Metrolinx
Noise Barrier Design Requirements

Revision 0

Metrolinx

Noise Barrier Technical Specifications

Publication Date: Feb 2022

Preface

This is the first edition of the Noise Barrier Technical Specifications. The purpose of the document is to provide technical requirements for Nosie Barriers to mitigate corridor infrastructure and equipment or fleet generated noise. It provides contractors and project delivery teams with Metrolinx design requirements, including prescriptive and performance criteria applicable network wide. All modes are addressed in this document.

Suggestions for revision or improvement should be sent to Metrolinx Design Standards, Attention: Senior Manager, Design Standards, Architectural Design & Construction Assurance

February 2022

TABLE OF CONTENTS

PART A – GENERAL

A.1 SCOPE

(a) This specification covers the design, supply, delivery and construction of pre-manufactured noise barrier systems to attenuate airborne noise from transit operations.

(b) Noise barriers shall be provided in compliance with the Environmental Obligations defined in the Environmental Assessment for noise mitigation.

(c) When it has been determined that noise barriers shall be employed as a noise mitigation strategy, the following criteria must be met.

A.2 REFERENCES

(a) Conform to the latest edition of the following:

(i) AREMA Manual for Railway Engineering;

(ii) CAN/CSA S6, Canadian Highway Bridge Design Code (CHBDC);

(iii) CSA A23.4, Precast concrete – Materials and construction;

(iv) CSA Z107.9, Standard for Certification of Noise Barriers;

(v) CSA-G40.20/G40.21, General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steels;

(vi) CAN/CSA G164-M, Hot Dip Galvanizing of Irregularly Shaped Articles;

(vii) CSA W47.1, Certification of Companies for Fusion Welding of Steel Structures;

(viii) CSA W59-M, Welding Steel Construction (Metal Arc Welding);

(ix) Canadian Foundation Engineering Manual

(x) AMPP SSPC-SP 6/NACE No. 3 – Commercial Blast Cleaning;

(xi) ASTM B209, Aluminum and Aluminum-Alloy Sheet and Plate;

(xii) ASTM C423, Standard Method for Sound Absorption and Sound Absorption Coefficient by the Reverberation Room Method;

(xiii) ASTM C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing;

(xiv) ASTM C672, Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals;

(xv) ASTM D638, Test Method for Tensile Properties of Plastic;

(xvi) ASTM D785, Test Method for Rockwell Hardness of Plastics and Electrical Insulating Materials;

(xvii) ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials;

(xviii) ASTM D1003, Test Methods for Haze and Luminous Transmittance of Transparent Plastics;

(xix) ASTM E84, Standard Test Method for Surface Burning Characteristics of Building Materials;

(xx) ASTM E90, Standard Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions;

(xxi) ASTM E313m Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates;

(xxii) ASTM E413, Standard Classification for Determination of Sound Transmission Class;

(xxiii) ASTM E795, Standard Practices for Mounting Test Specimens During Sound Absorption Tests;

(xxiv) ASTM E1996, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes;

(xxv) ASTM G155, Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials;

(xxvi) Metrolinx General Guidelines for the Design of Railway Bridges and Structures;

(xxvii) National Precast Concrete Association NPCA Plant Certification Quality Control for Precast Concrete Plants;

(xxviii) OPSS 206 Grading;

(xxix) OPSS 501 Compacting;

(xxx) OPSS 760 Construction Specification for Noise Barrier Systems;

(xxxi) OPSS 904 Concrete Structures;

(xxxii) OPSS 906 Construction Specification for Structural Steel for Bridges;

(xxxiii) OPSS 1350 Materials Specification for Concrete – Materials and Production; and

(xxxiv) OPSS 1440 Materials Specification for Steel Reinforcement for Concrete.

A.3 SUBMITTALS

(a) Submit manufacturer's product data minimum fourteen (14) days prior to commencement of manufacture and construction, indicating:

(i) Certified test data showing compliance with the design requirements.

(b) Submit working drawings minimum fourteen (14) days prior to commencement of manufacture and construction, indicating:

(i) Full details of noise barrier related items, construction procedures and, if applicable, connections to structures. All submissions shall be signed and sealed by a professional Engineer licenced to practice in the Province of Ontario.

(c) Submit a detailed plan for the site storage and protection of noise barrier components including during panel movement.

(d) Submit a construction work plan (outlining sequence of pre-construction and installation work) in accordance with Metrolinx requirements.

A.4 GENERAL REQUIREMENTS

(a) For GO/Heavy Rail systems, the minimum standard height for the noise barrier system shall be a post and panel configuration made with pre-manufactured modular panels, nominally (Industry Standard) 915 mm wide and 4265 mm extending 600 mm (typical) above grade resting on a precast concrete base for an approx. total height of 5m. Any height requirement in excess of this minimum standard height shall be determined by the project specific Environmental Assessment Report.

(b) For all other modes, i.e. Subway, Rapid Transit, etc., project specific Environmental Studies, Reports etc. shall govern height requirements to optimize performance.

(c) Noise barrier heights shall be referenced from top of adjacent rail, unless otherwise indicated.

(d) Noise barriers shall be designed so that there shall be no sections less than 100 m in length with variable height. Where topographical changes precipitate shifts in the datum of the noise wall – a minimum of five adjacent panels must be maintained at each given top of barrier elevation within the 100 m parameter.

(e) The visual aesthetic appearance of the noise barrier panels, in terms of colour, pattern and texture, shall be uniform and free from visible cracks or other defects when viewed at 15 m from the face of the barrier. Any visual blemishes shall be repaired and touched-up in accordance with the Manufacturer's recommendations.

(f) Site investigations shall be performed to determine soil parameters, water tables, location of underground services and above grade obstructions. Site specific geotechnical and hydrological

information shall be used to ensure the design meets the specific requirements of the site where the noise barrier is to be constructed.

(g) Parameters in Article A.4(f) of this specification shall be used to determine the depths, sizes and locations of the noise barrier post footings.

(h) The alignment and the top and bottom elevations of the noise barriers shall be established and these elevations shall be used to develop the layout and fabrication drawings indicating top and bottom of noise barrier elevations.

(i) Skewed end details shall be provided to allow noise barrier units to match ground profiles with grades in excess of 2% such that the difference in elevation between adjacent units of the same height shall not exceed 25 mm.

(j) Tops of posts shall be cut to match top of adjacent panel elevation.

(k) Site surveys shall be carried out and coordinated with Metrolinx to confirm locations of noise walls are in compliance with the Environmental Obligations defined in the Environmental Assessment for noise mitigation.

(l) All site preparation, rough and final grading, noise barrier marking and staking showing station number, bottom of noise barrier elevation, cut or fill dimension and offset to the centerline of the noise barrier wall at approximately 25 m intervals shall be performed.

(m) Below grade services shall be clearly marked on site to ensure the construction does not clash or interfere with existing below grade services.

(n) Positive drainage shall be provided to eliminate ponding at the base of the noise barriers.

(o) Flashing shall be installed and sealed to eliminate ponding where noise barriers are attached to structures.

(p) The manufacturer of the noise barriers shall be listed in the Ministry of Transportation (MTO) Designated Sources for Materials (DSM) Manual as an approved manufacturer of absorptive type noise barriers (ref. DSM List #5.50.20);

(q) Noise barrier manufacturer shall have a minimum of 5 years proven experience in the design, manufacture, and supply of noise barriers within the Greater Toronto Hamilton Area (GTHA) Region.

(r) Galvanized steel shall be used for all exposed steel. Galvanizing shall be in accordance with ASTM A123.

(s) Any stains, paints, and anti-graffiti coatings shall be applied at the noise barrier manufacturing plant.

(t) The noise barriers function safely and in a fully functional manner under the expected ambient conditions set out in Table A4.1, and under any abrupt changes in expected ambient conditions set out in Table A4.1.

TABLE A4.1 - Expected Ambient Conditions

High temperature conditions	44°C	111°F
Low temperature conditions	-40°C	-40°F
Relative humidity	20% to 100% (Non-Condensing)	
Snowfall rate per hour	50 mm	2 inches
Snowfall rate per day	300 mm	12 inches
Rainfall rate per hour	65 mm	2.5 inches
Rainfall rate per day	100 mm	4 inches
Ice accretion per hour	13 mm	0.5 inches
Ice accretion per day	50 mm	2 inches
Standing water above top of rail or roadway surface (as applicable)	76 mm	3 inches
Wind maximum continuous velocity	65 km/h	40 mph
Wind gusts	120 km/h	75 mph

A.5 DESIGN REQUIREMENTS

(a) Noise barriers shall be designed to withstand a wind pressure of a 50-year return period determined on a site-specific basis or a wind pressure of 520 Pa, which ever is greater. The design of wind loads shall be determined in accordance with CAN/CSA S6.

(b) Noise barriers shall achieve a minimum surface density of 20 kg/m2 or greater regardless if it is a solid or transparent panel.

(c) The Sound Transmission Loss (STL) shall be greater than 20 decibels at all frequencies as determined in accordance with ASTM E90 requirements. The Sound Transmission Class (STC) of the noise barrier panels shall be equal to or greater than 32 as determined in accordance with ASTM E90 requirements.

(d) The cumulative weight loss of particles after 300 freeze/thaw cycles shall be less than 1% as determined in accordance with ASTM C666 - Method A requirements.

(e) The loss of mass due to salt scaling after 50 freeze/thaw cycles shall be less than 0.8 kg/m2 as determined in accordance with ASTM C672 requirements.

(f) Noise barrier panels shall not exhibit any deterioration in the form of cracks, spalls or aggregate disintegration after 50 freeze-thaw cycles.

(g) The Flame Spread Index (FSI) of the noise barrier panels shall be less than 10 as determined in accordance with ASTM E84 requirements.

(h) The smoke development (SD) of the noise barrier panels shall be less than 12 as determined in accordance with ASTM E84 requirements.

(i) Noise barriers shall resist rusting, warping, animal and insect nesting and infestation:

  (i) Noise barriers shall be designed for a service life of fifty (50) years; and

  (ii) A warranty shall be submitted to Metrolinx to implement any maintenance requirements to the noise barriers related to workmanship or materials (including any significant deterioration, delaminating, disfigurement or failure) for a period of ten (10) years from the date of Certification of Completion of the Contract.

(j) Structural Component Requirements:

  (i) Posts may be steel or precast, reinforced concrete.

  (ii) Steel posts, if used, must conform to the following requirements:

    A. steel posts shall be new structural steel material conforming to CSA-G40.20/G40.21, Grade 350A or 350W;

    B. mill test certification requirements as per OPSS 906;

C. steel must be cleaned to SSPC-SP6/NACE No. 3 and hot dipped galvanized after fabrication with minimum zinc coating of 600 g/m2 to CAN/CSA G164-M; and

D. the post design shall be signed and sealed by a professional Engineer licenced to practice in the Province of Ontario.

(iii) Concrete posts, if used, must conform to the following requirements:

A. Concrete posts shall be precast, reinforced concrete in compliance with OPSS 1350 and OPSS 1440;

B. the minimum compressive strength of the precast concrete shall not be less than 35 MPa at 28 days after casting;

C. all reinforcing steel shall be deformed bars conforming to CSA-G30.18, Grade 400W; and

D. the post design shall be signed and sealed by a professional Engineer licenced to practice in the Province of Ontario.

(iv) Posts and footings shall be designed to withstand live, dead, lateral, wind, seismic, handling, transportation, erection, imposed and other loads.

(v) Post footings shall be designed to be installed until minimum soil bearing capacity is met or in rock in accordance with the design parameters of the noise barrier system:

A. the footing design shall be in accordance with OPSS 760 requirements; and

B. the footing design shall be signed and sealed by a professional Engineer licensed in the province of Ontario.

(vi) All welds shall conform to CSA W59-M and CSA W47.1.

(k) Utility coordination requirements:

(i) Field surveys, utility locates, and foundation test pits shall be performed as needed and in accordance with Article A.4(m).

(ii) Approvals from the utility owner shall be obtained for noise barrier installations within 3 metres of existing utilities.

(iii) Any underground utilities shall be avoided by altering post spacing and spanning the utility provided capacity of the noise barrier is not reduced.

(iv) Separation from underground and overhead utilities, regardless if clearances are either vertical or horizontal shall be in accordance with the utility owner’s standards.

(v) The following minimum clearances shall be achieved:

A. underground utilities running parallel to the noise barrier shall be a minimum of 1 metre clear from the edge of the footings; and

B. overhead utilities shall be a minimum of 3 metres clear from the noise barrier.

(l) Noise barrier design shall ensure that adjacent elements such as vegetative screenings do not impede periodic inspections and maintenance activities of other transit infrastructure assets.

A.6 CONSTRUCTION REQUIREMENTS

(a) The existing site conditions and accessibility to the site shall be used when determining how to construct the noise barrier including any required false work.

(b) Adequate protection to the panels shall be provided when handling moving and storing the panels to prevent staining, marking, chipping or spalling. Refer to item A.4(e) within this specification for visual appearance requirement.

(c) Noise barrier system manufacturer shall oversee field installation and certify the installed work as being in conformity with the Specifications.

(d) A minimum vertical or horizontal clearance shall be maintained per the utility owner's standards during excavation, and appropriate inspectors are on-site as required by the utility owner.

(e) The concrete for footings in augured holes shall be cast entirely in a stable soil, compacted engineered fill, or rock:

(i) should liners be required, concrete shall be poured into the liner and the liner withdrawn as pouring of the concrete progresses;

(ii) where site conditions dictate that special footings are to be constructed in large excavations, the non-standard footings shall be designed and signed and sealed by a professional engineer licenced to practice in the Province of Ontario;

(iii) excavation in soil shall be back-filled with granular material and compacted to at least 98% standard Proctor maximum dry density; and

(iv) excavation in rock shall be backfilled entirely with concrete. Excavation above the top of rock shall be formed to the required dimensions and the remainder of the excavation backfilled with granular material.

(f) The concrete in footings shall be cured in accordance with the requirements of OPSS 904 prior to construction works which places stress on the posts may be carried out:

(i) the tops of all footings shall be shaped and leveled to provide for full horizontal seating of the bottom panels; and

(ii) the remaining surface of the top of footing shall be rounded to allow running off for water.

(g) Posts for noise barriers shall be installed upright within +/- 10 mm of vertical in 5.0 m:

(i) the posts shall be located to the line and grades specified on the Contract Documents to within a tolerance of +/- 10 mm; and

(ii) any accidental coating of concrete on the above grade surfaces of the posts shall be washed off on the same day of installation.

(h) Zinc painting shall be avoided where possible to avoid failures in the material.

(i) Any galvanized surfaces, which are roughened shall be cleaned and painted with a zinc-rich painting according to ASTM 780.

(j) Intermediate panels shall be fitted tight to the panel below with joints free of foreign material, ice and snow.

(k) There shall be no visible gaps between the panels, between the panels and the posts, or beneath the bottom panels along the alignment of the noise barriers.

(l) Stain, paint, and anti-graffiti coating touch-up applied during or after installation shall be in accordance with the manufacturer's requirements.

(m) Remove from site (or deposit on site at designated location) all surplus materials excavated for the placing of noise barriers and footings.

(n) Clean panels and posts of any soils, dirt and debris.

(o) Each noise barrier unit (i.e. group of panels between posts) shall be tagged by identification plate as to its type, location, date of installation, manufacturer, installment Subcontractor, and orientation in the noise barrier system to help with identification for future maintenance or replacement. The identification plate shall be located on the side of the noise barrier system facing the transportation corridor, at approximately 1.2 m above the ground. The maximum dimensions of the plate shall be 200 by 200 mm. The plate shall be made from 0.81 mm thick anodized aluminum sheet according to ASTM B 209 series 1100 or 5005-H34.

PART B – BASE NOISE BARRIERS (TYPE NB-1)

B.1 GENERAL

(a) Noise barrier panels shall be precast concrete or cement-bonded material with reinforced concrete core.

(b) The minimum compressive strength of precast concrete shall not be less than 35 MPa at 28 days after casting.

(c) The panel design shall incorporate horizontal tongue and groove features for alignment and meshing of stacked panels.

(d) Panel face colour shall be Sika 'Precast' or equivalent subject to Metrolinx approval.

(e) Panel texture shall be as specified in the Contract Documents.

(f) The panel design shall be sealed by a professional engineer licensed to practice in the Province of Ontario.

(g) Stain applied to the surface of noise barrier panels shall not exhibit any apparent chalking, checking or blistering after 2,400 hours exposure in accordance with ASTM G155 requirements.

(h) The total difference in colour (ΔE*) of the stain shall not be greater than 3.0 as determined in accordance with ASTM G155 requirements.

(i) Noise barrier panels shall provide acoustical absorption on one side facing into the transportation corridor. No adhesive or mechanical fasteners may be used to attach the sound absorbing material to the structural concrete.

(j) Absorptive sides of panels shall have a Noise Reduction Coefficient (NRC) equal to or greater than 0.70, in accordance with ASTM C423 and ASTM E795.

(k) The raw materials used for the sound absorbing material shall be moisture resistant:

(i) the sound absorbing material shall drain freely and not trap or wick moisture into the sound absorbing panel.

(l) Non-sacrificial anti-graffiti coating approved by the noise barrier panel manufacturer and Metrolinx shall be applied to both sides of the noise barrier for all instances of precast panels and shall adhere to the following requirements:

(i) shall be clear, non-peeling, non-yellowing, and resistant to alkali attack;

(ii) be applied in a uniform coverage with appearance free of laps, voids, entrapped dust, dirt, blisters, peeling, blemishes, misses, drips, runs, or other marks or irregularities;

(iii) Shall be applied to a minimum height of 2.7 m above the ground and to any soffits less than 3.8 m from the ground; and

(iv) The extent of coverage shall align to noise barrier panel joints.

PART C – AESTHETICALLY ENHANCED NOISE BARRIERS (TYPE NB-2)

C.1 GENERAL

(a) The upper 20% of the area of each noise barrier unit shall be transparent infill panels, designed to meet the requirements described in Section C.2 of this specification. The remaining area of the noise barrier units shall be solid panels.

(b) Solid panels shall meet the requirements of Type NB-1 (as noted in Section B.1 of this specification), with panel face colours and textures as specified in the Contract Documents.

C.2 ADDITIONAL REQUIREMENTS FOR TRANSPARENT PANELS

(a) Noise barriers shall meet requirements of PART A of this specification, unless otherwise noted in this section.

(b) Noise barrier panels shall be a rigid monolithic sheet, and comply with the following requirements:

(i) transparent noise barriers shall be assembled within a frame, to provide a transparent panel assembly;

(ii) panel colour shall be clear, unless otherwise indicated;

(iii) transparent panels shall be shatter resistant and shall employ either an internal or external restraint system to retain all broken pieces within the frame to not pose a hazard;

(iv) Impact Resistance of the acrylic panels shall be shall meet the requirements of EN1794-1, Appendix C and the following:

A. ANSI Z97.1, safety glazing material; and

B. Sound barrier shall pass the large missile impact test, ASTM E1996;

(v) transparent panels of the noise barrier shall include bird deterrence by providing pattern capable of preventing in excess of 90% of bird impacts to comply with DS-05 Sustainable Design Standard Section 6.2:

A. bird deterring pattern must be an integral part of the transparent panel, capable of withstanding graffiti removal. Application of films in a secondary, post-production process, are not acceptable;

(vi) transparent panels of the noise barrier shall have wind load resistance that meets a maximum elastic deflection, (dmax), under the design wind load shall be less than 75 mm;

(vii) transparent panel used for the noise barrier shall meet the following performance requirements and ASTM testing standards:

PROPERTY	REQUIREMENT	ASTM Method
Tensile Strength	> 9,250 psi	D638
Flexural Modulus	> 445,000 psi	D790
Rockwell Hardness	M-90	D785
STC	> 32	E90 / E413
Optical Requirements		
Light Transmission	> 90%	D1003
Haze	< 1.5%	D1003

Yellowness Index	< 1	E313

(viii) transparent panel used for the noise barrier after exposure to outdoor weathering for a period of ten years or accelerated weathering in accordance with ASTM G155 for a period of 10,000 hours, panels shall show no evidence of cracking or crazing and shall comply with the following:

PROPERTY	REQUIREMENT	ASTM Method
Light Transmission	> 88%	D1003
Haze	< 10%	D1003
Yellowness Index	< 5	E313
Tensile Strength	> 75% of initial value	D638
Flexural Strength	> 75% of initial value	D790

(ix) transparent panel used for the noise barrier shall meet the flammability requirements of the following when tested in accordance with the associated test method:

PROPERTY	REQUIREMENT	Test Method
Resistance to brush fire	Min Class 3	EN 1794-2
Horizontal burn rate	< 2.5 in/min	ASTM D635
Smoke density	< 50%	ASTM D2843

PART D – CUSTOM ENHANCED NOISE BARRIERS (TYPE NB-3)

D.1 GENERAL

(a) Noise barrier units shall be provided with combination of solid and transparent panels as shown in the Contract Documents.

(b) Solid panels shall meet the requirements of Type NB-1 (as noted in Section B.1 of this specification), with panel textures as specified in the Contract Documents.

(c) Transparent panels shall meet requirements described in Section C.2 of this specification.

PART E – SPECIAL CONDITIONS NOISE BARRIERS (TYPE NB-4)

E.1 GENERAL

(a) Noise barrier units shall be provided with combination of solid and transparent panels as shown on Contract Documents.

(b) Solid panels shall meet the requirements of Type NB-1 (as noted in Section B.1 of this specification), with panel textures as specified in the Contract Documents, except do not apply anti-graffiti coating to barriers and panels prior to installation of painted murals and public art treatments as earmarked on Contract Documents.

(c) Transparent panels shall meet requirements described in Section C.2 of this specification.

E.2 ADDITIONAL REQUIREMENTS FOR DOUBLE-SIDED ABSORPTIVE PANELS (TYPE NB-4A)

(a) Type NB-4A noise barrier panels shall meet requirements of Type NB-4 solid panels (as noted in Section E.1(b) of this specification), with the exception that they shall provide acoustical absorption on both sides, and with panel textures as specified in the Contract Documents.

E.3 ADDITIONAL REQUIREMENTS FOR NOISE BARRIERS ON RETAINING WALLS (TYPE NB-4[X]-RW)

(a) Noise barriers shall meet requirements of PART A of this specification, unless otherwise noted in this section.

(b) Where precast barrier panels are not feasible, such as due to loading restrictions, metal sandwich panels may be selected subject to Metrolinx approval.

(c) Barriers indicated to be constructed on new retaining walls shall be designed to be integrated with the retaining wall to minimize changes in vertical plane and maintain consistent colour and texture between retaining wall and noise barrier panels, where possible.

(d) Barriers indicated to be constructed on existing retaining walls shall be designed to be mounted to the retaining wall without any visible gaps or openings between the bottom noise barrier panel and the retaining wall. A verification study shall be completed to include the following:

(i) confirm information related to existing retaining wall locations, dimensions, elevations, foundations, structural details, materials, and other information necessary to complete a deformation analysis of the structures.

(e) Noise barriers constructed on retaining walls shall have base plate connections to the concrete retaining wall cap. All elements of the base plate connection, including base plate and anchorages, shall be designed to comply with AREMA design criteria.

E.4 ADDITIONAL REQUIREMENTS FOR NOISE BARRIERS ON BRIDGES AND ELEVATED GUIDEWAYS (TYPE NB-4[X]-BR)

(a) Noise barriers shall meet requirements of PART A of this specification, unless otherwise noted in this section.

(b) Where precast barrier panels are not feasible, such as due to loading restrictions, metal sandwich panels may be selected subject to Metrolinx approval.

(c) Barriers indicated to be constructed on new bridges or elevated guideways shall be designed to be integrated with the bridge or elevated guideway structure to minimize changes in vertical plane and maintain consistent colour and texture between bridge or elevated guideway parapet and noise barrier panels, where possible.

(d) Barriers indicated to be constructed on existing bridges or elevated guideways shall be designed to be mounted to the bridge or elevated guideway structure without any visible gaps or openings between the bottom noise barrier panel and the bridge or elevated guideway parapet. A verification study shall be completed to include the following:

(i) confirm information related to existing bridge and elevated guideway locations, dimensions, elevations, foundations, structural details, materials, and other information necessary to complete a deformation analysis of the structures.

(e) All elements of noise barriers constructed on bridges and elevated guideways, including base plate and anchorages, shall be designed to comply with AREMA design criteria.

END OF SECTION