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the various elements of the structure consisting of vertical end support units, horizontal units, vertical sign brackets, structural framing for signing if required, sign lighting support hardware if required (horizontal brackets, pads, bolts, nuts, plates, etc.) and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer.

658.7-BASIS OF PAYMENT:

The quantities, determined as provided above, shall be paid for at the contract unit price for the items listed below, which prices and payment shall be full compensation for furnishing all the materials and doing all work prescribed in a workmanlike and acceptable manner, including staking out footings and stakes therefore; excavating for footings regardless of the type of material encountered; constructing and removing forms; furnishing and installing reinforcing steel, anchor bolts, washers and nuts; furnishing and installing electrical grounding and conduit sleeves; furnishing, placing, finishing and curing the concrete; furnishing and placing grout as required by the Plans; fabrication, delivery and erection of each overhead sign; and including all tools, equipment, supplies and incidentals necessary to complete the work. All incidental work and materials for which no basis of payment is provided will be considered as completely covered by the prices bid for the items included in the contract.

658.8-PAY ITEMS:

ITEM	DESCRIPTION	UNIT
658001-*	CLASS B CONCRETE FOOTINGS, REINFORCED, OVERHEAD	CUBIC YARD (METER)
658002-*	OVERHEAD SIGN, STEEL-ALUMINUM COMBINATION	EACH
658003-*	OVERHEAD SIGN, GALVANIZED STEEL	EACH
658004-*	OVERHEAD SIGN, WEATHERING STEEL	EACH

* Sequence number

SECTION 659

SIGN LIGHTING

659.1-DESCRIPTION:

Sign lighting shall consist of furnishing and installing or modifying sign illumination systems, including all necessary accessories, in accordance with the Plans and the following Specifications or as directed by the Engineer.

All electrical equipment shall conform to the standards of the National Electrical Manufacturers Association (NEMA), the Underwriters' Laboratories, Inc. (UL), or the Electronic Industries Association (EIA), whichever is applicable. In addition to the requirements of the Plans and these Specifications, all materials and workmanship shall conform to the requirements of the National Electrical Code (NEC), referred to as the Code; the American Society for Testing Materials (ASTM); the American National

Standards Association (ANSI); The American Wire Gauge (AWG), and any local ordinances which may apply.

Wherever reference is made in these Specifications to the Code or to the standards mentioned above, the references shall mean the code or standard, including revisions, that is in effect at the time of the award of the contract.

659.2-MATERIALS:

The materials furnished and used shall be new, except as may be specifically provided on the Plans. The materials shall be manufactured, handled, and used in a workmanlike manner to insure a completed installation in accordance with the Plans and Specifications.

All electrical materials shall conform to the special requirements and to the Standardization Rules of the Institute of Electrical and Electronic Engineers, IPCEA and, when governing, shall also conform to the National Electrical Code, local and special laws or ordinances, and the Underwriter's Laboratories.

659.2.1-Equipment Lists and Drawings: The Contractor shall submit to the Engineer for approval detailed drawings in duplicate of switch box and luminaire equipment and of any proposed deviations from the Plans. Following checking, correction, and approval, not less than eight complete sets shall be submitted to the Engineer. The Division will not be liable for any material purchased, labor performed, or delay to the work prior to such approval.

If ordered by the Engineer, the Contractor shall submit for approval sample articles of the materials proposed for use. Parts list, service instructions, and all apparatus warranties packaged with or accompanying the electrical equipment to be installed on the project shall be delivered to the Engineer.

659.2.2-Conduit: All conductors shall be run in conduit, except for overhead or temporary installations and where conductors are run inside poles. Conduit to be installed underground, on the surface of poles, or in structures, except as shown on the Plans, shall be Type R, Type F, or Type P as follows:

- i. Type R (Rigid Steel Conduit) shall meet the requirements of Section 715.42.10.1.
- ii. Type F (Flexible, Liquid-Tight Conduit) shall meet the requirements of Section 715.42.10.2.
- iii. Type P (Polyvinyl Chloride Conduit) shall meet the requirements of Section 715.42.10.3.

Standard and expansion couplings and other fittings for the Type P conduit shall all be of the same materials as the conduit.

Other fittings for metal conduit shall be threaded malleable iron conforming to the requirements of ASTM A 338 and shall be galvanized in accordance with the requirements of ASTM A 153.

The size of conduit used shall be as shown on the Plans or as specified. If size is not shown on the Plans, the National Electrical Code shall govern as to the necessary conduit size.

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659.2.3-Pull or Junction Boxes: Pull or junction boxes for structure installation shall be as shown on Plans or Type L. Boxes for ground (including sidewalk) installation shall be Type H (10x10). Type L shall meet the requirements of 715.42.11.1. Type H (10x10) shall meet the requirements of Section 715.42.11.2.

659.2.4-Cable: All wire and cable for sign lighting branch circuits shall conform to the requirements of the current edition of the National Electrical Code and shall meet all relevant ASTM Specifications. Conductors shall be coated softdrawn copper, unless otherwise noted on the Plans or in these Specifications. Insulation shall be Type THWN. Cable shall be UL approved.

Conductor sizes shall be standard American Wire Gauge sizes and shall be as noted on the Plans. All conductors shall be stranded. Stranded wire shall have a minimum of 19 strands.

Wire and cable for sign lighting projects included with roadway lighting projects shall be the same type as specified for the roadway lighting project.

All wire and cable shall have the size, voltage rating, and type of insulation and manufacturer's name permanently marked on the outer covering at regular intervals. The Manufacturer shall furnish to the Engineer and the Contractor all splicing or terminating information necessary for proper installation of the cable.

Color coding for sign lighting cables shall be permanent solid color as follows:

Single Phase		Three Phase	
Leg A	Black	Phase A	Black
Leg B	Red	Phase B	Red
Neutral	White or Natural Gray	Phase C	White or Natural Gray
Equipment Ground	Green	Equipment Ground	Green

Color coding of electrical conductors by use of phase tape or field paint is not acceptable. Conductors shall be manufacturer-colored, striped or ridge-marked.

Bare ground conductors shall be softdrawn copper, unless otherwise specified.

659.2.5-Connectors: Cable connections in boxes and handholes shall be made by means of connector kits, fused or non-fused, as indicated on the Plans. Splices for the signs shall be made by means of straight through or "Y" connector kits as required and as noted on the Plans. Where these connector kits cannot be used, as verified by the Engineer, connections on cables in

junction boxes shall be made by splicing as described elsewhere.

Fused "Y" connectors, if required, shall be composed of "Y" line side housing assembled with a load side and fuse terminal housing.

The housing shall be formed from water-resistant synthetic rubber. Each housing shall provide a water seal around the cables and when fully assembled shall form a watertight connector.

The interior shall be arranged to receive and retain line side wiring and the fuse contacts. The fuse contacts shall be spring-loaded copper designed for 30 amperes, 600 volts; shall have 90 percent minimum conductivity and shall be suitable for gripping a 10 amp, 600 volt cartridge-type midget fuse, 13/32 inch (10.3 mm) in diameter and 1-1/3 in. (33.9 mm) long. The contacts shall be fully annealed. The load side conductors shall be connected by crimping and the line side conductors shall be connected with screws. The connector shall be of the nonlocking type that will break off under extreme tensile stress leaving no exposed metal contacts on the line side of the connector.

The cable diameters used shall determine the size of each housing. The load side housing shall retain the fuse when disconnected.

Non-fused connectors shall be similar to the fused "Y" connectors. The cable diameter shall determine the size of each housing of each connector.

Fuses for connectors shall be rated at 10 amperes, unless otherwise noted.

659.2.6-Bonding and Grounding: Metallic cable sheaths, conduit, transformer cases, anchor belts, and metal poles and pedestals shall be made mechanically and electrically secure to form a continuous system and shall be effectively grounded. Bonding and grounding jumpers shall be copper wire or copper strap of the same cross sectional area as #4 AWG for all lighting systems.

Ground rods shall be copper clad steel, 3/4 inches (19 mm) in diameter with a minimum length as noted on the plans and shall be one piece. Sectional or segmented ground rods are not permitted. The ground rods shall be complete with ground clamp and square head bolt.

659.2.7-Service: Service equipment for a sign lighting system shall be provided as required by the Plans unless changed by the Engineer to meet a local condition. Where a meter is required, a meter base complete with sealing rings shall be installed by the Contractor. Installation of electric meter and final hookup shall be done by the serving utility company. A circuit breaker mounted in a NEMA Type 4 (dust and moisture proof) enclosure shall be installed as indicated on the Standard Drawings.

659.2.8-Wood Poles: All wood poles shall meet the requirements of Section 710.8.

659.2.9-Enclosures: Pole mounted enclosures for sign lighting shall of the type shown on the Plans and shall be NEMA Type 4 (dust and moisture proof).

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The design shall be of AISI 300 Series stainless steel with a flange mounted switch handle and a double defeater cover lock mechanism. Enclosure locks shall be such that all enclosures on the project can be opened with the same key. Locks shall be of quality bronze construction with bronze keeper chains.

Enclosure mounting brackets for mounting the enclosure on the sign support shall be as shown on the Plans.

659.2.10-Sign Lighting Fixtures: Type 3 (Mercury Vapor Sign Light) 100, 175 or 250 Watt:

The Type 3 luminaire shall be of the remote ballast, 100, 175 or 250-watt as indicated on the plans, mercury vapor type, furnished complete with housing, mounting bracket, reflector, refractor, lamp socket, ballast and lamp; Hollophane, Guth, G.E. or equal as approved by the Engineer. The luminaire shall be 250 watt unless otherwise indicated.

The housing shall be die-cast aluminum with captive closed cell neoprene and felt double gasketing. Closure shall be positive by use of stainless steel pressure latches and stainless steel hinges.

The reflector shall be assymetric polished aluminum. The refractor shall be molded prismatic thermal shock resisting borosilicate glass.

The lamp socket shall be of a heavy duty type and be provided with adjustable settings for varying beam pattern.

The ballast shall be 100, 175 or 250 watt high power factor constant wattage or constant wattage auto transformer for use with appropriate lamp and system voltage.

The lamp shall be 100, 175 or 250 watt deluxe white mercury vapor heavy glass type with rated life of 24,000 hours, equal to ANSI Code H38-4HT (100), H39-22KB (175) or H37-5KB (250).

The complete luminaire optical assembly consisting of reflector, refractor, lamp socket position and lamps shall produce a light distribution conforming to the Isofootcandle and Utilization Curves of Guth Vertol Signliter, Hollophane 780 Express lite or equal as approved by the Engineer.

659.2.11-Photoelectric Controls (For Independent Sign Light System Only): Photoelectric controls shown on the Plans shall be capable of switching multiple fluorescent or mercury vapor luminaires directly.

The photocell shall consist of a light-sensitive element connected directly to a control relay and shall be equipped with circuitry designed to accept a supply voltage of 120 volts, unless otherwise indicated on the Plans.

The unit shall be preset to "turn on" between 1.0 and 3.5 footcandles. "Turn off" shall be at least two times the "turn on" level; however, "turn off" must be greater than 3.0 and less than 15.0 footcandles.

The unit shall meet all relevant NEMA standards and shall be twistlock type equipped for pole-top mounting using a slipfitter or conduit stem, or where pole-top mounting is impossible, bracket mounting to the side of the pole. The unit shall be north oriented.

CONSTRUCTION METHODS

659.3-GENERAL:

Existing electrical systems (traffic signal, highway and street lighting, flashing beacon, and sign illumination), or approved temporary replacements thereof, shall be in effective operation for the benefit of the traveling public during the progress of the work, except when shut-down is permitted to allow for alterations or final removal of the systems.

All systems shall be complete and in operation to the satisfaction of the Engineer upon completion of all the work. This includes field focusing of lamp fixtures.

659.3.1-Excavating and Backfilling: The excavations required for the installation of conduit, foundations, and other appurtenances shall be performed in such a manner as to cause the least possible damage to streets, sidewalks, landscaping, and other improvements. The trenches shall not be excavated wider than necessary for the proper installation of the electrical appurtenances and foundations. Excavation shall not be performed until immediately before the installation of conduit and other appurtenances. The material from the excavation shall be placed in a position that will not cause damage or obstruction to vehicular and pedestrian traffic or interfere with surface drainage.

All excavations shall be backfilled with suitable random material in horizontal layers not to exceed 4 inches (100 mm) after compaction. Each lift shall be compacted to the satisfaction of the Engineer. Testing is not required.

All surplus material shall be removed from the right-of-way and the backfill finished flush with surrounding natural ground, including replacement of any damaged facilities or appurtenances. The Contractor shall restore all areas disturbed by this excavation or other operations to their original conditions including grading, seeding, mulching and fertilizing as directed by the Engineer.

The Contractor shall employ hand excavation methods in areas where underground facilities exist, in order to avoid damaging these facilities. Any damage caused by the Contractor to existing facilities shall be repaired by the Contractor at his own expense, to the satisfaction of the Engineer. The Contractor will be responsible for all claims and damages for interrupted service and all other damage suits which may result from such interrupted service.

659.3.2-Removing and Replacing Improvements: Improvements such as sidewalks, curbs, gutters, portland cement and asphalt concrete pavement, bituminous surfacing, base material, lawn and plants, and any other improvements removed, broken or damaged by the Contractor's operations shall be replaced or reconstructed with materials of equal quality. The new work shall be left in a serviceable condition satisfactory to the Engineer.

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Whenever a part of a square or slab of existing concrete sidewalk or driveway is broken or damaged, the entire square or slab shall be removed and the concrete reconstructed as specified.

The outline of all areas to be removed in portland cement concrete pavements shall be cut to a minimum depth of 4 inches (100 mm) with an abrasive type saw prior to removing the pavement material. The cut for the remainder of the required depth may be made by a method satisfactory to the Engineer. Cuts shall be neat and true with no shatter outside the removal area.

659.3.3-Conduit Installation:

659.3.3.1-Type R Conduit: Where pull boxes are installed adjacent to the base of a standard or a sign structure post, conduit installed between pull boxes and base shall not be less than 2 inches (50 mm) in diameter.

It shall be the option of the Contractor, at his expense, to use conduit of larger size than specified and where used, the larger size shall be for the entire length of the run from outlet to outlet. No reducing coupling will be permitted.

The ends of all conduits, whether shop or field cut, shall be reamed to remove burrs and rough edges. Cuts shall be made square and true so that the ends will butt or come together for the full circumference. Slip joints or running threads will not be permitted for coupling conduit. When a standard coupling cannot be used, an approved threaded union coupling shall be used.

The treads on all conduit shall be painted with a compound meeting specification MIL-P-21035 before the couplings are made up. All couplings shall be screwed up until the end of the conduits are brought together, providing a good structural connection throughout the entire length of the conduit run. Where the coating on the conduit has been damaged in handling or installation, such damaged places shall be painted with an approved rust preventative paint.

So far as practical, all conduit shall be run without traps. Where dips are unavoidable, a pull box or drainage tee shall be placed at each low point to drain any moisture accumulation. Conduit runs shall be made with as few couplings as standard length will permit and the total angle of all bends between any two boxes shall not exceed two quarter bends (180 degrees) unless otherwise approved by the Engineer.

Two cubic feet (600 cubic mm) of coarse aggregate (crushed stone or gravel) of a size and grade approved by the Engineer shall be placed at drainage tees for underground conduits.

Conduit bends, except factory bends, shall have a radius of not less than six times the inside diameter of the conduit. Where factory bends are not used, the conduit shall be bent without crimping or flattening, using the longest radius practicable.

Conduit shall be laid at a depth of not less than 18 in. (450 mm) below the curb grade in the sidewalk area, 36 in. (900 mm) below the highway pavement grade in the road areas, and 24 in. (600 mm) below the finished grade in all other areas. All conduit placed under paved roads shall have a minimum diameter of 2 inches (50 mm).

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Conduit shall be placed under existing pavement by jacking or drilling methods. Pavement shall not be disturbed without the approval of the Engineer. All local subterranean utility maps shall be checked before any jacking or drilling operations begin.

The near side of the jacking or drilling pits shall have a four foot (1.2 m) horizontal clearance from the edge of any type of pavement wherever possible. Water jetting will not be permitted.

Conduit terminating in standards or pedestals shall have a projection above the foundation of 4 inches (100 mm) and shall be sloped towards the handhole opening.

Conduit ends shall extend into concrete Junction boxes at least 1½ in. (40 mm) and be equipped with approved bonding bushings. Conduit shall be 2 inches (50 mm) above the bottom, and shall be sloped to facilitate pulling of conductors. Conduit entering through the bottom of a pull box shall be located near the end walls to leave the major portion of the box clear. At all outlets, conduits shall enter from the direction of the run.

Expansion or deflection fittings, or both, shall be installed in metallic conduit runs at all joints in the structure to compensate for deflection and expansion. Expansion fittings shall be bonded with approved flexible tinned copper bonding jumpers.

Where new pull boxes are placed in existing conduit runs, the conduit shall be fitted with threaded bushings and bonded as shown on the Plans.

Conduit run on the surface of bridge structures shall be secured with approved strapping spaced not more than 5 feet (1.5 m) apart. Expansion fittings, as detailed on the structure Plans, shall be installed where the conduit crosses an expansion joint in the structure. Each expansion fitting shall be provided with a bonding jumper of at least # 6 AWG copper wire or equal.

Conduit leading to soffit, wall or other lights or fixtures below the grade of the pull box shall be sealed by means of an approved sealing fitting and sealing compound.

A # 12 AWG copperclad pull wire shall be installed in all conduits which are to receive future conductors. At least 2 feet (600 mm) of pull wire shall be doubled back into the conduit at each termination.

After backfilling is completed and prior to the installation of cable, all conduits, existing and new, shall be rodded throughout their entire lengths with a mandrel ¼ in. (6 mm) smaller in diameter than the conduit and 2 inches (50 mm) in length, and with a cylindrical wire brush the same diameter as the conduit.

659.3.3.2-Type P Conduit: Type P conduits shall be installed in accordance with the applicable methods as prescribed for Type R conduits, with regard to parallel conduit installations, coordinated with the existing or newly installed facilities.

Type P conduit shall be made watertight by joining with solvent in accordance with manufacturer's specifications. Ends terminating in junction

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boxes shall be terminated with expansion couplings and end bells. Ends joining to metal conduit elbows at lighting standard foundations shall be connected through expansion couplings and adapters.

659.3.4-Luminaires: No luminaire shall be installed until the lamp socket position has been inspected and approved by the Engineer for conformance to the manufacturer's recommended position for the specified distribution.

The connections between the luminaire and connector kits shall be made with # 10 wires.

659.3.5-Pull Boxes: Pull boxes shall be installed at the locations shown on the Plans or, in long runs, shall be spaced at not more than 250 ft. (75 meters) It shall be the option of the Contractor, at his expense, to install additional pull boxes to facilitate his work.

Pull boxes shall be installed so that the covers are flush with the curb or sidewalk or 2 inches (50 mm) above the surrounding ground when no finished grade is established.

659.3.6-Cables: The Contractor shall provide adequate equipment for installation of cable, shall pull all wires through conduits in such a manner as not to overstress or stretch any wire, and shall use precautions so as not to score, cut, twist or damage the protective covering or insulation. In the pulling of cables in conduits, where the strain on the cables is likely to prove excessive, the Contractor shall use soapstone powder or other approved lubricant. Where two or more cables are to occupy the same conduit, they shall be drawn in together and kept parallel to each other by the use of a pulling head.

The Contractor, in connecting sockets, outlets and other similar equipment, shall ground the most accessible bare parts of each piece of equipment. In order to ensure that this has been done, each piece of equipment shall be tested after installation, and under the supervision of the Engineer, with a test lamp, one leg of which has been connected to a definite ground, or by other approved means of testing.

All cables in pull boxes and handholes shall be tested for circuit connections which shall be in conformity with those indicated on the detail drawings. All cables in junction boxes (pull boxes), manholes and standard bases shall be provided with individual non-corrosive metal (minimum 1½ in. (40 mm)) tags, die-stamped with control station, circuit and phase designation as applicable. Similarly designed tags shall be used in the switch boxes. The tags shall be securely attached to the cables with nylon cord of 1/16 in. (2 mm) minimum diameter.

Splices where necessary to form continuous circuits, complete and ready for operation, shall be made by the Contractor. Cable splices will be permitted only in accessible locations. Cable splices shall be accomplished by the use of manufactured splice kits. Splice design with a final wrap of tape will not be acceptable. Splice kits shall be installed strictly in accordance with the manufacturer's instructions.

Upon the completion of each wiring system, and before any connection is made to operating equipment, it shall be the responsibility of the Contractor to perform, in the presence of the Engineer, the following tests of each circuit to determine whether the installations are in acceptable working order:

- i. Tests for continuity
- ii. Tests for grounds
- iii. Tests for insulation resistance between circuit wires and from circuit wires to ground.

Upon completion of the electrical system, with fuses removed and before energizing, the insulation resistance shall be not less than fivemegohms.

659.3.7-Grounding:

659.3.7.1-General: The necessary conduit, conductors, bonding jumpers, clamps, connectors, ground rods, etc. for the grounding system shall be furnished, installed and connected by the Contractor.

Conduit systems must be effectively and permanently grounded with a cross section as required by the National Electrical Code and of capacity sufficient to ensure continuity and continued effectiveness of the ground connections for fault current. Ground conductors shall be as short and straight as possible, protected from mechanical injury and, if practicable, without splice or joint.

659.3.7.2-Codes and Approvals: All grounding work shall be done in accordance with the latest edition and revisions of the National Electrical Code and the regulations of State and local codes.

All connections in ground network shall be those of a type approved by NEC, Article 250.

659.3.7.3-Metal Conduits: All metal conduit ends shall be bonded and grounded by means of a # 4 bare copper cable. The grounding shall be accomplished by driving ground rods as detailed on the Plans and connecting it through a # 4 copper conductor in the foundation as shown on the Plans; or by driving ground rods through the junction box drainhole, and connecting it through a # 4 copper connector attached to a grounding stud on the sign lighting standard junction box frame, etc. The connection of the bonding cable to the junction box frames and to the shafts of the metallic sign lighting standard shall be done by means of a grounding stud, Burndy's Type K2C, Dossert Type DCM, or approved equal. Where the supply voltage is greater than 120/140, the neutral conductor shall be grounded at the service panels only with the neutrals of dry transformers.

At each service point, a ground electrode shall be furnished and installed. Ground electrodes shall be one-piece lengths of copperclad rod, diameter and length as shown on the Plans. Ground electrodes shall be installed in accordance with the provisions of the Code and as indicated on the Plans.

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659.3.8-Service: Service points shown on the Plans are approximate only. The Contractor shall determine the exact locations from the serving utility.

Poles shall be placed in the ground to a depth of at least 5 feet (1.5 m).

The Contractor shall furnish conduit, conductors and all other necessary material to complete the installation of the service riser. Service riser conduit shall terminate with a weather head to prevent the entrance of water, as approved by the serving utility.

Where a meter is required, a meter base, furnished by the serving utility, shall be installed by the Contractor.

Each multiple service installation shall be grounded in accordance with the provisions in the Code.

Where an approximate service point is shown on the Plans, installation and materials for the connection between the actual service point, as established by the serving utility, and the nearest pull box of the electrical system shown on the Plans, shall be paid for by the Contractor.

Where a service point is omitted from the Plans, installation and materials for the connection between the service point, as established by the serving utility, and the nearest pull box of the electrical system shown on the Plans, shall be paid per section 109.4 and 104.3.

Upon request of the Contractor, the Engineer will arrange with the serving utility to complete the service connections and the Contractor shall pay all costs and fees required.

Upon request of the Contractor, the Engineer will arrange for furnishing electrical energy. Energy used prior to the completion of the contract will be charged to the Contractor, except that the cost of energy used for the public benefit, when such operation is ordered by the Engineer, will be borne by the Division.

When the power service is within a roadway lighting system, it shall be necessary only to provide the connections as shown on the Plans.

659.3.9-Field Tests: Prior to the completion of the work, the Contractor shall cause the following tests to be made on all lighting circuits, in the presence of the Engineer.

- i. Each circuit shall be tested for continuity.
- ii. Each circuit shall be tested for unspecified grounds.
- iii. A megger test shall be made on each circuit between the circuit and the ground. The insulation resistance shall not be less than the values specified in the provisions of the Code.
- iv. A functional test shall be made in which it is demonstrated that each and every part of the system functions as specified or intended.

After the installation is completed, the Contractor shall conduct a continuous 24-hour operating test for approval. In addition, final acceptance of an installation will not occur until 30 days of operation termed satisfactory by the Engineer.

During the 30 days of operation, the Contractor shall be responsible for repairing or replacing any defective equipment within 24 hours after being notified by the Engineer. After any malfunctioning equipment has been repaired or replaced, the 30-day test shall begin anew.

Where the sign lighting installation is a part of, and connected to, a roadway lighting installation, the functional test shall be the same as the functional test for the roadway lighting system.

659.3.10-Ballasts And Isolating Transformers: Splices at ballasts and transformers shall conform to the Code. Where more than one conductor enters a ballast or transformer sleeve, the insulation and taping shall be applied between the conductors in such a manner as to provide a watertight joint. The splice installation shall be capable of satisfactory operation under continuous submersion in water.

659.4-METHOD OF MEASUREMENT:

Measurement for payment for sign lighting will be based on each individual lighting system (normally one per overhead sign structure) complete in place, which will include power service, service poles, meter bases, switch box, polemounted enclosure, transformers, photoelectric controls, disconnects, junction boxes, cable, conduit, luminaires, lamps, ballasts, impact-proof shields and any other accessories or hardware as required to make a complete installation as called for on the Plans or as directed by the Engineer.

659.5-BASIS OF PAYMENT:

The quantity, determined as provided above, shall be paid for at the contract price for each installation for the item listed below, which price and payment shall be full compensation for furnishing all the materials and doing all the work prescribed in a workmanlike and acceptable manner. This price shall include all compensation for fabrication, delivery, erection and for any additional materials, tools, equipment, incidentals and labor not shown on the Plans or called for which are necessary to complete the installation of the various systems and as directed by the Engineer, including any necessary excavating and backfilling, restoring sidewalk, pavement and appurtenances damaged or destroyed during construction, salvaging existing materials and making all required tests.

659.6-PAY ITEMS:

ITEM	DESCRIPTION	UNIT
659001-*	SIGN LIGHTING, TYPE "type"	LUMP SUM

*Sequence number

659-SIGN LIGHTING APPENDIX A STANDARD SPACING FOR TYPE 3 LUMINAIRE

USING DELUX WHITE MERCURY LAMP
(Where two or more signs have 3.0 ft. (1 m) or less
between the two signs, treat as one sign.)

SIGN OR GROUP LENGTH FEET (meter)	NUMBER OF LUMINARIES	DISTANCE OF FIRST LUMINAIRE FROM LEFT EDGE FEET (meter)	DISTANCE BETWEEN LUMINAIRES FEET (meter)
5.0 (1.5 m)	1	2.5 (0.750 m)	
5.5 (1.65 m)	1	2.75 (0.825 m)	
6.0 (1.80 m)	1	3.0 (0.900 m)	
6.5 (1.95 m)	1	3.25 (0.975 m)	
7.0 (2.10 m)	1	3.5 (1.05 m)	
7.5 (2.25 m)	1	3.75 (1.125 m)	
8.0 (2.40 m)	1	4.0 (1.200 m)	
8.5 (2.55 m)	1	4.25 (1.275 m)	
9.0 (2.70 m)	1	4.50 (1.35 m)	
9.5 (2.85 m)	1	4.75 (1.425 m)	
10.0 (3.00 m)	1	5.0 (1.50 m)	
10.5 (3.15 m)	2	2.75 (0.825 m)	5.0 (1.5 m)
11.0 (3.30 m)	2	3.0 (0.90 m)	5.0 (1.5 m)
11.5 (3.45 m)	2	3.25 (0.975 m)	5.0 (1.5 m)
12.0 (3.60 m)	2	3.50 (1.05 m)	5.0 (1.5 m)
12.5 (3.75 m)	2	3.75 (1.25 m)	5.0 (1.5 m)
13.0 (3.90 m)	2	4.0 (1.20 m)	5.0 (1.5 m)
13.5 (4.05 m)	2	4.25 (1.275 m)	5.0 (1.5 m)
14.0 (4.20 m)	2	4.50 (1.35 m)	5.0 (1.5 m)
14.5 (4.35 m)	2	4.75 (1.425 m)	5.0 (1.5 m)
15.0 (4.50 m)	2	5.0 (1.50 m)	5.0 (1.5 m)
15.5 (4.65 m)	2	3.25 (0.975 m)	9.0 (2.7 m)
16.0 (4.80 m)	2	3.50 (1.05 m)	9.0 (2.7 m)
16.5 (4.95 m)	2	3.75 (1.125 m)	9.0 (2.7 m)
17.0 (5.10 m)	2	4.0 (1.2 m)	9.0 (2.7 m)

SIGN OR GROUP LENGTH FEET (meter)	NUMBER OF LUMINARIES	DISTANCE OF FIRST LUMINAIRE FROM LEFT EDGE FEET (meter)	DISTANCE BETWEEN LUMINAIRES FEET (meter)
17.5 (5.25 m)	2	4.25 (1.275 m)	9.0 (2.7 m)
18.0 (5.40 m)	2	4.50 (1.35 m)	9.0 (2.7 m)
18.5 (5.55 m)	2	4.75 (1.425 m)	9.0 (2.7 m)
19.0 (5.70 m)	2	5.0 (1.50 m)	9.0 (2.7 m)
19.5 (5.85 m)	2	5.25 (1.575 m)	9.0 (2.7 m)
20.0 (6.00 m)	2	5.50 (1.65 m)	9.0 (2.7 m)
20.5 (6.15 m)	3	1.25 (0.375 m)	9.0 (2.7 m)
21.0 (6.30 m)	3	1.50 (0.45 m)	9.0 (2.7 m)
21.5 (6.45 m)	3	1.75 (0.525 m)	9.0 (2.7 m)
22.0 (6.60 m)	3	2.0 (0.60 m)	9.0 (2.7 m)
22.5 (6.75 m)	3	2.25 (0.675 m)	9.0 (2.7 m)
23.0 (6.90 m)	3	2.5 (0.75 m)	9.0 (2.7 m)
23.5 (7.05 m)	3	2.75 (0.825 m)	9.0 (2.7 m)
24.0 (7.20 m)	3	3.0 (0.90 m)	9.0 (2.7 m)
24.5 (7.35 m)	3	3.25 (0.975 m)	9.0 (2.7 m)
25.0 (7.50 m)	3	3.50 (1.05 m)	9.0 (2.7 m)
25.5 (7.65 m)	3	3.75 (1.125 m)	9.0 (2.7 m)
26.0 (7.80 m)	3	4.0 (1.20 m)	9.0 (2.7 m)
26.5 (7.95 m)	3	4.25 (1.275 m)	9.0 (2.7 m)
27.0 (8.10 m)	3	4.50 (1.35 m)	9.0 (2.7 m)
27.5 (8.25 m)	3	4.75 (1.425 m)	9.0 (2.7 m)
28.0 (8.40 m)	3	5.0 (1.50 m)	9.0 (2.7 m)
28.5 (8.55 m)	3	5.25 (1.575 m)	9.0 (2.7 m)
29.0 (8.70 m)	3	5.50 (1.65 m)	9.0 (2.7 m)
29.5 (8.85 m)	4	1.25 (0.375 m)	9.0 (2.7 m)
30.0 (9.00 m)	4	1.50 (0.45 m)	9.0 (2.7 m)
30.5 (9.15 m)	4	1.75 (0.525 m)	9.0 (2.7 m)

659.6

SIGN OR GROUP LENGTH FEET (meter)	NUMBER OF LUMINARIES	DISTANCE OF FIRST LUMINAIRE FROM LEFT EDGE FEET (meter)	DISTANCE BETWEEN LUMINAIRES FEET (meter)
31.0 (9.30 m)	4	2.0 (0.60 m)	9.0 (2.7 m)
31.5 (9.45 m)	4	2.25 (0.675 m)	9.0 (2.7 m)
32.0 (9.60 m)	4	2.50 (0.75 m)	9.0 (2.7 m)
32.5 (9.75 m)	4	2.75 (0.825 m)	9.0 (2.7 m)
33.0 (9.90 m)	4	3.0 (0.90 m)	9.0 (2.7 m)
33.5 (10.05 m)	4	3.25 (0.975 m)	9.0 (2.7 m)
34.0 (10.20 m)	4	3.50 (1.05 m)	9.0 (2.7 m)
34.5 (10.35 m)	4	3.75 (1.125 m)	9.0 (2.7 m)
35.0 (10.50 m)	4	4.0 (1.20 m)	9.0 (2.7 m)
35.5 (10.65 m)	4	4.25 (1.275 m)	9.0 (2.7 m)
36.0 (10.80 m)	4	4.50 (1.35 m)	9.0 (2.7 m)
36.5 (10.95 m)	4	4.75 (1.425 m)	9.0 (2.7 m)
37.0 (11.10 m)	4	5.0 (1.50 m)	9.0 (2.7 m)
37.5 (11.25 m)	4	5.25 (1.575 m)	9.0 (2.7 m)
38.0 (11.40 m)	4	5.50 (1.65 m)	9.0 (2.7 m)
38.5 (11.55 m)	5	1.25 (0.375 m)	9.0 (2.7 m)
39.0 (11.70 m)	5	1.50 (0.45 m)	9.0 (2.7 m)
39.5 (11.85 m)	5	1.75 (0.525 m)	9.0 (2.7 m)
40.0 (12.00 m)	5	2.0 (0.60 m)	9.0 (2.7 m)
40.5 (12.15 m)	5	2.25 (0.675 m)	9.0 (2.7 m)
41.0 (12.30 m)	5	2.50 (0.75 m)	9.0 (2.7 m)
41.5 (12.45 m)	5	2.75 (0.825 m)	9.0 (2.7 m)
42.0 (12.60 m)	5	3.0 (0.90 m)	9.0 (2.7 m)
42.5 (12.75 m)	5	3.25 (0.975 m)	9.0 (2.7 m)
43.0 (12.90 m)	5	3.50 (1.05 m)	9.0 (2.7 m)
43.5 (13.05 m)	5	3.75 (1.125 m)	9.0 (2.7 m)
44.0 (13.20 m)	5	4.0 (1.20 m)	9.0 (2.7 m)
44.5 (13.35 m)	5	4.25 (1.275 m)	9.0 (2.7 m)

SIGN OR GROUP LENGTH FEET (meter)	NUMBER OF LUMINARIES	DISTANCE OF FIRST LUMINAIRE FROM LEFT EDGE FEET (meter)	DISTANCE BETWEEN LUMINAIRES FEET (meter)
45.0 (13.50 m)	5	4.50 (1.35 m)	9.0 (2.7 m)
45.5 (13.65 m)	5	4.75 (1.425 m)	9.0 (2.7 m)
46.0 (13.80 m)	5	5.0 (1.5 m)	9.0 (2.7 m)
46.5 (13.95 m)	5	5.25 (1.575 m)	9.0 (2.7 m)
47.0 (14.10 m)	5	5.50 (1.65 m)	9.0 (2.7 m)
47.5 (14.25 m)	6	1.25 (0.375 m)	9.0 (2.7 m)
48.0 (14.40 m)	6	1.50 (0.45 m)	9.0 (2.7 m)
48.5 (14.55 m)	6	1.75 (0.525 m)	9.0 (2.7 m)
49.0 (14.70 m)	6	2.0 (0.60 m)	9.0 (2.7 m)
49.5 (14.85 m)	6	2.25 (0.675 m)	9.0 (2.7 m)
50.0 (15.00 m)	6	2.50 (0.75 m)	9.0 (2.7 m)
50.5 (15.15 m)	6	2.75 (0.825 m)	9.0 (2.7 m)
51.0 (15.30 m)	6	3.0 (0.90 m)	9.0 (2.7 m)
51.5 (15.45 m)	6	3.25 (0.975 m)	9.0 (2.7 m)
52.0 (15.60 m)	6	3.50 (1.05 m)	9.0 (2.7 m)
52.5 (15.75 m)	6	3.75 (1.125 m)	9.0 (2.7 m)
53.0 (15.90 m)	6	4.0 (1.20 m)	9.0 (2.7 m)
53.5 (16.05 m)	6	4.25 (1.275 m)	9.0 (2.7 m)
54.0 (16.20 m)	6	4.50 (1.35 m)	9.0 (2.7 m)
54.5 (16.35 m)	6	4.75 (1.425 m)	9.0 (2.7 m)
55.0 (16.50 m)	6	5.0 (1.5 m)	9.0 (2.7 m)
55.5 (16.65 m)	6	5.25 (1.575 m)	9.0 (2.7 m)
56.0 (16.80 m)	6	5.50 (1.65 m)	9.0 (2.7 m)
56.5 (16.95 m)	7	1.25 (0.375 m)	9.0 (2.7 m)
57.0 (17.10 m)	7	1.50 (0.45 m)	9.0 (2.7 m)
57.5 (17.25 m)	7	1.75 (0.525 m)	9.0 (2.7 m)
58.0 (17.40 m)	7	2.00 (0.60 m)	9.0 (2.7 m)

660.1

SIGN OR GROUP LENGTH FEET (meter)	NUMBER OF LUMINARIES	DISTANCE OF FIRST LUMINAIRE FROM LEFT EDGE FEET (meter)	DISTANCE BETWEEN LUMINAIRES FEET (meter)
58.5 (17.55 m)	7	2.25 (0.675 m)	9.0 (2.7 m)
59.0 (17.70 m)	7	2.50 (0.75 m)	9.0 (2.7 m)
59.5 (17.85 m)	7	2.75 (0.825 m)	9.0 (2.7 m)
60.0 (18.00 m)	7	3.0 (0.90 m)	9.0 (2.7 m)

SECTION 660 TRAFFIC SIGNALS

660.1-DESCRIPTION:

This work shall consist of furnishing and installing various types of traffic signal systems. It shall include, but not be limited to, traffic signals and traffic signal interconnection systems to be installed in accordance with this Specification, as shown on the Plans or as directed by the Engineer.

All electrical work shall conform to current requirements of the *National Electrical Code*, latest edition, all local codes and Section 631 of the Standard Specifications.

All details not specified or not shown on the Plans shall conform to the requirements of the latest issue of the *Manual on Uniform Traffic Control Devices*, (referred to as the MUTCD). This Manual is published by the Federal Highway Administration of the U.S. Department of Transportation and supplemented by the publication "Official Ruling on Request" and the West Virginia Division of Highways Traffic Engineering Division Directives.

660.2-MATERIALS:

All materials shall be new and shall conform to the requirements of the following subsections of 715.42, Traffic Signals.

MATERIALS	SUBSECTION
Pre-Timed, Fixed Cycle Traffic Signal Controllers	715.42.1
Solid State Traffic Actuated Signal Controllers	715.42.2
Traffic Adjusted Master Controller (Type OPV)	715.42.3
Local Coordinating Units	715.42.4
Traffic Detectors	715.42.5