METROLINX

GO Transit Signals & Communications Standards – Wayside Signal Structures Specification

Specification 34 42 03

Superseded

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Wayside Signal Structures Specification

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Preface

This is the second edition of the Wayside Signal Structures Specification. It specifies the design and manufacturing requirements for Wayside Signal Structures to be supplied for use on Metrolinx property.

The Second edition has updates on signal head spacing in addition to general updates based on stakeholder feedback.

This document was developed by the Signals & Communications Office, Engineering and Asset Management Division, Metrolinx.

Suggestions for revision or improvements can be sent to the Metrolinx Signals and Communications office, Attention: Director of Signals and Communications who shall introduce the proposed changes to the Metrolinx Signals and Communications office. The Director of the Signals and Communications office ultimately authorizes the changes. Be sure to include a description of the proposed change, background of the application and any other useful rationale or justification. Be sure to include your name, company affiliation (if applicable), e-mail address, and phone number.

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Revision	Date (DD/MM/YYYY)	Description of Changes
0	08/04/2020	Initial Release
1	25/02/2021	Revised section 4 for signal spacing

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1. Scope

1.1.1. This specification defines the design criteria and requirements for wayside signal structure assemblies consisting of signal mast, ladder and other associated elements, herein referred to as Wayside Signal Structures, for use on Metrolinx property. The scope of this specification excludes the Signal Units.

1.1.2. The following terms are used in this Specification:

a) Signal Aspect – Individual colour lamp (Red/Yellow/Green);

b) Signal Head – An assembly of up to three Signal Aspect in a housing; or a tri-colour LED Signal Head (Metrolinx preferred type), that a single Signal Head can display multiple Signal Aspect; and

c) Signal Unit – An assembly that can comprise one, two or three Signal Heads.

2. Abbreviations

AASHTO LRFD	American Association of State Highway and Transportation Officials, Load and Resistance Factor Design
AREMA	American Railway Engineering and Maintenance-of-Way Association
CROR	Canadian Railway Operating Rules
CSA	Canadian Standards Association
OHSA	Occupational Health and Safety Act
SCP	Standard Codes of Practice

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3. Wayside Signal Structures Design Requirements

3.1. Standards

3.1.1. The design, fabrication, and assembly of Wayside Signal Structures shall be in accordance with AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries and Traffic Signals 1st Edition, with 2017, 2018 and 2019 Interim Revisions.

3.1.2. Aluminum design, fabrication and assembly shall be in accordance with CAN/CSA S157-17/S157.1-17 – Strength Design in Aluminum and CSA W59.2-18 Welded Aluminum Construction.

3.1.3. All aluminum extruded tube and structural profiles (channels and angles) shall be made of alloy 6061-T6 conforming to ASTM B221 and ASTM B308/B308M, with a yielding stress of 240 MPa and tensile strength of 290 MPa.

3.1.4. Solid aluminum bars and rods shall be made of alloy 6061-T6 and shall conform to ASTM B 211M standards.

3.1.5. Aluminum plates and all other miscellaneous aluminum components shall be made of aluminum alloy 6061-T6 and shall confirm to ASTM B209 standard.

3.1.6. All steel components shall comply with CAN/CSA S16-14 – Design of Steel Structures.

3.1.7. The design of the Wayside Signal Structures shall take into account the location and clearance requirements as per GO Signals & Communications SCP-302

3.2. Loading Criteria

3.2.1. The design of the Wayside Signal Structures shall comply with loading criteria specified in sections 3.2.2 through 3.2.7 inclusive.

3.2.2. Dead Loads

a) The dead load shall consist of the weight of entire Wayside Signal Structure including all appurtenances and the equipment that will be attached to the structure by others, including the Signal Units, associated cables and signs. The point of application of the weights of the individual items shall be their respective centers of gravity.

3.2.3. Live Load

a) The service platform shall support a single point load of 500 lb distributed over a distance of 2 feet transversely.

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3.2.4. Fall Protection Loads

a) Fall Protection Anchorage Points shall be provided unless otherwise noted in the contract documents. Fall Protection Anchorage Points shall withstand a 5,000 lb (22 kN) load in any direction.

3.2.5. Ice Load

a) The Wayside Signal Structure shall withstand the following ice loads applied to all support elements and on all surfaces of the supported components:

i. working surface areas such as horizontal platform shall have an ice load of 1 kPa applied uniformly over the entire surface and

ii. all other surfaces shall have an ice load equivalent to 25 mm of surface icing with an ice density of 900 kg/m^3.

3.2.6. Thermal Forces

a) The Wayside Signal Structure shall withstand the thermal forces associated with the temperature range between -35 degrees Celsius and 50 degrees Celsius.

3.2.7. Wind Load

a) The wind load shall be based on a basic wind speed of 115 mph with 3 second gusts in accordance with the AASHTO LRFD Specifications.

b) The wind importance factor, Ir, shall be 1.0.

c) Height and Exposure Factor, Kz, shall be 1.0 for structures as applicable to a maximum height not exceeding 13.7 m.

d) Wind load shall be applied to all elements of the Wayside Signal Structure and the supported components. Shielding shall not be assumed for any element unless it is completely encapsulated by another structural element.

e) Wind exposure area shall take into account increase in exposure area due to surface icing.

3.3. Welding Criteria

3.3.1. Welding of elements of a Wayside Signal Structure shall be done by licensed personnel in accordance with CSA W47.2-11 standard and use of welding materials shall conform to CSA W59.2-18 standards.

3.3.2. The Contractor shall supplement the visual inspection of welds with non-destructive testing (NDT) of 50% of the welds. NDT shall consist of Liquid Penetrant Inspection (LPI). LPI procedures shall be in accordance with ASTM E165 and LPI acceptance requirements shall be in accordance with CSA W59.2.

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3.4. Fatigue Design

3.4.1. The Wayside Signal Structure shall be designed for infinite fatigue life.

3.4.2. The fatigue importance factor, I_F, shall be 1.0.

3.4.3. Galloping shall be considered in accordance with AASHTO LRFD Specifications as defined in section 3.1.1.

3.4.4. The Wayside Signal Structure shall withstand vehicle induced gusts in accordance with AASHTO LRFD section 11.7.1.3 for train speeds up to the maximum track design speed as confirmed by Metrolinx.

3.4.5. Vortex Shedding

The Wayside Signal Structure shall withstand vortex shedding loads in accordance with the following:

a) Vortex shedding shall be evaluated in accordance with CSA-S6 Canadian Highway Bridge Design Code.

b) Vortex shedding loads shall not be considered for the design of trusses. Individual aluminum members of the truss and tubular railings shall meet the following member slenderness restrictions to prevent vortex shedding fatigue on individual members:

   i. $L/r \leq 105$ for branch members in T-type tubular connections

   ii. $L/r \leq 115$ for branch members in K-type tubular connections

   iii. $L/r \leq 95$ for branch members with gusset plate connections

   The length, L, is the face-to-face length of member as measured along the member centerline.

c) Vortex shedding loads shall be considered for all other support structures and elements.

3.5. Foundations

3.5.1. Foundations shall be made by either concrete or galvanized steel and shall meet all requirements in AREMA C&S Manual Section 14.

3.5.2. Concrete design shall be in accordance with CAN/CSA A23.3 – Design of Concrete Structures.

3.5.3. The Contractor shall provide the anchor bolts embedded in the foundation and the associated nuts and washers to allow leveling and fastening of the structure.

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3.5.4. Helical galvanized steel foundations which are drilled into the ground may be specified and subject to the approval from Metrolinx.

4. Assembly and Components

4.1. General

4.1.1. The Wayside Signal Structure's height, number of service platforms and the detailed design will vary depending on the configuration requirements.

4.1.2. Wayside Signal Structures shall be supplied in the configurations listed below, or as requested by Metrolinx:

Table 4-1: Wayside Signal Structures

Wayside Signal Structure Type	Configuration	Height of Mast
Metrolinx-1C-1W	One Colour Light Unit - One Way	6.096 m (20 ft.)
Metrolinx-2C-1W	Two Colour Light Units - One Way	6.096 m (20 ft.)
Metrolinx-2C-1WH	Two Colour Light Units - One Way - High	10.363 m (34 ft.)
Metrolinx-3C-1W	Three Colour Light Units - One Way	7.925 m (26 ft.)
Metrolinx-3C-1WH	Three Colour Light Units - One Way - High	10.363 m (34 ft.)
Metrolinx-2C-2W	Two Colour Light Units - Two Way	6.096 m (20 ft.)
Metrolinx-3C-2W	Three Colour Light Units - Two Way	6.096 m (20 ft.)
Metrolinx-4C-2W	Four Colour Light Units - Two Way	6.096 m (20 ft.)

4.1.3. The Wayside Signal Structures shall comply with the following:

a) A service platform shall be provided for each Signal Head, ergonomically located to provide access to the Signal Head for a maintainer.

b) The Contractor shall provide a 2-inch by 4-inch slot in the mast and a tube type signal support arm for each Signal Head. The edges of the slot and signal support arm tube shall be smooth and free of any burrs. The tube type signal support arm shall be used to run all wiring to the Signal Head inside the tube and the main mast. The location of the slot for each Signal Head shall be 12 inches above the platform (measured from the platform surface to the center of the slot). A removable metal cap or plug shall be provided for each slot.

c) The orientation and spacing of the Signal Unit shall be easily accessed, free of any obstruction which may affect the maintenance or visibility of the Signal Unit when mounted, and shall comply with the following:

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i. the lowest or first Signal Head shall be located at 13 feet from top of rail when measured from the top of steel base plate to the center of the middle light of a Signal Head with three Signal Aspects;

ii. the spacing of additional Signal Heads shall be 72 inches, or 60 inches as directed by Metrolinx.

iii. provision shall be made to allow staggering of Signal Heads as required as per latest CROR (Canadian Rail Operating Rules).

4.1.4. Wayside Signal Structures shall be supplied in a pre-assembled condition to minimize field installation time without unduly impacting shipping and handling requirements. A complete isometric drawing showing all aspects of the structure assembly shall be provided with each structure. All fasteners used on pre-assembled sections shall be stainless steel, lubricated with NO-OX-ID grease, and torqued per the fastener manufacturer's specifications. The Contractor shall supply all hardware related to the mounting of the Signal Units. This shall include, mounting brackets, clamps, bolts, nuts and washers.

4.1.5. All holes, openings, and cavities which can provide shelter to insects or other wildlife shall be effectively plugged.

4.1.6. The Contractor shall ensure that all the cables are routed through the Wayside Signal Structure and remain unexposed.

4.2. Signal Mast

4.2.1. The Signal Mast and base shall be a complete aluminum assembly with the aluminum pole welded to reinforced gusset type base. The horizontal section of the base shall be an aluminum plate as shown in AREMA C&S Manual Part 7.2.40. The edges of the base shall be rounded to at least a minimum of 1 Inch radius. The top of the mast shall be closed or booted with a removable aluminum cap. The cap shall be secured to the pipe or mast with set screws.

4.2.2. A mileage signboard assembly shall be provided with each mast, one (1) for each one-way mast, and two (2) for each two-way mast. The main mast portion of the Wayside Signal Structure shall standardize on the use of 5 ½ inch diameter aluminum pipe when possible. This will permit the application of standard mounting hardware for Signal Units, signs, etc. In situations, such as high Signal Units with three Signal Heads, where the loading stress analysis (required by Loading Criteria defined in this specification) verifies the structural integrity of a 5½ inch mast design is inadequate, a larger diameter pipe shall be provided for the lower 8-foot portion of the mast with a transition to an upper 5½ inch section. The design shall comply with Loading Criteria defined in this specification.

4.2.3. A leveling plate shall be provided between the foundation and base plate to allow for level adjustments to be made to the mast.

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4.3. Ladder Assembly

4.3.1. A ladder assembly shall be provided complete with all mounting hardware, designed to secure it to the mast and/or service platform framework. The ladder shall be constructed of aluminum and be designed to comply with current OHSA standards affecting rail size and design, rung length (16 inches) and toe spacing. Rungs shall have a rugged anti-slip tread design. The base of the ladder shall be designed to provide a safe secure footing.

4.3.2. A removable aluminum security panel system shall be provided to fit on the ladder to prevent unauthorized access to the ladder structure. It shall be designed to be lockable using a standard railway signal lock

4.3.3. The ladder shall be designed to be:

a) secured (bolted) to heavy-duty galvanized steel footing, or

b) buried to a minimum depth of 18 Inches, or

c) secured to the mast assembly by means of a ladder brace.

4.4. Service Platforms

4.4.1. Service platform(s) shall be provided in compliance with the following:

a) the platform shall be constructed of aluminum;

b) the platform shall comply with the loading requirements specified Loading Criteria section in this specification.

c) Platform Area

i. A working surface area of not less than 36 inches in length by 32 inches wide.

ii. The platform surface shall be constructed using cross-linked style, anti-slip tread, aluminum grating welded to an aluminum frame. The platform access egress shall have a footstep extension to permit easy transition by users from the ladder to the service platform. A suitably sized utility plate for tools (with folded edges) shall be secured to one corner of the platform surface.

d) Platform Railing

i. The platform railing shall comply with the requirements of OHSA Regulation 851 Industrial Establishments, S-14.

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ii. The platform railing shall have a minimum height of 106.7 cm (42 inches), measured from the top of the platform surface.

iii. The railing shall extend the complete perimeter of the platform area, except at the egress area which shall be no less than 24 inches wide, for which a horizontal footing shall be provided at the mid-point of the egress floor. A hinged security rail designed with a spring return extending across the entry point shall be provided.

e) The service platform shall be secured to the mast and ladder portions of the Wayside Signal Structure with mounting brackets and U-bolts. All platform mounting / assembly hardware such as bolts, nuts and washers shall be stainless steel or cadmium plated.

4.5. Aluminum Junction Box

4.5.1. A junction box shall be provided on the main mast (U-bolt mounted) to mate with a 2-5/8 x 6-5/8 inch slot located in the main mast 40 inches from the signal base.

4.5.2. The junction box shall be equipped with a lockable, weather-sealed hinged door (complete with greased fittings) having a robust security locking latch system designed to accommodate a standard Railway type lock.

4.5.3. The junction box shall be equipped with twenty-four (24) double post AAR terminals (two rows of 12 double post strips), complete with insulated test straps, to which Signal Unit cables will be secured.

4.5.4. The junction box shall have a screened drain hole to allow rain or condensation water to drain out of the box.

5. Submittals

5.1.1. Structural calculations and engineering drawings of the complete assembly shall be submitted to Metrolinx for approval prior to manufacturing. Engineering drawings shall also be provided in electronic format. The engineering drawing shall contain the seal and signature of the professional engineer, registered in the Province of Ontario, responsible for the design attesting that the Wayside Signal Structure meets or exceeds all applicable design criteria herein. Design calculations shall be presented in a legible and logical format and shall be sufficiently detailed to allow a technical review of the design concepts and assumptions used in the design.

5.1.2. The structural calculations and engineering drawings shall include moment, shear, axial forces and fatigue analysis for all components of Wayside Signal Structures including:

a) signal mast;

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b) arm flange bolted connections;

c) all welded and bolted connections, stiffeners;

d) anchor bolts and associated nuts and washers;

e) platform and railings;

f) the foundation design loads (reaction load); and

g) foundation design including installation details for soil conditions, drainage and the necessary fill and compaction details that are applicable to retain the foundation, the signal mast and the associated loads specified within the specification.

5.1.3. The Contractor shall include, with each Wayside Signal Structure shipped, a schematic drawing showing the correct assembly of the structure and detailed installation procedures for both structure and foundation, which shall also identify the various components of the assembly, including part numbers.

5.2. Identification

5.2.1. The main mast and service platform portions of the Wayside Signal Structure shall have a permanent type label affixed to it, indicating the manufacturer, assembly type, part number, serial number and date of manufacture.

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