



**MINNESOTA DEPARTMENT OF TRANSPORTATION**  
**Structural Wall Committee**  
**Evaluating Highway Traffic Noise Walls**  
January 24, 2019

## **Introduction**

Noise barriers are structures intended to mitigate noise transmission from highways to adjacent properties. The purpose of barriers is to enhance the quality of life of the surrounding areas. Noise barriers can be constructed from earth, concrete, masonry, wood, metal, and other materials. A noise wall is a noise barrier with a vertical face and a limited above ground footprint built to divide an area of noise production from an area where noise is not desirable.

These guidelines will establish uniform standards for evaluation of noise wall systems, clarify submittals and prequalification procedures, provide useful information to project designers, and outline criteria for prequalifying noise barrier systems.

The highway traffic noise walls will be approved based upon the evaluation of Environmental (Acoustical and Toxicity), Structural, Material, Aesthetic, and Maintenance considerations.

Federal and MnDOT noise reduction and environmental requirements will be incorporated into the evaluation process. FHWA guidelines, AASHTO and the MnDOT LRFD Bridge Design Manual will be used for the structural evaluation. ASTM and MnDOT Standard Specifications for Construction will be used in the evaluation of materials and constructability of the noise wall system.

For further information, refer to the *MnDOT noise requirements* found on the web at [www.dot.state.mn.us/enviroment/noise/policy/index.html](http://www.dot.state.mn.us/enviroment/noise/policy/index.html).

## **Purpose**

The purpose of this document is to provide the following benefits:

1. Establish a uniform standard for Structural Wall Committee members in evaluating noise barriers.
2. Clarify submittal and prequalification requirements for vendors of noise barrier products.
3. Provide useful information for designers, project managers and functional groups concerning product materials, design requirements and/or limitations, installation, maintenance and cost.
4. Maintain printable guidance for reviewing and prequalifying noise barrier products that designers can use to select the best noise mitigation solution for particular project circumstances.

## **Guidelines**

See attachment: Guideline for the Evaluation of Noise Barrier Products.

## **Questions**

Questions regarding eligibility criteria for noise barrier systems should be addressed to the following contacts:

**Environmental Acoustics:** Office of Environmental Stewardship, Noise Analysis Unit (651) 366-5808

**Toxicity:** Office of Environmental Stewardship (651) 366-3608

**Aesthetics:** Office of Environmental Stewardship (651) 366-4637

**Structural:** Bridge Office, Standards Unit (651) 366-4485

**Foundations:** Office of Materials and Road Research (651) 366-5599

**Materials:** Office of Materials and Road Research (651) 366-5540

**Maintenance:** Maintenance Operations (651) 234-7948

**Attachment:** Guideline for the Evaluation of Noise Barrier Products.

**Guideline for the Evaluation of Noise Barrier Products**

**I) Pre-Qualification**

For a noise mitigation product and/or system to be considered on a MnDOT construction project, the product must be pre-qualified according to the requirements listed herein. The construction project specifications shall list those noise barrier products and/or systems that have been pre-qualified can be considered for bidding. The prequalification shall be based on conformance with current MnDOT, AASHTO and FHWA specifications and/or requirements for noise barriers, including experience and performance of the product or system. Pre-qualification shall not be regarded as final acceptance for any specific project.

**Initial Contact-** Send applications for pre-qualification to:

Minnesota Department of Transportation  
Office of Environmental Stewardship  
Environmental Modeling and Testing Unit  
6000 Minnehaha Avenue  
Saint Paul, MN 55111  
**Contact:** Peter Wasko, Unit Chief  
Phone: 651-366-5801

**II) Criteria for Acceptance**

Acceptance of the noise barrier system will be based on the test data and documentation submitted with the application and any subsequent results of laboratory and field testing and trial installations (if applicable). Further, acceptance will be granted only if the design and materials conform to the required specification and that the system has been demonstrated to be constructible. General grounds for a noise barrier system being accepted or rejected will be based on, but not limited to, the following conditions:

- A) **Structural Considerations:** The structural system will be evaluated for compliance with the structural requirements of this document, FHWA guidelines and AASHTO specifications (See Appendix A for details).
- B) **Materials:** The materials will be evaluated for compliance with the prescribed testing and sampling requirements and other MnDOT's requirements (See Appendix B for details).
- C) **Environmental:** The system Noise Abatement Characteristics and Potential for or creation of environmental damage or health hazard will be evaluated for compliance with the MnDOT's requirements (See Appendix C for details).

- D) Visual Appearance: The visual appearance of the noise barriers and its flexibility to be integrated with engineering solutions will be evaluated for the compliance with the requirements of this memorandum (See Appendix D for details).
- E) Performance: The system field performance, maintenance requirements, life cycle cost and constructability are important factors in the approval process.

### **III) Submittal And Review**

The submittal and review processes will be conducted in two stages. These are:

**Stage One - Preliminary Submittal and Review:** At this stage the system supplier/manufacturer will submit general information about the noise wall system (technical brochure and supporting materials). The supplier/manufacturer need also submit a completed copy of MnDOT New Product Preliminary Information. This form can be obtained from the MnDOT Approved/Qualified Products website ([www.dot.state.mn.us/products/](http://www.dot.state.mn.us/products/)). Questions regarding stage one submittals can be addressed to:

Minnesota Department of Transportation  
Bridge Office  
Structural Wall Committee Chair  
3485 Hadley Avenue North  
Oakdale, MN 55128

**Contact:** Joe Black, Chair  
Phone: 651-366-4485

The committee will review all materials submitted and make an assessment of the viability of the system and determine whether further information is needed. Approval may be granted if the system is deemed substantially equal to or better than an approved system.

**Stage Two - Detailed submittals and review:** Pending a successful stage one review, a full in-depth evaluation of the material will be conducted by members of the Structural Wall Committee (SWC). At this stage, more information may be requested from the supplier/manufacturer (such as questions about performance under local field conditions). The noise barrier product submittal at this stage shall include the following:

- A) **Materials Description** - Request for noise barrier products and/or systems pre-qualification shall be complete and include all information necessary for review and approval, including but not limited to:
  - 1. General product description, including product history and year commercialized.
  - 2. Technical description of all materials and components of the design, including supports, anchors, fasteners, structural details, preservative treatments and/or finishing products.

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3. Drawings showing all components of the design, including arrangement and details for supporting, anchoring, fastening, including relationship with or attachment to related work.
4. Foundation requirements, including minimum soil properties, right-of-way requirements, foundation preparation details, etc.
5. Material and color samples.
6. Photographs of completed work
7. Qualification data and contact information, including list of completed projects with project name, location and owner record.
8. Testing, including test of physical properties and acoustics.
9. Cost data for materials and finished installed products.
10. Other information necessary for review and approval as determined by MnDOT, such as limitations or disadvantages of the product, system or components and construction sequencing for product installation.

- B) **Test results** - The submittal shall include test reports. All testing is to be done by an accredited, independent laboratory acceptable to MnDOT. However, on some occasions, it may be necessary to have specific testing conducted by the manufacturer. This will only be allowed in the presence of the MnDOT representative knowledgeable in the specific test procedure. See attached appendices for a full list of required test procedures.

Whenever possible, testing of samples should be performed using full, production run products. Samples shall not be made specifically for testing purposes.

The submission should include complete copies of all required test results. Names of the laboratories, technicians, and telephone numbers shall also be available.

- C) **Drawings and Design Data** - The barrier designer shall be an engineer licensed by the State of Minnesota and shall prepare, sign, and date the design calculations, all drawings, and accompanying notes. A second engineer shall thoroughly check and sign the design calculations, drawings, and accompanying notes to verify compliance with applicable AASHTO, FHWA and MnDOT requirements, including those listed in this guidance. The drawings are to include the following items and details of the individual components:

1. Location and sizes of reinforcing bars in concrete (if applicable)
2. Weld details (if applicable)
3. Illustrations of the assembled noise barrier system
4. Component assembly details
5. Installation staging and techniques
6. Location of manufacturer's name and lot number on major components
7. Foundation design details for installation in both earth and rock
8. Typical grading details
9. Access openings and door details
10. Access openings/valves for fire hoses

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11. Structure mounting details
12. Termination and transition treatment
13. Post configuration for changes in alignment
14. Panel stepping details.

The accompanying notes are to include the following structural design data:

1. Reference wind pressure
  2. Handling and storage requirements
  3. Noise Reduction Coefficient (only for sound absorptive noise barrier products)
  4. Sound Transmission Class
  5. Properties of all materials used such as minimum strengths, type of steel used, and details of coatings
  6. Installation procedures.
- D) **Calculations** – The noise barrier manufacturer shall be responsible for the structural integrity of their noise barrier system. Therefore, provide copies of comprehensive design calculations demonstrating that the wall components panels, posts, footings, etc. are capable of withstanding various wind loads, vehicular collision forces, and soil conditions in accordance with AASHTO specifications. Limit Service I deflections to 1% of the exposed wall height.
- E) **Quality Control Plan** - The quality control plan should outline the manufacturer's procedures to ensure production of a consistently acceptable product. (This plan will vary considerably depending on the type of materials used as well as the differences in the manufacturing processes.)
- F) **Product Handling and Storage**- Handling and storage requirements should be detailed for all of the various components while at the manufacturing facility, en route to the project, and on the project site.
- G) **Maintenance** - Details should be provided to indicate what protection has been used to address the graffiti issue, and, specifically, how to restore the components to their original appearance. Also, in cases of minor damage, a description of the repair technique should be included.

Completion of this stage of the new product evaluation process usually leads to either acceptance or rejection of a product, except in those few instances where the need for further evaluation becomes evident.

#### **IV) Preparing Standard or Guidance to Designers**

After the pre-qualification of the system, the Structural Wall Committee (SWC) will add the system to the Approved Products List. The Bridge Office Standards Unit will maintain this list. Also, SWC will prepare information about appropriate use and aesthetic guidance to be posted on the web.

#### **V) Implementation**

The following are the guidelines to be used in noise wall implementations:

- A. Submit documentation for any noise wall systems to the Chair of the Structural Wall Committee for evaluation. No wall system shall be used on the trunk highway system until it has been evaluated and approved for use.
- B. Designers are to apply the basic MnDOT standard noise wall design (see current noise requirements document for guidance) to projects with the input from the Office of Environmental Stewardship, Environmental Planning and Design Unit.
- C. If, for structural or other engineering reasons, the standard wall type cannot be used, other wall types may be considered. A list of the approved, pre-qualified wall types is available at:  
<http://www.dot.state.mn.us/products/walls/approved-noise-wall-systems.html> .
- D. If a local agency desires to select a noise wall type that is different from the MnDOT standard wall type, the designer may agree to it considering such things as aesthetics and location. The local agency is responsible for the difference in cost between the standard wall type and the type they selected.
- E. If a wall type other than the standard wall type must be used because of a structural or other engineering reasons, the designer/project manager is to select a wall type that meets the required structural/engineering conditions and that offers the least cost. In this case the cost of the wall will be paid for by the state. Note: the designer/project manager should review the noise analysis to verify wall type and costs were considered in the analysis.
- F. If the designer has further questions about the wall systems, contact should be made with the Chair of the Structural Wall Committee

## **Appendix A: Structural Considerations**

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### **Appendix A: Structural Considerations**

#### **Structural Considerations**

Proper design of noise barrier systems requires the consideration of a variety of structurally related factors. This section is not intended to provide either a standard or a recommended process for the structural design of noise barriers. Rather, its goal is to identify structural issues that should be addressed and considered in the design of noise barrier systems.

If the vendor changes the design of the system or any of its components, the vendor must submit the changes to MnDOT for evaluation.

#### **Compliance with AASHTO Specifications**

All computations, construction procedures and details will be evaluated for compliance with current AASHTO LRFD design specifications and the MnDOT LRFD Bridge Design Manual.

#### **Expansion and Contraction of Barrier Materials**

All materials used in the construction of noise barriers expand and contract with temperature and moisture content changes throughout the seasons. Such expansion and contraction must be appropriately considered in the design of all elements of noise barrier systems. Failure to do so can result in structural, maintenance, acoustical, and aesthetic problems. The individual barrier elements themselves must be designed and constructed to preclude unacceptable deformation, cracking, etc. Conditions where consideration of such expansion and contraction effects is most essential include:

- a) Panel to post connections - Expansion/ contraction is normally accommodated by allowing sufficient space or gaps between the post and the panel. Most details utilize a post trough that the panel fits into. Some designs call for caulking or shimming of the panel/post trough contact point to assure adequate load transfer to eliminate vibration and to avoid sound leakage. Care must be taken to assure that the caulking and/or shimming material does not restrict panel expansion or contraction.
- b) Panel to panel connections - Such connections occur both horizontally (such as between stacked panels or tongue and groove panels) and vertically (such as vertical tongue and groove barrier systems or systems without posts). Such connections must allow sufficient movement while maintaining tight joints.
- c) Expansion joints on cast-in-place and brick/masonry noise barrier systems - Vertical expansion joints are required at sufficient intervals to preclude cracking of the wall system. Designing of such joints in a manner which assures aesthetic and acoustical integrity is often a challenge.
- d) Connections between ground-mounted and structure-mounted barriers - It is sometimes necessary for a ground-mounted barrier to continue onto a structure (bridge or retaining wall). In such instances, special detail barrier sections are required in order to accomplish an adequate connection which is both structurally and acoustically sound while maintaining the desired barrier aesthetics.
- e) Structure-mounted barriers - In addition to the expansion considerations discussed above, barriers mounted on structures must also accommodate expansion/contraction at the structure's expansion joint locations



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### **Appendix A: Structural Considerations**

#### **Foundation Requirements**

Footings and foundations for ground-mounted noise barriers are typically limited to concrete columns (caissons), spread footings, and continuous footings. The following factors contribute to the selection of the type of footing to be used as well as its depth and size:

- a) The bearing capacity and compressibility characteristics of the surrounding soil or rock;
- b) Possible ground movements;
- c) Anticipated future excavation activity adjacent to the foundations;
- d) Ground water levels;
- e) Extent of frost penetration;
- f) Extent of seasonal volume changes of cohesive soils;
- g) The proximity and depth of foundations of adjacent structures; and
- h) Overall ground stability, particularly adjacent to cut or fill slopes.

Foundation design for noise barrier shall be conducted in accordance with the most current AASHTO LRFD Bridge Design Specifications, MnDOT LRFD Bridge Design Manual, and the MnDOT Geotechnical Manual.

#### **Noise Barrier Loadings**

Design of noise barrier systems must include consideration of a variety of design loads, both individually and in combination with each other. Such loads include:

- a) **Dead Load** - The weight of the barrier itself must be considered in all barrier design calculations. Weight considerations are particularly critical in the design of structure-mounted barriers and can require modifications to the structure design itself. Lightweight barrier materials are often utilized in situations where existing or proposed structures are limited in the amount of additional weight which they can accommodate. Ice loads represent a special type of dead load caused by water freezing and building up on exposed barrier surfaces.
- b) **Wind Load** - Wind loads vary with geographic location and can be influenced by elevation in relation to existing topography. Calculate minimum design load using the current AASHTO LRFD Bridge Design Specification. Assume a Ground Surface Roughness and Wind Exposure Category of 'C'.
- c) **Earth Loads** – Design the wall for the proposed soil retained. In addition, the designer should assume 6" of possible settlement of soil on the low side of the noise wall and 6" of soil accumulation on the retained side. (i.e. 12" minimum of soil differential).

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- d) **Vehicular Collision Forces** – MnDOT requires all noise wall systems placed within the clear zone to be protected by a crashworthy barrier, or to be part of a MASH crash tested system meeting the minimum requirements of Test Level 3 (TL-3). The MnDOT APL includes two types for noise walls:

Type LW Noise walls only permitted greater than 4 feet outside the traffic face of a protecting rigid barrier system.

Type NLW Noise walls permitted to be placed 4 feet or less outside the traffic face of a protecting rigid barrier system, or noise walls that is part of a crash tested system.

All walls are assumed to be Type LW unless supporting documentation is submitted for Type NLW.

To designate a wall as Type NLW, submit details, drawings, calculations, and other supporting documentation for panels, posts, and all other noise wall components required for placement of the wall system 4 ft or less from the traffic face of a protecting barrier. Design the wall for a setback of 1 ft from the traffic face of a crashworthy rigid barrier system. Apply Test Level 3 (TL-3) loading criteria. Design noise wall system components in accordance with the current AASHTO LRFD Bridge Design Specification modified as follows as an estimate for MASH level loads: apply an Extreme Event II load factor of 1.15 to the design collision load until such time as updated loading is provided in AASHTO for MASH Test Level demands.

Noise wall systems are not permitted within 5 feet of the face of a protecting guardrail.

In lieu of design, noise wall systems may be crash tested alone or as a system to meet MASH criteria. Include as part of the testing a guardrail connection which matches current MnDOT guardrail standards. All testing and analysis is to be performed by an ISO/IEC 17025 accredited crash testing facility with a minimum of 5 years crash testing experience. Submit a report prepared by the crash test facility outlining the test procedure, stating any system constraints, and certifying that the proposed system meets MASH TL-3.

MnDOT will setback all features of a noise wall system at least 1 foot from the top edge of the traffic face of a protecting rigid barrier unless part of a crash tested system.

Noise wall systems meeting the above criteria will be indicated as Type NLW on the MnDOT APL. All other noise wall types that are approved will be listed as Type LW.

## **Appendix B: Material Considerations**

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### Appendix B: Material Considerations

Material requirements: The following materials Sampling and Testing Requirements will be used for evaluation of the systems:

- a) **Structural Strength** - The system supplier of the noise barrier shall provide structural strength properties of the individual components and the system to determine if it meets MnDOT requirements. Strength of the panel or components may be verified through load testing on a production panel sample.
- b) **Shatter Resistance** - Shatter resistance should be considered as both a maintenance issue and a safety issue. If the material is susceptible to fracturing or shattering, an analysis of the product's shatter resistance should be conducted to determine if the material's characteristics are acceptable for use in a noise barrier system. A typical test method to determine susceptibility to shatter is ASTM E695 or approved equivalent.
- c) **Flame Spread and Smoke Generated** - The material's burn characteristics, in accordance with the ASTM E84 numeric indexing, should be comparable to or better than the results achieved from Southern Yellow Pine (as control) under the same test conditions. Chemical flame retardants in the materials should be identified along with the corresponding Chemical Abstract Services (CAS) number.
- d) **Toxicity** – Materials used shall not cause environmental or health hazard for humans or animals. The material shall not cause safety concerns to people handling, installing, and maintaining the walls.( See Appendix C for details)
- e) **Durability**- The supplier shall provide documentations that the wall system will have a minimum of 35 years life (the wall should have consistent functionality and appearance) with little or no maintenance.
- f) **Recyclability** - The materials will be assessed for their ability to be recycled or disposed of in an acceptable and cost effective manner at the end of their useful life. This is particularly critical when considering the use of components already made of recycled materials.

The following are additional tests or conditions applicable to specific barrier systems (concrete, metal, and wood):

- a) **Concrete** -  
Concrete products shall meet the applicable portions of 2462 (Precast Concrete), 2472 (Metal Reinforcement), and 3240 (Precast Concrete Manufacturing).  
Drycast concrete products shall meet the requirements of Technical Memorandum 14-03-MAT-01 (Use of Dry-cast Segmental Masonry Retaining Wall Units).

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#### b) **Metals -**

1. **Accelerated Weathering:** This test provides information on how well the metal and its coating withstand extreme weather conditions. Although this accelerated test method is not a true representation of actual condition, it does provide a reasonable tool to predict the results of long term exposure to harsh climatic conditions. ASTM B117 is a suitable test method and has been thoroughly quantified over the numerous years in practice.
  
2. **Coating Durability:** The coating system should be tested in a weatherometer chamber in accordance with ASTM G155. The coating system should then be evaluated for the following weathering effects when rated according to the appropriate ASTM standards:
  - Checking - ASTM D660;
  - Cracking - ASTM D661;
  - Blistering - ASTM D714;
  - Adhesion - ASTM D3359;
  - Color change - ASTM D2244; and
  - Chalking - ASTM D4214.
  
3. **Coating Thickness -** Coating thickness, whether it is galvanized, painted, sprayed, or dipped, must be verified to ensure compliance with specifications.

#### c) **Wood -**

1. **Structural Grade:** Specifying a good structural grade of lumber does not guarantee that all pieces of wood will be straight enough to permit the tight fit normally required for wood barriers. Therefore it is essential to visually confirm the grade of the wood used. In addition, the supplier should have procedures for the removal of any boards that are warped, checked, split, or have excessive knots.
  
2. **Dimensional Stability:** Structural graded lumber does not ensure that the product will never shrink, particularly if the wood has not been properly seasoned or kiln dried before pressure treating. Therefore, all wood components, particularly timbers, beams, and posts thicker than 4 inches (100 mm), should be checked for dimensional tolerances.
  
3. **Determination of Penetration:** AWPA A19 is a suitable test to determine the depth of penetration of the preservative into the wood. The penetration rate may vary between species.

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### Appendix B: Material Considerations

4. **Moisture Content:** ISO 4470 details a method used to determine the amount of moisture in the wood. It is a nondestructive test and should be conducted on all lots, individual larger pieces, and particularly those where warping, checking, and splitting may not be preventable or may have a serious impact on the overall performance of the wall.
- d) **Special Considerations for Plastics -**
1. **Burning Characteristics:** Plastic noise barrier walls or wall materials containing plastic tend to be more flammable than barriers made of other materials. The smoke and emissions that may be generated from burning plastics should be considered toxic. The ash left from any burnt material could contain metals that could migrate into the surrounding soil and water supply. Ash should be collected and tested for metals and semi-volatiles to determine the hazardous waste status. (See Appendix C)
  2. **Shrinkage:** Some plastic products are not dimensionally stable and may tend to shrink leaving open cracks between joints or may be susceptible to accelerated creep and deformation.
  3. **Ultraviolet Protection:** Some plastic products are very sensitive to ultraviolet light and tend to cause rapid deterioration of pigments, surface appearance, and material strength. To avoid this, it is possible to slow down the deterioration process by adding ultraviolet protection into the composition of the plastic at the time of molding.
  4. **Creep:** Creep, which is evident in most plastics to varying degrees, should be considered during the design of the barrier system by reducing the amount of strain to which the plastic components may be subjected.
  5. **Vandalism:** Plastic panels are particularly susceptible to vandalism from paint, knives, and lighters.
  6. **Shatter Resistance:** Although most commonly used plastic products are relatively shatter resistant, this characteristic tends to deteriorate over time, and the product becomes more brittle and may shatter on impact by flying objects or vehicles. Damaged panels can usually not be repaired by patching. The only option is to replace the damaged sections, thus increasing the cost of repairs and possibly jeopardizing the appearance of the barrier if similarly molded panels are no longer available or are difficult to reproduce at a reasonable cost.
  7. **Glare:** Depending on the surface texturing applied to the plastic surfaces, the barrier panels may be susceptible to glare from opposing light sources.

e) **Special Considerations for Recycled Rubber -**

1. **Flammability and Smoke:** Rubber is notorious for its high flammability and the dense smoke which is produced when it burns. If a noise barrier wall containing this material should ignite as a result of such incidents as grass fires, accidents, or vandalism, the accelerated flame spread and the dense smoke produced could result in safety and legal complications. To reduce rubber's susceptibility to these concerns, flame and smoke retardants are available that can be added to the mixture during the manufacturing process.
2. **Toxicity:** Recycled rubber tire polymer leachate has been found to have low aquatic toxicity. However, additives, such as binders, retardants, coatings, and coloring, included in the mix to preserve and protect the material, can create potential toxicity concerns. These additives are, in some cases, proprietary with the specific formulations kept in confidence by the manufacturer. Noise barrier walls or wall materials with recycled rubber should not be placed in surface water.
3. **Structural Strength:** Rubber material, on its own, does not have sufficient rigidity to be considered as a structural component of a noise barrier panel. Therefore, bonding agents must provide adequate stiffness to enable the panels to be considered strong enough to withstand wind loading, or the rubber material must be firmly attached to a suitable stiffener, such as channel backings, cores, or casings.
4. **Binders:** Rubber and some binders tend to oxidize over time when exposed to the elements. They may also be susceptible to certain chemical or petroleum products. This increases the potential of premature disintegration of the panels. If concrete is used as a binder, concrete modifiers and special treatment of the crumb rubber are required before they will bond properly to each other. This is particularly important when these panels are exposed to salt, cold weather, and flexing for a long period of time.
5. **Coatings:** Some coatings suitable for rubber have a questionable life expectancy. They have a tendency to oxidize prematurely, particularly when used in conjunction with certain pigments. If the surfaces of the noise barrier panels are being manufactured to be sound absorptive, the coatings may clog the surface openings thereby reducing the Noise Reduction Coefficient (NRC).
6. **Sound Transmission Class (STC):** Although the weight of the panels may be sufficient to meet general requirements for minimum STC ratings, it may not be sufficient when produced as a porous panel. Even when stiff backers or cores are used, the nature of this material may require the cores or backers to be extensively perforated to promote bonding.
7. **Recyclability:** The recyclability of the final product may have been reduced drastically by the type of additives needed to alter the physical properties of the panel so that it can meet the various fundamental requirements for an effective, safe, and durable noise barrier product.

## **Appendix C: Environmental Considerations**



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**Appendix C: Environmental Considerations**

**Environmental Requirements**

The submittal shall meet the following requirements for toxicity and acoustics:

**Toxicity**

For uncommon, recycled, or chemical containing materials, concerns for environmental damage and health hazards should be addressed by requesting the following environmental testing to determine the toxicity characteristics of the final noise barrier panel material. All manufacturers submitting materials for consideration must include the following information if available:

- a) Vendor information
  - 1. Name of Company
  - 2. Address
  - 3. Technical Contact Name and Telephone Number
  - 4. Application Date
  - 5. Product Trade Name
  - 6. Product Chemical Name
  - 7. Product Data Sheet
  
- b) Provide Material Safety Data Sheets for all chemicals in the product/waste material.
  
- c) Regulatory Approvals & Status:
  - 1. Licenses
  - 2. Approval
  - 3. Permits
  - 4. TSCA Listing
  
- d) Chemical Status:
  - 1. Provide Individual Chemical & Physical Properties (EPA Methods 830.7200, 830.7220, 830.7840, 830.6317, 830.7370, 830.7570, 830.7950, 835.1230, and 835.2130 or equivalent method);
  - 2. Identify chemicals with molecular weights greater than 1000 Daltons (OECD Methods 118, 120 or equivalent);
  - 3. Verification by laboratory testing that final product would not be considered a hazardous waste under Minnesota Rules Chapter 7045 if disposed of unused;
  - 4. Names and Chemical Abstract Numbers (CAS numbers) of the reportable substances in the product (40 CFR 302);

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The following product-specific information must be submitted if known. If information for a representative test is unknown it must be stated as such. EPA SW-846 test method information can be found at: <https://www.epa.gov/hw-sw846/sw-846-compendium>. OECD<sup>1</sup> product test method information can be found at: <http://www.oecd.org/> or <http://www.oecd.org/chemicalsafety/testing/oecdguidelinesforthetestingofchemicals.htm>

- a) Leach test results (EPA Method 1312 with subsequent analysis for test substance or equivalent method);
- b) Biodegradation (EPA Method 835.3110, 835.3190, 835.3215, 835.3300, 835.4100 or equivalent method);
- c) Ecotoxicity to include three trophic levels (EPA Methods 850.1300, 850.1400, 850.4100, 850.4150, 850.5400, and 850.6200 or equivalent method);
- d) Other available test data that provide individual chemical fate and pathway information.

Full policy description can be found at:  
<http://www.dot.state.mn.us/policy/operations/op010.html>.

<sup>1</sup> Organization for Economic Co-operation and Development methodologies for product testing are equivalent methods and are acceptable.

**Acoustical Criteria / Noise Reduction Coefficient (NRC) for Absorbent Noise Walls**

If a proposed noise wall meets structural design criteria, but is not designed using Minnesota Department of Transportation (MnDOT) Standard Plans and/or does not use materials already in use in Minnesota, then a Noise Reduction Coefficient (NRC) evaluated using Sound Absorption Coefficients (SAC) determined using the standard ASTM C423-17 test, needs to be determined. The SAC test shall be conducted in accordance with ASTM Test Number ASTM C423-17 in one-third octave bands from 200 hertz to 2500 hertz inclusive. MnDOT requires the NRC be evaluated as the arithmetic average of the SAC values at the octave bands of 250, 500, 1000 and 2000 hz, to the nearest 0.05. The applicants shall furnish the MnDOT Noise engineer with all relevant SAC test data, including test data sheets and NRC calculations.

MnDOT requires that a physical test of SAC values will be carried out by a reputable acoustical laboratory. This test shall be conducted on a full scale mockup of the proposed wall design using materials and connections that would be used on the actual noise wall.

MnDOT requires that the calculated NRC be equal to or greater than 0.80. MnDOT would require an absorbent surface on both sides of a proposed noise wall if considered warranted based MnDOT's noise analysis and other germane circumstances.

### **Acoustical Criteria / Transmission Loss (TL)**

If the proposed noise wall meets structural design criteria, but is not designed using Minnesota Department of Transportation Standard Plans and/or does not use materials already in use in Minnesota, then a test for sound transmission loss will be required. The applicants shall furnish the MnDOT Noise engineer with all relevant transmission loss (TL) test data including test data sheets and computations.

MnDOT requires that a physical test of sound TL will be carried out by a reputable acoustical laboratory. This test shall be conducted on a full scale mock up of the proposed wall design using materials and connections that would be used in the actual noise wall.

The TL test shall be conducted in accordance with ASTM Test Number E 90-04 in one-third octave bands from 100 hertz to 8000 hertz inclusive.

MnDOT calculates a TL index, labeled Minnesota Department of Transportation Transmission Loss Index (MDTTLI), used to quantify the effectiveness of a proposed noise wall configuration in reducing transmitted sound. The MDTTLI gives the maximum design reduction that the noise wall can achieve. For example: A noise wall is designed to achieve a noise reduction of 12 dB. Only a noise wall with a MDTTLI greater than or equal to 12 can be used. Following is a worksheet that can be used to calculate the MDTTLI for the noise wall configuration in question, based on the laboratory results for the 1/3-octave band TL values.

See the MDTTLI Worksheet on the following page.

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MDTTLI Worksheet

1/3 Octave Band	1/3 Octave Band		1/3 Octave Band		1/3 Octave Band				
	50' H. Trk @ 70 mph Incident Level		TL		Transmitted Level				
Hz	dBA		dB		dBA				
100	60.00	-		=					
125	61.00	-		=					
160	62.00	-		=					
200	64.00	-		=					
250	67.00	-		=					
315	70.50	-		=					
400	74.00	-		=					
500	76.50	-		=					
630	79.00	-		=					
800	80.50	-		=					
1000	80.50	-		=					
1250	79.50	-		=					
1600	77.50	-		=					
2000	75.00	-		=					
2500	72.00	-		=					
3150	69.00	-		=					
4000	66.50	-		=					
5000	64.50	-		=					
6300	62.00	-		=					
8000	58.50	-		=					
	<b>Overall Incident Level Log Sum dBA</b>				<b>Overall Transmitted Level Log Sum dBA</b>				<b>MDTTLI    Index</b>
	<b>88</b>		<b>-</b>			<b>-</b>	<b>10</b>	<b>=</b>	

Notes: 
$$\text{Log Sum} = 10 * \log_{10} \left( \sum 10^{(1/3 \text{ Octave Band Level} / 10)} \right)$$
  
 Maximum design effectiveness of a noise wall is 15 dB.

## **Appendix D: Aesthetic Considerations**

## **Guideline for the Evaluation of Noise Barrier Products.**

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### **Appendix D: Aesthetic Considerations**

#### **General Criteria**

Successful noise barrier designs must achieve a balance among numerous goals (acoustical requirements, structural integrity, safety, visual quality, cost-effectiveness, constructability, maintainability, durability, etc.) that vary even among very similar design problems because the project related context and circumstances are always unique. Across the country, many roadway noise barriers have been designed with obvious care and attention to visual detail and yet they may not be perceived as visually successful, by travelers and neighbors, because they fail to relate and fit well within the adjacent environment, community or roadway.

#### **Visual Quality**

The importance of visual quality in attaining public acceptance of noise barriers or any other transportation project element should be no surprise recognizing how much a typical person's perception is based on sight. Visual quality must be an integrated element (not an "add-on") of good planning and design process with rigorous evaluation of alternatives to determine the most appropriate and cost-effective structural systems, materials and visual treatments for the context and circumstances.

#### **Flexibility in Design**

Successful noise barrier design requires thoughtful understanding, integration and coordination of visual design principles to minimize objectionable visual impacts and to achieve desired visual objectives, public acceptance and balanced solutions to best address unique project problems and goals.

The primary criteria for evaluating and accepting noise wall systems and products (for other than very selective use or application) based upon visual quality considerations, must be the flexibility in which the system or products can incorporate a widely varying range of the major elements of visual perception (line, color, form, texture) while balancing with other project goals (acoustical effectiveness, structural integrity, safety, cost-effectiveness, constructability, maintainability, durability, etc.).

A secondary consideration must be the flexibility in which the system or products can be adaptable in consideration of variable elements of visual perception (scale, proportion, distance, light, motion, etc.).

#### **References**

For guidance, on visual quality in noise barrier design, contact MnDOT's Environmental Planning and Design Unit Manager (651-366-4637) or Bridge Architectural Specialist (651-366-4465). For more information, refer to FHWA's "*A Guide to Visual Quality in Noise Barrier Design*" at:

[https://www.fhwa.dot.gov/environment/noise/noise\\_barriers/design\\_construction/visql/index.cfm](https://www.fhwa.dot.gov/environment/noise/noise_barriers/design_construction/visql/index.cfm)

## **Appendix E: Maintenance Considerations**

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