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| To: <p style="text-align: center;">SUPERSEDED BY <u>EB 06-057</u> EFFECTIVE <u>5/3/07</u></p> |  | New York State Department of Transportation ENGINEERING INSTRUCTION | EI 04-035 |
| Title: REVISIONS TO STANDARD SPECIFICATIONS - SECTIONS 645 and §730-05 | | | |
| Distribution: <input checked="" type="checkbox"/> Manufacturers (18) <input checked="" type="checkbox"/> Local Govt. (31) <input checked="" type="checkbox"/> Agencies (32) <input type="checkbox"/> Surveyors (33) <input checked="" type="checkbox"/> Consultants (34) <input checked="" type="checkbox"/> Contractors (39) <input type="checkbox"/> _____ () | Approved:  R. L. Sack, Deputy Chief Engineer, Technical Services | 8/13/04 Date | |

ADMINISTRATIVE INFORMATION:

- This EI is effective beginning with projects submitted for the letting of January 13, 2005.
- This EI supersedes EI 96-014, EI 97-004, and EI 00-029, and modifies EI 03-019.
- The attached shelf notes will be incorporated into the next revision of the Standard Specifications.

PURPOSE: To transmit revised Standard Specifications *Section 645 Signs* and *§730-05 Reflective Sheeting*.

TECHNICAL INFORMATION:

This revision modifies the Standard Specifications in order to allow for the implementation of the Type IX sign sheeting policy established by EI 04-034, *Type IX Retroreflective Sign Sheeting Policy*. Additionally, *Section 645 Signs* has been reorganized, and two new sign post items have been added. Breakaway wooden sign posts have been included in the Standard Specifications, as well as an item for concrete footings for Type A, High-Capacity Type A, and Breakaway Wooden Sign Posts. All items contained in EI 03-019 that related to *Section 645 Signs* have been incorporated into the Standard Specifications.

Previously, when a concrete footing was used, the cost was included in the High-Capacity Type A sign post item. This caused some confusion and field problems, because a concrete footing is not required in all cases. Breakaway wooden sign posts may or may not require a concrete footing as well, depending on site conditions. In order to properly design and call out High-Capacity Type A and Breakaway Wooden sign posts, a separate item for the concrete footing has been created.

IMPLEMENTATION:

- The Design Quality Assurance Bureau will insert the shelf notes into contract proposals beginning with projects submitted for the letting of January 13, 2005.
- This EI disapproves the following specifications: 15645.1701M, 15645.1702M, 15645.1703M - Breakaway Wooden Sign Post; 04645.7101, 04645.7102, 04645.7103, 04645.7104 - Warning Signs (Fluorescent Yellow Reflective Sheeting); and 04645.7201, 04645.7202, 04645.7203, 04645.7204 - Warning Signs (Fluorescent Yellow-Green Reflective Sheeting).

TRANSMITTED MATERIALS:

- Shelf note revising Section 645 of the Standard Specifications.
- Shelf note revising §730-05 of the Standard Specifications.

CONTACT: Direct questions regarding the policy established by this EI to Barbara Abrahamer of the Traffic Engineering and Highway Safety Division at (518) 457-2095 (babrahamer@dot.state.ny.us), and questions related to the material specifications to Pat Galarza of the Materials Bureau at (518) 457-4285 (pgalarza@dot.state.ny.us).

SIGNS

Make the following changes to Volume 2 of 3 of the Standard Specifications of January 2, 2002.
Page 6-148, line 11, **Delete SECTION 645 - SIGNS**, and **replace** it with the following:

SECTION 645 - SIGNS

645-1 DESCRIPTION. This work shall consist of fabricating, installing and covering traffic sign panels, sign support systems, sign posts, and illuminated sign panels in accordance with the contract documents, standard sheets, the MUTCD and as directed by the Engineer.

645-2 MATERIALS.

645-2.01 General. Materials shall meet the requirements of the following subsections of Section 700 *Materials and Manufacturing*:

| | |
|--|----------------------|
| Weathered Brown Guide Rail Paint | 708-24 |
| Wood Preservative - Water Borne | 708-31 |
| Stress Graded Timber and Lumber | 712-14 |
| Stainless Steel Connecting Products | 715-16 |
| Rubber Impregnated Woven Cotton-Polyester Fabric | 728-01 |
| Rubber Impregnated Random Fiber Pad | 728-02 |
| Aluminum Sign Panels | 730-01 |
| Reflective Sheeting | 730-05 |
| Reflectorized Sheeting Sign Characters (Type IV) | 730-12 |
| Reflectorized Sheeting Sign Characters (Type V) | 730-13 |
| Stiffeners, Overhead Brackets, and Miscellaneous Hardware | 730-22 |
| Fiberglass Reinforced Plastic Sign Panels | 730-23 |
| Type A Sign Supports | 730-24 |
| Type B Sign Posts | 730-25 |
| Breakaway Bases and Hinge Assemblies | 730-26 |
| U-Bolts | ASTM F1554, Grade 36 |

645-2.02 Sign Panels. Fabrication of all components shall produce a finished sign panel. Holes may be punched or drilled. Edges shall be smooth and true and free from burrs or ragged breaks. Sign panels shall be fabricated as shown on the standard sheets. Details for signs that are not shown on the standard sheets shall be similar to the closest shown sign blank size. All sign panels shall be clearly marked in the lower right corner on the back of the sign panel to show the Contract Number and the installation date (month/year). Markings shall be a minimum of 25 mm high and shall be permanently engraved, labels attached with pressure-sensitive adhesives, marked with an indelible ink or paint, or established by another method approved by the Engineer. U-Bolts used to attach sign panels to overhead sign structures shall be Type II galvanized in accordance with §719-01 *Galvanized Coatings and Repair Methods*.

A. Ground-Mounted Sign Panels (MUTCD Codes R, P, W and M). Panels for Ground-Mounted MUTCD Codes R, P, W and M signs shall be aluminum alloy 2.5 mm thick meeting the requirements of §730-01, *Aluminum Sign Panels*. Fiberglass Reinforced Plastic Sign Panels, 3.5 mm thick, meeting the requirements of §730-23 *Fiberglass Reinforced Plastic Sign Panels*, may be used for sign panels up to 1.2 m X 1.2 m.

B. Ground-Mounted Sign Panels (MUTCD Codes G and I) and Overhead-Mounted Sign Panels. Sign panels for ground mounted MUTCD Codes G and I signs and Overhead-Mounted Sign Panels shall be aluminum alloy 3 mm thick meeting the requirements of §730-01, *Aluminum Sign Panels*.

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C. Reflective Sheeting. Reflective sheeting materials used on sign panels shall conform to the requirements of §730-05 *Reflective Sheeting*. Type I (Class A) sheeting may be used on tourist and motorist services signs. Type III (Class B) sheeting shall be used on regulatory, warning, route marker, and guidance signs unless specified otherwise below.

Type I (Class A) sheeting shall be used whenever brown reflective sheeting is specified, and may be processed by a sign fabricator in its shop. The legend for a sign with brown background shall be made by applying cut-out letters or symbols of Type I (Class A) yellow sheeting.

1. High-Visibility Sheeting. Signs with the following MUTCD codes shall be fabricated using Type IX (Class E) sheeting: R1-1, R1-2, R1-3, R3-1, R3-2, R3-3, R3-15, and R3-16.

2. High-Visibility Fluorescent Yellow Sheeting. Signs with the following MUTCD codes shall be fabricated using Type IX (Class E) fluorescent yellow sheeting for the yellow portion of the sign face, and the appropriate nonfluorescent Type IX (Class E) color for the remainder of the sign face: W1-11, W1-12, W1-13, W1-14, W2-18, W3-22, W3-23, and W3-25.

3. High-Visibility Fluorescent Yellow-Green Sheeting. Signs with the following MUTCD codes shall be fabricated using Type IX (Class E) fluorescent yellow-green sheeting for the yellow portion of the sign face, and the appropriate nonfluorescent Type IX (Class E) color for the remainder of the sign face: R2-7, R2-8, W5-1, W5-3, W5-6, W6-1, W6-3, and W6-4.

Signs with the following National MUTCD codes shall also be fabricated using Type IX (Class E) fluorescent yellow-green sheeting for the yellow portion of the sign face, and the appropriate nonfluorescent Type IX (Class E) color for the remainder of the sign face: W16-1, W16-2a, W16-7P, and W16-9P.

D. Sheeting Sign Characters. Characters include letters, numerals, route shields, symbols, and borders. Characters shall be the size, series and color specified in the MUTCD and as specified in the contract documents. Only Type IV or Type V Characters, as appropriate, shall be used. White legends and borders shall be formed with directly-applied Type IV Characters. Interstate shields for signs shall be either demountable panels or directly-applied panels with Type V reverse-screened characters. Sign face characters and background shall be reflective, but black portions of a sign face shall not be reflective.

E. Sign Face Layouts. Sign face shape, color, dimensions, and characters shall be in accordance with:

1. MUTCD.
2. National MUTCD.
3. Standard Highway Signs Book - FHWA.
4. Standard Alphabets for Highway Signs and Pavement Markings (Metric Edition) - FHWA.

Standard sign face layouts for MUTCD Codes R, P, W and M sign panels are shown in the MUTCD. Sign face layouts for MUTCD Codes G and I sign panels will be available as Supplemental Information Available to Bidders. After contract award, two copies of the sign face layouts will be provided to the Contractor. The Contractor shall verify dimensions on the sign face layouts prior to fabrication.

F. Sign Structure Bearing Pads. Type A Sign Structure Bearing Pads shall be made from Rubber Impregnated Woven Cotton-Polyester Fabric. Type B Sign Structure Bearing Pads shall be made from Rubber Impregnated Random Fiber Pad

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645-2.03 Type A Sign Posts. Type A sign posts shall be selected from the Department's Approved List of Type A Sign Supports. The standard strength (i.e., moment capacity) of a Type A sign post shall be 2800 N•m, although weaker or stronger posts may be substituted.

A. Type A Sign Posts With Extra Embedment. Type A sign posts with extra embedment (more than 1 m) shall meet the requirements of the Materials Details for Type A Sign Supports.

B. Soil Plates for Type A Sign Posts. Type A sign posts with soil plates shall meet the requirements of the Materials Details for Type A Sign Supports.

C. High-Capacity Type A Sign Posts. High-Capacity Type A sign posts are defined as any Type A sign post system shown in the Materials Details for Type A Sign Supports that has a total combined capacity for the entire two- or three-post system higher than 10600 N•m. The Contractor shall calculate the design moment of the sign panel, and select an appropriate High-Capacity Type A sign post system capable of resisting that moment, subject to the Engineer's approval.

645-2.04 Type B Sign Posts. Type B sign posts shall be fabricated in accordance with the requirements of §730-25 *Type B Sign Posts*.

A. Rustic Type B Sign Posts. Rustic Type B sign posts shall be ungalvanized weathering steel meeting the requirements of ASTM A588M or A242M.

B. Breakaway Bases and Hinge Assemblies. Breakaway bases and hinge assemblies shall be fabricated in accordance with the requirements of §730-26 *Breakaway Bases and Hinge Assemblies*.

645-2.05 Concrete Foundations. Cast-in-place concrete for foundations shall meet the requirements of Class A concrete in Section 501, *Portland Cement Concrete-General*. Precast concrete foundations shall meet the requirements of §704-06 *Precast Concrete Cribbing*. The batching, mixing and curing methods, and the inspection facilities shall meet the approval of the Department. The Contractor may submit a mix at least equivalent to Class A Concrete for approval by the Engineer.

645-2.06 Breakaway Wooden Sign Posts. Breakaway wooden sign posts shall be either Grade 2 Southern Yellow Pine or Grade 2 Douglas Fir-Larch, surfaced four side (S4S) as designated by the National Design Specification (NDS) for Wood Construction, and meeting the requirements of §712-14 *Stress Graded Timber and Lumber*. The bending stress (Modulus of Rupture) shall not be less than 27000 kPa using the clear wood properties of ASTM D2555. Posts shall be pressure treated in accordance with §708-31 *Wood Preservative - Water Borne*, dried to a maximum moisture content of 15% before and after pressure treating. The embedded portion of each post shall be sealed to 50 mm above the ground surface or above the steel tube insert, with a heavy coat (0.3 mm dry film thickness) of an emulsified asphalt conforming to AASHTO M140.

All 89 mm x 140 mm posts shall have two 38 mm diameter breakaway holes drilled through the center of the post parallel to the sign face 100 mm and 450 mm above grade and filled with flexible caulk. All 140 mm x 190 mm posts shall have two 75 mm diameter breakaway holes drilled through the center of the post parallel to the sign face 100 mm and 450 mm above grade and filled with flexible caulk. Nails and fasteners shall be stainless steel meeting the requirements of §715-16. Cuts and holes made at the contract site shall be field treated with copper naphthenate having a minimum 2% metallic solution, in accordance with AWPA Standard M4. Breakaway holes shall be field treated with copper naphthenate before filling with flexible caulk.

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645-2.07 Pole-Mounted Sign Support Systems. Bands, brackets, hardware, and fasteners necessary to mount signs on traffic signal poles, street lighting poles or other poles shall be stainless steel. Bands shall be a minimum of 20 mm x 0.5 mm. Other methods of attachment may be substituted with prior approval of the Engineer.

645-2.08 Illuminated Signs. Illuminated Sign Panels shall be aluminum alloy 3 mm thick meeting the requirements of §730-01, *Aluminum Sign Panels*. All materials necessary to illuminate the sign panels shall be as shown in the contract documents.

645-2.09 Sign Covering Material. Material used to cover sign panels shall be of an opaque, porous, and windproof fabric. Plastic, mesh, translucent or transparent materials will not be allowed. The covering material shall be a single neutral color, except orange or yellow, and shall not contain any wording or images.

645-3 CONSTRUCTION DETAILS

645-3.01 General. Sign panels, overhead panels, overhead vertical brackets, vertical and horizontal Z-bars, sign support systems, sign posts, breakaway bases and hinge assemblies, and foundations for Type B sign posts shall be constructed in accordance with the contract documents, standard sheets, MUTCD and materials details. Sign locations shown in the contract documents are approximate, and the exact location for each sign will be approved by the Engineer in the field.

The Contractor shall erect new signs and remove existing signs in such a manner that the traveling public is provided all necessary regulatory, warning, and guidance information at all times. Certain items may be designated to be performed prior to other items of work.

An inspection installed signs will be made in the daylight for color, reflectivity, location, vertical post alignment, visibility, and appearance. The installed signs will also be inspected at night for color, orientation and reflectivity, traits which will be more conspicuous at night.

A. Wind Loads. The wind pressures given on the standard sheets have been calculated according to the procedure in the AASHTO *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. All wind loading shall be adjusted for height, drag, and gusting in accordance with AASHTO's *Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals*. Allowable sign areas shall be reduced when the sign centroid height is at an elevated site condition (e.g., an overpass) where the influence of the ground on the wind is reduced. For example, a sign centroid between 8.84 m and 14.94 m above the existing ground would result in a 37.5% increase in wind pressure (refer to the section "Loads" in aforementioned AASHTO Specifications).

| TABLE 645-1 WIND LOAD CRITERIA | | | | |
|---------------------------------------|------------------------|--------------------------|---|---|
| | Region | Wind Velocity (km/hr) | Wind Pressure at Panel Centroid ≤ 4.27 m (N/m ²) | Wind Pressure at Panel Centroid > 4.27 m (N/m ²) |
| Type A Post | 1, 2, 6, 8, and 9 | 97 | 690 | 919 |
| | 3, 4, 5, 7, 10, and 11 | 113 | 977 | 1207 |
| Type B Post | 1, 2, 6, 8, and 9 | 113 | NA | 1207 |
| | 3, 4, 5, 7, 10, and 11 | 129 | NA | 1609 |

Note: Panel centroid height measured above the surrounding terrain.

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645-3.02 Sign Panels. Sign panels shall be installed as shown on the standard sheets or as shown in the contract documents. Nominal widths are based on a conversion factor of 25 mm per inch in accordance with §200.8 of the MUTCD. Layout of sign panels and assemblies shall be as shown in the contract documents. Aluminum Overhead Mounted Sign Panels shall be separated from steel overhead sign structures in order to prevent corrosion by a Type A Sign Structure Bearing Pad or a Type B Sign Structure Bearing Pad as shown in the contract documents.

645-3.03 Type A Sign Posts. The Contractor shall install Type A sign posts individually or in groups to provide the required moment resistance. Type A sign posts with Extra Embedment, and Soil Plates for Type A sign post, shall be installed where extra embedment depth and/or soil plates are required. High-Capacity Type A sign posts shall also be installed where extra moment capacity is required.

The number of Type A sign posts indicated in the contract documents is based on the information available during design. The number and strength of Type A sign posts installed shall be based on conditions at the final sign location approved by the Engineer. The Contractor shall determine the required moment resistance for the Type A sign post(s) due to the wind loads indicated in §645-3.01A. *Wind Loads*, and propose an appropriate number and strength of Type A sign posts for the approval of the Engineer. The Contractor shall submit the approved Materials Details, and any computations, to the Engineer, and install the required number of Type A sign posts subject to the following criteria:

1. For signs with a nominal width greater than 750 mm, at least two posts are required, except that the nominal 750 mm x 750 mm diamond panel and the nominal 900 mm wide "YIELD" panel require only one post.
2. The maximum number of posts installed within a 2.13 m path shall be as described on the approved Materials Details.
3. For single flanged channel post installations only, the required moment resistance for the post shall be increased by 25% to account for torsional shear. The Materials Details include this adjustment.

645-3.04 Type B Sign Posts. The Contractor shall install Type B sign posts, breakaway bases, hinge assemblies and foundations in accordance with the details shown on the standard sheets or the manufacturer's approved materials details.

The Type B sign post type, size and number shown in the contract documents are based on the information available during design. The sign post type, size and number to be installed by the Contractor shall be based on conditions at the final location approved by the Engineer. The Contractor shall determine the required moment resistance for the Type B sign post(s) based on the wind loads indicated in §645-3.01A. *Wind Loads* and verify the sign post type, size, number, hinge capacity and 2.13 m wheel path criteria for the approval of the Engineer. The Contractor shall submit any computations to the Engineer.

The Contractor may install breakaway type bases under the contract pay item for nonbreakaway type posts provided that nonslotted hinge plates are used on both flanges and the installation is outside the clear zone or otherwise protected.

A. Rustic Type B Sign Posts. Rustic Type B sign posts shall be installed in the same manner as Type B sign posts.

B. Breakaway Bases and Hinge Assemblies. Breakaway bases and hinge assemblies shall be installed in accordance with the standard sheets or the manufacturer's approved materials details.

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When breakaway bases and hinge assemblies are used with rustic Type B sign posts, the breakaway bases and hinge assemblies shall be installed as follows:

1. The front (approach) flange hinge plate of rustic Type B sign posts shall be installed as shown on the contract drawings, except that an additional galvanized steel flat washer shall be installed on all four bolts between each post and the slotted hinge plate to assure proper slippage.
2. All miscellaneous visible galvanized steel hardware, except in the vicinity of the hinge plate slots, shall be painted with Weathered Brown Guide Rail Paint.

645-3.05 Concrete Foundations. Concrete foundations shall be constructed in accordance with the Materials Detail Sheets and contract documents. Upon completion of the sign installation the Contractor shall restore the area to its original state.

645-3.06 Breakaway Wooden Sign Posts. Breakaway wooden sign posts shall be installed in accordance with Table 645-2, *Allowable Sign Areas on 2 Breakaway Wooden Posts* and Materials Details. Each sign stringer to post attachment shall be bolted completely through the post using two 10 mm diameter stainless steel bolts with nuts and washers. Posts shall use a concrete foundation as noted in Section 645-2.05 in this specification, with a steel tube insert or be backfilled with compacted cushion sand or stone screening, as noted in the Materials Detail Sheets and contract documents.

| TABLE 645-2 ALLOWABLE SIGN AREAS ON 2 BREAKAWAY WOODEN POSTS | | | | | | | | | |
|---|---------------|------------------------------|------|------|------|------------------------------|------|------|------|
| Wooden Post Section (mm) | Embedment (m) | 97 km/h Wind Velocity | | | | 113 km/h Wind Velocity | | | |
| | | Height to Panel Centroid (m) | | | | Height to Panel Centroid (m) | | | |
| | | 1.8 | 2.4 | 3.0 | 3.6 | 1.8 | 2.4 | 3.0 | 3.6 |
| 89 x 89 | 1.5 | 1.36 | 1.02 | 0.81 | 0.68 | 0.96 | 0.72 | 0.57 | 0.48 |
| 89 x 140 | 1.8 | 3.26 | 2.44 | 1.96 | 1.63 | 2.30 | 1.73 | 1.38 | 1.15 |
| 140 x 190 | 2.1 | 8.65 | 6.48 | 5.19 | 4.32 | 6.10 | 4.58 | 3.66 | 3.05 |

Note: For 1 post, reduce allowable sign areas by 60%.
 For 3 posts, increase allowable sign areas by 50%.
 For 3 posts, outer posts shall be separated by more than 2.4 m.

645-3.07 Pole-Mounted Sign Support Systems. Pole-Mounted Sign Support Systems shall consist of stainless steel bands and brackets which shall be firmly attached to the pole in accordance with the standard sheets and/or manufacturer's instructions. Each horizontal Z-Bar stiffener shall be banded to the pole. Sign panels without Z-Bars shall be attached to the pole with two bands.

Where ground-mounted signs are to be mounted on traffic signal or street lighting poles, they and their mountings shall be designed to withstand the wind loadings shown in Table 645-1. Each horizontal Z-Bar stiffener (stringer) shall be firmly attached to the pole.

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645-3.08 Illuminated Signs. Illuminated sign panels shall be installed as shown in the contract documents. All work on the illumination system shall be performed in accordance with the National Electrical Code and the requirements of the local utility. Electrical circuits shall be tested by the Contractor for insulation resistance and ground resistance in accordance with the requirements below. Testing equipment shall be supplied by the Contractor and the tests shall be performed in the presence of the Engineer.

A. Insulation Resistance Test. Each circuit including ballasts and protective devices shall be insulation tested using an insulation tester according to manufacturers instructions. The Contractor shall compute a polarization index by dividing a ten-minute reading by a one-minute reading. The polarization index shall be greater than 4.0 for acceptance of new circuits, and greater than 2.0 for acceptance of existing circuits. The lighting system shall be properly grounded and disconnected while this test is conducted.

B. Ground Resistance Test. A ground test shall be performed by the Contractor using an earth tester with resolution to a minimum of 0.1 ohm. The test shall be performed, and the results interpreted, according to manufacturer's instructions. Readings of 5.0 ohms or less will be required for acceptance.

C. Functional Test. After satisfactory completion of all other tests, a functional test shall be performed consisting of not less than ten consecutive days of satisfactory operation. If unsatisfactory performance of any component of the lighting system is discovered during this time, the condition shall be corrected and the Engineer may require the test repeated until ten days of continuous satisfactory operation is obtained. Temporary shutdowns caused by power interruption or vehicle impact will not constitute discontinuity of the functional test.

645-3.09 Covering Signs. Signs shall be covered to eliminate noncurrent, conflicting, or unneeded information. The cover shall be held in place and positioned so that none of the sign face shows. More than one layer of fabric may be required to prevent legibility of the sign legend to be covered.

The cover shall be folded over the top and bottom of panel edges, but not on the sides, and secured to the back of the sign panel. Tape shall not be attached to the face of the sign panel nor shall holes be drilled in the sign panel or posts. Coverings that work loose shall be resecured by the Contractor at no additional expense to the State. The cover shall remain in place until the sign is no longer in conflict with current conditions.

645-4 METHOD OF MEASUREMENT

645-4.01 General. (VACANT)

645-4.02 Sign Panels. The work will be measured as the number of square meters measured to the nearest 0.01 square meter of sign panel satisfactorily covered or installed.

The area of each panel will be measured as the area shown on the standard sheets. For sign panels not shown on the standard sheets, the area will be measured as the product of length and width, with no reduction for rounded corners. When sign panels are mounted back-to-back, each panel face will be measured separately.

645-4.03 Type A Sign Posts. The work will be measured as the number of Type A sign posts required, which is the greater of either:

- 1) the number of posts required based on the width of the sign; or,
- 2) the number of posts of standard strength (2800 N•m moment capacity) required to resist the moment due to wind load.

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A. Type A Sign Posts With Extra Embedment. The work will be measured as the number of Type A sign posts with extra embedment satisfactorily installed with these modified bases.

B. Soil Plates for Type A Sign Posts. The work will be measured as the number of soil plates for Type A sign posts satisfactorily installed on either standard Type A sign posts, or on Type A sign posts with extra embedment.

C. High-Capacity Type A Sign Posts. The work will be measured as the number of high-capacity Type A sign posts satisfactorily installed. Post systems in which two posts are combined to function as a single post, such as the back-to-back flanged channel or the telescoping square tube, are measured as one post.

645-4.04 Type B Sign Posts and Rustic Type B Sign Posts. The work will be measured as the number of Type B sign posts or rustic Type B sign posts satisfactorily installed. When the Engineer directs that a different size Type B sign post be installed at a location that is called for in the contract documents, and there is no contract pay item in the contract for the directed post, the original quantity shall be multiplied by the following factor: kg/m of directed post divided by kg/m of original post.

645-4.05 Concrete Foundations. The work will be measured as the number of concrete foundations for Type A Sign Posts, High-Capacity Type A Sign Posts, or Breakaway Wooden Sign Posts with steel tube inserts satisfactorily installed.

645-4.06 Breakaway Wooden Sign Posts. The work will be measured as the number of breakaway wooden sign posts satisfactorily installed.

645-4.07 Pole-Mounted Sign Support System. The work will be measured as the number of pole-mounted sign support systems satisfactorily installed. A pole-mounted sign support system is defined as the hardware necessary to mount a single sign panel on an existing pole, regardless of the number of bands used.

645-4.08 Illuminated Sign Panels. The work will be measured as the number of square meters measured to the nearest 0.01 square meter of illuminated sign panel satisfactorily installed.

645-4.09 Covering Sign Panels. (Vacant).

645-5 BASIS OF PAYMENT

645-5.01 General. The unit price bid for all items shall include the cost of furnishing all labor, materials, and equipment necessary to complete the work.

645-5.02 Sign Panels. The unit price bid for sign panels shall include the panels, horizontal and vertical stiffeners (Z-Bars), vertical overhead brackets to mount sign panels to overhead structures, and fasteners and miscellaneous hardware necessary to complete the work. The cost of sign panels that are to become part of larger signs (e.g., route shields on large guide signs) shall be included in the unit price bid for the main panel.

645-5.03 Type A Sign Posts. The unit price bid for Type A sign posts, Type A sign posts with extra embedment, soil plates for Type A sign posts, and high-capacity Type A sign posts shall include the cost of furnishing all labor, materials and equipment necessary to complete the work.

645-5.04 Type B Sign Posts. The unit price bid for Type B sign posts shall include the posts, breakaway base and hinge assemblies, and concrete footings. Breakaway bases provided in lieu of nonbreakaway posts at the Contractor's option will be paid for at the bid price for nonbreakaway bases.

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645-5.05 Concrete Foundations. The unit price bid for Concrete Footing for Type A, High-Capacity Type A or Breakaway Wooden Sign Posts with steel tube inserts shall include the cost of furnishing all labor, materials and equipment necessary to install the footing and hardware.

645-5.06 Breakaway Wooden Sign Posts. The unit price bid for breakaway wooden sign posts shall include the posts and backfill if required.

645-5.07 Pole-Mounted Sign Support Systems. The unit price bid for pole-mounted sign support systems shall include the cost of furnishing all labor, materials and equipment necessary to install the sign panel on an existing pole, regardless of the number of bands used.

645-5.08 Illuminated Sign Panels. The unit price bid for illuminated sign panels shall include the work required under §645-5.02 *Sign Panels*, and all luminaires, bulbs, ballasts, wiring, conduit, and fittings from a point just above the footing to the most extreme luminaire. The unit price bid for illuminated sign panels shall also include the cost to energize and test the illuminated sign panel. The cost of energy necessary to illuminate sign panels before final contract acceptance shall be borne by the Contractor. The cost of controllers will be paid separately.

645-5.09 Covering Sign Panels. The unit price for covering sign panels shall include the work required for covering permanent signs: covering construction signs will be paid under Construction Signs.

Payment will be made under:

| Item No. | Item | Pay Unit | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|----------|---|-----------------------|-----------|-----------------------|-----------------------|-----------|-----------------------|----|-------|--------------|----|----|--------------|----|-------|---------------|----|----|---------------|----|-------|----------------|----|----|----------------|----|-------|----------------------|----|----|----------------------|--|
| 645.71XX | Ground-Mounted Sign Panel MUTCD Codes R, P, W, and M | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | <table border="0" style="width: 100%;"> <thead> <tr> <th style="text-align: left;">XX</th> <th style="text-align: left;">ASTM Type</th> <th style="text-align: left;">Panel Width (Nominal)</th> <th style="text-align: left;">XX</th> <th style="text-align: left;">ASTM Type</th> <th style="text-align: left;">Panel Width (Nominal)</th> </tr> </thead> <tbody> <tr> <td>01</td> <td>I/III</td> <td>Up to 450 mm</td> <td>11</td> <td>IX</td> <td>Up to 450 mm</td> </tr> <tr> <td>02</td> <td>I/III</td> <td>451 to 750 mm</td> <td>12</td> <td>IX</td> <td>451 to 750 mm</td> </tr> <tr> <td>03</td> <td>I/III</td> <td>751 to 1625 mm</td> <td>13</td> <td>IX</td> <td>751 to 1625 mm</td> </tr> <tr> <td>04</td> <td>I/III</td> <td>Greater than 1625 mm</td> <td>14</td> <td>IX</td> <td>Greater than 1625 mm</td> </tr> </tbody> </table> | XX | ASTM Type | Panel Width (Nominal) | XX | ASTM Type | Panel Width (Nominal) | 01 | I/III | Up to 450 mm | 11 | IX | Up to 450 mm | 02 | I/III | 451 to 750 mm | 12 | IX | 451 to 750 mm | 03 | I/III | 751 to 1625 mm | 13 | IX | 751 to 1625 mm | 04 | I/III | Greater than 1625 mm | 14 | IX | Greater than 1625 mm | |
| XX | ASTM Type | Panel Width (Nominal) | XX | ASTM Type | Panel Width (Nominal) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 01 | I/III | Up to 450 mm | 11 | IX | Up to 450 mm | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 02 | I/III | 451 to 750 mm | 12 | IX | 451 to 750 mm | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 03 | I/III | 751 to 1625 mm | 13 | IX | 751 to 1625 mm | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 04 | I/III | Greater than 1625 mm | 14 | IX | Greater than 1625 mm | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.72 | Overhead-Mounted Sign Panels, MUTCD Codes R, P, W and M | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.73 | Ground-Mounted Sign Panels, MUTCD Codes G and I | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.74 | Overhead-Mounted Sign Panels, MUTCD Codes G and I | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.76 | Illuminated Sign Panels | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.77 | Covering Sign Panels | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.78 | High-Visibility Overhead-Mounted Sign Panel MUTCD Codes R, P, W, and M | Square Meter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.81 | Type A Sign Posts | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.8104 | Type A Sign Posts with Extra Embedment | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.8105 | Soil Plate for Type A Sign Post | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.8106 | High-Capacity Type A Sign Posts | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.8107 | Concrete Footing for Type A, High-Capacity Type A or Breakaway Wooden Sign Posts With Steel Tube Inserts | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 645.82 | Breakaway Wooden Sign Posts | Each | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

SIGNS

645.8XYYZZ Type B Sign Posts

Each

| X | Appearance | YY | Section | ZZ | Base |
|----------|-------------------|-----------|----------------|-----------|---------------------------|
| 3 | Galvanized | 01 | S75X8 | 01 | Nonbreakaway |
| 4 | Rustic | 02 | W150X14 | 02 | Bidirectional Breakaway |
| | | 03 | W150X18 | 03 | Omnidirectional Breakaway |
| | | 04 | W200X22 | | |
| | | 05 | W250X28 | | |
| | | 06 | W250X33 | | |
| | | 07 | W310X39 | | |
| | | 08 | W360X51 | | |

645.85

Pole-Mounted Sign Support System (Band Mounting) Each

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Make the following changes to Volume 3 of 3 of the Standard Specifications of January 2, 2002: Page 7-270, line 1, **Delete** §730-05 REFLECTIVE SHEETING, and **Replace** it with the following:

730-05 REFLECTIVE SHEETING

SCOPE. These specifications cover reflective sheeting for use in the fabrication of highway and construction signs, delineators and other traffic control devices.

GENERAL. The reflective sheeting supplied shall be colored, flexible, weather resistant, and shall have a smooth outer surface. If the reflective sheeting contains spherical lens elements, the lens elements shall be embedded within a transparent plastic, so as to produce a smooth, flat outer surface. All sheeting shall be of good appearance, free from ragged edges, cracks, scales, blisters, or other defects.

The back of the reflective sheeting shall be protected by a removable liner and shall include a precoated pressure-sensitive or a heat-activated adhesive, either of which may be applied without the necessity of additional adhesive tack coats on the reflective sheeting or application surface.

Reflective sheeting shall be one of the following ASTM D4956 types:

730-05.01 - ASTM Type I (Class A). A medium-intensity reflective sheeting often referred to as engineer grade. It is recommended for highway signs, except where high reflectivity is required, and for construction barricades, panels, and other work zone devices.

730-05.02 - ASTM Type III (Class B). A high-intensity reflective sheeting often referred to as high intensity. It is recommended for highway signs, construction signs, delineators, and other work zone devices.

730-05.03 - ASTM Type V (Class C). A super-high-intensity reflective sheeting recommended for delineators, construction barricades, and vertical panels. This material is not recommended for highway or construction zone sign faces.

730-05.04 - Fluorescent Orange (Class D). A fluorescent orange-colored sheeting with reflective properties similar to Class B high intensity. This sheeting is only recommended for use on orange-colored construction signs, and for the orange portions of construction barricades, vertical panels, and other work zone devices with rigid substrates, when a high level of conspicuity or visibility is needed.

730-05.05 - ASTM Type IX (Class E). A very-high-intensity retroreflective sheeting having highest retroreflective characteristics at short road distances. Recommended for permanent signs, delineators, construction zone devices, and vertical panels, when a high level of conspicuity or visibility is needed.

MATERIAL REQUIREMENTS. Reflective sheeting shall meet the requirements of ASTM D4956 and the following:

1. Fluorescent Colors. Shall conform to the requirements of Table 730-05-1.

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TABLE 730-05-1 FLUORESCENT SHEETING REQUIREMENTS

| Fluorescent Color | Luminance Factor (Y Percent) Min. | | Maximum Spectral Radiance Factor (%) | Color Specification Limits ¹ | | | | | | | |
|-------------------|-----------------------------------|----------------|--------------------------------------|---|-------|-------|-------|-------|-------|-------|-------|
| | | | | 1 | | 2 | | 3 | | 4 | |
| | Y _t | Y _f | | x | y | x | y | x | y | x | y |
| Orange | 25 | 15 | 110.0 | 0.583 | 0.416 | 0.535 | 0.400 | 0.595 | 0.351 | 0.645 | 0.355 |
| Yellow | 45 | 20 | ----- | 0.479 | 0.520 | 0.446 | 0.483 | 0.512 | 0.421 | 0.557 | 0.442 |
| Yellow Green | 60 | 20 | ----- | 0.387 | 0.610 | 0.369 | 0.546 | 0.428 | 0.496 | 0.460 | 0.540 |

NOTE:
 1. Four pairs of chromaticity coordinates determine acceptable color in terms of the CIE, 1931 Standard Colorimetric System measured with Standard Illuminant D₆₅.

2. Fluorescent Orange Class D - 730-05.04. Class D fluorescent orange reflective sheeting:

A. Coefficient of Retroreflection (R_A). The coefficient of retroreflection shall meet or exceed the reflectivity requirements indicated in Table 730-05-2.

| TABLE 730-05-2 FLUORESCENT ORANGE COEFFICIENT OF RETROREFLECTION, R_A | | |
|--|--------------------|--|
| Observation Angle (°) | Entrance Angle (°) | Minimum R _A (cd/lx/m ²) |
| 0.2 | - 4 | 100.0 |
| 0.2 | + 30 | 34.0 |
| 0.5 | - 4 | 64.0 |
| 0.5 | + 30 | 22.0 |

B. Daytime Color. The color shall conform to the requirements for luminance factor, maximum spectral radiance factor (peak reflectance), and color specification limits indicated in Table 730-05-1. Color measurements shall be determined in accordance with ASTM E991, using instrumentation which has circumferential viewing (illumination). Calculations shall be performed in accordance with ASTM E308 for the CIE 1931 2° standard observer.

C. Artificial Weathering. After 1500 hours of artificial weathering performed in accordance with ASTM G 26, Method A, using a Type B weatherometer, the following requirements shall be met:

- The minimum coefficient of retroreflection shall be 55.0 cd/lx/m² at 0.2 degree observation angle; - 4 degree entrance angle.
- The luminance factor (Y Percent) shall be from 20.0 to 45.0.
- The maximum spectral radiance factor (peak reflectance) shall not be less than 60.0 percent.
- The color specification limits shall conform to the requirements shown above in Class D, *B. Daytime Color*.

3. Type IX (Class E) - 730-05.05. All colors shall conform to the requirements of ASTM D4956, except fluorescent colors. Fluorescent colors shall conform to the requirements of Table 730-05-1 and Table 730-05-3 of this specification.

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| TABLE 730-05-3 COEFFICIENT OF RETROREFLECTION (R_A) (cd/lx/m²) | | | | | |
|---|---------------------------|------------------------------|------------|------------|------------|
| | Entrance Angle (°) | Observation Angle (°) | | | |
| | | 0.1 | 0.2 | 0.5 | 1.0 |
| Fluorescent Orange | - 4° | 200 | 115 | 72 | 24 |
| | + 30° | 110 | 34 | 22 | 14 |
| Fluorescent Yellow | - 4° | 400 | 240 | 165 | 45 |
| | + 30° | 250 | 150 | 75 | 24 |
| Fluorescent Yellow-Green | - 4° | 540 | 325 | 235 | 65 |
| | + 30° | 380 | 200 | 105 | 35 |

FABRICATION. The reflective sheeting shall be so fabricated as to allow easy cutting to specified sizes and shapes.

The sheeting surface shall be solvent resistant and shall permit solvent cleaning. All solvents used for cleaning operations shall be as recommended by the sheeting manufacturer and shall comply with all Federal, State, and Local air quality regulations.

To ensure uniform appearance and brilliance under both nighttime and daytime conditions, the reflective sheeting shall be cut, matched and positioned on the prepared sign panel or other substrate in strict accordance with the recommendations of the sheeting manufacturer. Backgrounds, characters, delineators, etc., shall be coated and/or edge sealed in accordance with the recommendations of the sheeting manufacturer. When performed, coating operations shall be done in a workmanlike manner so as to create an even, clear, uniform coat which shall be free of streaks, drops or other defects which might affect reflectivity.

Reflective sheeting shall be furnished in both rolls and sheets. Rolls shall be packed individually and contain not more than four splices per 46 m linear measurement. Cut sheets shall be packaged flat and in such a manner as to minimize any damage or defacement that may occur to the sheeting during shipment or storage. The sheeting surface shall be capable of being readily processed and be compatible with recommended transparent and opaque process inks. The finished sheeting surface shall show no loss of the color with normal handling, cutting and application.

TESTING. Outdoor test specimen panels shall include both unprocessed reflective sheeting and reflective sheeting processed with the manufacturer's recommended transparent and opaque inks. Type I (Class A), Type III (Class B), and Type IX (Class E), except Type IX fluorescent orange, reflective sheetings shall be exposed outdoors on a test deck for a minimum 3-year continuous time period. Class D and Type IX (Class E) fluorescent orange sheeting shall be exposed outdoors on a test deck for a minimum 1 year continuous time period. Outdoor exposure testing will not be required for Type V (Class C) reflective sheeting.

Outdoor testing shall consist of exposing reflective sheeting test specimen panels, facing south, and inclined at an angle of 45° from a horizontal position. The test deck facility shall be located in a climate similar to that in which the material is intended to be used, or at a site approved by the Materials Bureau. Testing shall be performed by an independent testing agency or in conjunction with the National Transportation Product Evaluation Program (NTPEP).

Following the specified outdoor exposure time period, all weathered test panels of reflective sheeting shall meet the following performance requirements. The sheeting on the test panels shall show no appreciable adhesion loss, cracking, blistering, crazing, dimensional change, or color change. The minimum percent retained coefficient of retroreflection (R_A) shall be as specified below when compared to a control unexposed specimen counterpart. The control specimen reflectivity values (R_A) shall be measured at the start of outdoor exposure testing. Measurements shall be taken at 0.2 degree observation angle; - 4 degree entrance angle.

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| TABLE 730-05-4 MINIMUM PERCENT RETAINED COEFFICIENT OF RETROREFLECTION (R_A) | |
|---|-----|
| Type I (Class A) Materials Designation 730-05.01 | 50% |
| Type III (Class B) Materials Designation 730-05.02 | 80% |
| Class D (Materials Designation 730-05.04) | 50% |
| Type IX (Class E) Materials Designation 730-05.05 | 60% |

BASIS OF ACCEPTANCE. Approvals will be based upon independent laboratory analysis and outdoor exposure testing conducted in accordance with this specification. If the reflective sheeting passes the requirements for laboratory and outdoor exposure testing, the product will then be placed on the Department's "Approved List" of materials. Detailed requirements and procedures for approval are available from the Materials Bureau.

Contract acceptance of Type I (Class A), Type III (Class B), Type IX (Class E), and Class D reflective sheetings will be based on the inclusion of the sheeting material on the Department's "Approved List" of reflective sheeting materials and the manufacturer's certification of compliance with this specification.

Contract acceptance of Type V (Class C) reflective sheeting will be based on the manufacturer's certification of compliance with this specification.