Standard Specifications Manual

SERIES 800 - URBAN TRANSPORTATION

SERIES 800 URBAN TRANSPORTATION

Item No.

801 Construction Detours
802 Project Signs
803 Barricades, Signs and Traffic Handling
824 Traffic Signs
825 Street Names Signs
827 Designated Bicycle Lane Signing
829 Designated Bicycle Lane Markings
830 Traffic Signal Controller Foundation
831 Traffic Signal Drilled Shaft Foundations
832 Vehicular Traffic Signal Installation
833 Pedestrian Push Button Assembly
834 Traffic Signal Pull Boxes
835 Traffic Signal Conduit
836 Traffic Signal Risers
837 Traffic Signal Loop Detectors
838 Pedestrian Signal Installation
839 Traffic Signal Poles
840 Installation of Traffic Signals
842 Pull boxes
844 Trench Excavation and Backfill for Traffic Signal Conduit
860 Pavement Marking Paint
861 Thermoplastic Pavement Markings
862 Temporary Removable Pavement Markings
863 Reflectorized Pavement Markers
864 Abbreviated Pavement Markings
865 Non-Reflectorized Traffic Buttons
866 Jiggle Bar Tile
867 Epoxy Adhesive
870 Work Zone Pavement Markings
871 Reflectorized Pavement Markings
872 Prefabricated Pavement Markings
873 Raised Pavement Markings
874 Eliminating Existing Pavement Markings and Markers
875 Pavement Surface Preparation for Markings

SERIES 800 - URBAN TRANSPORTATION
Item No. 801

Construction Detours

This item shall govern: 1) the construction, manipulation, maintenance and removal, if required, of construction detours of the length and to the lines, grades and typical sections indicated on the Drawing; and 2) the provision for installation, movement, replacement, maintenance, cleaning and removal, as required, of all detour markers, signs, barricades and other devices used in traffic control and handling at the construction site upon completion of the work, as indicated on the Drawings or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

801.2 Submittals

The submittal requirements of this specification item include:

A. Type D HMAC mix design,
B. Type and Construction of the barricade, and
C. Identification of the type, source, mixture, Percent Live Seed (PLS) and rate of application of the seeding.

801.3 Materials

A. Flexible Base:

Flexible Base shall conform to Standard Specification Item No. 210, "Flexible Base ".

B. Stabilized Base:

When an HMAC Type A or B stabilized base is indicated on the Drawings, it shall conform to Standard Specification Item No. 340, "Hot Mix Asphaltic Concrete Pavement" and if an asphalt Stabilized Base is shown on the Drawings, it shall conform to Standard Specification Item No. 206, "Asphalt Stabilized Base (Plant Mix)".

C. Prime Coat:

Prime Coat shall conform to Standard Specification Item No. 306, "Prime Coat".

D. Tack Coat:

Tack Coat shall conform to Standard Specification Item No. 307, "Tack Coat".

E. Seal Coat:

Seal Coat shall conform to Standard Specification Item No. 312, "Seal Coat".

F. Hot Mix Asphaltic Concrete Pavement:

Hot Mix shall be Type C or D, as shown on the Drawings, conforming to Standard Specification Item No. 340, "Hot Mix Asphaltic Concrete Pavement".

G. Construction Pavement Markings:

1. Traffic Tape shall conform to Standard Specification Item No. 864, "Abbreviated Pavement Markings".

2. Pavement Paint shall conform to Standard Specification Item No. 860, "Pavement Marking Paint (Reflectorized)".

3. Pavement Markers shall conform to Standard Specification Item No. 871, "Reflectorized Pavement Markers".

4. Work Zone Pavement Markings shall conform to Standard Specification Item No. 870, "Work Zone Pavement Markings".

H. Barricades, Signs and Traffic Handling

Barricades, Signs and Traffic Handling shall conform to Standard Specification Item No. 803, "Barricades, Signs and Traffic Handling". All barricades shall be constructed with one of the following materials/combinations:

1. Wood
2. Wood and Steel
3. Plastic

I. Seeding

Seeding shall conform to Item No. 604, "Seeding for Erosion Control".

801.4 Construction Methods

The detours shall be constructed at the locations and to the lines and grades indicated on the Drawings. It shall be the entire responsibility of the Contractor to provide for the passage of traffic in comfort and safety without creating a dust problem.

Flexible base material shall be deposited on the prepared subgrade, sprinkled, bladed, compacted, and shaped to conform to the typical sections indicated on the Drawings, conforming to the City of Round Rock Standard Specification Item No. 2102, “Flexible Base”. The finished base shall receive surfacing where indicated on the Drawings in accordance with the pertinent City of Round Rock Standard Specification surfacing items.

After the detours are no longer needed for traffic, those materials, indicated for removal, shall become the property of the Contractor and shall be disposed of off the project. The site shall then either be restored to the original configuration and contours of the ground or to a landscape with a pleasing appearance that is composed of natural rounded slopes with re-vegetation / seeding.

All barricades, signs and other types of devices listed above shall conform to details indicated on the Drawings and/or in the City of Round Rock Standard Details and shall comply with the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

801.5 Maintenance

It shall be the Contractor's responsibility to maintain the construction detour and to repair the surface markers, striping and storm water drainage system as long as the detour is required.

801.6 Measurement

"Construction Detours", when included in the contract as a pay item, will be measured by the lump sum.

801.7 Payment

This item will be considered subsidiary to the various items of work, unless included as a separate pay item in the contract.

When included for payment, it shall be paid at the lump sum bid for "Construction Detours". The price shall include full compensation for all work, herein, specified, including the furnishing of all materials, equipment, tools, labor and incidentals necessary to complete the work.

Payment, when included as a contract pay item, will be made under:

Construction Detour	Per Lump Sum.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 801, “Construction Detours”

City of Round Rock Standard Specifications

Designation	Description
Item No.206	Asphalt Stabilized Base
Item No 210	Flexible Base
Item 306	Prime Coat
Item 307	Tack Coat
Item 312	Seal Coat
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 604	Seeding for Erosion Control
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 860	Pavement Marking Paint
Item No. 864	Abbreviated Pavement Markings
Item No. 870	Work Zone Pavement Markings"
Item No. 871	Reflectorized Pavement Markers"

Texas Department of Transportation Technical Documents:

Designation	Description
(TMUTCD)	Texas Manual on Uniform Traffic Control Devices

RELATED CROSS REFERENCE MATERIALS -
Specification Item No. 801, “Construction Detours”

City of Round Rock Standard Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 360	Concrete Pavement
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 873	Prefabricated Pavement Markers
Item No. 873	Raised Pavement Markers
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

City of Round Rock Standard Details

Designation	Description
863-1	Pavement Buttons (Reflectorized-Type I & Type II)
865-1	Traffic Buttons (Non-Reflectorized)

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item No. 801, “Construction Detours”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 502	Barricades, Signs and Traffic Handling
Item No. 508	Constructing Detours
Item No. 510	One-Way Traffic Control
Item No. 512	Portable Concrete Traffic Barrier
Item No. 514	Permanent Concrete Traffic Barrier
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

ITEM NO. 803
BARRICADES, SIGNS AND TRAFFIC HANDLING

803.1 Description

This item shall govern for providing, installing, moving, replacing, maintaining, cleaning and removing upon completion of the work, all temporary or permanent street closure barricades, signs, cones, lights or other devices required to handle the traffic in conformance with the current edition of the Texas Manual of Uniform Traffic Control Devices for Street and Highways and as indicated on the Drawings or directed by the Engineer or designated representative.

Construction Detours, if required, shall conform to Standard Specification Item No. 801, "Construction Detours".

This item shall also include the installation of all required safety fencing as described in the latest adopted version of Standard Detail 804-4.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

803.2 Submittals

The submittal requirements of this specification item include:

A. Type of Barricade and proposed materials and Construction of the barricade,

803.3 Materials

All barricades, signs, cones, lights and other types of devices to handle traffic, as indicated on the Drawings or directed by the Engineer or designated representative, shall conform to details shown on the Drawings or those indicated in the Texas Manual on Uniform Traffic Control Devices (TMUTCD).

803.4 Construction Methods

Prior to commencement of construction, suitable "Barricades, Signs and Traffic Handling" devices shall be installed to protect the workers and the public.

The Contractor shall be responsible for the installation of all markers, signs and barricades in accordance with the Drawings and in conformance with the Texas Manual on Uniform Traffic Control Devices (TMUTCD) and/or as indicated on the Drawings or directed by the Engineer or designated representative. If, in the opinion of the Engineer or designated representative, additional markers, signs or barricades are needed in the interest of safety, the Contractor will install such as are required or as directed by the Engineer or designated representative. All changes and/or revisions to the detour/traffic control plan shall be approved by the Engineer or designated representative.

Lumber shall be painted with 2 coats of paint as indicated on the Drawings.

803.5 Maintenance

It shall be the Contractor's responsibility to maintain, clean, move and replace if necessary, barricades, signs and traffic handling devices during the time required for

construction of the project. Permanent barricades shall be constructed as required after the completion of the street by drilling holes to place the posts and concrete foundations. Foundation concrete shall be cured before the rails are attached. When no longer needed, all temporary Barricades, Signs and Traffic Handling Devices shall be removed and the area restored to its original condition or as directed by the Engineer or designated representative.

803.6 Measurement

The work performed and material furnished as prescribed by this item, City of Round Rock Standard Details, details included on the Drawings or indicated in the TMUTCD shall be measured as follows:

A. Pavement Markings.

All pavement marking required for proper installation of the designated Traffic Control Plans and Details, as well as required removal of existing pavement marking, shall be measured and paid for under Standard Specification Item No. 870, "Work Zone Pavement Markings" and Standard Specification Item No. 874, "Eliminating Existing Pavement Markings".

B. Barricades, Signs and Traffic Handling.

All work performed and material furnished as prescribed by this item, City of Round Rock Standard Details, details shown on the Drawings or indicated in the TMUTCD, that are not included in the above paragraph, shall be measured by the day.

Traffic control for the project will be measured and paid for once per contract defined time period, i.e. either per Calendar Day, Working day or Month at the contract rate, regardless of the number of set-ups, locations or streets under construction.

C. Safety Fencing

Safety fencing will be measured by the lineal foot.

803.7 Payment

The work performed and materials furnished as prescribed by this item, measured as provided under section "803. Measurement" shall be paid for at the contract unit price for barricades, signs and traffic handling. This unit price shall include full compensation for furnishing and placement of all materials and for all labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Barricades, Signs, and Traffic Handling	Per Calendar Day.
Barricades, Signs, and Traffic Handling	Per Working Day.
Barricades, Signs, and Traffic Handling	Per Month.
Safety Fence	Per Lineal Foot.

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 803, “Barricades, Signs and Traffic Handling”

City of Round Rock Standard Specifications

Designation	Description
Item No. 801	Construction Detours
Item No. 802	Project Signs
Item No. 870	Work Zone Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers

Texas Technical Documents:

Designation	Description
(TMUTCD)	Texas Manual on Uniform Traffic Control Devices

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 803, “Barricades, Signs and Traffic Handling”

City of Round Rock Standard Specifications

Designation	Description
Item No. 403	Concrete for Structures
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 867	Epoxy Adhesive
Item No. 871	Reflectorized Pavement Markings
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 502	Barricades, Signs and Traffic Handling
Item No. 508	Constructing Detours
Item No. 510	One-Way Traffic Control
Item No. 512	Portable Concrete Traffic Barrier
Item No. 514	Permanent Concrete Traffic Barrier
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS 7110	Aluminum Sign Blanks
DMS 8310	Flexible Roll-up Reflective Signs

RELATED CROSS REFERENCE MATERIALS Continued
Specification Item No. 803, “Barricades, Signs and Traffic Handling”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-839-B	Determining Color in Reflective Materials
Tex-842-B	Method for Measuring Retroreflectivity

American Society for Testing and Materials (ASTM)

Designation	Description
A-307	Specification for Carbon Steel Externally Threaded Standard Fasteners
A-320	Specification for Alloys-Steel Bolting Materials for Low-Temperature Service
A-513	Specification for Electric-Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
B-108/B108M	Specification for Aluminum-Alloy Permanent Mold Castings
B-183	Practice for Preparation of Low-Carbon Steel for Electroplating
B-221/B-221M	Specification for Aluminum-Alloy Extended Bars, Rods, Wire, shapes, and Tubes
D-523	Test Method for Specular Gloss
D-822	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products
D-828	Test Method for Tensile Breaking Strength of Paper and Paperboard
G-23	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials

Item No. 824
Traffic Signs

824.1 Description

This item shall govern furnishing and placement of Traffic Signs including excavation and backfill, Portland cement concrete, reinforcement, posts, hardware and signs.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

824.2 Submittals

The submittal requirements of this specification item include:

A. Identification of the types of materials proposed for traffic sign, i.e. faces, posts, clamps, etc.,

B. Construction details (Portland cement concrete mix, reinforcing steel, etc.) for Portland cement foundation,

824.3 Materials

A. Portland Cement Concrete

Portland cement concrete for sign post foundations shall be Class A concrete conforming to Standard Specification Item No. 403, "Concrete for Structures".

B. Reinforcing Steel

Reinforcing steel for signpost foundations shall conform to Standard Specification Item No. 406, "Reinforcing Steel". The sizes, lengths and placement dimensions shall be as indicated on the Drawings.

C. Posts

Post tubing shall be provided in lengths of 10, 11, 12 and 13 feet (3.05, 3.35, 3.66 and 3.96 meters) as indicated on the Drawings.

Post Diameter, size and unit weight:

Outside diameter (O.D.) shall be 2.375 inches (60 millimeters);

Wall thickness shall be 0.065 inch (1.65 millimeters);

Unit weight shall be 1.60 pounds per foot (2.4 kilograms per meter).

Post shall be constructed of welded steel tubing conforming to ASTM A-513 or ASA 6036-T6-Mil, ASA 25995 schedule 10 seamless aluminum.

Steel post tubing shall be hot dipped galvanized to obtain a weight of 1.25 oz./square foot (381 grams per square meter) of sheet meeting Federal Specification A-G-90. Welded steel shall be hot dipped galvanized both inside and outside of tubing. Post tubing shall have up to 11 each 3/8 inch (10 mm) holes punched or drilled as indicated on the Drawings. All sharp edges shall be removed from ends of tubing to eliminate burrs, etc.

D. Hardware

The mounting clamp shall be able to be attached on a 2 3/8 inches (60 mm) outside diameter post by a U-bolt 5/16 inch (8 mm) diameter with 1 inch (25 mm) of threads on each end and shall meet the details indicated on the Drawings.

Hardware shall slide freely on the pipe post when properly loosened.

Clamp shall withstand a torque of 15 ft.-lbs. (2.1 meter-kilograms), when tightening nuts on U-bolts or sign blanks to a clamp.

U-bolt made from cold rolled steel shall withstand a minimum of 20 ft.-lbs. (2.8 meter-kilograms), torque when tightened around a signpost.

Pipe clamp casting shall be ASTM B-108 alloy A- 44.0-T4 or ASTM B-26 alloy 356.0-F. All sign mounting clamp parts that are not made from aluminum shall be cold rolled steel (ASTM A-36), stainless steel (ASTM A-320) or galvanized steel (ASTM A-307).

E. Sign Blanks

Sign blanks shall be 0.080-inch (2-mm) thickness; alodine finished, and shall conform to ASTM B-221, Alloy 6061-T6 aluminum of the dimensions indicated on the Drawings. The sign blanks shall be free of buckles, warps, dents, cockles, burrs and other defects and shall be essentially a plane surface.

F. Sign Faces (Reflective Sheeting)

1. General.

The reflective material shall consist of spherical enclosed lens elements embedded within a transparent plastic having a smooth, flat outer surface. The surface shall be compatible with recommended process inks needed to produce sign faces.

Sheeting, decals and/or sign faces shall be furnished in the size, shape and quantity indicated on the Drawings.

Sheeting, decals and/or sign faces shall be free from ragged edges, cracks, tears, pits, blisters, similar defects, foreign matter or other surface imperfections which would make it unsuitable for the intended usage.

Complete sign faces or 20 square feet (1.85 square meters) sections of sheeting shall appear uniform in color and retroreflectivity when viewed under normal day or night lighting conditions from a distance of 50 feet (15.2 meters).

All sheeting and each sign face shall have attached to the adhesive face a liner that will prevent contact between the message faces and adhesive. This protective liner shall be removable by peeling without soaking in any type of solvent and shall be easily removed after storage for 4 hours at 160^{o}F (71^{o}C) under a pressure of 3.0 pounds per square inch (2.1 grams per square mm).

2. Diffuse Day Color

The diffuse day color shall comply with the specified color requirements. Color requirements are defined by an enclosed area formed with the following CIE Chromaticity Coordinates as corner points and reflectance requirements for the various colors as shown in the following table before and after Weather-Ometer (Atlas, Sunshine type) exposure, as described in the 'Durability' section of this specification. The color shall be determined in accordance with TxDOT Test Method Tex-839-B, "Determining Color in Reflective Materials".

Chromaticity Coordinates			
Color	Chromaticity		Reflectance
	x	y	Y
White	0.310	0.300	
	0.29	0.320	
	0.360	0.360	40 minimum
	0.340	0.380	
Orange	0.530	0.360	
	0.530	0.400	
	0.590	0.410	12-30
	0.640	0.360	

The sheeting's face and all areas of the face of sign faces shall have an 85 degree gloss meter rating of not less than 35 when tested in accordance with ASTM D-523.

The diffuse day color of the reflective sheeting shall be determined in accordance with ASTM Designation: E-97, "45-degree, 0-degree Directional Reflectance Factor of Opaque Specimens by Broad-Band Filter Reflectometry". (Geometric characteristics must be confined to illumination incident within 10 degrees of and centered about a direction of 45 degrees from the perpendicular to the test surface; viewing is within 15 degrees of and centered about, the perpendicular to the test surface. Conditions of illumination and observation must not be interchanged.) The standard to be used for reference shall be the Munsell Papers. Papers must be recently calibrated on a spectrophotometer.

3. Specific Intensity Brightness

The Specific Intensity Brightness values of reflective sheeting, decals and each sign face, before exposure, shall meet all the minimum retrodirective reflectivity requirements for its respective type and color listed in the following table. Values are expressed in units of candlepower per foot-candle per square foot (lumens per lux per square meter). Specific intensities shall be determined according to TxDOT Test Method Tex-842-B.

Specific Intensity Minimum Brightness Values							
Brightness Values		Angle on Incidence Specific Intensity in Cp/ftc/ft^2 (lm/lx/m^2)					
Color	Divergence Angle	2^o		10^o		20^o	
White	0.2	75	(942)	50	(628)	25	(314)
	0.33	60	(753)	35	(439)	12	(151)
Orange	0.2	18	(226)	14	(176)	6	(75)
	0.33	12	(151)	8	(100)	4	(75)

4. Sheeting, Decals and Sign Faces

Decal or sign faces after 48 hours of conditioning, shall have a minimum tensile strength of sheeting of 15 pounds per inch (2.6 Newtons per mm) width when tested in accordance with ASTM Designation: D-828.

The sheeting, decals or sign faces, when applied in accordance with manufacturer's recommendations to a clean etched 0.020 inch by 2 inch by 8 inch (0.5 mm by 50 mm by 200 mm) aluminum panel of Alloy 6061-T6; conditioned a minimum of 48 hours and tested at 72^{o}F (23^{o}C) and 50 percent relative humidity, shall be sufficiently flexible to show no cracking when bent around a 3/4 inch (18 mm) mandrel.

The sheeting or sign faces shall permit cutting, application and color processing at any combination of the following temperatures and relative humidity: Temperature range of 60 to 100^o F (15 to 38^{o}C), relative humidity to 20 to 80 percent. Sheeting and sign faces will withstand heat curing of unapplied sheeting to 150^{o}F (65^{o}C) and of applied sheeting and sign faces to 200^{o}F (93^{o}C).

Sheeting or sign faces exposed for 48 hours of conditioning at 80 to 100^{o}F (27 to 38^{o}C), shall show no effect when exposed for 15 minutes to the following chemicals in accordance with Federal Test Method 8801: mineral spirits, zylol, turpentine or methanol.

Thickness of sheeting without adhesive and screen ink shall be 4.5 to 5 mils (0.11 to 0.13c mm).

Sheeting or sign faces, when applied in accordance with the manufacturer's specifications to clean, smooth, paintable and weatherproof surfaces, shall adhere so securely at a temperature range of -20 to 175^{o}F (-30 to 80^{o}C), that peeling, pulling or scraping of material from adhering surfaces in pieces containing areas greater than 2 square inches (1290 square mm) will be impossible. Adhesion test shall be conducted not less than 48 hours after application.

The reflective sheeting or sign faces shall include a pre-coated tack free adhesive, which will adhere to prescribed surfaces only when activated by heat in the range of 175 to 200^{o}F (80 to 95^{o}C). The pre-coated adhesive shall not require additional adhesive coats on the reflective material or the application surface.

5. Durability

Processed and applied on recommended procedures, the reflective material shall be weather resistant and following cleaning, shall show no appreciable discoloration, cracking, blistering or dimensional change and shall not have less than 50 percent of the specified (wet or dry) minimum reflective intensity values, when exposed to 1000 hours of Atlas Twin ARC weathering (ASTM Designation: G-23) in accordance with ASTM Designation: D-822. The following data is required to assure correlation with other laboratories.

a). Type and model of exposure device, ASTM G-23 Type E Atlas XW.
b). Type of light source - Sunshine carbon arc.
c). Age of filters - 1/4 of filters changed every 400 hours.
d). Flux density at sample location.
e). Spectural irradiance at sample location, 100, 360 micro-watts per square CM.
f). Elapsed exposure time - 1,000 hours.
g). Light/dark - water-humidity cycle employed - 102 minutes of light followed by 18 minutes of light with spray, 5 days per week - 48 hours per week without light or spray.

6. Process colors (inks) - A minimum of 96 hours after processing and after the Weather-Ometer exposure, no process ink will be removed when tested as follows:

a). Immerse in distilled water for 24 hours.
b). Remove from water and wipe dry with soft cloths.
c). Condition the panels for 8 hours at room temperature and humidity.
d). Make 2 parallel scratches, 1 inch (25 mm) apart, through to the metal.
e). Apply a 1 inch (25 mm) wide strip of "Scotch" Brand Masking Tape #250 and roll across the tape with 4 1/2 pound (2 kilogram) rubber roller, 8 times.
f). Quickly remove the tape with 1 motion and examine for damage to the inner coat or surface adhesion.

Unless otherwise indicated on the Drawings, the reflective sheeting for emblems, decals, cut out numbers and letters for vehicle marking and identification shall meet the performance criteria established in these specifications with the following exceptions: The above materials shall be pre-coated with a positional pressure sensitive adhesive backing meeting the requirements set out above.

The message shall be as indicated on the Drawings.

824.4 Construction Methods

Any excavation required for the sign installation shall be completed through whatever layers/materials are encountered to the dimensions and elevation indicated on the Drawings or required by the site conditions as directed by the Engineer or designated representative. This excavation shall be done in accordance with Standard Specification Item No. 401, "Structural Excavation and Backfill", except that it will not be measured for payment and will be considered subsidiary to the respective sign supports.

Reinforcing steel shall be positioned/placed as indicated on the Drawings and shall conform to Standard Specification Item No. 406, "Reinforcing Steel", except that it will not be measured for payment but will be considered subsidiary to the respective sign supports.

Foundations for all pipe posts shall conform to Standard Specification Item No. 410, "Concrete Structures".

Any sign posts, that are to be imbedded in drilled shaft foundations, shall be set carefully in the foundation holes and if directed by the Engineer or designated representative, shall be held in place by an approved template until the Portland cement concrete for the foundation is placed. The forms and templates, if used, shall not be removed until the Portland cement concrete has aged a minimum of 24 hours. Springing or raking of posts to secure proper alignment will not be permitted.

Electrical conduit, where required, and anchor bolts of the size, length and number as indicated on the Drawings, shall be positioned before the Portland cement concrete is placed. Anchor bolt groups shall be set and maintained in position with a template during the placement of that portion of Portland cement concrete where anchor bolts are embedded. Care shall be taken to obtain the orientation of the anchor bolts and spacing of the anchor bolt groups as indicated on the Drawings.

Parts of the Portland cement concrete foundations, that extend above the natural or finished ground line, shall be given an ordinary surface finish conforming to Standard Specification Item No. 410, "Concrete Structures". If a higher type finish is indicated on the Drawings, it shall conform to Standard Specification Item No. 411, "Surface Finishes for Concrete".

No structure or post shall be erected on a concrete finish nor shall any traffic sign be attached to a sign post embedded in Portland cement concrete until the Portland cement concrete has aged at least 7 curing days or until otherwise directed by the Engineer or designated representative.

The length of each traffic sign post that is indicated on the Drawings shall be verified by the Contractor in order to meet the existing field conditions and to conform with sign mounting heights indicated on the Drawings and/or in conformance with Texas Department of Transportation Manual of Uniform Traffic Control Devices. If it is necessary to field cut a steel post to shorten it; the cut end shall be placed in the Portland cement concrete foundation.

Pipe sign supports shall be built up as indicated on the Drawings. Any part of the pipe, which displays exposed bare metal or from which the galvanizing has been knocked or chipped off down to bare metal during fabrication, transit or erection, shall be repaired, in accordance with the manufacturer's recommendations, by application of galvanizing repair compounds meeting Federal Specification O-G-93 (stick only) or zinc dust-zinc oxide meeting Federal Specification TT-P-64lb.

The sign supports shall be located as indicated on the Drawings, except that the Engineer or designated representative may shift a sign support where necessary to secure a more desirable location. The Engineer or designated representative will approve all sign support locations.

Sign supports shall be erected at the direction of the Engineer or designated representative so that the sign faces will normally be vertical and, if necessary, angled sufficiently away from a position perpendicular to the roadway, when attached to the supports, to prevent specular glare. If specular glare is apparent on the mounted signs during nighttime inspection, corrective adjustments in the sign orientation shall be made at the direction of the Engineer or designated representative.

The multi-section pipe post supports may, at the Contractor's option, be cast in the Portland cement concrete foundation with or without the upper post section attached. However, if installation is made with the upper post section attached, the support shall not be exposed to traffic until the sign is properly affixed.

The pipe stub post shall be set carefully in the foundation holes and if directed by the Engineer or designated representative, it shall be held in place by an approved form or template before the Portland cement concrete for the foundation is placed. The forms and templates, if used, shall not be removed until the p.c. concrete has aged at least 24 hours. No sign shall be attached to the posts until the p.c. concrete has aged at least 7 curing days or until otherwise directed by the Engineer or designated representative. A curing day shall be as defined in Standard Specification Item No. 410, "Concrete Structures".

Springing or raking of posts to secure proper alignment will not be permitted.

The Contractor shall be responsible for the correctness of shop fit and field connections. Post lengths shall be approved by the Engineer or designated representative prior to the fabrication of any support.

Backfill shall conform to Standard Specification Item No. 401, "Structural Excavation and Backfill" and additional requirements specified herein.

All backfilling shall be completed prior to the erection of any sign on the structure.

Where rip-rap, embankment protection or surfacing is removed for placing foundations for traffic signs, it shall be replaced with like material as directed by the Engineer or designated representative.

The message as indicated on the Drawings shall be screened on the reflective sheeting in accordance with the sheeting producer's recommended practices utilizing screen inks approved by the Engineer or designated representative. Screen inks shall conform to

TxDOT Departmental Materials Specification DMS-8300, "Flat Surface Reflective Sheeting".

Before application, the surface must be prepared to the satisfaction of the Engineer or designated representative in accordance with the manufacturer's instructions. Whenever the sign is applied over expansion joints, deep cracks or seams, it shall be slit to avoid tearing or lifting. Any applied sign that has wrinkles, air pockets, ragged edges, tears or bends, shall be removed and replaced at the sole cost of the Contractor.

Signs will be installed as indicated on the Drawings or as directed by the Engineer or designated representative. The installation as a whole shall be carried out in conformance with requirements herein stated and with details and dimensions indicated on the Drawings. Upon completion, the work shall present a neat and workmanlike appearance.

824.5 Measurement

Traffic signs shall be measured as each complete sign constructed and placed as indicated on the Drawings.

824.6 Payment

The work performed and materials furnished as prescribed by this item will be paid for at the unit bid price for "Traffic Signs" per each complete in place. The unit bid price shall include full compensation for furnishing all materials, completing the excavation, setting posts in Portland cement concrete and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Traffic Signs	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS-
Specification Item No. 824, “Traffic Signs”

City of Round Rock Standard Specifications

Designation	Description
Item No. 401	Structural Excavation and Backfill
Item No. 403	Concrete for Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 411	Surface Finishes for Concrete
Item No. 722	Paint and Painting

Texas Department of Transportation Manual of Testing Procedures:

Designation	Description
Tex-839-B	Determining Color in Reflective Materials
Tex-842-B	Method for Measuring Retroreflectivity

Texas Department of Transportation; Departmental Materials Specifications

Designation	Description
DMS-8300	Flat Surface Reflective Sheeting

American Society for Testing and Materials (ASTM):

Designation	Description
A-36/A-36M	Specification for Structural Steel
A-307	Specification for Carbon Steel Externally Threaded Standard Fasteners
A-320	Specification for Alloys-Steel Bolting Materials For Low-Temperature Service
A-513	Specification for Electric Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
B-26	Specification for Aluminum-Alloy Sand Castings
B-108/B-108M	Specification for Aluminum-Alloy Permanent Mold Castings
B-221/B-221M	Specification for Aluminum-Alloy Extended Bars, Rods, Wire, Shapes, and Tubes
D-523	Test Method for Specular Gloss
D 822	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products
D 828	Test Method for Tensile Breaking Strength of Paper and Paperboard
E 97	45-degree, 0-degree Directional Reflectance Factor of Opaque Specimens by Broad-Band Filter Reflectometry
G 23	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials

Other Specifications

Federal Specification A-G-90
Federal Test Method 8801
Federal Specification O-G-93 (stick only)
Federal Specification TT-P-64lb.

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 824, “Traffic Signs

Texas Department of Transportation Technical Documents:

Designation	Description
(TMUTCD)	Texas Manual on Uniform Traffic Control Devices

City of Round Rock Standard Details

Designation	Description
824-1	Standard Street-End Markers

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 445	Galvanizing
Item No. 636	Aluminum Signs (Type A)
Item No. 637	Aluminum Signs (Type G)
Item No. 642	Aluminum Signs (Type O)
Item No. 646	Small Roadside Sign Supports
Item No. 647	Large Roadside Sign Supports
Item No. 656	Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-7110	Aluminum Sign Blanks
DMS-7120	Sign Hardware
DMS-8310	Flexible Roll-up Reflective Signs
DMS-8320	Vinyl, Non-reflective Decal Sheeting

Item No. 825
Street Name Signs

825.1 Description

This item shall consist of the furnishing and placing of Street Name Signs including excavation, concrete, posts, hardware and signs.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

825.2 Submittals

The submittal requirements of this specification item include:

A. A post cap and separator for flat and for extruded sign blades representing materials they propose to use, along with the results of any state or federal tests performed upon their product for approval, prior to ordering the hardware.

B. Results of any State or Federal tests for sign faces (reflectance, diffuse day color, specific intensity brightness, Weather-O-meter, etc.) performed on their products,

C. Upon request of the Engineer or designated representative, a sample shall be provided to the City with a 24 inch (600 mm) section of the sign post product and the results of any required federal or state tests.

D. Samples of all types of mounting clamps proposed for use,

E. Construction details (concrete mix, reinforcing steel, etc.) for Portland cement foundation,

825.3 Materials

A. Concrete

The Portland cement concrete for a street sign post foundation shall be Class A concrete conforming to Standard Specification Item No. 403, "Concrete for Structures".

B. Reinforcing Steel

Reinforcing steel for street signpost foundations shall conform to Standard Specification Item No. 406, "Reinforcing Steel". The sizes, lengths and placement dimensions shall be as indicated on the Drawings.

C. Posts

The street sign post tubing shall be 13 feet (4 meters) in length and constructed of welded steel tubing conforming to ASTM A-513 or ASA 6036-T6-Mil, 25995 ASA schedule 10 aluminum.

1. Post Diameter, size and unit weight:

The outside diameter (O.D.) of the post tubing shall be 2.375 inches (60 mm); the wall thickness shall be .065 inch (1.65 mm); and the weight per

foot (mass per meter) shall be 1.60 pounds per foot (2.4 kilograms per meter).

2. The welded steel post tubing shall be hot dipped galvanized inside and outside to obtain a weight (mass) of 1.25 oz/square foot (381 grams per square meter) of sheet conforming to Federal Specification A-G-90 commercial weight.

3. Post tubing shall be punched or drilled as indicated with 22 each 3/8-inch (10-mm) holes.

4. All sharp edges shall be removed from ends of tubing to eliminate burrs, etc.

   If required by the Engineer or designated representative, damaged galvanized areas shall be repaired using either galvanized Coating Repair Compound that conforms to Federal Specification 0-G-93 (stick only) or zinc dust-zinc oxide that conforms to Federal Specification TT-P-641b.

   Upon request of the Engineer or designated representative, a sample shall be provided to the City with a 24 inch (600 mm) section of the product and the results of any required federal or state tests.

D. Hardware

Hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum, in conformance with TxDOT's Departmental Materials Specification DMS-7120, "Sign Hardware" or equivalent hardware shall be smoothly finished and precision machined to fit standard flat blade sections or extruded blade sections as indicated on the Drawings allowing clearance for reflective facing according to requirements. When dissimilar materials are used, the metals shall be so selected or insulated to prevent corrosion.

Hardware shall be able to secure and support up to three 6-inch X 36-inch (150-mm x 900-mm) blades with a single post cap.

The post to sign bracket shall be able to be attached firmly on standard 2 3/8-inch (60-mm) O.D. pipe by means of three 5/16-inch (8-mm) diameter set screws through a wall section having 0.312 inch (8-mm) minimum thickness. The sign blades shall be secured in place by 5/16-inch (8-mm) diameter set screws. These requirements shall be met for both flat and extruded sign blades.

The sign to sign bracket shall be either 90 or 45 degree type as indicated on the Drawings and shall have minimum requirements equal to the post to sign bracket for holding the sign blades in place for either flat or extruded blades.

E. Sign Blanks

1. Sign blanks shall be 6-inch X 36-inch, 0.080 inch thickness, (150-mm x 900-mm, 2-mm thickness) alodine finished, ASTM B221 alloy 6061-T6 aluminum.

2. Flat sign blanks shall be .080 inch (2-mm) thick, anodized, alodine finished 5052-H38 aluminum with rounded corners. Extruded sign blanks shall be

anodized, alodine finished 6063-T6 aluminum with a .080 inch thick web (2-mm) and .245 inch (6-mm) thick extruded flanges, and may have square corners.

3. Pole mounted signs will have a minimum length of 18-inches (450-mm) and sized to accommodate the sign legend and 1-inch (25-mm) green borders on the leading and trailing sign edges.

4. All intersections with traffic signals shall have overhead street name signs 18-inches (450-mm) in height and shall have a minimum length of 24-inches (600-mm), sized to accommodate the legend and 2 inch (50 mm) green borders on the leading and trailing sign edges.

5. Sign blank size will be the same for both streets of the intersection and will be based on the larger of the two streets. Minimum sign blank dimensions are as follows:

Major Street Classification	Sign Blank	Height
Major Arterial	Extruded	9 Inch (225 mm)
Minor Arterial	Extruded	9 Inch (225 mm)
Primary Collector	Extruded	9 Inch (225 mm)
Industrial Collector	Extruded	9 Inch (225 mm)
Commercial Collector	Extruded	9 Inch (225 mm)
Neighborhood Collector	Extruded	9 Inch (225 mm)
Residential Collector	Flat	6 Inch (150 mm)
Local Street	Flat	6 Inch (150 mm)

F. Sign Faces

1. Materials for sign faces shall conform to Flat Surface, Flexible, Retro-Reflective Sheeting and Sign Faces of Section 824.3.F of Standard Specification Item No. 824, "Traffic Signs". Lettering will be white on a green background. The layout of the sign face will be as indicated in the figure below:

2. All lettering shall be Highway Series C. Size and case of the lettering to be used on each type of street name sign is as follows:

Sign Height	Street Name	Suffix / Block #
6 in. (150 mm)	4 in. (100 mm) Upper Case	2 in. (50 mm) Upper Case
9 in. (225 mm)	5 in. (125 mm) Upper Case	2.5 in. (62.5 mm) Upper Case
18 in. (450 mm)	8 in. (200 mm) Upper & Lower Case	4 in. (100 mm) Upper Case

825.4 Construction Methods

Any excavation required for the sign installation shall be completed through whatever layers/materials are encountered to the dimensions and elevation indicated on the Drawings or required by the site conditions as directed by the Engineer or designated representative. This excavation shall be done in accordance with Standard Specification Item No. 401, "Structural Excavation and Backfill", except that it will not be measured for payment and will be considered subsidiary to the respective sign supports.

Reinforcing steel shall be positioned/placed as indicated on the Drawings and shall conform to Standard Specification Item No. 406, "Reinforcing Steel", except that it will not be measured for payment but will be considered subsidiary to the respective sign supports.

Electrical conduit, where required, and anchor bolts of the size, length and number as indicated on the Drawings shall be positioned before the Portland cement concrete is placed. Anchor bolt groups shall be set and maintained in position with a template during the placement of that portion of Portland cement concrete where anchor bolts are embedded. Care shall be taken to obtain the orientation of the anchor bolts and spacing of the anchor bolt groups as indicated on the Drawings.

Pipe sign supports shall be constructed as indicated on the Drawings or as directed by the Engineer or designated representative. Any part of the pipe which displays exposed bare metal or from which the galvanizing has been knocked or chipped off down to bare metal during fabrication, transit or erection shall be repaired in accordance with the manufacturer's recommendations by application of Galvanized Coating Repair Compound.

The sign supports shall be located as indicated on the Drawings, except that the Engineer or designated representative may shift a sign support where necessary to secure a more desirable location. The Engineer or designated representative shall approve all sign support locations.

The post shall be set carefully in the foundation holes 18 inches (450 mm) below grade and if directed by the Engineer or designated representative, shall be held in place by an approved form or template before the p.c. concrete for the foundation is placed. The forms and templates, if used, shall not be removed until the Portland cement concrete has aged at least 24 hours. No sign shall be attached to the posts until the concrete has aged at least 48 hours or until otherwise directed by the Engineer or designated representative. A curing day shall be as defined in Standard Specification Item No. 410, "Concrete Structures".

Springing or raking of posts to secure proper alignment will not be permitted.

The work shall conform to Standard Specification Item No. 410, "Concrete Structures" and with the requirements herein.

All parts of the Portland cement. concrete foundations that extend above the natural or finished ground line shall be given an ordinary surface finish conforming to Standard Specification Item No. 410, "Concrete Structures". If a higher type finish is specified or indicated on the Drawings, it shall be completed in conformance with Standard Specification Item No. 411, "Surface Finishes for Concrete".

Backfill shall conform to Standard Specification Item No. 401, "Structural Excavation and Backfill". All backfill shall be completed prior to the erection of any sign on the structure. Where riprap, embankment protection or surfacing is removed for placing foundations for signs, it shall be replaced with like material as directed by the Engineer or designated representative.

Sign face and message shall be applied to sign blanks as indicated in Standard Specification Item No. 824, "Traffic Signs". Finished signs shall be attached to sign posts using hardware specified above and in accordance with manufacturer's recommendations or as indicated on the Drawings.

Signs will be installed as indicated on the Drawings or as directed by the Engineer or designated representative. The installation as a whole shall be carried out in conformance with requirements herein stated. Upon completion, the work shall present a neat and workmanlike appearance.

825.5 Measurement

Street name signs shall be measured as each complete sign constructed and placed as indicated on the Drawings and these specifications.

825.6 Payment

The work performed and materials furnished as prescribed by this item will be paid for at the unit bid price for "Street Name Signs" per each complete in place. The unit bid price shall include full compensation for furnishing all materials, completing the excavation, setting posts in Portland cement concrete and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Street Name Signs	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 825, “Street Name Signs

City of Round Rock Standard Specifications

Designation	Description
Item No. 401	Structural Excavation and Backfill
Item No. 403	Concrete for Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 411	Surface Finishes for Concrete
Item No. 722	Paint and Painting
Item No. 824	Traffic Signs
Section 824.3.F	Sign Faces

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-7110	Aluminum Sign Blanks

American Society for Testing and Materials (ASTM):

Designation	Description
A-513	Specification for Electric Resistance-Welded Carbon and Alloy Steel Mechanical Tubing
B-221/B-221M	Specification for Aluminum-Alloy Extended Bars, Rods, Wire, Shapes, and Tubes

Other Specifications

Federal Specification A-G-90
Federal Specification O-G-93 (stick only)
Federal Specification TT-P-64lb.

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 825, “Street Name Signs

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 445	Galvanizing
Item No. 636	Aluminum Signs (Type A)
Item No. 637	Aluminum Signs (Type G)
Item No. 642	Aluminum Signs (Type O)
Item No. 646	Small Roadside Sign Supports
Item No. 647	Large Roadside Sign Supports
Item No. 656	Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies

RELATED CROSS REFERENCE MATERIALS Continued
Specification Item No. 825, "Street Name Signs

Texas Department of Transportation Manual of Testing Procedures:

Designation	Description
Tex-839-B	Determining Color in Reflective Materials
Tex-842-B	Method for Measuring Retroreflectivity

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-7110	Aluminum Sign Blanks
DMS-8300	Flat Surface Reflective Sheeting
DMS-8310	Flexible Roll-up Reflective Signs
DMS-8320	Vinyl, Non-reflective Decal Sheeting

Texas Department of Transportation Technical Documents:

Designation	Description
(TMUTCD)	Texas Manual on Uniform Traffic Control Devices

American Society for Testing and Materials (ASTM):

Designation	Description
A-36/A 36M	Specification for Structural Steel
A-307	Specification for Carbon Steel Externally Threaded Standard Fasteners
A-320	Specification for Alloys-Steel Bolting Materials For Low-Temperature Service
B-26	Specification for Aluminum-Alloy Sand Castings
B-108/B-108M	Specification for Aluminum-Alloy Permanent Mold Castings
D-523	Test Method for Specular Gloss
D-822	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Testing Paint, Varnish, Lacquer, and Related Products
D-828	Test Method for Tensile Breaking Strength of Paper and Paperboard
E-97	45-degree, 0-degree Directional Reflectance Factor of Opaque Specimens by Broad-Band Filter Reflectometry
G-23	Recommended Practice for Operating Light- and Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials

Item No. 827
Designated Bicycle Lane Signing

827.1 Description

This item shall govern the signage for Designated Bicycle Lanes of the types, sizes and placement indicated on the Drawings. Designated Bicycle Lanes shall be for the exclusive use of bicycle traffic.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, inch-pound units are given preference followed by SI units shown within parentheses.

827.2 Submittals

The submittal requirements of this specification item include:

A. Identification of the types of materials proposed for each type of bicycle lane sign (i.e. face, post, clamps, etc.

B. Results of any State or Federal tests for sign faces (reflectance, diffuse day color, specific intensity brightness, Weather-O-meter, etc.) performed on their products,

C. Construction details (Portland cement concrete mix, reinforcing steel, etc.) for signpost p.c. foundation,

827.3 Materials

The sign posts and support foundation, as well as sign blanks and sign face reflective sheeting for the Bicycle Lane Signage shall conform to Standard Specification Item No. 824, "Traffic Signs".

827.4 Installation

A. General

Designated Bicycle Lanes shall be delineated with appropriate signs to alert the automobile/truck driver of the possibility of the presence of bicyclists. Preferential Lane markings and symbols shall be installed in conformance with Standard Specification Item No. 829, "Designated Bicycle Lane Markings". Signs shall be placed as described herein, as indicated on the Drawings and/or directed by the Engineer or designated representative.

B. Signage

A 'Bicycle Lane Ahead' sign (Texas MUTCD designation R3-16) shall be installed in advance of the beginning of the bicycle lane and a 'Bicycle Lane Ends' shall be placed prior to the end of the lane as identified in the Drawings or directed by the Engineer or designated representative. The 'Bicycle Lane Ends' sign shall be a modified Texas MUTCD designation R3-16 in which 'Ends' replaces 'Ahead' in the sign legend.

A 'Bicycle Lane Ends' sign should only be used at the end of the last segment of a stretch of bicycle lanes and should not be placed at a street intersection where the bicycle lane continues beyond the intersection.

The placement of 'Right Lane Bicycles Only' signs shall be coordinated with the installation of Preferential Lane markings. 'Right Lane Bicycles Only' signs should be placed at the beginning of the Designated Bicycle Lane and at the minimum spacing designated on the Drawings may be used on one way streets where the left portion of the street is designated for bicycle traffic only. The 'Left Lane Bicycles Only' sign shall be a modified Texas MUTCD designation R3-17 in which 'Left' replaces 'Right' in the sign legend.

The sign configuration and the lateral/vertical placement of sign face with respect to the outer edge of the bicycle lane as identified in the Drawings and shall conform to the requirements of Texas MUTCD, Part IX.

827.5 Construction Methods

Signs will be installed as indicated on the Drawings or as directed by the Engineer or designated representative. The installation as a whole shall be carried out in conformance with requirements herein stated and with details and dimensions indicated on the Drawings. Upon completion, the work shall present a neat and workmanlike appearance.

The sign supports shall be located as indicated on the Drawings, except that the Engineer or designated representative may shift a sign support where necessary to secure a more desirable location. The Engineer or designated representative will approve all sign support locations.

Sign supports shall be erected at the direction of the Engineer or designated representative so that the sign faces will normally be vertical and, if necessary, angled sufficiently away from a position perpendicular to the roadway, when attached to the supports, to prevent specular glare. If specular glare is apparent on the mounted signs during nighttime inspection, corrective adjustments in the sign orientation shall be made at the direction of the Engineer or designated representative.

The length of each traffic sign post that is indicated on the Drawings shall be verified by the Contractor in order to meet the existing field conditions and to conform with sign mounting heights indicated on the Drawings. If it is necessary to field cut a steel post to shorten it, the cut end shall be placed in the Portland cement concrete foundation.

The pipe stub post shall be set carefully in the foundation holes and if directed by the Engineer or designated representative, it shall be held in place by an approved form or template before the Portland cement concrete for the foundation is placed. The forms and templates, if used, shall not be removed until the Portland cement concrete has aged at least 24 hours.

No sign shall be attached to the posts until the Portland cement concrete has aged at least 2 days of curing or until otherwise directed by the Engineer or designated representative. A curing day shall be as defined in Standard Specification Item No. 410,

"Concrete Structures". Springing or raking of posts to secure proper alignment will not be permitted.

Any part of the pipe post, that displays exposed bare metal or from which the galvanizing has been knocked or chipped off down to bare metal during fabrication, transit or erection, shall be repaired, in accordance with the manufacturer's recommendations, by application of galvanizing repair compounds meeting Federal Specification O-G-93 (stick only) or zinc dust-zinc oxide meeting Federal Specification TT-P-64lb.

The message as indicated on the Drawings shall be screened on the reflective sheeting in accordance with the sheeting producer's recommended practices utilizing screen inks approved by the Engineer or designated representative. Screen inks shall conform to TxDOT Departmental Materials Specification DMS-8300, "Flat Surface Reflective Sheeting".

Before application, the surface must be prepared to the satisfaction of the Engineer or designated representative in accordance with the manufacturer's instructions. Whenever the sign is applied over expansion joints, deep cracks or seams, it shall be slit to avoid tearing or lifting. Any applied sign that has wrinkles, air pockets, ragged edges, tears or bends, shall be removed and replaced at the sole cost of the Contractor.

827.6 Measurement

This Standard Specification Item will be measured by sign type or by any other unit as shown on the Drawings. Payment for revised quantities will be paid for at the unit price bid for that bid item.

827.7 Payment

The work performed and materials furnished in accordance with this Standard Specification Item and measured as provided under “Measurement” will be paid for at the Unit bid price for "Bicycle Lane Signs" of the type and shapes specified. The unit bid prices shall include full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to place, maintain and remove, when required, the signs.

Payment will be made under one or more of the following:

'Bicycle Lane Ahead' sign	Per each.
'Bicycle Lane Ends' sign	Per each.
'Right Lane Bicycles Only' sign	Per each.
'Left Lane Bicycles Only' sign	Per each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 827, Designated Bicycle Lane Signing"

City of Round Rock Standard Specification

Designation	Description
Item No. 410	Concrete Structures
Item No. 824	Traffic Signs.
Item No. 829	Designated Bicycle Lane Markings

Texas Department of Transportation (TxDOT) Departmental Materials Specification

Designation	Description
DMS-8300	Flat Surface Reflective Sheeting".

State of Texas Technical Documents:

Designation	Description
(Texas MUTCD)	Texas Manual on Uniform Traffic Control Devices

Other Specifications
Federal Specification O-G-93 (stick only)
Federal Specification TT-P-64lb.

RELATED CROSS REFERENCE MATERIALS
Specification Item 827, Designated Bicycle Lane Signing"

City of Round Rock Contract Documents

Designation	Description
Section 00300U	Bid Form (Unit Price)

City of Round Rock Standard Specifications

Designation	Description
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling

Texas Department of Transportation Manual of Testing Procedures:

Designation	Description
Tex-839-B	Determining Color in Reflective Materials
Tex-842-B	Method for Measuring Retroreflectivity

Texas Department of Transportation; Departmental Materials Specifications

Designation	Description
DMS-8300	Flat Surface Reflective Sheeting

RELATED CROSS REFERENCE MATERIALS Continued
Specification Item 827, Designated Bicycle Lane Signing”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 445	Galvanizing
Item No. 636	Aluminum Signs (Type A)
Item No. 637	Aluminum Signs (Type G)
Item No. 642	Aluminum Signs (Type O)
Item No. 646	Small Roadside Sign Supports
Item No. 647	Large Roadside Sign Supports
Item No. 656	Foundations for Signs, Traffic Signals and Roadway Illumination Assemblies

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-7110	Aluminum Sign Blanks
DMS-7120	Sign Hardware
DMS-8310	Flexible Roll-up Reflective Signs
DMS-8320	Vinyl, Non-reflective Decal Sheeting

Other Specifications

Federal Specification A-G-90

Federal Test Method 8801

Item No. 829
Designated Bicycle Lane Markings

829.1 Description

This item shall govern the markings for Designated Bicycle Lanes of the colors, types and sizes required in Standard Detail No. 829-1, "Bicycle Lane Markings" and/or indicated on the Drawings. Designated Bicycle Lanes shall be for the exclusive use of bicycle traffic.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, inch-pound units are given preference followed by SI units shown within parentheses.

829.2 Submittals

The submittal requirements of this specification item include:

A. Identification of the types of marking materials (i.e. thermoplastic or paint type) materials proposed for each type of lane marking (i.e. lane striping, words and symbols).

B. Layout and installation plan.

829.3 Materials

The bicycle lane markings (i.e. lane striping, words and symbols) shall conform to the requirements of Standard Specification Item No. 871, "Reflectorized Pavement Markings".

829.4 Installation

A. General

Designated Bicycle Lanes shall be delineated with appropriate lane markings and symbols to alert the automobile/truck driver of the possibility of the presence of bicyclists. Preferential Lane markings and symbols shall be installed in conformance with this specification item, as indicated on the Drawings and/or directed by the Engineer or designated representative. Signs shall be installed in conformance with Standard Specification Item No. 827, "Designated Bicycle Lane Signing".

Under inclement weather conditions the placement of pavement markings as shown on the Drawings shall be delayed until the time that weather conditions allow the application of pavement lane markings, symbols and words.

B. Lane striping

The lateral extent (or width) of a Designated Bicycle Lane shall be defined by solid white edge striping with a minimum width of 4 inches (100 mm) that separates the bicycle lane from the adjacent traffic lane. With the exception of potential conflict areas, the edge striping shall be continuous throughout the length of the Designated Bicycle Lane. The edge striping may be broken in a 1 to 3 segment-to-gap ratio, with a nominal 3-foot (0.9 meter) segment and a 9-foot

(2.7 meters) in potential conflict areas including marked or unmarked pedestrian crosswalks, congested intersections and shared vehicular turning lanes at intersections. The striping shall be installed in conformance with Standard Specification Item No. 871, "Reflectorized Pavement Markings", as identified in the Drawings or as directed by the Engineer or designated representative.

C. Symbols

Marking of a Designated Bicycle Lane shall include the installation of Preferential Lane (directional arrow) and Bicycle Rider Symbols, as indicated on Standard Detail 829-1, "Bicycle Lane Markings". A combination of Preferential Lane and Bicycle Rider symbols shall be installed after each street intersection with the bicycle lane and at a maximum distance of 1000 feet (305 meters) along the bicycle lane. The Preferential Lane Symbols shall be spaced a maximum distance of 250 feet (75 meters) apart. The striping shall be installed in conformance with Standard Specification Item No. 871, "Reflectorized Pavement Markings", as identified in the Drawings or as directed by the Engineer or designated representative.

829.5 Maintenance of Markings

The Contractor shall be responsible for maintaining all bicycle lane markings for 30-calendar days after installation. Lane markings, that fail to meet the requirements of this specification for 30 calendar days from the date of installation, shall be removed and replaced by the Contractor at the Contractor's expense. The 30-calendar day maintenance requirement will be required for replaced markings from the time the original markings were installed.

829.6 Construction Methods

A. Placement and Maintenance

When required by the Engineer, the Contractor and the Engineer shall review the sequence of Work to be followed and the estimated progress schedule.

The Contractor shall exercise due diligence in the selection of materials and placement of bicycle lane markings. The Contractor at its own expense shall maintain lane markings to the satisfaction of the Engineer or designated representative in accordance with this Specification Item.

Markings may be placed on streets either free of traffic or open to traffic. On streets already open to traffic, the markings shall be placed under traffic conditions that exist with a minimum of interference to the operation of the facility. Traffic control shall be as shown on the Drawings or as approved in writing by the Engineer or designated representative. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement.

Guidemarks to mark the lateral location of pavement markings shall be in proper alignment with the final location of future standard markings as shown on the Drawings or as directed by the Engineer or designated representative. The Contractor shall establish the pavement marking guide and the Engineer or designated representative will verify the location of the guides. Any guidemarks,

which are not in alignment with standard markings, shall be removed by the Contractor at its own expense.

Markings shall essentially have a uniform cross-section. The density and quality of markings shall be uniform throughout their thickness. The applied markings shall have no more than five percent, by area, of holes or voids and shall be free of blisters.

Unless otherwise shown on the Drawings, pavement markings may be applied by any method that will yield markings meeting the requirements of the Specification Item.

Unless approved otherwise in writing by the Engineer or designated representative, all Portland cement concrete pavement surfaces shall have standard markings in place prior to opening to traffic.

All asphaltic surfaces, which are scheduled for opening to traffic, shall be marked with guidemarks immediately following placement and final rolling of any course. Guidemarks shall consist of a single temporary flexible-reflective street marker tab or a single temporary construction raised reflective pavement marker at 40-foot (12-meter) spacings.

The standard lane markings shall be installed in accordance with the Texas Manual on Uniform Traffic Control Devices for Streets and Highways (Texas MUTCD) and as shown on the Drawings.

Surfaces to receive surface treatments (Specification Item 320) shall be marked in accordance with the Drawings. Unless otherwise shown on the Drawings, the standard pavement markings shall be placed in accordance with Texas MUTCD, no sooner than three days or later than two weeks after the placement of the surface treatment.

B. Marking Removal

Any bicycle lane markings placed by the Contractor that conflict with any succeeding lane markings shall be removed by the Contractor at its own expense in accordance with Standard Specification Item No. 874, “Eliminating Existing Pavement Markings and Markers”, except for measurement and payment.

829.7 Measurement

This Standard Specification Item will be measured by material type (i.e. Type I or Type II) in lineal foot (lineal meter: 1 lineal meter is equal to 3.281 lineal feet) of standard lane marking (striping), by each symbol and by each letter of word markings, or by any other unit as shown on the Drawings. Where double stripes are placed, each stripe will be measured separately.

829.8 Payment

The work performed and materials furnished in accordance with this Standard Specification Item and measured as provided under “Measurement” will be paid for at the Unit bid price for “Reflectorized Bicycle Lane Pavement Markings” of the various types, shapes, sizes, widths and thickness (Type I markings only) specified. The unit bid

prices shall include full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to place, maintain and remove, when required, the markings, except as described below.

Removal of existing markings will be paid for under Specification Item No. 874, "Eliminating Existing Pavement Markings and Markers".

Payment will be made under one or more of the following:

Type I Bicycle Lane Markings, __inches in width, white in color
Per lineal foot

Type I Bicycle Lane Preferential (directional arrow) Symbols, white in color
Per each

Type I Bicycle Lane (Bike Rider) Symbol, white in color
Per each

Type I Bicycle Lane Letters, white in color Per each

Type II Bicycle Lane Markings, __ inches in width, white in color
Per lineal foot

Type II Bicycle Lane Preferential (directional arrow) Symbols, white in color
Per each

Type II Bicycle Lane (Bike Rider) Symbol, white in color
Per each

Type II Bicycle Lane Letters, white in color Per each

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 829, "Designated Bicycle Lane Markings"

City of Round Rock Standard Details

Designation	Description
Detail No. 829-1	Bicycle Lane Markings

City of Round Rock Standard Specifications

Designation	Description
Item No. 320	Two Course Surface Treatment
Item No. 827	Designated Bicycle Lane Signing
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 871	Reflectorized Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers

Texas State Technical Documents

Designation	Description
(Texas MUTCD)	Texas Manual on Uniform Traffic Control Devices

RELATED CROSS REFERENCE MATERIALS
Specification Item 829, “Designated Bicycle Lane Markings”

City of Round Rock Contract Documents

Designation	Description
Section 00300U	Bid Form (Unit Price)

City of Round Rock Standard Specification Items

Designation	Description
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 824	Traffic Signs
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 867	Epoxy Adhesive
Item No. 872	Prefabricated Pavement Markings
Item No. 875	Pavement Surface Preparation for Markings

RELATED CROSS REFERENCE MATERIALS (Cont’d)
Specification Item 829, “Designated Bicycle Lane Markings”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges

Designation	Description
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planning and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 427	Surface Finishes for Concrete
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation for Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-729-I	Sampling of Traffic Markers
Tex-732-I	Sampling of Prefabricated Pavement Marking Materials
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method for Measuring Pavement Temperature
Tex-854-B	Evaluation of Thermoplastic Striping for Uniformity and Thickness

Texas Department of Transportation: Departmental Materials Specification

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8300	Flat Surface Reflective Sheeting
YPT-10 &/or WPT-10	Pavement Paint

ITEM NO. 830
TRAFFIC SIGNAL CONTROLLER FOUNDATION

830.1 Description

This item shall govern furnishing and installing a traffic signal controller foundation in accordance with the specifications contained herein, the Drawings, Standard Detail No. 830-1, "Foundation Details for Base Mounted Controller Cabinet" and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

830.2 Submittals

The submittal requirements of this specification item may include:

A. The foundation plan and excavation/drilling details;
B. Class A Portland cement concrete mix design;
C. Anchor bolt plan and details;
D. Reinforcing Steel details and placement drawings and
E. Casing plan and details (if required).

830.3 Materials

A. General

All Portland Cement (PC) Concrete, materials, anchor bolts, ground rod, conduits and construction methods shall conform to Standard Detail 830-1, "Foundation Details for Base Mounted Controller Cabinet".

B. Portland Cement Concrete

The Portland cement concrete for foundations shall be Class A, conforming to Standard Specification Item No. 403, "Concrete for Structures". The Portland cement concrete mix design shall consist of a minimum of 5 sacks of cement per cubic yard (280 kilograms of cement per cubic meter) and shall attain a minimum compressive strength of 3000 psi (20.7 mPa) at 28 days unless noted otherwise on the Drawings. Slump of the p.c. concrete shall be between 4" and 5" (100 mm and 125 mm).

The fine and coarse aggregate shall meet the requirements of Standard Specification Item No. 403, "Concrete for Structures". The maximum nominal size of coarse aggregate shall be 1 1/2 inches (38 mm). The cement shall meet the requirements for a Type 1 of ASTM C-150. The water shall be clear, potable and free of all substances, which may be harmful to the p.c. concrete. A retarder or water reducing agent (Standard Specification Item 405, "Concrete Admixtures") will be required in all concrete when casing is required in unstable soil conditions.

C. Reinforcing Steel

Reinforcing steel, when required shall conform to the sizes and dimensions shown on the Drawings. The reinforcing steel shall be new domestic deformed billet steel conforming to ASTM A-615/615M, grade 60 (SI grade 400) and shall conform to Standard Specification Item No. 406, "Reinforcing Steel". If necessary the reinforcing steel may be spliced as long as the splice involves overlapping a minimum of 40 bar diameters.

D. Anchor Bolts

Unless noted otherwise on the Drawings, anchor bolts shall be medium strength, mild steel or alloy steel with maximum design yield strength of 55 ksi (380 mPa). Alloy anchor bolts shall conform to the requirements of ASTM A-193 Grade B7. Medium Strength, mild steel anchor bolts shall conform to the requirements of a modified ASTM A-36 [with a 55 ksi (380 mPa) yield strength] or ASTM A-572.

Welded splicing of rod material for anchor bolts will not be permitted.

When shown on the Drawings, anchor bolts that are to be embedded in p.c. concrete shall have the exposed end plus a minimum of 6 inches (150 mm) galvanized or coated with two (2) coats of a zinc rich coating.

Threads for anchor bolts shall be rolled or cut threads of 8 pitch or unified coarse thread series in accordance with ANSI B1.1. For rolled threads, the diameter of the unthreaded portion shall not be less than the minimum pitch diameter nor more than the maximum major diameter of the threads. All threads for bolts shall have a Class 2a tolerance in accordance with ANSI B1.1.

E. Nuts and washers

Nuts for alloy steel anchor bolts shall conform to ASTM A-194 Grade 2H or ASTM A-563, heavy hex, Class 12. Nuts for Medium Strength, mild steel anchor bolts shall conform to ASTM A-194 Grade 2H or ASTM A-563, Grade D or better. All threads for nuts shall have a Class 2b tolerance in accordance with ANSI B1.1. When nuts are to be galvanized, the untapped blanks shall be galvanized prior to cutting the threads.

Exposed nuts shall be galvanized or coated with a zinc-rich coating if the anchor bolts are not galvanized.

Washers installed with anchor bolts of any type shall conform to the requirements of ASTM F-436 and shall have the same finish or coating as the bolt and nut.

F. Grout Cap

The cement grout cap to cover the anchor bolts and conduit shall consist of a mixture of 5 sacks of sand for every 1 sack of cement.

830.4 Construction Methods

Foundations shall be located as shown on the Drawings, except that the Engineer or designated representative may within design guidelines shift a foundation where necessary to secure a more desirable location or to avoid conflict with utilities. Unless

indicated otherwise on the Drawings, the Contractor shall stake and the Engineer or designated representative will verify all foundation locations.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g., potholing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

Any damage to utilities and/or structures, which occurs as a result of any construction activity performed by the Contractor, shall be repaired by the Contractor's at his sole expense. Foundations shall only be paid for once, regardless of extra work caused by obstructions and/or Contractor damage.

All loose material shall be removed from the bottom of an excavation before Portland cement concrete is placed. Any water that accumulates in the bottom of the excavated foundation shall be removed by pumping or bailing, prior to Portland cement concrete placement.

The use of explosives will not be permitted.

The Portland cement concrete shall be placed as soon as possible after excavation is completed, the reinforcing steel placed and other hardware (anchor bolts, conduits, ground rod, etc.) installed. The Portland cement concrete shall not be placed when the atmospheric temperature (temperature reading taken in the shade away from artificial heat) drops below 35^0F (2^0C) unless permission is provided by the Engineer or designated representative.

A mechanical vibrator shall be used for consolidating the wet concrete. During consolidation of the Portland cement concrete, the Contractor shall insure that there is minimal contact of the vibrator with the reinforcing steel.

Anchor bolts shall be held in place with templates during the placement of Portland cement concrete. Any pots, conduits or other hardware to be embedded in the foundation shall be held in place during Portland cement concrete placement by templates or other suitable means approved by the Engineer or designated representative. Conduit, when used, shall be capped prior to placement of Portland cement concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends of bushings shall be installed on the conduit.

After the concrete has been placed and the top struck off, it shall be covered with wet cotton or burlap mats, for not less than 96 hours. Top templates may be removed after the Portland cement concrete has achieved initial set. Forms and other bracing, when used, shall not be removed until the Portland cement concrete has cured a minimum of 96 hours. When Type III cement is used in the foundation, the Portland cement concrete must cure a minimum of 48 hours. Anchor bolts and conduit shall not be subjected to any applied strain during the cuing period.

Placement and compaction of backfill shall be performed in accordance with Standard Specifications Item No. 201, "Subgrade Preparation" and 132, “Embankment”. Each layer shall be compacted to the required density by any method, and/or type and size of

equipment, which will produce the required compaction. Prior to and in conjunction with the compaction operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section in a length that is best suited to the sprinkling and compaction methods utilized, while rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section.

Where excavation is undertaken in the roadway shoulder, the shoulder shall be replaced with material equal to the original composition. All backfilling shall be completed prior to erection of any structure on the foundation.

All excavated material, not required for backfill, shall be known as "Waste" and shall become the property of the Contractor. It shall be the Contractor responsibility to promptly remove and dispose of the material outside the limits of the project. The work site shall be kept clean and neat at all times. All backfilling shall be completed prior to the erection of any structure on the Portland cement concrete foundation.

Unless permission is given by the Engineer or designated representative no concrete shall be placed when the atmospheric temperature drops below 35ºF (1ºC), where the temperature readings are taken in the shade away from artificial heat.

All parts of the Portland cement concrete foundations extending above the natural or finished ground shall be given an ordinary finish in accordance with Standard Specification Item No. 410, "Concrete Structures".

Where existing surfacing is removed for placement of Portland cement concrete foundations, repair shall be made by backfilling with material equal in composition and density to the surrounding area and replacing any removed surfacing, such as asphalt pavement or Portland cement concrete rip-rap, with like material to equivalent condition.

830.5 Measurement

This item will be measured by each traffic signal controller foundation installed complete in place.

830.6 Payment

Foundations for traffic signal controllers shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for furnishing and placement of all materials, excavation, disposal of waste material and all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Traffic Signal Controller Foundation	Per Each

End.

SPECIFIC Cross Reference Materials
Standard Specification Item No. 830, " Traffic Signal Controller Foundation"

City of Round Rock Standard Details

Designation	Description
Detail No. 830-1	Foundation for Base Mounted Controller Cabinet

City of Round Rock Standard Specification

Designation	Description
Item No. 132	Embankment
Item No. 201	Subgrade Preparation
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures
Item No. 406	Reinforcing Steel

American Society for Testing and Materials (ASTM)

Designation	Description
ASTM A 36	Specification for Carbon Structural Steel
ASTM A-193/193M	Specification for Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A-194/194M	Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A-563/563M	Specification for Carbon and Alloy Steel Nuts.
ASTM A-572/572M	Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
ASTM A-615/615M	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
ASTM F-436/436M	Specification for Hardened Steel Washers
ASTM C-150	Specification for Portland Cement

American National Standards Institute (ANSI) and ANSI/ASME/AWWA

Designation	Description
ANSI/ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)

ITEM NO. 831
TRAFFIC SIGNAL DRILLED SHAFT FOUNDATIONS

831.1 Description

This item shall govern furnishing and installation of traffic signal foundations in accordance with the specifications herein, the Drawings and/or as approved by the Engineer or designated representative.

Traffic signal pole foundation types shall be as designated on the Drawings and shall be one of the following:

Type 1	30”	(760-mm) diameter drilled shaft
Type 2	36”	(915-mm) diameter drilled shaft
Type 3	42”	(1070-mm) diameter drilled shaft
Type 4	48”	(1220-mm) diameter drilled shaft
Type 5	4	(100-mm) pedestrian signal pole foundation

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

831.2 Submittals

The submittal requirements of this specification item may include:

A. The foundation plan and drilling/excavation details;
B. Class A Portland cement concrete mix design;
C. Anchor bolt plan and details;
D. Reinforcing steel details and placement drawings and
E. Casing plan and details (if required).

831.3 Materials

A. General

All Portland cement concrete, materials, anchor bolts, ground rod, conduits and construction methods shall conform to Standard Detail 831-1, "Traffic Signal Drilled Shaft Foundation Details".

B. Traffic Signal Pole Types 1, 2, 3 and 4

Materials for Types 1,2,3, and 4 pole foundations include Portland cement concrete, anchor bolt assemblies, reinforcing steel, conduits, and copper clad ground rod.

C. Pedestrian Signal Pole Type 5

Materials for Type 5 pedestrian signal pole foundations include Portland cement. concrete, 4” (100-mm) threaded coupling, 10 X 4” (3-meter X 100-mm) intermediate metal pole (for pedestrian signals) or a 10 X 4” (3-meter X 100-mm) intermediate metal pole (for vehicle signals), and 4” (100-mm) rigid metal sweep with plug.

D. Portland Cement Concrete

The Portland cement concrete for foundations shall be Class A, conforming to Standard Specification Item No. 403, "Concrete for Structures". The Portland cement concrete mix design shall consist of a minimum of 5 sacks of cement per cubic yard (280 kilograms of cement per cubic meter) and shall attain a minimum compressive strength of 3000 psi (20.7 mPa) at 28 days unless noted otherwise on the Drawings. Slump of the Portland cement concrete shall be between 4" and 5" (100 mm and 125 mm).

The fine and coarse aggregate shall meet the requirements of Standard Specification Item No. 403, "Concrete for Structures". The maximum nominal size of coarse aggregate shall be 1 1/2 inches (38 mm). The cement shall meet the requirements for a Type 1 of ASTM C-150. The water shall be clear, potable and free of all substances, which may be harmful to the p.c. concrete. A retarder or water reducing agent (Standard Specification Item 405, "Concrete Admixtures") will be required in all Portland cement. concrete when casing is required in unstable soil conditions.

E. Reinforcing Steel

Reinforcing steel, when required shall conform to the sizes and dimensions shown on the Drawings. The reinforcing steel shall be new domestic deformed billet steel conforming to ASTM A-615/615M, grade 60 (SI grade 400) and shall conform to Standard Specification Item No. 406, "Reinforcing Steel". If necessary the reinforcing steel may be spliced as long as the splice involves overlapping a minimum of 40 bar diameters.

F. Anchor Bolts

Unless noted otherwise on the Drawings, anchor bolts shall be medium strength, mild steel or alloy steel with maximum design yield strength of 55 ksi (380 mPa). Alloy anchor bolts shall conform to the requirements of ASTM A 193 Grade B7. Medium strength, mild steel anchor bolts shall conform to the requirements of a modified ASTM A-36 [with a 55 ksi (380 mPa) yield strength] or ASTM A 572.

Welded splicing of rod material for anchor bolts will not be permitted.

Each anchor bolt shall have a 6-inch (150-mm) “L” bend at the bottom end and shall be threaded at the top end. The anchor bolts shall have the threaded end galvanized a minimum of 12 inches (300-mm).

Threads for anchor bolts shall be rolled or cut threads of unified coarse thread series in accordance with ANSI B1.1. For rolled threads, the diameter of the unthreaded portion shall not be less than the minimum pitch diameter nor more than the maximum major diameter of the threads.

All threads for bolts and nuts shall have Class 2 fit tolerances in accordance with ANSI B1.1.

Each high strength steel anchor bolt assembly shall include the following parts:

One (1) 1-3/4” X 90” (45-mm X 2.29-meter) anchor bolt;
Two (2) 1-3/4” (45-mm) heavy hex nuts;
Two (2) 1-3/4” (45-mm) hardened flat washers;
One (1) 1-3/4” (45-mm) split lock washer.

G. Nuts and washers

Nuts for alloy steel anchor bolts shall conform to ASTM A-194 Grade 2H or ASTM A-563, heavy hex, Class 12. Nuts for medium strength, mild steel anchor bolts shall conform to ASTM A-194 Grade 2H or ASTM A-563, Grade D or better. All threads for nuts shall have a Class 2b tolerance in accordance with ANSI B1.1. When nuts are to be galvanized, the untapped blanks shall be galvanized prior to cutting the threads.

Exposed nuts shall be galvanized or coated with a zinc-rich coating if the anchor bolts are not galvanized.

Washers installed with anchor bolts of any type shall conform to the requirements of ASTM F-436 and shall have the same finish or coating as the bolt and nut.

H. Grout Cap

The cement grout cap to cover the anchor bolts and conduit shall consist of a mixture of 5 sacks of sand for every 1 sack of cement.

831.4 Construction Methods

A. General

The traffic signal drilled shaft foundation shall be constructed in accordance with the details and instructions provided on the Drawings, and in accordance with the specification requirements described herein.

B. Foundation Location

The foundation shall be located as shown on the Drawings; however the Engineer or designated representative may within design guidelines shift a foundation where necessary to secure a more desirable location or to avoid conflict with utilities. Unless otherwise indicated on the Drawings, the Contractor shall stake and the Engineer or designated representative will verify all foundation locations.

C. Safety

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices.

D. Construction Requirements.

The Contractor shall adhere to the following requirements:

1. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g., potholing, ground

penetrating radar, etc.) to determine the location of existing utilities and structures.

2. The use of explosives will not be permitted.

3. Any damage to utilities and/or structures that occurs as a result of any construction activity performed by the Contractor shall be repaired by the Contractor at his sole expense. Foundations shall only be paid for once, regardless of extra work caused by obstructions and/or Contractor damage.

4. All loose material shall be removed from the bottom of the excavation before Portland cement concrete is placed. Any water that accumulates in the bottom of the excavated foundation shall be removed by pumping or bailing, prior to Portland cement concrete placement.

5. Anchor bolts, posts, conduits, ground rods or other hardware to be embedded in the foundation shall be held in place with templates during Portland cement concrete placement or by other means approved by the Engineer or designated representative. Conduit when used shall be capped prior to placement of Portland cement concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends or bushings shall be installed on the conduit.

6. The Portland cement concrete shall be placed as soon as possible after excavation is completed, the reinforcing steel placed and other hardware (anchor bolts, conduits, ground rod, etc.) installed. Unless permission is provided by the Engineer or designated representative the Portland cement concrete shall not be placed when the atmospheric temperature (temperature reading taken in the shade away from artificial heat) drops below 35^0F (2^0C).

7. The Portland cement concrete shall be continuously placed in the drilled shaft until the construction joint indicated on the Drawings is attained. The Portland cement concrete shall be placed with a suitable tremie or tube at a free fall height limited to 3 to 4 feet (0.9 to 1.2 meters). A mechanical vibrator shall be used for consolidating the wet Portland cement concrete. During consolidation of the Portland cement concrete, the Contractor shall insure that there is minimal contact of the vibrator with the reinforcing steel.

8. After Portland cement concrete placement is completed and the top struck off, the exposed surface shall be cured for a minimum of 96 hours using wet cotton or burlap mats. All external bracing and templates for anchor bolts shall also remain in place for 96 hours after the Portland cement concrete is placed. During this curing time, anchor bolts and conduit shall not be subjected to any applied strain. Springing or racking of anchor bolts or posts to secure proper alignment shall not be permitted.

9. Placement and compaction of backfill shall be performed in accordance with Standard Specifications Item Nos. 201, "Subgrade Preparation" and

132, “Embankment”. Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with the compaction operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

10. Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section in a length that is best suited to the sprinkling and compaction methods utilized, while rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section.

11. Where excavation is undertaken in the roadway shoulder, the shoulder shall be replaced with material equal to the original composition. All backfill shall be completed prior to erection of any structure on the foundation.

12. All excavated material, not required for backfill, shall be known as "Waste" and shall become the property of the Contractor. It shall be the Contractors responsibility to promptly remove and dispose of the material outside the limits of the project. The work site shall be kept clean and neat at all times.

13. A cap of cement grout shall completely cover the anchor bolts and conduits on traffic signal pole foundations that have been earmarked to receive such protection on the individual project drawings. Anchor bolts and conduits shall be covered with plastic film prior to construction of the dome to prevent the cement grout from adhering to these items.

831.4 Measurement

Traffic signal drilled shaft foundations shall be measured by each type of traffic signal pole foundation, complete in place:

Type 1	30” (760-mm) diameter traffic signal pole foundation
Type 2	36” (914-mm) diameter traffic signal pole foundation
Type 3	42” (1067-mm) diameter traffic signal pole foundation
Type 4	48” (1220-mm) diameter traffic signal pole foundation
Type 5	4” (100-mm) signal pole foundation

831.5 Payment

Traffic signal pole foundations will be paid for at the unit bid price per each. The unit bid price shall include full compensation for a) locating utilities, b) all excavations, c) any necessary removal of loose material and pumping of standing water; d) proper disposal of waste materials, e) furnishing and installation of anchor bolts, conduits and ground rods, f) placement and removal of required casings; g) furnishing and placing all Portland cement concrete and reinforcing steel, h) all backfilling, i) procurement of materials and covering the foundation with a grout cap (if required), j) curing of exposed Portland cement concrete and k) furnishing all tools, labor, equipment and incidentals

necessary to complete the work.

All foundations will be paid for only once, regardless of the need to abandon and reinstall a foundation due to unforeseen utility conflicts or any other reason

Extra payment will not be made for casings left in place.

Payment will be made under:

30” diameter Traffic Signal Drilled Shaft Foundations		
	8 Depth	per Each.
36” diameter Traffic Signal Drilled Shaft Foundations		
	10 Depth	per Each.
42” diameter Traffic Signal Drilled Shaft Foundations		
	12 Depth	per Each.
48” diameter Traffic Signal Drilled Shaft Foundations		
	14 Depth	per Each.
4” diameter Pedestrian Signal Foundation		per Each.
30” diameter Traffic Signal Drilled Shaft Foundations		
	8 Depth with casing	per Each.
36” diameter Traffic Signal Drilled Shaft Foundations		
	10 Depth with casing	per Each.
42” diameter Traffic Signal Drilled Shaft Foundations		
48” diameter Traffic Signal Drilled Shaft Foundations		
	14 Depth with casing	per Each.
4” diameter Pedestrian Signal Foundation		
	with casing	per Each.

End

SPECIFIC Cross Reference Materials
Standard Specification Item No. 831, "Traffic Signal Drilled Shaft Foundations”

City of Round Rock Standard Specifications

Designation	Description
Item No. 132	Embankment
Item No. 201	Subgrade Preparation

City of Round Rock Standard Details

Designation	Description
Detail No. 831-1	Traffic Signal Drilled Shaft Foundation Details
Detail No. 831-2	Solar Powered Flasher Assembly

American Society for Testing and Materials, ASTM

Designation	Description
A 193/193M	Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service
A 194/194M	Specification for Carbon and Alloy-Steel Nuts for Bolts for High-Pressure and for High Temperature Service
A 563/563M	Specification for Carbon and Alloy-Steel Nuts
A 572/572M	Specification for High-Strength Low-Alloy Columbium-Vanadium Steels of Structural Quality
A 615/615M	Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
C-150/150M	Specification for Portland Cement
F 43/F 43M	Test Methods for Resistivity of Semiconductor

American National Standards Institute (ANSI) and ANSI/ASME/AWWA

Designation	Description
ANSI/ASME B1.1	Unified Inch Screw Threads (UN and UNR Thread Form)

RELATED Cross Reference Materials
Standard Specification Item No. 831, "Traffic Signal Drilled Shaft Foundations”

City of Round Rock Standard Specifications

Designation	Description
Item No. 104	Removing Concrete
Item No. 111	Excavation
Item No. 130	Borrow
Item No. 401	Structural Excavation Backfill
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures

RELATED Cross Reference Materials
Standard Specification Item No. 831, "Traffic Signal Drilled Shaft Foundations”

City of Round Rock Standard Specifications

Designation	Description
Item No. 420	Drilled Shaft Foundations
Item No. 430	Concrete Curb and Gutter
Item No. 432	Concrete Sidewalks
Item No. 433	Concrete Driveways

Texas Department of Transportation: Standard Specifications for Construction, Maintenance Of Highways, Streets and Bridges

Designation	Description
Item No. 420	Concrete Structures
Item No. 421	Portland Cement Concrete
Item No. 440	Reinforcing Steel
Item No. 449	Anchor Bolts
Item No. 618	Conduit

ITEM NO. 832
VEHICULAR TRAFFIC SIGNAL INSTALLATION

832.1 Description

This item shall govern furnishing and installation of, traffic signal heads in accordance with the specifications contained herein, the Drawings manufacturer recommendations and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

832.2 Submittals

The submittal requirements of this specification item include:

A. Wire size, characteristics and designation for each wire application (i.e. traffic signal, pedestrian signal and/or pedestrian push button),

B. Type, number of sections, lens configuration and manufacturer for each traffic signal item specified on the Drawings,

C. Type, number of sections and manufacturer for each traffic signal item specified on the Drawings,

D. Catalog cut and Manufacturer installation recommendations for signal heads and louvers.

832.3 Materials

The traffic signal heads described herein shall be designed and constructed in accordance with Signal Head Standard included in the latest edition of ITE Technical Report entitled, “Adjustable Face Vehicle Traffic Control” and any additional requirements contained in this specification. The “Standard Traffic Signal Head” shall consist of three (3) glass lenses; each mounted in an individual door. The signal face shall be assembled for horizontal installation and shall be so assembled that the red lens will be located at the left, the yellow lens at the center, and the green lens at the right.

A. General Requirements

The lamp receptacle shall be of weatherproof, molded construction, and shall be equipped with a lamp grip to render it impossible for the lamps to be loosened by vibration. The receptacle shall be set so as to place the filament of a standard 135-watt traffic signal lamp, 2-2/12” IC, in the proper focal position with respect to the reflector. Provisions shall be made on the lamp receptacle to permit placement of a lamp so that the filament opening of the lamp is up, and provide a secure fastening for the lamp in that position. The metal portion of the lamp receptacle shall be compatible with brass or copper lamp bases.

The electrical and optical system of the signal head shall be designed for operation from a power supply of 115 volt, single phase, 60-cycle alternating current and for 60-150 watt standard a-21 traffic signal bulbs.

All exposed metal surfaces of the housing and door and the outside surface of all visors shall be given two (2) coats, separately baked on, of high-grade Federal yellow enamel. The inside surfaces of all visors shall be given two (2) coats of high-grade dull black enamel. Colors shall conform to ITE and Federal Highway Administration Color standards where applicable.

B. Lamps

1. All signal heads shall be provided with light bulbs meeting these criteria: 135 watt, 120-125-volt At-or A-19 HI-BEAM TRAFFIC, KRYPTON, 15500-16500 user hours.

2. All Traffic Signal Lamps shall be Duro-Test Watt-Savers or equivalent, but must meet these standards:

   a) Lamps shall have projection-type Copperflex-tungsten filaments that are supported by two impurity-free high-tensile-strength Molybdenum supports and five extra hook support points to protect against vibration, voltage, and environmental shock. The filament shall be wound on a precision molybdenum mandrel. The Contractor/supplier must be willing to have filament subjected to the filament stretch test.

   b) The filament shall be constructed with a “V” shaped projection to provide greater beam candlepower and to eliminate center dead spot.

   c) Life rating shall be guaranteed by contractor for two years from the date of installation. A manufacturing code date shall be etched on the stem support of each lamp to confirm user hour life rating.

   d) Each lamp shall be identified by information etched in the glass lamp including: manufacturers name, wattage, voltage, average rated user hour life, lot identification, rated lumens, and date of manufacture.

   e) The lamp filament support shall be a solid glass stem and shall be equipped with a polished aluminum deflector disc for greater candlepower concentration and as an aid in protecting the socket and wiring from bulb heat.

   f) Lamps shall have a built-in fuse wire located in the base of the lamp to prevent damage to socket and electrical controls.

   g) Lamps shall have a corrosion proof brass medium base joined to glass envelope by dual use silicone adhesive. The bulb glass shall be grooved to provide additional mechanical grip and to prevent vibration shake out, breakage, and socket weld.

   h) Lamp output shall meet or exceed the rated initial lumens and minimum initial lumens requirements specified in the latest edition of Institute of Transportation Engineers standard “Traffic Signal Lamps”.

i) Lamps shall have the ATC shape to allow for extra room for heat dissipation away from the filament. Super life A and ATC shape shall have user rated hours etched on the bulb at a position below the manufacturer-etched name.

Beam Candlepower specifications shall be supported by a report from a nationally recognized independent testing laboratory and certified by such laboratory personnel.

Lamp fill gas shall be no less than 90% krypton gas concentration ("volume per volume" of total fill gas in the lamp) for increased lumen output at stated wattage.

Gas analysis for krypton fill shall be supported by a report from a nationally recognized independent testing laboratory.

The Contractor shall provide a product that will meet or exceed all of the criteria of this specification. Any traffic signal lamps that are delivered but do not meet the above requirements will be returned at contractor's own expense.

C. Material Requirements

Traffic signal housings, signal face, and visors shall be of unitized construction. The housings shall be constructed of die-cast corrosion-resistant, non-ferrous metal such as aluminum. They shall have a smooth homogeneous finish and shall be accurately formed and free from pouring faults, sponginess, cracks, blowholes, or other defects affecting their strength and appearance.

All traffic signal housings when completely assembled with doors, lenses, and mounting attachments, shall be dust and moisture proof, and shall be of such construction as to assure permanent alignment of all lenses in the signal faces.

The portions of signal housings that provide attachment to supporting arms shall be manufactured with large bosses frilled for the supporting arms. Each housing case shall be attached to its supporting arm in a manner that will adjustment by rotation about its vertical axis through a full 360 degrees and may be rigidly clamped in any position throughout the range of its rotation.

LENS	HOT WIRE	NEUTRAL WIRE
Red	Red	White
Yellow	Yellow	White
Green	Green	White

Each signal head shall be provided with a common terminal block mounted in the center section of the signal head assembly in an easily accessible position. It shall be of weatherproof molded construction and equipped with identified terminals for signal and field wires. The terminal block shall have a minimum of six positions. Five of the positions shall be configured for signal circuits Green ball, Yellow ball, Red ball, two vacant positions and one position for a common connection point of all neutral wires. All neutral wires shall be terminated on one (1) terminal point.

D. Louvers

Where indicated on the Drawings, the contractor shall be required to furnish and install optically programmed louvers in the traffic signal heads. These louvers shall be 12" (300 mm) GPL 13 degree cut-off. Pelco part No. GL-1006 or equivalent approved by the Engineer or designated representative. The cost to provide and install louvers shall be considered subsidiary to this bid item.

E. Other Requirements

All signal heads installed on the job shall be from the same manufacturer. The horizontal assembly shall be oriented with the red lens on the left, amber lens in the middle, and the green lens on the right.

The Contractor will include a certificate with his bid indicating that the materials and the equipment to be supplied conform to the above specifications.

Upon request, the Contractor shall furnish the Engineer or designated representative within (7) working days of the bequest a sample of the proposed equipment.

The Department of Transportation services may test a sample of the signal head under normal conditions. Failure of the equipment to meet these specifications or perform in an unsatisfactory manner during such testing shall be cause to reject signal heads.

832.4 Installation

The Contractor will be responsible for installation of the signal heads in the field. This work shall include providing and installing the signal heads, louvers, backplates, wiring, and mounting hardware at the job site. Drilling wire feed holes and mounting the signal heads will be the Contractor's responsibility.

The Contractor shall wire all signal heads with adequate wire to tie each signal section into the signal cable for the system. Wiring for the signal head shall consist of connecting the terminal block in each signal section to the common terminal block in each signal face, and where applicable, connecting the common terminal block in each signal face to the terminal block in the signal head terminal compartment. All wire feeding through the mast arm or pole structure shall be wrapped once with plastic electrical tape and wrapped again with electrical friction tape extending 12 inches (300 mm) on each side of the pole opening for a total of 24 inches (600 mm). The contractor shall conform to the City of Round Rock’s color code when splicing all conductors. Cabling for each signal (number of conductors, wire gauge, etc) shall be in accordance with the Drawings.

Where required, the Contractor will be required to adjust all signal heads with louvers so that they provide visibility to the intended lane(s) of traffic.

All signal heads or parts of heads not in operation shall be covered with burlap until placed into service.

832.5 Measurement

This item will be measured by each traffic signal installed in place.

The cost of procuring, installing, and connecting mounting hardware, optically programmed louvers, and cable from the traffic signal heads to the controller shall be considered ancillary to various bid items and will not be paid for separately.

832.6 Payment

Traffic signals shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for: a) furnishing and installing all materials, b) drilling wire feed holes (as needed), c) mounting the signal heads on the mast arms and signal poles, d) covering the signal heads with Contractor-supplied burlap (if required), e) correctly cabling the signal head per the drawings, f) furnishing and installing optically programmable louvers, g) adjusting the signal head for proper visibility, as indicated on the Drawings and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Vehicular Signal Installation:	metal pole	per Each.
Vehicular Signal Installation:	wooden pole	per Each.

END

ITEM NO. 833
PEDESTRIAN PUSH BUTTON ASSEMBLY

833.1 Description

This item shall govern furnishing and installation of, pedestrian push button assemblies in accordance with the specifications contained herein, manufacturer recommendations, the Drawings and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

833.2 Submittals

The submittal requirements of this specification item include:

A. Wire size, characteristics and designation for each wire application (i.e. traffic signal, pedestrian signal and/or pedestrian push button),

B. Catalog cut and Manufacturer installation recommendations for required items.

833.3 Materials

A. General

The pedestrian push button assembly shall be weather-tight and tamper-proof. The assembly shall be designed to prevent an electrical shock under any weather condition and shall have provisions for grounding in accordance with the National Electrical Code (NEC).

Pedestrian push button housing shall be cast from aluminum alloy, free of voids, pits dents, molding, sand and excessive grinding marks. All design radii shall be smooth and intact. Exterior surface finish shall be smooth and cosmetically acceptable and free of blemishes. The manufacturer's name or trademark shall be located on the housing.

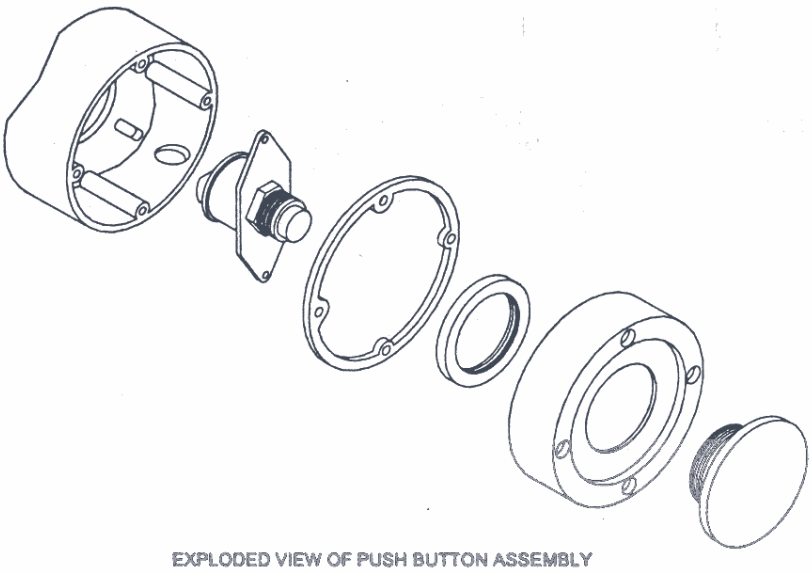
B. Design

The Push button assembly shall be fabricated with design characteristics shown in Figure 1

The bottom of the push button housing shall be tapped for and provided with a ½ inch (12.5-mm) NPT threaded conduit plug. The back of the push button housing shall be provided with a hole capable of being threaded for a ½ inch (12.5-mm) NPT threaded conduit plug and capped with a non-threaded ½ inch (12.5-mm) plastic plug. The back portion of the housing shall be designed to accommodate pole diameters from 3” to 14” (76-mm to 356-mm). The push button housing shall be tapped and provided with (4) hex nut, mounting positions, as shown to accommodate the push button cover. A neoprene 0-ring as shown shall be provided for a weather tight seal between the housing and cover.

The push button switch shall be actuated by a minimum 2” (50-mm) diameter plunger. The plunger shall have an integral shaft to actuate the switch and have a clear anodized finish. The assembly shall be designed so that the maximum

plunger travel does not exceed the switch travel. A spring shall be installed between the plunger and switch. The spring shall provide an operating force of less than 5 lbs (22.2 newtons). A protective shroud shall encircle the plunger to deter vandalism. The shroud shall be cast as an integral part of the cover. There shall be a moisture barrier between the plunger and the switch. The assembly shall conform to all minimum requirements set forth with the American with Disabilities Act.



EXPLODED VIEW OF PUSH BUTTON ASSEMBLY

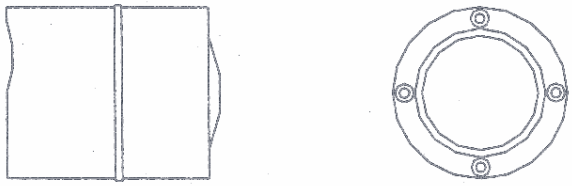


Figure 1: Push button assembly

C. Finish

Both housing and cover shall have an alodine conversion coating to provide a proper base for paint adhesion. The assembly shall be painted Federal Yellow and baked in a drying oven after painting.

D. Push Button Switch

The switch shall have terminal connection points on back to allow for an electrical spade connection to the back of the switch allowing user to connect twisted pair directly to the back of the switch. Wire and Wire nut connections from the back of the switch shall not be acceptable.

The switch assembly shall be capable of operating in temperature ranges of 65^{O}F through 180^{O}F (18^{O}C through 82^{O}C) and have a mechanical life of up to 10,000,000 actuations. The switch assembly shall be electrically rated to carry

25 Amp at 125 volts AC, 250 volts maximum. The switch assembly must have the following recognized certifications and/or approval: UL, CSSA, Mil Spec # MIL-S-8805.

All pedestrian push buttons installed on a job shall be of the same manufacturer.

Upon request, the Contractor shall furnish a sample within (7) working days of the equipment they propose to furnish the City of Round Rock.

The Department of Transportation Planning and Sustainability or succeeding department may test a sample of the signal head under normal conditions. Failure of the equipment to meet these specifications or perform in a satisfactory manner during such testing shall be cause to reject push buttons.

E. Mounting Attachments

Mounting attachments shall be as indicated on the Drawings.

F. Hardware

All bolts, nuts, washers, lock washers, screws and other assembly hardware shall be galvanized steel, stainless steel or dichromate sealed aluminum in conformance with TxDOT Departmental Materials Specifications DMS-7120, "Sign Hardware". When dissimilar metals are used, the metals shall be so selected or insulated to prevent corrosion.

G. Pedestrian Instructional Sign

The instructional sign shall include the legend indicated on the Drawings and shall meet the requirements presented in sections 824.3.E (Sign Blanks) and 824.3.F (Sign Faces) of Standard Specification Item No. 824, "Traffic Signs".

833.4 Installation

The Contractor will be responsible for installing the pedestrian push-buttons and signs in the field. Drilling wire feed holes and mounting the pedestrian push-button on signal poles will be the Contractor's responsibility.

All wire feeding through the mast arm pole structure shall be wrapped once with plastic electrical tape and wrapped again with electrical friction tape extending 12 inches (300-mm) on each side of the pole opening for a total of 24 inches (600-mm). Pedestrian push-buttons shall have a common ground wire that is completely isolated and independent from all other ground wires.

833.5 Measurement

This item will be measured by each pedestrian push button installed.

833.6 Payment

Pedestrian push buttons shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for: a) furnishing and installing all ancillary materials, b) drilling wire feed holes (as needed), c) mounting the push buttons on the signal poles and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

The cost of procuring, installing, and connecting mounting hardware, pedestrian signs, and cable from the push button to the controller is considered ancillary to various bid items and will not be paid for separately.

Payment will be made under:

Pedestrian Push-button per Each.

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 833, "Pedestrian Push Button Assembly"

City of Round Rock Standard Specifications

Designation	Description
Item No.824	Traffic Signs
Section 824.3.E	Sign Blanks
Section 824.3.F	Sign Faces

TxDOT Departmental Materials Specifications

Designation	Description
DMS-7120	Sign Hardware

ITEM NO. 834
TRAFFIC SIGNAL PULL BOXES

834.1 Description

This item shall govern constructing, furnishing and installing traffic signal pull boxes as indicated on the Drawings; in conformity with this specification item; the Drawings and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

834.2 Submittals

The submittal requirements of this specification item include:

A. Identification of the number and types (i.e. types A, B, C or D) of pull boxes proposed,

B. Mix design for 'Class A' Portland cement concrete,

C. Construction details (mortar, reinforcing steel, etc.) for the pull box and supporting foundation.

834.3 Materials

Traffic signal pull box types of the size specified on the Drawings, shall be constructed as shown in the following Standard Details:

No. 834-1 "Type A Traffic Bearing Pull Box,"
No. 834-2 "Frame and Lid for use with Type A Traffic Bearing Pull Box,"
No. 834-3 "Type B Pull Box,"
No. 834-4 "Ring and Lid for use with Type B Pull Boxes,"
No. 834-5 "Type C Pull Box with Light Weight Cover,"
No. 834-6 "Ring and Lid for use with Type C Pull Box",
No. 834-7 "Ring and Lid for Traffic Bearing Type C Pull Box," and
No. 834-8 "Type D Communication Pull Box and Torsion Assisted Lid."

Ring and Lid for each type pull box shall be produced by a manufacturer approved by the Engineer or designated representative.

Brick for pull boxes shall be new common brick.

Portland cement concrete for the pull box base and encasement shall be Class A Portland cement Concrete conforming to Standard Specification Item No. 403, "Concrete for Structures."

834.4 Construction Methods

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners

and application of subsurface utility engineering techniques (e.g., potholing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

Pull boxes shall be constructed in accordance with the lines, grades, details and dimensions indicated on the Drawings or established by the Engineer or designated representative. Pull boxes, which are exposed to view, as in sidewalks, shall be accurately set to the finished grade and anchored.

Masonry work for the lower portion of the pull boxes shall be accurately cut around the conduits and a smooth accurate bed shall be provided for the pre-cast concrete upper portion of the pull box. The pre-cast section shall be set in mortar upon the lower masonry course. The inside of pull boxes shall be left clean and the joints shall be wiped.

Any damage to utilities and/or structures that occurs as a result of any construction activity performed by the Contractor shall be repaired by the Contractor's at his sole expense. Pull boxes shall only be paid for once, regardless of extra work caused by obstructions and/or Contractor damage.

All loose material shall be removed from the bottom of an excavation before Portland cement concrete is placed. Any water accumulated in the bottom of the excavated foundation shall be removed by pumping or bailing, prior to Portland cement concrete placement.

The use of explosives will not be permitted.

The Portland cement concrete shall be placed as soon as possible after excavation is completed, the reinforcing steel placed and other hardware (anchor bolts, conduits, ground rod, etc.) installed. The Portland cement concrete shall not be placed when the atmospheric temperature (temperature reading taken in the shade away from artificial heat) drops below 35ºF (2ºC) unless permission is provided by the Engineer or designated representative.

A mechanical vibrator shall be used for consolidating the wet concrete. During consolidation of the Portland cement concrete, the Contractor shall insure that there is minimal contact of the vibrator with the reinforcing steel.

Anchor bolts shall be held in place with templates during the placement of Portland cement concrete. Any pots, conduits or other hardware to be embedded in the foundation shall be held in place during Portland cement concrete placement by templates or other suitable means approved by the Engineer or designated representative. Conduit, when used, shall be capped prior to placement of Portland cement concrete. Conduit shall be reamed to remove burrs and sharp edges. Bell ends of bushings shall be installed on the conduit.

After the concrete has been placed and the top struck off, it shall be covered with wet cotton or burlap mats, for not less than 96 hours. Top templates may be removed after the Portland cement concrete has achieved initial set. Forms and other bracing, when used, shall not be removed until the Portland cement concrete has cured a minimum of 96 hours. When a Type III cement is used in the foundation, the Portland cement concrete must cure a minimum of 48 hours. Anchor bolts and conduit shall not be subjected to any applied strain during the curing period.

Placement and compaction of backfill shall be performed in accordance with Standard Specifications Item Nos. 201, "Subgrade Preparation" and 132, “Embankment”. Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with the compaction operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section in a length that is best suited to the sprinkling and compaction methods utilized, while rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section.

Where excavation is undertaken in the roadway shoulder, the shoulder shall be replaced with material equal to the original composition. All backfilling shall be completed prior to erection of any structure on the foundation.

All excavated material, not required for backfill, shall be known as "Waste" and shall become the property of the Contractor. It shall be the Contractor responsibility to promptly remove and dispose of the material outside the limits of the project. The work site shall be kept clean and neat at all times. All backfilling shall be completed prior to the erection of any structure on the Portland cement concrete foundation.

Unless permission is given by the Engineer or designated representative; concrete shall not be placed where the atmospheric temperature drops below 35ºF (2ºC), when the temperature readings are taken in the shade away from artificial heat.

All parts of the Portland cement concrete foundations extending above the natural or finished ground shall be given an ordinary finish in accordance with Standard Specification Item No. 410, "Concrete Structures".

Where existing surfacing is removed for placement of Portland cement concrete foundations, repair shall be made by backfilling with material equals in composition and density to the surrounding area and by replacing any removed surfacing, such as asphalt pavement or Portland cement concrete rip-rap, with like material to equivalent section and condition.

834.5 Measurement

Pull boxes shall be measured as each type, complete in place.

834.6 Payment

Pull boxes shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for furnishing and constructing the pull-box as detailed on the Drawings and Standard Details, complete with all fittings, ring and lids covers, masonry work, excavation and backfill, for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Traffic Signal Pull Box, Type A	Per Each.
Traffic Signal Pull Box, Type B	Per Each.
Traffic Signal Pull Box, Type C	Per Each.
Traffic Signal Pull Box, Traffic Bearing Type C	Per Each.
Traffic Signal Pull Box, Type D	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Standard Specification Item No. 834, “Traffic Signal Pull Boxes”

City of Round Rock Standard Specifications

Designation	Description
Item No. 132	Embankment
Item No. 201	Subgrade Preparation
Item No. 403	Concrete for Structures
Item No. 410	Concrete Structures

RELATED CROSS REFERENCE MATERIALS
Standard Specification Item No. 834, “Traffic Signal Pull Boxes"

City of Round Rock Standard Specifications

Designation	Description
Item No. 401	Structural Excavation and Backfill
Item No. 403	Concrete for Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 411	Surface Finishes for Concrete

ITEM NO. 835
TRAFFIC SIGNAL CONDUIT

835.1 Description

This item shall govern furnishing and installation of all traffic signal conduit and/or materials in accordance with the specifications contained herein, the Drawings and/or written instructions from the Engineer or designated representative. This item shall consist of all applicable work, including conduit and termination of conduit in pull boxes, etc.

Cutting, removal and restoration of pavement and base courses, the furnishing and placement of select bedding, backfilling, the hauling and disposition of surplus materials, bridging of trenches and other provisions for maintenance of traffic or access as indicated on the Drawings shall be conducted and compensated in accordance with Standard Specification Item No. 844, “Trench Excavation and Backfill for Traffic Signal Conduit”.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

835.2 Submittals

The submittal requirements of this specification item may include:

A manufacturer’s certification that the PVC and other appropriate materials furnished under this Item were manufactured, sampled, tested, and inspected in accordance with the requirements of the pertinent ASTM specifications.

835.3 Pipe/Conduit Materials

All conduit and materials furnished by the Contractor shall be new and UL-listed and shall meet NEMA and NEC requirements. Unless indicated otherwise on the Drawings, junction boxes, expansion joints and conduit fittings shall be fabricated from a material similar to the connecting conduit.

Any PVC pipe and fittings, that are to be encased in Portland cement concrete or buried, shall meet the requirements of ASTM D3034 type SDR-35 of the nominal size shown on the Drawings. All other conduit shall be electrical conduit, schedule 40 PVC. All bends shall be large radius [minimum of 18 inches (450 mm)] to facilitate pulling of cable.

Rigid metal conduit (RMC) shall be steel, hot dipped galvanized inside and outside. When tested in accordance with ASTM A 90, zinc coating of RMC shall be a minimum of 1.5 ounces per square foot (0.45 kilograms per square meter) inside and outside. Polyvinyl chloride (PVC) conduit shall meet the requirements of NEMA Standard TC-2, UL 651, and the NEC.

ll 1” (50 mm) conduits including elbows and couplings shall be schedule 40 zinc-coated steel rigid threaded conduit (hot-dipped galvanized), conforming to Federal Specification WW-C-581d, ANSI C80 1, and Underwriters Laboratories Specifications.

All 2”, 3”, and 4” (50mm, 75 mm and 100mm) conduits shall be PVC. All PVC conduits, including elbows and couplings shall be schedule 40 PVC conduit, conforming to Federal Specification W-C 1094 and Underwriters Laboratories, Inc. Standard Ul-651.

835.4 Construction Methods

Prior to commencement of work, all erosion control and tree protection measures required shall be in place and all utilities located and protected as set forth in Standard Contract Document Section 00700, “General Conditions”. Adequate temporary supports and protection of surface and underground utilities shall be the responsibility of the contractor.

A street cut permit is required for excavation in an existing City street. Where traffic must cross open trenches, the Contractor shall provide suitable bridges. For trenches less than 2 feet (0.6 meter) in width, sheet steel plates having a minimum thickness of ½ inch (12.5 mm) shall be used. The plates shall overlay the top of the trench a minimum of 18 inches (450 mm) on both sides and secured by Cold-Mix asphalt that meets TxDOT Specification Item No. 334, “Hot Mix-Cold Laid Asphaltic Concrete Pavement”.

Conduit shall be placed in accordance with the lines, grades, details and dimensions shown on the Drawings or as otherwise directed in writing by the Engineer or designated representative. Unless indicated otherwise on the Drawings, underground conduit shall be installed a minimum of 30 inches (760 mm) deep. Installation of conduit shall be in accordance with the requirements of NEC. Conduit placed for Portland cement concrete encasement shall be secured and supported in such a manner that the alignment will not be disturbed during placement of the Portland cement concrete. No Portland cement concrete shall be placed until all of the conduit ends are capped and all box openings closed. Field bends in rigid metal conduit shall have a minimum radius equal to 12 times the nominal diameter of the conduit.

Each length of rigid metal conduit shall be reamed and threaded on each end and couplings shall be made tight. PVC conduit shall be joined by the solvent-weld method in accordance with the conduit manufacturer's recommendations. No reducer couplings shall be used.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g., potholing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

Any damage to utilities and/or structures that occurs as a result of any construction activity performed by the Contractor shall be repaired by the Contractor's at his sole expense. Conduits shall be paid for once, regardless of extra work caused by obstructions and/or Contractor damage.

The Contractor shall comply with City of Round Rock's Standard Specifications, when installing 2-inch (50 mm) conduit.

Unless otherwise noted by the Engineer, all traffic signal conduits shall be terminated in a new or existing pull box. The cost to make the termination is considered ancillary to the various bid items and no additional compensation will be made to the contractor for this work.

All conduit and fittings shall have burrs and rough places smoothed and shall be clean and free of obstructions before the cable is installed. Field cuts shall be made with a hacksaw only, and shall be square and true so that the ends will butt or come together for the full diameter thereof. In no case shall a cutting torch be used to cut or joint conduit. Slip joints or running threads will not be permitted for coupling conduit unless approved by the Engineer or designated representative. When a standard coupling cannot be used, an approved union coupling shall be used and shall provide a watertight coupling between the conduit. All couplings shall be properly installed to bring their ends of connected conduit together to produce a good rigid connection throughout the entire length of the conduit run. Where the coating on a metal conduit run has been damaged in handling or installation, such damaged parts shall be thoroughly painted with rust preventive paint. Ends of conduits shall be capped or plugged until installation of the wire is complete.

Upon request by the Engineer or designated representative, the Contractor shall draw a full-size metal wire brush, attached by swivel joint to a pull tape, through the metal conduit to ensure that the conduit is clean and free from obstructions. Any conduit not passing the wire brush shall be replaced at the contractor's expense. Conduits shall be placed in an open trench to provide a minimum cover of 30 inches (750 mm) below the curb grade in the sidewalk areas, and 30 inches (750 mm) cover in the street areas.

Prior to final acceptance by the Owner of any conduit placed for future use, the contractor shall furnish and install a continuous nylon mule tape in each duct. The mule tape shall have a tensile strength of not less than 1800 pounds (8 kilonewtons). The mule tape shall be securely tied at each end of the conduit.

The Contractor shall provide adequately bent conduit and shall properly excavate so as to prevent damage to the conduit or conductor by a bend radius, which is too short.

Unless otherwise specified or directed by the Engineer or designated representative, all conduit runs shall be continuous and of the same material (metal only or PVC only). Where tying into existing conduit, the Contractor must continue with the same material (metal to metal or PVC to PVC). All conduits placed in trenches shall be laid side by side (no stacking.)

The size and number of conduits shall be as called out on the Drawings. The ends of all conduits placed for future use shall be fitted with caps.

835.5 Trenching, Boring and Backfill

All trenching, excavation and backfill shall be to the lines and grades indicated on drawings and construction detail drawing in accordance with Standard Specification Item No. 401, "Structural Excavation and Backfill", except for measurement and payment. Where existing surfacing is removed for placing conduit, the repair shall be made by backfilling with material equal in composition and density to the surrounding

areas and by replacing any removed surfacing, such as asphalt pavement or concrete riprap, with like material to equivalent condition.

Jacking and Boring shall be as shown on the Drawings and in accordance with Standard Specification Item Nos. 501, “Jacking or Boring Pipe” and 502, “Tunneling”, except for measurement and payment.

The work shall be executed in a safe and orderly fashion and in accordance with applicable Federal, State, and local laws, rules, and regulations. All work shall be performed in a competent, workmanlike manner consistent with the best modern practices, notwithstanding any omissions from the plans or these specifications.

All conduits shall be placed on a minimum 1” (25 mm) layer of bedding sand and covered with a minimum 4” (100 mm) layer of sand prior to backfill.

Trench safety and trench safety systems shall be the responsibility of the contractor and shall be prepared in accordance with Standard Item No. 509, “Trench Safety Systems” and all applicable Federal, State, and local laws, rules, and regulations.

Trenches shall be excavated to lines and grades as indicated by on construction plans or as directed by the engineer. Trenches shall be a minimum of 4” (100 mm) and a maximum of 8” (200 mm) wider than the outside dimension of the conduit configuration. Trench bottoms shall be graded smooth with a minimum 1” (25 mm) layer of sand or other fine grain materials and shall be free of any trash, debris, loose material, or water. Trenches shall be excavated to a depth that insures that the required 30” (750 mm) conduit cover is achieved. Blasting or use of explosives as an aid to digging is not permitted.

The Engineer or designated representative reserves the right to inspect and approve all trenching prior to conduit placement.

Placement and compaction of backfill shall be performed in accordance with Standard Specifications Item Nos. 201, “Subgrade Preparation” and 132, “Embankment”. Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with the compaction operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8 inches (200 mm) or less in loose measure, for the full width of the individual cross section in a length that is best suited to the sprinkling and compaction methods utilized, while rock embankments shall be constructed in successive layers of 18 inches (450 mm) or less in thickness for the full width of the cross section.

Backfill under streets, driveways and all other pavement repairs shall conform to the City of Round Rock's Standard Specifications, Standards (Details) and Utility Criteria Manual, Section 5, “Cuts in Public Rights of Way”. Backfill material for use in backfiring trenches under streets and driveways shall be selected based on the material’s characteristic to maintain a consistent compacted density. Emphasis is placed upon the

need to obtain uniform density throughout the backfill. Backfill shall be compacted by mechanical tamping equipment.

If boring under a roadway or other structure is required, the contractor shall be responsible for all utility locations including any required pot holing. Such pot-holing and boring shall be completed at the sole expense of the contractor and shall be conducted in accordance with the requirements of the Utility Criteria Manual, Section 5, “Cuts in Public Rights of Way”.

835.6 Measurement

The lineal foot will measure the Work prescribed by this item (lineal meter: 1 lineal meter equals 3.281 lineal feet) of conduit for actual quantities completed based on the dimensions indicated on the Drawings.

The cost for utility location (including pot holing), boring, trenching, and any other excavation shall be conducted and compensated in accordance with Standard Specification Item No. 844, “Trench Excavation and Backfill for Traffic Signal Conduit”.

835.7 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per lineal foot for “Installing Traffic Signal Conduit”. The unit bid price shall include full compensation for furnishing and installation of all conduits to the lines and grades indicated on the Drawings; for repair of entry of conduit through walls of existing pull boxes; and for all labor, tools, equipment, manipulation, and incidentals necessary to complete the work.

The Work associated with construction of a new pull box will be paid for separately under a separate bid item identified with Standard Specification Item No 834, “Traffic Signal Pull Boxes”.

Payment will be made under the following:

Installing Traffic Signal Conduit with Conduit
1 inch in diameter Per Lineal Foot of conduit
Installing Traffic Signal Conduit with Conduit
2 inch in diameter Per Lineal Foot of conduit
Installing Traffic Signal Conduit with Conduit
3 inch in diameter Per Lineal Foot of conduit
Installing Traffic Signal Conduit with Conduit
4 inch in diameter Per Lineal Foot of conduit
Installing Traffic Signal Conduit with
____ Conduit ___ inches in diameter,
____ Conduit ___ inches in diameter and
____ Conduit ___ inches in diameter
Per Lineal Foot of conduit

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 835, “Traffic Signal Conduit”

City of Round Rock Standard Specifications

Designation	Description
Item No. 132	Embankment
Item No. 201	Subgrade Preparation
Item No. 401	Structural Excavation and Backfill
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 509	Trench Safety Systems
Item No. 834	Pull Boxes
Item No. 844	Trench Excavation and Backfill for Traffic Signal Conduit

City of Round Rock Standard Contract Documents

Designation	Description
Section 00700	General Conditions

American Society for Testing and Materials (ASTM)

Designation	Description
ASTM D-3034	Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM A90/90M	Test Method for Weight (Mass) of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings

Texas Department of Transportation and Development: Standard Specifications For Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement

Federal Specification WW-C-581d, ANSI C80 1
Federal Specification W-C 1094

RELATED Cross Reference Materials
Standard Specification Item No. 835, “Traffic Signal Conduits"

City of Round Rock Standard Specifications

Designation	Description
Item No. 104	Removing Concrete
Item No. 111	Excavation
Item No. 210	Flexible Base
Item No. 401	Structural Excavation Backfill
Item No. 402	Controlled Low Strength Material
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures

RELATED Cross Reference Materials Continued
Standard Specification Item No. 835, “Traffic Signal Conduits"

City of Round Rock Standard Specifications

Designation	Description
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 420	Drilled Shaft Foundations
Item No. 836	Traffic Signal Risers
Item No. 837	Traffic Signal Loop Detectors
Item No. 838	Pedestrian Signal Risers
Item No. 840	Installation of Traffic Signals
Item No. 842	Ducts

ITEM NO. 836
TRAFFIC SIGNAL RISERS

836.1 Description

This item shall govern furnishing and installing traffic signal risers in accordance with the specifications contained herein, the Drawings and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

836.2 Submittals

The submittal requirements of this specification item include:

A. Number and size of risers included within the Project,
B. Class A Portland cement concrete mix design;

836.3 Materials

Materials for traffic signal risers include: threaded rigid metal to glued PVC adapter, 90 degree sweep, threaded galvanized metal coupling, 24” (600-mm) threaded nipple, C-condulet, threaded couplings (as needed), three 10 (3-meter) lengths of schedule 40 galvanized metal conduit, galvanized steel standoff with all ancillary mounting hardware for mounting to a wood pole or galvanized steel mounting brackets for mounting to a steel pole, a weather head and class A Portland cement concrete (Standard Specification Item No. 403, “Concrete for Structures”) as required

836.4 Installation

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g., potholing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

Minimum clearances to all overhead power lines as required by TXU shall be maintained at all times in order to ensure worker safety

Any damage to utilities and/or structures that occurs as a result of any construction activity performed by the Contractor shall be repaired by the Contractor's at his sole expense. Risers shall be paid for once, regardless of extra work caused by obstructions and/or Contractor damage.

The installation of risers shall include procurement and placement of class A Portland cement concrete (as required) and the procurement and installation of a threaded rigid metal to glued PVC adapter, a 90 degree sweep, a threaded galvanized metal coupling placed 2”(50-mm) above grade, a 24” (600-mm) long threaded nipple, a C-condulet, three 10 (3-meter) lengths of schedule 40 galvanized metal conduits, a galvanized steel standoff with all ancillary mounting hardware for mounting to a wood pole or galvanized steel mounting brackets for mounting to a steel pole, and a weather head.

All loose material shall be removed from the bottom of the excavation before Portland cement concrete is placed. Any water accumulated in the bottom of the excavated foundation shall be removed by pumping or bailing, prior to Portland cement concrete placement.

The Portland cement concrete shall be placed in accordance with Standard Specification Item Nos. 403, "Concrete For Structures" and 410, "Concrete Structures", as soon as possible after excavation is completed, the reinforcing steel placed and other hardware (anchor bolts, conduits, ground rod, etc.) installed. The Portland cement concrete shall not be placed when the atmospheric temperature (temperature reading taken in the shade away from artificial heat) drops below 35ºF (2ºC) unless permission is provided by the Engineer or designated representative.

A mechanical vibrator shall be used for consolidating the wet concrete. During consolidation of the Portland cement concrete, the Contractor shall insure that there is minimal contact of the vibrator with the reinforcing steel.

836.5 Measurement

The Work prescribed by this item will be measured by each riser completed in place of the number and sizes identified on the Drawings.

The cost for utility location (including pot holing), boring, trenching, and any other excavation is considered ancillary to various bid items and will not be paid for separately.

836.6 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per each nominal size riser. The unit bid price shall include full compensation for removal of all materials to the depth shown on the Drawings; for furnishing, hauling and placement of all materials and for all labor, tools, equipment, manipulation, and incidentals necessary to complete the work.

Payment will be made under the following:

Traffic Signal Risers, 1 inch in diameter	Per each.
Traffic Signal Risers, 2 inch in diameter	Per each.
Traffic Signal Risers, 3 inch in diameter	Per each.
Traffic Signal Risers, 4 inch in diameter	Per each.

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 836, " Traffic Signal Risers"

City of Round Rock Standard Specifications

Designation	Description
Item No. 403	Concrete for Structures
Item No. 410	Concrete Structures

ITEM NO. 837
TRAFFIC LOOP SIGNAL DETECTORS

837.1 Description

This item shall govern furnishing and installation of traffic signal loop detectors in accordance with the specifications herein, the Drawings and/or as approved by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

837.2 Submittals

The submittals for this item include:

A. The type and manufacturer of the loop sealant,
B. Manufacturer's recommended application procedures for the loop sealant,
C. The size and manufacturer of the loop detector cable,
D. Certification that the loop detector cable conforms to the requirements of this item,
E. The specific loop analyzer proposed for measurement of total inductance of the loop and associated lead-in cable.
F. The procedure proposed to relate the percentage shift in loop inductance to various size vehicles that actuate the detector.

837.3 Materials

Loop detector wire installed in sawcuts located in the street shall be #14 AWG, stranded, type THHN gasoline and oil resistant one-conductor cable.

Loop detector lead-in wire installed in concrete medians shall be # 14 AWG, stranded, shielded two-conductor cable. The conductor and drain wires shall be tinned copper wires, with conductors shielded by a layer of aluminum bonded to polyester film. All wires shall be insulated with cross-linked polypropylene or polyethylene and surrounded with a vinyl jacket.

Loop detector sealant shall be TA-500 asphaltic compound or an approved equal as determined by the Engineer or designated representative. Samples of the loop detector sealant shall be submitted to the Engineer or designated representative for his approval before the initiation of any detector installation.

837.4 Installation

Installation of loop detectors shall be completed in accordance with the Drawings. Lead-in sawcuts from the street to the pull box [for loops that have separate detector channel(s)] shall maintain a minimum separation from other loops of 24 inches (600-mm) and a minimum separation of 6 inches (150-mm) from other lead-in sawcuts. The sawcut depth shall be 2" (50-mm) and be consistent, including the entry point into the stub out or curb. Sawcuts shall be free of sand, gravel or other objects prior to placement of wire and sealant.

The Contractor shall use a sealing compound for all loop detector installations. Loop sealant shall completely fill the sawcut after curing.

Insulation tests shall be made with a megar test set applying not less than 500 volts D.C. to the completed loop detector. A minimum resistance of 1 meg-ohm shall be obtained.

After the above insulation tests are completed, the Contractor shall assist the Engineer or designated representative in determining the loop inductance of each loop detector. A detector analyzer shall be used to determine the total inductance of the loop in the pavement and its associated lead-in cable. The analyzer shall also be used to determine the percentage shift in loop inductance for various size vehicles that actuate the detector.

All work related to the installation of a particular detector loop, with the exception of the layout task, shall be completed in the same workday. All loop installation work shall be performed during off-peak traffic hours (9:00 am to 3:30 pm weekdays). Loop installation shall not be made during any type of precipitation.

837.5 Measurement

This item will be measured by lineal feet of loop detector installed, excluding the lead in sawcut from the edge of roadway to the loop itself and any corner cuts. The lineal feet of detector installed will be measured along the outside perimeter of each loop detector and along the center cut for quadruple loops.

837.6 Payment

Loop detectors will be paid for at the unit bid price per lineal foot of loop detector installed. The unit bid price shall include full compensation for furnishing and installing all materials, labor, tools, equipment and incidentals necessary to complete the work.

Loop detector stubouts (consisting of a conduit pathway for the loop cable and all necessary fittings, as determined by the Engineer or designated representative, from the edge of pavement terminated in the nearest pull box) are considered subsidiary to this bid item, and no additional compensation will be paid to the contractor for this work.

Payment will be made under:

Traffic Signal Loop Detector	per Lineal Foot.

END

ITEM NO. 838
PEDESTRIAN SIGNAL INSTALLATION

838.1 Description

This item shall govern furnishing and installation of pedestrian signal heads in accordance with the specifications contained herein, manufacturer recommendations and/or written instructions from the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

838.2 Submittals

The submittal requirements of this specification item may include:

A. Wire size, characteristics and designation for each wire application (i.e. pedestrian signal and/or pedestrian push button),
B. Type, number of sections, lens configuration and manufacturer for each pedestrian signal item specified on the Drawings,
C. Type, number of sections and manufacturer for each pedestrian signal item specified on the Drawings,
D. Catalog cut and Manufacturer installation recommendations for signal heads and louvers

838.3 Materials

A. General

All pedestrian signal heads installed on a job shall be by the same manufacturer. The pedestrian signal shall be designed to meet or exceed the requirements of the current State of California Standard Specifications for Type A pedestrian signals and shall be designed to fit the same mounting brackets as employed by State of CALIFORNIA Type B and C Neon Pedestrian Signals. The construction design shall be compatible with clamshell mounting hardware.

The general construction shall include a single-piece cast aluminum housing, a single-piece double parabolic reflector, a two symbol two color message lens, a single-piece cast aluminum swing down door frame, a blankout eggcrate type sun visor, two traffic signal lamps conforming to Section 831.3 (F), “Lamps” of this specification item and appropriate sockets and other hardware. The design shall optimize performance per unit of energy consumed and shall accommodate 60, 67, 69, and 116 watt (J/s) lamps.

Optically, the pedestrian signal shall be capable of displaying, brightly and uniformly, the alternate messages “HAND” in Portland orange and “WALKING PERSON” in Lunar white while being subject to strong ambient light conditions. Under the same strong ambient light conditions, the messages shall “Blankout” when the signal is not energized.

The signal shall be furnished complete with two installed A21 traffic signal lamps. In order to facilitate installation and maintenance, the signal shall be

designed so that all components are readily accessible from the front by merely opening the signal door.

B. Dimensions

The maximum overall dimension of the signal shall be 18 ½ inches (470 mm) wide, 18 ¾ inches (476 mm) high, and 9 inches (229 mm) deep including eggcrate type visor and hinges. The distance between the mounting surfaces of the upper (non-shurlock) and the lower (shurlock) openings shall be 15 ¾ inches (400 mm).

C. Optical System

The optical system shall consist of the following:

1. Two symbol two-color message lens,
2. Double parabolic reflector,
3. Lamps and lamp sockets and
4. Eggcrate type sun visor

The optical system shall be designed to minimize the return of the outside rays entering the unit from above horizontal (known as sun phantom). The optical unit shall be so designed and assembled that erroneous messages cannot be displayed by lamp burnout or by light spill over.

D. Two Symbol Message Lens

Messages shall be Lunar white and Portland orange as defined in the current version of Institute of Transportation Engineers standard "Adjustable Face Pedestrian Signal Head Standard".

Two lens materials may be used, as follows:

1) STANDARD 0.187 inch (4.75 mm) tempered glass with the outside surface textured to eliminate message "HOT SPOTS".

2) OPTIONAL 0.250-inch (6.35 mm) polycarbonate plastic with C-64 or C-66 pattern texture on the outside surface to eliminate message "HOT SPOTS".

The lens shall be located at least 1.75 inches (44.5 mm) away from the closest glass envelope extremity of the ANSI Designation A21 traffic signal lamp.

The left side of the symbol lens when illuminated shall display the "HAND" symbol in Portland orange. The right side of the symbol lens when illuminated shall display the "WALKING PERSON" symbol in lunar white.

The inside face of each symbol section shall be painted in the message areas with an appropriate transparent color to produce a Portland orange "HAND" symbol and a lunar white "WALKING PERSON" symbol when illuminated by a traffic signal lamp operating at rated voltage. All other areas shall be painted black.

The inside of the lens shall be fitted with a one-piece sponge neoprene gasket fitted around the perimeter such that a weatherproof seal is afforded whenever the reflector, lens, doorframe, and case are properly mated.

E. Double Parabolic Reflector

A single piece double parabolic reflector shall be vacuum formed from 0.250-inch (6.35 mm) minimum thickness textured polycarbonate plastic sheet. The texture shall be on the lamp side of the reflector and shall conform to C-64 or C-66 pattern or equivalent for light uniformity.

The lamp side of the reflector shall be reflectorized by vacuum deposition of an aluminum coating, which shall in turn be protected by a hard wear resistant coating.

The two sections of the reflector shall be divided by a full depth 0.040 aluminum divider that properly mates with the symbol lens, to effectively prevent light spillage from one section to the other.

F. Lamps

The pedestrian signal shall be completely equipped with traffic signal lamps and sockets (one set for each of the two sections of the double parabolic reflector). Each lamp shall conform to the following specification.

1. The light bulb shall be:
   68 watt (J/s), 120-125-volt At- or A-19 HI-BEAM TRAFFIC, KRYPTON, 15500-16500 User Hours.

2. All Traffic Signal Lamps shall be:
   Duro-Test Watt-Savers or equivalent, but must meet these standards:

   a) Lamps shall have projection-type Copperflex-tungsten filaments supported by two impurity- free high-tensile-strength Molybdenum supports and five extra hook support points to protect against vibration, voltage, and environmental shock. The filament shall be wound on a precision molybdenum mandrel. Bidder must be willing to have filament subjected to the filament stretch test.

   b) The filament shall be of the “V” shaped projection construction for greatest beam candlepower and to eliminate center dead spot.

   c) Life rating shall be guaranteed by the lamp manufacturer for two years from the date of installation. A confidential manufacturing code date shall be etched on the stem support of each lamp to justify user hour life rating.

   d) Each lamp shall be identified with information etched into the glass lamp with manufacturers name, wattage, voltage, average rated user hour life, lot identification, rated lumens, and date of manufacture.

   e) The lamp filament support shall be a solid glass stem and shall be equipped with a polished aluminum deflector disc for greater

candlepower concentration and to help protect the socket and wiring from bulb heat.

f) Lamps shall have built-in fuse wire in base of lamp to prevent damage to socket and electrical controls.

g) Lamps shall have a corrosion proof brass medium base adhered to glass envelope with dual use silicone adhesive. Bulb glass shall be grooved to give added mechanical grip, prevent vibration shake out, breakage, and socket weld.

h) Lamps shall meet or exceed rated initial lumens and minimum initial lumens requirements as specified in the Institute of Transportation Engineers standard “Traffic Signal Lamps”, latest edition.

i) Beam Candlepower specifications shall be supported by a report from a nationally recognized independent testing laboratory and certified by such laboratory personnel.

j). Lamp fill gas shall be no less than 90% krypton gas concentration (“volume per volume” of total fill gas in the lamp) for increased lumen output at stated wattage.

k). Gas analysis for krypton fill shall be supported by a report from a nationally recognized independent testing laboratory.

l). Lamps shall have the ATC shape to allow for extra room for heat dissipation away from the filament. Super life A and ATC shape shall have user rated hours etched onto the bulb at a position below the etched name of the manufacturer.

3. The Contractor shall provide traffic signal lamps that conform to all of the criteria of this specification. Any traffic signal lamps that are delivered but do not meet the above requirements will be returned at contractor’s own expense.

G. Lamp Sockets

Each lamp socket shall be accurately positioned in the center and pre-focused in its respective section of the reflector when the above-described lamps are installed.

The mounting shall be made to a die cast aluminum case in order to efficiently conduct heat away from the respective socket.

The lamp socket may be made of molded Bakelite, molded phenolic, or ceramic and shall be provided with a brass screw shell with lamp grip. An optional socket rotating mechanism with a minimum of 8 spring-loaded detents shall be available to allow positioning of the opening of the lamp filament upwards.

Each lamp socket shall be provided with one colored lead (non-white and non-green) from the socket and one white lead from the shell. Leads shall be 18 AWG and shall be wired to respective terminals of a three terminal pair screw type terminal block. The two white wires shall be connected to a common

terminal. The terminal block shall be located inside the pedestrian signal housing.

H. Eggcrate Visor

Each signal shall be provided with an eggcrate type visor designed to eliminate sun phantom. The eggcrate type sun shield shall be installed parallel to the face of the "HAND/WALKING PERSON" message. The eggcrate visor assembly shall be held in place by the use of stainless steel screws.

The eggcrate assembly shall consist of a minimum of 20 straight horizontal louvers and 21 zigzag pattern louvers.

Each alternate formed louver shall be reversed in order to form cells 1 inch (25 mm) square but rotated 45 degrees from the horizontal to provide diamond shaped cells when assembled. Each diamond shall be bisected by a straight louver inserted between each pair of formed zigzag louvers. Where the apex of each formed louver comes in contact with the interspersed straight louver, the entire length of the joint shall be chemically welded.

The basic material used in construction of the eggcrate shall be nominally 0.030 inch (0.762 mm) thick and shall be 100% impregnated black polycarbonate plastic processed with a flat finish on both sides. Additional members may be employed outside the two legend areas but are not required unless dictated by structural strength of the particular assembly technique employed.

The assembly shall be enclosed in a mounting frame constructed of 0.040-inch (1.02 mm) minimum thickness of aluminum. This frame shall be 1 ½ inches (38 mm) deep and shall contain mounting holes for installation directly in the pedestrian signal doorframe.

I. Case

The case shall be a one-piece corrosion resistant aluminum alloy die casting complete with integrally cast top, bottom, sides, and back. Four integrally cast hinge lug pairs, two at the top and two at the bottom of each case, shall be provided for operation of a swing down door.

The case, when properly mated to other pedestrian signal components and mounting hardware, shall provide a dustproof and weatherproof enclosure with easy access to and replacement of all components.

Three versions of the case may be used dependent upon the specific job application. The first version shall be supplied with clamshell mounting hardware installed (ordered concurrently) for installation of "pole left of message". The second version shall be the same except intended installation shall be "pole right of message". The third version shall contain upper and lower openings as described below suitable for either post top or bracket mounting. The first and second versions need not include upper and lower openings but when provided shall be adequately plugged.

The openings included in the third version at the top and bottom of the case shall accommodate standard 1 ½ inch (38 mm) pipe brackets. The bottom opening of

the signal case shall have a shurlock boss integrally cast into the case. The dimensions of the shurlock boss shall be as follows: Outside diameter 2.625 inches (66.7 mm); inside diameter 1.969 inches (50mm); number of teeth 72; angle of teeth 90 degrees; and depth of teeth 5/64 inch (2 mm). The teeth shall be clean and sharp and provide full engagement. The radial angular grooves of the shurlock boss, when used with shurlock fittings, shall provide positive positioning of the entire signal to eliminate rotation or misalignment of the signal.

J. Door Frame

The door frame shall be a one-piece corrosion resistant aluminum alloy die casting, complete with two hinge lugs cast at the bottom and two latch slots cast at the top of each door. The door shall be attached to the case by means of two Type 304 stainless steel spring pins. Two stainless steel hinged bolts with captive stainless steel wing nuts and washers shall be attached to the case with the use of stainless steel spring pins. Hence, latching or unlatching of the door shall require no tools.

K. Paint

Prior to final assembly; the case, doorframe and eggcrate visor (aluminum portion only) shall be thoroughly cleaned and a chromate conversion coating applied inside and out per Military Specification Mil-C-5541. A synthetic enamel conforming to Military Specification TTE-529 shall then be electro statically applied. The color and gloss of the case and doorframe shall be selected by the purchaser. The color of the eggcrate visor shall be flat black. The finish shall be oven cured for a minimum of 20 minutes at 350^{o}F (177^{o}C).

L. Warranty

The entire pedestrian signal including eggcrate visor, message lens, single piece double parabolic reflector, lamp sockets, case, and door shall be warranted against defects in workmanship and/or materials for two (2) years from the date of original shipment.

838.4 Installation

The Contractor shall be responsible for the installation of the pedestrian signal heads in the field as shown on the drawings. This work shall include providing and installing the pedestrian heads, wiring, and mounting the hardware at the job site. Drilling wire feed holes and mounting the pedestrian signal head will also be the Contractor's responsibility.

All wire feeding through the pole structure shall be wrapped once with plastic electrical tape and wrapped again with electrical friction tape extending 12 inches (300 mm) on each side of the pole opening for a total of 24 inches (600 mm). The contractor shall adhere to the City of Round Rock’s color code when splicing all conductors. Cabling for each signal (number of conductors, wire gauge, etc) shall be in accordance with the Drawings.

All pedestrian signal heads not yet in operation shall be covered with burlap until placed into service.

838.5 Measurement

This item will be measured by each pedestrian signal installed in place.

The cost of procuring, installing and connecting mounting hardware and cable from the pedestrian heads to the controller is considered ancillary to various bid items and will not be measured or paid for separately.

838.6 Payment

The work performed and material furnished in accordance with this item and measured as provided under "Measurement" will be paid for at the unit bid price for "Pedestrian Signals" per each. The unit bid price shall include full compensation for: a) furnishing and installing all materials, b) drilling wire feed holes (as needed), c) mounting the pedestrian signal heads on the mast arms and signal poles, d) covering the pedestrian signal heads with Contractor-supplied burlap (if required), e) correctly cabling the signal head per the drawings and f) adjusting the pedestrian signal head for proper visibility, as indicated on the Drawings and for furnishing all labor, tools, equipment and incidentals necessary to complete the Work.

Payment will be made under:

Pedestrian Signal Installation: Metal Pole	per Each
Pedestrian Signal Installation: Stand Alone	per Each
Pedestrian Signal Installation: Solar Powered	per Each

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 838, "Pedestrian Signal Installation"

U.S. Corps of Engineers
Military Specification Mil-C-5541
Military Specification TTE-529

RELATED Cross Reference Materials
Standard Specification Item No. 838, "Pedestrian Signal Installation"

City of Round Rock Standard Specifications

Designation	Description
Item No. 104	Removing Concrete
Item No. 111	Excavation
Item No. 401	Structural Excavation Backfill
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 420	Drilled Shaft Foundations

ITEM NO. 839
TRAFFIC SIGNAL POLES

839.1 Description

This item shall govern furnishing and installation of traffic signal poles in accordance with the specifications contained herein, the Drawings, the manufacturer's recommendations and/or written instructions from the Engineer or designated representative.

Traffic signal poles shall be of the size and type shown on the project drawings and referenced details.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

839.2 Design Requirements

All design drawings and calculations for traffic signal poles shall be signed, dated and sealed by a Licensed Professional Engineer registered in the State of Texas, who shall be wholly responsible for the design of all poles, arms and davit extensions. Acceptance of traffic signal pole designs by the City of Round Rock shall not relieve the designer of this responsibility.

839.3 Submittals

The Contractor shall submit to the City of Round Rock, with the submittal data, the design drawings showing design details and copies of the design strength and deflection calculations for each completed pole/arm/ davit extension structure for review and acceptance prior to fabrication. The ASTM specifications numbers for the materials to be used shall be included as part of the design strength calculations.

839S.4 Materials

A. General Requirements

This section of the Specifications describes steel poles, mast arms and davit extensions for traffic signal and street light support. The Specifications cover monotube steel strain and mast arm poles, monotube steel cantilevered mast arms and davit type steel luminaire poles and extensions for steel strain and mast arm poles. The general design of the poles, arms and extensions shall conform to the requirements of the plans and the typical drawings with no guys, struts, rods, stay braces, or clamps of U-bolts, except where noted otherwise.

B. AASHTO Specifications

The design of the completed assembly of poles, davit extensions, mast arms and hardware shall equal or exceed the most current version of AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals, and addenda thereto, assuming ice and 80 mph. (128 kmph) winds with 104 mph (167kmph) gusts when loaded in accordance with the typical drawings and these Specifications.

C. Dimension Limits

Each complete pole/arm/extension assembly shall be within the dimension limits shown on the drawings.

D. Structural Cross-Sections

All poles, arms and davit extensions shall have a round cross-sectional design with a uniform taper between 0.1 and 0.2 inches of diameter change per foot of length (between 8.0 and 16.0 mm of diameter change per meter of length).

E. Mounting Points

Suitable mounting points with 1.5-inch (38-mm) internally threaded half-couplings shall be provided for mounting the signals and pedestrian pushbuttons to poles and mast arms as indicated on the typical drawings. The couplings shall be internally threaded according to the National Pipe Thread (N.P.T.) and shall be mounted within the poles and arms. All couplings shall be essentially flush with the outside surfaces of the poles and arms. The couplings shall be installed before galvanizing. All mounting points shall have sufficient strength to support the signal and pedestrian pushbutton loads described below when mounted in accordance with the typical drawings. A threaded plug shall be furnished and installed (after galvanization to ensure a good threaded fit) in each mounting point including the end of the mast arm. The surface of the plug shall be essentially flush with the outer end of the mounting point when installed and shall have a recessed hole to accommodate a standard wrench.

F. Cable Outlets

The design shall permit all cables to be installed inside poles, mast arms and davit extensions. Cable passages from the signal heads to the insides of the poles and mast arms shall be inside the 1.5-inch (38-mm) internally threaded couplings.

G. Galvanizing

The complete pole and arms, including all parts used in the assembly shall be completely hot-dip galvanized after fabrication. All threaded material shall be brushed and re-tapped as necessary after galvanizing. Threaded plugs shall be separately galvanized and installed after the mast arms and poles have been galvanized. Hot-dipped galvanizing on the structure shall be in accordance with ASTM Standard A-123, and galvanizing on the hardware shall be in accordance with ASTM Standard A-153.

H. Weights and Areas of Signal Heads, Luminaires and Signs to be supported

In the design of the pole/arm/extension structures, the following weights and areas shall be assumed:

1) Signal head at end of mast arm:
   2-way, 5-section, 12 inch (300 mm) with backplate
   Weight: 145 pounds (66 kilograms)
   Projected area: 15 square feet (1.39 square meters)

2) Each inboard signal head on mast arm:
1-way, 3-section, 12-inch (300 mm) with backplate
Weight: 50 pounds (22.7 kilograms)
Projected area: 9.75 square feet (0.9 square meters)

3) Signal heads attached to span wire, including backplate, disconnect hanger, brackets and adjustable drop bracket
   a) 2-way, 5-section, 12-inch (300 mm)
      Weight: 145 pounds (66 kilograms)
      Projected area: 15 square feet (1.39 square meters)
   b) 1-way, 5-section, 12-inch (300 mm)
      Weight: 75 pounds (34 kilograms)
      Projected area: 15 square feet (1.39 square meters)
   c) 1-way, 3-section, 12-inch (300 mm), 4-section
      Weight: 50 pounds (22.7 kilograms)
      Projected area: 9.75 square feet (0.9 square meters)

4) All signal heads attached to pole shaft, worst case, common mounting:
Weight: 135 pounds (59 kilograms)
Projected area: 15 square feet (1.39 square meters)

5) Each luminaire:
Weight: 75 pounds (34 kilograms)
Projected area: 3.3 square feet (0.31 square meters)

6) Signs on mast arm:
   a) One mounted with its center 5.5 feet (1.68 meters) from the end of the arm:
      Weight: 27 pounds (11.8 kilograms)
      Projected area: 9 square feet (0.84 square meters)
   b) One mounted with its center 7.0 feet (2.13 meters) from the center of the pole:
      Weight: 36 pounds (15.7 kilograms)
      Projected area: 18 square feet each (1.67 square meters each)

I. POLES

1) General

   a) Worst-Case Loads. The poles and hardware shall be designed to support the worst-case loads, including twin davit extensions, shown in the typical drawings.

   b) Pole Deflection. The allowable pole deflection, when loaded with a twin davit extension and the worst-case signal and sign dead loads specified above and in the typical drawings, shall not exceed an angular rotation of one degree forty minutes, as measured between the intersection of the vertical centerline through the base and the projection of the centerline through the top. The deflection of the pole when loaded in this manner shall not exceed 0.35 inch/foot (29 mm/m).

2) Base Plate

Each pole shall have a base plate as shown in the typical drawings. The anchor boltholes in the pole base plate shall be 1/4-inch (6.35 mm) larger than the anchor bolts diameters. Anchor bolt holes in the base plates shall be elongated as shown on the typical drawings to provide adequate adjustment of the pole's orientation.

3) Handholes

Each pole shall have a 4" x 6.5" (102 mm by 165 mm) handhole with a reinforced frame located as shown on the typical drawings. The hand hole shall be furnished with a cover and screws. In addition, 20 percent spare handhole covers shall be furnished with each order. For small orders, at least one spare cover shall be furnished with each order.

4) Pole Types

Each kind of pole (mast arm or strain) shall be classified by type. Type 0 applies only to strain poles and indicates that the pole does not support a mast arm. Types 1, 2 and 3 apply to mast arm poles. The types indicate the lengths of mast arms, which the pole shall be designed to support as follows:

a) Type 1 - 15 to 30-foot (4.57 to 9.14 meter) arm;
b) Type 2 - 35 to 45-foot (10.67 to 13.724 meter) arm; and
c) Type 3 - 50 to 60-foot (15.24 to 18.29) arm.

The poles shall be permanently stamped above the hand holes with their type numbers, the manufacturer's name and logo, and the date of manufacture.

5) Davit Extension Provisions

Each pole shall be furnished with a steel plate in the top to accommodate the mounting of a davit extension as shown in the typical drawings. The plate shall have eight (8) threaded holes arranged at 45-degree intervals to accommodate the extension attachment bolts. Four (4) bolts shall be used to attach the extension and the eight holes in the plate shall allow the extension to be oriented at any 45-degree increment with respect to the pole. Six (6) (2 spare) bolts shall be provided with each pole.

6) Pole Cap and Base Cover

Each pole shall be furnished with a removable pole cap for the top, to be used in the absence of a davit extension, and with a base cover. Suitable attachment screws shall also be furnished.

7) Mountings for Signals and Pushbuttons

Four (4) couplings shall be provided on the pole for the mounting of pedestrian pushbuttons at a height of 42-inches (1 meter) above the base, as shown on the typical drawings.

Four (4) couplings shall be provided on the pole for the mountings of signals and pedestrian signals. These mountings points shall be at a height of 9 feet (2.75 meters) above the base, as shown on the typical drawings.

8) Grounding Lugs

Each pole shall be equipped with a grounding lug, which will accommodate an A.W.G. #6 ground wire. The lug shall be electrically bonded to the pole and shall be located inside the pole opposite the handhole.

9) Mast Arm Poles

a) Davit Extension. Mast arm poles shall accommodate Type 1 davit extension, both single and twin. For the purpose of pole design, the pole shall be assumed to have a twin davit oriented to be in the same vertical plan as the mast arm.

b) Mast Arm Attachment. Each mast arm pole shall be furnished with a pole plate and associated gussets and fittings as shown in the typical drawings for the attachment of the appropriate type of mast arm. Type 1 poles shall include six (6) (2 spare) bolts, which mate with the threaded holes in the pole plate.

J. STRAIN POLES

1) Sign Loading on Span Wire Suspension

Traffic signs, which are supported by the span wire suspension, shall be mounted on the leveling cable instead of on the support cable unless otherwise noted.

2) Davit Extension

Strain poles shall accommodate Type 2 davit extensions, both single and twin. For the purpose of pole design, the pole shall be assumed to have a twin davit extension oriented to provide a worst-case loading.

3) Mast Arm Attachment

a) Type 0 strain poles shall not accommodate a mast arm. Each Type 1,2, and 3 mast arm pole shall be furnished with a pole plate and associated gussets and fittings as shown in the typical drawings for the attachment of the appropriate type of mast arm. Type 1 poles shall include six (6) (2 spare) bolts, which mate with the threaded holes in the pole plate.

b) The mast arm attachment shall be located on the pole to provide the orientation with respect to the span wire load that is shown on the plan and the typical drawings. The orientation angle, in degrees, shall be stamped on the pole above the handhole and adjacent to the type stamp.

c) As part of the mast arm attachment, a cable passage hole shall be provided in the pole to allow passage of the signal cables from the pole to the arm.

4) Messenger Cable Attachment Provisions

a) Each strain pole shall be equipped with a 0.625-inch (15.9 mm) diameter thimbleye bolt for connection to the leveling cable. The bolt shall be at a height of 22 6" (6.86 meters) above the base of the pole and the thimbleye shall be on the side of the pole where the span wires are to be attached.

b) Each strain pole shall include a span wire clamp and associated hardware for the attachment of the support cable of the span wire suspension. The diameter of the clamp shall be appropriate to its location on the pole. The clamp shall conform to the requirements of the typical drawings.

5) Grommeted Cable Outlet

A 2-inch (50-mm) hole equipped with a grommet shall be provided on the span wire load side of the pole at a height of 22'3" (6.78 meters) above the base of the pole to accommodate passage of the signal cables from inside the pole to the leveling cable.

K. MAST ARMS

1. Arm Fabrication

All mast arms up to and including 40-foot (12.2-meter) arms shall be one piece. 45-foot, 50-foot, 55-foot and 60-foot (13.72, 15.24, 16.76 and 18.29 meter) arms may be fabricated in two pieces which overlap each other by at least 1.5 times the inside diameter of the outside section. Each of the two pieces of 45, 50, 55, and 60 foot (13.72, 15.24, 16.76 and 18.29 meter) arms shall be fabricated of one piece monotube steel. Mast arms shall not have any transverse butt welds.

2. Mast Arm and Pole Types

All mast arms up to and including 30-foot (9.14-meter) arms shall be interchangeable on any Type 1 pole. All 35-foot through 45-foot (10.67-meter through 13.72-meter) arms shall be interchangeable on any Type 2 pole. All 50-foot through 60-foot (15.24-meters through 18.29-meters) arms shall be interchangeable on any Type 3 pole.

3. Variance From Horizontal

Each mast arm shall have a variance within the range of -0 degrees and +1.5 degrees from the horizontal plane when loaded as discussed above and as shown in the typical drawings and with the pole exactly vertical. This may be achieved with or without shims or other similar devices. If shims are required, then the manufacturer shall include these shims with the material delivery. All mast arms and mast arm fastening plates shall

be manufactured to maintain a vertical clearance between the bottom of the mounted signal heads to the top of the pole base plate between 17.5 to 19.0 (5.33 to 5.79 meters).

4. Mast Arm Attachment

   The mast arm shall be fastened to the pole as shown on the typical drawings. The arm plate and all necessary attachment hardware, including bolts, nuts, washers and brackets, which is not included, as part of the pole shall be furnished as part of the arm.

5. Signal Clamps Required

   A signal clamp corresponding to each mounting point on the arm shall be furnished as part of the arm. The number of clamps shall equal the number of mounting points. The diameter of each clamp shall correspond to the diameter of the arm at its intended location. The clamps shall conform to the requirements of the typical drawings.

6. Mounting for Signals

   Couplings shall be provided on the mast arm for the mounting of signals as shown on the typical drawings.

839.5 Installation

The Contractor shall be responsible for installing the pole assemblies in the field on the pole foundations. The contractor will not be allowed to store signal poles at the job sites except as approved by the Engineer or designated representative on a case-by-case basis.

839.6 Measurement

This item will be measured by each type and/or length of signal pole item (strain poles, mast arm pole, mast arm, single davit extension, twin davit extension) installed in place.

839.7 Payment

Traffic signal pole items shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for furnishing and installing all materials, and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Type O Strain pole	per Each
Type 1 Mast Arm Pole	per Each
Type 2 Mast Arm Pole	per Each
Type 3 Mast Arm Pole	per Each
15-foot Mast Arm	per Each
18-foot Mast Arm	per Each
20-foot Mast Arm	per Each
25-foot Mast Arm	per Each
30-foot Mast Arm	per Each
35-foot Mast Arm	per Each
40-foot Mast Arm	per Each
45-foot Mast Arm	per Each
50-foot Mast Arm	per Each
55-foot Mast Arm	per Each
60-foot Mast Arm	per Each
Type 1 Single Davit Extension	per Each
Type 2 Single Davit Extension	per Each
Type 1 Twin Davit Extension	per Each
Type 2 Twin Davit Extension	per Each

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 839, "Traffic Signal Poles"

American Society for Testing and Materials

Designation	Description
A-123/123M	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
A-153/153M	Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Hardware

ITEM NO. 840
INSTALLATION OF TRAFFIC SIGNALS

840.1 Description

This item shall govern furnishing and installation of traffic signals in the City of Round Rock, Texas and its traffic signal maintenance jurisdiction in accordance with the specifications herein, the Standard Specifications and Standard Details listed below, the Drawings, manufacturers' recommendations, and/or written instructions from the Engineer or designated representative.

A. Standard Specifications:

Item No. 830 "Traffic Signal Controller Foundation"
Item No. 831 "Traffic Signal Drilled Shaft Foundation"
Item No. 832 "Vehicular Traffic Signal Installation"
Item No. 833 "Pedestrian Push Button Assembly"
Item No. 834 "Traffic Signal Pull Boxes"
Item No. 835 "Traffic Signal Conduit"
Item No. 836 "Traffic Signal Risers"
Item No. 837 "Traffic Signal Loop Detectors"
Item No. 838 "Pedestrian Signal Installation"
Item No. 839 "Traffic Signal Poles"

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

840.2 Submittals

Submittal requirements are identified with other relevant Traffic Signal standard specifications.

840.3 Materials

Multi-conductor cable shall be supplied with a sufficient number of conductors to safely operate the traffic signal. The required number of conductors will either be indicated on the individual project Drawings or established by the Contractor. In either case, the Engineer or designated representative shall have final authority and approval over the number of conductors used in a specific traffic signal.

All multi-conductor cable shall be capable of operating at 600 volts maximum and suitable for use at conductor temperature not exceeding 75^{o}C (167^{o}F). All such cable shall meet the requirements of the National Electrical Code.

Conductors shall be stranded annealed uncoated copper. The copper wire (before insulating) shall meet the requirements of the latest American Society for Testing and Materials' (ASTM) standards for uncoated wire.

The 2 conductor, 4 conductor, 7 conductor, and 12 conductor cables shall be #12 AWG. The 20 conductor cable shall be #14 AWG.

The overall cable jacket shall consist of a polyvinyl chloride compound, that provides a tough, heat, moisture, and flame resistant covering meeting the requirements of the Insulated Power Cable Engineer's Association (I.P.C.E.A.).

Standard color-coding shall be in accordance with IMSA specifications and the following table. The base color shall be the insulation color. Tracers shall be colored stripes that are part of or are firmly adhered to the insulation surface for the full length of the wire.

Conductor No.	Base Color	Tracer Color	Conductor No.	Base Color	Tracer Color
1	Black	-	11	Blue	Black
2	White	-	12	Black	White
3	Red	-	13	Red	White
4	Green	-	14	Green	White
5	Orange	-	15	Blue	White
6	Blue	-	16	Black	Red
7	White	-	17	White	Red
8	Red	Black	18	Orange	Red
9	Green	Black	19	Blue	Red
10	Orange	Black	20	Red	Green

840.4 Construction and Installation

The Contractor will be responsible for a) acquisition and installation of all materials and equipment and b) providing the experience and labor necessary to insure a complete and operational traffic signal.

Inspections by the City shall include but be not limited to all concrete pours, all trenching, all conduit installation, and all cable installation. The Contractor shall be responsible for contacting the traffic signal shop a minimum of 48 hours prior to all required inspections.

The Contractor shall be responsible for coordinating all power installation and hook-up with TXU Energy or appropriate power company.

The contractor shall install all required cables as shown on the Drawings. Cabling shall be accomplished in accordance with the standard splicing procedures and color codes for cabling traffic signals.

840.5 Installation Requirements

Prior to pulling cable in an existing underground conduit, the conduit shall be cleared of obstructions using a mandrel or cylindrical wire brush and blown out with compressed air.

The conductors shall be installed in a manner that prevents harmful stretching of the conductors or damage to the insulation. Installation methods shall conform to the recommendations of the cable manufacturer.

All cables in a given conduit run shall be pulled at the same time and the conductors shall be assembled to form one loop so that the pulling tension is equally distributed to all the cables. Long, hard pulls will necessitate the use of pulling eyes. For short runs, the cables may be gripped directly by the conductors by forming them into a loop to which the pull wire or rope can be attached. The insulation on each conductor shall be removed before the loop is formed. The method used will depend on the anticipated maximum pulling tension in each case.

In many instances, existing conduits, which contain signal cable, shall be used for the installation of new cables. In locations where new cables are to replace existing cables, the existing cables may be used to pull in the new cables. At locations where new cables are to be added to existing cable runs, the existing cables shall first be pulled out, then replaced when adding the new cables to the existing cables to form one cable pull. Installation and removal shall be done in such a way that prevents damage to the existing and/or new cables. In the event of damage, the Contractor shall bear the responsibility for providing the material and labor required in the replacement of defective cables at no extra cost to the City.

The cable shall be fed freely off the reel into the conduit without making a reverse curve. At the pulling end, the pull wire and cables shall be drawn from the conduit in direct line with the conduit. Sheaves or other suitable devices shall be used as required to reduce any hazards to the cable during installation. The cables shall be adequately lubricated to reduce friction and further minimize possible damage. Lubricants for lead sheathed cables shall not be grease or oil types but shall be one of several commercially available wire pulling compounds that are suitable for P. V. C. sheathed cables. They shall consist of soap, talc, mica, or similar materials and shall be designed to have no deleterious effect on the cables being used.

Cables shall be neatly trained to their destinations in manholes, cabinets, pole bases, pull boxes, and all other terminations. The Contractor shall adhere to the cable manufacturer's recommended values for the minimum bending radii to which cables may be bent for permanent training during installation. These limits do not apply to conduit bends, sheaves, or other curved surfaces around which these cables may be pulled under tension while being installed. Larger radius bends are required for such conditions.

Splices are strictly prohibited inside conduit runs.

Splicing methods shall follow standard electrical practices and the cable manufacturer's recommendations. All materials used shall be of high quality and specifically intended for this purpose. Cables shall be trained to their final position and cut to proper lengths. The cable jacket and insulation shall be removed as required. Proper care should be exercised to ensure against nicking the conductors. The connection shall be installed tightly and all burrs, rough edges, etc. shall be removed.

Where two conductors are to be spliced; only crimp style “butt” connectors shall be used. If three or more conductors are to be connected, then a Kearney connector shall be used.

If the Engineer or designated representative directs that connectors shall be soldered, then heat shall be applied by using a hot soldering iron. Heating the connection with a direct flame will be allowed only on a case by case basis and only when specifically approved by the Engineer or designated representative. Care shall be used to protect insulation during soldering operations. The entire surface shall be cleaned taking special care in cleaning the outside jacket in order to remove the wax finish. Two (2) layers of reverse wrap vinyl tape shall be applied. Then two (2) layers of rubber tape shall be applied taking special care to diaper adjacent cables. (Note: This tape requires a pressure and temperature in service to complete its vulcanizing process and shall be stretched to 2/3 its normal width when applied.) The completed splice shall be covered with two (2) layers of vinyl plastic electrical tape. This wrapping shall be smooth, but the tape shall not be stretched more than necessary.

840.6 Contractor Obligations

All work shall be done in a safe and conscientious manner and in conformance with all local, State, and Federal safety guidelines.

The Contractor will not be allowed to conduct work in the street during peak traffic periods (7:00 AM to 8:30 AM and 4:30 PM to 6:00 PM.) Exceptions to this stipulation may be made on a case-by-case basis and only with special permission by the Engineer or designated representative.

Completed traffic signal installations shall operate continuously for a minimum of thirty calendar days in a manner satisfactory to the Engineer or designated representative. If any equipment furnished by the Contractor fails during the thirty-day test period, the Contractor shall repair or replace that equipment at no cost to the City of Round Rock, and a new thirty-day test period shall commence. The test period will be suspended when any equipment fails that is not furnished by the Contractor. The test period will resume after the failed equipment has been repaired.

The Contractor will be responsible for providing and installing miscellaneous minor hardware items, including, but not limited to nuts, bolts, electrical tape, etc, that are necessary for the proper installation and operation of individual bid items in this item. The cost of providing and installing this hardware will be considered incidental to the various bid items. In addition, the cost of reconnecting or reassigning existing signal cables will be considered incidental. The cost of removing stop signs and their corresponding signposts at intersections where a new signal has been activated shall also be considered incidental. The Contractor shall be responsible for returning the removed signs and signposts to the City’s Traffic Sign Shop.

The Contractor's responsibility for correcting any substandard workmanship and/or materials shall extend for a period of twelve months from the date the work is accepted by the City.

If deviations from any of the stated procedures or substitutions for any materials or equipment are desired, the Contractor shall submit a written request with sample(s) or cut sheets of the substitute materials or equipment to the Engineer or designated representative for approval. The approval of the Contractor’s submittal by the Engineer or designated representative shall be in written form.

The locations of signal pole foundations, controller cabinet foundations, pull boxes, conduits and steel guy poles that are shown on construction drawings shall be considered approximate. The Contractor shall verify existing underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g., potholing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

The Contractor shall give the Owner 48 hours notice of his intention to establish the final location of these items and shall acquire approval for the locations on the ground by the Owner representative, or the Owner's inspector.

It shall be the Contractor's responsibility to locate all utilities prior to initiation of any excavation work. If damage to utilities occurs as a result of any construction performed by the Contractor, it shall be the Contractor's responsibility to effect and pay for the repairs at no cost to the City.

If more than one unit of a given bid item is required, then the Contractor shall ensure that all units are the product of one manufacturer, unless otherwise directed by the Engineer or designated representative.

All materials furnished by the Contractor shall become the property of the City effective from the date the Contractor is paid by the City for the materials. The Contractor shall have full responsibility with respect to damage, theft, or loss of the material until the date of installation.

After installation, but prior to final acceptance of the work, the Contractor shall be responsible for damages or losses to installed City-furnished materials that are caused by his own negligent act(s) or omission(s). The Contractor agrees to replace materials furnished by the City that are lost, damaged or destroyed due to the Contractor's negligence, at his sole cost, or reimburse the City for replacement cost of such material.

The Contractor agrees to defend, indemnify, and hold harmless the City, its officers, agents, and employees, from any and all claims, judgments, lawsuits, fines, penalties, liens, costs, and other damages, whether suffered by third persons or by the Contractor, arising out of the transportation, storage, installation, or use of the City's material during performance of the work. The City will not be responsible for storage rental charges of any kind, and no lien shall be attached to the materials as a result of Contractor's failure to pay rental charges or other charges. The Contractor agrees to prevent liens and encumbrances of any nature from attaching to the material while it is in his possession.

Materials furnished by the City shall at all times remain the property of the City, and the Contractor shall ensure that the materials are kept, protected and stored separately from the Contractor's property or other property. The Contractor shall advise others by labeling or other means that the materials are the City's property solely for use in the performance of the particular work. The City may require return of any materials hereunder, or refuse to furnish further materials in the event of failure to abide by these provisions.

While performing work under this price agreement, the Contractor bears the sole risk of loss for damages to or destruction of any traffic signal equipment, appurtenances or any

equipment that was not to be replaced or installed under this price agreement, but which was damaged or destroyed through the fault or negligent act of the Contractor. The Contractor shall replace such damaged or destroyed equipment, etc., at no cost to the City.

The Contractor shall assume full responsibility for the preservation of existing landscaping (sod, shrubbery, trees, and etc.), sprinkler systems, and other private property at the job site during the installation of items covered by this specification item. Damaged landscaping, sprinkler systems, and other private property shall be replaced and/or repaired to the satisfaction of the Owner within a reasonable time, by the Contractor at his own expense.

No trees or shrubbery shall be cut except upon the specific authority of the Owner.

Removal of mailboxes in the way of construction requires 48 hours advance notice to the U.S. Post Office.

The Contractor shall secure permission from the proper authority and the approval of the Owner before cutting into or removing any walks or curbs that is required during construction.

After work is completed, the Contractor shall restore any curbs or walks that have been removed and/or damaged during construction to the equivalent or better than the original condition. The repair and/or replacement shall be completed to the satisfaction of the Engineer or designated representative at no additional cost to the City of Round Rock.

Initial testing of all materials, construction items (including initial compaction and density tests deemed necessary in connection with the construction of embankment, backfill of structures or excavation) and/or products incorporated in the work shall be performed at the direction of the Engineer or designated representative and at the expense of the Contractor,

In the event that a material, construction item, product incorporated in the work, embankment fill, backfill, excavation or any other item fails to satisfy the minimum requirements of the initial test described above, appropriate prove-out tests shall be made as directed by the Engineer or designated representative to determine the extent of the failure and to verify that corrective measures successfully satisfy appropriate specification requirements. The cost of all testing necessary to determine the extent of the failure and the adequacy of the corrective measures shall be the responsibility of the Contractor.

The Contractor shall comply with all the requirements of the latest editions of Chapter 8 of the City of Round Rock's Transportation Criteria Manual, Standard Specification Item Nos. 801, “Construction Detours’, 802, “Barricades, Signs and Traffic Handling” and the State of Texas Manual on Uniform Traffic Control Devices as they relate to work zone safety requirements. The costs associated with such compliance will be considered incidental to the various bid items, and no additional compensation will be made to the Contractor for any associated work or materials except as noted in this item. This work shall include but not be limited to furnishing and installing traffic cones barricades, arrow boards and signs for work zones on City streets.

The Contractor shall provide and maintain all warning devices and shall take all precautionary measures required by law to protect persons and property while said persons or property are approaching, leaving, or located within the work site of any area adjacent to said work site. No separate compensation will be paid to the Contractor for the installation or maintenance of any warning devices, barricades, lights, signs, or any other precautionary measures, including off duty police officers, required by law for the protection of persons or property.

The Contractor shall be held responsible for all damages to work items and other public or private property due to the failure of warning devices, barricades, signs, lights, or other precautionary measures in protecting said property. Whenever evidence is found of such damage, the Engineer or designated representative may order the damaged portion immediately removed and replaced by the Contractor at the Contractor's own expense.

The Contractor shall provide adequate police traffic control assistance for planned signal controller replacements or any other operational procedures, when requested by the Engineer or designated representative. Police assistance shall be arranged by the Contractor directly, at least twenty-four (24) hours in advance of the work activity. If it is discovered that the Contractor has failed to provide adequate police assistance, the Engineer or designated representative may order additional assistance. Police traffic control assistance, for any purpose, shall be the financial responsibility of the Contractor, regardless of the person requesting the assistance.

As the work proceeds, the Contractor shall retain and mark-up an original set of Drawings, indicating all revisions and additions to the work, including field relocation of work concealed from view and conductor cable lengths. The Contractor shall deliver these "as-built" drawings to the City's traffic signal engineer within ten (10) working days after the work has been accepted.

840.7 Measurement

Each traffic signal complete, in place, and operational.

840.8 Payment

Traffic signal installations will be paid for at the unit bid price per each. The unit bid price shall include full compensation for furnishing and installing all materials, labor, tools, equipment and incidentals necessary to complete the work and result in an operational traffic signal.

Payment will be made under:

Traffic Signal Installation	Per Each.

END

SPECIFIC Cross Reference Materials
Standard Specification Item No. 840, " Installation of Traffic Signals"

City of Round Rock Standard Specifications

Designation	Description
Item No. 830	Traffic Signal Controller Foundation
Item No. 831	Traffic Signal Drilled Shaft Foundation
Item No. 832	Vehicular Traffic Signal Installation
Item No. 833	Pedestrian Push Button Assembly
Item No. 834	Traffic Signal Pull Boxes
Item No. 835	Traffic Signal Conduit
Item No. 836	Traffic Signal Risers
Item No. 837	Traffic Signal Loop Detectors
Item No. 838	Pedestrian Signal Installation
Item No. 839	Traffic Signal Poles

ITEM NO. 842
PULL BOXES

842.1 Description

This item shall govern the construction of pull boxes by methods indicated on the Drawings and in conformity with this specification item.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

842.2 Submittals

The submittal requirements of this specification item include:

A. Identification of the number and types (i.e. traffic or non-traffic) of pull boxes proposed,
B. Mix design for Class A Portland cement concrete,
C. Construction details (mortar, reinforcing steel, etc.) for the pull box and supporting foundation.

842.3 Materials

Non-traffic type pull boxes, of the size specified on the Drawings, shall be pre-cast concrete with cast iron lids, and shall be equal to pre-cast concrete pull box Model R-65 with Model C-65 cover as manufactured by a manufacturer approved by the Engineer or designated representative.

Traffic type pull boxes, of the size specified on the Drawings, shall be constructed with a steel lid and frame equal to Model M-60 lid and M-60 frame as manufactured by the Tyler Pipe and Foundry Co or a manufacturer approved by the Engineer or designated representative.

Brick for pull boxes shall be new common brick.

Portland cement concrete for the pull box base and encasement shall be Class A Portland cement Concrete conforming to Standard Specification Item No. 403, "Concrete for Structures".

842.4 Construction Methods

Pull boxes shall be constructed in accordance with the lines, grades, details and dimensions indicated on the Drawings or established by the Engineer or designated representative. Pull boxes, which are exposed to view, as in sidewalks, shall be accurately set to the finished grade and anchored.

Masonry work for the lower portion of the pull boxes shall be accurately cut around the conduits and a smooth accurate bed shall be provided for the pre-cast concrete upper portion of the pull box. The pre-cast section shall be set in mortar upon the lower masonry course. The inside of pull boxes shall be left clean and the joints shall be wiped.

842.5 Measurement

Pull boxes shall be measured as each type, complete in place.

842.6 Payment

Pull boxes shall be paid for at the unit bid price per each. The unit bid price shall include full compensation for furnishing and constructing the pull-box as detailed on the Drawings and Standard Details, complete with all fittings, covers, masonry work, excavation and backfill, for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Traffic Type Pull Box	Per Each.
Non-Traffic Type Pull Box	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 842, “Pull Boxes”

City of Round Rock Standard Specifications

Designation	Description
Item No. 403	Concrete for Structures

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 842, “Pull Boxes"

City of Round Rock Standard Specifications

Designation	Description
Item No. 401	Structural Excavation and Backfill
Item No. 403	Concrete for Structures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 411	Surface Finishes for Concrete

ITEM NO. 844
TRENCH EXCAVATION AND BACKFILL
FOR TRAFFIC SIGNAL CONDUIT

844.1 Description

This item shall govern trench excavation and backfill for installation of traffic signal conduit constructed in accordance with the lines and grades indicated on the Drawings, construction detail drawings, and/or written instructions from the Engineer or designated representative. This item shall include all applicable work, including trench excavation, bedding material, backfill for the traffic signal conduit and Portland cement concrete trench cap and encasement.

Unless indicated otherwise on the Drawings, this item shall include cutting, removal, disposal and restoration of existing pavement surface and base courses, furnishing and placement of select bedding, backfilling, hauling and disposition of surplus materials, bridging of trenches and other provisions for maintenance of traffic or roadway access as indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

844.2 Submittals

The submittal requirements of this specification item may include:

A. Portland cement concrete mix design and characteristics of various mix ingredients,
B. Source, characteristics and test results for proposed flexible base material,
C. Source, gradation, decantation results and resistivity of the bedding sand,
D. Source, characteristics and test results for proposed controlled low strength material
E. Trench Safety System for trench excavation.

844.3 Materials

A. Portland Cement Concrete

Portland cement concrete shall conform to Standard Specification Item No. 403, “Concrete for Structures”.

B. Flexible Base

Flexible base shall conform to Standard Specification Item No. 210, “Flexible Base”.

C. Bedding Sand

Bedding material shall consist of clean, hard, durable, and uncoated particles of natural or manufactured sand or combination thereof, with or without mineral filler. It shall be free of frozen material or injurious amount of salt, alkali, vegetable matter, or other objectionable material and shall not contain more than 0.5 percent by weight of clay or other binding agents.

It shall be a homogeneous material composed mainly of granular mineral matter and shall be clean and free of mud, silt, clay lumps or clods, vegetation or debris. The quantity of material removed by decantation (TxDOT Test Method TEX-406-A) plus the weight of any clay lumps shall not exceed 4.5 percent by weight.

The average electrical resistance when water-saturated (TxDOT Test Method TEX-129-E shall be at least 1,800 ohm/cm by the single probe method, with no single test reading lower than 1,500 ohm/cm. The gradation of bedding sand shall be as follows:

Gradation Table		
Sieve Size		% Retained by Weight (Mass)
US	SI	
¼ inch	6.35 mm	0
No. 6	3.36 mm	75 to 100
No. 100	150 µm	95 to 100

D. Controlled Low Strength Material

The backfill material shall conform to Standard Specification Item No. 402, "Controlled Low Strength Material".

844.4 Construction Methods

The work shall be executed in a safe and orderly fashion and in accordance with applicable Federal, State, and local laws, rules, and regulations. All work shall be performed in a competent, workmanlike manner consistent with the best modern practices, notwithstanding any omissions from the Drawings or these specifications

Trenching for traffic signal conduit shall be divided into the following categories, or "classes", of trench.

Class 1: trenches of nominal 6" (150 mm) width that accommodate one 2" (50 mm) conduit or one 3" (75 mm) conduit.

Class 2: trenches of nominal 12" (300 mm) width that accommodate two 2" (50 mm) conduits, three 2" (50 mm) conduits, two 3" (75 mm) conduits, or one 4" (100 mm) conduit.

Class 3: trenches of nominal 18" (450 mm) width that accommodate three 3" (75 mm) conduits or two 4" (100 mm) conduits.

Prior to commencement of work, all erosion control and tree protection measures required shall be in place and all utilities located and protected. Adequate temporary supports and protection of surface and underground utilities shall be the responsibility of the contractor.

Construction near any underground or overhead utilities shall be accomplished using established industry and utility safety practices. The Contractor shall verify existing

underground utilities through review of record data, use of one-call utility locates, collection/observation of visible surface evidence, consultation with utility facility owners and application of subsurface utility engineering techniques (e.g. pot-holing, ground penetrating radar, etc.) to determine the location of existing utilities and structures.

Any damage to utilities and/or structures that occurs as a result of any construction activity performed by the Contractor shall be repaired by the Contractor at his sole expense. Conduit shall be paid for only one time, regardless of any extra work caused by obstructions and/or Contractor damage.

The Contractor shall provide adequately bent conduit and shall properly excavate so as to prevent damage to the conduit or conductor by a bend radius, which is too short.

All trenching, excavation and backfill shall be completed to the lines and grades indicated on design drawings, construction detail drawings and in accordance with Standard Specification Item No. 401, "Structural Excavation and Backfill", except for measurement and payment.

Where existing pavement structure is removed for trenching and/or conduit placement, the repair shall be made by backfilling with material equal in composition and density to the surrounding areas and by replacement of any removed surfacing, such as asphalt pavement or Portland cement concrete, with approved like material to equivalent condition.

Jacking and Boring shall be as shown on the Drawings and in accordance with Standard Specification Item Nos. 501, "Jacking or Boring Pipe" and 502, "Tunneling", except for measurement and payment.

All conduits shall be placed on a minimum 1" (25 mm) layer of bedding sand and covered with a minimum 4"(100 mm) layer of sand prior to backfill.

Trench safety and trench safety systems shall be the responsibility of the contractor and shall be prepared in accordance with Standard Item No. 509, "Trench Safety Systems" and all applicable Federal, State, and local laws, rules, and regulations.

Trenches shall be excavated to lines and grades as indicated by on construction drawings or as directed by the Engineer or designated representative. Trenches shall be constructed between a minimum of 4" (100 mm) and a maximum of 8" (200 mm) wider than the outside dimension of the conduit configuration. Trench bottoms shall be graded smooth with a minimum 1" (25 mm) layer of sand or other fine grain materials placed in the bottom and shall be free of any trash, debris, loose material, or water. Trenches shall be excavated to a depth that insures that the required 30" (750 mm) conduit cover is achieved. Blasting or use of explosives as an aid to digging is not permitted.

The Engineer or designated representative reserves the right to inspect and approve all trenching prior to conduit placement.

Placement and compaction of backfill shall be performed in accordance with Standard Specifications Item Nos. 201, "Subgrade Preparation" and 132, "Embankment". Each layer shall be compacted to the required density by any method, and/or type and size of equipment, which will produce the required compaction. Prior to and in conjunction with

the rolling operation, each layer shall be brought to the moisture content necessary to obtain the required density and shall be kept leveled with suitable equipment to insure uniform compaction over the entire layer.

Unless directed otherwise, earth embankments shall be constructed in successive layers, with a thickness of 8" (200 mm) or less in loose measure, for the full width of the individual cross section and in a length that is best suited to the sprinkling and compaction methods utilized, while rock embankments shall be constructed in successive layers of 18" (450 mm) or less in thickness for the full width of the cross section.

Backfill under streets, driveways and all other pavement repairs shall conform to the City of Round Rock Standard Specifications. Backfill material for use in backfilling trenches under streets and driveways shall be selected based on the material's characteristic to maintain a consistent compacted density. Emphasis shall be placed upon the need to obtain uniform density throughout the backfill. Backfill shall be compacted by mechanical tamping equipment.

If boring under a roadway or other structure is required, the contractor shall be responsible for all utility locations including any required pot-holing. Such pot-holing and boring shall be completed at the sole expense of the contractor

844.5 Measurement

The Work prescribed by this item will be measured by the lineal foot (lineal meter: 1 lineal meter equals 3.281 lineal feet) of completed trenching of the various classes (including sand bedding for conduit, backfill and compaction, and pavement repair for streets, driveways, and sidewalks), based on the dimensions indicated on the Drawings.

The cost for utility location (including pot-holing) shall be considered ancillary to various bid items and will not be paid for separately.

844.6 Payment

The work performed as prescribed by this item will be paid for at the unit bid price per lineal foot for "Trenching for Traffic Signal Conduit". The unit bid price shall include full compensation for removal of all materials to the depth shown on the Drawings; for hauling, placement and preparation of bedding materials; for hauling, moving, placement and compaction of backfill materials; for repair of pavement for streets, driveways, and sidewalks damaged or removed as a result of trenching; for repair of conduit entry through walls of existing pull boxes; and for all labor, tools, equipment, manipulation, and incidentals necessary to complete the work.

The Work associated with construction of a new pull box will be paid for separately under a separate bid item identified with Standard Specification Item No 834, "Traffic Signal Pull Boxes".

Payment will be made under the following:

Class 1 Trenching for Traffic Signal Conduit
Per Lineal Foot of trench.

Class 2 Trenching for Traffic Signal Conduit
Per Lineal Foot of trench.

Class 3 Trenching for Traffic Signal Conduit
Per Lineal Foot of trench.

END

SPECIFIC Cross Reference Materials
Standard Specification Item 844, “Trench Excavation and Backfill for Traffic Signal Conduit”

City of Round Rock Standard Specifications

Designation	Description
Item No. 132	Embankment
Item No. 201	Subgrade Preparation
Item No. 210	Flexible Base
Item No. 401	Structural Excavation and Backfill
Item No. 402	Controlled Low Strength Material
Item No. 403	Concrete for Structures
Item No. 501	Jacking or Boring Pipe
Item No. 502	Tunneling
Item No. 509	Trench Safety Systems
Item No. 834	Pull Boxes

Texas Department of Transportation and Development: Standard Specifications For Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement

Texas Department of Transportation and Development Manual of Testing Procedures

Designation	Description
TEX-129-E	Method for Test For The Resistivity Of Soils Material
TEX-406-A	Material Finer Than 75 µm (No. 200) Sieve in Mineral Aggregates (Decantation Test For Concrete Aggregates)

Federal Specification WW-C-581d, ANSI C80 1
Federal Specification W-C 1094

RELATED Cross Reference Materials
Standard Specification Item 844, “Trench Excavation and Backfill for Traffic Signal Conduit”

City of Round Rock Standard Specifications

Designation	Description
Item No. 104	Removing Concrete
Item No. 111	Excavation
Item No. 401	Structural Excavation Backfill
Item No. 403	Concrete for Structures
Item No. 405	Concrete Admixtures
Item No. 406	Reinforcing Steel
Item No. 410	Concrete Structures
Item No. 420	Drilled Shaft Foundations
Detail No. 505-1	Concrete Encasement
Detail No. 510-1	Concrete Trench Cap
Detail No. 510-3	Typical Trench with Paved Surface
Detail No. 510-5	Typical Trench with Unfinished Surface
Detail No. 831-1	Traffic Signal Drilled Shaft Foundation Details
Detail No. 835-1	Trench Detail for Traffic Signal Conduit

Item No. 860
Pavement Marking Paint

860.1 Description

This item shall govern the installation of reflectorized paint pavement marking. The width of the line shall be 4 inches (100 millimeters) and the color as indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

860.2 Submittals

The submittal requirements of this specification item include:

A. Proposed paint color(s), brand names, raw materials and products for traffic paint.
B. Sampling and testing procedures and specific test results for pigment, calcium carbonate, acrylic resins and other materials used in the traffic paints.
C. Proposed shipping requirements including container type(s) (drums and/or buckets), and labeling.
D. Manufacturer's recommendations for mixing, storage and application of the traffic glass beads and traffic paint.
E. All applicable Materials Safety data Sheets for the traffic paint.

860.3 Materials

A. Traffic Stripe Reflective Glass Traffic Beads

1. The glass spheres shall not contain more than 30 percent (by weight {mass}) irregular shaped particles when tested in accordance with TxDOT Test Method-832-B. The no. 20 (850 mm) sieve shall have a maximum of 35% by weight (mass) allowed irregular particles, based on a visual inspection.

   Unless noted otherwise on the Drawings or designated in writing by the Engineer or designated representative, the application rate of the glass traffic beads shall not be less than 6 pounds per gallon (0.7 kilograms per liter). Glass traffic beads shall be essentially free of sharp angular particles and particles showing milkiness or surface scarring or scratching. Glass traffic beads shall be water white in color.

2. The glass traffic beads shall meet the following graduation requirements when tested in accordance with TxDOT Test Method Tex-831-B:

US Sieve	SI Sieve	% weight (mass) retained
# 20	(850 mm)	3 to 10
# 30	(600 mm)	20 to 40
# 40	(425 mm)	30 to 50
# 50	(300 mm)	15 to 35
# 80	(180 mm)	0 to 10

3. Index of Refraction: The glass traffic beads, when tested by the liquid immersion method at 77^0F (25^0C), shall show an index of refraction within the range of 1.50 to 1.53.

4. Wetting: The glass traffic beads shall be capable of being readily wet with water, when tested according to TxDOT Test Method Tex-826-B.

5. Stability: The glass traffic beads shall show no tendency toward decomposition, surface etching, change in retroreflective characteristics or change in color after

   (a) One-hour exposure to concentrated hydrochloric acid at 77ºF (25ºC),
   (b) 24 hours exposure to weak acids, weak alkali, and
   (c) 100 hours of weather-o-meter (Atlas, Sunshine Type) exposure, ASTM G-23, Method 1, Type EH.

6. Contaminants: Glass traffic beads shall:

   (a) contain less than 1/4 of 1 percent moisture by weight (mass).
   (b) free of trash, dirt, etc.
   (c) show no evidence of objectionable static electricity when flowing through a regular traffic bead dispenser.

7. Sampling and Testing (TxDOT Test Method Tex-801-B) shall be in accordance with the latest applicable procedures included in the TxDOT Manual on Testing. Applicable test methods include but are not limited to the following:

   Tex 806-B, "Method for Determining Grind and Oversize Pigment Particles"
   Tex-810-B, "Test Method for Color and Color Stability of Opaque Colored Pigments"
   Tex-811-B, "Skinning Characteristics of Coatings"
   Tex-822-B, "Method for Determining Refractive Index of Glass Beads"
   Tex-826-B, "Water Absorption Test of Beads"
   Tex-828-B, "Determining Functional Characteristics of Pavement Markings"
   Tex-830-B, "Method for Sampling Traffic Stripe Beads"

Tex-831-B, "Method for Determining the Gradation of Glass Traffic-Stripe Beads"
Tex-832-B, "Methods for Determining the Roundness of Glass Spheres"

B. Pavement Marking Paint

1. Functional Requirements

(a) All paint-type materials that are applied at ambient or slightly elevated temperatures shall conform to TxDOT Departmental Materials Specifications DMS-8200, YPT 10 and/or WPT-10 and DMS-8290.

(b) The paint shall be homogenous, well ground to a uniform and smooth consistency and shall not skin nor settle badly nor cake, liver, thicken, curdle or gel in the container.

(c) The paint, when applied to a bituminous pavement surface under normal field conditions at the required rate of .015 inch (0.4 mm) wet film thickness, shall have a maximum "no pickup" drying time of 15 minutes to prevent displacement or discoloration under traffic.

(d) In preparation of the paint, the pigments shall be dispersed in the vehicle by appropriate methods so that a fineness reading of not less than 4 is obtained with a Hegman grind gauge.

(e) Consistency viscosity, measured with a Krebs-Modified-Stormer Viscometer at 77ºF (25ºC), shall be from 80-90 K.U (with water deleted).

(f) A thin film of paint spread on a glass plate and allowed to dry thoroughly shall not darken or show any discoloration when subjected to ultraviolet rays for a period of 5 minutes.

2. Material Requirements

(a) Raw Materials

(1) The exact brands and types of raw materials used in the wet standards are listed for the purpose of facilitating the selection of parallel materials that are equal, not only in quality and composition but also in physical and chemical behavior after aging in the finished product.

(2) No substitution will be allowed during the manufacture without prior agreement with the City.

(3) It shall be the responsibility of the Contractor to utilize materials that not only meet the individual raw material specification, but that also produce a coating that meets the specific formula requirements.

(4) All materials required to meet TxDOT, Federal and ASTM

specifications must meet the latest specification as indicated on the Drawings in effect on the date of the proposal or invitation to bid.

(b) Pigments

(1) Titanium Dioxide:

Titanium Dioxide shall meet ASTM D-476, Type II requirements.

(2) Yellow Pigment:

Yellow Pigment CI 65 (Reddish Yellow)	
Characteristic	Values
Specific Gravity	1.74 to 1.76
Oil Absorption	20 to 30 %
Moisture	0.5 % maximum
Pigment retained on #325 (45 mm) sieve	0.1 % maximum
C.I. Number	11740
Heat Stability	266ºF (130ºC)

In addition to the requirements identified above, evidence shall be provided that the infrared spectrum matches the standard spectrum on file with TxDOT's Construction Division, Materials Section (CSTM)

(3) Calcium Carbonate: Calcium Carbonate shall conform to ASTM D-1199, Type GC, Grade I, with a minimum of 95% $CaCO_3$ and Type PC, with a minimum of 98% $CaCO_3$.

(c) Acrylic Traffic Resins: The acrylic traffic resin shall be similar and equal to the standard sample submitted by the manufacturer. The resin shall be approved prior to the contract award for the proposed use of the pavement paint.

Acrylic Traffic Emulsion	
Characteristic	Values
Solids Content	49.5 to 50.5
Viscosity, #2 Spindle, 60 rpm, 77ºF (25ºC), cps	250 maximum
pH	10.0 to 10.6
Film appearance, 3 mil (75 mm) dry	Smooth, clear, continuous

In addition to the requirements identified above, evidence shall be provided that the infrared spectrum matches the standard spectrum on file with TxDOT's Construction Division, Materials Section (CSTM)

(d) Miscellaneous Materials: These materials shall be similar and equal to the standard sample submitted by the vendor. The specific materials shall be approved prior to the contract award for the proposed use of the pavement paint.

1) Dispersant
   Byk 156
   Tamol 850
   Colloids 226/35

2) Surfactant
   Triton X-405
   Colloids CA-407

3) Defoamer
   Foamaster 111
   Drew 493
   Colloids 654

4) Hydroxy Ethyl Cellulose
   Natrosol 250 HBR
   Bermocoll E431FQ
   Cellosize QP - 30,000

5) Coalescent
   Texanol
   Exxate 1200

6) Preservative
   Troysan
   Dowicil 75
   Nuosept 101

7) Methyl Alcohol
   ASTM D-1152, 1.3320 maximum

(e) Standard Formulae:

The following tables represent the Standard Formulae to be followed by the manufacturer when manufacturing paint to be used by the Contractor on City of Round Rock paint striping contracts.

Formula: White Traffic Paint

WPT-11 - LEAD FREE WHITE TRAFFIC PAINT		
Component	Pounds	Kilograms
Acrylic Emulsion, 50% Solids, Fastrack 2706	540.	245
Coalescent, Texanol	20.	9.1
Titanium Dioxide, Rutile, Type II, Tiona RCL-9	100.	45.4
Calcium Carbonate, Type PC, Mississippi M-60	150.	68.
Calcium Carbonate, Type GC, Hubercarb M-4	440.	199.6
Hydroxy Ethyl Cellulose, Natrosol 250 HBR (*)	0.5	0.2
Defoamer, Foamaster 111	5.	2.3
Disapersant, Colloids 226/35	9.	4.1
Surfactant, Triton X-405	2.	0.9
Methyl Alcohol	30.	13.6
Preservative, Troysan 192	2.	0.9
Water, Potable (**)	18.**	8.1**
TOTALS	1316.5	597.2

(*) The Hydroxy Ethyl Cellulose amount may be varied up to two (2) pounds [0.9 kilograms].

(**) Only 10 pounds (4.5 kilograms) shall be used in the actual manufacture of the pavement paint. The remaining 8 pounds (3.6 kilograms) shall be used as a drum float.

Formula: Yellow Traffic Paint

YPT-11 - LEAD FREE YELLOW TRAFFIC PAINT		
Component	Pounds	Kilograms
Acrylic Emulsion, 50% Solids, Fastrack 2706	540	245.
Coalescent, Texanol	20	9.1
C.I. Pigment Yellow 65, Sunglow Yellow 1244	30.	13.6
Titanium Dioxide, Rutile, Type II, Tiona RCL-9(***)	20.	9.1
Calcium Carbonate, Type PC, Mississippi M-60	150	68.
Calcium Carbonate, Type GC, Hubercarb M-4	450	204.1
Hydroxy Ethyl Cellulose, Natrosol 250 HBR (*)	0.5	0.2
Defoamer, Foamaster 111	5.	2.3
Dispersant, Colloids 226/35	9.	4.1
Surfactant, Triton X-405	2.	0.9
Methyl Alcohol	30.	13.6
Preservative, Troysan 192	2.	0.9
Water, Potable (**)	18.**	8.1**
TOTALS	1276.5	579.0

Additional Criteria for Pavement Paint

Item	Requirements
Grind Particles:	4 minimum, 8 maximum (TxDOT Test Method Tex-806-B)
Gallon Weight:	± 0.10 lbs. of theoretical gallon weight
(Liter mass:)	(± 0.012 kilograms of theoretical liter mass)
Consistency:	80 to 90 K.U.
PH:	a minimum of 9.6
Skinning:	No skinning within 48 hours (TxDOT Test Method Tex-811-B)

(*) The Hydroxy Ethyl Cellulose amount may be varied up to two (2) pounds [0.9 kilograms]

(**) Only 10 pounds (4.5 kilograms) shall be used in the actual manufacture of the pavement paint. The remaining 8 pounds (3.6 kilograms) shall be used as a drum float.

(***) Titanium Dioxide, Rutile, Special, Hilox will be allowed as a substitute in the YPT-11 formula only.

(f) Container and Marking

1) Shipment: Shipment shall be made in suitable, strong, well-sealed containers that meet this specification, State of Texas, and federal requirements and are sufficiently sturdy to withstand normal shipping and handling.

2) Drum Package Requirements. The paint shall be provided in a new, serviceable, non-leaking, 55 gallon (209 liter) lined, steel drum meeting all applicable federal regulations. Drums are to be non-returnable with full removable heads, three (3) rolling hoops and 12 gauge locking rings with 5/8 inch (15.9 millimeter) locking nut bolt. The nominal metal thickness is to be 0.044 inch (1.1 mm). Each drum is to be equipped with a natural sponge-rubber cord, high-density gasket. The rubber shall be approximately 0.4375 inch (10.9 mm) thick. The gasket, when compressed, shall produce an airtight closure when the drum is sealed.

When a locking nut is used on drum rings, the locking nut shall be in a non-locking position while tightening the ring. After the ring is tight, the locking nut shall be secured in the locking position.

A seal shall be affixed to each drum in a manner that the contents of the drum cannot be adulterated without destroying the seal.

3) Bucket Packaging Requirements: Paint is to be furnished in new 5 gallon (19 liter) lined, 24 gauge steel, non-leaking buckets.

4) Filling Instructions: The paint drums will be filled at 54.5 gallons (206.4 liters) by weight (mass) with a water float of 0.53 gallons (2.0 liters).

The paint buckets will be filled at 4.95 gallons (18.75 liters) by weight (mass) with a water float of 0.05 gallons (0.18 liters).

5) Labeling: Finished paint product containers and cases shall be plainly and securely labeled with:

a) Name and designation of the product,
b) Requisition number,
c) Batch number,
d) Manufacturing date,
e) Gross weight, and
f) Manufacturer's name.

Labeling shall be prominently displayed on the sides of containers and cases and must be moisture resistant to withstand outdoor storage for a minimum of one year. When the finished product is palletized for shipment, the labels shall be displayed on the outside fore easy identification. Once the finished product has been labeled properly, the label shall not be modified or changed in any manner without specific approval from the City. (Note: The material manufacturer shall supply a Materials Safety Data Sheet to comply with OSHA's "Hazard Communication Standard 29 CFR x 1910.1200").

860.4 Construction Methods

The Contractor shall use a crew, that is experienced in the work of installing pavement markings and in the necessary traffic control for such operations on the roadway surface, and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the pavement markings as indicated on the Drawings or directed by the Engineer or designated representative. All work shall conform to the current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD).

The pavement surface to receive the pavement markings shall be thoroughly cleaned of all dirt, organic growth or other material that will prevent adhesion of the paint to the roadway surface.

The pavement markings shall be placed in the proper alignment with guides established on the roadway. Deviation from the alignment established shall not exceed 2 inches (50 millimeters) and in addition, the deviation in alignment of the markings being placed

shall not exceed 1 inch per 200 feet (25 millimeters per 30 meters) of roadway nor shall any deviation be abrupt.

When deemed necessary by the Engineer or designated representative, the Contractor, at his expense, shall place any additional pilot markings required to facilitate the placement of the permanent markings in the alignment specified. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway.

Materials used for pilot markings and equipment used to place such markings shall be approved by the Engineer or designated representative.

Paint markings on the roadway that are not in alignment or sequence as indicated shall be totally and completely removed by any effective method approved by the Engineer or designated representative, except that grinding will not be permitted.

Paint shall be applied at a rate of not less than 15 gallons or more than 20 gallons per mile of solid 4 inch stripe (not less than 35 liters or more than 45 liters per kilometer of solid 100-mm stripe). Application rate for solid 8-inch (200-mm) stripe shall be between 30 and 40 gallons per mile (between 70 and 90 liters per kilometer). (These rates yield wet film thickness from 15 to 20 mils [0.4 to 0.5 mm].)

Beads shall be applied to the paint markings at a uniform rate sufficient to achieve the retroreflective characteristics specified when observed conforming to TxDOT Test Method Tex-828-B. All markings placed shall have uniform and distinctive retroreflective characteristics.

Applied markings shall be protected from traffic until they have dried sufficiently so as not to be damaged or tracked by normal traffic movements.

860.5 Equipment

Paint striping equipment used to place 4 inch (100 mm) solid or broken lines shall have the capability of placing a minimum of 60,000 linear feet (18 300 lineal meters) of marking per working day. Equipment used for placing markings in widths other than 4 inches (100 mm) shall have capabilities similar to 4 inch (100 mm) marking equipment and shall be capable of placing linear markings up to 8 inches (200 mm) in width in 1 pass.

The equipment shall be maintained in satisfactory operating condition. The equipment shall be equipped so that one 4-inch (100-mm) broken line and either 1 or 2 solid lines can be placed at the same time in alignment and spacing as indicated on the drawings. Four inch (100 mm) marking equipment will be considered as unsatisfactorily maintained if it fails to attain an average hourly placement rate of 7000 linear feet (2 100 linear meters) in any 5 consecutive working days of 7 hours or more.

The equipment shall be equipped with an automatic cutoff device (with manual operating capabilities) to provide clean, square marking ends and to provide a method of applying broken line in a stripe to gap ratio of 15 to 25. The length of the stripe shall not be less than 15 feet or longer than 15.5 feet (less than 4.5 meters nor longer than 4.7 meters). The total length of the stripe-gap cycle shall not be less than 39.5 feet nor longer than 40.5 feet (less than 12 meters nor longer than 12.3 meters) in variance from

one cycle to the next nor shall the average total length of a cycle for a road mile (1.6 kilometer) of broken line exceed 40.5 feet or be less than 39.5 feet (exceed 12.3 meters or be less than 12 meters).

The equipment shall be capable of placing lines of all widths with clean edges and of uniform cross section. Four-inch (100-mm) lines shall be 4 inches (100 mm) plus or minus 1/8 inch (3 mm). Eight inch (200 mm) lines shall be 8 inches (200 mm) minimum and 8 1/4 inches (210 mm) maximum in width.

The equipment shall be equipped with an outrigger or outriggers as required to place edge-lines as called for in the plans.

The equipment shall be equipped with traffic glass bead dispensers, 1 for each paint spray gun, placed on the equipment so that beads are applied to the paint almost instantly as the marking is being placed on the roadway surface. The traffic glass bead dispensers shall be designed and aligned so that the beads are applied uniformly to the entire surface of the marking. The traffic glass bead dispensers shall be equipped with automatic cutoff controls, synchronized with the cutoff of the marking equipment. Paint pots or tanks shall be equipped with an agitator that will keep the paint thoroughly mixed and may be either a pressurized or non-pressurized type.

860.6 Measurement

Work for Pavement Marking Paint lines will be measured by the lineal foot (lineal meter: 1 meter equals 3.28 feet) of the various widths. Work for pavement marking, paint letter or figures will be measured by the square foot (square meter: 1 square meter equals 10.76 square feet).

860.7 Payment

Work performed as prescribed by this item, measured as provided under "Measurement", shall be paid for at the unit bid price for "Pavement Marking Paint" per lineal foot or square foot of the various widths specified. This price shall include full compensation for furnishing all labor, tools, equipment, materials and incidentals necessary to complete the work specified.

Payment will be made under one of the following:

Pavement Marking Paint (Reflectorized), __In.

Per Lineal Foot.

Pavement Marking Paint (Reflectorized)

Per Square Foot.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 860 "Pavement Marking Paint (Reflectorized)"

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 801-B	Testing Coatings and Related Materials
Tex 806-B	Method for Determining Grind and Oversize Pigment Particles
Tex-810-B	Test Method for Color and Color Stability of Opaque Colored Pigments
Tex-811-B	Skinning Characteristics of Coatings
Tex-822-B	Method for Determining Refractive Index of Glass Beads
Tex-826-B	Water Absorption Test of Beads
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-830-B	Method for Sampling Traffic Stripe Beads
Tex-831-B	Method for Determining the Gradation of Glass Traffic-Stripe Beads
Tex-832-B	Methods for Determining the Roundness of Glass Spheres

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-8200	Pavement Paint
YPT-11 and/or WPT-11	Pavement Paint

American Society for Testing and Materials (ASTM)

Designation	Description
D 476	Specification for Titanium Dioxide Pigments
D 1152	Specification for Methanol (Methyl Alcohol) with Refractive Index
D 1199	Specification for Calcium Carbonate Pigments
G-23	Recommended Practice for Operating Light-and- Water-Exposure Apparatus (Carbon-Arc Type) for Exposure of Nonmetallic Materials

Federal Specifications – OSHA 29 CFR

Designation	Description
1910.1200	Hazard Communication Standard."

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance,Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

RELATED CROSS REFERENCE MATERIALS
Specification Item 860 "Pavement Marking Paint (Reflectorized)"

City of Round Rock Standard Specifications

Designation	Description
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markings
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markers
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-829-B	Method For Measuring Pavement Temperature

American Society for Testing and Materials (ASTM)

Designation	Description
D-235	Specification for Mineral Spirits
D-362	Specification for Industrial Grade Toluene
D-600	Specification for Liquid Paint Driers
D-605	Specification for Magnesium Silicate Pigment (Talc)
D-740	Specification for Methyl Ethyl Ketone
D-1210	Test Method For Fineness Of Dispersion Of Pigment-Vehicle Systems

ITEM NO. 861
THERMOPLASTIC PAVEMENT MARKINGS

861.1 Description

This item shall consist of the materials, composition, application, sampling, testing, measurement and payment of pavement markings of the color, length, thickness and width as indicated or as directed by the Engineer.

It is the object of this specification to insure the installation of tightly adherent, defect-free, pavement markings of quality, visibility and performance to either asphaltic or Portland cement concrete road surfaces.

Markings to be placed may be on roadways- either free of traffic or open to traffic. On roadways already open to traffic, the markings shall be placed under traffic conditions that exist with a minimum of interference to the operation of the facility. Traffic control shall be as indicated or as directed by the Engineer. All markings placed under traffic shall be protected from traffic damage and disfigurement.

861.2 General Characteristics

When placed on the roadway in the form of marking, these markings shall not be slippery when wet, lift from pavement under normal weather conditions nor inhibit a tacky, exposed surface. Cold ductility of the material shall be such as to permit normal movement with the road surface without chipping or cracking.

These markings shall retain their original color, dimensions and placement under normal traffic conditions at road surface temperatures of 70 C (158 F) and below.

When applied 1/8 inch thick, the setting to traffic time shall not exceed a characteristic straight-line curve; the lower limits of which are 4 minutes at 15 C (59 F) road surface temperature; the upper limits of which are 10 minutes at 32C (90 F) road surface temperature; both temperatures measured at a maximum relative humidity of 90 percent and according to SDHPT Test Method Tex-829-13.

These markings shall essentially have a uniform cross-section. The density and quality of the marking shall be uniform throughout their thickness. The applied markings shall be 95 percent free of holes and voids and free of blisters for a minimum of 30 days after application of all pavement markings is complete.

The markings in place on the roadway shall be completely reflectorized both internally and externally. The marking, when observed in accordance with SDHPT Test Method Tex-838-13, shall show that the retrodirective reflectance of the marking is uniform and the marking shall definitely and distinctively exhibit retroreflective characteristics.

861.3 Material Requirements

A. General

At temperatures up to and including 230 C (446 F), materials shall not give off fumes which are .toxic or otherwise injurious to persons, animals or property. The material shall not break down or deteriorate when held at 205 C (401 F). The temperature versus viscosity characteristics of the material in the plastic state shall remain constant throughout up to four reheatings to 205 C (401 F) and from

batch to batch. The material shall not be adversely altered by contract with sodium chloride, calcium chloride or other similar chemicals on or used on the roadway surface or because of the oil content of pavement materials or from oil dropping from traffic.

The material shall not soften at 180 F when tested by the Ball and Ring Method, American Society of Testing Materials (ASTM) Method E28-58T.

B. Material Composition

The material shall consist of binder, prime pigment or pigments, filler pigment and glass traffic beads in a uniform blend so that any 90 to 100 gram sample shall be representative of lot, batch or mix sampled.

A minimum of 90 percent of the binder shall be hydrocarbon resins. The total binder content of the pavement marking material shall be not less than 25 percent no more than 30 percent by weight.

A minimum of 98 percent of the prime and filler pigments used in the formulation, when wash free of resins by solvent washing, shall pass a U.S. Standard Sieve No. 230 (0.0024 inch opening).

The prime pigment of the white pavement marking material shall be titanium dioxide and shall be a minimum of 12 percent by weight of total material.

The prime pigment or pigments of the yellow pavement marking material shall be medium chrome yellow or other approved yellow pigments ranging from 10 to 15 percent by weight of total material.

The filler pigment of both white and yellow pavement marking material shall be calcium carbonate of at least 95 percent purity.

The glass traffic beads shall be uniformly incorporated into the pavement marking material at a rate of not less than 30 or more than 45 percent by weight of the pavement marking material.

Total silica used in formulation shall be in the form of glass traffic beads. Glass traffic beads used in the formulation and applied to the surface of the markings shall not be affected (such as surface etching or degradation) when subjected to concentrated hydrochloric acid for one hour at room temperature, 25 C (77 F).

The glass traffic beads used in the formulation and applied to the surface of the marking to obtain the initial retrodirective reflective characteristics of the marking shall have a refractive index between 1.50 and 1.53 when tested by the liquid immersion method at 25 C shall consist of 70 percent minimum true spheres, by weight, that are lustrous, clear and transparent, free of air inclusions, surface scores and pits and milkiness and shall meet the following gradation requirements:

U.S. Sieve Number	Percent Passing
30	80-100
50	18-35
100	0-4

C. Color

The color of the marking materials as specified, when in place and dry, shall be free from dirt and shall appear uniform. Its CIE Chromaticity Coordinate, when determined in accordance with SDHPT Test Method Tex-839-13, shall fall within an area having the following comer points and shall meet the following brightness requirements:

	1		2		3		4		Brightness
	X	Y	x	Y	x	y	X	Y	Y
white	.290	.315	.310	.295	.350	.340	.330	.360	min. 70
yellow	.470	.455	.510	.489	.490	.432	.537	.482	45-60

The white and yellow pavement marking materials shall meet the above specified color requirements, for each color respectively, before and after 70 hours of exposure in a Weather-0-Meter (Atlas, Sunshine-Type) fitted with an 18-102 (18 minutes of sunshine and rain and 102 minutes of sunshine) cyclic gear. Panels for testing shall be prepared with pavement marking material as supplied to the project.

861.4 Equipment

The pavement marking material may be either spray applied or extruded hot to the pavement surface unless application method is specified on the plans.

The equipment shall be constructed to provide continuous mixing and agitation of the material. It shall be equipped with an automatic cut-off device (with manual operating capabilities) to provide clean, square marking ends and to provide a method of applying broken line in a stripe-to-gap ratio of 10 to 25. The length of the stripe shall not be less than 10 feet or longer than 10.5 feet. The total length of the stripe-gap cycle shall not be less than 39.5 feet or longer than 40.5 feet in variance from one cycle to the next nor shall the average total length of a cycle for a road mile of broken line exceed 40.5 feet or be less than 39.5 feet. The shaping die or spray gun shall be equipped with a cut-off device remotely controlled to provide clean, square, marking ends and to provide a method for applying "skip" lines. The use of pans, aprons or similar appliances which the die overruns shall not be permitted under this specification.

Equipment used to place 4 inch continuous or "skip" line shall be capable of placing a minimum of 60,000 linear feet of marking per working day. Equipment used for placing markings in widths of other than 4 inches shall have capabilities similar to 4 inch marking equipment. Equipment used for placing markings shall be maintained in satisfactory operating conditions. Equipment shall be considered in unsatisfactory

working condition if it fails to have an average hourly placement rate of 7,000 linear feet of acceptable 4 inch continuous or "skip" line over any 5 consecutive working days of 7 hours or more due to equipment malfunction. Upon notification by the Engineer of equipment in unsatisfactory operating condition, the Contractor shall repair and place such unsatisfactory equipment in satisfactory condition or replace with equipment meeting the requirements of this specification. Equipment used to place markings other than continuous or "skip" lines shall have production capabilities satisfactory to the Engineer. The container must be so equipped and arranged as to satisfy the requirements of the National Fire Underwriters and the Texas Railroad Commission. The Contractor shall supply the Engineer with a thermometer for the project, capable of measuring the temperature of the pavement marking material to be applied.

Beads applied to the surface of the material shall be applied by an automatic bead dispenser attached to the pavement marking equipment in such a manner that the beads are dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser shall be equipped with an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment.

It is the intent of the equipment requirements specified above to insure the placement of pavement markings meeting the requirements of this specification. All markings placed that do not meet the requirements of this specification and fail to adhere to the road surface properly shall be completely removed and replaced at the expense of the Contractor.

861.5 Construction Methods

The Contractor shall use a crew experienced in the work of installing pavement markings and shall supply all the equipment and materials necessary for the placement of the pavement markings.

The pavement marking material shall be applied within the material temperature limits recommended by the supplier.

The pavement markings shall be placed in proper alignment with guide lines established on the roadway or by the Engineer. Deviation from the alignment established shall not exceed 2 inches and, in addition, the deviation in alignment of the marking being placed shall not exceed 1 inch per 200 feet of roadway nor shall any deviation be abrupt.

When deemed necessary by the Engineer to achieve specified alignment, the Contractor, at his expense, shall place any additional markings required to achieve alignment specified throughout both straight and horizontally curved sections of roadway. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway. Materials used for alignment markings and equipment used to place such markings shall be approved by the Engineer.

During placement of the thermoplastic markings, glass traffic beads shall be uniformly applied to the surface of the markings at a rate sufficient to achieve the retrodirective reflective characteristics specified when observed in accordance with SDHPT Test Method Tex-828-B.

The pavement upon which the pavement markings are to be placed shall be cleaned and prepared to the satisfaction of the Engineer prior to placement of the markings.

Cleaning shall be by any effective method, approved by the Engineer that completely and effectively removes contaminants, loose materials and conditions deleterious to proper adhesion.

Portland cement concrete surfaces shall not be cleaned by grinding.

Portland cement concrete surfaces shall be further prepared after cleaning by completely sealing with a methylmethacrylate sealer or primed with an adhesive or adhesion promoter, approved by the Engineer, prior to placement of the markings.

When deemed necessary by the Engineer, asphaltic surfaces exhibiting polished aggregate shall be primed with a sealer, adhesive or adhesion promoter meeting the requirements specified for sealers, adhesives and adhesion promoters to be used on Portland cement concrete surfaces.

All other pavement surfaces may be prepared by any effective method, approved by the Engineer that will insure complete removal of all materials or conditions deleterious to proper adhesion of the markings to the roadway surface.

The materials shall be installed in increments of 4, 6, 8 or 12 inch widths or otherwise shaped as indicated. Deviation from specified width shall not exceed 1/8 inch except when due to undulations in the pavement surface, in which case the deviation in width shall not exceed ¼ inch.

The material, when formed into pavement markings, must be readily renewable when application is made over an existing marking.

The application of hot-applied pavement markings shall be done only on a clean, dry pavement having a road surface temperature above 13 C (55 F) for Portland cement concrete surfaces and above 7 C (45 F) for asphaltic surfaces. When pavement marking application is by spray and operations cease for 5 minutes or more, the spray head must be flushed by spraying pavement marking material into a pan or similar container until the pavement marking material being sprayed out the nozzle is at the proper temperature for application. The pavement temperature shall be measured in accordance with SDHPT Test Method Tex-829-B.

Unless otherwise directed by the Engineer, pavement marking materials shall not be placed on roadways between September 30 and March 1, subject to temperature and moisture limitations specified elsewhere herein.

Unless otherwise specified in the plans, the minimum thickness of spray-applied markings, as measured on a flat plat by micrometer or similar device shall be as shown in the following table:

Description of Surface	Minimum Thickness
Smooth: Portland cement concrete or fine-graded asphaltic concrete pavement	65 mils
Intermediate: Open-graded surface treatment, Grades 4 and 5 aggregate	70 mils
Coarse: Open-graded surface treatment, Grades 1, 2 and 3 aggregate	80 mils

The thickness of the markings shall be uniform throughout their lengths and widths. Unless otherwise indicated, the minimum thickness of the markings applied by extrusion, as measured above the plane formed by the pavement surface, shall not be less than 1/8 inch thick in the center of the marking and 3/32 inch thick ½ inch from the edge. Maximum thickness shall be 3/16 inch. The Contractor shall supply a device, suitable to the Engineer, to measure thickness of the applied extruded markings.

861.6 Performance

Installed pavement markings shall meet all requirements of this specification for a minimum of 30 calendar days after final installation of pavement markings is complete. Pavement markings that fail to meet all requirements of this specification shall be removed and be replaced with pavement markings meeting the requirement of this specification at the expense of the Contractor. The Contractor shall replace all pavement markings failing the requirements of this specification within 30 working days following notification by the Engineer of such failing pavement markings. All pavement markings, including replacement pavement markings, shall meet all requirements of this specification for a minimum of 30 calendar days after final installation of original and necessary replacement pavement markings.

861.7 Measurement

Measurement of the markings shall be made for each color by the linear foot of the various widths, by the square foot of the various shapes as indicated or other unit as indicated, complete in place.

861.8 Payment

The work performed and materials furnished as prescribed by this item, measured as provided under "Measurement," shall be paid for at the unit price bid for each color per linear foot of the various widths, per square foot of the various shapes as indicated or other unit as indicated, complete in place. This price shall be full compensation for furnishing and placing all materials and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

Thermoplastic Pavement Markings -	Per Linear Foot.
Thermoplastic Pavement Markings -	Per Linear Foot.
Thermoplastic Pavement Markings -	Per Linear Foot.
Thermoplastic Pavement Markings -	Per Square Foot.

Item No. 862
Temporary Removable Pavement Markings

862.1 Description

This item shall govern furnishing, placement and removal of prefabricated removable pavement markings of the types, colors, shapes and sizes indicated on the Drawings or as directed by the Engineer or designated representative.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

862.2 Submittals

The submittal requirements of this specification item include:

A. List of temporary, removable, pavement markings, shapes, words, etc. with associated manufacturer.
B. Manufacturer's recommended preparation, cleaning, placement and installation instructions.
C. Type of adhesive and application recommendations.

861.3 Materials

The prefabricated pavement marking materials shall conform to TxDOT Departmental Material Specification DMS-8240. The materials shall be stored in a weatherproof enclosure in such a method that will prevent damage.

862.4 Sampling

Sampling will be conducted in accordance with TxDOT Test method Tex-732-1.

862.5 Construction Methods

A. General

Guides to mark the lateral location of pavement markings shall be established as indicated on the Drawings or as directed by the Engineer or designated representative. The Contractor shall establish the pavement marking guides and the Engineer or designated representative will verify the location of the guides prior to installation of final striping.

The pavement markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed one (1) inch per 200 feet (25 mm in 60 meters) of roadway. The maximum deviation shall not exceed two (2) inches (50 mm) nor shall any deviation be abrupt.

B. Seasonal Limitation

Unless directed otherwise in writing by the Engineer or designated representative, temporary pavement marking materials shall not be placed between September 30 and March 1, subject to any specified temperature and moisture limitations.

C. **Dimensions**

Markings shall be in accordance with the color, length, width, shape and configuration indicated on the Drawings. The alignment and location shall be as indicated on the Drawings or as directed in writing by the Engineer or designated representative.

D. **Methods**

All material placement shall be in accordance with the material manufacturer's instructions, unless otherwise directed in writing by the Engineer or designated representative. In addition to the manufacturer's instructions, material placement shall be in accordance with surface condition, moisture and temperature requirements specified within this item.

E. **Surface Preparation**

Surface preparation shall be accomplished by any cleaning method, approved by the Engineer or designated representative, that effectively removes contaminants and loose materials and corrects existing conditions considered deleterious to proper adhesion. Surface preparation utilizing blast cleaning will only be required if indicated on the Drawings.

Surfaces shall be further prepared after cleaning by sealing or priming, as recommended by the manufacturer of the temporary pavement marking materials or as directed in writing by the Engineer or designated representative.

Adhesive, when required, shall be of the type and quality recommended by the manufacturer of the temporary pavement marking material. Portland cement concrete pavement surfaces shall not be cleaned by grinding.

F. **Moisture**

The pavement surface on which the marking material is to be placed shall be completely dry. A pavement shall be considered dry, if on a sunny day after observation for 15 minutes, condensation does not develop on the underside of a one (1) foot (300 mm) square piece of clear plastic, which has been placed on the pavement and weighted down on the edges.

G. **Temperature**

The pavement and ambient air temperature requirements, which are recommended by the material manufacturer, shall be followed. If no temperature requirements are established by the material manufacturer, the material shall not be placed if the pavement surface temperature is below 50^0F (10^0C) or above 130^0F (55^0C).

862.6 Performance Requirements

A. **Adhesion**

Installed pavement markings shall not lift, shift, smear, spread, flow or tear by traffic action.

B. **Appearance**

Pavement markings shall present a neat, uniform appearance, free of excessive adhesive, ragged edges and irregular lines or contours.

C. **Visibility**

Installed pavement markings shall have uniform and distinctive retroreflectance when observed in accordance with TxDOT Test Method Tex-828-B.

D. **Observation Period**

The Contractor shall be responsible for maintaining at its own expense all temporary pavement markings from the time of installation until completion and acceptance of the Work in accordance with this Item and to the satisfaction of the Engineer or designated representative. Pavement markings, that fail to meet the requirements of this specification shall be removed and replaced by the Contractor at the Contractor's expense.

862.7 Measurement

Measurement of the markings shall be made for each color by the lineal foot (lineal meter: 1 meter is equal to 3.281 feet) of the various widths; by each for word(s), shape or symbol or by any other unit as indicated on the Drawings, complete in place.

862.8 Payment

The work performed and materials furnished as prescribed by this item and measured as provided under "Measurement," will be paid for at the unit bid price for "Temporary Removable Pavement Markings" of the various types, colors, shapes and sizes indicated on the Drawings. This price shall include full compensation for: cleaning the pavement surface by any suitable means other than blast cleaning; for furnishing, placing and removal of all materials; and for all labor, tools, equipment and incidentals necessary to complete the work.

Payment for Temporary Removable Pavement Markings will be made under the following:

4" yellow Markings,	Per Lineal Foot.
24" yellow Markings,	Per Lineal Foot.
Shape(s) of _____ color	Per Each.
Symbol(s) of _____ color	Per Each.
Word(s) of _____ color	Per Each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 862 “Temporary Removable Pavement Markings”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-732-I	Sampling of Prefabricated Pavement Marking Materials
Tex-828-B	Determining Functional Characteristics of Pavement Markings

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-8240	Temporary Marking Material

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

RELATED CROSS REFERENCE MATERIALS
Specification Item 862 “Temporary Removable Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 662	Work Zone Pavement Markings
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-829-B	Method for Measuring Pavement Temperatures Thickness

ITEM NO. 863
Reflectorized Pavement Markers

863.1 Description

This item governs reflectorized pavement markers to be used to delineate traffic lanes or fire hydrants.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

863.2 Submittals

The submittal requirements of this specification item include:

A. List of specific application(s) [i.e. type: (reflectorized Type I-A, I-C or II-A-A, II-B-B or II-C-R)] and applicable epoxy system and adhesive types [867S.5].

B. Specific manufacturer with test results and technical specifications for proposed pavement markers.

C. Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.

D. Adhesive components and mixing recommendations.

863.3 Materials

All materials shall meet the requirements as specified below. The pavement markers shall comply with TxDOT Departmental Materials Specifications DMS-4210.

A. Design and Shape

The outer surface of the marker shall be smooth and all corners and edges exposed to traffic must be rounded. The base of the marker shall have a width of 4.0 inches + 1/2 inch (100 mm + 13 mm) and shall have a minimum area exposed to traffic of 12.5 square inches (8000 square mm). The maximum height shall be 3/4 inch (19 mm). The maximum slope of the reflector face or faces shall be not more than 30 degrees from the horizontal.

The bottom surface of the markers shall be of a design for adhesion with epoxy adhesives to comply with TxDOT Test Method Tex-611-J.

The marker shall be designed to show no change in shape or color when subjected to the requirements of TxDOT Test Method Tex-846-B, at a temperature of 140^{o}F (60^{o}C) with the marker in a vertical position.

B. Optical

1. Definitions

(a) Horizontal entrance angle is defined as being in a plane parallel to the base of the road marker, between a line in the direction of the incident light and a line that is perpendicular to the leading edge of the reflective surface.

(b) Divergence angle shall mean the angle at the reflector between observer's line of sight and the direction of the light incident on the marker.

(c) Specific intensity shall mean candle power of the returned light at the chosen divergence and entrance angles for each footcandle of incident light per reflective face. TxDOT Test Method Tex-842-B will be used to determine specific intensity.

2. Performance

For the pavement markers the specific intensity of the reflecting surface at a 15-degree divergence angle shall be not less than the following when the incident light is parallel to the base of the marker.

	Specific Intensity	
Horizontal Entrance Angle, Degrees	Crystal	Amber
0	3.0	2.0
20	1.5	1.0

The specific intensity of the marker shall not be less than 80 percent of the above minimum values after being subjected to heat test of TxDOT Test Method Tex-846-B.

C. Pavement Marker Types

Pavement markers shall be of the following types:

1. Type I-A shall contain an approach face that reflects amber light. The body, other than the reflective face, shall be yellow.

2. Type I-C shall contain an approach face that reflects white light. The body, other than the reflective face, shall be white, silver white or light gray.

3. Type II-A-A, shall contain two reflective faces (approach and trailing), each of which shall reflect amber light. The body, other than the reflective faces, shall be yellow.

4. Type II-B-B shall contain two reflective faces (approach and trailing) with glass covered pneumatic reflective faces, each of which shall reflect blue light. The body, other than the reflective faces, shall be blue.

5. Type II-C-R shall contain two reflective faces (approach and trailing), one of which reflects white light and one of which reflects red light. The body, other than the reflective faces, shall be either white, silver white or light gray or one-half white, silver white or light gray on the side that reflects white light and one-half red on the side that reflects red light.

The reflective faces of the Type II markers shall be located so that the direction from one face shall be directly opposite the direction of reflections of the other face.

863.4 Sampling

Sampling will be conducted in accordance with TxDOT Test Method Tex-729-I.

863.5 Testing

The Contractor shall certify that the markers meet the requirements defined in the specification and meet or exceed the applicable tests required. All testing will be in accordance with the TxDOT manual of Testing Procedures. Applicable tests shall include the following:

Tex-611-J:	Adhesion Requirements
Tex-842-B:	Light Retroreflectivity
Tex-846-B:	Heat Resistance

Blue markers' color will conform to Fire Department requirements.

863.6 Construction Methods

The Contractor shall use a crew experienced in the work of installing reflectorized pavement markers and in the necessary traffic control for such operations on the roadway surface and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the pavement markings as indicated on the Drawings or as directed by the Engineer or designated representative. All work shall conform to the current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD), and City of Round Rock Transportation Criteria Manual.

All reflectorized pavement markers shall be from the same manufacturer. Surfaces to which markers are to be attached by an adhesive shall be prepared by any method approved by the Engineer or designated representative to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond. Unless indicated otherwise on the Drawings, surface preparation for installation of raised reflectorized pavement markers will not be paid for directly, but shall be considered subsidiary to this specification item.

Guides to mark the lateral location of pavement markings shall be established as indicated on the Drawings or as directed by the Engineer or designated representative. The Contractor will establish the pavement marking guides and the Engineer or designated representative will verify the location of the guides prior to final installation.

The pavement markers shall be placed in proper alignment with the Guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet (25 millimeters per 60 meters) of roadway. The maximum deviation shall not exceed 2 inches (50 millimeters) nor shall any deviation be abrupt.

Markers placed which are not in alignment indicated on the Drawings shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Specification Item 874 except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

The Reflectorized Pavement Markers shall be applied using an approved epoxy adhesive to the lines and spacings as indicated on the Drawings or as directed by the Engineer or designated representative. The adhesive shall be applied in sufficient quantity to ensure that 100 percent of the bonding area of the pavement markers shall be in contact with the adhesive. The adhesive shall be applied in accordance with the manufacturer's recommendations.

Pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.

When deemed necessary by the Engineer or designated representative, the Contractor, at his expense, shall place any additional pilot markings required to facilitate the placement of the permanent markings in the alignment specified. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway. Materials used for pilot markings and equipment used to place such markings shall be approved by the Engineer or designated representative.

863.7 Measurement

Reflectorized Pavement Marker will be measured as per each, complete in place.

863.8 Payment

Payment will be made at the unit bid price per each. The price shall include full compensation for all work performed and all materials furnished in constructing, transporting and placing the markers.

Payment will be made under:

Reflectorized Pavement Markers (Type I-A) -	Per Each.
Reflectorized Pavement Markers (Type I-C) -	Per Each.
Reflectorized Pavement Markers (Type II-A-A) -	Per Each.
Reflectorized Pavement Markers (Type II-B-B) -	Per Each.
Reflectorized Pavement Markers (Type II-C-R) -	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 863 " Reflectorized Pavement Markers"

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 611-J	Adhesion Test For Traffic Buttons, Markers, and Jiggle Bars
Tex-729-I	Sampling of Traffic Markers
Tex-842-B	Method for Measuring Retroreflectivity
Tex-846-B	Method of Testing The Heat Resistance of Reflector Units

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-4210	Pavement Markers (All Weather Reflectorized

City of Round Rock Standard Specifications

Designation	Description
Item No. 867	Epoxy Adhesive
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8`	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

RELATED CROSS REFERENCE MATERIALS
Specification Item 863 "Reflectorized Pavement Markers"

City of Round Rock Standard Specifications

Designation	Description
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markings
Item No. 873	Raised Pavement Markers

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 666	Reflectorized Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

ITEM NO. 864
ABBREVIATED PAVEMENT MARKINGS

864.1 Description

This item shall govern the placement, maintenance and removal of temporary abbreviated markings, which are to be placed on all roadways, that are open to traffic and that do not have standard markings in place.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

864.2 Submittals

The submittal requirements of this specification item include:

A. Specific applications and color of traffic markings.

B. Specific manufacturer with test results and technical specifications.

C. Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.

864.3 Materials

The pavement-marking material shall consist of an adhesive-backed reflective tape, which can be applied to the pavement. Markings shall be of good appearance, have straight, unbroken edges and have a color that complies with all federal regulations.

A. **Color**

The markings, as well as retroreflected light from the markings, shall be white or yellow as indicated on the Drawings or provided in writing by the Engineer or designated representative.

B. **Visibility**

The pavement markings (during daylight hours) shall be distinctively visible for a minimum of 300 feet (90 meters) unless sight distance is restricted by geometric roadway features.

The pavement markings (when illuminated by automobile low beam headlights at night) shall be distinctively visible for a minimum of 160 feet (48 meters) unless sight distance is restricted by geometric roadway features.

The day and night visibility requirements, which are specified above, shall be met when viewed from an automobile traveling on the roadway.

864.4 Construction Methods

The Contractor shall use a crew experienced in the work of installing pavement markings and in the necessary traffic control for such operations on the roadway surface and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the pavement markings as indicated on the Drawings or as directed by the Engineer or designated representative. All work shall conform to the

current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD) and the City of Round Rock Transportation Criteria Manual.

Abbreviated markings, which meet all specification requirements, shall be in place on all roadways on which traffic is allowed and where suitable standard pavement marking is not in place. The transverse location of the line(s) formed by the markings shall be as indicated on the Drawings or determined by the Engineer or designated representative.

Unless otherwise indicated, the abbreviated makings shall be placed as follows:

Condition	Spacing	Length of Stripe
Straight	20 feet (6 meters) approximately	24 inch (600 mm)
Curve greater than 2 degrees	20 feet (6 meters) maximum	24 inch (600 mm)
Curve less than or equal 2 degrees	10 feet (3 meters)	24 inch (600 mm)

Pavement markings shall be a minimum of 3 7/8 inches (100 millimeters) wide. Lengths and spacings will be in accordance with these specifications.

The spacing of stripes may be modified by the Engineer or designated representative. However, the maximum spacing specified above shall not be exceeded in any case.

The Contractor will be responsible for maintaining the abbreviated pavement markings until standard pavement markings are in place.

Abbreviated pavement markings shall be removed after all permanent markings have been placed.

864.5 Performance

Installed abbreviated pavement markings shall meet all requirements of this specification for a minimum of seven (7) days after installation of the abbreviated markings is complete. Pavement markings that fail to meet all requirements of this specification shall be removed and shall be replaced at the sole expense to the Contractor with pavement markings that meet the requirements of this specification.

864.6 Measurement and Payment

Abbreviated pavement markings will not be measured and payment will be considered subsidiary to the various pavement items indicated on the drawings.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 864 "Abbreviated Pavement Markings

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

RELATED CROSS REFERENCE MATERIALS
Specification Item 864 "Abbreviated Pavement Markings"

City of Round Rock Standard Specifications

Designation	Description
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 872	Prefabricated Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 662	Work Zone Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

ITEM NO. 865
NON-REFLECTORIZED TRAFFIC BUTTONS

865.1 Description

This item shall govern furnishing of "Non-Reflectorized Traffic Buttons" complete in place in conformity with details indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

865.2 Submittals

The submittal requirements of this specification item include:

A. Specific applications and color of traffic buttons.

B. Specific manufacturer with test results and technical specifications for proposed traffic buttons.

C. Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.

D. Applicable epoxy system and adhesive types [867.5], adhesive components and mixing recommendations.

865.3 Materials

The outer surface of the button shall be round and dome-shaped with a uniform curvature. The topsides of the buttons shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration and any other defects, which adversely affect appearance and application.

The bottom surface of the markers shall be of a design for adhesion with epoxy adhesives conforming to Item No. 867, "Epoxy Adhesive" and shall be rough textured, free from gloss, glaze or any other substance that may reduce its bond to the adhesive. The buttons shall be made of a ceramic material meeting the following specifications:

A. **Glaze Thickness**

The glazed surface shall have a mean thickness of not less than 0.005 inch (125 µm) when measured not closer than 1/4 inch (6.5 millimeters) from the edge of the button. The glaze thickness shall be measured on a fractured edge of the button to the nearest 0.001 inch (25 µm) by a calibrated scale microscope.

B. **Water Absorption**

The water absorption of the button shall not exceed 1.0 percent of the original dry weight (mass) when tested in accordance with ASTM Designation: C 373.

C **Autoclave Test**

The glazed surface of the button shall not craze, spall or peel when subjected to one cycle of the Autoclave Test at 250 psi (1725 kPa) in accordance with the procedures of ASTM Designation: C 424.

D. **Color**

The color of the buttons shall be determined by visual comparison with calibrated standards having C.I.E. Chromaticity Coordinated limits determined in accordance with Federal Methods of Tests TT-T-141, Method 4252 falling within an area having the following corner points:

	1		2		3		4		Brightness
	x	y	x	y	x	y	x	y	(%MgQ)
White	.290	.316	.310	.296	.330	.321	.310	.342	80 min
Yellow	.453	.456	.472	.423	.544	.456	.516	.484	40 min

865.4 Testing

Testing will be in accordance with the TXDOT manual of Testing Procedures. Results of appropriate tests shall be furnished by the Contractor when required by the Engineer or designated representative. Applicable tests shall include the following:

Tex-611-J (adhesion requirements)

Federal methods TT-T141A, Method 4252 (color requirements)

ASTM Designation: C 373 (water absorption)

ASTM Designation: C 424 (autoclave test)

The Engineer or designated representative shall inspect and reject any buttons that are cracked, chipped, or otherwise damaged prior to acceptance.

865.5 Construction Method

The Contractor shall use a crew experienced in the work of installing traffic buttons and in the necessary traffic control for such operations on the roadway surface and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the traffic buttons as indicated on the Drawings or as directed by the Engineer or designated representative. All work shall conform to the current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD) and the City of Round Rock Transportation Criteria Manual.

The traffic buttons shall be placed in accordance with the Drawings or as directed by the Engineer or designated representative. The portion of the highway surface to which the button is attached by the adhesive shall be prepared by any method approved by the Engineer or designated representative in order to be free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement and any other material which would adversely affect the bond of the adhesive. The wet epoxy shall be applied in sufficient quantity so as to insure the following:

A. 100 percent of the bonding area of the button shall be in contact with epoxy.

B. The button itself shall not contact the pavement but shall sit on the epoxy "cushion".

C. When the button is pressed onto the pavement, adhesive shall be forced out around its entire perimeter.

Unless indicated otherwise on the Drawings, the epoxy adhesive shall be machine mixed and applied in accordance with the manufacturer's recommendations.

Any excess adhesive or other foreign material on or in front of the reflective face(s) of the button shall be removed so that reflectivity will not be impaired.

When the project is complete, the button shall be firmly bonded to the pavement, lines formed by the buttons shall be true and the entire installation shall present a neat appearance. Any individual button placed that does not conform to the requirements of this specification and/or plans shall be removed and replaced with buttons conforming to these requirements at the Contractors' expense.

865.6 Measurement

Non-Reflectorized Traffic Buttons will be measured per each, complete in place.

865.7 Payment

Payment will be made at the unit bid price per each traffic button of the color and material specified. The price shall include full compensation for all work performed and all materials furnished in constructing, transporting and placing the buttons.

Payment will be made under:

Non-Reflectorized Traffic Buttons; _____ in color of _____ material -Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 865 "Non Reflectorized Traffic Buttons

City of Round Rock Standard Details

Designation	Description
865-1	Traffic Buttons (Non-Reflectorized)

City of Round Rock Specifications

Designation	Description
Item No. 867	Epoxy Adhesive

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 611-J	Adhesion Test For Traffic Buttons, Markers, and Jiggle Bars

American Society for Testing and Materials (ASTM)

Designation	Description
C 373	Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
C 424	Test Method for Crazing Resistance of Fired Whitewares by Autoclave Treatment

Federal Specifications

Designation	Description
Federal methods	TT-T141A, Method 4252 (color requirements)

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part IIIMarkings	
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

RELATED CROSS REFERENCE MATERIALS
Specification Item 865 "Non Reflectorized Traffic Buttons"

City of Round Rock Standard Specifications

Designation	Description
Item No. 873	Raised Pavement Markers
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

ITEM NO. 866
Jiggle Bar Tile

866.1 Description

This item shall govern the materials, composition, quality, sampling and testing of jiggle bar tile of either ceramic or plastic resin body construction, reflectorized or nonreflectorized types as described herein.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

866.2 Submittals

The submittal requirements of this specification item include:

A. List of specific application(s) [i.e. designation and type: (reflectorized Type I-A, I-C or II-A-A; nonreflectorized-Type W or Y)] and applicable epoxy system and adhesive types [Standard Specification Item Section 867.5].

B. Specific manufacturer with test results and technical specifications for proposed jiggle bar tile

C. Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.

D. Adhesive components and mixing recommendations.

866.3 Materials

Jiggle bar tiles shall be either ceramic body or plastic resin body construction and shall be either reflectorized or nonreflectorized as indicated on the Drawings. Jiggle bar tiles furnished for any one project shall be of the same material and manufacturer. The Jiggle Bar Tile shall comply with TxDOT Departmental Materials Specifications DMS-4100.

A. Types of Jiggle Bar Tile

1. Reflectorized jiggle bar tiles shall be of the following types:

(a) Type I-A shall contain an approach face that reflects amber light and the body other than the reflective face shall be yellow.

(b) Type I-C shall contain an approach face that reflects white light. The body, other than the reflective face, shall be white.

(c) Type II-A-A shall contain 2 reflective faces (approach and trailing) each of which shall reflect amber light. The body, other than the reflective faces, shall be yellow. The direction of the reflection of the trailing face shall be directly opposite to the direction of reflection of the approach face.

2. Nonreflectorized jiggle bar tiles shall be of the following types:

(a) Type W shall have a white body.

(b) Type Y shall have a yellow body.

B. Appearance Requirement

The top and sides of the jiggle bar tile shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration and any other defects which adversely affect appearance and application.

The bottom of the jiggle bar tile may be of a rough texture, free from gloss, glaze or any other substance that may reduce its bond to the adhesive. It shall be shaped such that any air, which may be entrapped during installation, will not impair adhesion. Exclusive of any irregularities that are intentionally manufactured as functional characteristics of the tile, the bottom shall not deviate from a true plane by more than 1/16 inch (1.5 mm).

C. Color Requirements

The diffuse day color shall comply with the specified color requirements. Color requirements are defined by an enclosed area formed by using the following CIE Chromaticity Coordinates as corner points and the listed Y reflectance limits.

CHROMATICITY COORDINATES AND REFLECTANCE LIMITS			
Color	Chromaticity Points		Reflectance Limits
	x	y	y
White	0.290	0.316	70 minimum
	0.310	0.296	
	0.330	0.321	
	0.310	0.342	
Yellow	0.448	0.455	38.0 - 60.
	0.468	0.420	
	0.544	0.456	
	0.516	0.484	

Individual yellow jiggle bar tiles in any shipment or lot shall not have a variance in chromaticity coordinates x and y greater than 0.025 units nor shall the variance in reflectance exceed 6.0 units. Color shall be determined in accordance with TxDOT Test Method Tex-839-B.

D. Optical Requirements for Reflectorized Jiggle Bar Tiles

1. Reflective Device(s)

Reflective jiggle bar tiles shall have an approved reflective device(s) inserted in a protective ramp and adhered to a recess in the ramp base. The reflective device(s) shall be as indicated on the Drawings.

2. Optical Performance

The reflective device(s) shall be capable of providing reflection of amber, red or white light as indicated. The reflective light of each reflective face shall conform to the minimum reflective intensity requirements as follows:

Specific Intensity per Reflective Face At 0.2 Degrees Observation Angle		
Horizontal Entrance Angle	Crystal	Amber
4 Degrees	3.00	2.00
20 Degrees	1.50	1.00

Horizontal entrance angle shall mean the angle, in a plane parallel to the base of the marker, between a line in the direction of the incident light and a line perpendicular to the leading edge of the reflective surface.

Observation angle shall mean the angle at the reflector between observer's line of sight and the direction of the light incident on the jiggle bar tile.

Specific intensity shall mean candlepower of the returned light at the chosen observation and entrance angles for each foot-candle of incident light per reflective face. TxDOT Test Method Tex-842-B will be used to determine specific intensity.

E. Physical Requirements for Ceramic Jiggle Bar Tiles

1. Appearance

The top and sides of the ceramic jiggle bar tile shall be smooth and free from surface irregularities, pits, cracks, checks, chipping, discoloration and any other defects which adversely affect appearance and application.

The bottom of the ceramic jiggle bar tile may be of a rough free from gloss, glaze or any other substance that may reduce its bond to the adhesive. Excluding any protrusions, which are intentionally manufactured as functional characteristics of the jiggle bar tile, the base shall not deviate from a true plane by more than 1/16 inch (1.6 mm).

2. Glaze Thickness

The glazed surface shall have a mean thickness not less than 0.005-inch (125-mm) when measured not closer than 1/4-inch (6.5-mm) from the edge of the jiggle bar tile. The thickness shall be measured on a fractured edge with a calibrated scale microscope.

3. Autoclave

The ceramic glaze shall not discolor, craze, spall or peel when subjected to 1 cycle of the autoclave test ASTM Designation: C-424 at 250 psi (1.725 mPa).

4. Water Absorption

The water absorption of the jiggle bar tile shall not exceed 1.0 percent of the original dry weight when tested in accordance with ASTM Designation: C-373. Specimens may be broken pieces taken from the strength test.

5. The compressive strength of ceramic tiles shall be as follows:

(a) 6000 psi (41.4 mPa), minimum average of 5 units.

(b) 5000 psi (34.5 mPa), minimum for any individual unit.

Compressive strength shall be determined on a 1 inch (25 mm) diameter right cylinder test specimen cut through the center portion of the tile by core drilling. Specimen ends shall be ground or lapped to form plane and parallel faces. The faces shall be capped with high strength capping compound to make them perpendicular to the axis of the specimen. The specimen shall be loaded in accordance with TxDOT Test Method Tex-418 A.

6. Adhesion

The ceramic jiggle bar tile shall be tested in accordance with TxDOT Test Method Tex-611-J. Unless otherwise specified, the following shall be the criteria for acceptance:

The 5 specimens tested must evidence a minimum average bond strength of 500 psi (3.45 mPa). In addition, no more than 1 individual specimen may evidence a bond strength less than 500 psi (3.45 mPa). If the average bond strength is less than 500 psi (3.45 mPa) or 2 or more individual specimens evidence a bond strength less than 500 psi (3.45 mPa), the lot represented by the samples shall be rejected.

F. Physical Requirements of Plastic Resin Jiggle Bar Tiles

1. Appearance

Plastic jiggle bar tiles may contain inert fillers and coloring pigments. Except for the base filler, the plastic jiggle bar tile shall be of the same material throughout.

2. Hardness

Plastic jiggle bar tiles shall have a Shore Durometer Hardness (Type D) of 70 minimum conforming to ASTM Designation: D-2240.

3. X-Ray Analysis

Plastic jiggle bar tiles shall match the X-ray analysis of previously approved jiggle bar tiles.

4. Infrared Analysis

Plastic jiggle bar tiles shall match the infrared analysis of previously approved jiggle bar tiles.

5. Adhesion

   Plastic jiggle bar tiles shall meet the same requirements as ceramic jiggle bar tile unless otherwise specified or indicated on the Drawings.

866.4 Construction Methods

The Contractor shall use a crew experienced in the work of installing jiggle bar tile and in the necessary traffic control for such operations on the roadway surface and shall supply all the equipment, personnel, traffic control and materials necessary for the placement of the pavement markings as indicated or as directed by the Engineer or designated representative. All work shall conform to the current edition of the Texas Manual of Uniform Traffic Control Devices (TMUTCD) and the City of Round Rock Transportation Criteria Manual.

The jiggle bar tile shall be installed to the lines and spacings where indicated on the Drawings or as directed by the Engineer or designated representative. Guides to mark the lateral location of jiggle bar tile shall be established as indicated on the Drawings or as directed by the Engineer or designated representative. The Contractor will establish the pavement marking guides and the Engineer or designated representative will verify the location of the guides prior to final installation.

The pavement markers shall be placed in proper alignment with the Guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet (25 millimeters per 60 meters) of roadway. The maximum deviation shall not exceed 2 inches (50 millimeters) nor shall any deviation be abrupt.

Markers placed which are not in alignment indicated on the Drawings shall be removed by the Contractor at the Contractor's expense. Removal shall be in accordance with Specification Item 874 except for measurement and payment. Guides placed on the roadway for alignment purposes shall not establish a permanent marking on the roadway.

When deemed necessary by the Engineer or designated representative, the Contractor, at his expense, shall place any additional pilot markings required to facilitate the placement of the permanent markings in the alignment specified. Any and all additional markings placed on the roadway for alignment purposes shall be temporary in nature and shall not establish a permanent marking on the roadway. Materials used for pilot markings and equipment used to place such markings shall be approved by the Engineer or designated representative.

The surface on which tiles are to be placed shall be dry and shall be prepared by any method approved by the Engineer or designated representative to remove all forms of grease, oil, dirt and other materials deleterious to proper adhesion. Unless indicated otherwise on the Drawings, surface preparation for installation of jiggle bar tile will not be paid for directly but shall be considered subsidiary to this specification item.

Epoxy adhesive shall conform to the requirements of City of Round Rock Specification Item 867. The wet epoxy shall be machine mixed and applied in sufficient quantity so as to insure the following:

100 percent of the bonding area of the tile shall be in contact with the epoxy.

The tile itself shall not contact the pavement surface but shall sit on an epoxy "cushion".

When the tile is pressed onto the pavement, adhesive shall be forced out around its entire perimeter.

Any excess adhesive or other foreign material on or in front of the reflective face(s) of the tile shall be removed so that reflectivity will not be impaired. Any individual jiggle bar tile placed that does not conform to the requirements of this specification and/or as indicated on the Drawings shall be removed and replaced with tile conforming to these requirements at the Contractor's expense.

866.5 Measurement

Jiggle Bar Tile will be measured as each jiggle bar tile complete in place.

866.6 Payment

The work performed under this item and measured as provided under "Measurement" shall be paid for at the unit bid price for "Jiggle Bar Tile", of the type, color and material specified on the Drawings. The unit bid price shall include full compensation for all labor, materials, incidentals and services necessary to complete the work.

Payment will be made under one of the following:

Jiggle Bar Tile (Type I-A) -	Per Each.
Jiggle Bar Tile (Type I-C) -	Per Each.
Jiggle Bar Tile (Type II-A-A) -	Per Each.
Jiggle Bar Tile (Type W) -	Per Each.
Jiggle Bar Tile (Type Y) -	Per Each.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 866 “Jiggle Bar Tile”

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-418-A	Compressive Strength of Cylindrical Concrete Specimens
Tex-611-J	Adhesion Test For Traffic Buttons, Markers, And Jiggle Bars
Tex-839-B	Method for Determining Color In Reflective Materials
Tex-842-B	Method For Measuring Retroreflectivity

American Society for Testing and Materials (ASTM)

Designation	Description
C-373	Test Method for Water Absorption, Bulk Density, Apparent Porosity, and Apparent Specific Gravity of Fired Whiteware Products
C-424	Test Method for Crazing Resistance of Fired Glazed Whitewares by Autoclave Treatment
D-2240	Test Method for Rubber Property-Durometer Hardness

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-4100	Jiggle Bar Tile

RELATED CROSS REFERENCE MATERIALS
Specification Item 866 “Jiggle Bar Tile”

City of Round Rock Standard Specifications

Designation	Description
Item No. 867	Epoxy Adhesive
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

City of Round Rock Standard Specifications

Designation	Description
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 873	Raised Pavement Markers

RELATED CROSS REFERENCE MATERIALS - continued
Specification Item 866 “Jiggle Bar Tile”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 575	Epoxy
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature

Item No. 867
Epoxy Adhesive

867.1 Description

This item shall govern the various types of epoxy materials suitable for the construction and maintenance of streets and roads indicated on the Drawings or considered in the Item.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, the inch-pound units are given preference followed by SI units shown within parentheses.

All of these materials shall consist of a resin component and a hardener component, which must be mixed immediately prior to use to produce the finished epoxy. Unless otherwise indicated on the Drawings, these materials should not be used if the substrate temperature is below 50ºF (10ºC). The specific materials covered by this item are as follows:

A. Traffic marker adhesives
B. Concrete adhesives
C. Binder for epoxy grout or concrete
D. Epoxy for crack injection
E. Epoxy coating for concrete
F. Surface sealing of cracks

867.2 Submittals

The submittal requirements of this specification item include:

A. List of specific application(s) [i.e. items A through F in Section 867.1] and applicable epoxy system and adhesive types [Section 867.5].

B. Manufacturer's recommendations for surface preparation, cleaning, placement temperatures and installation instructions.

C. Adhesive components and mixing recommendations.

867.3 Epoxy Materials Requirements

A. General

Epoxy materials described herein shall be in accordance with TxDOT Departmental Material Specification DMS-6100. Additional information regarding epoxy characteristics and copies of specification DMS-6100 are available from the TxDOT Materials and Tests Division, 125 East 11th Street, Austin, Texas 78701-2483.

B. Packaging, Labeling and Storage

The components shall be packaged in suitable, well-sealed containers clearly labeled as to the type material and the ratio of the components to be mixed by volume. Any special instructions regarding mixing shall be included. The label shall show resin or hardener component, the brand name, name of manufacturer,

lot or batch number, date of packaging and the quantity contained therein. Caution warnings regarding contact of the epoxy with skin and eyes, shelf life and vapor warning must be included on the labels.

The epoxy components must be stored at temperatures between 60ºF and 100ºF (16ºC and 38º C). Any material which shows evidence of crystallization, lumps, skinning, extreme thickening or settling of pigments which cannot be readily redispersed with normal agitation shall not be used.

C. Mixing

Prior to use, each component shall be stirred to re-disperse any settling or separation of the fillers and liquid portions. The components shall then be placed immediately in the proper reservoir when used in automatic mixing and dispensing equipment. For application by other means, the components must be properly proportioned and mixed until a uniform color and appearance are obtained. Unless otherwise indicated by the manufacturer or approved by the Engineer, or designated representative no addition of solvents is allowed.

867.4 Application and Surface Preparation

Requirements on application and preparation of the surface upon which the epoxy is to be placed shall be in accordance with manufacturer's recommendation and applicable specification items.

867.5 Epoxy System

The various types of materials and their intended use are described below.

A. Traffic Marker Adhesive System

This system consists of five basic types of epoxy adhesive for bonding ceramic, plastic or metal traffic markers to roadway, bridge, or other concrete surfaces.

1. Types I and I-M

   Rapid Setting Marker Adhesive for use when a very fast set is required or if markers must be placed when pavement temperature is below 50ºF (10ºC).

2. Types II, II-M and II-MA

   Medium Setting Marker Adhesive

3. Types III and III-M

   Standard Setting Marker Adhesive

4. Types IV and IV-M

   Slow Setting Marker Adhesive for use where setting time is not a consideration.

Those adhesives designated as Types I through IV are intended for hand mixing and application. On projects where the adhesive is to be handled by automatic metering, mixing and application equipment, Types I-M through IV-M, which are

designed specifically for machine application, shall be used. Type II- MA adhesive is designed for placement of all-weather markers. For all types of marker adhesives, the resin component shall be pigmented white and the hardener component black.

The type of adhesive to be used for placing ceramic or plastic markers on a specific project shall be designated by the Contractor and approved by the Engineer or designated representative, based upon the setting time required under the prevailing weather and traffic conditions.

B. Concrete Adhesives System

This system consists of three types of epoxy adhesive with different viscosities designed to bond fresh Portland Cement concrete to existing Portland Cement concrete, hardened concrete to hardened concrete and steel to fresh or hardened concrete.

1. Type V

   Standard (medium viscosity) for applying to horizontal and vertical surfaces. This material is suitable for surface sealing of fine cracks in concrete and setting of dowels in accordance with Specification Item 410, "Concrete Structures".

2. Type VI

   Low viscosity for application with spray equipment to horizontal surfaces.

3. Type VII

   Paste consistency for overhead application and where a high build-up is required. This material is suitable for surface sealing of cracks in concrete, which are veed out prior to sealing and for grouting of dowel bars where clearance is 1/16 inch (1.5 mm) or less.

   Any specific coloring of resin and hardener components shall be as directed by the Engineer or designated representative.

C. Epoxy Binder System (Type VIII)

This system is intended for mixing with selected aggregates to produce an epoxy mortar or concrete for grouting dowel bars or repairing spalls and other defects in existing Portland cement concrete. Type VIII shall comply with the requirements for Type VI epoxy except that the mixing ratio of resin and hardener shall be as specified by the manufacturer and the requirement for ability to bond fresh Portland cement concrete to hardened concrete does not apply.

The aggregates used with the epoxy binder to form the epoxy mortar or concrete must be clean and surface dry. Siliceous aggregates are required unless otherwise approved by the Engineer or designated representative.

D. Crack Injection (Type IX)

This system is a low viscosity epoxy material designed for pressure injection into cracks in existing concrete to restore the structural integrity. The system shall be capable of bonding to damp surfaces.

E. Epoxy Coating (Type X)

This is a high-solids epoxy used for waterproofing columns, caps, etc. The material is designated for application by brush or roller, but can also be applied by airless spray by addition of a maximum of 5 percent toluene solvent at the direction of the Engineer or designated representative. This material may also be used to coat the interior concrete block walls and as a coating for concrete picnic tables and benches.

867.6 Measurement and Payment

The work performed, the materials furnished and all labor, tools, equipment and incidentals necessary to complete the work under this item will not be measured or paid directly, but will be considered subsidiary to the particular bid items indicated on the Drawings or included in the Contract.

End

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item 867 "Epoxy Adhesive”

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-6100	Epoxy Materials

City of Round Rock Standard Specifications

Designation	Description
Item No. 401	Concrete Structures

RELATED CROSS REFERENCE MATERIALS
Specification Item 867 "Epoxy Adhesive”

City of Round Rock Standard Specifications

Designation	Description
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markings
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markers
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 575	Epoxy
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature

RELATED CROSS REFERENCE MATERIALS Continued
Specification Item 867 "Epoxy Adhesive"

American Society for Testing and Materials (ASTM)

Designation	Description
D-362	Specification for Industrial Grade Toluene

City of Round Rock Transportation Criteria Manual

Designation	Description
Section 8	Traffic Control

State of Texas Manual on Uniform Traffic Control Devices for Streets and Highways

Designation	Description
Part III	Markings
Part VI	Traffic Controls for Street and Highway Construction, Maintenance, Utility and Incident Management Operations
Part VI, Article D	Markings
Part VI, Article F	Control of Traffic Through Work Areas

ITEM NO. 870
WORK ZONE PAVEMENT MARKINGS

870.1 Description

This item shall govern the placement and maintenance of work zone pavement markings of the colors, types and sizes indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, inch-pound units are given preference followed by SI units shown within parentheses.

870.2 General

Work zone pavement markings shall consist of guide marks, short-term markings and/or standard pavement markings. Existing markings are considered to be any standard pavement markings in place at the time of commencement of the Work. All streets, which are to be opened to traffic, shall be marked with short-term markings or standard markings, as shown on the Drawings, at the end of each day of operation.

When inclement weather prohibits the application of short-term markings or standard markings indicated on the Drawings, guide marks may be considered as temporary short-term markings for asphaltic surfaces, upon approval by the Engineer. The placement of pavement markings as shown on the Drawings may be delayed until the time that weather conditions allow the application of pavement markings.

870.3 Materials

All non-removable markings shall be thermoplastic, unless otherwise indicated on the Drawings. Thermoplastic markings shall have a thickness of 90 mils (2.3 millimeters) unless indicated otherwise on the Drawings. All non-removable work zone markings shall conform to the requirements of Specification Item 871, “Reflectorized Pavement Markings”, except for Section 871C.5, ‘Performance Period for Type I Markings’, Section 871C.6, ‘Measurement and Section 871C.7, ‘Payment’.

Thermoplastic or paint and beads applications shall not be used for removable markings.

Unless otherwise shown on the Drawings or indicated in the Contract Documents:

> The Contractor shall have the option to use raised pavement markers to simulate standard markers in accordance with the Drawings. Longitudinal lines wider than four (4) inches {100 millimeters} may be simulated by the side-by-side placement of markers to increase the apparent line width in multiples of four (4) inches {100 millimeters}.

Removable work zone pavement markings on final pavement surfaces shall be removable tape conforming to TxDOT Departmental Materials Specification DMS-8241.

When raised reflective pavement markers are required on the Drawings to supplement the removable pavement markings, a marker shall be applied to the top of the tape at the approximate mid-length of tape used for broken lines and at approximate 20 foot (6 meter) spacing for solid lines.

Raised pavement markers will not be allowed for words, symbols, shapes and diagonal or transverse lines.

The paint shall be water-based and shall conform to Standard Specification Item 860, “Pavement Marking Paint”.

The beads shall conform to Standard Specification Item 860, “Pavement Marking Paint”.

The thermoplastic type materials shall conform to TxDOT Departmental Materials Specification Item DMS-8220, “Thermoplastic Pavement Markings”.

870.4 Performance Requirements

The markings in construction areas shall remain in proper alignment and shall be distinctly visible when dry from a minimum distance of 300 feet (90 meters) in daylight hours and distinctly visible from a minimum distance of 120 feet (36 meters) at night, when illuminated by automobile low-beam headlights. The visibility distances will be determined when viewed from an automobile traveling on the street.

The daytime color and the nighttime reflected color of the markings shall be distinctly white or yellow as shown on the Drawings. The markings shall exhibit uniform retroflective characteristics.

870.5 Construction Methods

A. Placement and Maintenance.

The Contractor shall exercise due diligence in the selection of materials and placement of work zone pavement markings. The Contractor at its own expense shall maintain work zone pavement markings to the satisfaction of the Engineer or designated representative in accordance with this Specification Item.

Unless approved otherwise in writing by the Engineer or designated representative, all Portland cement concrete surfaces shall have standard markings in place prior to opening to traffic.

All asphaltic surfaces, which are scheduled for opening to traffic, shall be marked with guide marks immediately following placement and final rolling of any course. Guide marks shall consist of a single temporary flexible-reflective street marker tab or a single temporary construction raised reflective pavement marker at 40-foot (12-meter) spacing.

Guide marks shall be placed in proper alignment with the final location of future standard markings. Any guide marks, which are not in alignment with standard markings, shall be removed by the Contractor at its own expense.

The standard pavement markings shall be installed in accordance with the Texas Manual on Uniform Traffic Control Devices for Streets and Highways (TMUTCD) and as shown on the Drawings.

Surfaces to receive surface treatments (Standard Specification Item 320) shall be marked in accordance with the Drawings. Unless otherwise shown on the Drawings, the standard pavement markings shall be placed in accordance with TMUTCD, no sooner than three (3) days nor later than two (2) weeks after the placement of the surface treatment.

Short- term markings required by the Drawings shall conform to the TMUTCD and details shown on the Drawings. Unless otherwise shown on the Drawings, short-term markings shall be removed immediately prior to placement of the final pavement markings.

B. Marking Removal.

Any work zone pavement markings placed by the Contractor that conflict with any succeeding work zone markings shall be removed by the Contractor at its own expense in accordance with Specification Item 874, "Eliminating Existing Pavement Markings and Markers", except for measurement and payment.

Removable marking materials shall leave minimal evidence of the existence of the marking upon removal.

C. Maintenance of Markings

The Contractor shall be responsible for maintaining all work zone pavement markings in accordance with this specification item, at its own expense, to the satisfaction of the Engineer or designated representative.

870.6 Measurement

This Standard Specification Item will be measured by the lineal foot (lineal meter: 1 lineal meter is equal to 3.281 lineal feet) of standard marking or short-term marking, by each guide mark, by each word, shape or symbol, by each temporary flexible-reflective street marker tab on surface treatments or by any other unit as shown on the Drawings. Raised pavement markers used to simulate a stripe will be measured by the lineal foot (lineal meter) of simulated stripe or each raised pavement marker as shown on the Drawings. Where double stripes are placed, each stripe will be measured separately.

When quantities are revised by a change in design, the "Plan Quantity" will be increased or decreased by the amount involved in the design change.

Payment for revised quantities will be paid for at the unit price bid for that bid item.

870.7 Payment

The work performed and materials furnished in accordance with this Standard Specification Item and measured as provided under "Measurement" will be paid for at the Unit bid price for "Work Zone Pavement Markings (Removable)", "Work Zone Pavement Markings (Non-removable)", "Work Zone Pavement Markings (Short-Term)" and "Work Zone Pavement Markings (Guide mark)" of the width, color and type shown on the Drawings. This price shall include full compensation for furnishing all materials, labor, tools, equipment and incidentals necessary to place, maintain and remove, when required, the markings, except as described below.

Removal of existing markings will be paid for under Specification Item 874, "Eliminating Existing Pavement Markings and Markers".

Final work zone pavement markings (paint and beads) which will be used within 30 calendar days after application as a sealer for Type I pavement markings will not be paid for under this Specification Item, but will be paid for under Specification Item 871, "Reflectorized Pavement Markings".

Payment will be made under one or more of the following:

Work Zone Pavement Markings (Removable),
___inches in width, _____ in color per lineal foot.

Work Zone Pavement Markings (Non-removable),
___inches in width, _____ in color per lineal foot.

Work Zone Pavement Markings (Short Term),
___inches in width, _____ in color per lineal foot.

Work Zone Pavement Markings (Guide mark),
___inches in width, _____ in color per lineal foot.

Work Zone Pavement Marking (Removable), Words
per each.

Work Zone Pavement Marking (Removable), Symbols
per each.

Work Zone Pavement Marking (Non-removable), Words
per each.

Work Zone Pavement Marking (Non-removable),Symbols
per each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification 870, “Work Zone Pavement Markings

City of Round Rock Standard Specifications

Designation	Description
Item No. 320	Two Course Surface Treatment
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 871	Reflectorized Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers

RELATED CROSS REFERENCE MATERIALS
Specification 870, “Work Zone Pavement Markings

City of Round Rock Standard Specifications

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 413	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markers
Item No. 875	Pavement Surface Preparation For Markings

RELATED CROSS REFERENCE MATERIALS - continued
Specification 870, “Work Zone Pavement Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-729-I	Sampling of Traffic Markers
Tex-732-I	Sampling of Prefabricated Pavement Marking Materials
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

RELATED CROSS REFERENCE MATERIALS - Continued
Specification 870, “Work Zone Pavement Markings

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT-10	Pavement Paint

ITEM NO. 871
REFLECTORIZED PAVEMENT MARKINGS

871.1 Description

This item shall govern furnishing and placement of reflectorized pavement markings of the colors, types, shapes, sizes, widths and thickness indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text and accompanying tables, the inch-pound units are given preference followed by SI units shown within parentheses.

871.2 Materials

A. Type I Marking Material.

Type I markings are thermoplastic type materials that require heating to elevated temperatures for application. Type I marking materials shall conform to TxDOT Departmental Materials Specification Item DMS-8220, “Thermoplastic Pavement Markings”. Each container of Type I Marking Material shall be clearly marked to indicate the color, weight (mass), type of material, manufacturer’s name and lot/batch number.

B. Type II Marking Material.

Type II markings are paint- type materials that are applied at ambient temperature or slightly elevated temperatures. Type II marking materials shall conform to Specification Item No. 860, “Pavement Marking Paint”.

871.3 Equipment Requirements

The equipment used to place pavement markings shall:

A. be maintained in satisfactory operating condition;

B. be considered in satisfactory operating condition if it has an average placement rate of 5,000 lineal feet (1,525 lineal meters) per hour of acceptable four (4) inch (100 millimeters) solid or broken lines over any five (5) consecutive working days;

C. meet or exceed the material handling at elevated temperature requirements of the National Fire Underwriters and the Texas Railroad Commission;

D. be capable of placing a minimum of 40,000 lineal feet (12,190 lineal meters) of 4 inch (100 millimeters) solid or broken markings per day;

E. have production capabilities similar to four-inch (100 millimeters) marking equipment and shall be capable of placing linear markings up to 8 inches (200 millimeters) in width in a single pass when used for placing markings in widths other than 4 inches (100 millimeters);

F. have production capabilities considered satisfactory by the Engineer or designated representative, when used to place markings other than solid or broken lines;

G. be capable of placing a centerline and no-passing barrier-line configuration consisting of one broken line with two solid lines at the same time to the alignment and spacing shown on the Drawings;

H. be capable of placing broken and/or continuous white line from both sides;

I. be capable of placing lines with clean edges and of uniform cross-section. All lines shall have a tolerance of plus or minus 1/8 inch per 4-inch width (3 mm per 100-mm width);

J. have an automatic cut-off device with manual operating capabilities to provide clean, reasonably square marking ends to the satisfaction of the Engineer, and to provide a method of applying broken line in an approximate stripe-to-gap ratio of 10 to 30. The length of the stripe shall not be less than 10 feet (3.05 meters) or more than 10.5 feet (3.2 meters). The total length of any stripe-gap cycle shall not be less than 39.5 feet (12 meters) or more than 40.5 feet (12.3 meters);

K. provide continuous mixing and agitation of the pavement marking material. The use of pans, aprons or similar appliances, which the die overruns, will not be permitted for longitudinal striping applications;

L. apply beads by an automatic bead dispenser attached to the pavement marking equipment in such a manner that the beads re-dispensed uniformly and almost instantly upon the marking as the marking is being applied to the road surface. The bead dispenser shall have an automatic cut-off control, synchronized with the cut-off of the pavement marking equipment.

871.4 Construction Methods

A. General.

When required by the Engineer, the Contractor and the Engineer shall review the sequence of Work to be followed and the estimated progress schedule.

Markings may be placed on streets either free of traffic or open to traffic. On streets already open to traffic, the markings shall be placed under traffic conditions that exist with a minimum of interference to the operation of the facility. Traffic control shall be as shown on the Drawings or as approved in writing by the Engineer or designated representative. All markings placed under open-traffic conditions shall be protected from traffic damage and disfigurement. On streets open to traffic with 3 lanes of travel in one direction, all markings shall be placed from the outside lanes only, unless otherwise approved in writing by the Engineer or designated representative.

Guides to mark the lateral location of pavement markings shall be established as shown on the Drawings or as directed by the Engineer or designated representative. The Contractor shall establish the pavement marking guide and the Engineer or designated representative will verify the location of the guides.

Markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet (25 mm per 60 meters) of street. The maximum deviation shall not exceed 2 inches (50 millimeters) nor shall any deviation be abrupt.

Markings shall essentially have a uniform cross-section. The density and quality of markings shall be uniform throughout their thickness. The applied markings shall have no more than five (5) percent, by area, of holes or voids and shall be free of blisters.

Markings, in place on the street, shall be reflectorized both internally and externally. Glass beads shall be applied to the materials at a uniform rate sufficient to achieve uniform and distinctive retroflective characteristics when observed in accordance with TxDOT Test Method Tex-828-B.

Contractor personnel shall be sufficiently skilled in the Work of installing pavement markings.

Markings placed that are not in alignment or sequence, as shown on the drawings or as stated in the Standard Specification Item, shall be removed by the Contractor at its own expense. Removal shall be in accordance with Specification Item 874, "Eliminating Existing Pavement Markings and Markers", except for measurement and payment. Guides placed on the street for alignment purposes shall not establish a permanent marking on the street.

Unless otherwise shown on the Drawings, pavement markings may be applied by any method that will yield markings meeting the requirements of the Specification Item.

B. Surface Preparation.

New Portland cement concrete surfaces shall be cleaned in accordance with Specification Item 875, "Pavement Surface Preparation for Markings" to remove curing membrane, dirt, grease, loose and/or flaking existing construction markings and other forms of contamination.

Older Portland cement concrete surfaces and asphaltic surfaces that exhibit loose and/or flaking existing markings shall be cleaned in accordance with Specification Item 875, "Pavement Surface Preparation for Markings" to remove all loose and flaking markings.

Pavement to which material is to be applied shall be completely dry. Pavements shall be considered dry if, on a sunny day after observation for 15 minutes, no condensation occurs in the underside of a 1 foot (300 mm) square piece of clear plastic that has been placed on the pavement and weighted on the edges.

C. Application of Type I Markings.

New Portland cement concrete surfaces shall be further prepared for Type I markings, after cleaning, by placing a Type II marking as a sealer in accordance with the Specification Item. When placing Type I markings in new locations on asphaltic surfaces 3 years old or older or any Portland cement concrete surfaces, a Type II marking shall be used as a sealer. Unless otherwise shown on the Drawings, existing Portland cement concrete and asphaltic surfaces to be restriped will not require Type II markings as a sealer; existing markings may be used as a sealer in lieu of Type II markings. Type II markings shall be placed a minimum of 2 and a maximum of 30 calendar days in advance of placing Type I markings. Type II markings which become dirty due to inclement weather or street conditions shall be cleaned by washing, brushing, compressed air or other means approved by the Engineer, prior to application of Type I markings. If washing is used, the surface of Type II markings shall become thoroughly dry

before placing Type I markings. Color, location and configuration of Type II markings shall be the same as that of Type I markings.

Type I pavement marking material shall be applied within temperature limits recommended by the material manufacturer. Application of Type I pavement markings shall be done only on clean, dry pavement having a surface temperature above 50^0F (10^0C). Pavement temperature shall be measured in accordance with TxDOT Test Method Tex-829-B.

When Type I pavement marking application is by spray, and operations cease for 5 minutes or more, the spray head shall be flushed by spraying pavement marking material into a pan or similar container until the pavement marking material being sprayed is at the proper temperature for application.

Unless otherwise directed by the Engineer in writing, Type I pavement-marking materials shall not be placed on streets between September 30 and March 1, subject to temperature and moisture limitations specified herein.

Unless otherwise shown on the Drawings, the minimum thickness of Type I marking shall be 0.060 inches (60 mil) (1.5 millimeters) for edgeline markings and 0.090 inches (90 mil) (2.3 millimeters) for stop-bars, legends, symbols, gore and center-line/no-passing barrier-line markings, when measured in accordance with TxDOT Test Method Tex-854-B. The maximum thickness of all Type I markings shall be 0.180 inches (180 mil) (4.6 millimeters).

The thickness of Type I markings at the time of placement will be measured above the plane formed by the pavement surface. The Contractor will supply an approved device to measure the thickness of the applied markings. The markings shall be of uniform thickness throughout their lengths and widths.

D. Application of Type II Markings.

The application of Type II marking materials shall be done only on surfaces with a minimum surface temperature of 50^0F (10^0C).

The application rate for Type II marking material shall be between 15 and 20 gallons per mile (35 to 47 liters per kilometer) of solid 4 inch (100 millimeter) line and between 30 and 40 gallons per mile (70 to 95 liters per kilometer) of solid 8 inch (200 millimeter) line. For new surface treatment projects the application rate shall be between 25 and 30 gallons per mile (60 to 70 liters per kilometer) of solid four (4) inch line (one hundred (100) millimeters) and between 40 and 50 gallons per mile (95 to 120 liters per kilometer) of solid 8 inch (200 millimeters) line.

Pavement markings for new surface treatment projects shall be applied in two applications, each approximately one-half the application rate. The first application shall not contain glass beads. The interval between the first and second application shall be a minimum of 1 hour.

When there is impending inclement weather and the Contractor chooses to apply water-based traffic paint and the markings, that are subsequently damaged by rain, sleet, hail, etc., the Contractor is responsible for all costs associated with

the replacement markings. The Contractor will be paid, when the work is acceptable.

871.5 Performance Period for Type I Markings

Type I pavement markings shall meet all the requirements of this technical specification for a minimum of 15 calendar days after installation. Pavement markings that fail to meet all requirements of this specification shall be removed and replaced by the Contractor at its own expense. The Contractor shall replace all pavement markings failing the requirements of this technical specification within 30 calendar days following notification by the Engineer or designated representative of such failing. All replacement markings shall also meet all requirements of this technical specification for a minimum of 15 calendar days after installation.

871.6 Measurement

This Specification Item will be measured by the lineal foot (lineal meter),by each of the various words, shapes or symbols, or by any other unit as shown on the Drawings.

Where double stripes are placed, each stripe will be measured separately.

When quantities are revised by a change in design, the “Plan Quantity” will be increased or decreased by the amount involved in the design change. Payment for revised quantities will be paid for at the unit price bid for that bid item.

Type II pavement markings requiring 2 applications on new surface treatments (Specification Item No. 320) will be measured as 1 marking.

Type II pavement marking materials, when used as a sealer for Type I markings will be measured as Type II markings.

871.7 Payment

The work performed and materials furnished in accordance with this Standard Specification Item and measured as provided under “Measurement” will be paid for at the Unit bid price for “Reflectorized Pavement Markings” of the various types, colors, shapes, sizes, widths and thickness (Type I markings only) specified. This price shall include full compensation for furnishing all materials; for application of pavement markings; and for all other labor, tools, equipment and incidentals necessary to complete the Work, except as described below.

Surface Preparation, when indicated on the Drawings, will be paid for under Specification Item 875, “Pavement Surface Preparation for Markings.”

Final work zone pavement markings (paint and beads), which will be used as a sealer for Type I pavement markings, will be paid for under this Specification Item.

When replacement Type II markings are required due to damage to the original markings from rain, sleet, hail, etc., and the original markings were placed at the Direction of the Engineer, the plan quantity requirements under “Measurement” do not apply to the original and replacement markings. The Contractor will be paid for the actual quantity of original and replacement markings at the unit bid price for the bid item.

Payment will be made under one or more of the following:

Original placement of Reflectorized Pavement Markings:

Reflectorized Type I Thermoplastic Pavement Markings
___inches in width, ___mils in thickness____ in color per lineal foot.

Reflectorized Type I Thermoplastic Pavement Markings **Words**
___inches in width, ___ mils in thickness____ in color per each.

Reflectorized Type I Thermoplastic Pavement Markings **Shapes**
___inches in width, ___ mils in thickness____ in color per each.

Reflectorized Type I Thermoplastic Pavement Markings **Symbols**
___inches in width, ___ mils in thickness____ in color per each.

Reflectorized Type II Paint Pavement Markings
___inches in width, ____ in color per lineal foot.

Reflectorized Type II Paint Pavement Markings **Words**
___inches in width, ____ in color per each.

Reflectorized Type II Paint Pavement Markings **Shapes**
____inches in width, ____ in color per each.

Reflectorized II Paint Pavement Markings **Symbols**
___inches in width, ____ in color per each.

Replacement of Reflectorized Pavement Markings:

Replace Reflectorized Type I Thermoplastic Pavement Markings
___inches in width, ___mils in thickness____ in color per lineal foot.

Replace Reflectorized Type I Thermoplastic Pavement Markings **Words**
___inches in width, ___ mils in thickness____ in color per each.

Replace Reflectorized Type I Thermoplastic Pavement Markings
___inches in width, ___ mils in thickness____ in color per each.

Replace Reflectorized Type I Thermoplastic Pavement Markings **Symbols**
___inches in width, ___ mils in thickness____ in color per each.

Replace Reflectorized Type II Paint Pavement Markings
___inches in width, ____ in color per lineal foot.

Replace Reflectorized Type II Paint Pavement Markings **Words**
___inches in width, ____ in color per each.

Replace Reflectorized Type II Paint Pavement Markings **Shapes**
___inches in width, ____ in color per each.

Replace Reflectorized Type II Paint Pavement Markings **Symbols**
___inches in width, ____ in color per each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 871, “Reflectorized Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 320	Two Course Surface Treatment
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 874	Eliminating Existing Pavement Markings and Markers
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 871, “Reflectorized Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Rubber Asphalt Joint and Crack Sealant
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Nonreflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markers
Item No. 863-1	Pavement Buttons (Reflectorized-Type I & Type II)
Item No. 865-1	Traffic Buttons (Non-Reflectorized)

RELATED CROSS REFERENCE MATERIALS Continued
Specification Item No. 871, “Reflectorized Pavement Markings”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 729-I	Sampling of Traffic Markers

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DM S-410	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT-10	Pavement Paint

ITEM NO. 872
PREFABRICATED PAVEMENT MARKINGS

872.1 Description

This item shall govern furnishing and placement of prefabricated pavement markings of the colors, types, shapes, and sizes indicated on the Drawings.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

872.2 Materials

Prefabricated pavement marking materials shall conform to TxDOT Departmental Materials Specification DMS-8240.

Materials shall be stored in weatherproof enclosure in such a manner to prevent damage.

872.3 Sampling.

Sampling will be conducted in accordance with TxDOT Test Method Tex-732-I.

872.4 Construction Methods

A. General.

When required by the Engineer, the Contractor and the Engineer or designated representative shall review the sequence of Work to be followed and the estimated progress schedule. Waste generated by this Work shall be removed from the job site before the end of each working day.

Guides to mark the lateral location of pavement markings shall be established as shown on the Drawings or as directed by the Engineer or designated representative. The Contractor shall establish the pavement marking guide and the Engineer or designated representative will verify the location of the guides prior to installation.

The pavement markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet {25 mm per 60 meters} of street. The maximum deviation shall not exceed 2 inches {50 millimeters} nor shall any deviation be abrupt.

B. Seasonal Limitation.

Unless otherwise directed in writing by the Engineer or designated representative, pavement-marking materials shall not be placed between September 30 and March 1, subject to temperature and moisture limitations specified.

C. Dimensions.

Markings shall be in accordance with the color, length, width, shape and configuration indicated on the Drawings. The alignment and location shall be as

shown on the Drawings or as directed in writing by the Engineer or designated representative.

D. Methods.

All material placement shall be in accordance with the material manufacturer's instructions, unless otherwise directed in writing by the Engineer or designated representative. In addition to the manufacturer's instructions, material placement shall be in accordance with the surface condition, moisture and temperature requirements specified by this specification item.

E. Surface Preparation

Surface preparation shall be accomplished by any cleaning method approved by the Engineer or designated representative that effectively removes contaminants, loose materials and conditions deleterious to proper adhesion. Surface preparation by blast cleaning will not be required unless shown on the Drawings. When required, blast cleaning shall be done in accordance with 875, "Pavement Surface Preparation for Markings". Surfaces shall be further prepared after cleaning by sealing or priming, as recommended by the manufacturer of the pavement marking material or as directed in writing by the Engineer or designated representative.

Adhesive, when required, shall be of the type and quality recommended by the manufacturer of the pavement marking material. Portland cement concrete pavement surfaces shall not be cleaned by grinding.

F. Moisture.

The pavement shall be completely dry before the material is applied. Pavements shall be considered dry if, on a sunny day after observation for 15 minutes, no condensation occurs on the underside of a 1 foot square (300-mm square) piece of clear plastic that has been placed on the pavement and weighted on the edges.

G. Temperature

The pavement and ambient air temperature requirements recommended by the material manufacturer shall be followed. If no temperature requirements are established by the material manufacturer, the material shall not be placed, if the pavement temperature is below 60^0F (16^0C) or above 120^0F (49^0C).

872.5 Performance Requirements.

A. Adhesion.

Installed pavement markings shall not lift, shift, smear, spread, flow or tear by traffic action.

B. Appearance.

Pavement markings shall present a neat, uniform appearance, free of excessive adhesive, ragged edges and irregular or contours.

C. Visibility.

Installed pavement markings shall have uniform and distinctive retroflectance when observed in accordance with TxDOT Test Method Tex-828-B.

D. Observation Period.

Unless otherwise shown on the Drawings, pavement markings shall meet all the requirements of this technical specification for a minimum of 15 calendar days after installation. Pavement markings that fail to meet all requirements of this specification shall be removed and replaced by the Contractor at its own expense. The Contractor shall replace all pavement markings failing the requirements of this technical specification within 30 calendar days following notification by the Engineer or designated representative of such failing. All replacement markings shall also meet all requirements of this technical specification for a minimum of 15 calendar days after installation.

872.6 Measurement

This Specification Item will be measured by the lineal foot (lineal meter) by each word(s), shape or symbol, or by any other unit as shown on the Drawings.

When quantities are revised by a change in design, the "Plan Quantity" will be increased or decreased by the amount involved in the design change. Payment for revised quantities will be paid for at the unit price bid for that bid item.

872.7 Payment

The work performed and materials furnished in accordance with this Specification Item and measured as provided under "Measurement" will be paid for at the Unit bid price for "Prefabricated Pavement Markings" of the various types, colors, shapes and sizes specified. This price shall include full compensation for cleaning the pavement by any suitable means other than blast cleaning; for furnishing and placing all materials; and for all other labor, tools, equipment and incidentals necessary to complete the Work, except as described below.

Surface Preparation, when indicated on the Drawings, will be paid for under Specification Item 875, "Pavement Surface Preparation for Markings."

Payment will be made under one or more of the following:

Prefabricated Pavement Markings **Words.**
___inches in width, _____ in color per each.
Prefabricated Pavement Markings **Shapes**
___inches in width, _____ in color per each.
Prefabricated Pavement Markings **Symbols.**
___inches in width, _____ in color per each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 872, “Prefabricated Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-8240	Prefabricated Marking Materials

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-732-I	Sampling of Prefabricated Pavement marking Materials
Tex-828-B	Determining Functional Characteristics of Pavement Markings

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 872, “Prefabricated Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Rubber Asphalt Joint and Crack Sealant
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 320	Two Course Surface Treatment
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markings
Item No. 873	Raised Pavement Markers
Item No. 874	Eliminating Existing Pavement Markings and Markers

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item No. 872, “Prefabricated Pavement Markings”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 729-I	Sampling of Traffic Markers
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item No. 872, “Prefabricated Pavement Markings”

Texas Department of Transportation: Departmental Materials Specifications

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT-10	Pavement Paint

ITEM NO. 873
RAISED PAVEMENT MARKINGS

873.1 Description

This item shall govern furnishing and installation of raised pavement markings of various classes and types shown.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text, inch-pound units are given preference followed by SI units shown within parentheses.

873.2 Materials

Raised pavement marking materials shall comply with the requirements of City of Round Rock Specification Items and TxDOT Materials Specifications as follows:

Class A, Jiggle Bar Tile: Standard Specification Item No. 867,
Class B, Pavement Markers (Reflectorized): Standard Specification Item No. 863;
Class C, Traffic Buttons: TxDOT DMS-4300;
Class D, Traffic Buttons (Oval): TxDOT DMS-4300;
Class E, Pavement Markers (All Weather Reflectorized): TxDOT DMS-4210.

Raised pavement markers shall be of the following classes and types:

Class A, Raised Pavement Markers (Jiggle Bar Tile): Class A raised pavement markers shall include types: I-A, I-C, II-A-A, W and Y.
Class B, Raised Pavement Markers (Pavement Markers, Reflectorized): Class B raised pavement markers shall include types: I-A, I-C, II-A-A and II-C-R.
Class C and D, Raised Pavement Markers (Traffic Buttons): Class C and D raised pavement markers shall include types: I-A, I-C, I-R, II-A-A, II-C-R, W and Y.
Class E Raised Pavement Markers (All-Weather Reflectorized): Class E raised pavement markers shall include types: I-A, I-C, I-R, II-A-A and II-C-R.

The following are descriptions for each type of raised pavement marker:

Type I-A. Type I-A shall contain an approach face that reflects amber light. The body, other than the reflective face, shall be yellow.

Type I-C. Type I-C shall contain an approach face that reflects white light. The body, other than the reflective face, shall be white, silver-white or light gray.

Type I-R. Type I-R shall contain a trailing face that reflects red light. The body, other than the reflective face, shall be white, silver-white or light gray or may be one-half red on the side which reflects red light.

Type II-A. Type II-A shall contain two (2) reflective faces (approach and trailing), each of that shall reflect amber light. The body, other than the reflective face, shall be yellow light.

Type II-C-R. Type II-C-R shall contain two (2) reflective faces (approach and trailing), an approach face, which shall reflect white light, and a trailing face, which

shall reflect red light. The body, other than the reflective face, shall be white, silver-white of light gray. Optionally, the body may be one-half white, silver-white or light gray on the side that reflects white light and one-half red on the side that reflects red light.

Type W. Type W shall have a white body and no reflective faces.

Type Y. Type Y shall have a yellow body and no reflective faces.

The reflective faces of all Type II markers shall be positioned so that the direction of reflection of one face shall be directly opposite to the direction of the other face.

Bituminous adhesive shall conform to the requirements of TxDOT Departmental Materials Specification DMS-6130. Epoxy adhesive shall conform to the requirements of Standard Specification Item 867, “Epoxy Adhesive”.

873.3 Sampling.

Sampling will be conducted in accordance with TxDOT Test Method Tex-732-I.

873.4 Construction Methods

Each class of raised pavement marker shall be provided from the same manufacturer.

Surfaces to which markers are to be attached by an adhesive shall be prepared by any method approved by the Engineer or designated representative to ensure that the surface is free of dirt, curing compound, grease, oil, moisture, loose or unsound pavement markings and any other material which would adversely affect the adhesive bond. Unless otherwise shown on the Drawings, surface preparation for installation of raised pavement markers will not be paid for directly, but shall be considered subsidiary to this Standard Specification Item.

Guides to mark the lateral location of pavement markings shall be established as shown on the Drawings or as directed by the Engineer or designated representative. The Contractor shall establish the pavement marking guide and the Engineer or designated representative will verify the location of the guides prior to installation.

The pavement markings shall be placed in proper alignment with the guides. The deviation rate in alignment shall not exceed 1 inch per 200 feet {25 mm per 60 meters} of street. The maximum deviation shall not exceed 2 inches {50 millimeters} nor shall any deviation be abrupt.

Markings placed that are not in alignment or sequence, as shown on the drawings or as stated in the Specification Item, shall be removed by the Contractor at its expense. Removal shall be in accordance with Standard Specification Item 874S, “Eliminating Existing Pavement Markings and Markers”, except for measurement and payment. Guides placed on the street for alignment purposes shall not establish a permanent marking on the street.

Unless shown otherwise on the Drawings, the Contractor shall use the following adhesive materials for placement of markers:

Epoxy adhesive for Class E markers;

Bituminous adhesive for Class A, B, C and D markers on bituminous pavements;

Epoxy adhesive for Class A, B, C and D markers on p. c. concrete pavements.

Adhesive shall be applied in sufficient quantity to ensure the following:

100% of the bonding area of raised pavement markers shall be in contact with the adhesive;

Raise pavement markers, except Class E, shall not be in contact with the pavement surface but shall be seated on a continuous layer of adhesive.

Unless otherwise required by this Specification Item, adhesives shall be applied in accordance with the manufacturer's recommendations. When bituminous adhesive is used, pavement and raised pavement marker temperature shall be at least 40^0F (5^0C). The bituminous adhesive shall not be heated above 400^0F (204^0C). The bituminous adhesive shall be agitated intermittently to ensure even heat distribution.

Epoxy adhesive shall be machine mixed.

Raised pavement markers shall be free of rust, scale, dirt, oil, grease, moisture or contaminants, which might adversely affect the adhesive bond.

Raised pavement markers shall be placed immediately after the adhesive is applied and shall be firmly bonded to the pavement. Adhesive or any other material that impairs functional reflectivity will not be acceptable.

873.5 Measurement

This Specification Item will be measured as each raised pavement marker.

When quantities are revised by a change in design, the "Plan Quantity" will be increased or decreased by the amount involved in the design change. Payment for revised quantities will be paid for at the unit price bid for that bid item.

873.6 Payment

The work performed and materials furnished in accordance with this Standard Specification Item and measured as provided under "Measurement" will be paid for at the Unit bid price for "Raised Pavement Markings" of the classes and types. This price shall include full compensation for furnishing all materials, surface preparation, installation, labor, tools, equipment and incidentals necessary to complete the Work.

Payment shall be made by one or more of the following:

Class A, Raised Pavement Markings, ____ Type	per each.
Class B, Raised Pavement Markings, ____ Type	per each.
Class C, Raised Pavement Markings, ____ Type	per each.
Class D, Raised Pavement Markings, ____ Type	per each.
Class E, Raised Pavement Markings, ____ Type	per each.

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 873, “Raised Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 863	Reflectorized Pavement Markers
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 875	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 732-I	Sampling of Prefabricated Pavement Marking Materials

Texas Department of Transportation: Departmental Materials Specification

Designation	Description
DMS-4210	Pavement Markers
DMS-4300	Traffic Buttons
DMS-6130	Bituminous Adhesive

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 873, “Raised Pavement Markings”

City of Round Rock Standard Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Rubber Asphalt Joint and Crack Sealant
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 320	Two Course Surface Treatment
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markers
Item No. 872	Prefabricated Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers

RELATED CROSS REFERENCE MATERIALS - Continued
Specification Item No. 873, “Raised Pavement Markings”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

Texas Department of Transportation: Departmental Materials Specification

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT-10	Pavement Paint

ITEM NO. 874
ELIMINATING EXISTING PAVEMENT MARKINGS AND MARKERS

874.1 Description

This item shall govern the elimination of existing pavement markings of various types and sizes, and pavement markers as shown on the Drawings or as directed, in writing, by the Engineer or designated representative.

874.2 Materials

All surface treatment material application rates shall be as directed by the Engineer or designated representative. Unless otherwise shown on the Drawings, surface treatment materials shall conform to the requirements of Specification Item No. 301, "Asphalts, Oils and Emulsions," and Specification Item No. 302, "Aggregates for Surface Treatment." Testing of surface treatment materials may be waived by the Engineer or designated representative. Asphalt and aggregate types and grades shall be as shown on the Drawings or as approved by the Engineer or designated representative.

874.3 Construction Methods

Elimination of existing pavement markings and markers shall be accomplished by one or more of the following methods as approved by the Engineer or designated representative.

A. Markings on Asphaltic Surfaces.

1. Placement of a surface treatment a minimum of 2 feet (600 mm) wide to cover the existing marking.

2. Placement of a surface treatment, thin overlay or microsurfacing a minimum of 1 lane in width in areas where directional changes of traffic are involved or other areas as directed by the Engineer or designated representative. Construction methods for surface treatments shall conform to Specification Item No. 320, "Two Course Surface Treatment."

B. Markings on Concrete Surfaces.

Removal by an approved burning method.

C. Markings on Asphaltic or Concrete Surfaces.

Removal by water, water-sand blasting techniques or any other method(s) proven satisfactory to the Engineer.

D. Markers on Asphaltic or Concrete Surfaces.

Removal by any mechanical method to remove marker and adhesive.

Existing pavement markings and markers on both concrete and asphaltic surfaces shall be removed in such a manner that color and/or texture contrast of the pavement surface will be held to a minimum.

Removal of pavement markings on concrete surfaces by blast cleaning shall be accomplished in accordance with Specification Item No. 875, "Pavement Surface Preparation for Markings," except for measurement and payment. Blast cleaning

shall be performed in such a manner that damage to the Portland cement concrete surface is held to a minimum.

When thermoplastic pavement markings or prefabricated pavement markings are encountered, the application of heat may be used to remove the bulk of the marking material prior to blast cleaning. When heat is used, care shall be taken to prevent spalling of Portland cement concrete surfaces.

A burner may be used for complete removal of pavement markings. Broom removal or light blast cleaning may be used for removal of minor residue.

Damage to asphaltic surfaces, such as spalling, shelling, etc., that is greater than ¼ inch (6 mm) in depth and is caused by the removal of pavement markers shall be repaired by the application of a 2 foot (600 mm) wide surface treatment for longitudinal markers with no directional change or a minimum of 1 lane width surface treatment in areas where directional changes of traffic are involved.

Grinding is not an acceptable method of marker or marking removal. However, equipment utilizing special milling flails is considered acceptable in the removal of markings and markers on asphalt and Portland cement concrete surfaces.

874.4 Measurement

This Specification Item will be measured by the square yard (square meter: 1 square meter is equal to 1.196 square yards) of surface treatment, thin overlay or microsurfacing (full lane width) placed; by each word, symbol or shape eliminated; by the lineal foot (lineal meter: 1 lineal meter is equal to 3.281 lineal feet) of markings eliminated; or by any other unit as shown on the Drawings, as each raised pavement marker.

When quantities are revised by a change in design, the “Plan Quantity” will be increased or decreased by the amount involved in the design change. Payment for revised quantities will be paid for at the unit price bid for that bid item.

874.5 Payment

The work performed and materials furnished in accordance with this Specification Item and measured as provided under “Measurement” will be paid for at the unit bid price for “Eliminating Existing Pavement Markings and Markers” of the various types specified. This price shall include full compensation for blast cleaning, mechanical cleaning and/or other cleaning methods; for all materials, tools, equipment and incidentals necessary to complete the Work, except as specified below.

No payment will be made for the elimination of pavement markers when pavement markers are to be removed in conjunction with the elimination of longitudinal markings.

Payment will be made under one or more of the following:

Eliminating Existing Pavement Markings:
__inches in width, per lineal foot

Eliminating ExistingWork Zone Pavement Markings:
__inches in width, per lineal foot

Eliminating ExistingReflectorized Thermoplastic Pavement Markings: **Words**
___inches in width per each

Eliminating ExistingReflectorized Thermoplastic Pavement Markings: **Shapes**
___inches in width per each

Eliminating ExistingReflectorized Thermoplastic Pavement Markings: **Symbols**
___inches in width per each

Eliminating ExistingRaised Pavement Markings,
____ Type per each

END

SPECIFIC CROSS REFERENCE MATERIALS
Specification Item No. 874, “Eliminating Existing Pavement Markings And Markers”

City of Round Rock Standard Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 320	Two Course Surface Treatment
Item No. 875	Pavement Surface Preparation For Markings

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 874, “Eliminating Existing Pavement Markings And Markers”

City of Round Rock Standard Specifications

Designation	Description
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Cleaning and/or Sealing Joints and Cracks (Asphaltic Concrete)
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 413	Cleaning and/or Sealing Joints and Cracks (Portland Cement Concrete)
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markers
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markings

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment

RELATED CROSS REFERENCE MATERIALS (Continued)
Specification Item No. 874, “Eliminating Existing Pavement Markings And Markers”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 729-I	Sampling of Traffic Markers
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

Texas Department of Transportation: Departmental Materials Specification

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT	Pavement Paint

ITEM NO. 875
PAVEMENT SURFACE PREPARATION FOR MARKINGS

875.1 Description

This item shall govern the surface preparation of pavement surface areas prior to placement of pavement markings or raised pavement markers.

This specification is applicable for projects or work involving either inch-pound or SI units. Within the text the inch-pound units are given preference followed by SI units shown within parentheses.

875.2 Materials

Abrasive blasting medium, when used, shall be a quality commercial product capable of producing the specified surface cleanliness without the deposition of deleterious materials on the cleaned surface. Water used in blasting operations shall be potable.

875.3 Equipment

Equipment shall be maintained in good condition. Air compression equipment shall utilize moisture and oil traps, in working order, of sufficient capacity to remove contaminants from blasting air and prevent the deposition of moisture, oil or other contaminants on the street surface.

875.4 Construction Methods

Widths, lengths and shapes of the prepared surfaces shall be of sufficient size to include the full area of pavement markings or raised pavement markers shown on the Drawings.

Surface preparation of Portland cement concrete surfaces shall be sufficient to remove contaminants. Damage to the street due to over-blasting shall be held to a minimum. Asphaltic surfaces shall be cleaned by brushing, washing, compressed air, high pressure water or any combination thereof to remove all forms of contamination and loose materials. All other surfaces to be cleaned by blast cleaning shall be cleaned sufficiently to remove loose and flaking materials from the street surface.

When existing markings are encountered, they shall be cleaned sufficiently to remove all loose and flaking materials. Small spots of old markings or contaminants of up to 0.5 square inch (320 mm^2) in area may remain if the contaminant is not removed by the following test:

Firmly press a 10 inch (250 mm) long, two-inch (50 mm) wide strip of monofilament tape onto the surface to be tested, leaving approximately 2 inches {50 mm} free. Grasp the free end and remove the tape with a sharp pull.

Blasting pressure and technique shall be controlled to prevent damage to the pavement surface. Portland cement concrete surfaces shall not be cleaned by grinding.

875.5 Measurement

This Specification Item will be measured by the lineal foot (lineal meter: 1 lineal meter is equal to 3.281 lineal feet) of the various widths, by each of the various words, symbols or shapes, or by any other unit as shown on the Drawings.

When quantities are revised by a change in design, the “Plan Quantity” will be increased or decreased by the amount involved in the design change. Payment for revised quantities will be paid for at the unit price bid for that bid item.

875.6 Payment

The work performed and materials furnished in accordance with this Specification Item and measured as provided under “Measurement” will be paid for at the unit bid price for “Pavement Surface Preparation for Markings” of the various types specified. This price shall include full compensation for all materials, tools, equipment, labor and incidentals necessary to complete the Work.

Payment shall be made by one or more of the following:

Pavement Surface Preparation for existing pavement surface
___inches in width, for _____ Surface Type per lineal foot
Pavement Surface Preparation for existing **Words**
___inches in width, for _____ Surface Type per each
Pavement Surface Preparation for existing **Shapes**
___inches in width, for _____ Surface Type per each
Pavement Surface Preparation for existing **Symbols**
___inches in width, for _____ Surface Type per each

END

RELATED CROSS REFERENCE MATERIALS
Specification Item No. 875, “Pavement Surface Preparation For Markings”

City of Round Rock Technical Specifications

Designation	Description
Item No. 301	Asphalts, Oils and Emulsions
Item No. 302	Aggregates for Surface Treatments
Item No. 310	Emulsified Asphalt Treatment
Item No. 311	Emulsified Asphalt Repaving
Item No. 312	Seal Coat
Item No. 313	Rubber Asphalt Joint and Crack Sealant
Item No. 315	Milling Asphaltic Concrete Paving
Item No. 320	Two Course Surface Treatment
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 341	Paving Fabric
Item No. 350	Heating, Scarifying and Repaving
Item No. 360	Concrete Pavement
Item No. 801	Construction Detours
Item No. 803	Barricades, Signs and Traffic Handling
Item No. 860	Pavement Marking Paint (Reflectorized)
Item No. 863	Reflectorized Pavement Markers
Item No. 864	Abbreviated Pavement Markings
Item No. 865	Non-Reflectorized Traffic Buttons
Item No. 866	Jiggle Bar Tile
Item No. 867	Epoxy Adhesive
Item No. 870	Work Zone Pavement Markings
Item No. 871	Reflectorized Pavement Markers
Item No. 872	Prefabricated Pavement Markings
Item No. 873	Raised Pavement Markings
Item No. 874	Eliminating Existing Pavement Markings and Markers

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 302	Aggregates for Surface Treatments
Item No. 314	Emulsified Asphalt Treatment
Item No. 315	Emulsified Asphalt Seal
Item No. 316	Surface Treatments
Item No. 334	Hot Mix-Cold Laid Asphaltic Concrete Pavement
Item No. 340	Hot Mix Asphaltic Concrete Pavement
Item No. 342	Plant Mix Seal
Item No. 351	Repairing Existing Flexible Pavement Structure
Item No. 354	Planing and/or Texturing Pavement
Item No. 358	Asphaltic Concrete Surface Rehabilitation
Item No. 360	Concrete Pavement

RELATED CROSS REFERENCE MATERIALS (Continued)
Specification Item No. 875, “Pavement Surface Preparation For Markings”

Texas Department of Transportation: Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges

Designation	Description
Item No. 421	Portland Cement Concrete
Item No. 427	Surface Finishes for Concrete
Item No. 428	Concrete Surface Treatment
Item No. 662	Work Zone Pavement Markings
Item No. 666	Reflectorized Pavement Markings
Item No. 667	Prefabricated Pavement Markings
Item No. 672	Raised Pavement Markers
Item No. 677	Eliminating Existing Pavement Markings and Markers
Item No. 678	Pavement Surface Preparation For Markings

Texas Department of Transportation: Manual of Testing Procedures

Designation	Description
Tex 729-I	Sampling of Traffic Markers
Tex-828-B	Determining Functional Characteristics of Pavement Markings
Tex-829-B	Method For Measuring Pavement Temperature
Tex-854-B	Evaluation Of Thermoplastic Striping For Uniformity And Thickness

Texas Department of Transportation: Departmental Materials Specification

Designation	Description
DMS-4100	Jiggle Bar Tile
DMS-4200	Pavement Markers (Reflectorized)
DMS-4300	Traffic Buttons
DMS-4210	Pavement Markers
DMS-6130	Bituminous Adhesive
DMS-8200	Pavement Paint
DMS-8220	Thermoplastic marking material
DMS-8240	Prefabricated Marking Materials
DMS-8241	Removable Tape
DMS-8290	Pavement Paint
YPT-10 and/or WPT	Pavement Paint