621 MISCELLANEOUS ELECTRICAL WORK

621.01 DESCRIPTION

Miscellaneous Electrical Work shall consist of furnishing all labor, equipment and materials and installing all electrical equipment, conduits, manholes, pull boxes, wiring, transformers, fixtures, non-roadway lighting, and all electrical facilities as shown in the contract documents, and as specified herein for a complete working electrical system. This work shall also include necessary excavation, and backfill, disposal of discarded materials and restoration of disturbed facilities and surfaces in accordance with these specifications.

Wherever the word "provide" is used, it shall mean "furnish and install complete in place and ready for use."

Items of electrical equipment shall consist of products of the same manufacturer, as far as practicable. Each system shall conform as to voltage, amperage, frequency, and type specified.

In order to provide the proposed lighting system the Contractor shall cooperate with PEPCO. PEPCO will supply the type of power required at the locations outlined in the contract documents.

621.02 CODES AND STANDARDS

Material, equipment and installation shall conform to the following:

American Society for Testing and Materials (ASTM)

American National Standards Institute (ANSI)

Certified Ballast Manufacturers

Institute of Electrical and Electronic Engineers (IEEE)

Insulated Power Cable Engineers Association (IPCEA)

National Electrical Code (NEC)

National Electrical Manufacturers Association (NEMA)

Underwriters Laboratories, Inc. (UL)

District of Columbia Electrical Code

National Electric Safety Code

United States of America Standards Institute (USASI)

Rules and Regulations of the Potomac Electric Power Company (PEPCO)

American Association of State Highway and Transportation Officials (AASHTO)

Electrical contractors must be bonded in the District and their electricians must have District licenses. The Contractor's Master Electrician shall secure a permit approved by the Electrical Engineer, D.C. prior to starting any project work, and the Master Electrician shall be

responsible for all project electrical work. The project electrical work shall at all times be inspected by electrical inspectors of the Department of Transportation.

No work shall be covered at any time prior to inspection.

The Contractor must have approved shop drawings, catalog cuts, and specifications available at the jobsite for inspection by the Chief Engineer and the Department's electrical inspector.

621.03 MATERIALS

(A) GENERAL. New first quality materials shall be furnished in conformance with 819. Material and equipment must be UL listed and labeled. All electrical parts, switches, wire, and other elements of the installations shall be of ample capacity to carry required current without excessive heating or causing an excessive drop in potential. Except as otherwise provided herein, each individual item of equipment shall bear a nameplate or other type of indelible marking or brand that shall identify it as to type, catalog number, and manufacturer, and shall be heavy duty industrial-rated. This applies to hardware and miscellaneous materials.

(B) COORDINATION WITH OTHER TRADES. It shall be the responsibility of the Contractor to coordinate the location of equipment, conduit, devices, fixtures, outlets, etc., furnished and installed under other sections and by other trades to the extent that interference among such items is avoided. Relocation of items required as a result of failure of the Contractor to coordinate his work with the work of other trades shall be at the expense of the Contractor and at no additional cost to the District.

(C) STANDARD PRODUCTS. Unless otherwise indicated, materials furnished shall be standard products of a manufacturer regularly engaged in the production of such equipment and shall be the manufacturer's latest standard design complying with the specification requirements.

Where materials, equipment, apparatus, or other products are specified by manufacturer, brand name, type, or catalog number, such designation is to establish standards of desired quality and style and shall be the basis of the bid. Specified materials shall be furnished unless changed by mutual agreement. Where two or more designations are listed, the choice shall be optional with the Contractor.

Should the Contractor propose to furnish materials and equipment other than those specified, as permitted by the "or approved equivalent" clauses, he shall submit a written request for any or all substitutions to the Chief Engineer and must demonstrate that the equivalent product being submitted is equal to or exceeds all technical performance and visual criteria of the original specified item. Where such substitutions alter the design or space requirements indicated on the plans, the Contractor shall include in his request all items of cost for the revised design and construction including cost of all allied trades involved.

Acceptance of the proposed substitutions shall be subject to approval of the Chief Engineer. If requested by the Chief Engineer, the Contractor shall submit for inspection samples of both the specified and the proposed substitute items.

In all cases where substitutions are permitted, the Contractor shall bear any extra cost of evaluating the quality of the materials and equipment to be installed.

(D) SAMPLES. When samples are required they shall be submitted to the Chief Engineer for approval within 8 weeks after award of contract or prior to start of work, properly marked for identification and free of expense to the District. The District reserves the right to mutilate or destroy any sample submitted when considered necessary for testing purposes. Samples not so mutilated or destroyed will be returned to the Contractor at his expense when no longer necessary for the performance of the contract. Sections 106.01, 106.02, and 106.03 shall apply to samples and materials used in conjunction with Electrical Work.

The Contractor shall submit the following:

(1) The name and manufacturer of the equipment he proposes to furnish.

(2) Such data and descriptive materials as may be necessary for the mechanical trades in connection with maintenance.

(3) All wiring or necessary diagrams and drawings for approval.

(4) Any additional samples if deemed necessary.

(E) MATERIAL AND WORKMANSHIP. Installation work shall be in accordance with the contract documents. Defective equipment or equipment damaged in the course of installation or test shall be replaced or repaired by the Contractor in a manner meeting the approval of the District without additional compensation.

The contract drawings indicate the extent and general arrangement of the conduit and wiring systems. If departures from the contract drawings are deemed necessary by the Contractor, details of such departures and the reasons therefore, shall be submitted as soon as possible to the District for approval. No departures shall be made without prior written approval.

The Contractor shall be responsible for all cutting and patching necessary for accomplishing the work. All such modified areas shall be left in as good repair as prior to the beginning of this work, at the expense of the Contractor and at no additional cost to the District. Cutting of structural members shall not be done without approval of the Chief Engineer.

Materials and items of work shall be as specified in 819, on the contract plans and/or in the Special Provisions.

(F) GUARANTY. The Contractor shall guarantee all electrical work to be in accordance with contract requirements and free from defective or inferior materials, equipment, and workmanship for a period of 1 year from date of acceptance of the electrical work.

If, within the guaranty period, the Department finds that guaranteed work needs to be repaired or changed because of the use of materials, equipment, or workmanship which are inferior, defective or not in accordance with the terms of the contract, the Department shall so inform the Contractor in writing and the Contractor shall promptly and without additional expense to the District: **(1)** Place in a satisfactory condition all such guaranteed work; **(2)** Make good all damage to equipment, the site, the structure, and/or related

appurtenances, which is the result of such unsatisfactory guaranteed work; **(3)** Make good any work, materials, and equipment that are disturbed in fulfilling the guarantee.

Should the Contractor fail to proceed promptly in accordance with the guarantee, the District may cause such work to be done and the Contractor and the surety or sureties under the bond shall be jointly and severally liable for the cost of same.

621.04 CONTRACT PLANS AND MANUFACTURER'S DRAWINGS

(A) ELECTRICAL PLANS. These plans indicate the general arrangements of circuits and conduits and the locations of outlets, equipment, other devices, and appurtenances. The plans and Special Provisions are intended to show and describe the work entirely. However, every item necessary to complete the work may not be specifically shown or mentioned. Equipment necessary for the proper operation of a complete electrical system, such as power connections, wiring, and minor items such as fittings, transitions, hangers, etc., not shown or specified, shall be included in the work. The Contractor shall be responsible for furnishing all materials for the installation, complete, so as to insure the successful operation of the equipment.

(B) MANUFACTURER'S DRAWINGS. Manufacturer's drawings shall consist of all shop and installation drawings, catalogs, photometric curves, performance data, equipment installation details, etc. The Contractor shall secure and/or prepare these drawings and submit them as required by 105.02 before purchasing materials or proceeding with construction. Shop drawings shall show complete details of construction for all portions of the work included. Drawings shall be clearly marked to show building location, equipment item or device number, and any other information required to clearly associate an item with its intended application. All electrical diagrams and symbols used on shop and working drawings shall conform to NEMA and/or USASI Standards. The Contractor shall check each drawing to insure conformance with the contract plans and specifications, and each shall bear the Contractor's signature and certification. Drawings and data not clearly identified will be returned without approval to the Contractor.

Transmittals accompanying all shop drawings shall contain names and addresses of the Contractor, subcontractors, and suppliers. Project title, reference to prior actions on submissions and specification reference shall also be indicated.

621.05 STRUCTURE GROUNDS

Each bridge, wall, overhead section of guide sign structure, all non-current carrying metal parts for roadway lighting systems, and other structures having electrical elements contained therein or attached thereto shall be permanently grounded and checked for a grounding condition.

Furnishing of all materials necessary to provide the entire structure grounding system, including ground rods complete in place, shall be included in this item. Grounding shall be accomplished as soon as materials are in place to which the grounding wires are to be attached.

Each lighting standard shall be grounded with a No. 8 stranded copper wire connecting the pole shaft to the adjacent junction box. Each conduit pipe cap inside a lighting standard shall

be replaced with an insulated grounding bushing fitting. This bushing shall be bronze, threaded and shall be provided with an insulator ring mechanical bonding wire connection.

Connections of all grounding cables shall be made with approved solderless mechanical connectors made of copper alloy with silicon bronze components.

In order to provide continuity in the grounding of conduit at light poles on bridge structures, No. 8 AWG, stranded, bare, soft drawn copper wire shall be installed between grounding lugs of each grounding bushing and the ground lug or bolt in the pole base. Where the plans require the use of a raceway employing a junction box with locknuts and bushing connections, the work shall be connected between the grounding bushings and the pole ground connection.

In order to minimize potential differences between units of a bridge structure, each unit shall be electrically tied to each adjacent unit both longitudinally and transversely with grounding cable connecting the outside girders or beams together or as shown on the plans. The superstructure shall be grounded with wire brazed to the structure and connecting to the rods as shown on the plans. The ground and bonding jumper copper wire, suitably looped, shall be installed to allow for movement of the girders. Transverse electrical ties need not be made when the lateral separation between sections of parallel bridges is 6 feet or greater. Two coats of insulating varnish shall be applied over all exothermic welds and exposed cable.

621.06 GROUND RODS

Ground rods conforming to 820.10 shall be driven at the location shown on the plans. Copper wire conforming to 820.11 shall be secured to the upper end of the ground rod with an approved connection. If required by the plans, the ground conductor shall be installed in a 3/4 inch rigid conduit between the ground rod and service and control equipment enclosure as shown on the plans. The ground conductor connection to the ground rod shall be accessible for inspection after completion of installation.

Each ground rod shall be tested as specified in 621.16 (A). If the earth resistance measurement exceeds 25 ohms, a second ground rod shall be installed as shown on the plans. The two rods shall be temporarily connected together with ground wire and the earth resistance measured. If the earth resistance still exceeds the above value, a 10-foot rod shall be exothermically welded to the top of the second rod to constitute a continuous 25-foot long rod. After this is driven into the earth it shall be temporarily connected to the first rod and the earth resistance measured. If the earth resistance still exceeds the required value, this procedure of lengthening and driving the second rod shall continue until either an acceptable value of earth resistance is obtained or the extended rod cannot be driven further.

If the measured earth resistance still exceeds the required value after the last rod is driven and interconnected, the Chief Engineer shall be contacted for his final determination and further instructions.

Where rock is encountered and acceptable earth grounds cannot be accomplished by driving as described above, a grounding grid utilizing direct buried messenger cable or rods exothermically welded end to end shall be used to bond light poles and structures in continuous series to some point on a type of terrain that will permit obtaining an acceptable earth ground. Payment for this change shall be made by supplemental agreement.

Connections between rods and cable shall be made by exothermic welds with two coats of insulating varnish applied over welds and exposed cable.

621.07 PULL BOXES

Pull boxes and covers shall be furnished as specified, and shall be located where designated on the plans. When required, excavation shall be performed as nearly as practicable to the outside dimensions of the pull box. After boxes are set to proper grades, excavated spaces around the boxes shall be backfilled with suitable material placed and thoroughly tamped in thin layers.

621.08 TRENCH

Trenches shall have a minimum depth of 2 feet and shall not exceed 12 inches in width without prior approval of the Chief Engineer. Trenches located adjacent to and parallel with curbs or pavements shall not deviate more than 6 inches from the designated lines.

Sawcut lines in paved areas shall follow existing joints or grooves where possible and shall be pre-marked and approved by the Chief Engineer before sawing.

Trench backfill shall be placed in layers not to exceed 4 inches in thickness and compacted with mechanical tampers or other approved mechanical compactors as directed. Backfill material for trenches in areas of pavement, paved shoulders, or stabilized aggregate shoulders shall consist of granular material. Backfill material for trenches in other areas shall consist of suitable soil or granular material except that the material around and in the first 4 inches above the top of unit type duct-cable not encased in concrete shall not contain pieces larger than 1/2 inch..

621.09 CONDUITS

Conduits shall be of the size shown in the contract documents and/or as specified herein and shall be concealed in the structure and under the roadways in compliance with all codes and standards cited in 621.02. The spacing and location of conduits shall conform to the dimensions shown on the drawings. All conduits shall be rigidly supported in an approved manner during pouring of concrete. Ends of all conduits shall be plugged or capped to prevent seepage of grout, concrete, water, or dirt into the conduit during construction.

Conduits shall be dripped at low points to prevent accumulation of condensate by sloping to boxes or installing “T” drains.

Where conduits pass through joints in concrete, approved expansion fittings shall be installed.

After installation, all conduits which will be left empty shall have a pull wire or cord installed. Pull wire or cord shall be made of corrosion resistant material with a minimum breaking strength of 200 lb. Rigid conduit shall be cleared after installation by drawing an iron shod mandrel through each section of conduit line between pull boxes as it is constructed. The mandrel shall not be more than ¼ inch smaller than the internal diameter of the conduit and shall have a rubber or leather gasket slightly larger than the bore of the conduit. Defective conduits shall be repaired and the mandrel again drawn through.

Rigid metal conduit shall be installed with a minimum of bends and in no case shall the total angle of bends between outlet boxes of junction boxes exceed 180 degrees. Except for factory ells, the center line radius of conduit bends shall not be less than 12 internal diameters of the conduit. All bends shall be regular and symmetrical and the conduit shall not be flattened or distorted. The conduit shall be coupled and connected at the conduit fitting, junction and outlet boxes and expansion fittings, to assure electrical continuity throughout the entire metallic conduit system. Conduit shall be terminated in the junction boxes with insulated bushings to protect the wires. The use of running threads is prohibited and in lieu thereof an Erickson coupling shall be used.

Conductive compound shall be applied to all threaded ends.

621.10 CONDUIT EXPANSION AND DEFLECTION FITTINGS

Expansion Fittings – Conduit expansion and deflection fittings shall be installed as required where conduit crosses a structural expansion joint or open joint. Where expansion exceeds ¾inch, an expansion fitting shall be combined with the expansion and deflection fitting at the joint. Expansion fittings and expansion and deflection fittings shall be installed in place in accordance with the manufacturer's instructions.

621.11 WIRING SYSTEM

The Contractor shall furnish and install the type, and size of copper wire cables indicated on the plans and/or specified herein in strict compliance with all codes and standards cited in 621.02. Wires shall be drawn into place free from electrical and mechanical injury. No lubricant other than an approved type will be permitted to be used on wire installed in conduit. All wires shall be permanently marked with approved fiber tags as described to expedite tracing of circuits where device terminals are not otherwise identified. Wire shall be placed in rigid conduit unless otherwise specified and the total cross sectional area of the wire shall not exceed 40 percent of the conduit cross section area.

621.12 CABLE CONNECTIONS

All wire and cable shall be continuous from origin to destination without running splices in intermediate trays, pull boxes or manholes. In cases where splices are necessary because of long lengths, approval of splice locations shall be obtained from the Chief Engineer. Splices will not be permitted in conduits, ducts, or trays.

Splices in 600-volt rubber insulated wires and cables (where permitted) shall be accomplished by means of compression connectors. The connector shall be suitable for the size wire used and shall be of one piece tubular tinned copper construction. The indentation shall be such as to assure maximum electrical connection and sufficient physical strength. The connection shall be covered with approved electrical tape, half-lapped to a thickness not less than 50 percent greater than the conductor insulation.

If approved soldered connections are specified in the Special Provisions, each splice shall be covered with polyvinylchloride plastic insulating tape to provide insulation equivalent to that on the wire. Neoprene tape shall then be applied over the splice in half-lap wrappings to a thickness equivalent to the wire or cable outer jacket. Two final laps of polyvinylchloride tape

shall be applied and the splice shall then be painted with an approved air drying insulating varnish.

621.13 CIRCUIT IDENTIFICATION

The Contractor shall furnish and install identifying tags on all circuit cables, in all junction boxes for line and light identification. Tags shall be as per 820.14. Identification markings, designated by the Chief Engineer, shall be stamped on the tags by means of small tool dies. Each tag shall be securely tied to the proper conductor by non-metallic core plastic. Self-adhesive plastic tags shall not be used unless approved by the Chief Engineer.

Each conductor passing through a junction or splice box or terminating in a street light or outlet shall be permanently identified as to circuit number and phase.

621.14 JUNCTION BOXES

Junction boxes of the sizes and types specified shall be furnished and installed as shown on the plans. All junction boxes embedded in concrete structures shall be provided with drains. Any necessary deviation from the plans resulting from existing grade conditions shall be done only under the direct approval of the Chief Engineer in which case the method of installation for the junction box shall be determined by job conditions.

At each location in the electrical cable runs where the Contractor elects to make cable splices other than those shown on the plans or as specified, a junction box of the type indicated on the drawings for similar installations shall be furnished and installed at no additional cost to the District.

621.15 PAINTING ELECTRICAL WORK

Cleaning and painting shall be done in accordance with 707 except that primer shall be zinc-chromate alkyd type conforming to the requirements of Federal Specification TT- P-645. Painted parts shall not be loaded for shipment until paint is thoroughly dry and in any case not less than 24 hours after final shop paint has been applied. No degree of tackiness shall be present at time of loading for shipment.

After electrical equipment installations are complete, all exposed shop painted surfaces shall be field painted with one coat of gray channel paint meeting requirement of Federal Specification TT-E-489C.. Also, all exposed conduits, supports, and other galvanized fittings or exposed parts thereof shall be field painted with one coat of zinc oxide galvanized primer paint meeting FS TT-P-641B, Type II. Before painting, all oil, grease or white oxide shall be removed by cleaning with oil-free naphtha solvent.

621.16 ELECTRICAL TEST

The Contractor shall be responsible for furnishing all personnel and equipment required to perform the following tests and demonstrations successfully to the satisfaction of the Chief Engineer.

Not less than 30 days prior to commencement of each required electrical test, the Contractor shall submit to the Chief Engineer the types, styles, or catalog numbers of all testing equipment to be used for such tests. At the same time, the Contractor shall include a written certification

that the testing equipment was last calibrated not more than 60 days prior to the date when such tests are performed by a testing agency, whose qualifications as such are acceptable to the Chief Engineer.

(A) GROUND TEST. Each ground rod, structure ground, and ground grid shall be measured for earth resistance immediately after being installed and before the ground wire is attached. If the earth resistance measurement exceeds 25 ohms, the Contractor shall proceed as specified in 621.06. Units of measurement for reporting shall be expressed in ohms.

(B) CABLE INSULATION TEST. The insulation resistance shall be measured for each insulated cable, except pole and bracket cable, located in each primary feeder, secondary feeder, and distribution circuit, including duct- cable used in distribution circuits. The test shall be performed on each cable of each circuit with all ballasts disconnected and all connections to earth grounds, including ground rods and grounding connections to light poles, disconnected. Units of measurements for reporting shall be expressed in mega ohms. The cable insulation resistance shall exceed 10 mega ohms at 60º F.

(C) DEMONSTRATION. The Contractor shall demonstrate to the satisfaction of the Chief Engineer that all:

(1) Lighting and control circuits are continuous and free of short circuits.

(2) Circuits are free from unspecified grounds.

(3) Circuits are properly connected in accordance with applicable wiring diagrams.

(4) Circuits are operable, which demonstration shall include the functioning of each control not less than 10 times and continuous operation of each lighting circuit for not less than ½hour and/or as specified in the Special Provisions.

(5) The Contractor shall record all faults, the method and date of correction of each, and submit a written report to the Chief Engineer in an orderly and approved format.

(D) COSTS. All costs of labor, materials, equipment, electrical energy and incidentals required for performing the above electrical test shall be included in the contract price. Defects in materials or workmanship in the installation as disclosed by the tests shall be corrected or replaced by the Contractor without additional compensation.

621.17 NAVIGATION LIGHTS

(A) Description. This work shall incude furnishing, installing and wiring of navigation lights complete and ready for service on structures, as shown in the contract documents or as directed by the Chief Engineer.

(B) Materials. Conduit, boxes and fittings shall conform to the requirements of this Section and 820. Conductors and electrical components shall conform to the requirements of this Section and 820. No. 8 single-conductor wire shall be used from the connection at the service pole to the first junction box on the structure, and No. 10 single-conductor wire shall be used for other wiring.

(C) Electrical Service. Power will be furnished within 100 feet of the end of the bridge by 120/240 volt, single phase, 60 hertz, three wire service. The Contractor shall furnish and

install a wood pole on which the power company will terminate its service lines. The Contractor shall install service entrance equipment on the wood pole in accordance with the requirements of SE-8. Safety switch shall be rated at 30 amps, 240 volts, two pole, solid neutral 120 AC and fused for 15 amps.

(D) Lights. Lights shall be furnished and installed in accordance with the current rules and regulations for lighting bridges furnished by the U.S. Coast Guard (USCG) and shall be subject to USCG approval. Material and workmanship shall conform to the standards of NEC and the requirements of PEPCO. Lights shall be equipped with an automatic lamp changer with the capacity of four lamps and a step-down transformer to operate standard low voltage refocused lamps. Lights shall be arranged to be turned on and off automatically from sunset to sunrise. Lights shall be controlled by a photoelectric control. The control shall operate a two-pole, 30 ampere, normally opened, magnetic relay mounted in a NEMA 3R control center cabinet. The control for the lights shall be mounted on the service pole.

621.18 MEASURE AND PAYMENT

The unit of measure for Miscellaneous Electrical Work as specified in the contract documents will be the job.

Miscellaneous Electrical Work will be paid for at the contract lump sum price, which payment will include all labor, materials, tools, equipment and incidentals necessary to complete the work.