

## Chapter 32

### Sound Barriers

32.1	General Requirements .....	32-1
32.2	Noise Study Report Addendum.....	32-3
32.3	Noise Abatement Criteria .....	32-4
32.4	Public Involvement .....	32-8
32.5	Final Noise Abatement Commitments .....	32-11
32.6	Structural Design.....	32-12
32.7	Geotechnical Investigation .....	32-14
32.8	Preparation of Control Drawings .....	32-15
32.9	Detail Drawings .....	32-16
Tables		
Table 32.1	Noise Abatement Criteria .....	32-7

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## Chapter 32

### Sound Barriers

#### 32.1 General Requirements

**Chapter 23 of the Code of Federal Regulations Part 772 (23 CFR 772) entitled “Procedures for Abatement of Highway Traffic Noise and Construction Noise”** contains the federal regulations for the assessment of traffic noise impacts and abatement on federal aid projects. **Chapter 335.17 of the Florida Statutes** requires the use of **23 CFR 772** for traffic noise impact assessment on highway projects, regardless of funding. **Policy No. 000-360-005, Noise Abatement** contains the policy for abatement of traffic noise on Department projects. The requirements for assessing the noise impacts and abatement commitments are detailed in **Part 2, Chapter 17 of the Project Development and Environmental Manual (PD&E Manual) (Topic No. 650-000-001)**. The initial evaluation of noise impacts is made during the Project Development and Environmental (PD&E) phase of a project. Any preliminary commitments to provide reasonable and feasible noise abatement measures on a project are included in the Noise Study Report (NSR) and summarized in the environmental document. The environmental documents and any subsequent re-evaluations shall be reviewed to identify all preliminary noise abatement commitments.

Preliminary noise abatement commitments made during the PD&E phase are subject to change due to refinements during final design. Designers must consider final roadway grades and horizontal alignments, land use changes, as well as ground elevation at sound barrier locations. Noise abatement identified as reasonable and feasible during the PD&E phase need to be reassessed against the final roadway features. The typical PD&E phase assumptions are appropriate for reasonableness and feasibility decisions but the final design must utilize location specific data that reflects proposed vertical and horizontal locations of the travel lanes and sound barriers. The noise specialist shall provide the top of wall elevation for both minimum and desirable insertion reductions as described below. The designer shall coordinate with the noise specialist in the District Environmental Management Office to ensure proper analysis and public involvement occurs during final design.

If no noise abatement is identified in the environmental document or any subsequent

environmental re-evaluations, no further effort is required during final design. However, it may still be necessary to evaluate construction noise and vibration impacts and develop any special provisions to be included in the plans.

Upon review of the environmental documents the designer and the noise specialist should identify the noise receptors considered during the noise impact assessment performed in PD&E. Noise receptors resulting from development completed after the approval date of the environmental documents should not be considered as the Department is not responsible for providing noise abatement at these sites. A detailed design reassessment of the preliminary noise abatement commitments should be conducted for the following:

1. Locations of preliminary noise abatement commitments
2. Receptor sites where roadway geometric refinements are likely to change noise impacts

An addendum to the NSR prepared by the District Environmental Management Office during Final Design will document the final noise abatement commitments.

## 32.2 Noise Study Report Addendum

The primary effort related to the reassessment of preliminary noise abatement commitments during design is the preparation of an addendum to the NSR. The reassessment shall be based on the final roadway geometry and the proposed noise abatement design, including sound barrier type, location, dimensions and estimated costs. For consistency, the Final Design reassessment should be conducted using the latest version of the FHWA's Traffic Noise Model (TNM).

Noise abatement measures are considered when noise levels at a receptor(s) approach or exceed the noise abatement criteria or substantially exceed existing noise levels. The noise abatement criteria is listed in **Table 32.1**. Approaching the criteria means within 1 dBA of the noise abatement criteria. A predicted increase of 15 dBA or more is considered substantial. Noise abatement is generally only considered for Activity Categories 'A' and 'B'. Preliminary noise abatement commitments are documented in the original NSR.

## 32.3 Noise Abatement Criteria

The insertion loss is the level of noise reduction as a result of abatement. The desirable insertion loss is 10 dBA or more; however, the minimum insertion loss should be 5 dBA for an impacted receiver for abatement to be considered reasonable. If a sound barrier can meet the desired insertion loss for a cost of \$42,000 or less per benefited receiver site, the barrier is considered cost reasonable. The statewide average unit cost (per square foot) and the upper limit of the cost per benefited receiver to be used in determining cost reasonableness is established by the Environmental Management Office. As of the printing of this update the statewide average unit cost of sound barriers to be used in the calculation of the cost/benefited receiver is \$30.00/ft<sup>2</sup>. The PD&E manual should be referenced for the latest unit cost update. Additional costs such as required additional right of way, special drainage features, special bridge support and special foundations associated with the installation of a sound barrier should be added to the unit cost if appropriate. If these special features increase the cost per benefited receiver above \$42,000, the decision whether or not to provide a barrier must be made in consultation with the District Environmental Management Office and FHWA. Any decision to eliminate a sound barrier from consideration based on the additional cost of special features will require clear demonstration that the need for such special features are associated only with the sound barrier and cannot be mitigated by other considerations.

If a minimum of 5 dBA insertion loss cannot be achieved at a receiver, that receiver is not benefited; therefore, it cannot be considered in the cost effective calculation to determine the reasonableness of that barrier. The noise specialist should thoroughly investigate the scenarios required to meet the desirable insertion loss of 10 dBA at \$42,000 or less per benefited receiver particularly where design changes or the consideration of special features require cost or abatement level reanalysis.

**Section 32.6, Structural Design**, provides structural design criteria and procedures, and horizontal clearance requirements. Under normal conditions sound barriers shall not exceed the following heights:

1. For sound barriers at the right of way line or outside the clear zone use a maximum height of 22 feet.
2. For sound barriers on bridge and wall structures use a maximum height of 8 feet.
3. For sound barriers at the shoulder point, mounted on embankments only, use a maximum height of 14 feet.

Use of barrier heights greater than these shall require a Design Variation. Justification for a variation should include, as a minimum, a description of site conditions requiring the increased height and a comparison to the standard height of both insertion loss and cost per benefited receiver.

The designer should provide analytical results to the Department project manager evaluating barrier heights necessary to achieve minimum, desired and optimum insertion loss. The optimum barrier height should be most cost effective in consideration of noise reduction benefits per unit cost of the barrier. An evaluation matrix is suited to this type of comparative analysis. The evaluation matrix should consider an appropriate range of sound barrier configurations (height, length and roadway offset) that provide the desirable insertion loss (10 dBA) per impacted receiver and the minimum insertion loss (5 dBA) per impacted receiver. The number of benefited receivers should be identified and the cost per benefited receiver calculated for each configuration evaluated. If a sound barrier configuration can provide the desirable insertion loss (10 dBA) at a reasonable cost (less than \$42,000 per benefited receiver), then it should be provided. If this is not achievable, the designer should select a sound barrier configuration that optimizes insertion loss per impacted receiver and cost per benefited receiver. The designer should always provide a recommendation with the evaluation. The designer should also coordinate with the District Structures Design Office to ensure that the sound barrier design meets appropriate structural design standards and that construction is feasible and achievable.

The height of the sound barrier is measured from the ground elevation to the top of the barrier. Tall sound barriers are seldom necessary at the top of roadway embankments or berms since the elevation of the embankment contributes to the effective height of the barrier. In addition, changes in the vertical grade of the top of the barrier should be gradual and abrupt changes in barrier heights should be avoided. Often natural ground elevations at the base of the barrier fluctuate, even in flat terrain. Therefore, the designer should provide plan details that make clear to the contractor the final barrier top elevations, foundation step locations and post spacing.

When an otherwise continuous barrier is broken resulting in a horizontal separation between the barriers, it is often necessary to overlap the barriers to reduce insertion loss degradation. Applications of this occur when the mainline barrier is located at the right of way line, but must be moved to the shoulder point at a bridge location. This may also occur at interchanges when transitioning from the mainline to a ramp. The overlap distance of sound barriers is generally equal to four times the separation; however, an analysis by the noise specialist is necessary to determine the optimum overlap. The need or effectiveness of a sound barrier in the infield area of an interchange should be reviewed as well during final design. The attenuation of ramp traffic may provide

adequate insertion loss when considering the intersecting roadway's noise contribution. Maintenance access and clear zone must be considered when selecting barrier termini details.

Other noise abatement techniques that may be considered to supplement or replace sound barrier walls are:

1. Traffic management measures (e.g., traffic control devices and signing for prohibition of certain type vehicles, time use restrictions for certain type vehicles, modified speed limits, and exclusive lane designations);
2. Alteration of horizontal and vertical alignments;
3. Acquisition of property rights for construction of sound barriers by donation, purchase or condemnation;
4. Acquisition of the balance of a noise-sensitive property from which there is a taking, if acquisition is less expensive than other methods;
5. Acquisition of right of way for landscaping adjacent to sound barriers and for buffer zones.



**Table 32.1 Noise Abatement Criteria**  
 [Hourly A-Weighted Sound Level-decibels (dBA)]

Activity Category	Abatement Level (in $L_{Aeq}$ )		Description of Activity Category
	FHWA	FDOT	
A	57	56 (Exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose.
B	67	66 (Exterior)	Picnic areas, recreation areas, playgrounds, active sports areas, parks, residences, motels, hotels, schools, churches, libraries, RV parks, day care centers and hospitals.
C	72	71 (Exterior)	Developed lands, properties, or activities not included in Categories A and B above.
D			Undeveloped lands.
E	52	51 (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

## 32.4 Public Involvement

The identification and design of noise abatement measures during the project design phase will require additional public involvement efforts and will be especially important in the establishment of sound barrier design features such as barrier texture. Public coordination is often necessary to finalize barrier locations, heights and aesthetic features, especially if there are substantial changes to prior commitments. These changes may be the result of any of the considerations noted in **Section 17-4.6.1** of the **PD&E Manual**. Coordination with the District Public Involvement or Community Liaison Coordinator in obtaining additional input during the final design of the sound barrier is required.

When a barrier is warranted, a written survey shall be conducted to establish whether a numerical majority of the benefited receivers are in favor of the construction of the barrier. If they are not in favor, the Department may choose not to build it. If agreement cannot be reached by a neighborhood on the use of sound barriers, the decision to provide them or not will rest solely with the Department. This survey will usually be conducted during the design phase although it is possible that a survey could be conducted during the PD&E phase. Survey issues should be coordinated with the District Environmental Management Office.

Sound barriers located on arterial roadways can potentially impact access. The ability to construct an effective sound barrier(s) can depend on an individual property owner's willingness to sign a right of way indenture allowing access to be cut off or modified. For these type projects it is general practice to obtain a written statement from each affected property owner demonstrating support for the sound barrier. If an adjacent property owner(s) declines to sign the indenture the noise specialist shall re-evaluate the effectiveness of noise abatement on the project segment considering alternate sound barrier layouts. If insertion loss criteria cannot be met, the noise specialist shall document in the NSR Addendum that the barrier is not feasible.

**F.S. 479.25** (as amended by **HB 273**) "Outdoor Advertising", allows permitted, conforming, lawfully erected outdoor advertising signs to be increased in height if visibility is blocked due to construction of "noise attenuation" barriers. In addition, the amended statute requires the Department to notify a local government or local jurisdiction before erecting a sound barrier that will block a lawfully permitted sign. The local government or local jurisdiction is then required to notify the Department if increasing the height of an outdoor advertising sign will violate any local ordinance or land development regulation of the local government. When the notice has been received from the local government or local jurisdiction and prior to erection of the

sound barrier, the Department shall:

a.) Inform all the benefited receivers, as part of the written survey, that:

1. Erection of a specific sound barrier may block the visibility of an existing outdoor advertising sign;
2. The local government or local jurisdiction may restrict or prohibit increasing the height of the existing outdoor advertising sign to make it visible over the barrier;
3. If a majority of the benefited receivers vote for construction of the sound barrier, the local government or local jurisdiction will be required to:
  - a. Allow an increase in the height of the sign in violation of a local ordinance or land development regulation;
  - b. Allow the sign to be relocated or reconstructed at another location if the sign owner agrees; or
  - c. Pay the fair market value of the sign and its associated interest in the real property.

The amended statute also requires the Department to hold a public hearing within the boundaries of the affected local government or local jurisdiction to receive input on proposed sound barriers that may conflict with the local ordinances or land development regulations and to suggest or consider alternatives or modifications to the proposed sound barrier to alleviate or minimize the conflict with the local ordinances or land development regulations or minimize any costs associated with relocating, reconstructing, or paying for the affected outdoor advertising sign. Alternatives or modifications to barriers that will reduce the insertion loss below the minimum of 5 dBA will not be considered unless the results of the survey indicate that a numerical majority of the benefited receivers do not favor construction of the sound barrier.

The written survey materials shall inform the affected property owners of the location, date, and time of the public hearing. The public hearing may be held concurrently with other public hearings scheduled for the project. A general notice of the public hearing shall also be published in a newspaper in accordance with the notice provisions of **F.S. 335.02(1)** and containing the same information provided in the written survey materials. The notice shall not be placed in that portion of a newspaper in which legal notices or classified advertisements appear. Please refer to **Part 1, Chapter 11 Public Involvement, of the PD&E Manual** for additional details about meeting notification requirements.

The Department shall not construct a sound barrier that screens or blocks the visibility of an outdoor advertising sign until after the public hearing is held and the numerical majority of the benefited receivers has approved the construction of the barrier. If the construction of the sound barrier is approved the department shall notify the local governments or local jurisdictions. The local governments or local jurisdictions shall then exercise one of the options in paragraph 3 above.

## 32.5 Final Noise Abatement Commitments

During the final design phase, the noise abatement locations, sound barrier types, lengths and heights will be determined. The final noise abatement commitments must be documented in the environmental reevaluation and the noise study report addendum prior to construction advertisement. The required data collection, analysis and documentation detailed in **Part 2, Chapter 17 of the Project Development and Environmental Manual** will be documented in the NSR addendum. It should also contain a description of the methodology for selecting final sound barrier dimensions including any evaluation matrix(s) used.

A copy of the NSR addendum, a summary of proposed sound barrier and a summary of the public involvement regarding noise abatement that took place during the design effort will be provided to the District Environmental Management Office. The environmental management staff will ensure that the final noise abatement commitments are reflected in the reevaluation of the environmental document and will obtain concurrence from FHWA.

## 32.6 Structural Design

Designers shall specify the Department's Design Standard for Sound Barriers and any applicable sound barrier panels or systems listed on the QPL (see **Section 32.8**).

Except as specified below, **AASHTO's Guide Specifications for Structural Design of Sound Barriers** shall be used for the structural design; however, the designer shall also refer to the **Department Specifications, Section 534**, the **5200 Series** of the **Design Standards**, and the Structures Design Office's **Structures Manual, Volume 6, Chapter 2, Sound Barrier Evaluation Criteria** for specifications and general design requirements, the **Structures Manual, Volume 3** for guidance in the preparation of the drawings and the **Structures Detailing Manual** for conformance in detailing.

All sound barrier in the State of Florida shall be designed for a minimum wind velocity of 110 mph. If the sound barriers are not located on other structures, the wind pressures shown in **Table 1-2.1.2.C (Exposure B2)** of the referenced **AASHTO Guide Specifications** shall be used. If the noise barriers are located on bridge structures, retaining walls, or traffic barriers, the wind pressures shown in **Table 1-2.1.2.D (Exposure C)** of the referenced **AASHTO Guide Specifications** shall be used. For sound barriers located on embankments and structures, the height zone shall be determined by using the elevation of adjoining ground as being the approximate elevation of the original ground surface prior to embankment construction.

For panels, the maximum deflection due to service wind load shall not exceed the lesser of  $1/180^{\text{th}}$  of the post spacing or  $1\frac{1}{2}$  inch (deflection measured relative to posts). For posts or top of barrier, the maximum deflection due to service wind load shall not exceed the lesser of  $1/50^{\text{th}}$  of the barrier height or 5 inches for sound barriers on deep foundations or 3 inches for sound barriers founded on shallow foundations, and measured from the following:

1. Sound barriers on deep foundations: the deflection shall be measured relative to the point of fixity in the soil. The lateral displacement at the base of the barrier shall not exceed 1 inch.
2. Sound barriers on shallow foundations: the deflection shall be measured relative to the base of the barrier system.

More restrictive panel and barrier deflection limits may be required based on the specific barrier system utilized. Design auger cast piles in accordance with the **Soils and Foundations Handbook, Appendix B**. See **5200 Series** of the **Design Standards** for standard auger cast pile foundation sizes and depths. Increase auger cast pile foundation diameters to 42 inches when depths exceed 30 feet.

If steel pile foundation is considered suitable for the project, determine the environmental classification for corrosion rate evaluation.

Unless approved by the Department, the maximum post spacing for sound barrier panels shall not exceed 20'-0".

On flush shoulder roadways, sound barriers shall be located outside the clear zone unless shielded, and as close as practical to the right of way line. On urban curbed roadways, sound barriers shall be a minimum of 4 feet back of the face of curb. However, additional setbacks may be required to meet minimum sidewalk requirements. Sound barriers may be combined with traffic railings on a common foundation if the combination meets the crash test requirements of NCHRP 350 Test Level 4 criteria.

Besides the structural integrity of the sound barrier, the structural engineer should also be concerned with aesthetics, maintainability, constructability, cost and durability.

Sound barriers should not be located on bridge structures where feasible alternative locations exist. Sound barriers on bridge structures cause a disproportionate increase in bridge cost because of strengthening of the deck overhang and exterior girder. In addition, sound barriers on bridges interfere with normal maintenance inspection access and detract from the aesthetic quality of the structure. Where feasible alternative locations do not exist and sound barriers must be located on bridges or retaining walls, they shall not be taller than 8 ft. unless specifically approved in writing by the State Structures Design Engineer. See ***Design Standards, Index Nos. 5210 and 5212*** for acceptable crash tested 8 ft. bridge and retaining wall mounted sound barriers.

On bridges or on the top of retaining walls, where the sound barrier does not meet crash test requirements of NCHRP 350, Test Level 4, sound barriers shall be placed a minimum of 5 feet beyond the gutter line of a FDOT approved standard bridge railing, and the sound barrier shall be limited to 8 feet in height unless authorized by the State Structures Design Engineer due to reasons stated in the previous paragraph. Sound barriers may be combined with the traffic railing as long as the structural system meets the crash test requirements of NCHRP 350, Test Level 4 criteria.

## 32.7 Geotechnical Investigation

Once the barrier location, alignments, height and minimum thickness are determined, the soil exploration should be undertaken. The geotechnical engineer should follow the Department's ***Soils and Foundations Handbook*** for exploration.



## 32.8 Preparation of Control Drawings

The initial set of drawings to be prepared by the EOR is referred to as Control Drawings. By preparation of these drawings, the EOR shall provide all control parameters such as alignments, limits, notes, etc., and shall provide all the information which is common to all wall types including but not necessarily limited to:

1. Barrier alignments (horizontal and vertical)
2. Barrier limits (beginning and ending)
3. Location of all existing utilities (overhead and/or underground in the vicinity of the proposed barrier)
4. Location of fire-access openings
5. Location of drainage openings
6. Sound barrier graphics details
7. General Notes
8. "Report of Core Borings" (Soil Information Data)
9. Quantities (barrier area as described below for payment purposes only; the itemized quantities such as concrete volume, etc., shall be provided in the specific drawings)
10. All other information that may be construed to be of general nature
11. NOTE: The barrier area for bidding purposes shall be the area bounded by the barrier limits (beginning and ending), the top of the barrier, and the bottom of the lowest panel between posts. This is the vertical surface area that can be seen on an elevation view plus the portion of the lowest panel which is buried.

## 32.9 Detail Drawings

The EOR shall prepare Detail Drawings showing the specific details required for the implementation of the selected Design Standard barrier type. All barrier components such as: foundations, posts, panels, etc. shall be fully detailed for construction. All sound barriers shall include the FDOT Design Standard (non-proprietary) design. The Structures FDOT CADD Menu cell tables shall be included in the plans depicting which QPL proprietary barrier designs are compliant with project specific requirements. These drawings shall provide the specific information as shown in the applicable drawings (see the ***Design Standards***).

Manufacturers of proprietary sound barrier products may have their products evaluated by the Department in accordance with the FDOT Sound Barrier Acceptance Criteria. Approved products will be listed on the Qualified Products List (QPL). The designer or project manager shall establish the project requirements for sound barriers and include commitments made during the PD&E phase or during the design phase public involvement. Project requirements may include color, textures, graphics, post spacing (10 feet or 20 feet), absorptive vs. reflective surface, flush vs. recessed panels, etc. The project requirements shall be listed in the plans.

The designer should refer to options outlined in the ***Structures Detailing Manual, Chapter 15***.

In addition to the Department's Design Standard for concrete sound barriers, the plans shall list proprietary sound barrier products that meet the project requirements and are listed in the QPL. Specify the environmental classification in the plans (for corrosion rate evaluation), if steel pilings can be considered for the project. Characteristics and details of each approved proprietary sound barrier product included in the QPL are listed in the Specification Office's web page.