# BASIC MATERIALS AND METHODS SECTION 16100

## PART 1 GENERAL

#### 1.01 SECTION INCLUDES:

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. Furnish and install all electrical work, materials and accessories indicated schematically by Drawings, schedules and as specified herein including, but not limited to, the following:
  - 1. Rigid Galvanized Steel Conduit (RGSC)
  - 2. RGS conduit with PVC coating
  - 3. Electrical Metallic Tubing (EMT)
  - 4. Flexible Metal Conduit (FMC)
  - 5. Intermediate Metal Conduit (IMC)
  - 6. Liquid-tight Flexible Metal Conduit (LTFC)
  - 7. Underground PVC Conduit
  - 8. Bushings
  - 9. Fittings
  - 10. Boxes
  - 11. Wire and Cable
- 1.02 RELATED WORK:
  - A. As specified in the following divisions:
    - 1. Section 16420 Airfield Lighting Regulators
- 1.03 REFERENCES:
  - A. See Specification Section 16010 1.03.
- 1.04 SUBMITTALS:
  - A. See Specification Section 16010 1.04.

- B. The Contractor must submit with the wire submittal a listing of the code numbers used by the Manufacturer of the wire/cable the Contractor is submitting.
- 1.05 QUALITY CONTROL:
  - A. See Specification Section 16010 1.05.
- 1.06 DELIVERY STORAGE AND HANDLING:
  - A. See Specification Section 16010 1.06.
- 1.07 WARRANTIES AND GUARANTEES:
  - A. See Specification Section 16010 1.07.
- 1.08 EXTRA MATERIALS AND SPARE PARTS:
  - A. None required
- 1.09 ENVIRONMENTAL REQUIREMENTS:
  - A. None required
  - Β.
- 1.10 SPECIAL REQUIREMENTS:
  - A. Field Measurements Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
  - B. Coordination Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.
- PART 2 PRODUCTS
- 2.01 EQUIPMENT BASES:
  - A. The Contractor must provide concrete pedestals, bases, pads, curbs, anchor blocks, anchor bolts, slab inserts, hangers, channels, cradles, saddles, etc., for installation of all electrical equipment and apparatus that is floor mounted.
  - B. Concrete pads must be 6 inches high, unless shown otherwise on the Drawings, complete with steel reinforcing and necessary bolts, anchors, etc. Where the concrete pad is set directly on a concrete

floor, drill and epoxy dowels into the floor after scarification. These pads must be extended at least 2 inches beyond the equipment outlined on all four (4) sides, unless otherwise indicated on the Drawings. The Contractor must chamfer the edges of the pad at a 45° angle.

#### 2.02 VIBRATION ISOLATION:

- A. Vibration producing equipment must have either spring elements in the hanger rods or isolation pads under the equipment.
- B. Conduit connections to vibration producing equipment must be made with flexible conduit, using either FMC or LTFC as required.
- C. Acceptable manufacturers must be Barry Division of Barry Wright Corp., Consolidated Kinetics Corp. or Mason Industries.

#### 2.03 CONDUIT AND FITTINGS:

- A. Rigid Galvanized Steel Conduit (RGSC):
  - 1. Conduit and fittings must be rigid galvanized steel, heavy wall type, hot-dipped galvanized with zinc-coated threads and acceptable agency labeled.
  - 2. Rigid Galvanized Steel conduit and couplings must be threaded, rigid steel, hot-dipped galvanized after fabrication and must be in accordance with UL 6, Federal Specification WW-C-581d and ANSI Standard C80.1.
  - 3. RGSC must be used for all exposed work, unless permitted otherwise in these Specifications, outdoor conduit runs and for all conduit work installed in slabs.
  - 4. Split, compression or setscrew couplings and connectors are not acceptable. All connections and fittings must be threaded.
- B. Intermediate Metal Conduit (IMC)- Minimum size 2 inches:
  - 1. Conduit and fittings for intermediate metal conduit (IMC) must be heavy wall type, hot-dipped galvanized with zinc-coated threads and acceptable agency labeled.
  - IMC and couplings must be threaded, rigid steel, hot-dipped galvanized after fabrication and must be in accordance with UL 6.
  - 3. IMC can be used for indoor exposed work in dry locations. It must not be installed below 8 feet with the exception of

completing conduit runs to cabinets, panels and pull and junction boxes where the installation has been in IMC.

- 4. The use of "Uni-swivel" type IMC is acceptable. The "Uniswivel" system must employ a fully threaded connection. The use of set-screw type of connections are not acceptable.
- 5. Splice, compression or setscrew couplings and connectors are not acceptable. All connections and fittings must be threaded.
- C. EMT Conduit
  - 1. Electrical metallic tubing (EMT) "thin wall" conduit must be steel, electroplate galvanized after fabrication and acceptable agency labeled. The conduit must be in accordance with UL 6.
  - 2. EMT couplings and connections must be of the compression type with insulated throats. The insulated throats must be of flameproof and non-combustible composition materials.
  - 3. EMT must be used for indoor installations where the conduit is concealed in walls and above finished ceilings. EMT will not be installed in concrete.
  - 4. Set-screw, die cast, white or pot metal and indenter type fittings are not acceptable.
- D. PVC Coated RGS Conduit
  - 1. PVC coated rigid steel conduit, including elbows and fittings must be made with RGS conduit, conforming to the RGSC Section if this Specification, to which is bonded a Polyvinyl chloride (PVC) coating for the protection of the conduit.
  - 2. The minimum thickness of the exterior coating must be 40 mils.
  - A Urethane chemical coating must be uniformly and consistently applied to the interior of the conduit and fittings. The internal coating must be applied at a minimum thickness of 2 mils.
  - 4. The PVC coated galvanized rigid conduit must be U.L. listed / labeled. The Manufacturer must submit certified test results from a recognized independent testing company validating that their product meets or exceeds the requirements of ASTM D870-02 Testing Water Resistance of PVC Coating Using Water Immersion and ASTM D2247-02 Testing Water Resistance of PVC Coating in 100% Relative Humidity, to signify compliance to the adhesion performance standards.
  - 5. PVC coated conduit must conform to NEMA Standard RN1-1986.

- 6. All fittings and components for use with PVC coated conduits must be PVC coated as specified in this Specification. Each coupling must be furnished loose with each length of the conduit and must have a PVC sleeve extending one (1) pipe diameter, or 2 inches, whichever is greater, beyond the end of the coupling. The inside diameter of the sleeve must be the same as the outside diameter of the IPS conduit used with it. The wall thickness of the sleeve must be the same as the PVC coating in the conduit. All screws for fittings which are PVC Coated must be Stainless Steel.
- 7. PVC coated conduit must be used in chemical environments, and for exterior work and underground ductbanks where so specified.
- E. Any portion of the conduit system that shows corrosion within the guarantee/warranty period must be replaced at no cost to the City.
- F. The minimum conduit size, unless specified otherwise, is 3/4 inch.
- G. All conduit fittings must be of the types specified, must be in accordance with UL 514 for normal application, and UL 886 for hazardous applications
- H. Acceptable conduit manufacturers must be Allied Tube and Conduit Corp., Wheatland Tube Company or Steel Duct Conduit Products.
- I. Acceptable conduit fitting manufacturers must be Appleton, Crouse-Hinds, OZ Gedney, Bridgeport, Regal or T&B.

# 2.04 FLEXIBLE CONDUIT AND FITTINGS:

- A. Liquid-Tite Flexible Conduit (LTFC) must be galvanized steel with a moisture and oil-proof plastic-coated jacket, listed and labeled by an acceptable agency. LTFC must be rated for the temperature environment in which it must be placed.
- B. LTFC must be in accordance with UL 360, with PVC outer jacket and integral ground conductor.
- C. Connectors must be malleable iron or steel with insulated throat, squeeze-type, with annular gripping rib. Particular attention must be given to maintaining ground bond and firm support through flexible connections. Liquid-tight connections must have insulated throats.
- D. Flexible metal conduit (FMC) must be in accordance with UL 1.

- E. Fittings for FMC must be specifically designed and manufactured for the use with FMC.
- F. Flexible metal conduit installed in air return ceilings and other plenums will be as approved by the City of Chicago Bureau of Electrical Inspection.
- G. Acceptable manufactures are Anamet, Electro-Flex or Ultra-Tite.
- 2.05 PVC CONDUIT:
  - A. Non-metallic conduit must be PVC Schedule 40 with concrete encasement where shown on Drawings.
  - B. PVC conduit, including elbows and couplings, must meet the requirements of NEMA Standard TC2 (latest edition), UL Standard 641, Federal Specifications WC-1094A and must be UL rated and listed for use with 90 degrees C rated conductors in compliance with Article 347 of the NEC. Materials must have a minimum strength of 7,000 psi, flexural strength of 11,000 psi, and compressive strength of 8,600 psi, all at an ambient temperature of 23 degrees C.
  - C. The conduit must be manufactured from virgin PVC compound that must meet the applicable requirements of ASTM D1784.
  - D. PVC conduit fittings must meet with the requirements of NEMA Standard TC3 (latest edition), UL Standard 514 supplement and Federal Specification WC-1094A.
  - E. Standard fittings and cement must be obtained from the conduit manufacturer. Assembly of the PVC conduit system must be in strict accordance with the manufacturers instructions.
  - F. Acceptable PVC conduit manufacturers must be National Pipe, Carlon (Lamson and Sessions), Cantex, and IPEX.

# 2.06 BUSHINGS:

- A. Bushings for Rigid and IMC conduit must be malleable iron body with 105 degrees C and with 150 degrees C insulating ring. Insulator material must be molded in place and must be non-removable.
- B. Acceptable manufacturers must be Appleton, Catalog Series BU75I, OZ/Gedney Catalog Series IBC-125.
- C. Grounding bushings for RGSC and IMC must be Appleton Series GIB-75L or OZ/Gedney Series HBLG0722. Bushings must be hot-dipped

galvanized or triple coated with an insulating ring molded into the bushing with a 150 degree C rating. Insulating ring must be non-removable.

D. All bushings must be of the threaded type. Set screw or compression type bushings are not acceptable.

## 2.07 CONDUIT SEALS AND EXPLOSION-PROOF FITTINGS:

- A. Conduit seals must be Crouse-Hinds Type EYS or EZS, Appleton ESUF or ESUM or OZ Gedney and filled with compound after first damming with proper fiber per the manufacturers instructions. The fiber and compound must be from the same manufacturer as the fitting.
- B. Explosion-proof seal, drain and breather conduit fittings must be installed as required by Code.
- C. Fittings and sealing compound must be designed for application at the Class, Division and Group at locations indicated on the Drawings. Fittings must be of the malleable iron type.
- D. Combination seal and drain fittings may be used in lieu of two separate fittings.
- E. Acceptable explosion-proof manufacturers must be Appleton Electric Co., Crouse-Hinds Co. or OZ Gedney.

#### 2.08 PULL AND JUNCTION BOXES:

- A. Pull and junction boxes in non-hazardous environment exterior of buildings, interior wet areas, and chemical environment where chemicals are stored or mixed with liquids and areas where subject to corrosive elements must be NEMA Type 4X, 316 stainless steel, with stainless steel hinged cover, stainless steel fasteners and stainless steel hardware. Minimum gauge must be 12 ga. for boxes with no dimension larger than 18 inches, and 10 ga. for all other boxes. The welds must be ground or polished to present a clean and neat finish.
- B. Pull and junction boxes in non-hazardous and dry environment must be NEMA Type 12 gasketed, 12-gauge, seam welded, galvanized, with a rust inhibitive primer, screwed type or hinged as required by job conditions. All screws must be stainless steel.
- C. Pull and junction boxes located in a hazardous environment must be explosion-proof type, rated for the environment into which they must be located.

- D. Covers for non-hazardous boxes must be secured with round or flat head machine screws. Where required screws must be of the tamper-proof type.
- E. Where required by building construction, special junction or pull boxes must be provided in sizes and shapes determined from field measurements as required to make a neat and workmanlike installation. Special size and/or shaped boxes must be sized in accordance with the Chicago Electrical Code.
- F. Where required, boxes with metal barriers or separators for grouping of dissimilar conductors for voltage or system must be provided in compliance with the City of Chicago Electrical Code.
- G. Where required by the Drawings or job site conditions special finishes must be provided. These may be hot-dipped galvanized, PVC coated, etc. The Contractor must take extreme precaution when working in these areas to insure that the proper finishes are provided.
- H. Acceptable manufacturers must be Appleton Electric, Crouse-Hinds, Hoffman, Keystone, A.W. Circle, Chicago Switchboard or IEC.

# 2.09 OUTLET BOXES:

- A. Outlet boxes for indoor, dry work must be of the galvanized, pressed steel, knockout type. Boxes must be suitable for the structural conditions with the size determined by the number of conduits entering, and the devices or fixtures attached as required by the manufacturer. All outlet boxes must be in accordance with UL 514 for normal application and UL 886 for applications in hazardous locations.
- B. Outlet boxes must generally be 4 inches square or octagonal except as follows:
  - 1. In masonry walls, where conduit is installed concealed, each outlet box must be square cut masonry boxes.
  - 2. For concrete installation boxes must be suitable and constructed for installation in concrete.
  - 3. In exposed work, suitable boxes must be used for switches and receptacles. The NEMA type must be as described in this Specification.
  - 4. Outlet boxes for use outdoors or in wet/damp locations must be of the threaded hub, cast malleable iron type, with malleable iron cast covers. Covers must be gasketed unless of the threaded type.

- 5. In finished plaster walls, drywall, etc., raised device covers on outlet boxes must be provided.
- 6. Where 1-1/4-inch conduit is required, the box size must be a minimum of 4-11/16 inches square.
- C. Proper covers on flush mounted boxes must be provided.
- D. Device Boxes
  - 1. Recessed ceiling fixtures, unless otherwise specified by the light fixture manufacturer, must have 4 inch square sheet steel box with blank cover.
  - 2. Surface mounted ceiling fixture and surface mounted wall bracket fixtures must have 4 inch sheet steel octagon box with round opening plaster ring.
  - 3. Ceiling outlets and wall bracket outlets in dry locations must have 4 inch sheet steel octagon box with proper plaster ring.
  - 4. Outlet boxes on exposed conduit run in wet or damp locations must be a cast iron box with threaded hubs and gasketed cover.
  - 5. Wall switch and receptacle boxes installed in tiled or plastered walls must have 4 inch square sheet steel box or multigang box with proper tile or plaster ring as required. Two (2) gang utilization may be provided by means of 4 inch square box with two (2) gang tile or plaster ring.
  - 6. Wall switch and receptacle boxes in dry locations in brick walls, unfinished walls, woodwork, etc. must be a 4 inch square sheet box, with single gang or two (2) gang plate ring of the proper depth.
  - 7. The use of single gang boxes is prohibited.
  - 8. Extra deep boxes must be provided for such devices as dimmers, G.F.I.C.'s or where there are more than 4 wires spliced together with a wiring device(s) also contained in the same box.
- E. Plaster covers must have threaded ears and must be of suitable depth for the application.
- F. The Contractor must provide boxes with metal barriers, baffles or separators for grouping of dissimilar conductors or system separation.
- G. Acceptable manufacturers must be Appleton, Raco, Steel City or Crouse-Hinds.

#### 2.10 EXPANSION JOINTS:

- A. The Contractor must provide expansion couplings with 8 inch movement and with bonding jumpers in all conduit crossing building and structure expansion joints.
- B. Expansion fittings must be Appleton, XJ with XJB jumpers, Crouse-Hinds or OZ Gedney.
- 2.11 FLOOR BOXES AND FITTINGS:
  - A. Concrete tight floor boxes must be pressed steel boxes with adjustment brass flange and covers. Acceptable manufacturers must be Bell F4052, Hubbell 2529 or Walker.
  - B. Watertight floor boxes must be cast iron with adjustable brass flange and covers. Close up plugs and reducing bushings must be provided as required. Acceptable manufacturers must be Bell F122-NR, Hubbell 2537 or Walker
- 2.12 WIRE AND CABLE 600 VOLT:
  - A. Wire and cable must be soft copper, properly refined and must have minimum conductivity of 98 percent. Aluminum conductors are <u>not</u> acceptable.
    - 1. Conductors for power and lighting must have 600-volt type insulation, must be not less than No. 12 AWG, must conform to the latest CEC and must bear acceptable agency label.
    - 2. Wire for signal and control systems must be No. 14 AWG stranded unless otherwise indicated on the Drawings, or elsewhere in the Specifications.
    - 3. Factory wired equipment of a manufacturers' standard product line must be wired with the manufacturers' standard wire size and type provided that the wiring meets all applicable Code requirements. This does not apply to custom-built equipment as specified elsewhere in the Specifications.
  - B. Wire and cable must be delivered to the job site in original packaging or on factory reels. All wire and cable must bear tagging or marking on the finish at regular intervals and consisting of manufacturers' name or code number, as well as the insulation type, voltage rating and acceptable agency listing.
  - C. Wire and cable must be factory color-coded insulation and must be installed and connected as follows:

1. Color coding for voltage system of 250 volts and less must be

a.	"A" Phase	-	Black	
b.	"B" Phase	-	Red	
C.	"C" Phase	-	Blue	
d.	Neutral	-	White	
e.	Ground	-	Green	
Color coding for voltage system o				

2. Color coding for voltage system of over 250 volts and less than 600 volts must be

a.	"A" Phase	-	Brown
b.	"B" Phase	-	Orange
C.	"C" Phase	-	Yellow
d.	Neutral	-	Gray
e.	Ground	-	Green
0			

- 3. Green must be used for grounding only.
- 4. Three-way and four-way switch travelers must be of a different color from colors stated above and they must be of the same color.
- D. The insulation must be applied tightly to the conductor and must be free stripping.
- E. Branch circuit wiring must be solid copper No. 12 AWG unless otherwise specified.
- F. Wire No. 10 AWG and larger must be stranded copper.
- G. Type THHN/THWN thermo-plastic insulated, 90 degrees C dry and 75 degrees C wet rated must be used for light, power and other wiring not specifically defined for all sizes. Type THHN thermo-plastic insulated 90 degrees C rated must be used for continuous row fluorescent fixture wiring.
- H. Type SF-2 silicone insulated glass braid jacket, 200 degrees C< 600-volt rated must be used for fixture wiring and or recessed incandescent fixture wiring and must be No. 12 AWG minimum.
- I. Teflon insulated 200 degrees C rated must be used for use within 5 feet of boilers and 1 foot of heating pipes.
- J. Wire and cables 600-volt rated for installation in floor slabs, etc. and outdoor use in exposed conduit must be XHHW-2. All underground ductbank installation must be RHH/RHW/USE, either XLP-USE or EPR with a CPE jacket, insulated.

- K. If any of the cable types are modified by the Drawings, the Drawings must be followed.
- L. Wire types for the telephone, communications, public address, computer data, door security and fire alarm systems must be in accordance with recommendations of the equipment manufacturer. Acceptable manufacturers of this type of cable must be American Insulated Wire, Belden, Dekoron, Okonite, Pirelli or West Penn.
- M. The 600-volt insulated wires and cables must be factory tested prior to shipment in accordance with the latest ICEA standards for the insulation specified.
- N. Samples and reports on the results of shop tests for all wire and cables, descriptive literature for splices and terminations must be submitted and must be treated as a Shop Drawing submittal.
- O. Acceptable cable manufacturers for 600-volt rated cable must be American Insulated Wire Corp., Southwire, Cerro, Aetna,, Pirelli, and Draka Cableteq.

# 2.13 CONNECTORS:

- A. For connections to bus bars, use copper compression connectors. Connectors must be crimp type. All connectors must be copper. Copper compression connectors must be long barrel, tin plated, closed end compression type. The barrel for each cable lug must be sized for the exact cable size specified. Copper-Aluminum connectors are not acceptable.
- B. Mechanical or set screw types are not acceptable. The cables must be terminated with the die type compression tools. The compression connection must be UL rated. Use only those tools which must provide a UL rated connection for the manufacturers product used.
- C. Conductors No. 2 AWG and larger must terminate in two-hole solderless lugs.
- D. Conductors No. 10 AWG and No. 4 AWG, inclusive, must terminate in one (1)-hole lug.
- E. Multiple-hole lugs must have NEMA spacing
- F. Acceptable connector manufacturers must be Burndy Type YA, Anderson Type VHCL, Thomas & Betts Co., Series 54800 and 54900 or Panduit Series LCB.

- 2.14 TAPE:
  - A. Tape must be UL approved, black or colors as required, self-fusing jacketing tape, resistant to weather, oils, water and chemicals. Tape must met or exceed Scotch 33+.
  - B. Acceptable manufacturers must be Amazon, Plymouth or 3-M.
- 2.15 WIRE-PULLING LUBRICANT:
  - A. Where necessary to use a lubricant for pulling wires, the compound must be listed by Underwriters Laboratories. Cable pulling lubricant must be biodegradable, non-flammable, non-toxic compound with a solid residue of not more than 1.5 percent and a viscosity of at least 50,000 C.P.S.
  - B. Cleaning agents or lubricants that have a deteriorous effect on conductors covering must not be used. Cable lubricant must contain no waxes, greases, silicones or polyalkylene glycol oils.
  - C. Lubricant must be rated to match temperature conditions at the time of installation.
  - D. Acceptable manufacturers must be Polywater J, High Performance Cable Lubricant, Ideal or Aqua-Jel 2.
- 2.16 SUPPORTS:
  - A. Where conduits are supported with one-hole straps, spacers must be used to provide 1/4 inch minimum clearance between the conduits and supporting surfaces. All hangers, racks and straps must be galvanized steel.
  - B. Perforated strap hangers are not acceptable. The use of tie wire is <u>not</u> acceptable.
  - C. Hanger rods for trapeze-type hangers must be made from high tensile strength carbon steel not less than 3/8 inch diameter. The rods must have free-running, burr-free Unified National Coarse threads, with an electro-galvanized finish. Threaded rods used outdoors, in wet areas or in corrosive areas must be Grade 316 stainless steel.
  - D. Conduit supports for trapeze hangers must be made from U-shaped steel components which are galvanized. Minimum material thickness must be 12 gauge. Supports must be hot-dipped galvanized or stainless steel for exterior use. For areas of corrosive nature, or where PVC Coated strut is used, PVC coated components must be provided.

The use of painted components is prohibited. The miscellaneous components which are required to complete the support materials, except the threaded rod, must have the same finish as the U-shaped channel. Conduit supports must be as manufactured by Unistrut Corp., Kindorf, Powerstrut or B-line.

- E. When conditions exceed the structural capabilities of U-shaped strut the Contractor must submit for review detailed Drawings indicating the proposed method of support. The submittal must contain complete details of fabrication, calculations, materials and finishes.
- F. All field cut ends must be treated in a manner which must insure the integrity of the support system immediately after cutting and before installation. The repair must be done with materials which are compatible with the factory finish. In no case must spray on galvanizing be acceptable for PVC or other special finishes.
- G. Supports must be held to concrete walls and ceilings by power-driven fasteners or electro-galvanized steel or stainless steel inserts as manufactured by Ramset, Unistrut Corp. or Hilti. The support type must be determined by the area conditions.
- H. Where single conduits are supported in ceilings, products such as "minis", must be used. The hanger rod size must be as required by the hanger manufacturer.
- I. In metal stud walls, products such as "Caddy clips" must be used to support conduits. These supports must be of the locking type which have an overstrap to lock the conduit into place. These supports must be held in place with screws which must attach them to the metal stud construction.
- J. For 4 inch and 4-11/16 inch boxes, 1/4 inch rods must be the minimum size. Larger size boxes must have hanger rods sized in accordance with the load, but must not be smaller than 1/4 inch.
- K. Boxes installed in stud walls must be secured to the studs by attaching to the stud with mounting brackets specifically designed for this purpose. No box will be installed with support supplied on only one side of the box. Acceptable manufacturers are Appleton, Raco, Steel City or Caddy.

#### 2.17 SPLICES:

A. No splicing will be permitted except in junction boxes, handholes and manholes. Splices and terminations in wire/cable larger than 8 AWG

must be made with compression type connectors and lugs. The tools used must provide a UL certified connection. Indenter type compression fittings must not be acceptable. Lugs must be one (1) or two (2)-hole, color keyed. Lug bolting must include a flat washer, Belleville washer and a locknut.

- B. Outdoor splices of conductors must be made using heat shrink products which, when properly installed, must produce a completely sealed covering over the connectors or lugs. The tube or jacket must be completely coated with mastic to insure a 100 percent seal to the conductor jacket. The splice, when completed, must be watertight. An acceptable manufacturer of this type product is Raychem Inc.
- C. All splices and pigtail connections in lighting and receptacles wiring No. 8 AWG and smaller must be made up with the pre-insulated spring connectors. Acceptable products are Buchannan, Ideal Wingnut or Scotch Lock 2.

#### 2.18 TERMINAL BOXES:

- A. Terminal boxes must be UL 508 Listed for Type 12 and Type 13 or Type 4X. They must conform to NEMA Standards for Types 12 and 13 or Type 4X and they must conform to JIC Standard EGP-1-1967.
- B. Each box must have provisions for the mounting of terminals, either on an internally mounted panel, or on metal strips which are provided by the manufacturer expressly for the purpose of attaching terminal strips. Wherever a panel or strips are provided they must be mounted on studs using lockwashers and nuts.
- C. Terminal boxes in non-hazardous environments which are exterior of buildings, in interior wet areas, in chemical environment where chemicals are stored or mixed with liquids and in corrosive areas must be NEMA Type 4X, 10-gauge minimum for boxes with a dimension over 18 inches, 12 gague minimum for smaller boxes, 316 stainless steel with stainless steel hinged door, stainless steel fasteners and stainless steel hardware. Boxes must have provisions for external locks. The welds must be ground or polished to present a neat and clean appearance.
- D. Terminal boxes in non-hazardous and dry environment must be NEMA Type 12 gasketed, 12-gauge, seam welded, galvanized, with a rust inhibitive primer, hinged door, and must have provisions for external locking. The interior must be painted with white enamel. The exterior will be painted, color as required by the Commissioner.

- E. Acceptable manufacturers of enclosures are Hoffman, A. W. Circle and IEC.
- F. The terminals must be 30 ampere, 600 volt rated, barriered, with pressure plate lugs for termination of control wiring. The terminals must be of modular design and must be held in place in such a manner as to prevent them from becoming loose when adding or removing terminals. Terminal blocks will be acceptable agency listed. Acceptable manufacturers are Buchanan, Allen Bradley, Eaton/Cutler-Hammer/Westinghouse, G. E., and Square D.
- G. The terminal box assembly must be acceptable agency labeled. Identification of terminals and wiring must be per Specification 16195 -Identification.
- H. Acceptable suppliers of the assembled terminal box are Panatrol, Chicago Switchboard, and Gus Berthold.
- PART 3 EXECUTION
- 3.01 INSTALLATION GENERAL:
  - A. Interferences:
    - 1. Locations of conduits, fixtures and equipment must be adjusted and supported to accommodate the work in accordance with field conditions encountered, anticipating potential interferences.
    - 2. The Contractor must determine the exact route and location of each pipe, duct and electrical raceway prior to fabrication.
  - B. Accessibility
    - 1. The work must be installed to permit removal (without damage to or removal of other parts) of parts requiring periodic replacement or maintenance and as defined by the Chicago Electrical Code.
    - 2. Conduits and equipment must be arranged to permit ready access to components and to clear the openings of swinging and overhead doors and of access panels.
    - 3. The Contractor must provide necessary access panels in equipment as required for inspection of interior and for proper maintenance. Access panels must be as specified in other parts of the Contract Documents.
  - C. Exterior Wall Openings

- 1. Openings in exterior walls, particularly at or below grade, must be kept properly plugged and caulked at all times, except when being worked on, to prevent the possibility of flooding due to storms or other causes.
- 2. After completion of work, openings must be permanently sealed and caulked so as to provide leakproof and/or to maintain the fire-rated conditions of the structure penetrated.

#### 3.02 CONDUIT INSTALLATION:

- A. All conduits must be installed as required. The conduit system must be installed complete with all accessories, fittings, boxes and supports in an approved and workmanlike manner to provide proper raceways for electrical conductors.
  - 1. All conduit runs shown in the Drawings are shown diagrammatically for the purpose of outlining the general method of routing the conduits to avoid interferences.
  - 2. Conduit systems must be run concealed or exposed as shown or as dictated by job-site conditions.
  - 3. Exposed conduit runs must be installed true, plumb, parallel with or at right angles to adjacent building members, and must present an orderly, neat and workmanlike appearance.
  - 4. Field bends must be carefully made to prevent conduit damage or reduction in internal areas. All bends must be made with equipment specifically made for the purpose of bending conduit. The bending radius must not be less than six (6) times the nominal diameters of the conduit, with carefully matched bends on parallel runs to present a neat appearance. The number of crossovers must be kept to a minimum. Where larger radii are required to meet utility company requirements, etc., they must be provided. Hickey bends are not acceptable.
  - 5. For PVC conduit bends which exceed the radii available the Contractor must field bend the conduit using equipment and methods as directed by the conduit manufacturer. Extreme care must be taken not to deform the conduit.
  - 6. Conduits which are crushed or deformed in any way will not be installed.
  - 7. All conduits cut on the job must be carefully reamed inside and out to remove burrs. All field cut ends of conduits must be cut square and must be done with the proper tools. The use of tubing cutters is strictly prohibited. Conduits not properly cut will be replaced at no cost to the City.

- 8. For PVC coated conduits all field bends must be made using tools specifically designed for the purpose of bending PVC coated conduits. If the Contractor does not have these tools he must bend the PVC coated conduit using a bend radius one size larger than would normally be used for that size conduit.
- 9. All threads must be tapered. No running threads will be permitted. Threads on steel conduit must be given a coat of zinc duct in oil, or other approved compound. All joints must be properly tightened and must be watertight and insure a low resistance ground path in the conduit system.
- 10. For PVC coated conduits field cut threads must be done with tools as specified by the manufacturer of the PVC coated conduit. Extreme care must be taken to prevent damage to the PVC coating. The manufacturers' instructions must be followed for this operation. After the threads have been cut any damage to the coating must be immediately repaired using materials and methods as recommended by the manufacturer. The material thickness of any field repair must be equal to the factory finish which has been damaged. Repairs must be done immediately.
- 11. The Contractor must exercise extreme care in the assembly of PVC coated conduits. Metal jawed tools will not be used for this assembly. Conduits which are damaged as a result of using improper tools must be removed and replaced by the Contractor at no cost to the City.
- 12. All conduits must be carefully cleaned before and after installation and all inside surfaces must be free of imperfections likely to injure the cable. After installation of complete runs, all conduit must be snaked with an approved tube cleaner equipped with an approved cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. Any conduits through which the mandrel will not pass must be removed and replaced. All conduits installed in interior areas 1 inch and smaller must be cleaned by pulling clean rags thru the conduits. After cleaning, the ends of the conduits must be protected as specified to prevent the entrance of water and other foreign matter. The use of such items as plastic bags, tape, paper, rags, etc. will not be used under any circumstances. Failure to properly protect conduit ends must result in the Contractor having to again mandrel the conduits immediately before installing the wires.
- 13. Lines of nylon, polyolefin or polypropelene, propelled by carbon dioxide, vacuum or compressed air, must be used to snake or pull wire and cable into conduits. Flat steel tapes or "sparks"

type tapes can only be used in conduit runs of 50 feet or less. They will not be used in PVC or PVC coated conduits. Metal cables are expressly forbidden for pulling wire/cable. Nonmetalic pull tapes can be used for all types of conduits.

- 14. Where conduits are connected to boxes or equipment enclosures, drilled holes or full size knockout openings must provide electrical continuity for grounding and must be assured by the use of bonding type locknuts. Where connections are at slightly eccentric openings, jumper type grounding bushings and wire jumpers must be installed. Should the openings become excessively eccentric, as determined by the Commissioner, the box or equipment must be replaced at no cost to the City. The use of reducers will not be found acceptable under any circumstances.
- 15. Telephone conduit radius must not be less than 10 conduit diameters. The Contractor must verify with the company providing phone service as to their actual requirements for installation.
- 16. Conduit systems must be installed, with fittings, couplings, connectors, double locknuts, bushings, etc., and made up tight to insure ground continuity throughout the system.
- B. As far as practicable, conduit must be pitched slightly to drain to the outlet boxes, or otherwise installed to avoid trapping of condensate. Where necessary to secure drainage, a breather-drain fitting must be installed in the boxes at low points. Each breather drain fitting must be manufactured by Crouse-Hinds Co., Appleton Electric Co., or O.Z. Gedney. Conduit must not run through columns or beams unless so specifically detailed, submitted and accepted by the Commissioner.
- C. Each building expansion joint, each straight uninterrupted run of surface mounted conduit, and vertical risers in excess of 100 feet must be provided with appropriate expansion fitting. The distance between fittings as installed must not exceed 200 linear feet.
- D. The Contractor must furnish and install expansion couplings and bonding jumpers for metallic conduit system where conduits cross building expansion joints or where conduits transfer between structurally independent pipes, poles or supports.
- E. Conduits crossing building-expansion joints must be provided with expansion fittings and flexible grounding bonds bypassing the fittings to insure ground continuity.
- F. Conduit Installed in Concrete Slab

- 1. Where conduit is to be installed in concrete slab, conduit must be placed in the center of slab and no closer than 3 diameters from adjacent conduits. The maximum outside diameter of conduits in the slab must be no greater than \_ of the slab thickness. The minimum slab thickness must be 6 inches for embedded conduit installation. In no case must conduits be installed in the bedding material of the finish floor covering.
- 2. Conduit openings must be temporarily plugged to exclude water, concrete, plaster and other foreign material. For smaller conduits push pennies may be acceptable, as determined by the Commissioner.
- 3. Conduits run in or below any floor slab must be entirely encased in reinforced steel concrete. In no case must conduit be laid in the fill below slab.
- 4. Conduits embedded in concrete must be blocked and braced in place by use of adequate conduit separators to prevent displacement during the placing of concrete. The Contractor must be held responsible for proper position of conduits and must rearrange any conduit that may be displaced, when concrete is placed, at his own expense.
- 5. Conduits run in floor slabs or underground must be a minimum of 1 inch in size, rigid galvanized steel conduit unless noted otherwise on the Drawings.
- 6. All concealed conduits must be placed in walls and ceilings at the proper time, in accordance with the progress of the structural work.
- 7. Concrete-encased conduit runs extending through structural expansion joints must have fittings permitting longitudinal movement of the conduit ends without damaging the contained wires. The fittings must be watertight and include a grounding bond.
- G. Conduits installed in dry locations requiring a flexible connection for adjustment or vibration isolation must be provided with an 18 inch minimum length of either FMC or LTFC, as required by the area conditions.
- H. Flexible conduit installed in wet locations, exterior locations, air return ceilings and at motors must be liquid-tight type except for lighting in air return ceilings which must be of a type acceptable to the Bureau of Electrical Inspection, City of Chicago.

- I. Flexible conduit in ½ inch trade size may be used for connections with a maximum length of 18 inches for such devices as limit switches, for which the use of ¾ inch flexible conduit may not be practical due to the manufacturer providing only threaded hubs of the ½ inch size. In the case of such installations as electric door locks, where only ½ inch provisions are available, the Contractor can install ½ inch conduit from the device to a box located as close as possible.
- J. The number of 90 degree bends must be limited to four or a total of 360 degrees including all off sets, sweeps, kicks, etc. This must be between any pull points.
- K. The Contractor must be aware that the conduits are sized for cables routed in exposed rigid steel conduits, as denoted on the Contract Drawings. The same cables may be partly routed in ductbanks. The ductbanks are sized on the Drawings.
- L. Conduits entering motor control center conduit compartments, switchboards, switchgear, unit substations, etc. must be fitted with jumper type insulated grounding bushings, bonded together and to the structure of the enclosure by a continuous bonding wire.
- M. Conduit runs entering the building from outdoors are subject to moisture accumulation due to condensation. After the wires and cables are installed, the end of the conduit continuing into the warmer area must be packed with a non-setting sealing compound.
- N. All communication, telephone, data and computer conduits must have a minimum separation of 12 inches from any AC power and control conduits.
- O. The Contractor must orient outlet boxes for duplex receptacles or multiple gang switches for horizontal mounting.
- P. An outlet box must be provided at each location requiring one
  - 1. Outlet box locations as shown on the Drawings must be considered as approximate only, unless noted otherwise on the Drawings.
  - 2. Exact locations must be determined from the Drawings and/or from field instructions and coordination with the work of all other trades.
  - 3. Boxes must be installed true and plumb, so that the covers or plates must be level, and at uniform elevations for the type of wiring devices contained.

- 4. Boxes for toggle switches and pilot lights at doorways must be located at the strike side of the door.
- 5. Fixtures which weigh more than 5 pounds must be supported independently of the box.
- Q. There must be no more openings made in any box than are required for the conduits entering same. Depths of boxes must be as to allow for easy wire pulling and proper installation of wiring devices.
- R. All boxes must be supported independent of the conduit system. The boxes must be supported from the building structure. Conduits must not be supported from the boxes.
- S. Switches and receptacles must be ganged in a common box only when directed or indicated on the Drawings.
- T. All ceiling outlets must have adequate supports and must be equipped with adequate devices to carry and mount the light fixtures. They must not be supported from the ceiling structure.
- U. Conduit connections to NEMA 12 equipment must be made up with sealing locknuts. Conduit connections to NEMA 4 and NEMA 4X equipment must be made with Myer's type hubs. In no case must the Contractor terminate conduit to a NEMA 4 or 4X component by providing knock-outs and locknuts.

#### 3.03 CONDUIT CONNECTIONS TO EQUIPMENT:

- A. The conduit system must terminate at the terminal box or at the conduit connection points of electric motors, devices and equipment. Terminations of conduit at such locations will permit direct wire connections to the motors, electrical devices or other equipment.
- B. Conduit connections must be made with rigid conduit if the equipment is fixed and not subject to adjustment, mechanical movement or vibration. A union type fitting must be provided when GRS or IMC is terminated at each enclosure or piece of equipment which contains a threaded termination for the conduit. This may be a threaded hub or through a fitting such as a Myers type hub. Conduit terminations using double locknuts do not require union type fitting.

#### 3.04 PULL BOX INSTALLATION:

A. Pull boxes must be installed where shown and where necessary to insure that the installed cable will not be damaged.

- B. The Contractor must add pull boxes where needed even through not shown on the Drawings.
- C. Junction boxes and pull boxes of the proper size and shape must be provided. Where suitable, standard outlet boxes must be used as junction boxes and pull boxes.
- D. Pull boxes and junction boxes must be supported from the building structure and must not be supported by the conduit. Pull/junction box supports must comply with the applicable requirements for supports as contained in these Specifications.

# 3.05 HAZARDOUS AREAS:

- A. The conduit system installed in hazardous locations must be provided as shown, specified and required. The installation must conform to the requirements of the CEC for Class, Division and Group as shown on the Drawings or required by Project conditions.
- B. Explosion proof fittings must be provided for all conduits, within hazardous areas, leaving the hazardous areas, and where they enter the non-hazardous areas, as required.
- C. Explosion-proof seal, drain and breather conduit fittings must be installed as required by Code.

# 3.06 WIRING INSTALLATION:

- A. All cable and wire must be installed in conduit.
- B. No splices will be permitted between terminals, except at approved junction or terminal box points. Cable and wire runs must be looped through pull boxes without cutting and splicing where possible. Boxes must be sized to allow cable and wire installation without splices.
- C. All hardware, such as cable stanchions, racks, insulators, brackets, structural supports, wall inserts, cable and junction boxes, bolts, connectors, clamps, fittings and other accessories for the installation of wires and cables in buildings, manholes and outdoors must be furnished and installed complete to provide a satisfactory operating installation.
- D. All wiring systems must be "pullable" and use of "BX" is prohibited.
- E. Branch Wiring

- 1. Branch circuit wiring for lighting and other single phase applications must be sized for a voltage drop in accordance with the City of Chicago Electrical Code.
- 2. The maximum voltage drop for each circuit must be 3 percent for power and 1 percent for lighting circuits.
- 3. The Contractor must use multi-wire circuits utilizing separate neutrals and must follow the color coding established. The Contractor must size the wire in accordance with the following:
  - a. Under no circumstances must any switch break a neutral conductor.
  - b. Where farthest wiring device or light is no more than 75 feet from the panel, No. 12 AWG wire must be used between all wiring devices and for home runs.
  - c. Where the farthest wiring device or light is more than 75 feet from the panel, the Contractor will submit voltage drop calculation to the Commissioner, prior to sizing the wire. These calculations must show the wire size to be installed by the Contractor.
  - d. The minimum wire size must be No. 10 AWG between the panel and the first wiring device or fixture when located more than 75 feet from the panel, with a minimum No. 12 AWG wire being used between all other wiring devices or fixtures.
  - In office areas, each circuit must have its own neutral. Networking of circuits is not permissible in these areas. This does not apply to lighting circuits with the exception of fixtures which employ electronic ballasts.
- F. Wiring systems in plenum spaces must be installed in accordance with the Chicago Electrical Code and the Chicago Fire Code.
- G. Feeders must be installed with the sizes as indicated on the Drawings and must be connected as required for the proper operation of the equipment they serve.
- H. Building utility motors must be provided under other sections of the Specifications.
  - 1. The Contractor must make all connections necessary to leave motor driven equipment in satisfactory operating condition.
  - 2. The Contractor must provide power branch circuit wiring for all motors and starting equipment.

- 3. The Contractor must verify the actual motor sizes to be installed, and the actual locations, and provide wiring and equipment of proper sizes as required.
- 4. At the time when each motor is first operated, the Contractor must check the motor terminal voltages and the amperes in each motor lead to ascertain that, under normal load conditions, the currents do not exceed the nameplate rating on the motor.
- 5. If the ampere reading in any leads exceeds the nameplate rating of the motor, or if the motor terminal voltages vary more than 5 percent from the nameplate rating of the motor, the Contractor must disconnect the motor and request further instructions from the Commissioner.
- I. Proper termination of conduits and wires at motors, control panels or other equipment items must be provided.
- J. In the event that conduit and wire sizes increase beyond the motor or equipment manufacturer's normal provisions for conduit and wire terminations, due to voltage-drop or other considerations in motor branch-circuit designs, the Contractor must provide auxiliary termination facilities, with adequate boxes, lugs, terminals, knock-outs, etc., as may be required.
- K. Equipment having safety devices such as limit switches, overload relays, high-low water cut-outs, high-low pressure switches, solenoids, pilot devices, flow switches, freeze protection thermostats, etc., must be so wired that they must always be in the control circuits of selector switches regardless of switch position.
- L. The only devices that may be shunted out in the manual position of a selector switch are remote pushbutton stations, clocks, timers and room thermostats and ductstats of the non-limit type.

#### 3.07 SPLICES AND TERMINATIONS - 600-VOLT CABLE:

- A. All splices and terminations must be carefully taped and covered using material recommended by the cable manufacturers, to provide insulation equal to that of the conductors.
- B. All splices must be made in proper splice or junction boxes. Splices must not be made in power or control panels. Splices must not be pulled into any conduit. Splices must not be made in any fitting.
- C. Shielded Cable Grounding

- Shielded control cables must have the shields grounded at one (1) end. The shield must be insulated from ground, equal to that of the original cable instructions, at each splice.
- 2. Coaxial cable shields must be insulated from ground throughout the length of the cable run. The shields must be grounded at, and only at, the coaxial connector terminating in the equipment on each end of the cable run.
- D. Splices
  - 1. Splices must be performed only by experienced and qualified cable splicers regularly engaged in this type of work.
  - 2. Shielded cables must have the ends of the shielding bonded together across splices to provide a continuous electrical path. Splice will be made with a terminal block and only when approved by the Commissioner.
  - 3. All cable runs must be given an insulation resistance test and continuity check at the completion of each splice throughout the length of the cable run.
  - 4. Where a cable is cut preparatory to splicing, the work must proceed without delay. When an unavoidable delay is encountered in completing a splice, the opened cable must be protected to prevent the entrance of moisture and foreign matter with a heat shrink cap.
  - 5. The Contractor must splice control cables with the splice kits and materials manufactured for the purpose of splicing control wiring and in accordance with manufacturer's instructions. A power cable splice kit or resin must not be used to make a control cable splice, and vice versa, under any conditions.

#### 3.08 WIRING METHODS:

- A. All remote mounted devices such as control stations limit switches or pressure switches in a common circuit must have their wires brought back to the terminals on one (1) panel.
- B. When multi-conductor cables are used the number of conductors to be provided in each cable to be such that at least 1 spare conductor must be available for up to 5 conductors in use, 2 spare conductors must be available for 6 to 10 conductors in use, and 20 percent must be available for more than 10 conductors in use. The spare conductors are only required between major electrical equipment.

- C. Multi-conductor cable jacket must be pulled back and neatly trimmed to allow conductors to be separated, so they can be terminated to more than one (1) device. The cable must be supported in the panel where it enters the enclosure.
- D. Spare conductors must have the ends taped and they must be neatly coiled and tied and left in the bottom of the enclosure. They must be marked as spare conductors.

# 3.09 ELECTRICAL HARDWARE INSTALLATION:

- A. Locations
  - 1. Anchor bolts, sleeves, inserts, hangers and supports required for the work must be furnished and installed by the Contractor.
  - 2. Any expense resulting from improper location or installation must be paid for by the Contractor at no cost to the Commissioner.
  - 3. Where conduit and equipment is to be suspended from poured concrete construction, the Contractor must provide approved concrete inserts in the form work. Expansion shells may be used on precast concrete members but not closer than three (3) inches from the edge. The Contractor must verify the acceptable depth of anchors before beginning work on any pre or post tensioned members.
- B. Hangers
  - 1. The Contractor must provide adequate supports for all conduits and equipment, either suspended from the construction above, or by means of struts to the construction below. Where metal deck pan is used for the concrete floor above, anchors must only be placed in the rib. When the weight of the support system, including the completed electrical assembly, exceeds 100 pounds per hanger the Contractor will submit his design for review to the Commissioner.
  - 2. Hangers for support of conduit must be fabricated type, but not of the perforated iron type, and must conform to the requirements of the Contract Documents.
  - 3. Hangers must be suitable for the weight of the material / equipment being supported. This must include any and all pulling loads, as well as the load of the conductors, which the support may be subject to.
  - 4. Trapeze type hangers may be used where several conduits are to be installed at the same elevation.

- 5. The Contractor must provide straps, clamps, threaded rods, turnbuckles and anchors and all miscellaneous specialties for the attachment of hangers and supports to the structure.
- 6. Vertical conduits must be supported by heavy metal clamps or collars anchored in or to the construction at each floor.
- C. Conduit Supports
  - 1. Exposed conduits must be supported in an approved manner. Conduits must not be fastened to or come in contact with any mechanical system pipes, ducts or equipment of other trades, except as approved by the Commissioner. In all conduit work, acceptable hangers, racks or a combination thereof must be used as supports.
  - 2. Conduit trapeze supports must be located at intervals not exceeding 5 feet. Single conduits must be supported as required by the Chicago Electrical Code.
  - 3. Conduits must be securely fastened to each trapeze with U-bolts, straps or clamps.
  - 4. Whenever possible conduits must be supported from the building structural steel. Beam clamps must be used to attach to the steel. When the conduit supports must be attached to the structural concrete proper anchors must be installed. Anchors must not be closer than 3 inches from the edge of the concrete. The use of anchors containing lead, plastic or wood is strictly prohibited.
- D. Sleeves
  - 1. The Contractor must provide sleeves in fire rated walls and floors, and when penetrating CMU walls.
  - 2. Wall sleeves must be minimum 18-gauge galvanized sheet metal, as approved by Code, of sufficient length to finish flush with finished surfaces at both ends of the sleeves.
  - 3. Sleeves must be not less than 1 inch larger than outside diameter of the conduit.
  - 4. Floor sleeves must be galvanized steel pipe, as approved by Code, 3 inches above floor, and must be watertight.
  - 5. Where conduit passes through floors or exterior walls, the Contractor must caulk sleeves with an appropriate system to insure the complete sealing of the opening to prevent passage of water, dirt or air and to insure the fire rating of the structure penetrated.

6. Sleeves must be set true to line plumb and position and must be so maintained during construction. Where sleeves are provided in poured concrete, the Contractor must inspect same during and after concrete is poured to insure proper position and to correct any deviation at the Contractors expense.

# 3.10 PAINTING:

- A. Prime Coat
  - 1. Shop fabricated and factory built equipment without a primer must be galvanized or protected by plating. Before delivery to the site, the equipment must be cleaned and given one (1) shop coat of zinc-chromate primer.
  - 2. Any portions of the shop coat damaged in delivery or during construction must be recoated.
  - 3. Nameplates, labels, tags, stainless steel or chromium-plated items such as motor shafts, levers, handles, trim strips, etc. must not be painted.
- B. Finish Coat
  - 1. Conduit and equipment must be left cleaned and primed, ready for finish painting provided under the Painting Section of the Specifications.
  - 2. All equipment, panelboards, switchboards, etc. must be factory finished in baked enamel or lacquer, or as specified. Standard finishes must be as approved. All scratches must be neatly touched-up by the Contractor.
  - 3. All metal work installed by this Contractor exposed to weather and not factory finished must be painted with one coat of rust inhibitive primer and two coats of oil based paint of color selected by the Commissioner.

# 3.11 PATCHING:

- A. The Contractor must provide all cutting and patching of building materials required for the installation of the work herein specified:
  - 1. No structural members must be cut without the approval of the Commissioner.
  - 2. Roof deck is considered a structural member.
  - 3. Approved cutting must be done with concrete saws or core drills.

- B. Patching must be provided by mechanics of the particular trade involved and done in a neat and workmanlike manner.
- C. Slots, chases, openings and recesses through floors, walls, ceilings and roofs must be cut by the Contractor. The Contractor must see that they are properly located.
- D. Slots, chases, openings and recesses in the structure must be cut by a qualified Contractor. The Contractor must patch and repair as required. Where patching or repair becomes excessive at a location, as determined by the Commissioner, the Contractor must use skilled craftsmen of the appropriate trade to make the repairs or patching.

#### 3.12 CLEANING:

- A. Open ends of conduit and equipment must be properly capped or plugged to keep dirt and other foreign manner from entering.
- B. Each length of conduit must remain capped until the conduit connections are required.
- C. Trenches must be kept free from water. Conduits for ductbanks must not be laid when conditions of the trench are unsuitable for such work, or the weather must prevent quality work.
- D. When work is not in progress, open ends of conduit and fittings must be securely closed so that no water, earth or other substance must enter.
- E. When so directed by the Commissioner all material being removed must become the property of the Contractor, must be removed from the Airport and must be legally disposed of off City property by the Contractor.
- F. The Contractor must be responsible to keep the areas where work is occurring broom clean at all times.

# END OF SECTION 16100

# ELECTRICAL IDENTIFICATION SECTION 16195

# PART 1 GENERAL

## 1.01 SECTION INCLUDES:

- A. Work under this section is subject to the requirements of the Contract Documents.
- B. Furnish and install Electrical Identification as shown on the Drawings and as specified herein, including but not limited to the following:
  - 1. Conduit markers
  - 2. Wire / Cable Markers.
  - 3. Warning Tape.
  - 4. Danger Signs.
  - 5. Equipment Identification.
- C. For the purposes of this Specification the term "Cable" must apply to any type of conductor mentioned in the Contract Documents.
- 1.02 RELATED WORK:
  - A. As specified in the following divisions:
    - 1. Not Used
- 1.03 REFERENCES:
  - A. See Specification Section 16010 1.03.
- 1.04 SUBMITTALS:
  - A. The Contractor must submit data to the Commissioner prior to purchasing and installation. The data must include but not be limited to the following:
    - 1. Catalog cuts and major electrical equipment manufacturers' Drawings must include, but is not limited to, relays, meters, current and potential transformers, disconnect switches, fuses, contractors, lighting and more.
    - 2. Complete rating data for all equipment must be provided.

- 3. Instruction books, operation and maintenance manuals with spare parts must be provided.
- B. Submit samples of Conduit markers, cable markers and Phenolic Tags.
- C. Submit a nameplate log which must clearly indicate the exact wording for each nameplate.
- D. Shop Drawings See Specification Section 16010 1.04 B.
- 1.05 QUALITY CONTROL:
  - A. See Specification Section 16010 1.05.
- 1.06 DELIVERY STORAGE AND HANDLING:
  - A. See Specification Section 16010 1.06.
- 1.07 WARRANTIES AND GUARANTEES:
  - A. See Specification Section 16010 1.07.
- 1.08 EXTRA MATERIALS AND SPARE PARTS:
  - A. None required
- 1.09 ENVIRONMENTAL REQUIREMENTS:
  - A. See Specification Section 16010 1.09.
- 1.10 SPECIAL REQUIREMENTS:
  - A. Field Measurements Before proceeding with the fabrication of the Work, the Contractor must verify all dimensions and take such measurements as are required for proper fabrication and erection of the Work.
  - B. Coordination Coordinate Work of this section with related Work specified in the other divisions/sections of the Contract Documents.
- PART 2 PRODUCTS
- 2.01 ACCEPTABLE MANUFACTURERS:
  - A. Products of one of the following Manufacturers will be acceptable (for each type marker):

- 1. Alarm Supply Co., Inc.
- 2. Brady, W.H. Co.
- 3. Calpico Inc.
- 4. Cole-Flex Corp.
- 5. Direct Safety Co.
- 6. George-Ingraham Corp.
- 7. Griffolyn Company
- 8. Ideal Industries, Inc.
- 9. LEM Products, Inc.
- 10. Markal Company
- 11. National Band and Tag Co.
- 12. Panduit Corp.
- 13. Garfoplast.

#### 2.02 UNDERGROUND CABLE MARKERS:

- A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than one (1) type is specified for an application, selection is installer's option, but provide only one selection for each application.
- B. Cable markers for all underground cables must be vinyl tags, with the lettering etched through the outer layer. Tags must have the lettering engraved through the outer layer exposing the second layer. The edges of each tag must be beveled. Markers must be held in place with Nylon, self-locking cable ties. Each marker must be provided with a hole at each end of the marker for the purposes of attaching the marker to the cable.
  - 1. The cable markers must be white vinyl with black letters. Letters must be a minimum of 3/8 inch in height.
- C. Cable identification must be the circuit number and the panel designation it is powered from. Where the cable originates from a piece of equipment, which is not a panel, the marking must be the item being fed and the source, i.e. "EF-1 MCC-1".

#### 2.03 UNDERGROUND LINE MARKERS:

A. Manufacturer's standard permanent, bright-red, continuous-printed plastic tape, intended for direct-burial service, not less than 6 inches

wide x 4 mils thick. Provide tape with printing which most accurately indicates type of buried electrical service. Tape must be of the Aluminum Foil Polyethylene Laminate type which must be detectable when buried.

#### 2.04 INTERIOR CABLE MARKERS:

- A. Cable markers must be installed on both ends of all conductors. Selfadhesive, self-laminating, or heat shrink tubing or plastic bead type must be used. All markers must be mechanically printed. Cable markers must be rated for the environment in which they are placed. Acceptable manufacturers will be Brady, 3M, Panduit or Garfoplast.
- B. Circuit identification must be per the Contract Drawings. Should the Drawings not specify the circuit identification the following system must be used:
  - 1. For branch circuit wiring from receptacle/lighting panels the circuit identification must be the panel number and the circuit number.
  - 2. For circuiting from distribution panels the circuit identification must be the panel number and the circuit number.
  - 3. For power conductors from MCC's the identification must be the MCC designation, the item being supplied and the phase designation. Control wiring must be per the wiring diagrams.
- C. Conductor color coding must be done using tape as specified elsewhere in the Contract Documents. Provide color coding for all conductors which do not come with factory applied colors.

#### 2.05 CONDUIT MARKERS:

- A. Conduit tags must be either stainless steel, grade 316 minimum, or brass. Tags must have the identification either stamped in or embossed in the material. Tags must be fastened to the conduit with either stainless steel wire or with nylon, self-locking cable ties. For interior, dry locations nylon tags which are mechanically printed may be used.
- B. Conduit tags for underground use must be as described above. Where it is not practical to attach the tag to the conduit, i.e., in handholes and manholes, the tags must be fastened to the structure at the point where the conduit enters the structure. The Contractor may use a single large plate type marker for this purpose. The marker must accurately depict the conduits and their identification. The identification

must be attached using anchors as described in other parts of the Contract Documents.

#### 2.06 WARNING/DANGER SIGNS:

- A. Provide manufacturer's standard "DANGER" signs of rigid Polyethylene; of standard, red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision, with recognized standard explanation wording, e.g., HIGH VOLTAGE, KEEP AWAY, BURIED CABLE, DO NOT TOUCH SWITCH, etc.
- B. Provide "Warning" signs, as required, of rigid Polyethylene, colors as required by OSHA.
- C. Signs must be attached with Stainless Steel screws. Warning/Danger signs must not be of the adhesive type for attachment to doors or walls.

#### 2.07 EQUIPMENT IDENTIFICATION:

- A. After finish painting is completed, the Contractor must provide white with black core laminated phenolic nameplates with 1/4 inch minimum lettering etched through the outer covering. Inscription must be made with all upper case letters and must be the same inscriptions as shown on the Drawings or as directed by the Commissioner.
  - 1. All major electrical equipment must be so identified, including motor starters, disconnect switches, panels, switches, etc.
  - 2. Disconnect switches serving feeders and overcurrent protective devices mounted in a switchboard must be so identified.
  - 3. Embossed self-adhering plastic tape labels will not be accepted.
  - 4. Use stainless steel screws, except where contact-type permanent adhesive may be required when screws cannot or should not penetrate substrate.
  - 5. For Fire Alarm Systems provide white with red core laminated phenolic name plates.
  - 6. For Emergency Power equipment provide red with white letters.
  - 7. The Contractor must take care when attaching the identification so that the NEMA rating of the equipment is not violated.

#### 2.08 LETTERING AND GRAPHICS:

- A. Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.
- B. Identification markings on signs and markers must not be done with pens, pencils, crayons, magic markers, paint, dymo-labels, etc.
- C. Identification on small boxes, i.e., 4 inch square and 4-11/16 inch boxes may be done with a permanent marker in neat and legible block printing. Black markers must be used for this purpose. The Contractor must identify the circuits contained and the panel(s) of origin.

#### 2.09 TERMINAL IDENTIFICATION:

A. Terminal strips must be identified by using markers supplied by the terminal manufacturer. Whenever possible they must be mechanically printed. When this is not possible the strips must be marked in neat and legible block lettering using a permanent marking system acceptable to the terminal strip manufacturer. The terminal marking must be the wire number attached to that terminal.

#### 2.10 PULL BOX IDENTIFICATION:

- A. Identification markers for pull boxes, junction boxes, etc. must be of the polyester film type, self adhesive and pre-printed. The marker must contain the highest voltage level contained within that box. The marker must be yellow with black letters and the lettering must be visible from the floor.
- B. The box must have a phenolic nameplate, white with black letters, affixed to the box with stainless steel screws with the box identification. Each box must have a identifying designation that must be shown on the Drawings.
- 2.11 CABLE TIES:
  - A. Cable ties must be fungus-inert, self-extinguishing, one-piece, selflocking nylon cable ties, 0.18 inch minimum width, 50 lb. minimum tensile strength, and suitable for a temperature range from minus 50
degrees F to 350 degrees F. Provide ties in specified colors when used for color coding.

B. Acceptable manufacturers will be Thomas & Betts Co., Brady Co. and Panduit.

### 2.12 WIRE IDENTIFICATION IN EQUIPMENT:

- A. The wire identification for manufactured equipment must match the wire identification shown on the manufacturers wiring diagrams. All wires must be identified. The manufacturer must use product as specified in the Contract Documents.
- B. For custom built equipment the wire identification must match the wire identification shown on the assemblers approved Shop Drawings. All wires must be identified.
- C. In no case must a wire number change designations as a result of termination at a terminal.
- D. Where multi-conductor cables are used the cable must be identified as well as each conductor contained within that cable.

### PART 3 EXECUTION

### 3.01 APPLICATION AND INSTALLATION:

- A. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, requirements of Chicago Electrical Code and the Contract Documents.
  - 1. Where identification is to be applied to surfaces which require a specific finish, install identification after completion of the finish. The Contractor must take all precautions to avoid damaging the finish. Any damage must be repaired in a manner acceptable to the Commissioner.
  - 2. Comply with governing regulations and requests of governing authorities for identification of electrical work.
- B. The Contractor must provide a typewritten directory of circuits in lighting and power panels. The Contractor must clearly indicate the purpose of each circuit, i.e., lighting, receptacles, water cooler, etc. and must indicate the location of the supplied equipment.

### 3.02 CONDUIT, WIRE, CABLE AND BUS IDENTIFICATION:

- A. When not shown on the Contract Drawings the Contractor must indicate on his/her field marked set of Drawings, as required by the Contract Documents, the conduit identification.
- B. Each cable must be labeled at all terminals and at all accessible points in equipment, panelboards, manholes, handholes and pull boxes, etc. Labels must be as specified herein.
- C. All wires and feeder cables must be labeled in all junction boxes pull boxes, control panels, motor control centers, panelboards, switchboards, etc. All conductors must be tagged in cabinets at the time wires are pulled in and tested and markers must not be removed for any reason.
- D. Markers approved by the Commissioner must be attached to all cables where entering or leaving from conduit runs. The cable designation and circuit use must appear on the tag.
- E. Apply colored, pressure sensitive tape in half-lapped turns for a distance of 2 inches from the cable marker and in all boxes. Provide color coding at all splices and taps to each side of the splice or tap. Apply the last two laps of tape with no tension to prevent possible unwinding. Do not obliterate cable tag with the tape.
- F. All conduit runs must be identified by means of non-corrosive metal tag with stamped identification thereon, as shown on Contractor's installation Drawings and attached at all conduit terminations, including junction boxes. For interior work a nylon tag, mechanically printed may be used in lieu of metal.
- G. Conduit identification tags must be fastened to the conduit near the point of termination where conduits enter motor control centers, switchboards, switchgear, terminal cabinets, outlet boxes, junction boxes, pull boxes and other items. The tag must be held in place by a nylon, self-locking cable tie.
- H. Conduits in miscellaneous pull boxes in runs where the system identity cannot be clearly seen must have identifying tags indicating the name of the system. Such tags must be installed as described above. Miscellaneous systems must include, but not be limited to, telephones, lighting, etc.
- I. Conduits terminating at lighting fixtures, wall switches, telephones, terminal cabinets, lighting panelboards, receptacle outlets and similar

items need not be tagged where their system identification is obvious, except as noted above for clarity.

- J. Exterior installed conduits, except branch lighting circuit conduits, must be tagged at the ends and in intermediate boxes, chambers, manholes, handholes and other enclosures in accordance with the same inscriptions as shown on the Drawings.
- K. Tags must be fastened as specified except that where this method is not practicable they must be fastened to the adjacent masonry by means of expansion bolts.
- L. Phase identification letters must be 1 inch high in readily visible locations, and must be stamped into the main bus bars of switchboards and panelboards.
- M. For conduits in duct banks and embedded in structural slabs, etc. the conduit identification must be installed at the point where the conduit exits the slab.

### 3.03 OPERATIONAL IDENTIFICATION AND WARNING:

- A. Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
- B. In addition to installation of danger signs required by governing regulations and authorities, install appropriate danger signs at locations indicated, either by the Contract Documents or as directed by the Commissioner, and at locations subsequently identified by installer of electrical work as constituting similar dangers for persons in or about the facility.
  - 1. Install danger signs wherever it is possible, under any circumstances, for persons to come into contact with electrical power of voltages higher than 110-120 volts.
  - 2. Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons, damage to or loss of property.

### 3.04 EQUIPMENT/SYSTEM IDENTIFICATION:

- A. Install engraved plastic-laminate signs on each unit of electrical equipment; including central or master unit of each electrical system including communication/control/ signal systems, unless unit is specified with its own self-explanatory identification or signal system. Provide text matching terminology and numbering from the Contract Documents and Shop Drawings. Provide signs for each unit, but not limited to, the following categories of electrical work:
  - 1. Panelboards, electrical cabinets and enclosures.
  - 2. Access panel/doors to electrical facilities.
  - 3. Major electrical switchgear.
  - 4. Electrical substations.
  - 5. Motor control centers.
  - 6. Power transfer equipment.
  - 7. Transformers.
  - 8. Inverters.
  - 9. Disconnect Switches.
  - 10. Motor Starters.
  - 11. Time Clocks, Contactors, etc.
  - 12. Rectifiers.
  - 13. Frequency converters.
  - 14. Battery racks.
  - 15. Power generating units.
  - 16. Telephone switching equipment.
  - 17. Clock/program master equipment.
  - 18. Call system master station.
  - 19. TV/audit monitoring master station.
  - 20. Fire alarm master station.
  - 21. Security monitoring master station.
- B. Install signs at locations indicated or, where not otherwise indicated, at the location which provides the best convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use a permanent adhesive where fasteners should not or cannot penetrate substrate.

C. Provide Identification on all pull, junction, splice or terminal boxes. Identification must consist of the voltage contained within the enclosure and the enclosure identification.

## END OF SECTION 16195

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# AIRFIELD LIGHTING REGULATORS SECTION 16420

PART 1 GENERAL

- 1.01 SECTION INCLUDES:
  - A The work under this Section is subject to the requirements of the Contract Documents. The Contractor will furnish and install complete, the required Airfield Lighting Regulators, Control Modifications and accessories as shown on the Drawings and as required by these Specifications.
  - B. This item shall consist of furnishing and installing the switchgear style L-829 Constant Current Regulators (CCRs) in accordance with these specifications. The CCRs shall be installed in a switchgear line-up with a continuous bus, dry type, and of draw-out construction.
  - C. This item shall also include all wire and cable connections, the furnishing and installing of all necessary conduits and fittings and all necessary mounting structures. It shall also include the testing of the installation and all incidentals necessary to place the CCR switchgear lineups in operation as a completed line-up to the satisfaction of the Commissioner. Refer to other sections for related requirements, such as interfacing with the control/monitor system.
- 1.02 RELATED WORK:
  - A As specified in the following Sections:
    - 1. Section 16010 Basic Electrical Requirements
    - 2. Section 16100 Basic Material and Methods
    - 3. Section 16195 Electrical Identification
    - 4. Section 16730 Communication Cabling
    - 5. Section 16950 Testing
    - 6. Section L-125 ALCMS Modifications

### 1.03 REFERENCES:

- A See Specification Section 16010 1.03.
- B. Federal Aviation Administration (FAA)
- 1.04 SUBMITTALS:
  - A See Specification Section 16010 1.04.

- B. The Shop Drawings shall show the details of bus, connections, terminals, etc., including the complete ground bus arrangement and ground connections. In addition, the Shop Drawings shall detail the proposed Series Plug Cutout connections with details regarding "Normal Mode", "Shorted Mode", "Supply Grounded", and "Return Grounded" modes of operation as detailed in the Contract Drawings.
- 1.05 QUALITY ASSURANCE:
  - A See Specification Section 16010 1.05.
  - B. CCRs and Regulator Monitors covered by FAA Specifications are to have the prior approval of the F.A.A. and are as described in FAA Advisory Circular (AC) 150/5345-10G, "Specification for Constant Current Regulators and Regulator Monitors" and shall be listed in the FAA AC 150/5345-53D, "Airport Lighting Equipment Certification Program", Appendix 3 and Appendix 4 and its addendum.
- 1.06 DELIVERY STORAGE AND HANDLING:
  - A See Specification Section 16010 1.06.
- 1.07 WARRANTIES AND GUARANTEES:
  - A See Specification Section 16010 1.07.
- 1.08 EXTRA MATERIALS AND SPARE PARTS:
  - A See Specification Section 16010 1.08.
- 1.09 ENVIRONMENTAL REQUIREMENTS:
  - A Not applicable.
- 1.10 SPECIAL REQUIREMENTS:
  - A. See Specification Section 16010 1.10.
- 1.11 CONTRACT DRAWINGS:
  - A. See Specification Section 16010 1.11.
- 1.12 EXECUTION, CORRELATION AND INTENT OF DOCUMENTS:
  - A. See Specification Section 16010 1.12.
- 1.13 INSTRUCTIONS AND ADJUSTMENTS:
  - A. See Specification Section 16010 1.13.
- 1.14 OPERATION AND MAINTENANCE MANUAL:

- A. See Specification Section 16010 1.14.
- 1.15 BINDERS:
  - A. See Specification Section 160101.15.
- PART 2 PRODUCTS
- 2.01 CONSTANT CURRENT REGULATORS (CCR) SWITCHGEAR LINEUPS:
  - A. Manufacturers
    - 1. Only products of the following manufacturer are acceptable
      - a. ADB/Siemens Airfield Solutions
  - B. General
    - 1. The CCRs shall conform to applicable requirements in FAA Advisory Circular 150/4345-10G "Specification for Constant Current Regulators and Regulator Monitors." The CCRs and CCR switchgear shall be ETL Certified.
    - 2. The unit shall be factory assembled, tested by the manufacturer, and shipped to the job site.
  - C. Equipment Supplied
    - 1. Each switchgear line-up shall consist of the number of CCRs and other functional systems mounted in individual bays as shown in the Design Drawings. Some individual bays shall be furnished without power units but fitted for the future addition of power units without modification of the bays. Details on each CCR wattage, ampacity and arrangement are shown on the Contract Drawings.
  - D. L-828 Constant Current Regulators
    - 1. L-828 CCRs shall be available in a range of 4KW to 30KW for 6.6A circuits. L-828 CCRs shall be available in a range of 15KW for 20A circuits. All CCRs shall be 480VAC input, single phase, 60 Hz. and shall provide automatic input voltage compensation for a -5 percent to a +10 percent voltage variation. 6.6A CCRs shall be available with three or five-step brightness controls. 20A CCRs shall be available with five-step brightness controls. CCRs shall operate through the brightness steps from either remote control or with a rotary switch mounted on the front of the unit. Power for remote control operation shall be supplied internally and shall be 120VAC, 60 Hz. Refer to the Design Drawings for complete details regarding the quantity of regulators, KW rating of regulators and lineup configurations.

- 2. Each CCR shall be designed so that switching the CCR on and off, changing brightness steps, or shorting the load will not produce output surges that will damage lamps connected to the output circuit. Input power to the CCR shall be isolated from the output. The CCR shall include an open-circuit protective device to open a primary switch within two seconds after an open circuit occurs in the CCR output circuit. The device shall reset within two seconds after the remote/local control switch is turned off and re-energized. Switching of load circuits or other transients shall not trip the device.
- 3. All CCRs shall include an overcurrent protective device according to the requirements of FAA AC 150/5345-10F that opens the primary switch when the output current exceeds specification levels. The device shall reset within two seconds after the remote/local control switch is turned off and re-energized. A momentary overcurrent caused by switching of loads or other transients shall not activate the overcurrent protection. Distribution type lightning arrestors shall be provided on all CCR outputs. Lightning protection devices (MOVs) shall also be provided on the input side of each CCR.
- 4. CCRs up to 30KW shall be mounted with CCR modules stacked two high in a mechanically separate bay. 50KW CCRs shall be mounted in one individual bay. A 30KW power pack shall be fully interchangeable with any 4KW to 30KW CCR within the switchgear system. This allows one interchangeable spare regulator to be used for backup purposes.
- 5. CCR Switchgear Bus
  - a. Input power to each CCR switchgear lineup shall be 480 VAC, 3 Phase 60 Hz. Input power shall be distributed along a horizontal copper bus.
  - b. All bus bars shall be silver-plated copper. The main horizontal bus bars shall be mounted with all three phases arranged in the same vertical plane. Per the Chicago Electrical Code, bus bars shall have a minimum ampacity of 1000 amperes per square-inch of cross sectional area. Where ETL testing temperature criteria demands a greater bus ampacity, the greater bus ampacity shall be used. The bus bars shall be braced to withstand a symmetrical fault of 65,000 amps.
  - c. A continuous horizontal, copper ground bus shall be

provided for equipment grounding. The bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The ground bus short time withstand rating shall meet that of the largest circuit breaker within the assembly.

d. A continuous horizontal, copper isolated ground bus shall be provided for ground testing of each regulator circuit. The bus shall be furnished firmly secured to each vertical section structure and shall extend the entire length of the switchgear. The bus shall be mounted on standoffs and be completely isolated from the CCR switchgear lineup. The ground bus short time withstand rating shall meet that of the largest circuit breaker within the assembly. Refer to the Contract Drawings for details regarding the isolated ground, required connections, and modes of operation.

- e. All hardware used on conductors shall be high-tensile strength and zinc-plated. All bus joints shall be provided with Belleville- type washers.
- 6. The power electronics for 4KW to 30KW CCRs shall be contained in individual power units that can be easily removed for maintenance procedures. No special tools shall be required to remove a power pack from a bay. Power packs shall be designed with rollers/castors to allow for easy movement on a lifting device and on the floor during troubleshooting procedures.
- 7. Each CCR power unit shall be removable and shall have autoaligning stab connections for input power, control and monitoring signals and output power.
- 8. Each CCR shall have an individual incoming circuit breaker. It shall be possible to remove the power unit while the rest of the CCR switchgear lineup remains powered, eliminating the need to shut down the entire CCR switchgear lineup. The CCR shall be designed to prevent the disconnecting of the 5KV output series power prior to disengaging the CCR contactor.
- 9. Separate horizontal wiring channels shall be used within the CCR switchgear lineup to isolate the high voltage and low voltage wiring.
- 10. For maintenance personnel safety, the switchgear system shall be designed with no high voltage (<600 volts) on the door. Each CCR front door shall have a two-point latching

system for smooth operation and a positive seat. The CCR switchgear enclosures shall be designed for indoor use to provide protection against dust, dirt, dripping water and external condensation of non-corrosive liquids. The enclosures shall be rate NEMA 12. Each CCR shall be designed to pass all FAA AC 150/5345-10F temperature Tests. The entire CCR enclosure line-up shall have gray polyester paint electrostatically applied over a zinc undercoat.

- 11. Each CCR shall be provided with a series plug cutout in order to make maintenance functions more efficient. Refer to Contract Drawingsfor cutout requirements.
- E. CCR Architecture
  - 1. Constant current regulation shall be obtained using a ferroresonant transformer, capacitor and control circuitry. Output current regulation shall be accomplished by adjusting the ferroresonance in the capacitor bank using an electronic feedback circuit. The ferroresonant design shall produce minimal EMI and have high efficiency near unity power factor for FAA AC 150/5345-10H test conditions. The CCR shall meet the conducted and radiated emissions testing requirements defined in FAA AC 150/5345-10H, par. 4.2.10. Solid-state designs susceptible to extraneous signals are not acceptable. The CCR shall be designed to limit transient current peaks without the use of solid- state series circuit controls with a soft-on feature.
- F. L-829 CCR Control/Monitoring
  - 1. Each CCR shall include a Distributed Control Board (DCB) to provide an integrated control and monitoring package. Inclusion of DCB with an L-828 CCR equates to an L-829 CCR. Each CCR shall also be equipped with an Input Current Voltage Monitor, Output Current Voltage Monitor and Insulated Resistance Measurement System. The DCB shall interface with these devices in order to monitor information being gathered by these devices. The DCB on each CCR shall be equipped with a front-mounted output current digital indicator with an accuracy of ±2 percent. Refer to Specification 16991 for additional requirements for the DCB, Input Current Voltage Monitor, Output Current Voltage Monitor, and Insulated Resistance Measurement System.
- G. Incoming Power Bay
  - 1. An Incoming Power Bay shall be included as shown on the Design Drawings to switch the input power coming into the

entire line-up.

- H. Painting
  - 1. All interior and exterior seams shall be carefully filled and smooth for neat appearance. The equipment manufacturer shall remove oils and dirt and form a chemically and anodically neutral conversion coating, to improve the finish to metal bond and to provide resistant to corrosion. All surfaces shall be phosphatized before any of the protective coatings are applied.
  - 2. The exterior surface of all structures shall be thoroughly cleaned and painted. The equipment manufacturer's standard color utilizing epoxy resin applied with a "powder coat" system.

## PART 3 EXECUTION

- 3.01 INSTALLATION:
  - A. Refer to Part 3 of specification 16100.
  - B. The Contractor shall furnish, install, locate, connect and test all equipment, equipment accessories, conduit cables, wires, buses, grounds and support necessary to insure a complete and operable CCR.
  - C. Contractor is responsible for the physical installation of all associated CCR switchgear. The Contractor shall install the equipment in strict accordance with the final reviewed shop drawings and the equipment manufacturer's recommendations.
  - D. The CCR switchgear shall be mounted at the locations shown on the Design Drawings. Final adjustments to the equipment shall include verification of the proper mechanical operation, verification of the instrument operation and setting of any appurtenant devices. The Contractor shall xray the vault floor beneath the house keeping pad to avoid any steel supports and wet saw core drill a 6" diameter hole through the house keeping pad and vault floor to the basement below. A 5" diameter sleeve shall be installed through the 6" diameter holr This effort shall be incidental to the CCR line item.
  - E. The equipment shall be installed complete and operational.
  - F. Service Engineer
    - 1. The Equipment manufacturer shall provide a qualified factory trained service engineer to provide technical direction for the installation and final adjustments of the equipment.

- 2. The service engineer shall certify that the equipment has been installed in accordance with the equipment manufacturer's recommendation.
- G. Each CCR shall be calibrated according to the manufacturer's instructions using a True RMS meter. An open-circuit and overcurrent test shall then be conducted on each CCR according to the manufacturer's instructions. The entire line-up of CCRs shall then be fully tested by continuous operation for not less than 24 hours prior to acceptance. The test shall include operating each CCR in each step (Local and Remote) no less than 10 times at the beginning and end of the 24-hour test.
- H. All CCR equipment shall be installed in accordance with the manufacturer's recommendations. No deviations from the manufacturer's installation procedures will be allowed. The CCR equipment manufacturer shall provide on-site supervision for all CCR component installation.
- I. The equipment installation and mounting shall comply with the requirements of the Chicago Electrical Code and local code agency having jurisdiction.
- 3.02 MARKING AND LABELING:
  - A. See specification Section 16195.
- 3.03 RACEWAY, WIRE AND CONNECTIONS:
  - A. See Specification Section 16100.
- 3.04 AIRFIELD LIGHTING CONTROL SYSTEM (ALCS) INTEGRATION:
  - A. The CCRs shall be integrated into the proposed ALCS. Refer to Specification L-125 for additional details and requirements.
  - B. Commissioning of the CCR shall not begin until all Communication Cabling test reports are submitted and approved by the Commissioner. Refer to Specification 16730 for additional details and requirements.
- 3.05 FIELD QUALITY CONTROL:
  - A. The CCR manufacturer's representative shall provide technical direction and assistance to the Contractor in the general configuration of the CCR including, installation, connections, adjustments, and testing of the assembly and components contained therein.
  - B. The CCR manufacturer's representative shall provide inspection of the final installation. The CCR manufacturer's representative shall

perform site start- up and functional checkout of the CCR.

C. The Contractor shall provide three (3) copies of the CCR Manufacturer's field start-up report.

### 3.06 MANUFACTURER'S CERTIFICATION:

- A. A qualified factory-trained representative of the CCR Manufacturers shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the Manufacturer's recommendations.
- B. The Contractor shall provide the Commissioner with three (3) copies of the CCR manufacturer's representative's certification before the commissioning of the CCR commences.

### 3.07 CCR CUTOVER SEQUENCING AND OPERATIONAL REQUIREMENTS:

A. The normal operating functions of the Airport will be continued while the work under the Contract is being accomplished. Operations and work in some areas will be permitted only at specific times and in suitable weather conditions. The installation of equipment and the oaring of vital circuits shall be done only for minimum intervals at such times and with such restrictions as approved and agreed upon by the Commissioner and may be required during non-regular working hours. The installation of temporary wiring may also be required in order to permit operations and work in certainareas.

### 3.08 FACTORY CHECKOUT:

- A. The CCR equipment shall be completely and functionally tested in the manufacturer's facility prior to shipment.
- B. Prior to shipping the CCR equipment, the Contractor shall perform an in- house self-test at the CCR Manufacturer's factory to demonstrate that the system functions as required in its configuration as described in these specifications and drawings. The Contractor in writing to the Commissioner shall certify this test has been completed.
- C. A certified test report of all standard production tests shall be shipped with each assembly.

### 3.09 FACTORY ACCEPTANCE TEST:

- A. Before shipment, the CCR equipment shall be assembled as an operating system at the CCR Manufacturer's test facilities for a Factory Acceptance Test. The CCR Manufacturer shall make the Factory Acceptance Test available for representative(s) for the Commissioner to witness the testing of the system.
- B. The Contractor shall provide the Commissioner a Factory

Acceptance Test Plan and schedule forty-five (45) days before the scheduled Factory Acceptance Test. The Commissioner's representatives shall review the Factory Acceptance Test Plan and schedule for content and reserves the right to make changes. The Contractor shall provide the Commissioner a copy of the final Factory Acceptance Test Plan and schedule ten (10) working days before the Factory Acceptance Test.

- C. At a minimum, the Factory Acceptance Test shall allow for two (2) days of testing and review, but may require additional time dependingon the results of the testing.
- D. The Contractor shall incur the costs of setting up and performing the test including the cost for transportation and lodging for up to four (4) Commissioner's representatives.
- E. During the Factory Acceptance Test, minor adjustments shall be incorporated.
- 3.10 CCR COMMISSIONING:
  - A. The CCR Manufacturer shall perform the following installation and commissioning tasks.
    - 1. Verify Contractor connections including power, control and monitoring.
    - 2. Verity proper labeling of equipment.
    - 3. Verify communication connections.
    - 4. Verify power and ground connections, including review of the torque log which shall document connector tightening torques vs. specified tightening torque requirements and calibration histories of the torqueing tools.
    - 5. Perform system testing including control, monitoring and diagnostics.

### 3.11 SYSTEM ACCEPTANCE TEST:

- A. See Specification Section 16950.
- B. Following the final installation and commissioning of the system, the CCR Manufacturer shall perform a demonstration of the CCR performance. Representatives of the Commissioner shall be present for the test.
- C. The CCR manufacturer shall provide a System Acceptance Test Plan forty- five (45) days before the scheduled acceptance test date. The Commissioner shall review the System Acceptance Test Plan for content and reserves the right to make changes. The

Contractor shall provide to the Commissioner the final System Acceptance Test Plan ten (10) working days before acceptance testing.

- D. A preliminary System Acceptance Test shall be completed and documented prior to the system being demonstrated to the Commissioner's representatives.
- E. As part of the System Acceptance Test, demonstration of the following as a minimum, shall be included. Certified test results shall be presented to the Commissioner.
  - 1. Automated sequences of operation as specified.
  - 2. Testing monitoring capabilities.
  - 3. Lighting control functions.
  - 4. Testing of communications links.
  - 5. Alarm and fault functions Tests shall include the creation of artificial fault conditions to test alarm and fault responses.
  - 6. Monitor and display functions.
  - 7. CCR electrical and electronic features.
- F. Tests requiring the activation or deactivation of runway or taxiway lighting systems or related equipment shall be performed at a time when no aircraft operations are occurring, including late night. All tests of this nature will be requested in writing to the Commissioner at least 24 hours in advance, and no tests will be made until written approval is received. If unanticipated conditions prohibit the System Acceptance Testing at schedule times, the testing shall be rescheduled. The City shall not incur any additional expense for the rescheduling of the System Acceptance Testing due to unanticipated conditions.
- 3.12 ON-SITE TRAINING:
  - A. General Requirements
    - 1. The training shall be tailored to the operations of the system installed at O'Hare, and shall not be a canned session, dealing with general systems of a similar nature.
    - 2. For all training sessions, the Contractor shall provide the Commissioner a Training Course syllabus and training schedule forty- five (45) days before on-site training. The Commissioner shall review the syllabus and training schedule for content and reserves the right to make changes. The Contractor shall provide the Commissioner a copy of the final Training Course syllabus and training schedule ten

(10) working days before on-site training.

- 3. Training plan and manuals for the training shall be provided with lists of reference materials and sections of Operation & Maintenance (O&M) Manuals to be addressed. The Contractor shall provide training documentation in three-ring binders for all trainees. Provide materials for up to ten (10) persons per session.
- 4. All training sessions shall be held in a facility provided by the DOA. This facility shall have tables, chairs, projection screen and sufficient space to lay out manuals and drawings. The Contractor shall provide all required visual aids and projectors.
- 5. The Contractor shall provide qualified CCR manufacturer's representatives to conduct the training classes for the Commissioner's representatives. Training shall include classroom instruction and hands on training with system components.
- 6. Training shall occur after the Contractor has assembled all elements of the CCR and verified proper operation of all components.
- B. Maintenance Training
  - 1. Commissioner shall designate a Training coordinator that shall be responsible for scheduling and organizing the on-site Maintenance Training for their personnel.
  - 2. An Initial Training Session and a Follow-up Training Session shall be provided for Maintenance Training.
    - a The initial Training Session shall be completed prior to the CCR System Acceptance Test as defined by this Contract.
    - b. The Follow-up Training Session shall be provided as required by the Commissioner up to one year after Preliminary Acceptance of the CCR as defined by this Contract. The second training session is to be designed for refreshing users with operations and maintenance, and to aid in areas that are unclear to users. The second training session shall be requested in writing by DOA and shall be scheduled at a time agreeable to CCR manufacturer and Commissioner.
  - 3. This training shall include, as a minimum, discussion and review of the following:

- a. System Block Diagram
- b. System Assemblies and Wiring Diagrams
- c. Description of the CCR including startup, normal operation, normal shutdown, emergency startup, emergency shutdown, normal test
- d. Control and Monitoring Features
- e. Granting Local Control to the Vaults
- f. Power Up and Power Down Sequences
- g. Failsafe Operations
- h. Implementing Airfield Lighting Changes
- i. Maintenance Report Generation
- j. Review trouble modes and remedies
- k Explanation of CCR identification system
- I. Describe interfaces including interlocks, sequencing, start-up, shut-down, emergency, safety, system failure, security and other provisions
- m. Display and conduct a "thumb-through" explanation of the maintenance manuals, record drawings, spare parts inventory, metering and other serve items
- n. Conduct a detailed review of preventative maintenance and troubleshooting measures
- C. Training Audio/Video Recording
  - 1. The Contractor shall record all training sessions and (10) copies of the audio/video recordings are to be provided to the Commissioner.
  - 2. The Contractor shall provide all equipment, materials and qualified personnel to visually and audibly record on videotape all training sessions described in this section. The qualifications of the video recording personnel shall be submitted for approval at least 10 days prior to the session. Videotapes shall be produced in VHS format. Each system or piece of equipment covered shall be recorded as a single program and correlated with the O&M manuals. An identification label shall be affixed to the tape and be shown on the first two minutes of recording. The label shall identify the project, project contract number, equipment or system discussed, length of recording, and O&M manual reference.

- 3. The CCR manufacturer shall coordinate training dates with the Contractor and the Contractor shall provide all required video recording personnel and video equipment necessary to videotape each training session.
- 4. All video recording should be completed in accordance with the contract specifications.
- 5. The Contractor is responsible for coordination and scheduling all training with the Commissioner.
- D. The training sessions shall be held at the time of the designated shift unless otherwise directed by the Commissioner. The shift times are as follows: First Shift: 7:00 A.M. to 3:00 P. M., Second Shift: 3:00 P.M. to 11:00 P.M., and the Third shift: 11:00 P.M. to 7:00 A.M. The Contractor shall conduct the following training sessions on the CCR for the minimum durations indicated.

Training Section	Duration Per	Number of
Training Session	Sessions	Sessions
DOA Initial (First Sift Operators)	8 Hours	1
DOA Initial (Second Shift Operators)	8 Hours	1
DOA Initial (Third Shift Operators)	8 Hours	1
DOA Follow-up (First Shift Operators)	8 Hours	1
DOA Follow-up (Second Shift Operators)	8 Hours	1
DOA Follow-up (Third Shift Operators)	8 Hours	1

### PART 4 METHOD OF MEASUREMENT

- 4.01 MEASUREMENT
  - A. Constant current regulators (CCRs) of the size and type required shall be measured per each.

### PART 5 BASIS OF PAYMENT

- 4.01 PAYMENT
  - A. The accepted quantities of constant current regulators will be paid for at the contract unit price per each. This price will be full compensation for furnishing all materials, for all preparation, for all installation, and for all work required to complete the item in accordance with the contract documents and to the satisfaction of the Commissioner.
  - B. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
16420-01	CONSTANT CURRENT REGULATOR, 15KVA	EA

## END OF SECTION 16420

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## COMMUNICATION CABLING SECTION 16730

### PART 1 GENERAL

### 1.01 SECTION INCLUDES:

- A. Furnish, install, test, and place in satisfactory operating condition, communication cabling as shown on the Drawings and as specified herein.
- B. Communication cabling must be provided for use with the following systems:
  - 1. Integrated Safety Security Operations and Communications System (ISSOCS)
  - 2. O'Hare Campus Connectivity System (OCC)
  - 3. City Data Network (CDN) which will encompass the Supervisory Monitoring System (SMS)
- C. Communication cables include racks, fiber shelves, patch panels, splice closures, terminal connectors, data and voice outlets, jacks, testing, and all other related equipment and services needed for a complete communication installation.

### 1.02 RELATED WORK

- A. Related Work specified elsewhere includes:
  - 1. Section 16010 Basic Electrical Requirements
  - 2. Section 16195 Electrical Identification
  - 3. Section L-110 Installation of Airport Underground Electrical Duct
  - 4. Section L-115 Electrical Manholes and Handholes
  - 5. Section L-118 CED/FAA Communication MH/HH As-Built Checklist

### 1.03 REFERENCES

- A. See Specification Section 16010 1.03.
- B. Underwriters Laboratories, Inc. (UL):
  - 1. U. L. 910: Plenum Cable
  - 2. U. L. 1666: Riser Cable
- C. Institute of Electrical and Electronics Engineers (IEEE):
  - 1. IEEE Standard 383: Flame Retardancy.
- D. American National Standards Institute (ANSI)
  - 1. ANSI/TIA-526
  - 2. ANSI/TIA-568
  - 3. ANSI/TIA-569
  - 4. ANSI/TIA-607
  - 5. ANSI/TIA-758
  - 6. ANSI/TIA-36, 40, and 50
  - 7. ANSI X3 T9.5
- E. NESC: National Electric Safety Code
- F. NFPA: National Fire Protection Agency
- G. NETA: The International Testing Association Acceptance Testing Specification
- H. CEC: Chicago Electrical Code
- 1.04 SUBMITTALS
  - A. Submit the following in accordance with Section XI of Part 2 General Conditions and Specification Section 16010 1.04.B.
    - 1. Installer Qualifications Include resumes of staff and previous project experienced with references. Proposed Products List.
    - 2. Qualification data for firms and individuals specified in the Quality Assurance section of this Specification to demonstrate their capabilities and experience. Provide copy of the RCDD certifications and manufacturer's certifications. Certifications must be current. Manufacturer's certification must/match be consistent with the products being installed.

- 3. Outline drawings of termination cabinets showing dimensions, cables, jumpers, and associated hardware for termination.
- 4. Provide written confirmation that products being submitted are acceptable to control systems supplier.
- 5. For each component and material submit shop drawing which must include:
  - a. Manufacturer
  - b. Model number
  - c. General data and description
  - d. Engineering specifications and data sheets
  - e. Catalog cuts
  - f. Submit manufacturer's printed installation instructions
- B. Submit a drawing showing the routing for the communication cabling network. Include the following information:
  - 1. Routing, length, and attenuation based on TIA-568-B.
  - 2. Cable and conduit identification.
  - 3. Locations of all handholes, manholes, pull boxes, and patch panels.
  - 4. Proposed fiber splice locations. Unless approved by the Director prior to installation, splicing of fiber cables will not be allowed except where factory terminated pigtails are used for fiber terminations.
- C. Test Documentation:
  - 1. General
    - a. All cabling must be tested prior to cabling in accordance with the definitions and procedures specified in the EIA/TIA testing standards to determine if the cable complies with the requirements called for in this Specification. For each type of cable supplied, provide a certificate of compliance stating that the finished cable meets the requirements of this Specification.
  - 2. Fiber Cable Testing
    - a. All fibers in the finished fiber optic cable must be tested prior to cabling in accordance with the definitions and procedures specified in the EIA/TIA-455 Fiber Optic Test Procedures (FOTP's) to determine if the fiber complies with Section 2.01 of this Specification. The fiber

manufacturer must provide a certificate of compliance for the following properties where indicated by a "Yes".

Table –	<b>Properties</b>	for Certification	1
---------	-------------------	-------------------	---

	Single-mode
Core Diameter	
Cladding Diameter	Yes
Protective Coating Diameter	Yes
Core-Cladding Concentricity	Yes
Core Non-Circularity	
Cladding Non-Circularity	Yes
Tensile Strength	Yes
Numerical Aperture	
Zero-Dispersion Wavelength	Yes
Zero-Dispersion Slope	Yes
Bandwidth	
Mode-Field Diameter	Yes
Cut-Off Wavelength	Yes

### b. Cable Assembly Tests

- (1) The tests described in Sections 1.04.C.2.c and 1.04.C.2.d of this Specification must be performed on all fiber reels.
- (2) The tests described in Sections 1.04.C.2.e and 1.04.C.2.l of this Specification must be performed on the basis of sampling. One 25-meter length of cable must be cut from the end of reels to be selected randomly, with a maximum sampling of one sample per each 15 km. A minimum sample for orders less than 15 km is one sample. Each sample will be identified by reel number, contract/order number, and specification number. The reels must be numbered sequentially for this purpose in the order of manufacture. The Commissioner must be notified in the event of failure to pass any test.
- c. Optical attenuation The optical attenuation of the cable must be validated in accordance with the requirements of this Specification on all fibers of every reel of finished cable. The test results for each reel must be provided upon delivery in a sealed waterproofed envelope.
- d. Optical bandwidth The -3dB end-to-end optical bandwidth of all fibers in all multimode cables must be determined by FOTP 30B. For lengths greater than 1 km, the required -3dB end-to-end bandwidth must be

calculated from:

- (1) BW-3dB ≥ 1,000 Mhz/(length in kilometers).85,
  (50/125um)
- (2) BW-3dB ≥ 500 Mhz/(length in kilometers).85, (62.5/125um)
- e. Temperature dependence of attenuation The temperature dependence of attenuation must be determined by FOTP 3 (for 48 hours or when it is ensured that the cable has uniformly reached the test temperature) on all fibers of one reel of cable selected at random. Measurements must be made at -40° C and +60° C,  $\pm 2^{\circ}$  C.
- f. Cable flexing The specimen(s) selected from the sample must be prepared in accordance with FOTP 37A, except that a mandrel having a diameter up to 20 times the cable diameter shall be permitted. Test condition D (0° C and 40° C) of Table I of FOTP 37A shall suffice, as shall Test Level 2 (10 mandrel turns) of Table III. The test mass must be in accordance with Table II.
- g. Compound flow test Test specimens selected randomly from the samples must be subjected to a compound flow test in accordance with FOTP 81A, Method B at a temperature of 60° C ±2° C (140°F ±3.5° F). There must be no evidence of compound flowing or dripping from any buffer tube or other cable component.
- Water intercept tests Test specimens selected randomly from the sample must be tested per FOTP 82B. There must be no evidence of water leakage.
- i. Cable pulling capacity test This test must be performed in accordance with FOTP 33A. This test must be a type acceptance test on a production run basis.
- j. Sheath material properties certification The manufacturer must certify that the extrusion process used for application of the sheathing compound complies with the recommendations of the compound supplier.
- k. Crush resistance test Test specimens taken at random

from the samples must be subjected to the crush force as specified. The optical attenuation must not change from before the test to after the test in the tested sample.

- I. Impact resistance test test specimens taken at random from the samples must be subjected to the impact force as specified. The optical attenuation must not change from before the test to after the test in the tested sample.
- 3. Provide factory certified test report verifying that all outdoor and indoor-outdoor rated fiber optic cable is not susceptible to damage due to submersion with jet fuel and potassium acetate solution.
- 4. Document results of tests (shop test, field test, acceptance test) and submit copies of documents to the Commissioner/CM as tests are completed.

### 1.05 QUALITY ASSURANCE

- A. Provide in accordance with Section VI of Part 2 General Conditions and as specified herein.
- B. Communication cables and related equipment must be the products of approved manufacturers. Fabrication of the cables and related equipment must utilize the most advanced commercial materials and manufacturing processes. Manufacturer must be ISO 9001 and TL-9000 certified.
- C. The communication cabling installer must be qualified in the installation of structured cabling systems. The term qualified means experienced in performing the Work required by this section on projects of comparable scope, size, and complexity. The Contractor must be able to demonstrate to the satisfaction of the Commissioner and Chief Procurement Officer that it and/or any subcontractors performing such Work have the qualifications, experience, and, if applicable, licenses and permits to perform Work in accordance with the terms ad conditions of this Contract. The Contractor must submit evidence of such qualifications, licenses, and permits upon request by the Commissioner.
- D. Experienced cable installers who are regularly engaged in the installation of communication cables must perform cable installation.
- E. Experience professionals who are regularly engaged in splicing and termination of communication cables must perform cable splicing and terminations.

- F. Installer must have on staff a Registered Communications Distribution Designer (RCDD), certified by the Building Industry Consulting Service International (BICSI) and by the manufacture that will provide the system warranty.
- G. The Contractor must retain the services of the cable manufacturer's technical representative to certify that the cable installation is in accordance with the manufacturer's installation requirements.
- H. The Contractor must retain the services of an independent testing firm who must perform acceptance testing of the communication cable installation. The testing firm must have experience in the inspection and testing of cables of the specified type and must be a member company of NETA.

### 1.06 DELIVERY, STORAGE, AND HANDLING

- A. Provide in accordance with Section 16010 1.06.
- B. The completed cable must be packaged for shipment on nonreturnable wooden reels. Required cable lengths must be stated in the purchase order.
- C. Top and bottom ends of the cable must be available for testing.
- D. Both ends of the cable must be sealed to prevent the ingress of moisture.
- E. Each reel must have a weather resistant reel tag attached identifying the reel and cable.
- F. A cable data sheet must accompany each cable.
- 1.07 WARRANTIES AND GUARANTEES
  - A. See Specification Section 16010 1.07.

## 1.08 EXTRA MATERIALS AND SPARE PARTS

- A. Furnish two (2) spare connectors for each type used. The connectors must be of a type and manufacturer that are generally available.
- B. Furnish two (2) spare patch cords for each type used.

### 1.09 ENVIRONMENTAL REQUIREMENTS

A. See Specification Section 16010 1.09.

### 1.10 SPECIAL REQUIREMENTS

- A. See Specification Section 16010 1.10.
- 1.11 SHOP TESTS
  - A. Communication cables must be shop tested at the manufacturer's plant in accordance with the manufacturer's standard testing procedures.
  - B. All optical fibers in cables must be 100 percent attenuation tested. The attenuation must be measured at 1310 nm and 1550 nm for single-mode fibers. The manufacturer must store these values for a minimum of five years. These values must be available upon request. Shop tests must be performed prior to shipment of the fiber optic cables.
  - C. The Contractor must submit manufacturer's shop test reports.
- PART 2 PRODUCTS
- 2.01 FIBER OPTIC CABLE
  - A. Manufacturers
    - 1. Products of one of the following Manufacturers will be acceptable:
      - a. Corning Cable Systems
      - b. Systimax
      - c. ADC/Krone
      - d. Belden
  - B. General
    - 1. Provide fiber cables of loose-tube or tight-buffered construction, comprised of singlemode fibers as called for in this Specification or on the Drawings.
    - 2. 8.3/125µm singlemode fiber optic cables must be used for the ISSOCS, OCC, and CDN. Refer to the Drawings for the fiber optic strand count and additional cable requirements.
    - 3. Outdoor and indoor/outdoor rated cables for all system applications must include an outer jacket to provide protection from hydrocarbon fuels.

- 4. Potassium acetate is used as a de-icing agent. Outdoor and indoor/outdoor rated cables for all system applications must have outer jacket that provides proper protection from this agent.
- C. Guaranteed Channel Performance
  - 1. The 8.3/125µm Singlemode Guaranteed Channel Performance
    - a. The 8.3/125µm Singlemode fiber optic channel must support the following applications: 10BASE-FL, 100BASE-FL, 100BASE-FL, 100VG-AnyLAN Demand Priority Access Method, 1000 BASE-ZX (1,550 nm wave), 1000BASE-SX, 1000BASE-LX, 52/155/622 Mb/s ATM, 1000 Mb/s Cell-Based ATM, FDDI, 133/266/531/1062 Mb/s Fiber Channel, EIA-423.A, Digital Signal Level (DSL), Token Ring LAN, Vendor-Independent Active Token Ring, 100Mb/s Token Ring, Composite Analog Baseband Video, Broadband Video, Voice and BAS.
- D. Fiber Optic Cable Optical Specifications
  - 1. The Singlemode Fiber Optic cable must have the following optical specifications:

<b>č</b> i i	
Mode Field Diameter	9.2 +/-0.3µm @ 1310 nm,
	10.4 (nominal) @ 1550 nm
Group Index of Refraction	1.478
Operating Wavelength	1310 nm/1550 nm
Maximum Attenuation	0.7 dB/km at 1310 nm,
	0.7 dB/km at 1550 nm
Point Discontinuities @ 1310 nm or 1550 nm	<= 0.15 dB
Gigabit Ethernet Distance	5000 meters
Proof Test	<= 100 kpsi
Cable Cutoff Wavelength	< 1260 nm

### Table – Single-mode Optical Specification

### E. Riser Rated Fiber Optic Building Cable

 For application requiring 6 or fewer fibers, the cable must consist of dielectric strength members, individual sub-cables and a ripcord covered by an outer jacket. Each sub-cable must consist of the main fiber strand with a 250 µm fiber coating and a 900µm tight buffer.

- 2. For applications requiring more than 6 fibers (6-24 count), the fiber cable must be organized in subgroups with each subgroup containing no more than (6) individual fiber subcables. The cable must consist of dialectic strength member, subgroup cables and a ripcord covered by an outer jacket. Each subgroup cable must consist of no more than 6 individual subcables with dielectric strength members, a ripcord, and a color coated subgroupcable jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating and a color coated 900µm tight buffer. For fiber cables with fiber strand counts greater than 24 (24-144 count), subgroup cables with no more than 12 subcables are acceptable, up to a maximum bundle of 144 strands.
- 3. The cable must be reinforced with Aramid yarn for superior strength.
- 4. The cable must not contain metallic elements or central strength members.
- 5. Individual fiber strands and or groupings must be color coded per ANSI/FIA/EIA guidelines.
- 6. The cable must meet the following Physical Specifications:

Fiber Type	Single-mode
Core Diameter	8.3 μm
Core Non-Circularity Error	< 5.0%
Cladding Diameter	125 +/- 1.0 μm
Core/Clad Concentricity Error	<= 3 µm
Clad Non-Circularity Error	<= 2.0%
Coating Diameter	250 μm
Buffer Diameter	900 µm
Storage Temperature	-40 to 70°C
Operating Temperature	-20 to 70° C
Cable or Subunit Min Bend Radius During Installation	15 times cable/subunit diameter
Cable or Subunit Min Bend Radius After Installation	10 times cable/subunit diameter
Crush Resistance	Per Telcordia Standards
Impact Resistance	Per Telcordia Standards
Flex Resistance	Per Telcordia Standards
Approval Listings	NEC OFNR, CSA FT-4
Flame Resistance	UL-1666 (For riser and general building

	applications)
Fiber Type	Single-mode
Single-mode Outer Jacket Color	Yellow

### F. Plenum Rated Fiber Optic Building Cable

- For application requiring 6 or fewer fibers, the cable must consist of dielectric strength members, individual sub-cables, and a ripcord covered by an outer jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating and a 900µm tight buffer.
- 2. For applications requiring more than 6 fibers (6-24 count), the fiber cable must be organized in subgroups with each subgroup containing no more than 6 individual fiber subcables. The cable must consist of dialectic strength member, subgroup cables, and a ripcord covered by an outer jacket. Each subgroup cable must consist of no more than 6 individual sub-cables with dielectric strength members, a ripcord, and a color coated subgroup cable jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating and a color coated 900µm tight buffer. For fiber cables with fiber strand counts greater than 24 (24-144 count), subgroup cables with no more than 12 subcables are acceptable, up to a maximum bundle of 144 strands.
- 3. The cable must be reinforced with Aramid yarn for superior strength.
- 4. The cable must not contain metallic elements or central strength members.
- 5. Individual fiber strands and or groupings must be color coded per ANSI/TIA/EIA guidelines.
- 6. The cable must meet the following Physical Specifications:

Fiber Type	Single-mode
Core Diameter	8.3 µm
Core Non-Circularity Error	< 5.0%
Cladding Diameter	125 +/- 1.0 μm
Core/Clad Concentricity Error	<= 3 µm
Clad Non-Circularity Error	<= 2.0%
Coating Diameter	250 μm
Buffer Diameter	900 µm

Storage Temperature	-40 to 70°C
Operating Temperature	-20 to 70° C
Cable or Subunit Min Bend Radius During Installation	15 times cable/subunit diameter
Cable or Subunit Min Bend Radius After Installation	10 times cable/subunit diameter
Crush Resistance	Per Telcordia Standards
Impact Resistance	Per Telcordia Standards
Flex Resistance	Per Telcordia Standards
Approval Listings	NEC OFNR, CSA FT-6
Flame Resistance	UL-910 (For plenum, riser and general building applications)
Single-mode Outer Jacket Color	Yellow

- G. Outside Plant Cable (OSP) Loose Tube Fiber Optic Cable
  - 1. Standard Duty Outside Plant Cable (OSP) Loose Tube Fiber Optic Cable
    - a. For application requiring 6 or fewer fibers, the cable must consist of dielectric strength member, individual subcables in a filled buffer tube, and a ripcord covered by a polyethylene outer jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture.
    - For applications requiring more than 6 fibers (6-24 b. count), the fiber cable must be organized in subgroups with each subgroup containing no more than 6 individual fiber subcables. The cable must consist of dielectric strength member, subgroup cables, additional dielectric strength members, a ripcord, and a polyethylene outer jacket. Each subgroup cable must consist of no more than 6 individual sub-cables with a filled color-coded buffer tube. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture. For fiber cables with fiber strand counts greater than 24 (24-144 count), subgroup cables with no more than 12 subcables are acceptable, up to a maximum bundle of 144 strands.
  - 2. The fiber must use a carefully controlled refractive index profile to achieve low attenuation and high bandwidth at both operating

wavelengths, the fiber bandwidth must meet the standards for FDDI and support Ethernet, fast Ethernet, Gigabit Ethernet, Token Ring, ATM, and FDDI applications.

- 3. The buffer tubes must be compatible with standard hardware, cable routing, and fan-out kits.
- 4. The cable must be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
- 5. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
- 6. It must be suitable for underground, aerial, direct buried, tunnel, or tray installations.
- 7. Individual fiber strands and or groupings must be color coded per ANSI/TIA/EIA guidelines.
- 8. The cable must meet the following Physical Specifications:

···· · · · · · · · · · · · · · · · · ·	
Fiber Type	Singlemode
Core Diameter	8.3 μm
Core Non-Circularity Error	< 5.0%
Cladding Diameter	125 +/- 1.0 μm
Core/Clad Concentricity Error	<= 3 μm
Clad Non-Circularity Error	<= 2.0%
Coating Diameter	250 μm
Storage Temperature	-40 to 70°C
Installation Temperature	-30 to 70° C
Operating Temperature	-40 to 70° C
Cable or Subunit Min Bend Radius During Installation	15 times cable/subunit diameter
Cable or Subunit Min Bend Radius After Installation	10 times cable/subunit diameter
Crush Resistance	Per Telcordia Standards
Impact Resistance	Per Telcordia Standards
Flex Resistance	Per Telcordia Standards
Water Penetration	Meet 1 Meter Test Per TIA/EIA 455-82 Standard
Compound Flow	Meet TIA/EIA 455-81 Standard
Approval & Listings	RUS 7 CFR 1755.900
Design & Test Standards	ANSI/IECA S-87-640
Outer Jacket Color	Black

- H. Indoor-Outdoor Riser Related Cable Loose Tube Fiber Optic Cable
  - For application requiring 6 or fewer fibers, the cable must consist of dielectric strength member, individual sub-cables in a filled buffer tube and a ripcord covered by an outer jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture.
  - 2. For applications requiring more than 6 (6-24 count), the fiber cable must be organized in subgroups with each subgroup containing no more than 6 individual fiber subcables. The cable must consist of dielectric strength member, subgroup cables, additional dielectric strength members, and a ripcord covered by an outer jacket. Each subgroup cable must consist of no more than 6 individual sub-cables with a filled color-coded buffer tube. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture. For fiber cables with fiber strand counts greater than 24 (24-144 count), subgroup cables with no more than 12 subcables are acceptable, up to a maximum bundle of 144 strands.
  - 3. The fiber must use a carefully controlled refractive index profile to achieve low attenuation and high bandwidth at both operating wavelengths, the fiber bandwidth must meet the standards for FDDI and support Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring, ATM, and FDDI applications.
  - 4. The buffer tubes must be compatible with standard hardware, cable routing, and fan-out kits.
  - 5. The cable must be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
  - 6. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
  - 7. It must be suitable for indoor/outdoor conduit or tray installations.
  - 8. Individual fiber strands and or groupings must be color coded per ANSI/TIA/EIA guidelines.
  - 9. The cable must meet the following Specifications:
| Tahlo | - Phy  | vsical | Sner | rification |
|-------|--------|--------|------|------------|
| Iable | - F II | ysicai | Spec | JIIICation |

Fiber Type	Singlemode
Core Diameter	8.3 μm
Core Non-Circularity Error	< 5.0%
Cladding Diameter	125 +/- 1.0 μm
Core/Clad Concentricity Error	<= 3 µm
Clad Non-Circularity Error	<= 2.0%
Coating Diameter	250 μm
Storage Temperature	-40 to 70°C
Installation Temperature	-30 to 70° C
Operating Temperature	-40 to 70° C
Maximum Tensile Load	2670 N Short Term 810 N Long Term
Cable or Subunit Min Bend Radius During Installation	20 times cable/subunit diameter
Cable or Subunit Min Bend Radius After Installation	15 times cable/subunit diameter
Crush Resistance	Per Telcordia Standards
Impact Resistance	Per Telcordia Standards
Flex Resistance	Per Telcordia Standards
Water Penetration	Meet 1 Meter Test Per TIA/EIA 455-81 Standard
Compound Flow	Meets TIA/EIA 455-81 Standard
Approval & Listings	NEC OFN, CSA FT-4
Outer Jacket Color	Black

- I. Indoor-Outdoor Plenum Rated Loose Tube Fiber Optic Cable
  - For application requiring 6 or fewer fibers, the cable must consist of dielectric strength member, individual sub-cables in a filled buffer tube, and a ripcord covered by an outer jacket. Each sub-cable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture.
  - 2. For applications requiring more than 6 fibers (6-24 count), the fiber cable must be organized in subgroups with each subgroup containing no more than 6 individual fiber subcables. The cable must consist of dielectric strength member, subgroup cables, additional dielectric strength members, and a ripcord covered by an outer jacket. Each subgroup cable must consist of no more than 6 individual subcables with a filled color-coded buffer tube.

Each subcable must consist of the main fiber strand with a 250µm fiber coating. The cable must have a gel or dry water blocking system to fill all voids and indices to prevent the intrusion of moisture. For fiber cables with fiber strand counts greater than 24 (24-144 count), subgroup cables with no more than 12 subcables are acceptable, up to a maximum bundle of 144 strands.

- 3. The fiber must use a carefully controlled refractive index profile to achieve low attenuation and high bandwidth at both operating wavelengths, the fiber bandwidth must meet the standards for FDDI and support Ethernet, Fast Ethernet, Gigabit Ethernet, Token Ring, ATM, and FDDI applications.
- 4. The buffer tubes must be compatible with standard hardware, cable routing, and fan-out kits.
- 5. The cable must be designed for point-to-point applications as well as midspan access, provide a high-level of protection for fiber installed in the outside plant environment.
- 6. This cable is designed to connect equipment or facilities that are separated by an outdoor type environment.
- 7. It must be suitable for indoor/outdoor conduit or tray installations.
- 8. Individual fiber strands and or groupings must be color coded per ANSI/TIA/EAI guidelines.
- 9. The cable must meet the following Specifications:

Fiber Type	Singlemode
Core Diameter	8.3 μm
Core Non-Circularity Error	< 5.0%
Cladding Diameter	125 +/- 1.0 μm
Core/Clad Concentricity Error	<= 3 µm
Clad Non-Circularity Error	<= 2.0%
Coating Diameter	250 μm
Storage Temperature	-40 to 70°C
Installation Temperature	-30 to 70° C
Operating Temperature	-40 to 70° C
Maximum Tensile Load	2670 N Short Term
Cable or Subunit Min Bond Bodius During Installation	15 times coble/submit diameter
Cable of Suburnit Min Benu Radius During Installation	To times cable/submit diameter

#### Table - Physical Specification

#### Table - Physical Specification

Cable or Subunit Min Bend Radius After Installation	10 times cable/subunit diameter
Crush Resistance	Per Telcordia Standards
Impact Resistance	Per Telcordia Standards
Flex Resistance	Per Telcordia Standards
Water Penetration	Meet 1 Meter Test Per TIA/EIA 455-82 Standard
Compound Flow	Meets TIA/EIA 455-81 Standard
Approval & Listings	NEC OFN, CSA FT-6
Flame Resistance	UL-910 (For plenum, riser, and general building applications)
Outer Jacket Color	Black

#### 2.02 FIBER TERMINATION HARDWARE

- A. Manufacturers
  - 1. Products of one of the following Manufacturers will be acceptable:
    - a. Corning Cable Systems
    - b. Systimax
    - c. ADC
    - d. 3M Telecom Systems
- B. Rack Mountable Combination Fiber Optic Shelves with Integral Splice Tray
  - 1. Low Profile Combination Modular Shelf
    - a. The fiber-optic shelf must be used for a combination of splicing and termination of fiber-optic building cable or outside plant (OSP) cables.
    - b. The shelf must be used for a combination of splices and terminations with a minimum capacity of 24 fibers strands using SC connections.
    - c. The shelf must be either 19-inch or 23-inch rack mountable as indicated on Drawings.
    - d. The modular shelf must be a 3U or 2U-height fully enclosed shelf, with integrated front cable management trough included.

- e. The shelf must have slide-out tray for easy access.
- f. The modular shelf system must have interchangeable adapters, available in SC for 50, 62.5, and 8.3 solutions. The adapter must be offered with or without preassembled and factory-terminated pigtails and couplers.
- g. A modular shelf must provide easy access and administration of a minimum of (2) individual removable splice trays.
- h. Provide factory-terminated pigtails for connection to fiber shelves. Pigtails must be fusion spliced.
- i. Each modular shelf must be equipped with the following:
  - (1) Hinged front doors for easy access
  - (2) Front cable management trough
  - (3) Top cover panel
  - (4) Blank labels for identifying fiber splices and terminations
- j. Provide splice trays, as required.
- k. Provide dust caps for all terminated, spare fiber strands.
- I. Provide blank modules, as applicable.
- 2. 4U Combination Modular Shelf
  - a. The fiber-optic shelf must be used for a combination of splicing and termination of fiber-optic building cable or outside plant (OSP) cables.
  - b. The shelf must be used for combined termination and splicing for up to 72 fibers strands with SC connections.
  - c. The shelf must be either 19-inch or 23-inch rack mountable as indicated on Drawings.
  - d. The modular shelf must be a 4U-height fully enclosed shelf, with integrated front cable management trough included.

- e. It must be designed to combine both splicing and termination in a sliding format, which in turn provides both rear and full front access.
- f. A single shelf must be provided for splicing, termination, and fiber management.
- g. The modular shelf system must have interchangeable adapters, available in SC for 50, 62.5, and 8.3 solutions. The adapter must be offered with or without pre-assembled and factory-terminated pigtails and couplers.
- h. The modular shelf must provide easy access and administration of (6) individual slide out splice trays.
- i. Provide factory-terminated pigtails for connection to fiber shelves. Pigtails must be fusion spliced.
- j. The shelf must include the following:
  - (1) Hinged front and rear doors constructed of black polycarbonate and equipped (rear door) with knockouts for optional lock mechanism
  - (2) The adapter panels must mount on a hinged panel, allowing full access to the rear of the adapters and splice trays
  - (3) Cable entry protectors for incoming building fibers
  - (4) Fiber jumper bend limiters
  - (5) Top cover panel
  - (6) Blank labels for identifying fiber splices and terminations
- k. Provide splice trays, as required.
- I. Provide dust caps for all terminated, spare fiber strands.
- m. Provide blank modules, as applicable.
- C. Fiber Optic Connectors
  - 1. General

- a. The connector must be generally available for singlemode and multi-mode fiber optic cables.
- b. Unless otherwise noted on the Drawings, the following type of connector must be used for the specified system.
  - (1) ISSOCS SC Connectors
  - (2) CDN SC Connectors
  - (3) OCC SC Connectors
  - (4) ALCS SC Connectors
  - (5) SMS SC Connectors
- 2. SC Fiber Optic Connectors
  - a. Provide factory-terminated connectors with pigtails.
  - b. The connector must be available for singlemode fiber optic cables.
  - c. The connector must utilize a zirconia ferrule for fiber alignment.
  - d. The connector must have push-pull hardware for easier connections, as well as high optical stability.
  - e. The connectors must have an average loss of less than or equal to 0.3 dB.
- D. Fiber Patch Cords and Pigtails
  - 1. Provide factory terminated fiber patch cords and pigtails consisting of buffered, graded index fiber with 125 micron cladding. Core size to match application requirements. The 900 micron fiber coating must be covered by Aramid yarn and a jacket of flame retardant PVC. Provide factory-terminated connectors with ceramic ferrules. Provide the connector type as called for in this specification or on the Drawings.
  - 2. Provide two-strand riser rated zipcord style cords for all duplex patch through and equipment connections. Provide single strand cords for single equipment connections.

- 3. Provide the quantities and length of patch cords required to make orderly, manageable connections between all patch panels and equipment being cross connected. Provide SC to ST patch cords if required to make connections to equipment.
- 4. Mated Connector Loss: 0.2 dB typical, guaranteed maximum of 0.5 dB, 500 insertions.
- 5. Operating Temperature: -40 Degree C to +70 Degree C.<0.3 dB change.
- 6. Cable Retention: 11.2 lb. minimum, <0.2 db change.

### 2.03 FIBER CABLE SPLICING

- A. General
  - 1. Fiber optic splices are not allowed except where factory terminated pigtails are used for fiber terminations in fiber shelves, unless depicted on contract drawings to meet maximum cable length requirements. If field conditions warrant additional splices, submit a written request to the Commissioner and obtain approval prior to splicing cables.
  - 2. Fiber optic splices must be fusion splices performed in the field by a qualified splicer. Mechanical splices are not allowed.
  - 3. Splicing equipment must provide 3-axis alignment for fiber coatings of 250 to 900 micrometers and a splice loss of less than 0.05 dB.
  - 4. Provide heat shrink splice protection for all fiber optic splices.
  - 5. For splicing performed in fiber shelves or housings, provide adequate number of splice trays to fully transition all installed fibers to factory-terminated pigtails.
  - 6. Provide fiber optic splice closures with fiber trays for all fiber splicing required in manholes, handholes, and outdoor locations unless indicated otherwise on Drawings.
- B. Rack Mountable Fiber Optic Splice Housing
  - 1. 4U Fiber Optic Splice Housing
    - The housing must be a 4U-height fully enclosed shelf,
      with integrated front cable management trough included.
      3U-height fully enclosed shelves are also acceptable.
    - b. The housing must be used for splicing of fiber-optic building cable or outside plant (OSP) cables.

- c. The housing must be either 19-inch or 23-inch rack mountable as indicated on Drawings.
- d. The housing must be used when the application prohibits the use of the 4U Combination Modular Shelf, termination of fiber optic cables are not required at the location, or as indicated on Drawings.
- e. The housing must be used for splicing for up to 144 fiber strands.
- f. A housing must provide easy access and administration of (6) individual slide out splice trays.
- g. The housing must include the following:
  - (1) Hinged front and rear doors constructed of black polycarbonate
  - (2) Cable entry protectors for incoming building fibers
  - (3) Fiber bend limiters
  - (4) Top cover panel
  - (5) Blank labels for identifying fiber splices
- h. Provide splice trays, as required.
- C. Fiber Optic Splice Closures
  - 1. Manufacturers:
    - a. Products of one of the following Manufacturers will be acceptable:
      - (1) Corning Cable Systems
      - (2) Commscope
      - (3) ADC
      - (4) 3M Telecom Systems
  - 2. Fiber optic splices are not allowed except where factory terminated pigtails are used for fiber terminations in fiber

shelves, unless depicted on contract drawings to meet maximum cable length requirements. If field conditions warrant additional splices, submit a written request to the Commissioner and obtain approval prior to splicing cables. Splice closures of appropriate type (indoor/outdoor) must be provided for all splices other than those cables spliced in fiber shelves or housings.

- 3. When approved, provide splice closures constructed of thermoplastic, suitable for "butt" or "through" cable entry, moisture tight sealing arrangement, removable splice tray organizer, splice trays for mechanical splices, grounding lugs or equivalent for grounding cable armor.
  - a. The optical fiber splice closure must meet all requirements stated in this Specification.
  - b. The splice closure must be resistant to solvents, stress cracking, and creep. The housing materials must also be compatible with chemicals and other materials to which they might be exposed in normal applications. For splice closures installed in manholes/handholes the housing material must be compatible with hydrocarbon fuels and potassium acetate.
  - c. The optical fiber closure must be capable of accepting any optical fiber cable used in interoffice, outside plant, and building entrance facilities.
  - d. The optical fiber closure must be available in distinct sizes to accommodate a variety of cable entries as specified in the table below:

Canister (Butt) Configuration		Branch (In-Line) Configuration		
Express Entries/ Max. Cable Diameter (mm)	Drop Port Entries/Max. Cable Diameter (mm)	Express Entries/ Max. Cable Diameter (mm)	Drop Port Entries/Max. Cable Diameter (mm)	
2/32	6/25	4/32	12/25	
2/25	4/18	4/25	8/18	
2/20	3/15	4/20	6/15	

#### Table - Cable Capacity

e. As an option, the ability to double the cable capacity of an installed canister splice closure by use of a kit must be available. Such a conversion must not disturb existing cables or splices.

- f. Encapsulation must not be required to resist water penetration.
- g. The splice closure must be re-enterable. The closure end cap must be capable of accepting additional cables without removal of the sheath retention or strength member clamping hardware on previously installed cables or disturbing existing splices. The optical fiber splice closure must provide a clamping mechanism to prevent positioning of the central member or strength members and to prevent cable sheath slip or pullout.
- h. The splice closure must have appropriate hardware and installation procedures to facilitate the bonding and grounding of metal components in the closure and the armored cable sheath. The cable bonding hardware must be able to accommodate a copper conductor equal to or larger than a #6 AWG.
- i. Aerial splice closures must have available the necessary hardware to attach and secure the closure to an aerial strand.
- j. The closure must accommodate splice trays suitable for single fiber, single fiber heat shrink, mechanical, or ribbon heat shrink splices.
- Spliced fibers must not be subjected to a bend radius smaller than 30 mm (1.2 inches). Buffer tubes must not be subjected to a bend radius smaller than 38 mm (1.5 inches).
- I. The installation for the splice closure must not require specialized tools or equipment, other than those normally carried by installation crews.
- m. Provide splice trays, as required.

### 2.04 INNERDUCT

A. See Specification Section L-110, paragraph 2.05.

# 2.05 TELECOMMUNICATION ROOM RACKS

A. Manufacturers

- 1. Products of one of the following Manufacturers will be acceptable:
  - a. AMP
  - b. Systimax
  - c. 3M
  - d. Chatsworth
- B. Provide the number of racks as called for on the Drawings.
- C. Racks used in the telecommunication room(s) must be 7 feet tall, steel floor-mounted and have mounting rails for standard 19" equipment.
- D. Racks must meet the ANSI/EIA 310-D standard and include a universal ½" to 5%" hole pattern drilled on the front and rear.
- E. Racks must be properly grounded and bonded in accordance with ANSI/TIA/EIA-607. As a minimum, a 6 AWG green copper conductor must be used for grounding.
- F. Provide double-sided vertical management sections for all racks. Vertical management systems may be integrated into the rack design or attached separately. Vertical management must be provided on both sides of each rack. If more than one rack is required in a row, a single vertical management section may be used to join the adjacent racks.
- 2.06 SMALL FIBER COUNT WALL MOUNTED FIBER SHELVES (12, 24, AND 48 PORT)
  - A. Manufacturers
    - 1. Products of one of the following Manufacturers will be acceptable:
      - a. Corning Cable Systems
      - b. Systimax
      - c. ADC
      - d. 3M Telecom Systems
  - B. General Requirements
    - 1. The wall mounted fiber shelf must have the following provisions.
      - a. The fiber shelf must be suitable for wall mounting and be

constructed of a minimum of 16-gauge steel with durable power coated finish.

- b. The fiber shelf must be used for a combination of splicing and termination of fiber-optic building cable or outside plant (OSP) cables.
- c. The fiber shelf system must have interchangeable adapters, available in SC and ST for 50, 62.5, and 8.3 solutions. The adapter must be offered with or without pre-assembled and factory-terminated pigtails and couplers.
- d. 6-port SC type adapter modules with factory-terminated pigtails. Adapters are to be installed in fiber shelf. Refer to the Drawings for the total number of adapters required.
- e. Splice trays for fusion splicing of cables to pigtails. Fusion splice pigtails to all incoming and outgoing cables.
- f. Fiber shelf must provide easy access and administration of splice trays.
- g. Each modular fiber shelf must be equipped with the following:
  - (1) Removable hinged, gasketed front doors for easy access
  - (2) Interior door that can be used as a work surface.
  - (3) Fiber radius loops
  - (4) Sealed rubber cable entry grommets
  - (5) Blank labels for identifying fiber splices and terminations
  - (6) Mounting hardware
  - (7) Provisions for locking
- h. Provide duplex fiber optic patch cables as required to meet application and patching requirements for

connectivity of all strands.

- i. Provide splice trays, as required.
- j. Provide dust caps for all terminated, spare fiber strands.
- k. Provide blank modules, as applicable.

### 2.07 BONDING AND GROUNDING

- A. Communication bonding and grounding must be in accordance with the Chicago Electric Code and NFPA.
- B. Horizontal cables and equipment must be grounded in compliance with ANSI/NFPA 70 and local requirements and practices.
  - 1. Horizontal equipment includes cross connect frames, patch panels and racks, active telecommunication equipment, and test apparatus and equipment.
- C. Telecommunications Bonding Backbone

Provide a Telecommunications bonding Backbone utilizing a #6-AWG or larger bonding conductor that provides direct bonding between equipment rooms, equipment cabinets, and telecommunications rooms. This is part of the grounding and bonding infrastructure (part of the telecommunications pathways and spaces in the building structure), and is independent of equipment or cable.

### PART 3 EXECUTION

- 3.01 Installation
  - A. All Work must be in full compliance with standards, requirements, rules, regulations, codes, statutes, and ordinances, etc., of local, county, and state governments, local utilities, and labor regulations, and must be consistent with acceptable trade practice and standards.
  - B. Install the equipment in strict accordance with the final review shop Drawings and the equipment manufacturer's recommendations.
  - C. Final adjustments to the equipment must include verification of the proper mechanical operation, verification of the operation, and setting of the equipment and devices.
  - D. Adjust the location of equipment to accommodate the Work in accordance with field conditions encountered.

- E. The equipment must be installed with work space clearances required by the Chicago Electrical Code.
- F. The equipment must be installed to permit maintenance and replacement of parts, and must be clear of all openings with swinging or moving doors, partitions, or access panels.
- G. Install cable directly from shipping reels. Ensure that cable is not:
  - 1. Dented, nicked, or kinked.
  - 2. Subjected to pull stress greater, or bend radius less, than manufacturer's specification.
  - 3. Subjected to treatment, which may damage cables during installation.
- H. During installation, lubricate cables with lubricants specially formulated for the type of cabling jacket being installed. The Contractor must ensure that the maximum pulling tensions of the specified cables are not exceeded and cable bends maintain the proper radius during their placement in facilities. All pulleys used to aid in the installation of the cables must be sized according to the minimum bending radius. Failure to follow the appropriate guidelines will require the Contractor to provide in a timely fashion the additional material and labor necessary to properly rectify the situation. This must also apply to any and all damages sustained to the cables by the Contractor during the implementation.
- I. Provide fiber shelves, fiber housings, splice closures, splice trays, patch panels, pigtails, patch cables, jacks, etc., as required and as indicated to install a complete communications network as indicated.
- J. Install fiber optic cables in underground ducts as detailed in Drawings. Ensure clear path per this specification and Section L-110 which outlines the installation of innerducts and pull cords.
- K. Install communication cable in innerduct as detailed in Drawings and as specified in Section L-110.
- L. Seal cables into innerducts to stop ingress of water and grit with expansion plugs or duct seal.
- M. Manholes/Handholes
  - 1. Support all communication cables from manhole/handhole cable supports and rack arms without disturbing existing cables. Provide all additional racks/rack arms as required per cable

manufacturer requirements and OMP standard details.

- 2. Provide a minimum 4-foot coil of spare cable in each manhole throughout the cable length.
- N. Telecommunication Room Racks
  - 1. The bottom of the racks must be securely mounted to the floor. Provide cable tray or other support measures, as required to support the top of the rack.
  - 2. Fasten base plate by installing finder washers, lag bolts, masonry anchors, or a combination thereof as required due to flooring conditions.
  - 3. Racks or components must be installed as not to obstruct access to any existing or future equipment, or to infringe on any code required clearances.
  - 4. Adequate room must be provided, and sufficient work space around the rack(s) must be available to access, add, or remove equipment and cables without removing any obstructions.
  - 5. Provide all additional items to support the rack and make it ready for operation in accordance with the manufacturer's requirements.
- O. Fiber Optic Cable Splices
  - 1. All fiber optic cable splices must be fusion type.
  - 2. Unless approved by the Commissioner prior to installation, splicing of fiber cables will not be allowed except where factory terminated pigtails are used for fiber terminations.
  - 3. Completed splices must be covered with a protective sleeve, heat shrink type, to restore the protective properties of the fiber coating and buffering. Deviations to the splice, location, and pull plan will not be permitted without written approval from the Commissioner. All fiber colors must be continuous from end to end. Switching or staggering of the color scheme within the cable at splice points is not allowed. Fibers must be spliced in order.
  - 4. Cables must be brought out of splice enclosures in a controlled environment to perform fusion splice operation. Splice must be completed by returning the cable to the splice enclosure such that excess cable does not impede future entrance and utilization. Cable must be secured at regular intervals.
- P. Labeling

- 1. Refer to Specification Section 16195 for cable labeling requirements.
- Q. Sequencing
  - 1. Provide cables in accordance with sequencing requirements.
- R. Support cables in riser conduits and riser innerducts at intervals as required by the National Electrical Code. As required to provide cable strain relief, provide mesh type cable grips at appropriate intervals to ensure that the cable's maximum tensile load is not exceeded. Care must be taken to ensure that the minimum bend radius of the cable is met at the top of the cable raiser. Cable grip must be suitable for the type of cable installed.
- S. Exposed cables installed on vertical cable tray must be support at intervals of no more than 4 feet using Velcro cable ties.
- T. Bonding and Grounding
  - 1. The contractor is responsible for providing an approved ground at all newly installed distribution frames, and/or insuring proper bonding to any existing facilities.
  - 2. The Contractor is responsible for ensuring ground continuity by properly bonding all appropriate cabling, closures, cabinets, service boxes, racks, cable trays, and framework.
  - 3. All grounds must consist of #6 AWG copper wire and must be supplied from an approved building ground and bonded to the main electrical ground.
  - 4. Grounding must be in accordance with the CEC, NFPA, and all local codes and practices.
- U. Power Separation
  - 1. The Contractor must not place any communication cabling alongside power lines, or share the same conduit, channel, or sleeve with electrical apparatus.
- V. Miscellaneous Equipment
  - 1. The Contractor must provide all necessary screws, anchors, clamps, tie wraps, distribution rings, raceway, miscellaneous grounding, and support hardware, etc., necessary to facilitate the installation.
- W. Special Equipment and Tools

- 1. It is the responsibility of the Contractor to furnish any special installation equipment or tools necessary to properly complete the installation.
- 2. Tools must include, but are not limited to:
  - a. Tools for terminating cables
  - b. Testing and splicing equipment for balanced twisted pair and fiber cables,
  - c. Communication devices
  - d. Jack strands for cable reels
  - e. Cable wenches
- X. Cable Storage
  - 1. The Contractor must not roll or store cable reels without an appropriate underlay.
- Y. Cable Records
  - 1. The Contractor must maintain conductor polarity (tip and ring) identification at the main equipment room (switch room), risers, and station connecting blocks in accordance with industry practices.

# 3.02 CABLE TERMINATIONS

- A. Terminate cables in accordance with TIA/EIA standards.
- B. Provide factory-terminated pigtails suitable for fusion splicing in the field.
- C. Provide all equipment, mounting kits, and consumable materials required for a proper installation as defined by the manufacturer.
- D. Each individual cable must be clearly and uniquely identified. At a terminal cabinet or backboard provide a type written directory listing the cable, identification code, and type of signal. The directory must be mounted within the termination cabinet or on the backboard and protected by a clear plastic cover.
- E. Provide a minimum of 10 feet (3 meters) of neatly coiled, slack cable at each terminal cabinet or backboard for flexibility.

# 3.03 PHYSICAL INSPECTION

A. General Procedures:

- 1. Conduct physical checkout of the communication network.
- 2. Physical checkout must be performed prior to functional testing.
- B. Check Procedures:
  - 1. Verify that cable reels have been off-loaded from truck carefully and not damaged.
  - 2. Verify that the cable assemblies are of the type and quantity as specified.
  - 3. Verify that cable construction is of the type specified.
  - 4. Verify that all equipment have been installed plumb and level at locations indicated.
  - 5. Verify that fiber optic splice closures have been installed at locations indicated.
  - 6. Verify that cable connections or terminations within patch fiber shelves, fiber housings, splice closures, patch panels, and jacks are in accordance with cable manufacturer's printed recommendations.

### 3.04 FIELD TESTING

- A. Conduct the following field tests after cable installation:
  - Visually, inspect terminal connectors for out-of-round condition and surface defects such as microchips and cracks using a 100X (minimum) inspection microscope.
- B. Cable Testing
  - 1. At a minimum, provide test results as outlined in the ANSI/TIA/EIA Standards (latest edition) for the applicable cable being installed.
  - 2. Fiber Optic Cables
    - a. Test all fiber optic cable strands for continuity and performance before and after the cables are pulled and terminated.
    - All singlemode fiber cables must be tested at both 1310µm and 1550µm after installation.
    - c. Provide end-to-end dB loss testing for each fiber.
    - d. Test each fiber strand utilizing an OTDR bi-directional tester at the wavelengths specified above. Overall, the OTDR test results must be made up of the wavelength of the conducted test, the link length, measured attenuation

in both directions including average results, cable identification, and the locations of the near end, the far end, and each splice point or points of discontinuity.

- e. No splice may show a loss of greater than 0.3 dB and no connector may show a loss of greater than 0.75 dB.
- 3. Contractor tests must utilize a compliant cable tester for the respective cable being installed. Provide equipment, instrumentation, and supplies necessary to perform testing. The Commissioner will have the option to witness and participate actively in on-site tests.
  - a. Notify Commissioner at least 3 days prior to testing.
- 4. Each cable and associated connector must be 100% identified and tested. Printed test results for each fiber strand are required.
- 5. Hard-copy and electronic-copy results for each cable must be submitted as part of "As-Built" project performance acceptance records. In addition to the above information, the documentation will also include a pass/fail indication for the specified cable, the test date, the serial number, and software version of the test equipment, and a copy of the calibration certificate for the test equipment. The above acceptance records and documentation must be submitted to the Commissioner to support the milestone the cable is associated with and at project closeout. The Contractor must also provide manhole/handhole checklists as specified in Section L-118, for each structure fiber optic cabling was installed in (to indicate which particular cell and innerduct each cable was installed).
- 6. At no additional cost to the Owner, the Contractor must replace all cables and/or mated connector pairs that do not meet performance standards and perform retests until cable meets requirements.

# PART 4 METHOD OF MEASUREMENT

- 4.01 This Work will not be measured or paid for separately and will be considered incidental to the other items of work requiring communication cabling.
- 4.02 All raceway installed in facilities, innerduct, terminations, termination hardware, equipment racks, equipment enclosures, fiber shelves, fiber closures, fiber trays, patch panels, testing, and all other ancillary items to install the cable complete and ready for operation will be considered

incidental to this Contract.

# END OF SECTION 16730

# AIRFIELD LIGHTING CONTROL AND MONITORING SYSTEM MODIFICATIONS SECTION L-125

# PART 1 DESCRIPTION

- 1.01 SECTION INCLUDES:
  - A. The work under this Section is subject to the requirements of the Contract Documents.
  - B. This work includes all installation, programming, coordination, on-site testing, tools, and equipment necessary to modify the Airport's existing Airfield Lighting Control and Monitoring System (ALCMS) and Touchscreen Graphic User Interface (GUI) Panels located in the Main, North and South ATCT's (Air Traffic Control Towers), NALCV (North Airfield Lighting Control Vault), EALCV (East Airfield Lighting Control Vault), SALCV (South Airfield Lighting Control Vault), and AMB Building, and incorporate new graphics including programming the PLC, as required to reflect the airfield lighting installed as part of this Contract..
- 1.02 RELATED WORK:

(Not Used)

- 1.03 REFERENCES:
  - A. FAA: L-890 AC 150/5345-56 (Current Edition)
- 1.04 SUBMITTALS
  - A. Proposed computer touch screen revisions showing the new runway and taxiway lighting circuit configurations and proposed control modifications must be submitted to the Airport for approval prior to implementing the changes.
- 1.05 QUALITY ASSURANCE:
  - A. Must conform to FAA, ATCT requirements.
- 1.06 DELIVERY STORAGE AND HANDLING:

(Not Used)

- 1.07 WARRANTIES AND GUARANTEES:
  - A. As specified in Part 2 General Condition.
- 1.08 EXTRA MATERIALS AND SPARE PARTS;

(Not Used)

- 1.09 ENVIRONMENTAL REQUIREMENTS: (Not Used)
- 1.10 SPECIAL REQUIREMENTS:
  - A. Coordination with CDA and FAA Local ATCT personnel.
- 1.11 CONTRACT DRAWINGS
  - A. Airfield Lighting and Electrical Plans
- 1.12 EXECUTION, CORRELATION AND INTENT OF DOCUMENTS;
  - A. See Section L-100
- 1.13 INSTRUCTIONS AND ADJUSTMENTS:
  - A. FAA, L-890
- 1.14 OPERATION AND MAINTENANCE MANUAL;
  - A. See Specification Section FAA, L890
- 1.15 BINDERS:
  - A. FAA, ATCT
- PART 2 PRODUCTS

(Not Used)

- PART 3 EXECUTION
- 3.01 INSTALLATION
  - A. The equipment installation and mounting must comply with the requirements of The Chicago Electrical Code and local code agency having jurisdiction.

# 3.02 AIRFIELD LIGHTING TOUCHSCREEN MODIFICATIONS

A. The Contractor must retain the services of an FAA-approved manufacturer to modify the existing ALCS. The system consists of an industrial workstation computer in all three Air Traffic Control Towers, NALCV, EALCV, SALCV and AMB Building. The system is microprocessor based and software controlled. The modifications to the Airfield Lighting Control System must be coordinated with CDA and the FAA, and must be done on-site. The Contractor must submit an operational control report for review by the Commissioner and FAA prior to modifying the program. The Contractor must coordinate with the Commissioner, FAA, and the CDA to obtain access to the SALCV, EALCV, NALCV, ATCT and AMB Building required and must perform the following ALCMS modifications (including necessary PLC programming):.

- 1. Update the computer graphics to include the revised taxiway layout. The computers located in the ATCT, NALCV, EALCV, SALCV, and AMB Building, must be upgraded to reflect these modifications.
- 2. Provide functionality to turn the reallocated runway and taxiway regulator units off/on based on commands from the touchscreen in the ATCT. All work required by the Contractor to obtain temporary work badges and escorting duties for technicians associated with this work item will be considered as work necessary to complete the installation.
- B. Programming must be completed no later than 30 days prior to commissioning of the taxiways, runways, or other modified airfield elements and geometry. The Contractor must provide one training session on the System to the FAA Air Traffic Control representatives as soon as the programming has been completed.
- PART 4 METHOD OF MEASUREMENT
- 4.01 MEASUREMENT
  - A. The quantity of work performed under "ALCS Modifications" allowance includes modifications to the existing Airfield Lighting Control System, including graphic updates to incorporate the new taxiways, control wiring, integration of proposed fiber optic cables (phasing of cutovers and patching), calibration, testing and commissioning of the modified system. These items are included for payment as part of the allowance for this item. Expenses from the allowance will be subject to prior review and approval by the Commissioner. All work will be measured as indicated in the Part 2 General Conditions, Article X. "Changes in Work", 3. Unused portions of this allowance will not be paid to the Contractor, but will be returned to the City in the form of an appropriate credit.

# PART 5 BASIS OF PAYMENT

### 5.01 PAYMENT

A. Payment will be made at the contract price under the following items:

ITEM NO.	DESCRIPTION	UOM
L-125-01	ALLOWANCE FOR MODIFICATIONS TO EXISTING AIRFIELD LIGHTING CONTROL SYSTEM (ALCS)	AL

# END OF SECTION L-125

# INSTALLATION OF RUNWAY INSTRUMENT LANDING SYSTEM (ILS) SECTION L-895

### PART 1 GENERAL

- 1.01 DESCRIPTION
  - A. This Item contains the system site preparation for new instrument landing system (ILS) NAVAID packages intended for Category II/III use on Runway 9R-27L at O'Hare International Airport. The work will include all labor and materials as necessary to complete the work as shown on the plans.
  - B. The ILS equipment and shelters will be furnished and installed by the FAA.
  - C. The Contractor must furnish all materials and labor to prepare the NAVAID sites as shown on the contract documents. This work will include all materials, excavation, stone, concrete, conduits, duct bank, base cans, lighting protection, grounding, electrical and other items necessary to provide a working platform for the FAA to construct their facilities.
  - D. The Contractor is responsible for preparing the 9R ALSF / 27L LOC Shelter site up to proposed subgrade, however the FAA will be managing the construction of the shelter and area within the lease hold. Requirements shown relating to shelter construction are for information only.
  - E. The Contractor is responsible for preparing the 27L Glide Slope Antenna and Shelter site up to proposed subgrade, however the FAA will be managing the construction of the shelter, antenna, and area within the lease hold. Requirements shown relating to shelter construction are for information only.

### 1.02 REFERENCES

- A. FAA-STD-019f Lightning Protection, Grounding, Bonding and Shielding Requirements for Facilities
- B. Specification Section L-108 Installation of Underground Cable for Airports
- C. Specification Section L-110 Installation of Airport Underground Electrical Duct
- D. Specification Section L-115 Electrical Manholes and Handholes

- E. FAA GL-918D Specification for Construction of Terminal Navigational Aid Facilities
- PART 2 PRODUCTS (Not Used)
- PART 3 EXECUTION
- 3.01 GENERAL
  - A. Work done in preparation for FAA installation of NAVAIDs will be monitored by and in coordination with the FAA
- 3.02 EQUIPMENT TO BE PURCHASED BY THE CONTRACTOR. (Not Used)
- 3.03 GENERAL SYSTEM REQUIREMENTS. This Item applies to the complete ILS system. All equipment furnished must meet the requirements of this specification and the requirements of Specification FAA-G-2100/1. In the event of a conflict, the requirements of this specification must take precedence over the requirements of the general specification.
- 3.04 SHOP DRAWINGS AND MATERIAL LISTS
  - A. Prior to the installation of any material and equipment and within 30 days of contract award, the Contractor must submit to the Commissioner for approval, six (6) copies of manufacturers' brochures containing complete dimensional and performance characteristics, installation and operation instructions, etc.
  - B. The submittal must be <u>complete</u> and made in <u>one submission</u> in booklet form with hard-bound (3-ring binder) cover. Partial submissions will not be reviewed or considered. No fabrication work will be started until all design documentation has been approved by the Commissioner. Submittal approvals will in no way relieve the Contractor from meeting the requirements of this specification.
- 3.05 TEST EQUIPMENT (Not Used)
- 3.06 SHELTERS
  - A. The ALSF/LOC equipment shelter will be furnished and installed by the FAA.

- B. The Glide Slope equipment shelter and antenna will be furnished and installed by the FAA.
- 3.07 INSTRUCTION BOOKS. (Not Used)
- 3.08 TESTING/INSPECTION
  - A. FIELD INSPECTION. For FAA-related work, prior to placing any concrete in forms, the reinforcing and formwork will be inspected by the FAA and the Commissioner, and any discrepancies found must be corrected by the Contractor at his expense. The Contractor must give the FAA and the Commissioner at least 24 hours advance notice for such inspection. All concrete must be placed in the presence of the FAA and the Commissioner.

When excavations are completed on FAA-related work, notify FAA Inspector for his inspection and approval prior to installation of cables, ducts, or piping.

On FAA-related work, after foundations have been constructed and have reached adequate set, trenches and excavations must be backfilled. Backfill must be placed on both sides of foundations at the same time and both sides tamped prior to placing of the next layer of material. Special care must be taken to prevent any uneven wedging action against the structure. The FAA Inspector will inspect all installations prior to placement of backfill. Placement of backfill must be in 6-inch layers. Base material under concrete slabs must be CA-6 aggregate base in accordance with the civil specifications.

### 3.09 INSTALLATION

A. General. The Contractor must prepare the NAVAID infrastructure and site work as shown on the plans to support the FAA's work to result in a complete and functional Category II and III Instrument Landing System, suitable for FAA commissioning and takeover. The system is intended to become the property of the FAA.

# 3.10 SCREW ANCHOR FOUNATIONS:

- A. This section applies to the installation of screw anchor foundations to be used as foundations for localizer antenna arrays and RVR VS poles and VS power and control stands.
- B. The Contractor shall furnish the installation equipment for screw anchor foundations. The digger derrick or other driving

equipment:

- 1. Shall have sufficient clearance between the driving head and the ground to accommodate the screw anchor foundations shown on the drawings.
- 2. Shall have the capacity to apply sufficient down force on a foundation that the foundation advances by exactly the pitch of the helix with every revolution, without churning the soil.
- C. Pre-drilling, or any other excavation at the anchor installation site for the purpose of gaining clearance under the driving head to accommodate the length of the anchor foundations, is prohibited except under the following conditions:
  - 1. Pre-drilling is defined as augering a hole centered on the design location of a foundation. Pre-drilling is sometimes necessary in very stiff soils, to permit driving the foundation to design depth without exceeding a torque which would damage the foundation.
  - 2. Pre-drilling, if authorized by the Commissioner, shall be accomplished using an auger not larger in diameter than the foundation shaft diameter (not helix diameter).
  - 3. The need for, and depth of, pre-drilling shall be determined solely by the Commissioner, with information from the Contractor. The Contractor shall do no pre-drilling until the Commissioner authorizes him/her to do so. The Contractor shall not pre-drill to a depth greater than the depth authorized by the Commissioner.
- D. As each anchor is driven, sufficient down force shall be applied that the anchor advances by exactly the pitch of the helix with every revolution, so that the helix does not churn the soil by rotating without advancing.
- E. The foundations shall be installed plumb, within a tolerance of 1/8" horizontal per foot vertical.
- F. The foundation shall not be backed out to meet a specific foundation top elevation. Therefore, the top elevation must be checked as the foundation is driven. Foundations shall be turned down an additional fraction of a revolution in order to properly align the bolt holes.

# PART 4 METHOD OF MEASUREMENT

#### 4.01 MEASUREMENT

- A. Payment for Far Field Monitor infrastructure and site work will be made on a lump sum basis.
- B. Payment for Inner Marker infrastructure and site work will be made on a lump sum basis.
- C. Payment for Localizer infrastructure and site work will be made on a lump sum basis.
- D. Payment for PAPI PCU infrastructure and site work will be made on a lump sum basis.
- E. Payment for Touchdown RVR infrastructure and site work will be made on a lump sum basis.
- F. Payment for ASOS infrastructure and site work will be made on a lump sum basis.

# PART 5 BASIS OF PAYMENT

- 5.01 PAYMENT
  - A. Payment for accepted quantities of Far Field Monitor Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to installing concrete foundations, aggregate, duct, grounding cable, handholes, and labor and incidentals required to perform the work as shown on the contract drawings. Equipment and power/control cable will be installed by others.
  - B. Payment for accepted quantities of Inner Marker Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to, installing concrete foundation and furnishing and installing all other materials, concrete pads, duct, grounding cable, handholes, and labor and incidentals required to perform the as shown on the contract drawings. Equipment and power/control cable will be installed by others.
  - C. Payment for accepted quantities of Localizer Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to, installing Localizer foundations (grading, aggregate, geotextile fabric, anchor rods), duct, grounding cable, handholes, and labor and incidentals required to perform the work as shown on the contract drawings. Equipment and power/control cable will be installed by others.
  - D. Payment for accepted quantities of PAPI PCU Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to, installing PAPI PCU and LHA foundations

(grading, aggregate, geotextile fabric, anchor rods), duct, grounding cable, handholes, and labor and incidentals required to perform the work as shown on the contract drawings. Equipment and power/control cable will be installed by others.

- E. Payment for accepted quantities of Touchdown RVR Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to, installing Touchdown RVR foundations (grading, aggregate, geotextile fabric, anchor rods), duct, grounding cable, handholes, and labor and incidentals required to perform the work as shown on the contract drawings. Equipment and power/control cable will be installed by others.
- F. Payment for accepted quantities of ASOS Infrastructure will be made at the contract unit price per lump sum. The work includes, but is not limited to, installing ASOS foundations (grading, aggregate, geotextile fabric, anchor rods), duct, grounding cable, handholes, and labor and incidentals required to perform the workas shown on the contract drawings. Equipment and power/controlcable will be installed by others.

ITEM NO.	DESCRIPTION	UOM
L-895-01	RUNWAY 9R FAR FIELD MONITOR	LS
L-895-02	RUNWAY 9R INNER MARKER INFRASTRUCTURE	LS
L-895-03	RUNWAY 27L LOCALIZER INFRASTRUCTURE	LS
L-895-04	RUNWAY 27L PAPI <del>PCU</del> INFRASTRUCTURE	LS
L-895-05	RUNWAY 27L TOUCHDOWN RVR INFRASTRUCTURE	LS
<del>L-895-06</del>	RUNWAY 27L ASOS- INFRASTRUCTURE	ŁS

G.F. Payment will be made under:

# END OF SECTION L-895

# PAVEMENT REMOVAL SECTION P-150

- PART 1 DESCRIPTION
- 1.01 GENERAL
  - A. This work will include removal of existing bituminous concrete access roads shown on the Plans to be removed within the Project limits. Limits of pavement removal must be as shown on the Plans. The Contractor must note the variable depths of the existing bituminous pavements. The work under this Section is subject to the requirements of the Contract Documents.
  - B. The work under this Section is related to Airside pavements subject to vehicle use as directed by the Commissioner.
  - C. The Contractor shall provide connection between limits of removal on these items to existing underdrain and electrical items that are to remain in service. Disruption of service shall be minimal and coordinated with the Commissioner.
- 1.02 RELATED WORK

Section P-152 – Excavation and Embankment

- PART 2 MATERIALS Not Applicable
- PART 3 CONSTRUCTION METHODS
- 3.01 PAVEMENT REMOVAL
  - A. Method of Removal Equipment and methods used for removing pavement or shoulders will be such as to prevent cracking, shattering, or spalling of the adjacent pavement remaining in place. All bituminous pavement removal, including the pavement from bituminous composite pavement, must be removed by milling operation. Breaking pavement by means of a ball breaker or a gravity drop hammer will not be permitted. Double Saw cutting of pavement full depth is required prior to removal where shown on the plans or directed by the Commissioner.
  - B. Recycling The Contractor must submit a sieve analysis per ASTM C
    136 for every 2500 tons of aggregate produced, or a minimum of one test every two weeks, whichever is more frequent to show that the

product meets gradation of **CA-6 for Recycled Asphalt Pavement** (**RAP**); conforming to Article 1004 of the Illinois Department of Transportation, Standard Specifications for Road and Bridge Construction (S.S.R.B.C.), latest edition.

- C. Disposal Surplus materials and broken pavement conforming to the Recycling gradation specified herein will be disposed of as directed by the Commissioner on-site, within Airport limits, as specified in Specification Section 01524 Construction Waste Management. Any excess material that is not recycled for use on the project will be disposed of off-site.
- D. Comply with all applicable City, State and Federal governmental regulations regarding crushing operations. This includes but is not limited to: Illinois Environmental Protection Agency (IEPA) Joint Construction and Lifetime Operating Permit for Portable Emissions Unit; City of Chicago Department of Environment (DOE) Construction Site Reprocessing Authorization Application Requirements (Crushing Authorization) and Installation Permit Application for Processing Equipment or Area (Crushing Equipment Installation Permit).

### PART 4 METHOD OF MEASUREMENT

### 4.01 MEASUREMENT

- A. Pavement removal will be measured in place at the top surface of pavement and the area computed in square yards. Additional measurements and compensation will not be allowed for pavements that are thicker than shown on the plans. Saw cutting limits of pavement removal of all pavements will be incidental to this item. The removal of subgrade material and the base granular materials under the pavement to be removed will be measured and paid for as Unclassified Excavation described in Section P-152 Excavation and Embankment.
- B. For locations of pavement removal required for utility installation, the maximum pavement removal for payment shall be the maximum trench width plus 2 feet.
- C. If additional pavement is removed due to negligence on the part of the Contractor, the additional quantity of pavement removal and replacement will not be measured for payment.

- D. Bituminous surface removal will be measured for payment according to Article 440.07 of the Illinois Department of Transportation Standard Specifications.
- PART 5 BASIS OF PAYMENT
- 5.01 PAYMENT
  - A. Payment for pavement removal will be made at the contract unit price per Square Yard which will be payment in full for all labor, materials, equipment, saw cutting, milling and all work necessary to remove the entire pavement, recycle and/or dispose of offsite in accordance with this Specification.

ITEM NO.	DESCRIPTION	UOM
P-150-01	PAVEMENT REMOVAL – PCC TAXIWAY (FULL DEPTH)	SY
P-150-02	PAVEMENT REMOVAL - BITUMINOUS SHOULDER (FULL DEPTH)	SY
P-150-03	PAVEMENT REMOVAL - BITUMINOUS ACCESS ROAD	SY

B. Payment will be made under the following items:

# END OF SECTION P-150

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# EXCAVATION AND EMBANKMENT SECTION P-152

### PART 1 DESCRIPTION

#### 1.01 GENERAL

A. This item covers excavation, sorting, screening, stockpiling, disposal, placement, backfilling, and compaction of materials within the limits of the work required to construct the safety areas, runways, taxiways, aprons, pavements, and intermediate as well as other civil work areas in accordance with these Specifications and in conformity to the dimensions and typical sections shown on the Drawings or as directed by the Commissioner.

### 1.02 RELATED DOCUMENTS

- A. Related Specification Sections include the following:
  - 1. Section 01111 Air Quality Equipment Emissions
  - Section 01525 Disposal of Clean Construction or Demolition Debris (CCDD) and Uncontaminated Soil
  - 3. Section 02240 Dewatering
  - 4. Section 02710 Dust Control
  - 5. Section M-103 Airport Safety and Security
  - 6. Section P-150 Pavement Removal
  - 7. Section P-151 Clearing and Grubbing
  - 8. Section P-154 Frost Protection Course
  - 9. Section P-156 Temporary Air and Water Pollutions, Soil Erosion and Sediment Control
  - 10. Section P-159 Lime Modified Soils
  - 11. Section T-905 Top soiling
  - 12. Section X-100 Site Demolition
  - 13. Section Q-100 Quality Control Program

### 1.03 CLASSIFICATION – EXCAVATION AND EMBANKMENT

- A. All excavated material will be classified as defined below:
  - 1. <u>Unclassified Excavation</u>: Unclassified excavation will consist of

the excavation, sorting, screening, rock picking (regardless of size), placement, and/or disposal of all material, regardless of its nature, including stripping of topsoil, which is not otherwise classified and paid for under other items.

A screen will be used when separating refuse or recycled material from earth. The screen will be capable of removing all refuse material.

Unclassified Excavation includes the following:

- a. Required Excavation: Excavation will consist of the excavation within the project limits required to achieve the grading depicted on the Drawings or as directed by the Commissioner. This item to include all the cost to excavate, sort, screen, rock picking (regardless of size), and stockpile required excavation.
- b. Borrow Excavation: Borrow Excavation will consist of excavation of approved material required for the construction of embankment or for other portions of the work in excess of the quantity of usable material available from required excavations. Borrow material will be obtained from areas as shown on the Drawings or as directed by the Commissioner.
- c. Topsoil Stripping: Topsoil Stripping will consist of the stripping of topsoil material. Topsoil which cannot be placed in its final location will be stockpiled or disposed of off-site at a facility approved as instructed by the Commissioner. Stockpiles will be at the locations and to the heights and slopes approved by the Commissioner. Section P-156 requirements will apply to all stockpiles and all stockpiles will be included in this Work.
- d. Excavation and Sorting of Recyclable Material: This refers to the excavation of any recyclable material such as broken Portland cement concrete, pieces of bituminous concrete, brick, metallic debris, or materials otherwise considered unsuitable for embankment construction with a maximum dimension exceeding two feet in any direction. PCC and asphalt must be delivered to the Recyclable Material stockpile area on the Airport as shown on the Drawings or as instructed by the Commissioner, within five miles of the site to be stockpiled for recycling or disposal by others. Wood must be sorted, chipped, and disposed of offsite. All
excess materials must be disposed of off-site by the contractor.

- e. Unsuitable Material is any material containing vegetation or organic matter, such as muck, peat, organic silt, topsoil, or sod and will be considered unsuitable for use in embankment construction and must be disposed of at an approved licensed disposal facility. Such material, when approved by the Commissioner as capable of supporting vegetation, may be used on embankment slopes.
- f. Refuse material is any material containing trash, bagged refuse, demolition debris, and any material that is by general definition, garbage and is not material included in A.1.d. Such material must be sorted from other classifications and transported off site to an approved licensed disposal facility. If the refuse is co-mingled with soil, the soil must be sampled and characterized to determine the appropriate disposal facility.
- Unclassified Excavation Contaminated Material: Unclassified Excavation – Contaminated Material will consist of the excavation, handling and offsite disposal of materials as described below. This also includes removal and disposal of underground storage tanks (UST), drums, and other containers with either regulated substances or contaminated materials inside. Disposal must conform to Article XIV, Part 2, General Conditions, of the Contract Documents:

Contaminated Material is any material which contains a regulated substance. A regulated substance is a hazardous substance, special waste, Non-Aqueous Phase Liquids (NAPL) or petroleum or any fraction thereof, as those terms are defined in the Illinois Compiled Statutes. Environmental testing must be performed by the Contractor on any contaminated material to determine how the material should be classified, if existing data which may be provided to the Contractor does not sufficiently characterize the material.

State and local permitting requirements must be complied with prior to disturbing underground storage tanks (UST). These requirements include, but are not limited to, applying for and obtaining regulatory permits, environmental sampling protocols, and site visits by the regulatory agencies to approve the removal of the tank.

Based on the results of the environmental studies, the soils will be classified as non-hazardous contaminated material, hazardous contaminated material, or NAPL. If environmental studies of the work area have identified areas of contaminated material or non-hazardous contaminated material, the contractor must dispose of these materials offsite. The Contractor must submit the analytical results and a waste profile form, supplied by the landfill, for the Commissioner's review and signature. The Contractor must notify the Commissioner at least 48-hours (weekdays) in advance of requiring Generator or property owner signatures on waste shipment records to document proper disposal of contaminated materials at a licensed facility.

Alternatively, the Commissioner may direct the disposal be performed by others. Based on the data from the environmental studies, the soils will be classified as non-hazardous/non-special contaminated materials, special waste, hazardous waste, or NAPL. Disposal must conform to Article XIV, Part Two, General Conditions of the Contract Documents.

CDA will claim Generator status for any pre-existing hazardous waste or special waste materials encountered on this project.

- B. All excavated material will be further classified and sorted, rock picked or manipulated as necessary for placement in embankments or stockpiles, or otherwise disposed of as defined below:
  - 1. Suitable Material: To be considered suitable for construction of subgrade and embankment areas for safety areas, runways, taxiways, aprons, pavements, building foundations, or service roadways, the material must meet the conditions described below:
    - a. Suitable material is unclassified excavation material that is non-organic, non-decayable, and non-rubble material having a maximum dry density of not less than 98 pounds per cubic foot. It will contain no rock, stones, or broken concrete greater than four (4) inches in the largest dimension in the top twelve (12) inches of the proposed subgrade; no greater than nine (9) inches in the largest dimension within one (1) foot to four (4) feet below the finished subgrade; and no greater than twenty (20) inches in the largest dimension below four (4) feet of the finished subgrade. The contractor must remove any rocks necessary to ensure compliance with these requirements. The material must be easily compactable

to the required density and approved by the Commissioner. Compaction requirements for suitable material are provided in Table 1. Suitable material must be placed in the embankment in accordance with the size limitations described in Paragraph 3.05.D.

In addition, the top 1.5 feet minimum of embankments under all pavement areas must be an impervious cohesive soil, uncontaminated by deicing salts, chemical waste, sewage, or disposal wastes of any kind, with the following properties:

The material will not possess an organic content greater than five percent when tested in accordance with AASHTO T-194.

The material will have a maximum dry density of not less than 98 pounds per cubic foot.

The material must have:

- i. 40% or more passing No. 200 sieve.
- ii. A plasticity index between 12% and 25%.
- iii. A liquid limit between 25% and 50%.
- 2. Restricted Material: Material with deviations from the above requirements for suitable material is restricted to use for construction of embankments in areas outside of the runway or taxiway safety areas, apron pavements, service roadways, or building footprints if acceptable to the Commissioner. The Commissioner will be the sole judge of the suitability of all materials whether taken from required excavations, on-site stockpiles, or off-site borrow sources. Compaction requirements for restricted material are provided in Table 1.
- 3. Unsuitable Material:
  - a. Material as defined in Section 1.03.A.1.e is not suitable for embankment construction.
  - b. Asphalt grindings must not be used in embankments <u>but</u> are acceptable for use as frost protection course as shown on the plans.
- 4. Recyclable Material:
  - a. Recyclable Material refers to any large chunks of

Portland cement concrete or bituminous concrete with a maximum dimension exceeding 20 inches in any direction.

- b. Masonry, brick, metallic debris, or other such materials unacceptable for use in embankment construction may be considered Recyclable Material, if directed by the Commissioner.
- c. These items must be delivered to a designated Recyclable Material Stockpile area on Airport property, as stipulated in Section 1.03.A.1.d or as directed by the Commissioner. The Contractor must recycle or otherwise dispose of these items as directed by the Commissioner. If directed by the Commissioner, the Contractor will dispose of the material off Airport property. Alternatively, the Commissioner may direct that the disposal be performed by others.
- d. This work will be included in the Contract unit price for the pay item "Unclassified Excavation".
- C. Pavement Removal: The Contractor must refer to Section P-150, Pavement Removal. Pavement removal will be paid for separately under P-150.

# 1.04 SUBMITTALS

- A. Work Plan The Contractor must submit a work plan to the Commissioner for approval prior to beginning the excavation and embankment work. The Work Plan must include:
  - 1. Excavation of materials and direct placement, excavation of materials and stockpiling in temporary stockpile areas and placement, and excavation and placement of excess materials to the stockpile areas shown on Drawings or as directed by the Commissioner.
  - 2. The plan must provide for multiple work areas within the Project area for performing Work such that there will always be work areas available if certain areas are shut down or are unavailable to the Contractor for any reason.
  - 3. The plan must include clearing and grubbing tasks, seeding and mulching, and erosion control in accordance with the Storm Water Pollution Prevention Plan (SWPPP).
  - 4. List of equipment to be used for excavation, hauling, compaction, disking, and testing.

- 5. Sequence of excavation and placement and schedule in compliance with Contract requirements. This shall be inclusive of when the contractor intends to pick rocks (i.e. during excavation or placement).
- 6. Quality Control testing plan and independent testing laboratory experience for performing quality control testing as established in the requirements of Section Q-100, "Contractor Quality Control Program", of these Specifications.
- 7. Procedures for constructing, maintaining, and removing haul roads, including signage as required in Section 01502, "Traffic Control".
- Submit all proposed licensed disposal facilities for CDA approval. Facilities required for submittal include, but are not limited to, a currently permitted RCRA Subtitle D landfill (non-hazardous solid waste) and a currently permitted RCRA Subtitle C landfill (hazardous waste).
- PART 2 PRODUCTS [NOT USED]
- PART 3 EXECUTION
- 3.01 GENERAL
  - Α. The Contractor must inform and satisfy themselves as to the character, quantity, and distribution of all material to be excavated. The Commissioner will make the final determination of classification of all excavated material. No payment will be made for any excavated material which is used for purposes other than those designated. Before beginning excavation, grading and embankment operations in any area, the area must be completely cleared and grubbed and stripped of topsoil. Erosion control measures and materials must be installed prior to land disturbing activities in accordance with the Contractor's approved Erosion Control Plan as accepted by the Commissioner and in accordance with Section P-156 and must be maintained throughout the duration of the work. The Contractor must be responsible for the sorting, screening (if necessary), removing rocks and segregation of Suitable, Select, Restricted, Recyclable, Topsoil. and Unsuitable materials, whether during excavation, placement, or stockpiling operations. Stockpiles will be placed at the locations and to the heights and slopes approved by the Commissioner. Section P-156 requirements must apply to all stockpiles placed.
  - B. The Contractor is advised that it must classify, manipulate if necessary and sort all materials encountered according to the requirements of Paragraph 1.03. Attention is called to the Drawings, soil borings, geotechnical report, environmental analytical chemistry, and other

applicable Contract Documents. The Contractor may need to modify its earthwork operations and methods to sort, screen (if necessary), embank, and stockpile materials accordingly. In addition to the requirements of Section Q-100, the Contractor must employ a full time licensed professional engineer, specializing in geotechnical engineering and acceptable to the Commissioner, who must be on site at all times during earth moving operations.

- C. The suitability of material to be placed in embankments must be acceptable to the Commissioner. All Unsuitable Material and refuse material will be disposed of offsite in licensed disposal facilities. All material hauled off airport property must be disposed of in a licensed disposal site in accordance with Article XIV of the General Conditions.
- D. Recyclable Material and all other materials not considered suitable for use elsewhere must be disposed of offsite at a licensed disposal or recycling facility approved by the Commissioner. In no case will any discarded materials be left in windrows or piles adjacent to or within the Airport limits. The manner and location of disposal of materials will be subject to the acceptance of the Commissioner and must not create an unsightly or objectionable view.
  - E. Blasting will not be allowed.
  - F. If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor will be responsible for and must take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor must notify the Commissioner, who will arrange for their removal if necessary. The Contractor must, at its own expense, satisfactorily repair or pay the cost of all damage to such facilities or structures which may result from any of the Contractor's operations during the period of the Contract.
  - G. When the Contractor's excavating operations encounter potential artifacts of historical or archaeological significance, the operations must be temporarily discontinued, the area must be cordoned off, and the Commissioner must be notified. At the direction of the Commissioner, the Contractor must excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.
  - H. Those areas outside of the pavement areas in which the top layer of soil material has become compacted, by hauling or other activities of

the Contractor, must be scarified and disked to a depth of 4 inches, to loosen and pulverize the soil.

- I. The excavation must be carried out to the required lines and grades shown on the Drawings unless the Commissioner authorizes overexcavation to remove unsuitable materials. Should the Contractor, through negligence or other fault, excavate below the designated lines, it must replace the excavation with approved materials, in an acceptable manner and condition, at its own expense.
- J. The Contractor must repair eroded areas and take all measures to prevent continued erosion immediately and/or as indicated by the Commissioner. No separate payment will be made for this Work.
- K. The Contractor must sort, separate, and remove all logs and wood material encountered in excavated material. The Contractor must chip this wood material and dispose of offsite. No separate payment will be made for sorting, separating, chipping, or disposal of the wood material.

# 3.02 EXCAVATION

- A. No excavation will be started until the work has been staked out and cross sectioned by the Contractor and the Commissioner has received, reviewed, and concurred with the elevations and measurements of the ground surface. All Suitable Material must be used in the formation of embankment, subgrade, or for other purposes shown on the Drawings. Excess Suitable Material will be embanked or stockpiled as shown on the Drawings or as directed by the Commissioner. All Unsuitable and Refuse Material must be disposed of offsite at a licensed disposal facility approved by the Commissioner.
- B. When the Contractor encounters an area of suspected contaminated material, any container with suspect contents inside, including underground storage tanks (UST), the Commissioner must be notified immediately prior to any further work in the general vicinity. The area must be marked and delineated with safety fencing to alert personnel of a potential hazard in the area. The Commissioner will perform tests as necessary to determine the degree of contamination and the limits of material to be removed and disposed of as Unclassified Excavation-Contaminated Material. At the direction of the Commissioner, the Contractor, at no expense to the City, must redirect its labor and equipment to other work areas until the City's environmental consultant can evaluate the types and levels of contamination. The analytical data collected during this process will be furnished to the Contractor to assist in securing the necessary permits and licenses for disposal.

The Contractor is responsible for any additional waste characterization sampling and testing required while obtaining permits or approvals for hauling and disposal of the Contaminated Material.

Based on the results from the Commissioner's environmental consultant's assessment, the Commissioner will direct the Contractor as follows:

- Material Must be Transported by the Contractor to a Licensed Disposal Facility: If the contractor has the resources to properly manage this material, the City may issue the Contractor a Field Order to handle and transport the material to a licensed disposal facility approved by the Commissioner. The Contractor is responsible for any additional testing required in obtaining permits or approvals for hauling and disposal. Compensation for this Work will be in accordance with Article X.C.3 of Part 2 – General Conditions using the allowance included in Pay Item P-152-03 "Allowance for "Unclassified Excavation-Contaminated Material". For any soil handled by the Contractor in this manner, the City will subtract this soil volume from the appropriate P-152 Pay Item to avoid double payment for the same quantity of soil.
- 2. Material Must be transported by a third-party contractor to a Licensed Disposal Facility: The City reserves the right to use a third-party contractor for managing this type of soil. If the City selects this option, the Contractor will not be eligible for any additional compensation as a result of the third-party contractor's work. For any soil removed by a third-party contractor, the City will deduct the volume of this soil from the Contractor's appropriate P-152 Pay Item quantity.
- If the Contractor's additional compensation for Items 1 and 2 above exceeds the allowance amount in Pay Item P-152-03 "Allowance for Unclassified Excavation-Contaminated Material", a Contract Modification will be required in accordance with Article X.D of Part 2 – General Conditions. Any additional compensation resulting from the Contractor's handling and management of contaminated soil is subject to the Commissioner's approval.
- C. When the volume of the required excavation exceeds that required to construct the embankments to the grades indicated, the excess suitable material will be stockpiled as shown on the plans or as directed by the Commissioner. All other excess materials will be hauled offsite to a licensed disposal facility approved by the Commissioner. The Contractor must plan to use all excavation and excavated spoils from utility structures and utility trenches prior to using borrow materials.

- D. When the volume of required excavation is not sufficient for that required to construct the embankments to the grades indicated, the deficiency will be obtained from borrow areas. Borrow must be obtained from sources as shown on the Drawings or as directed by the Commissioner. The Contractor must notify the Commissioner at least 15 days prior to beginning the excavation, so necessary measurements and tests can be made. All borrow pits must be opened to expose the vertical face of various strata of suitable material to enable obtaining a uniform product. Borrow pits must be excavated to regular lines to permit accurate measurements, and they must be drained and left in a neat, presentable condition with all slopes dressed uniformly.
- E. The grade must be maintained so that the surface is well drained at all times. When necessary, temporary drains and drainage ditches must be installed to intercept or divert surface water which may affect the work.
- F. After surface stripping in areas of proposed embankment, and in cut areas, the cut grade or subgrade must be inspected by proof-rolling in embankment areas, after surface stripping, and in cut areas after excavating to the required subgrade level. The subgrade must be proof-rolled with a 25-ton (or heavier) pneumatic tired roller making at least 8 passes over the entire area in alternate (perpendicular) directions or a fully loaded semitruck loaded to the legal limit at the Commissioner's discretion. Any continuously yielding or unstable area, as determined by the Commissioner, must be undercut and backfilled in accordance with the undercutting requirements below. The final lift of embankment must be proof rolled under pavement areas.
- G. When Selective Grading is indicated on the Drawings and Specifications, the more suitable material as designated by the Commissioner must be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it must be stockpiled in approved areas for later use or disposed of off-site at a licensed disposal facility approved by the Commissioner.
- H. The Contractor is advised that it must classify, manipulate if necessary and sort all materials encountered according to the requirements of Section P-152. Attention is called to the Drawings, soil borings, Geotechnical Report, and other Contract Documents. The Contractor may need to modify its excavation methods and operations in order to sort, remove rocks, embank, and stockpile materials accordingly. In addition to the requirements of Section Q-100, the Contractor must

employ a full time licensed professional engineer, specializing in geotechnical engineering and acceptable to the Commissioner, who must be on site at all times during earth moving operations. The Commissioner will make the final determination of classification of excavated material. The suitability of material to be placed in embankments or stockpiles must be acceptable to the Commissioner.

- Ι. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for runway safety areas, subgrades, roads, shoulders, or any areas intended for turfing must be excavated to a minimum depth of 12 inches, or to the depth specified by the Commissioner, below the subgrade or designated grade. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation as determined by the Commissioner, must be removed to the depth specified by the Commissioner and backfilled with Stabilization Stone CA-1 capped to subgrade level with 4 inches of CA-6, unless otherwise directed by the Commissioner, in accordance with Section P-152 and/or the requirements for undercut and backfill of Section P-154, Frost Protection Course. Any failures of proof rolls on the final lift of embankment placed by the Contractor under pavement areas, will be undercut or corrected by the Contractor to the satisfaction of the Commissioner at no cost to the Commissioner. Unsuitable materials must be disposed of offsite at a licensed disposal facility approved by the Commissioner.
- J. Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as shown on the plan or authorized by the Commissioner. All overbreak must be graded or removed by the Contractor and disposed of as directed; however, payment will not be made for the removal and disposal of overbreak. Unavoidable overbreak as determined by the Commissioner, will be classified as "Unclassified Excavation".

# 3.03 EMBANKMENT

- A. Compaction Requirements: Refer to Table 1 for subgrade compaction requirements in Sections under proposed pavements and Sections outside pavement areas. The material to be compacted must be within ± 2 percent of optimum moisture content before rolling to obtain the prescribed compaction.
  - 1. The Commissioner will make the determination as to cohesive and non-cohesive soil regarding selecting the proper type of equipment required to compact the material.
  - 2. When the level of compaction of in-situ soils reaches the specified

level of compaction, no further removal, manipulation and recompacting will be necessary.

- 3. Further removal, manipulation and recompacting necessary to obtain the required field density will not be paid separately but considered included in the Unclassified Excavation.
- 4. The in-place field density will be determined in accordance with ASTM D 1556, ASTM D 2167 or ASTM D 6938. Stones or rock fragments larger than 4 inches in their greatest dimension will not be permitted in the top 12 inches of the subgrade. The finished grading operations, conforming to the typical cross section, must be completed and maintained at least 1,000 feet ahead of the paving operations or as directed by the Commissioner.
- 5. In cuts, all loose or protruding rocks on the back slopes must be barred loose or otherwise removed to line of finished grade of slope. All cut-and-fill slopes must be uniformly dressed to the slope, cross section, and alignment shown on the Drawings or as directed by the Commissioner.

#### TABLE 1

#### Soil Compaction Requirements Percent of Maximum Density as Determined by ASTM D-1557

	E	Beneath Rigid Pavement <sup>1</sup>				Beneath Flexible Pavement <sup>2</sup>			Outside Pavement Area		
	C	Cohesive Soils	No	oncohesive Soils <sup>3</sup>	C	ohesive Soils	No	ncohesive Soils <sup>3</sup>	Co	ohesive Soils	Noncohesive Soils
Cut sections (compaction of subgrade)	•	Top 6 inches of subgrade - 90%	•	Top 6 inches of subgrade - 100% Next 18 inches - 95%	•	Top 9 inches of subgrade - 95% 9 to 18 inches below top of subgrade - 90% 18 to 27 inches below top of subgrade - 85% 27 to 36 inches below top of subgrade -	•	Top 23 inches of subgrade- 100% 23 to 41 inches below top of subgrade - 95% 41to 59 inches below top of subgrade - 90% 59 to 76 inches below top of subgrade - 85%			
Fill sections (including existing subgrade if fill thickness is less than 36 inches for cohesive soils and 76 inches for non-cohesive soils)	•	Entire fill section - 90% Top 6 inches of existing soil - 90%	•	Top 6 inches of fill - 100% Remaining depth of fill - 95% Top 6 inches of existing soil - 90%	•	80% Top 9 inches of fill - 95% 9 to 18 inches below top of fill - 90% 18 to 27 inches below top of fill - 85% 27 to 36 inches depth and below - 80% (including top 6 inches of existing soil if fill thickness is greater than 36 inches)	•	Top 23 inches of fill - 100% 23 to 41 inches below top of fill - 95% 41 to 59 inches below top of fill - 90% 59 to 76 inches below top of fill - 85% 76 inch depth and below - 80% (including top 6 inches of existing soil if fill thickness is greater than 76 inches)	•	Entire fill section - 90%	Entire fill section – 95%

<sup>1</sup>Rigid pavements consist of Portland Cement Concrete placed upon a granular or treated subbase course over compacted subgrade. Rigid pavements may have bituminous overlays.

<sup>2</sup>Flexible pavements consist of a bituminous wearing surface placed on a base course and possibly a subbase over a compacted subgrade. The base course may consist of bituminous base, crushed aggregate base or cement treated base course.

<sup>3</sup>For those soils having a plasticity index (P.I.) of greater than or equal to 4 or less than 6 and other borderline soils, the Commissioner will determine the soil classification for the purpose of determining soil compaction requirements and compaction equipment (see 2.08.A). The Commissioner will determine the type of compaction equipment under 2.08.A. Non-cohesive soils for purposes of determining compaction are those soils having a plasticity index (P.I.) of less than 6.0.

# 3.04 PREPARATION OF EMBANKMENT AREA

- A. Where an embankment is to be constructed, all topsoil, sod, and vegetable matter must be removed from the surface upon which the embankment is to be placed, and the cleared surface must be completely broken up by plowing or scarifying to a minimum depth of 6 inches. This area must then be compacted as required by this Specification.
- B. Where embankments are to be placed on natural slopes steeper than 3 to 1 (H:V), or against cut slopes, horizontal benches 2 to 3 feet wide must be cut into the slope or constructed as directed by the Commissioner.
- C. No direct payment will be made for the preparation work performed under this Section. No separate payment will be made for benching. This work will be considered included in the Contract unit price for Unclassified Excavation.

# 3.05 FORMATION OF EMBANKMENTS

- A. Embankments will be formed in successive horizontal layers of not more than 8 inches in loose depth for the full width of the cross section, unless otherwise directed by the Commissioner.
- B. The grading operations must be conducted, and the various soil strata must be placed, to produce a soil structure as shown on the typical cross section or as directed. Materials such as topsoil, brush, hedge, roots, stumps, grass and other organic matter will not be incorporated or buried in the embankment. All materials used in the formation of embankments under the pavement will be Suitable Material.
- C. Operations on earthwork must be suspended at any time when satisfactory results cannot be obtained because of rain, freezing, or other unsatisfactory conditions of the field. The Contractor must drag, blade, or slope the embankment to provide proper surface drainage if operations are suspended.
- D. Subgrade materials will contain no rock, stones, or broken concrete greater than four (4) inches in the largest dimension in the top twelve(12) inches of the proposed subgrade; no greater than nine (9) inches in the largest dimension between one (1) foot and four (4) feet below finished subgrade; and no greater than twenty (20) inches in the largest dimension at depths greater than four (4) feet below the finished subgrade. The contractor must remove rocks as necessary to

maximize the use of the existing materials and ensuring they are meeting this specification.

- Ε. The material in the layers must be within ± 2 percent of optimum moisture content as determined by ASTM D 1557 before rolling to obtain the prescribed compaction. In order to achieve uniform moisture content throughout the layer, wetting or drying of the material and manipulation must be required when necessary. Should the material be too wet to permit proper compaction or rolling, all Work on all of the affected portions of the embankment must be delayed until the material has dried to the required moisture content. The material may be disked to a depth of 8 inches to hasten drying and then be recompacted to the requirements listed in Table 1. Sprinkling of dry material to obtain the proper moisture content must be done with approved equipment that will sufficiently distribute the water. Sufficient equipment to furnish the required water must be available at all times. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken for each 250 cubic yards or in a 100 ft x 100 ft grid of material placed per layer, or as required by the Commissioner. Based on these tests, the Contractor must make the necessary corrections and adjustments in methods, materials or moisture content in order to achieve the correct embankment density. The Contractor must at a minimum perform one modified proctor test in accordance with ASTM D1557 for each 10,000 cy of material placed or when materials change substantially as determined by the Commissioner.
- F. Wet soils are defined as those soils whose moisture content, when placed in an embankment, exceeds the optimum moisture content necessary for compaction in accordance with this Specification. Embankment layers that are determined to be wet as a result of the moisture content of the in-situ excavation will be subject to the requirements below. No separate payment will be made for drying by any means of embankment layers that become wet as the result of the Contractor's failure to properly control surface drainage during construction. If wet soils are encountered during embankment construction or subgrade preparation, the Contractor, at a minimum, must take the following steps in an effort to obtain the moisture content needed to achieve the specified level of compaction:
  - 1. If the moisture is above the optimum moisture for the soil, the Contractor must air dry the uncompacted layer. The Contractor must disc, till or use whatever means appropriate to process the full depth of the uncompacted layer each day for three (3) consecutive good drying days. The Contractor must periodically check the moisture content during processing. As soon as acceptable

moisture contents are achieved, the Contractor must acceptably complete the compaction of that layer.

- 2. If, in the opinion of the Commissioner, the specified level of compaction or moisture content cannot be obtained after air drying or the in-situ moisture level at the time of excavation is excessive, Lime Modification in accordance with Specification P-159, Lime Modified Soil may be authorized by the Commissioner in writing. The quantity of lime approved for modification of the soil layer will be determined by the moisture content of that soil layer and by the type of the soil. Lime modified soil layers will be accepted based on the compaction and testing requirements of this Specification. The Commissioner has the sole discretion in the use of lime for the purpose of modifying soils in order to achieve the specified level of compaction.
- G. Compacting operations must be continued until the embankment is compacted to the requirements listed in Table 1.
- H. On all areas outside of the pavement area, no compaction will be required on the top 4 inches.
- I. The in-place field density must be determined in accordance with ASTM D 1556, ASTM D 2167, or ASTM D 6938.
- J. Compaction areas must be kept separate, and no layer will be covered by another until the proper density is obtained.
- K. During construction of the embankment, the Contractor must route its equipment at all times, both when loaded and when empty, over the layers as they are placed and must distribute the travel evenly over the entire width of the embankment. The equipment must be operated in such a manner that hardpan, cemented gravel, clay, or other chunky soil material must be broken up into small particles and become incorporated with the other material in the layer.
- L. In the construction of embankments, layer placement must begin in the deepest portion of the fill; as placement progresses, layers must be constructed approximately parallel to the finished pavement grade line.
  - 1. In embankments greater than 10 feet, sands, silts, silty sands, and sandy silts shall be placed in the lower portion of the embankment as directed by the Commissioner.
- M. The final lift of embankment must be proof rolled under pavement areas. Any failures of proof roll on the final lift of embankment under pavement areas will be undercut or corrected by the Contractor to the

satisfaction of the Commissioner at no cost to the Commissioner.

- 1. Sands, silts, silty sands, and sandy silts should not be placed in the top 5 feet of embankment.
- N. When rock and other embankment material are excavated at approximately the same time, the rock must be incorporated into the outer portion of the embankment and the other material must be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches in their greatest dimensions will not be allowed in the top 12 inches of the subgrade. Rockfill must be brought up in layers as specified or as directed and every effort must be exerted to fill the voids with the finer material forming a dense, compact mass. Rock or boulders must not be disposed of outside the excavation or embankment areas, except at places and in the manner designated by the Commissioner.
- O. When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment, as directed by the Commissioner, in layers not exceeding 2 feet in thickness. Each layer must be leveled and smoothed with suitable leveling equipment and by distribution of spalls and finer fragments of rock. These type lifts must not be constructed above an elevation four (4) feet below the finished subgrade. Density requirements will not apply to portions of embankments constructed of materials which cannot be tested in accordance with specified methods.
- P. Frozen materials must not be placed in the embankment nor will embankment be placed upon frozen material.
- Q. There will be no separate measurement for payment for compacted embankment, and all costs of placing in layers, rock picking, compacting, disking, watering, mixing, sloping, and other necessary operations for construction of embankments will be included in the Contract price for Unclassified Excavation.
- R. No additional payment will be considered for material excavated, stockpiled, and rehandled. The work required to rehandle stockpiled material will be considered included in the Contract unit price for Unclassified Excavation.
- S. Any embankment in paving areas placed in the previous year must be recompacted to the requirements of Table 1 for the top 8 inches and re-approved before paving or additional embankment construction. This requirement will consist of disking, recompacting, and proof-rolling

the embankment surface in accordance with the Specifications. No additional payment will be made for this Work.

# 3.06 FINISHING AND PROTECTION OF SUBGRADE

- A. After the subgrade has been substantially completed, the full width must be conditioned by removing any soft or other unstable material which will not compact properly. The resulting areas and all other low areas, holes, or depressions must be brought to grade with suitable select material. Scarifying, blading, rolling, and other methods must be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the Drawings.
- B. Grading of the subgrade must be performed so that it will drain readily. The Contractor must limit hauling over the finished subgrade to that which is essential for construction purposes.
- C. All ruts or rough places that develop in a completed subgrade must be smoothed and recompacted.
- D. No subbase, or other paving course will be placed on the subgrade until the subgrade has been accepted by the Commissioner. Any damage to the accepted subgrade due to the Contractor must be repaired to the satisfaction of the Commissioner by the Contractor at the Contractor's expense.
- 3.07 HAUL
  - A. All hauling will be considered a necessary part of the work. Its cost must be considered by the Contractor and included in the Contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

# 3.08 EQUIPMENT

A. The Contractor may use any type of earth moving, compaction, and watering equipment it may desire or has at its disposal, provided that the equipment is in satisfactory condition and is of sufficient capacity to perform the Work as specified. The only requirements specified are that tamping rollers (generally referred to as Sheepsfoot Rollers) will be considered the proper type of equipment for compaction of cohesive soils and vibratory/mechanical tamping equipment will be applicable for compacting granular soils. Subgrade rollers can be used to smooth minor surface deviations in both types of subgrade/embankment, but in no case will a steel wheel or vibratory roller be used to compact cohesive embankment. In all cases, the adequacy of the equipment will be determined by the Commissioner. Failure to obtain the specified results, or failure to meet the schedule planned by the Contractor and acceptable to the Commissioner, due to inadequate equipment will not be cause for delay or additional payment. The Contractor must furnish, operate, and maintain such equipment as is necessary to control density, section, and smoothness of grade.

B. The requirements of Section 01111, Construction Air Quality – Diesel Vehicle Emissions Controls apply to this Specification Section.

# 3.09 TOLERANCES

- A. In those areas upon which a subbase or base course is to be placed, the top of the subgrade must be of such smoothness that, when tested with a 16-foot straightedge applied parallel and at right angles to the centerline, it must not show any deviation in excess of ½-inch, or must not be more than 0.05-foot from true grade as established by grade hubs or pins. Any deviation in excess of these amounts must be corrected by loosening, adding, or removing materials; reshaping; and recompacting by sprinkling and rolling.
- B. On safety areas, intermediate and other designated areas, the surface must be of such smoothness that it will not vary more than 0.10 foot from the design grade. Any deviation in excess of this amount must be corrected by loosening, adding or removing materials, and reshaping.

# 3.10 TOPSOIL

- A. When topsoil is specified or required as shown on the Drawings or under Item T-905, it must be salvaged from stripping or other grading operations. The topsoil must meet the requirements of Section T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its proper and final section of finished construction, the material must be stockpiled at approved locations. Stockpiles must not be placed within 50 feet of pavement or areas and must not be placed on areas which subsequently will require any excavation or embankment.
- B. Upon completion of grading operations, stockpiled topsoil must be handled and placed as directed, or as required in Section T-905. No stockpiles will be allowed to remain at the end of the Project.
- C. No separate payment will be made for topsoil stripping and stockpiling as such under Section P-152. The quantity removed and placed directly or stockpiled is included in the Contract unit price for the Pay Item "Unclassified Excavation".

# 3.11 BACKFILLING OF REMOVAL ITEMS

A. Any items removed as part of site demolition that lie in the proposed pavement or shoulder areas must be backfilled to grade with FA-6 or CA-6 and mechanically compacted with vibratory equipment in accordance with Section X-100 as directed by the Commissioner.

# PART 4 METHOD OF MEASUREMENT

# 4.01 GENERAL

- A. The quantity of Unclassified Excavation to be paid for will be the number of cubic yards measured in its original position after removal of surface features as shown in the demolition drawings and/or vegetation clearing and grubbing has been completed. This measurement for payment includes all sorting and screening of the material that is required. The quantity of the excavation will be computed by the average end area method.
- B. The unsuitable material stockpiled will be disposed of offsite and the quantity will be measured in tons from the weight tickets as measured at the disposal facility. The disposal facility must be licensed by the State of Illinois and approved by the Commissioner. Waste sampling, characterization and analysis will be provided by contractor's qualified environmental consultant.
- C. Refuse material will be disposed of offsite and the quantity will be measured in tons from the weight tickets as measured at the disposal facility. The disposal site must be licensed by the State of Illinois and approved by the Commissioner.
- D. Measurement will not include the quantity of materials excavated without authorization beyond normal slope lines, and dimensions shown on the Drawings or the quantity of material used for purposes other than those directed.
- E. No measurement or payment will be made for stockpiled or rehandled material that is used for embankment.
- F. The topsoil quantity removed and either placed directly or stockpiled or disposed offsite will be paid as Unclassified Excavation.
- G. Allowance for Unclassified Excavation-Contaminated Material: An allowance is established for approved excavation and disposal offsite of contaminated materials. The allowance is to be used exclusively to pay for the additional/extra work, if required, to remove and dispose of

the contaminated material above and beyond the conditions shown on the Drawings. Work under this allowance will be subject to prior approval by the Commissioner.

- H. Unclassified Excavation Undercut and Backfill per cubic yard will be the number of cubic yards removed and backfilled as measured in its original condition. All undercut will be at the direction of the Commissioner.
- I. For payment specified by the cubic yard, measurement for all excavation will be computed by the average end area method. The end area is that bound by the original ground line (after clearing and grubbing) established by field cross sections and the final theoretical pay line established by excavation cross sections shown on the Drawings, subject to verification by the Commissioner. After completion of all excavation operations and directed undercutting; and prior to placing of embankment, base or subbase material, the final excavation will be verified by the Commissioner by means of field cross sections taken randomly at intervals not exceeding 50 linear feet. Volume quantity for payment (Unclassified Excavation) will be subject to applicable deduction in accordance with Paragraph 3.02.B.
- J. Final field cross sections will be employed if the following changes have been made: Plan width of embankments or excavations are changed by more than plus or minus 1.0 foot; or Plan elevations of embankments or excavations are changed by more than plus or minus 0.5 foot.
- K. Clearing and Grubbing will be measured separately and will be paid under Section P-151.
- L. Pavement Removal will be measured and paid under Section P-150.
- M. Cost of excavation for erosion control devices/measures will not be measured separately and will be considered included in the erosion control P-156 Pay Items.
- PART 5 BASIS OF PAYMENT
- 5.01 GENERAL
  - A. For "Unclassified Excavation" payment will be made at the Contract unit price per cubic yard. This price will be full compensation for excavation of material from its original place and placement to the final location or embankment as specified, directed by the Commissioner, or shown on the Drawings including single or multiple handling. This

price will be for furnishing all materials, labor, equipment, tools, hauling, and all work necessary to complete the item, including topsoil stripping and placement, undercutting, borrow material excavation, sorting, screening, rock picking, stockpiling, saw cutting, disposal offsite, interim stockpiling and re-handling, as required by this Specification or shown on the Drawings. This price will also include segregating the recyclable materials, and other debris and stockpiling such materials at the designated area shown on the Drawings and disposing of unsuitable materials as shown on the Drawings or as directed by the Commissioner. Wood must be segregated, chipped and disposed of off Airport property, as directed by the Commissioner.

- B. For "Unclassified Excavation Undercut and Backfill" payment will be made at the Contract unit price per cubic yard. This price will be full compensation for excavation of material from its original place and placement of backfill material as directed by the Commissioner. This price will be for furnishing all materials including geotextile filter fabric; for all excavation furnishing and placement of virgin stone meeting P-154 standards, removal and disposal of material off of Airport property at an approved disposal facility; for preparation, hauling, placing and compacting these materials; and for all labor, equipment, tools, and all work necessary to complete the item. Payment will not be made for materials placed outside the theoretical grade line beyond the limits defined on the typical sections.
- C. For "Allowance for Unclassified Excavation Contaminated Material" payment will be made for excavation, onsite placement or offsite disposal of contaminated material and includes approved additional special handling and procedures required during excavation, obtaining waste stream authorization, surveying, loading into hauling trucks, transporting and disposing of the materials at an approved disposal facility. This allowance is only for effort that is clearly above and beyond the effort required for Unclassified Excavation. Any work under this allowance must have prior approval by the Commissioner. Unused portions of this allowance will not be paid to the Contractor but will be returned to the City in the form of an appropriate credit.
- D. For "Disposal of Unsuitable and Restricted Material Offsite" and "Disposal of Refuse Material Offsite" payment will be made at the Contract unit price per ton based on weight tickets from an approved licensed Subtitle D disposal facility. This price will be full compensation for excavation of excess material from its original location and offsite placement in its final location. This pay item also includes delivery to a location off of airport property as well as any dumping fees. This price will include furnishing all materials, surveying, labor, equipment, tools, hauling, and all work necessary to complete the item, including topsoil

stripping and placement, undercutting, borrow material excavation, sorting, screening, stockpiling, saw cutting, disposal, interim stockpiling and re-handling, as required by this Specification or shown on the Drawings. This price will also include segregating the recyclable materials, rocks and other debris and stockpiling such materials at the designated area shown on the Drawings and disposing of unsuitable materials as shown on the Drawings or as directed by the Commissioner. Wood must be segregated, chipped and disposed of off Airport property, as directed by the Commissioner.

Ε. For "Disposal of Material from Stockpile SP-ATopsoil Offsite" and "Disposal of Miscellaneous Material from Crushing Yards 3 and 4 Offsite" payment will be made at the Contract unit price per cubic yard. Miscellaneous materials include, but are not limited to, chunks of unprocessed concrete and asphalt, processed concrete and asphalt millings, aggregates, topsoil, and other materials. This price will be full compensation for excavation/removal of excess material from its original location and offsite placement/disposal in its final location. This pay item also includes delivery to a location off of airport property as well as any dumping fees. This price will include furnishing all materials, surveying, labor, equipment, tools, hauling, and all work necessary to complete the item, including sorting, screening, stockpiling, saw cutting, disposal, interim stockpiling and re-handling, as required by this Specification or shown on the Drawings. See drawings for breakdown of material types and approximate quantities.

ITEM NO.	DESCRIPTION	UOM
P-152-01	UNCLASSIFIED EXCAVATION	CY
P-152-02	UNCLASSIFIED EXCAVATION – UNDERCUT AND BACKFILL	CY
P-152-03	ALLOWANCE FOR UNCLASSIFIED – CONTAMINATED MATERIAL	AL
P-152-04	DISPOSAL OF UNSUITABLE AND RESTRICTED MATERIAL OFFSITE	TON
P-152-05	DISPOSAL OF REFUSE MATERIAL OFFSITE	TON

F. Payment will be made under:

P-152-06	DISPOSAL OF MATERIAL FROM STOCKPILE SP-ATOPSOIL OFFSITE	CY
P-152-07	DISPOSAL OF MISCELLANEOUS MATERIAL FROM CRUSHING YARDS 3 AND 4 OFFSITE	CY

# END OF SECTION P-152

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# WARM MIX ASPHALT CONCRETE PAVEMENTS SECTION P-405 (WMA)

PART 1 GENERAL

# 1.01 SECTION INCLUDES

- A. Work under this Section is subject to the requirements of the Contract Documents.
- B. This Section covers the production and installation of warm mix asphalt (WMA) flexible pavement using acceptable WMA Systems and Additives. The Contractor must define and submit with the bid, the proposed WMA System and Additive to be used in the Project with supporting data indicating that the Contractor/Subcontractor has successfully used the System/Additive or that the specified System/Additive has been successfully used on other airfield pavement projects including at least one reference with contact information of the airfield project(s). Acceptable WMA additives and/or processes include among others, Rediset WMX (AKZ0 Nobel), Sasolwax (Sasobit), Evotherm (MeadWestvaco), Double Barrel Green (Astec Industries), Green Machine (Gencor Industries), and Terex WMA System (Terex Roadbuilding).
- C. The WMA must consist of mineral aggregate, reclaimed asphalt pavement (RAP) / fractionated RAP (FRAP) / reclaimed asphalt shingles (RAS), PG binders and additives mixed in a central mixing plant and placed as warm mix asphalt pavement in accordance with this Specification.
- D. Per IDOT S.S.R.B.C., Hot Mix Asphalt (HMA) Base course will be considered Hot Mix Asphalt Binder courses with an IL19.0 size.
- E. Furnish and install all Bituminous Concrete Pavements as shown on the Drawings and as specified herein, including but not limited to the following:

Furnishing, placing and compacting bituminous base, leveling course, temporary ramps, and surface courses.

This work will apply to the base course under the PCC pavement and the bituminous components of the runway shoulders, and taxiway shoulders, and blast pads. This work also applies to roadways, parking areas, and temporary bituminous pavement.

#### 1.02 RELATED WORK

- A. Section P-602 Bituminous Prime Coat
- B. Section P-603 Bituminous Tack Coat

### 1.03 REFERENCES

- A. "Standard Specifications for Road and Bridge Construction" (IDOT S.S.R.B.C.), Illinois Department of Transportation, latest edition.
- B. Illinois Tollway Special Provision *Reclaimed Asphalt Materials (RAM)*, Effective February 1, 2019, or latest edition.
- C. Illinois Tollway Special Provision *Asphalt Mixtures*, Effective February 1, 2019, or latest edition.
- D. ASTM C 566 Standard Test Method for Total Evaporable Moisture Content of Aggregate by Drying
- E. ASTM D 1461 Standard Test Method for Moisture of Volatile Distillates in Asphalt Mixtures
- F. FAA-GL-918 Specification for Construction of Terminal Navigational Aid Facilities

### 1.04 SUBMITTALS

- A. Submit the following for review and approval by the Commissioner:
  - 1. Warm Mix Asphalt (WMA) system and additives.
  - 2. Data that the WMA System/Additive has been successfully used on an airfield pavement project(s) including at least one reference with contact information of the airport project(s).
  - 3. Mix Designs for Base and Surface courses.
  - 4. Current material certifications from IDOT.
  - 5. Contractor QC Addendum in accordance with the IDOT S.S.R.B.C. and the Special Requirements of this Specification.

# 1.05 SPECIAL REQUIREMENTS

A. Reference Standards - The Work is subject to the requirements of applicable portions of Section 355 (Base Course), Section 406 (Binder and Surface Courses), Section 1030, Section 1031 (RAP) and other

articles referenced within Sections 355, 406, 1030 or other Sections or Articles cited elsewhere in the Specifications of the following:

- 1. "Standard Specifications for Road and Bridge Construction" prepared by the Illinois Department of Transportation, latest edition, and the supplemental Specifications and recurring special provisions (separate book). The "Standard Specifications for Road and Bridge Construction" is referred to in the following Articles as the "Standard Specifications" and except as may be otherwise stated, the work to be done under this Section must conform to the requirements of said "Standard Specifications."
- 2. Where the "Standard Specifications" refer to the "Engineer" it will be understood to mean "Commissioner", except in cases where it is deemed to be QC testing by the Contractor.
- 3. This work is subject to applicable provisions of the latest IDOT special provision on requirements for Hamburg Wheel and Tensile Strength testing during the mix design and during production. Refer to the latest *IDOT Hot Mix Asphalt-Mix Design Verification and Production (BDE)* Effective November 1, 2013 for the Hamburg Wheel and Tensile Strength tests criteria.
- 4. This work is subject to provisions of the Illinois Tollway Special Provision *Reclaimed Asphalt Materials (RAM)*, Effective February 1, 2019, or latest edition.
- 5. This work is subject to provisions of the Illinois Tollway Special Provision *Asphalt Mixtures*, Effective February 1, 2019, or latest edition.
- 6. Prime coat and tack coat must be in accordance with Sections P-602 and P-603, respectively.
- 7. Standard Specifications articles referring to "Method of Measurement' and Basis of Payment" are not applicable.
- Asphalt plants must meet the requirements of IDOT S.S.R.B.C. Article 1102.01 for hot-mix asphalt (HMA) inclusive of policy memoranda and permissive use per mix Class I or otherwise, except as modified to allow use of Warm Mix Asphalt (WMA).
- B. <u>Requirements for Warm Mix Asphalt (WMA)</u>

- 1. Mixtures shall be designed according to the Illinois Tollway Special Provision *Asphalt Mixtures*, except that no slag shall be allowed for any mixtures.
- 2. Grade Bump Reduction due to RAP/RAS If the Contractor intends to use RAP or RAS, the Contractor must indicate in the Mix Design and their QC Addendum, the proposed RAP/RAS % and the proposed PG binder grade as per Table 9 of the Illinois Tollway Special Provision for *Asphalt Mixtures*. The reduced grade when combined with the RAP must result in the final effective PG as indicated in the Mix Design or the PG parameters on Table 1 of this Specification.
- Mix Verification For WMA technologies that cannot be replicated in the laboratory, the Contractor must indicate in their QC Addendum steps the Contractor will take to verify that the mix will be suitable for the proposed application.
- 4. Determination of Moisture Sensitivity Contractor must indicate in their QC Addendum, actions the Contractor will take to ensure the WMA will not be susceptible to moisture damage.
  - a. If the WMA system to be used is a system that incorporates water, the Contractor must submit in his Quality Control Plan, how the water will be controlled and monitored.
  - b. The Contractor's Quality Control Plan must include monitoring of the moisture content of the aggregates used for production and the moisture content of the mixture.
    - (1) The moisture content of both fine and coarse aggregates used for production must be determined twice per day in accordance with ASTM C 566.
    - (2) The moisture content of the mixture must be determined once per lot or at least once per day, in accordance with ASTM D 1461. If it exceeds 0.5 percent by weight of dry mix, the Contractor must cease production until an action acceptable to the Commissioner is taken.
- Proposed Mix Production Temperature Contractor to determine what WMA technology is being proposed, what temperature reduction is expected and what production temperature range the Contractor anticipates running the WMA.

- 6. Anti-Strip (A-S) Additive Anti-strip additives must be used.
- 7. Only chemical additives are to be used between the months of November and April.
- 8. Manufacturer's Representative Contractor must arrange for a representative of the WMA technology/equipment during the initial production at his own cost.
- 9. Opening to Traffic The Contractor at the completion of the Mix Design and placement of the test section must determine the appropriate time/temperature of the pavement for opening to traffic to prevent rutting.

# 1.06 QUALITY CONTROL AND QUALITY ASSURANCE (QC/QA)

- A. QC/QA for the work must be in accordance with IDOT S.S.R.B.C. Article 1030.05 of the Standard Specifications.
  - 1. Quality control of bituminous production and paving including providing testing laboratory at the plant, all QC tests and inspections at the plant and in the field, corrective actions, maintenance of QC plan and control charts and other quality control activities required in Article 1030.05 of the Standard Specifications will be performed by the Contractor. The cost for all QC testing will be borne by the Contractor and included in the price for the bituminous concrete pavements.
  - 2. A test section of at least 500 tons must be performed to verify the mix parameters at the plant and laydown performance at the project site.
  - 3. Quality assurance bituminous paving inspections and tests specified herein, or deemed required by the Commissioner, will be performed by a testing laboratory employed by the Commissioner. The Contractor must cooperate with said testing laboratory in every respect by providing samples for testing and necessary facilities at the job site for field tests and sample procurement. All sampling, coring including filling up of core holes, and delivering samples to the QA laboratory will be performed by the Contractor at the Contractor's cost. The cost for QA testing will be paid by the Commissioner.
  - 4. Tests must include analysis and determination of the quality of various bituminous compositions, including air voids, VMA,

density, etc., base material, and compaction of bituminous paving, verifying design as indicated or required.

# 1.07 WARRANTIES AND GUARANTEES

The Contractor must repair or replace defective materials and workmanship during the Contract Period and for one (1) year from the date of Substantial Completion of the Project.

## PART 2 PRODUCTS

# 2.01 MATERIALS

- A. Materials must be of the best quality throughout, using approved aggregates and bituminous materials.
  - 1. Coarse and fine aggregates must be supplied from sources certified per the Aggregate Gradations Control System (AGCS) by the IDOT Bureau of Materials and Physical Research. Certifications must be submitted to the Commissioner.
  - 2. Reclaimed Asphalt Pavement (RAP) will not be allowed in mixtures containing polymer modified asphalt binder. RAP must be in accordance with the Illinois Tollway Special Provision *Reclaimed Asphalt Materials (RAM)*, Effective February 1, 2019, or latest edition..
  - 3. The WMA system and additives must be approved by the Commissioner.

It is the intent of the Specifications to indicate the standards of construction desired and the Contractor must, before starting this work, submit to the Commissioner for approval, mix proportions he intends to use and the means and methods of construction he intends to employ. The Contractor must provide a certified technician to monitor the rolling pattern and compaction of the bituminous courses and control the paving process to maintain the complete installation within Specifications.

- B. Reclaimed Asphalt Pavement (RAP), Fractionated RAP (FRAP), and Reclaimed Shingles (RAS) may be used subject to the requirements of the Illinois Tollway Special Provision *Reclaimed Asphalt Materials* (*RAM*) Effective February 1, 2019, or latest edition.:
  - 1. Description, production, stockpiling, and testing of RAP, FRAP, and RAS (Type 1 and Type 2) must meet all requirements of the Illinois Tollway Special Provision.

- 2. The percentage virgin asphalt binder replacement when RAP is used alone or RAP is used in conjunction with RAS, must not exceed the amounts listed in Table 9 of the Illinois Tollway Special Provision for *Asphalt Mixtures*.
- 3. The percentage of virgin asphalt binder replacement when FRAP is used alone or FRAP is used in conjunction with RAS, must not exceed the amounts listed in Table 9 of the Illinois Tollway Special Provision for *Asphalt Mixtures*.
- C. Virgin asphalt binder for WMA shall be selected as per Table 9 of the Illinois Tollway Special Provision for *Asphalt Mixtures*. Bituminous base course under runway, taxiway and taxilane concrete mainline pavements and shoulders must be in accordance with Section 355 of the "Standards Specifications."
- D. Bituminous surface course on runway shoulders and taxiway shoulders must be in accordance with Section 406 of the "Standards Specifications."
- E. Bituminous base course for roadways and parking areas must be as specified in Section 406 of the "Standards Specifications."
- F. Bituminous mixes for airside and landside roadways and pavements must be in accordance with Section 406 (for surface and base courses) and Section 355 (for base course) of the "Standard Specifications."
- G. Protection Protect materials against damage from mechanical abuse, salts, acids, and other foreign matter by an approved means during transportation, storage and placement and until completion of construction work. All unsatisfactory materials must be removed from the premises, and all damaged materials replaced with new materials.
- H. Asphalt Concrete Pavement for Terminal Navigational Facilities -Asphalt Concrete materials for FAA Terminal Navigational Aid Facilities installations or modifications must meet the requirements of Specification FAA GL-918 (latest version) Section 2C. These installations include, but are not limited to, all FAA sites/facility improvements and access roadways. This Specification is included in the Appendix to these contract documents. No additional payment will be made for compliance with this Specification.

\*Per IDOT – S.S.R.B.C., Hot Mix Asphalt (HMA) Base course will be considered Hot Mix Asphalt Binder course with an IL-19.0 size.

# **TABLE 1 - P-405 BITUMINOUS CONCRETE PAVEMENT MIX DESIGN PARAMETERS**

LANDSIDE PAVEMENTS								
PAVEMENT USAGE	ESAL	N DESIGN	TOLLWAY MIX DESIGNATION (1)	BAS / SURFACE COURSE	THICKNESS (Inches)	AIR VOIDS		
		70	IL-9.5	Surface	1 1/2	4%		
Parking Lot	High	70	IL-19.0	Base	2 1/2	4%		
		50	IL-19.0	Base	6	2%		
Osmine David		70	IL-9.5 or IL-12.5	Surface	2	4%		
Service Road	High	70	IL-19.0	Base	3	4%		
'		50	IL-19.0	Base	6	2%		
Access Road	Low	30	IL-9.5 or IL-12.5	Surface	1 1/2	3%		
'		30	IL-19.0L	Base	2 1/2	4%		
(1) All mix designs shall be according to Table 4 and 5 of the Illinois Tollway Special Provision Asphalt Mixtures, and shall follow limitations set forth for RAP/FRAP/RAS/ABR.								

AIRFIELD (AIRSIDE) PAVEMENTS							
PAVEMENT USAGE	N DESIGN	TOLLWAY MIX DESIGNATION (1)	BASE/ SURFACE COURSE	THICKNESS (Inches)	AIR VOIDS		
Runway Base Course Under PCC Pavement	50	IL-19.0	Base	6	4%		
Taxiway Base Course Under PCC Pavement	50	IL-19.0	Base	6	4%		
Runway/Taxiway Shoulders, Blast Pad	70	IL-9.5 or IL-12.5	Surface	3	4%		
	50	IL-19.0	Base	4	2%		
	70	IL-9.5 or IL-12.5	Surface	2	4%		
Airside Service Road	70	IL-19.0	Base	3	4%		
	50	IL-19.0	Base	6	2%		
Fire Rescue Road / Snow Equipment Staging Area	70	IL-9.5 or IL-12.5	Surface	3	4%		
	70	IL-19.0	Base	6	4%		
Perimeter Road	70	IL-9.5 or IL-12.5	Surface	1 1/2	4%		
	70	IL-19.0	Base	2 1/2	4%		
Access Road Within RSA and TSA (Incl. Access to FAA Facilities)	30	IL-9.5 or IL-12.5	Surface	2	3%		
(1) All mix designs shall be a limitations set forth for RAP/	according to FRAP/RAS/A	Table 4 and 5 of th BR.	ie Illinois Tollway S	Special Provision	Asphalt Mix	tures, and shall follow	

# PART 3 EXECUTION

# 3.01 INSPECTION AND VISUAL EVALUATION OF PAVEMENT

- A. The Contractor must not commence bituminous paving work in this Section until the underlying course has been accepted by the Commissioner. This must be agreed to in a written document by the Contractor and the Commissioner.
- B. Visual evaluation of airfield pavements (runway shoulder, taxiway shoulder, base course under PCC pavement, and blast pad) The Contractor and his/her paving subcontractor, Quality Control Testing Laboratory and WMA System/Additive manufacturer's representative are required to attend the joint visual evaluation of the installed pavement with the Commissioner (CM), the FAA AAS-100 Civil Engineer or designee, and the Consultant/Designer, at the following schedules:
  - 1. Prior to opening of the bituminous pavement to traffic or placement of PCC.
  - 2. One month after traffic if any locations are subjected to traffic.
  - 3. Three or six months after traffic, whichever, if either, deemed needed at the time of the one month review or if no areas trafficked, one year after placement.

The Commissioner (CM) will coordinate the joint visual evaluations.

#### 3.02 MATERIAL TRANSFER DEVICE

- A. The Material Transfer Device must be used for the placement of the WMA concrete base and surface courses on the Runways, Taxiways, and Shoulders. The Material Transfer Device speed must be adjusted to the speed of the paver to maintain a continuous, nonstop paving operation.
- B. The Material Transfer Device must have a minimum surge capacity of 25 tons, must be self-propelled and capable of moving independently of the paver, and must be equipped with the following:
  - 1. Front Dump Hopper and Conveyor. The conveyor must provide a positive restraint along the sides of the conveyor to prevent material spillage.
  - 2. Paver Hopper Insert. The paver hopper insert must have a minimum capacity of 14 tons.

3. Mixer/Agitator Mechanism. This re-mixing mechanism must consist of a segmented, anti-segregation, re-mixing auger or two full length longitudinal paddle mixers designed for the purpose of re-mixing the bituminous material. The longitudinal paddle mixers must be located in the paver hopper insert.

# 3.03 INSTALLATION

TABLE 2

A. The pavements must be finished to indicated grades, slopes and elevations and must meet existing or established grades as applicable. All work required to adapt to existing conditions to obtain proper transition between the new work and the existing must be performed. No depressions or waves will be permitted over 1/4 inch in 10 feet, non-cumulative. WMA concrete must not be placed upon a wet surface or when the temperature of the underlying course is less than specified in Table 2. The temperature requirements may be waived by the Commissioner, if requested in writing and a cold weather paving plan has been submitted and approved; however, all other requirements including compaction must be met.

Base Temperature Limitations								
Mat Thickness	Base Temperature Deg. F							
3 in. or greater	40							
Greater than 1 in. but less than 3 in.	45							
1 in. or less	50							

- B. The underlying course must have been previously placed and compacted as specified in the applicable Sections of the Specifications. Before proceeding, the Contractor must carefully examine the underlying course and must perform any minor grading, shaping, filling or other preparatory work required, in the opinion of the testing laboratory or the Commissioner, to properly install the bituminous pavement.
- C. Bituminous concrete base course under runway shoulders, taxiway and taxilane shoulders must be placed as Specified in Section 355 of the "Standard Specifications."
- D. Bituminous concrete base and surface courses must be placed as specified in Section 406 of the "Standard Specifications." Rolling must be done on each of the separate courses by utilizing a test strip to determine the maximum obtainable density and must be continued until the required density is obtained. If there is any doubt as to the adequacy of the bituminous courses, cores must be taken and density

checked as specified in Section 406 of the Standard Specifications to determine if the placed mix conforms to the approved mix.

- E. Protection Adequate barriers must be provided to prevent the movement of traffic over the bituminous pavement until it has set for at least 24 hours. Also, the Contractor must be responsible for any damage to adjacent pavements caused by the paving operations.
- F. Inspection All thicknesses shown on the Plans are measured after compaction and are subject to inspection and approval. The Contractor must patch any core holes and cuts made for inspection and density tests, as part of the work. Tolerances in surface must be as specified.

#### 3.04 GENERAL CLEAN-UP

- A. All rubbish and debris resulting from the Work of this Section must be collected, removed from the site and disposed of legally.
- B. All work areas must be left in a broom clean condition.
- PART 4 METHOD OF MEASUREMENT

#### 4.01 MEASUREMENT

- A. WMA Concrete Pavements will be measured by the number of tons of each bituminous mixture used in the accepted work in accordance with IDOT – S.S.R.B.C. Article 406.13. Recorded truck scale weights will be used to determine the basis for the tonnage. However, payment will not be made for bituminous mixture in excess of 100% of the theoretical weight in tons as computed by the Commissioner. For locations with pavement replacement following utility installation, the maximum pavement area for payment will be the maximum trench width plus 2 feet.
- B. A test strip required for asphalt pavement will be measured as a lump sum, placed and accepted. Work includes the preparation, paving, and removal of each test strip for the associated pavement course. Failed test strips are to be repeated at no additional cost to the Commissioner.
- PART 5 BASIS OF PAYMENT
- 5.01 PAYMENT
  - A. Payment for WMA Concrete Pavements will be made at the Contract unit price per ton for each bituminous mixture placed and accepted by the Commissioner. The price will be full compensation for furnishing

all materials, for all preparation, mixing and placing of those materials, and for all labor, equipment, tools and all work necessary to complete the item.

- B. Payment for Bituminous Concrete Testing Test Strip will be made at the contract lump sum price. The work includes all preparation, mixing and placing of those materials, and for all labor, equipment, tools and all work necessary to complete the test strip for each course of pavement and for removal.
- C. Payment will be made under the following items:

ITEM NO.	DESCRIPTION	UOM
P-405-01	BITUMINOUS CONCRETE BASE COURSE, (IDOT BINDER IL-19.0, N50)	TON
P-405-02	BITUMINOUS CONCRETE SURFACE COURSE, (IDOT SURFACE IL-9.5, N70)	TON
P-405-03	BITUMINOUS CONCRETE TESTING – TEST STRIP	LS

# END OF SECTION P-405(WMA)




## NOTES:

15-1 AND 15-2.

QUANTITIES.



/.	PAVEMENT STATUS
	NO CLOSURE



DATE: MARCH 11, 2019 SHEET NO. GC-007

NDO

REVISION

	Earth	Cut (CY)			Fill (CY)						Balance (CY)				
Project	Balance Areas	Suitable	Restricted	Topsoil	Unsuitable	Suitable	Suitable (+10%)	Restricted	Restricted (+10%)	Topsoil	Unsuitable	Suitable(9)	Restricted (10)	Topsoil(11)	Unsi
	9R West	169,234	-	87,500	42,309	40,500	44,550	,	-	14,100		124,684		73,400	
	Stockpile SP-A(see Note 11)	-	-	152,000					-		-			152,000	
000144 200	9R East Sediment Stockpile	-			7,813	-	-	-	-	-	-	-	-	-	
010144.200.	9R East FSIP Restricted	-			2,697		-	-	-	-	-	-	-	-	
420	ZJ Remaining Earthwork	-				62,697	68,967	-	-	-	-	(68,967)	-	-	
RW 9R-27L		-	•	-	•		-	-	-	-	-	-	-	-	
		-	-	-	•	-	-	-	-	-	-	-	-	-	
	Subtotal	169,234		239,500	52,819	103,197	113,517		10	14,100		55,717	-	225,400	

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Recycled Materials		Cut	(CY)	Recycled Products (CY) Fill (CY)					Balance (CY)						
Project	Balance Areas	Recyclable PCC (13)	Recyclable Asphalt	Recycled RCB (PCC + 20%)	Recycled CA-1	Recycled CA-6	Recycled Grindings	RCB	Recycled CA-1	Recycled CA-6	Recycled Grindings	RCB(12)	Recycled CA-1	Recycled CA-6	Red Grind
	Pavement Demo	1,580	1,176	1,896				1,896				-	-		
	Crushing Yard 4	42,000		50,400			58,000	25,904			18,550	24,496	-		
0000444 000	Crushing Yard 3						142,000					-	-		
JH0144.200.				-	•	-		•		•		-	-		
420						-		•	-	-		-	-		
RW 9R-27L		-			•			•		-		-	-		
		-	-	-	•			•		•		-	-	-	
	Subtotal	43,580	1,176	52,296		1000	200,000	27,800	-		18,550	24,496	-		

## Notes:

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- 1. Suitable material as defined in P-152 "Excavation and Embankment" Part 1, 1.03.B.1, and suitable borrow as defined in P-152 "Excavation and Embankment" Part 1, 1.03.A.1.b.
- Restricted material as defined in P-152 "Excavation and Embankment" Part 1 1.03.B.2.
- 3. Unsuitable material as defined in P-152 "Excavation and Embankment" Part 1.103.A.1.e
- 4. Topsoil as defined in T-905
- 5. Recyclable PCC and Asphalt: Materials as defined in P-152 Part 1 1.03.A.1.d
- 6. All material within runway and taxiway safety areas is required to be suitable fill.
- 7. 6" depth used for topsoil stripping; 4" depth used for topsoil placement
- 8. Creation of Recycled RCB from Recyclable PCC furnishes 20% more per equal volume.
- Excess suitable material shall be stockpiled on-site as shown on the plans
  Excess topsoil, restricted material, and unsuitable material shall be disposed of off-site.
- 11. Stockpile SP-A contains approximately 152,000 CY of topsoil to be disposed of off-site. Disposal of excess topsoil off-site shall be paid for under Item P-152-06.
- 12. Excess material remaining in Crushing Yards 3 and 4 including asphalt chunks, grindings and unprocessed PCC shall be disposed of off-site. This shall be paid for under Item P-152-07.
- 13. There is approximately 42,000 CY of unprocessed PCC in Crushing Yard 4 that is recyclable. Contractor is responsible for sorting the recyclable and non-recyclable material and processing the recyclable material for use in the project. 14. There is approximately 28,000 CY of unprocessed PCC in Crushing Yard 4 that is not recyclable. This material shall be disposed of off-site.

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N 2.24 pw/pv





PM -

3.26.25 pw/pw



















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N -19:06 pw/pw













## **TABLE 1: PAPI INSTALLATION**

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DESCRIPTION	LIGHT EMITTING DIODE (LED) PRECISIO APPROACH PATH INDICATOR (PAPI)
TYPE	FA-30200
STYLE	Α
CLASS	NOTE 10
NOMINAL ANGLE	3°
LOWEST ON-COURSE ANGLE	2° 45'
* DIMENSION A (DISTANCE BETWEEN	1049.46'
PAPI AND THE END OF ULTIMATE RWY)	
* DIMENSION B (FROM EDGE OF RWY TO THE NEAREST PAPI)	75
* DIMENSION C (DISTANCE, PAPI	30
CENTER TO CENTER)	
* DIMENSION D (DISTANCE BETWEEN R/W	274.25
Ç AND PAPI CONTROLLER UNIT)	
THRESHOLD CROSSING HEIGHT	55.00
RWY STATION AT Q (* POINT E)	3+78.70
RWY CL ELEVATION (* POINT E)	652.52
THRESHOLD ELEVATION (END OF ULTIMATE RWY)	652.40
GROUND ELEVATION AT BOX NO. 1	648.91
GROUND ELEVATION AT BOX NO. 2	648.26
GROUND ELEVATION AT BOX NO. 3	647.61
GROUND ELEVATION AT BOX NO. 4	646.99
GROUND ELEVATION AT CONTROLLER	646.80
APERTURE ELEVATION BOX NO. 1	652.52
APERTURE ELEVATION BOX NO. 2	652.52
APERTURE ELEVATION BOX NO. 3	652.52
APERTURE ELEVATION BOX NO. 4	652.52
AIMING ANGLE BOX NO. 1	3°35′
AIMING ANGLE BOX NO. 2	3°15'
AIMING ANGLE BOX NO. 3	2°45'
AIMING ANGLE BOX NO. 4	2°25'

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## \* SEE INSTALLATION DIAGRAM FOR UNDERSTANDING OF DIMENSIONS AND POINTS CALLED OUT IN TABLE

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NOTES: 1. CONSTANT VOLTAGE PAPI ASSEMBLY CONSISTS OF FOUR PAPI LIGHT UNITS AND ONE POWER AND CONTROLLER UNIT (PCU).

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- 2. PAPI LIGHT UNITS MUST BE LOCATED AS INDICATED IN PLAN SHEETS CN-100 AND CN-105 . SUBJECT TO MANUFACTURER'S INSTALLATION REQUIREMENTS.
- 3. DIMENSIONS SHOWN IN THE DETAILS ARE APPROXIMATE, ACTUAL DIMENSION MUST BE SPECIFIED BY THE MANUFACTURER.
- 4. PAPI CONTROLLER TO LIGHT UNIT WIRING SHALL BE SPECIFIED BY MANUFACTURER TILT WIRING LEADS ARE NO LESS THAN #14 AWG AND POWER WIRING LEADS ARE NOT LESS THAN #8 AWG.
- 5. CONTRACTOR IS ADVISED THAT NOT ALL ITEMS ARE SHOWN ON THE PAPI INSTALLATION DETAILS ARE SUPPLIED BY THE MANUFACTURER: THAT IS, WIRE, CONDUIT, FRANGIBLE COUPLINGS, BASE CANS, ETC. NEED TO BE PROCURED SEPARATELY FROM PAPI.
- 6. PAPI ASSEMBLY WILL BE SUPPLIED BY FAA.
- 7. SEE PARAGRAPH 504, TABLE 5-2 OF FAA ORDER 6850.2 FOR AIMING IN CONSTRUCTION WITH HEIGHT GROUP 6 AIRCRAFT ON RUNWAYS WITH ELECTRONIC GLIDE SLOPE.
- 8. EACH PAPI LAMP HOUSING UNIT MUST BE AIMED OUTWARD INTO THE APPROACH ZONE AND PARALLEL WITH THE RUNWAY CENTERLINE, WITH A TOLERANCE OF ± DEGREES.
- 9. FAA WILL PROVIDE THE CONTRACTOR WITH A LAMP HOUSING ASSEMBLY (LHA) AND SIE BOX TO USE FOR DETERMINING LOCATIONS OF DUCTBANK STUBS FOR PAPI EQUIPMENT.



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