction) approach $17 million, this figure represents only about 0.13% of the CA/T Project's total completion budget [2]. Moreover, it must be noted that the true value of the lessons learned through the CA/T noise control program will pay dividends for decades to come as other large-scale construction projects nationwide benefit from the CA/T's state-of-the-art approaches and strategies [3,4].

The Project has made it publicly clear that noise control is highly regarded. Fair noise-related policies and specifications have been developed which balance the community's needs for peace and quiet with the Project's needs to advance the work [2]. The cornerstone of the Project's noise control program is the Construction Noise Control Specification 721.560 [5], the most comprehensive specification of its kind in the United States. The Noise Specification sets noise limits for the contractor, describes required submittals, contains contract-specific noise mitigation commitments, and provides guidance on source, pathway, and receptor noise control options. The intent of the Noise Specification is to address noise proactively whenever possible; to anticipate and avoid creating undue noisy conditions, and to allow proper reaction as well to control noisy conditions without sustaining costly claims from the contractors.

Indeed the entire CA/T construction noise control program can be described in terms of its proactive and reactive strategies. Project officials have learned that by proactively predicting and anticipating loud construction noise conditions, many noisy situations can be completely avoided or at least significantly minimized. However, not all noisy conditions can be anticipated, so a strong and flexible reactive ability is necessary as well to mitigate unexpected excessive noise without incurring costly claims from the construction contractors.

PROACTIVE AND REACTIVE EXAMPLES

Many examples can be cited of proactive and reactive strategies employed by the CA/T Project to control construction noise. Again, the overall goal is to proactively anticipate and avoid generating as much excessive noise as possible, but with the ability to react as well should unexpected noisy conditions requiring mitigation present themselves.

Construction Noise Control Specification 721.560 [5]

Proactive Approach. The CA/T Noise Spec 721.560 is the most comprehensive construction noise control specification in the country. It clearly details the noise-related restrictions under which the contractors must comply. The Noise Spec contains proactive operational constraints such as the prohibition of pile driving, hoe ramming, or jack hammering at night. Amongst other restrictions, the Noise Spec requires that contractors submit the qualifications of their acoustical consultant, a Noise Monitoring Plan, equipment noise certification tests, construction noise compliance readings, mitigation measures shop drawings, and Noise Control Plans.

Reactive Ability. The Noise Spec contains specific language making it clear that it is the contractors' responsibility to comply with all the operational constraints, equipment noise emission limits, and receptor lot-line noise limits. In addition, neighborhood-specific concerns can be accommodated through the development of Noise Agreement Sheets, which then become commitments that the contractors must follow. Violations of any of these noise requirements may lead to deficiency reports or moneys being withheld from the contractors. Moreover, any noise-related work shutdowns cannot be held as a contractor claim against the Project.

Noise Control Plans

Proactive Approach. The Noise Spec requires contractors to predict anticipated worst-case construction noise levels affecting residential and commercial receptors throughout the contract area based on intended equipment locations and types of work operations. Should the predicted Lmax or L10 noise levels exceed applicable daytime, evening, or nighttime criteria limits, then suitable noise mitigation measures are warranted and must be proactively implemented in the field.

Reactive Ability. Once a Noise Control Plan has been submitted by the contractor and approved by the Project, it then becomes an enforceable commitment with which the contractor must comply in the field. Failure to fulfill the Plan's noise mitigation commitments can lead to deficiency reports, the withholding of moneys, or fines imposed by the City of Boston.

Community Interaction and Involvement

Proactive Approach. The Project recognizes the need and benefits of actively involving the affected communities in any and all noise mitigation plans [6]. Towards this end, the Project holds regular (monthly) public meetings at which construction schedules and mitigation plans are presented. The public is encouraged to participate and when ever possible their ideas and wishes are accommodated. The Project has found that open and honest disclosure of noise mitigation plans can greatly increase the public's tolerance to construction noise.

Reactive Ability. The Project maintains a twenty-four hour per day, seven day per week hotline (at CAT-HELP) that the public can call and register a noise complaint. The noise patrol technician is then immediately notified of the noise complaint and can respond quickly to investigate and mitigate the complaint circumstances. This hotline gives the public an immediate connection to the Project resulting in the public's gaining a better sense of control of their noise environment.

Nighttime Noise Patrol

Proactive Approach. The Project utilizes a noise technician to patrol the entire project at night in an attempt to proactively avoid unnecessarily noisy construction operations. The noise technician can evaluate measured noise readings against the Noise Spec criteria limits, and reconcile the commitments made in the contractors' approved Noise Control Plans against actual field conditions.

Reactive Ability. Should the Project receive a noise complaint at night, then the noise patrol technician can respond immediately to the scene and investigate the circumstances of the complaint. Noise readings can be collected to check for compliance against Noise Spec criteria limits. If excessively noise conditions are found which cannot be quickly mitigated in the field, then the noise technician is empowered to order to the shutdown of the offending work.

Backup Alarms

Proactive Approach. Backup alarms were responsible for generating the most number of nighttime noise complaints Project-wide. A backup alarm demonstration study [7] was conducted in 1996, which indicated that manually adjustable or ambient-sensitive backup alarms were notably (-20 dBA) quieter than standard backup alarms but still provided an adequate margin of safety for laborers in the field. Thus, the proactive requirement that all vehicles operating at night on the Project be equipped with these quieter-type backup alarms was incorporated into the Noise Specification.

Reactive Ability. In reaction to intense public concern in very noise-sensitive neighborhoods, the Project opted to prohibit the use of audible backup alarms at night from midnight to 6:00 a.m. in certain contract areas. Such a prohibition is acceptable to OSHA providing that an observer is used to direct the rearward movement of construction vehicles on site.

Vacuum Excavator Trucks (vac-trucks)

Proactive Approach. The Project received numerous noise complaints citing the low frequency rumble from vacuum excavator trucks (Fig. 1). In hopes of curing this mechanical noise issue, the Project undertook an acoustic study [8] of a vac-truck and determined that improving the intake and exhaust silencers would address the low frequency emissions being generated by these trucks. The Project worked cooperatively with the vac-truck manufacturer, the contractor, and the silencer vendor in order to retrofit a vac-truck with improved silencers. Once these new silencers were installed and proven effective, the vac-truck was earmarked for use in noise-sensitive neighborhoods.

FIG. 1. Vacuum Excavator Truck

Reactive Ability. Because the numbers of noise complaints were so great citing the low frequency rumble associated with vac-trucks, the Project had to implement an interim policy regarding the use of these vac-trucks until such time as a more comprehensive noise solution could be devised. The Project mandated that all vac-trucks must operate at their lower power level (about 1,200 rpm), which reduces noise emissions by about 3-6 dBA as compared to full power (1,800 rpm). The Project also prohibited the use of vac-trucks at night in certain noise-sensitive residential areas.

Window Acoustical Treatment Program

Proactive Approach. In 1998 in anticipation of construction noise mitigation requirements associated with several future noise-sensitive contracts, the Project formulated an acoustical window treatment contract (C30A1) to proactively identify and treat those bedroom windows deemed eligible. The C30A1 contract made use of construction noise prediction models to justify, which receptors should benefit from window treatments. To date, some 400-bedroom windows have been acoustically treated with interior sashes or full replacement windows, at a cost of about $400,000 [9].

Reactive Ability. While the Project prefers to mitigate construction noise at the source or along the pathway, there have been numerous occasions in which additional receptor noise control measures were required. In reaction, the Project developed an Off-Site Noise Mitigation Policy [10] in 1997 that defines criteria to determine which abutters would be eligible to receive acoustical window treatments from the Project. Issues addressed in the policy include the duration of night work, the proximity of the work zones to the receptor, the associated noise levels at the receptor's location, the existence of any hardship conditions, and cost limitations for the approved window treatments.

CA/T Environment Panel

Proactive Approach. In late 1996, the Project organized an internal Environmental Panel comprised of construction, environmental, legal, community liaison, and management staff in order to proactively develop noise-related policies. Other agencies associated with the Project were also part of the panel including FHWA, Massachusetts DEP, and the City of Boston. The panel was able to quickly and efficiently draft Project policies for Senior Management's approval. The panel continues to meet to this day to refine policies as necessary and to ensure that ongoing environmental-related matters challenging the Project are properly addressed.

Reactive Ability. Should unforeseen environmental-related issues challenge the Project, then the Environmental Panel is scoped with developing and coordinating appropriate mitigation efforts to respond to the given issues. The panel can bring pressures to bear on non-compliant contractors to ensure that noise mitigation commitments are fulfilled.

Noise Control Training

Proactive Approach. The Project requires that all field engineers be trained in the aspects of construction noise control and to understand the terms contained in the Noise Specification. A one-hour training session is provided several times a year, which all field engineers must attend at least once.

Reactive Ability. In the event that particularly contentious noisy situations develop in a given contract area, then a special noise control training session can be held in the given contract's field office to reaffirm the noise control requirements contained in the contract's Noise Specification. The feasibility and applicability of specific noise mitigation solutions are also discussed at these special training sessions.

NOISE CONTROL METHODS

Should construction noise conditions warrant mitigation, the CA/T Project follows a step-wise approach towards selecting appropriate noise mitigation measures for the given circumstances. The expected noise reduction performance benefits of proposed mitigation measures are weighed against cost implications. Noise mitigation measures are implemented only when justified based on careful consideration of all relevant technical, cost, and policy issues. General examples of source, path, and receptor noise control measures routinely applied on the CA/T Project include:

Source Controls:

- Time Constraints - prohibiting work during sensitive nighttime hours
- Scheduling - performing noisy work during less sensitive time periods
- Equipment Restrictions - restricting the type of equipment used
- Emission Restrictions - specifying stringent noise limits
- Substitute Methods - using quieter methods/equipment when possible

- Lubrication & Maintenance - well maintained equipment with quality mufflers
- Reduced Power Operation - use only necessary size and power
- Limit Equipment On-Site - only have necessary equipment on-site
- Noise Compliance Monitoring - technician on site to ensure compliance
- Quieter Back-up Alarms - manually-adjustable or ambient-sensitive types

Path Controls:

- Noise Barriers - semi-permanent or portable wooden or concrete barriers
- Noise Curtains - flexible intervening curtain systems hung from supports (Fig. 2).
- Enclosures - encasing localized and stationary noise sources (Fig. 3).
- Increased Distance - perform noisy activities farther away

FIG. 2. Twenty foot tall noise barrier of scaffolding and noise curtains.

Receptor Controls:

- Window Treatments - reinforcing the building's noise reduction ability
- Community Participation - open dialog to involve affected residents
- Noise Complaint Process - ability to log and respond to noise complaints
- Temporary Relocation - only in extreme otherwise non-mitigatable cases

FIG. 3. Crane with noise curtains enclosing the engine and muffler area.

KEY LESSONS LEARNED

The CA/T Project has been called the largest construction laboratory in the world within which all forms of construction techniques and mitigation strategies can be developed and refined. Some of the more valuable noise control lessons learned to date include:

- Project Managers must publicly demonstrate that noise control will be held in high regards.
- Noise Policy commitments and noise control goals must be consistently applied project-wide.
- A comprehensive Noise Spec is essential for managing the contractors and avoiding claims.
- A relative noise criteria (Baseline L10 +5 dBA) is fair to the public and allows work to progress.
- Noise control strategies must be flexible and include source, path, and receiver control options.
- Noise barriers significantly reduce construction noise and “hide” noise-producing sources.
- Acoustical window treatments are a very cost-effective means to reduce noise inside residences.

- A noise technician, with authority to stop work, can proactively avoid or respond to complaints.
- Back-up alarms should be required to be either manually-adjustable or ambient-sensitive types.
- The affected community must be involved and informed regarding work schedule and mitigation.

Through these key measures and by consistently implementing the policies, specifications, and strategies of a comprehensive noise control program, the CA/T Project has demonstrated that construction noise can be successfully managed on a large-scale urban construction project [2,3,4].

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