

## PART XI – LIGHTING INSTALLATION

### ITEM L-101 AIRPORT ROTATING BEACONS

#### DESCRIPTION

**101-1.1** This item shall consist of furnishing and installing airport rotating beacons. This work shall include the mounting, leveling, wiring, painting, servicing, and testing of the beacon and all materials and incidentals necessary to place the beacons in operating condition as a completed unit to the satisfaction of the Engineer. This item shall include a mounting platform if specified in the plans.

#### EQUIPMENT AND MATERIALS

##### 101-2.1 GENERAL.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

**101-2.2 BEACON.** The beacon shall meet the requirements of AC 150/5345-12, Specification for Airport and Heliport Beacons.

**101-2.3 PANEL BOARDS AND BREAKERS.** Panel boards and breakers shall conform to the requirements of Fed. Spec. W-P-115.

**101-2.4 WEATHERPROOF CABINETS.** The weatherproof cabinets shall conform to National Electrical Manufacturers Association Standards and shall be constructed of steel not less than No. 16 USS gauge.

**101-2.5 WIRE.** Wire in conduit rated up to 5,000 volts shall conform to AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits for Rubber Insulated Neoprene Covered Wire, or Fed. Spec. J-C-30, Type RHW, for rubber insulated fibrous covered wire. For ratings up to 600 volts, the thermoplastic wire conforming to Fed. Spec. J-C-30, Types TW, THW, and THWN, shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

**101-2.6 CONDUIT.** Rigid steel conduit and fittings shall conform to the requirements of Underwriters Laboratories Standard 6, 514, and 1242.

##### 101-2.7 PAINT.

**a.** Priming paint for ungalvanized metal surfaces shall be a high solids alkyd primer conforming to TT-P-664D.

**b.** Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint conforming to MIL-P-24441/19B. If necessary, add not more than ½ pint (0.06 liter) of turpentine to each gallon (liter).

c. Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed non-fading paint meeting the requirements of Fed. Spec. TT-E-489. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

d. White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Commercial Item Description A-A-3067.

e. Priming paint for wood surfaces shall be mixed on the job by thinning the above-specified orange or white paint with ½ pint (0.06 mm) of raw linseed oil to each gallon (liter).

## CONSTRUCTION METHODS

**101-3.1. PLACING THE BEACON.** The beacon shall be mounted on a beacon tower, platform, or building roof as shown in the plans.

**101-3.2 HOISTING AND MOUNTING.** The beacon shall be hoisted to the mounting platform by using suitable slings and hoisting tackle. Before fastening the beacon to the mounting platform, the mounting holes shall be checked for correct spacing. Beacon base or mounting legs shall not be strained or forced out of position to fit incorrect spacing of mounting holes. The beacon base shall be raised first, set in position, and bolted in place. The drum shall then be raised and assembled to the base.

**101-3.3 LEVELING.** After the beacon has been mounted in place, it shall be accurately leveled *following manufacturer's instructions*. The leveling shall be checked in the presence of the Engineer and shall be to the Engineer's satisfaction.

**101-3.4 SERVICING.** Before placing the beacon in operation, the Contractor shall *check the manufacturer's manual for proper servicing requirements. Follow the manufacturer's servicing requirements for each size beacon.*

**101-3.5 BEAM ADJUSTMENT.** After the beacon has been mounted and leveled, the elevation of the beams shall be adjusted. The final beam adjustments shall be made at night so that results can be readily observed. The beams shall be adjusted to the elevation directed by the Engineer or as shown in the plans, except that, in no case shall the elevation of the beams be less than 2 degrees above the horizontal.

**101-3.6 BEACON MOUNTING PLATFORM.** Where the beacon is to be mounted at a location other than the beacon tower and where a special mounting platform is required, the construction of this mounting platform and any necessary lightning protection equipment shall be in accordance with the details shown in the plans.

**101-3.7 WIRING.** The Contractor shall furnish all necessary labor and materials and shall make complete above ground electrical connections in accordance with the wiring diagram furnished with the project plans. *The electrical installation shall conform to the requirements of the latest edition of National Fire Protection Agency, NFPA-70, National Electric Code.*

If underground cable for the power feed from the transformer vault to the beacon site and duct for this cable installation under paved areas is required, the cable and duct shall be installed in accordance with and paid for by linear foot measurement as described in Item L-108, Underground *Power* Cable for Airports, and Item L-110, Airport Underground Electrical Duct *Banks and Conduit*.

Unless otherwise specified, the Contractor shall connect the tell-tale relay mechanism in the beacon to energize the tower obstruction light circuit when failure of the beacon service (primary) lamp occurs.

If lightning protection is specified in the plans or proposal as a part of this item, it shall be in accordance with 103-2.3, 103-2.4, 103-2.5, 103-2.6, and 103-3.4 in Item L-103, Installation of Airport Beacon Towers.

**101-3.8 PANEL AND CABINET.** Unless otherwise specified, the Contractor shall furnish and install at the top of the beacon tower or mounting platform a circuit-breaker panel consisting of four 15-ampere breakers mounted in a weather-proof cabinet to provide separate protection for the circuits to the beacon lamps, motor, obstruction lights, and other equipment. The cabinet shall be located on the side of the beacon platform, as directed by the Engineer.

**101-3.9 CONDUIT.** All exposed wiring shall be run in not less than  $\frac{3}{4}$  inch (19 mm) galvanized rigid steel conduit. No conduit shall be installed on top of a beacon platform floor. All conduit shall be installed to provide for drainage. If mounted on a steel beacon tower, the conduit shall be fastened to the tower members with “wraplock” straps, clamps, or approved fasteners, spaced approximately 5 feet (150 cm) apart. The conduit shall be fastened to wooden structures with galvanized pipe straps and with galvanized wood screws not less than No. 8 or less than 1- $\frac{1}{4}$  inches (31 mm) long. There shall be at least two fastenings for each 10-foot (3 m) length.

**101-3.10 BOOSTER TRANSFORMER.** If shown in the plans or specified in job specifications, a booster transformer to compensate for voltage drop to the beacon shall be installed in a suitable weatherproof housing under or on the tower platform or at the base of the tower. The installation shall be as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, it shall be installed in accordance with and paid for as described in Item L-109, Airport Transformer Vault and Vault Equipment.

**101-3.11 PHOTOELECTRIC CONTROL.** If shown in the plans or specified in job specifications, the Contractor shall furnish and install an automatic control switch at the location indicated in the plans. The switch shall be a photoelectric type. It shall be a standard commercially available unit suitable for aviation service. It shall be installed, connected, and adjusted in accordance with the manufacturer's instructions.

**101-3.12 OBSTRUCTION LIGHTS.** Unless otherwise specified, the Contractor shall install on the top of the beacon tower or mounting platform two L-810 obstruction lights on opposite corners. These lights shall be mounted on conduit extensions to a height of not less than 4 inches (100 mm) above the top of the beacon. They shall be connected in series into the tell-tale circuit with the necessary relay and wiring connections.

**101-3.13 PAINTING.** If construction of a wooden mounting platform is stipulated in the proposal as part of this item, all wooden parts of the platform shall be given one priming coat of white or aviation-orange paint after fabrication but before erection and one body and one finish coat of aviation-orange paint after erection. Steel mounting platforms shall be given one priming coat of corrosion-inhibiting primer before erection and one body and one finish coat of aviation-orange paint after erection. All equipment installed under this contract and exposed to the weather shall be given one body and one finish coat of aviation-orange or white paint as required. This shall include beacon (except glass surfaces), beacon base, breaker cabinet, all conduit, and transformer cases. It shall not include lightning rods or obstruction light globes.

The paint shall be applied uniformly in the proper consistency by skilled painters. The finished paint shall be free from sags, holidays, and smears. Each coat of paint shall be given ample time to dry and harden before the next coat of paint is applied. A minimum of 3 days shall be allowed for drying on wood surfaces, and a minimum of 4 days shall be allowed for drying on metal surfaces. Painting shall not be done in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40° F (4° C), nor started when the weather forecast indicates such conditions for the day.

All surfaces shall be cleaned before painting. The surfaces shall be dry and free from scale, grease, rust, dust, and dirt when paint is applied. All knots in wood surfaces shall be covered with shellac immediately before applying the priming coat of paint. Nail holes and permissible imperfections shall be filled with putty. The ready-mixed paint shall be thinned for the priming and body coats in accordance with the manufacturer's recommendations. In the absence of such recommendations, the following shall apply:

a. Body coats (for both wood and steel surfaces) - add  $\frac{1}{2}$  pint (0.06 liter) of turpentine to each gallon (liter) of ready-mixed paint for body coats.

b. Finish coats (for both wood and steel surfaces) the ready-mixed paint shall be used as it comes from the container for finish coats.

**101-3.14 TESTING.** The installation shall be fully tested in operation as a completed unit prior to acceptance. These tests shall include operation of the lamp-changer operation and taking megger and voltage readings. The insulation resistance to ground of the beacon supply circuit shall be not less than 50 megohms when measured ungrounded. Testing equipment shall be furnished by the Contractor. Tests shall be conducted in the presence of the Engineer and shall be to his/her satisfaction.

## METHOD OF MEASUREMENT

**101-4.1** The quantity to be paid for shall be the number of beacons installed as completed units in place, accepted, and ready for operation.

## BASIS OF PAYMENT

**101-5.1** Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item L-101-5.1	Airport Rotating Beacon, in place--per unit
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## MATERIAL REQUIREMENTS

AC 150/5345-7	Specification for L-824 Underground Cable for Airport Lighting Circuits
AC 150/5345-12	Specification for Airport and Heliport Beacons
Commercial Item Description A-A-3067	Paint: Alkyd, Exterior, Low VOC
Fed. Spec. J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
Fed. Spec. TT-E-489	Enamel, Alkyd, Gloss, Low VOC Content
Fed. Spec. TT-P-664D	Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant
Fed. Spec. W-P-115	Panel, Power Distribution
Fed. Std. 595	Colors
MIL-P-24441/19B	Paint, Epoxy -Polyamide, Zinc Primer, Formula 159, Type III
Underwriters Laboratories Standard 6	Rigid Metal Conduit
Underwriters Laboratories Standard 514	Fittings for Conduit and Outlet Boxes

Underwriters Laboratories Standard 1242

Intermediate Metal Conduit

*National Fire Protection Agency*

*NFPA-70, National Electric Code*

## ITEM L-102 HAZARD BEACON

### DESCRIPTION

**102-1.1** This item shall consist of furnishing and installing a hazard flashing beacon in accordance with these specifications. This work shall include the mounting, leveling, wiring, servicing, painting, and testing of the beacon and all materials and incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the Engineer. This item shall include a mounting platform if specified in the plans.

### EQUIPMENT AND MATERIALS

#### 102-2.1 GENERAL.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

**102-2. BEACON.** The beacon shall conform to the requirements of AC 150/5345-43, Specification for Obstruction Lighting Equipment.

**102-2.3 PANEL BOARDS AND BREAKERS.** Panel boards and breakers shall conform to the requirements of Fed. Spec. W-P-115.

**102-2.4 WEATHERPROOF CABINETS.** Weatherproof cabinets shall conform to National Electrical Manufacturers Association Standards and shall be constructed of steel not less than No. 16 USS gauge.

**102-2.5 WIRE.** Wire in conduit rated up to 5,000 volts shall conform to AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits for Rubber Insulated Neoprene Covered Wire, or Fed. Spec. J-C 30, Type RHW, for rubber insulated fibrous covered wire. For ratings up to 600 volts, thermoplastic wire conforming to Fed. Spec. J-C-30, Types TW, THW, and THWN shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

**102-2.6 CONDUIT.** Rigid steel conduit and fittings shall conform to the requirements of Underwriters Laboratories Standard 6, 514, and 1242.

#### 102-2.7 PAINT

**a.** Priming paint for ungalvanized metal surfaces shall be a high solids alkyd primer conforming to TT-P-664D.

**b.** Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint, conforming to MIL P 24441/19B. If necessary, add not more than ½ pint (0.06 liters) of turpentine to each gallon (liter).

**c.** Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed non-fading paint meeting the requirements of Fed. Spec. TT-E-489. The color shall be in accordance with Federal Standards 595, Aviation Gloss Orange Number 12197.

d. White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Commercial Item Description A-A-3067.

e. Priming paint for wood surfaces shall be mixed on the job by thinning the above specified orange or white paint by adding ½ pint (0.06 liters) of raw linseed oil to each gallon (liter).

**102-2.8 FLASHER.** The beacon flasher shall be a standard commercially available unit designed for the service intended. The mechanism in the flasher shall be designed to flash not more than 40 and not less than 12 flashes per minute. The flashing switch shall be of the mercury contact-type encapsulated in nonbreakable plastic. The entire unit shall be housed in a weatherproof cabinet.

## CONSTRUCTION METHODS

**102-3.1 PLACING THE BEACON.** The beacon shall be mounted on a beacon tower, platform, building roof, or on a pole as shown in the plans.

**102-3.2 MOUNTING AND LEVELING.** The support to which the beacon is fastened shall be accurately leveled before mounting the beacon.

**102-3.3 FLASHER.** If shown in plans or specified in job specifications, a separate flashing mechanism for the beacon shall be installed adjacent or near the beacon. The mechanism in this flasher shall be designed to flash not more than 40 and not less than 12 flashes per minute.

**102-3.4 MOUNTING PLATFORM.** If shown in plans or specified in job specifications, the Contractor shall construct a special mounting platform for the beacon, flasher, and incidental equipment. Design and materials for the special platform shall be as shown in the plans. This mounting platform may be constructed on top of a steel beacon tower, or wood pole if specified, and shall be as shown in the plans.

**102-3.5 WIRING.** The Contractor shall furnish all necessary labor and materials and shall make complete aboveground electrical connections in accordance with the wiring diagram furnished with the project plans. *The electrical installation shall conform to the requirements of the latest edition of National Fire Protection Agency, NFPA-70, National Electric Code.*

If underground cable for the power feed from the transformer vault to the beacon site and duct for the installation of this cable under paved areas is required, the cable and duct shall be installed in accordance with and paid for by linear foot measurement as described in Item L-108, Underground *Power* Cable for Airports, and Item L-110, Airport Underground Electrical Duct *Banks and Conduit*.

If lightning protection is specified in the plans or proposals as a part of this item, it shall be in accordance with Item L-103, Installation of Airport Beacon Towers, paragraphs 103-2.3, 103-2.4, 103-2.5, 103-2.6, and 103-3.4.

**102-3.6 PANEL AND CABINET.** If shown in plans or specified in job specifications, the Contractor shall furnish and install a circuit breaker panel. The panel shall be of the type and rating indicated in the plans, and it shall be mounted in a weatherproof cabinet. The cabinet shall be located near the beacon or as directed by the Engineer.

**102-3.7 CONDUIT.** All exposed wiring shall be run in not less than ¾ inch (19 mm) galvanized rigid steel conduit. No conduit shall be installed on top of a beacon platform floor. All conduit shall be installed to provide for drainage. If mounted on a steel beacon tower, the conduit shall be fastened to the tower members with “wraplock” straps, clamps, or approved fasteners spaced approximately 5 feet (150 cm) apart. Conduit shall be attached to wooden structures with galvanized pipe straps and fastened with galvanized wood screws not less than No. 8 or less than 1-¼ inches (31 mm) long. There shall be at least two fastenings for each 10-foot (3 m) length.

**102-3.8 BOOSTER TRANSFORMERS.** If shown in plans or specified in job specifications, a booster transformer to compensate for voltage drop to the beacon shall be installed in a suitable weatherproof housing under or on the tower platform or at the base of the tower or pole. The installation shall be as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, it shall be installed in accordance with and paid for as described in Item L-109, Airport Transformer Vault and Vault Equipment.

**102-3.9 PHOTOELECTRIC CONTROL.** If shown in plans or specified in job specifications, the Contractor shall furnish and install an automatic control switch at the location indicated in the plans. This switch shall be a photoelectric type. It shall be a standard commercially available unit suitable for aviation service. It shall be installed, connected, and adjusted in accordance with the manufacturer's instruction.

**102-3.10 PAINTING.** Wood poles and wooden parts of mounting platforms shall be given one priming coat of white or aviation-orange paint after fabrication but before erection and one body and one finish coat of aviation-orange paint after erection. Steel mounting platforms shall be given one priming coat of corrosion-inhibiting primer before erection and one body and one finish coat of aviation-orange paint after erection. All equipment under this contract and exposed to the weather shall be given one body and one finish coat of aviation-orange or white paint as required. This shall include beacon (except glass surfaces), breaker cabinet, and all conduit and transformer cases. It shall not include lightning rods.

The paint shall be applied uniformly in the proper consistency by skilled painters. The finished paint shall be free from sags, holidays, and smears. Each coat of paint shall be given ample time to dry and harden before the next coat of paint is applied. A minimum of 3 days shall be allowed for drying on wood surfaces and a minimum of 4 days shall be allowed for drying on metal surfaces. Painting shall not be done in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40° F (4° C), nor started when the weather forecast indicates such conditions for the day.

All surfaces shall be cleaned before painting. The surfaces shall be dry and free from scale, grease, rust, dust, and dirt when paint is applied. All knots in wood surfaces shall be covered with shellac immediately before applying the priming coat of paint. Nail holes and permissible imperfections shall be filled with putty.

The ready-mixed paint shall be thinned for the priming and body coats in accordance with the manufacturer's recommendations. In the absence of such recommendations, the following shall apply:

**a.** Body coats (for both wood and steel surfaces) - add ½ pint (0.06 liters) of turpentine to each gallon (liter) of ready-mixed paint for body coats.

**b.** Finish coats (for both wood and steel surfaces) - the ready-mixed paint shall be used as it comes from the container for finish coats.

**102-3.11 TESTING.** The installation shall be tested in operation as a completed unit prior to acceptance. Tests shall include taking megger and voltage readings. Testing equipment shall be furnished by the Contractor. The insulation resistance to ground of the beacon supply circuit shall be not less than 50 megohms when measured ungrounded.

Tests shall be conducted in the presence of the Engineer and shall be to his/her satisfaction.

## METHOD OF MEASUREMENT

**102-4.1** The quantity to be paid for shall be the number of beacons installed as completed units in place, accepted, and ready for operation.

## BASIS OF PAYMENT

**102-5.1** Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item L-102-5.1                      Hazard Beacon, in place--per unit

## MATERIAL REQUIREMENTS

AC 150/5345-7                      Specification For L824 for Underground Electrical Cable for Airport Lighting Circuits

AC 150/5345-43                      Specification for Obstruction Lighting Equipment

Commercial Item  
Description A-A-3067                      Paint: Alkyd, Exterior, Low VOC

Fed. Spec. J-C-30                      Cable and Wire, Electrical (Power, Fixed Installation)

Fed. Spec. TT-E-489                      Enamel, Alkyd, Gloss, Low VOC Content

Fed. Spec. TT-P-664D                      Primer Coating, Alkyd, Corrosion-Inhibiting, Lead and Chromate Free, VOC-Compliant

MIL-P-24441/19B                      Paint, Epoxy -Polyamide, Zinc Primer, Formula 159, Type III

Fed. Spec. W-P-115                      Panel, Power Distribution

Fed. Std. 595                      Colors

Underwriters  
Laboratories  
Standard 6                      Rigid Metal Conduit

Underwriters  
Laboratories  
Standard 514                      Fittings for Conduit and Outlet Boxes

Underwriters  
Laboratories  
Standard 1242                      Intermediate Metal Conduit

*National Fire Protection Agency NFPA-70, National Electric Code*

## ITEM L-103 AIRPORT BEACON TOWERS

### DESCRIPTION

**103-1.1** This item shall consist of furnishing and installing an airport beacon tower of the type shown in the plans, in accordance with these specifications. This work shall include the clearing of the site, erection of the tower, installation of lightning protection, painting, and all incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the Engineer.

### EQUIPMENT AND MATERIALS

**103-2.1 GENERAL.** All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

**103-2.2 TOWER.** The beacon tower shall conform to the requirements of Advisory Circular (AC) 150/5340-30, *Design and Installation Details for Airport Visual Aids, Chapter 6*.

**103-2.3 LIGHTING ROD.** The lightning rod shall consist of a galvanized steel, copper, or copper-clad rod with the upper end drawn to a point and of sufficient length to extend from the point of fastening to not less than 6 inches (150 mm) above the top of the beacon.

**103-2.4 DOWN CONDUCTOR.** The down conductor cable for lightning protection shall consist of No. 8 AWG or larger bare stranded copper wire.

**103-2.5 GROUND ROD.** The ground rod shall be of the diameter and length specified in the plans. It shall be copper or copper clad.

**103-2.6 GROUND CLAMP.** Ground clamp shall be similar and equal to the Type GR as manufactured by the Burndy Engineering Company.

#### **103-2.7 PAINT.**

**a.** Priming paint for galvanized steel towers shall be zinc dust-zinc oxide primer paint conforming to MIL-P-24441/19B. If necessary, add not more than 1/2 pint (0.06 liter) of turpentine to each gallon (liter).

**b.** Priming paint for ungalvanized steel towers shall be a high solids alkyd primer conforming to TT-P-664D.

**c.** Orange paint for the body and finished coats on metal and wood surfaces shall consist of a ready-mixed nonfading paint meeting the requirements of Fed. Spec. TT-E-489. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

**d.** White paint for steel tower shall be ready-mixed paint conforming to Commercial Item Description A-A-3067.

### CONSTRUCTION METHODS

**103-3.1 CLEARING AND GRADING.** The site on which the beacon tower is to be erected shall be cleared and leveled. All trees and brush shall be removed from the area within a distance of 25 feet (7.5 m) from the tower or as

called for in the job plans. Stumps shall be removed to a depth of 18 inches (45 cm) below finished grade and the excavation filled with earth and tamped. If a transformer vault or other structure is included as part of the installation, the area shall be cleared to a distance of 25 feet (7.5 m) from these structures. The ground near the tower shall be leveled to permit the operation of mowing machines. The leveling shall extend at least 2 feet (60 cm) outside the tower legs. All debris removed from the tower site shall be disposed of by the Contractor to the satisfaction of the Engineer and in accordance with Federal, state, or local regulations.

**103-3.2 EXCAVATION AND FILL.** Excavation for the tower footings shall be carried to a minimum of 4 inches (100 mm) below the footing depth. The excess excavation below the footing depth shall then be backfilled with gravel or crushed stone and compacted to the required level. The footing plates shall be installed, and a thickness of not less than 18 inches (45 cm) of the same gravel or crushed stone shall be placed immediately above the footing plates in layers of not over 6 inches (150 mm). Each layer above the footing plates shall be thoroughly tamped in place. The remainder of the backfill may be of excavated earth placed in layers not to exceed 6 inches (150 mm). Each layer shall be thoroughly compacted by tamping.

Where solid rock is encountered, which prevents the carrying of the foundation legs to the required depth but which is of sufficient strength to use holddown bolts, the tower anchor posts shall be cut off at the required length and the holddown bolts shall be installed as indicated in the plans with the approval of the Engineer. Each tower leg shall be anchored to the rock by means of two 7/8-inch (21 mm) diameter by 3-foot (90 cm) long expansion or split bolts and shall be grouted with neat portland cement into holes drilled into the natural rock. Except as required for rock foundations, the footing members shall not be cut off or shortened. If excavated material is of such character that it will not readily compact when backfilled, the Engineer may order the excavation backfilled with concrete or other suitable material.

The concrete footing for tubular beacon towers shall be installed in accordance with the manufacturer's recommendations. Portions of the footing in the topsoil layer shall not be included in the footing height.

**103-3.3 ERECTION.** Detail erection drawings furnished by the manufacturer shall be strictly followed during construction. All towers shall be erected in sections from the ground up unless otherwise specified. In final assembly, all bolts and fastenings shall be installed, and the structure shall be plumb, true, square, and level. Nuts shall be taken up to a firm bearing after which the bolts shall, if necessary, be cut to proper length to protrude three full threads. Approved locknuts shall be placed on each bolt over the regular nut. Ladder bolts shall be inserted with the head to the outer face of the tower. Diagonal, leg, and handrail bolts shall be installed with nuts on the outer face of the tower, unless otherwise specified. Bent parts shall be straightened before erection without damage to the protective coating. Surfaces abraded or bared of protective coating shall be painted with the proper priming paint as specified in these specifications.

The Contractor shall install the ladder on the side of the tower adjacent to the driveway or most accessible approach to the tower. Tubular beacon towers shall be erected in accordance with the manufacturer's recommendations. The safety cable shall be located on the side of the tower adjacent to the driveway or most accessible approach to the tower.

**103-3.4 LIGHTNING PROTECTION.** The Contractor shall furnish and install a lightning rod, down conductor, and at least one ground plate or rod for each beacon tower. The lightning rod shall be installed at the top of the tower with the tip of the rod extending not less than 6 inches (150 mm) above the top of the beacon.

Down-conductor cables shall be securely fastened to the surface of the tower leg at 5-foot (150 cm) intervals with suitable bronze fasteners having bronze or noncorrosive metal bolts. Sharp turns or bends in the down conductor will not be permitted.

All connections of cable to cable, cable to lightning rods, and cable to ground plates or rods shall be made with approved type solderless connectors or noncorrosive metal and shall be of substantial construction.

The down-conductor cable shall be securely attached to ground rods or plates placed at least 2 feet (60 cm) away from the tower foundations. The ground rod shall be driven into the ground so that the top is at least 6 inches (150 mm) below grade. The down-conductor shall be firmly attached to the ground plate or rod by means of a ground connector or clamp. Plates shall be embedded in the area of permanent moisture.

The complete lightning protection installation shall be accomplished to the satisfaction of the Engineer. The resistance to ground of any part of the lightning protection system shall not exceed 25 ohms.

**103-3.5 PAINTING.** The Contractor shall furnish all materials and labor for painting the beacon tower. The color scheme for the steel tower shall be as shown in the plans.

**a. Parts to be Painted.** Tower parts (except those parts to be exposed to earth) shall not be treated or primed before erection. All tower parts placed below ground level or within 12 inches (300 mm) above ground level shall be given two coats of approved bituminous paint.

The paint shall be applied uniformly in the proper consistency by skilled painters. The finished paint shall be free from sags, holidays, and smears. Division lines between colors shall be sharply defined. Each coat of paint shall be given ample time to dry and harden before the next coat is applied. A minimum of 4 days shall be allowed for drying on metal surfaces. Painting shall not be done in cold, damp, foggy, dusty, or frosty atmospheres, or when air temperature is below 40° F (4° C), nor started when the weather forecast indicates such conditions for the day.

All surfaces shall be cleaned before painting. The surfaces shall be dry and free from scale, grease, rust, dust, and dirt when paint is applied.

The number of coats of paint applied shall be in accordance with the following instructions:

**b. Steel Towers, Galvanized.** One priming coat of zinc dust-zinc oxide primer after erection and one body and one finish of white or orange paint (as required by the color scheme) applied after erection.

**c. Steel Towers, Not Galvanized.** One priming coat of corrosion-inhibiting primer and one body and one finish coat of white or orange paint (as required by the color scheme) applied after erection.

The above specified orange and white ready-mixed paints shall be thinned for the body coats in accordance with the manufacturer's recommendations. In the absence of such recommendations, the following shall apply:

**d. Body Coats.** Add not more than 1/2 pint (0.06 liters) of turpentine to each gallon (liter) of ready-mixed paint for body coats.

**e. Finish Coats.** The ready-mixed paint shall be used as it comes from the container for finish coats.

## METHOD OF MEASUREMENT

**103-4.1** The quantity to be paid for under this item shall be the number of airport beacon towers installed as completed units in place, accepted, and ready for operation.

## BASIS OF PAYMENT

**103 5.1** Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item L-103-5.1 Beacon Tower, in place-per unit

### MATERIAL REQUIREMENTS

| AC 150/5340-30

*Design and Installation Details for Airport Visual Aids*

Commercial Item

Description. Spec A-A-3067

Paint: Alkyd, Exterior, Low VOC

Fed. Spec. TT-E-489

Enamel, Alkyd, Gloss, Low VOC Content

Fed. Std. 595

Colors

MIL-P-24441/19B

Paint, Epoxy -Polyamide, Zinc Primer, Formula 159, Type III

## ITEM L-107 AIRPORT 8-FOOT AND 12-FOOT WIND CONES

### DESCRIPTION

**107-1.1** This item shall consist of furnishing and installing an airport wind cone in accordance with these specifications and in accordance with the dimensions, design, and details shown in the plans.

The work shall include the furnishing and installation of a support for mounting the wind cone, the specified wire, and a concrete foundation. The item shall also include all cable connections, conduit and conduit fittings, the furnishing and installation of all lamps, ground rod and ground connection, the testing of the installation, and all incidentals necessary to place the wind cone in operation as a completed unit to the satisfaction of the Engineer.

### EQUIPMENT AND MATERIALS

#### 107-2.1 GENERAL.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program.

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

**107-2.2 WIND CONES.** The 8-foot (240 cm) and 12-foot (3.5 m) wind cones and assemblies shall conform to the requirements of AC 150/5345-27, Specification for Wind Cone Assemblies.

**107-2.3 WIRE.** Wire in conduit rated up to 5,000 volts shall conform to AC 150/5345-7, Specification for L-824 Underground Cable for Airport Lighting Circuits for Rubber Insulated Neoprene Covered Wire, *or* Fed. Spec. J-C-30, Type RHW, for rubber insulated fibrous covered wire. For ratings up to 600 volts, thermoplastic wire conforming to Fed. Spec. J-C-30, Types TW, THW, and THWN, shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

**107-2.4 CONDUIT.** Rigid steel conduit and fittings shall conform to the requirements of Underwriters Laboratories Standard 6, 514, and 1242.

**107-2.5 CONCRETE.** The concrete for foundations shall be proportioned, placed, and cured in accordance with Item P-610, Structural Portland Cement Concrete.

#### 107-2.6 PAINT.

**a.** Priming paint for ungalvanized metal surfaces shall be a high solids alkyd primer conforming to TT-P-664D.

**b.** Priming paint for galvanized metal surfaces shall be zinc dust-zinc oxide primer paint conforming to MIL-P-24441/19B. If necessary, add not more than ½ pint (0.06 liter) of turpentine to each gallon (liter).

**c.** Orange paint for the body and the finish coats on metal and wood surfaces shall consist of a ready-mixed nonfading paint meeting the requirements of Fed. Spec. TT-E-489. The color shall be in accordance with Federal Standards 595, Aviation Gloss Orange Number 12197.

**d.** White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Commercial Item Description A-A-3067.

e. Priming paint for wood surfaces shall be mixed on the job by thinning the above specified aviation-orange or white paint by adding ½ pint (0.06 liter) of raw linseed oil to each gallon (liter).

## CONSTRUCTION METHODS

**107-3.1 INSTALLATION.** The hinged support or hinged pole shall be installed on a concrete foundation as shown in the plans.

**107-3.2 COUNTERWEIGHT.** The Contractor shall furnish and install a counterweight on the hinged support for the 12-foot (3.5 m) wind cone. The counterweight may consist of lead weights which may be furnished with the “A” frame assembly or it may consist of concrete poured around the bottom of the hinged support. Where concrete is used, the counterweight shall be approximately 12 inches (300 mm) wide by 24 inches (600 mm) deep and should weigh approximately 500 pounds (230 kg). The counterweight should be 25 to 50 pounds (10 to 20 kg) less than the weight needed to balance the assembly. The counterbalancing should operate to the satisfaction of the Engineer.

**107-3.3 ELECTRICAL CONNECTION.** The Contractor shall furnish all labor and materials and shall make complete electrical connections in accordance with the wiring diagram furnished with the project plans. *The electrical installation shall conform to the requirements of the latest edition of National Fire Protection Agency, NFPA-70, National Electric Code.*

If underground cable from the transformer vault to the wind cone site and duct for this cable installation under paved areas is required, the cable and duct shall be installed in accordance with and paid for by linear foot measurement as described in Item L-108, Underground *Power* Cables for Airports, and Item L-110, Airport Underground Electrical Duct Banks and Conduits.

**107-3.4 BOOSTER TRANSFORMER.** If shown in plans or specified in job specifications, a booster transformer to compensate for voltage drop to the lamps shall be installed in a suitable weatherproof housing. The booster transformer shall be installed as indicated in the plans and described in the proposal. If the booster transformer is required for installation in the transformer vault, it shall be installed in accordance with and paid for as described in Item L-109, Airport Transformer Vault and Vault Equipment.

**107-3.5 GROUND CONNECTION AND GROUND ROD.** The Contractor shall furnish and install a ground rod, grounding cable, and ground clamps for grounding the “A” frame of the 12-foot (3.5 m) assembly or pipe support of the 8-foot (240 cm) support near the base. The ground rod shall be of the diameter and length specified in the plans and shall be copper or copper clad. The ground rod shall be driven into the ground adjacent to the concrete foundation so that the top is at least 6 inches (150 mm) below grade. The grounding cable shall consist of No. 8 AWG bare stranded copper wire or larger and shall be firmly attached to the ground rod by means of a ground connector or clamp. The other end of the grounding cable shall be securely attached to a leg of the “A” frame or to the base of the pipe support with noncorrosive metal and shall be of substantial construction. The resistance to ground shall not exceed 25 ohms.

**107-3.6 PAINTING.** Three coats of paint shall be applied (one prime, one body, and one finish) to all exposed material installed under this item except the fabric cone, obstruction light globe, and lamp reflectors. The wind cone assembly, if painted on receipt, shall be given one finish coat of paint in lieu of the three coats specified above. The paint shall meet the requirements of Fed. Spec. TT-E-489. The color shall be in accordance with Federal Standard 595, Aviation Gloss Orange Number 12197.

**107-3.7 LAMPS.** The Contractor shall furnish and install *lamps as specified by the manufacturer.*

**107-3.8 CHAIN AND PADLOCK.** The Contractor shall furnish and install a suitable operating chain for lowering and raising the hinged top section. The chain shall be attached to the pole support in a manner to prevent the light fixture assembly from striking the ground in the lowered position.

A padlock shall also be furnished by the Contractor on the 8-foot (240 cm) wind cone for securing the hinged top section to the fixed lower section. Keys for the padlock shall be delivered to the Engineer.

## METHOD OF MEASUREMENT

**107-4.1** The quantity to be paid for shall be the number of wind cones installed as completed units in place, accepted, and ready for operation.

## BASIS OF PAYMENT

**107-5.1** Payment will be made at the contract unit price for each completed and accepted job. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item L-107-5.1	12-Foot (3.5 m) Wind Cone, in place—per unit
Item L-107-5.2	8-Foot (240 cm) Wind Cone, in place—per unit

## MATERIAL REQUIREMENTS

AC 150/5345-7	Specification for L-824 Underground Cable for Airport Lighting Circuits
AC 150/5345-27	Specification for Wind Cone Assemblies
Commercial Item Description. Spec A-A-3067	Paint: Alkyd, Exterior, Low VOC
Fed. Spec. TT-E-489	Enamel, Alkyd, Gloss, Low VOC Content
Fed. Spec. J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
Fed. Spec. W-P-115	Panel, Power Distribution
Fed. Std. 595	Colors
MIL-P-24441/20	Paint, Epoxy -Polyamide, Green Primer, Formula 150, Type III
Underwriters Laboratories Standard 6	Rigid Metal Conduit
Underwriters Laboratories Standard 514	Fittings For Conduit and Outlet Boxes
Underwriters Laboratories Standard 1242	Intermediate Metal Conduit

*National Fire Protection Agency NFPA-70, National Electric Code*

# ITEM L-108 UNDERGROUND **POWER** CABLE FOR AIRPORTS

## DESCRIPTION

**108-1.1** This item shall consist of furnishing and installing *power cables directly-buried and furnishing and installing power cables within conduit or duct banks*-in accordance with these specifications at the locations shown *on-the plans*. *It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the Engineer. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of any cable for FAA facilities. Requirements and payment for trenching and backfilling for the installation of underground conduit and duct banks is covered under Item L-110 “Airport Underground Electrical Duct Banks and Conduits.”*

## EQUIPMENT AND MATERIALS

### 108-2.1 GENERAL.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall *be approved under the Airport Lighting Equipment Certification Program described in Advisory Circular (AC) 150/5345-53, current version.*

**b.** All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the Engineer.

**108-2.2 CABLE.** Underground cable *for airfield lighting facilities (runway and taxiway lights and signs) shall be Type C, No. 8 or No. 6 AWG, copper, 7 strand, single conductor cable with 5,000 volt cross-linked polyethylene insulation and shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.*

*Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Federal Specification J-C-30 and shall be type THWN.*

Cable type, size, number of conductors, strand and service voltage shall be *as* specified *on-the plans*.

**108-2.3 BARE COPPER WIRE (COUNTERPOISE OR GROUND) AND GROUND RODS.** *Wire for counterpoise or ground-installations for airfield lighting systems shall be No. 6 AWG solid for counterpoise and or No. 6 AWG stranded for ground wire conforming to ASTM Specifications B 3 and B 8, and shall be [bare copper wire] [tinned copper] conforming to the requirements of ASTM D 33.*

*Ground rods shall be [solid stainless steel] [copper] or [copper-clad]. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8-feet (240 cm) long nor less than 5/8 inch (15 mm) in diameter.*

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*Engineer should evaluate the soils in the vicinity of proposed counterpoise and ground rod installations and determine if soil conditions would adversely affect copper. Engineer shall specify the type of ground rod and counterpoise wire to be installed in consideration of the soil conditions. If tinned copper counterpoise or ground wire is specified, include requirement for UL listing.*

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**108-2.4 CABLE CONNECTIONS.** In-line connections of underground primary cables shall be of the type called for on-the plans, and shall be one of the types listed below. *No separate payment will be made for cable connections.*

**a. The Cast Splice.** A cast splice, employing a plastic mold and using epoxy resin equal to that manufactured by Minnesota Mining and Manufacturing Company, “Scotchcast” Kit No. 82--B, or as manufactured by Hysol Corporation, “Hyseal Epoxy Splice” Kit No. E1135, *or equal, is used* for potting the splice is *acceptable*.

**b. The Field-attached Plug-in Splice.** Figure 3 of AC 150/5345-26, Specification for L-823 Plug and Receptacle, Cable Connectors, employing connector kits, is *acceptable*-for field attachment to single conductor cable.

**c. The Factory-Molded Plug-in Splice.** Specification for L-823 Connectors, Factory-Molded to Individual Conductors, *is acceptable*.

**d. The Taped or Heat-Shrunked Splice.** Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape *is acceptable*. The rubber tape should meet the requirements of *ASTM D 4388* and the plastic tape should comply with *Mil Spec. MIL-I-24391* or Fed. Spec. *A-A-55809*. *Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.* In all the above cases, connections of cable conductors shall be made using crimp connectors utilizing a crimping tool designed *to make* a complete crimp before the tool can be removed.

**108-2.5 CONCRETE.** Concrete for cable markers shall conform to Specification Item P-610, “Structural Portland Cement Concrete.”

**108-2.6 FLOWABLE BACKFILL.** *Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153 “Controlled Low Strength Material”.*

### CONSTRUCTION METHODS

**108-3.1 GENERAL.** The Contractor shall install the specified cable at the approximate locations indicated on-the plans. *Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Wherever possible, cable shall be run without splices, from connection to connection.*

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual *isolation* transformers. The Contractor shall be responsible for providing *cable* in continuous lengths for home runs or other long cable runs without connections, unless otherwise authorized in writing by the Engineer or shown on-the plans.

*In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed or at least once in each access point where L-823 connectors are not installed.*

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*Engineer should determine and specify on the plans an adequate number of locations for installing L-823 connectors to provide maintenance and test points.*

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*Provide not less than 3 feet of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot vertically above the top of the access structure. This requirement also applies where primary cable passes through empty base cans, junction and access structures to allow for future connections, or as designated by the Engineer.*

**108-3.2 INSTALLATION IN DUCT BANKS OR CONDUITS.** This item includes the installation of the cable in duct banks or conduit as described below. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be in accordance with the latest National Electric Code, or the code of the local agency *or authority* having jurisdiction.

The Contractor shall make no connections or *splices*-of any kind in cables installed in conduits or duct *banks*.

*Duct banks or conduits* shall be installed as a separate item in accordance with Item L-110, "Airport Underground Electrical Duct *Banks and Conduit*." The Contractor shall *run a mandrel through duct banks or conduit prior to installation of cable to insure that the duct bank or conduit is open, continuous and clear of debris. Mandrel size shall be compatible with conduit size.* The cable shall be installed in a manner to prevent harmful stretching of the conductor, injury to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape *providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing* before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a *conduit*, all cable shall be pulled in the *conduit*-at the same time. The pulling of a cable through duct *bank*s or conduits may be accomplished by handwinch or power winch with the use of cable grips or pulling eyes. *Maximum pulling-tensions shall*-be governed by *cable manufacturer's recommendations*. A *non-hardening* lubricant recommended for the type of cable being installed shall be used where pulling lubricant is required. .

*[Contractor shall submit pulling tension values to the Engineer prior to any cable installation. If required by the Engineer, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the Engineer. Cable pull tensions shall be recorded by the Contractor and reviewed by the Engineer. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.]*

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*Engineer may optionally add this language.*

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**108-3.3 INSTALLATION OF DIRECT-BURIED CABLE IN TRENCHES.** *Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable(s) shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable(s) shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.*

*Where cables must cross over each other, a minimum of 3-inch vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.*

*Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, handholes, pullboxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than ¼ inch in size. The cable circuit identification shall match the circuits noted on the construction plans.*

**a. Trenching.** Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable trenches shall be excavated to a minimum depth of 18 inches below finished grade, except as follows:

1. When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches unless otherwise specified.
2. Minimum cable depth when crossing under a railroad track, shall be 42 inches unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches. Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. Flowable backfill material may alternatively be used. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All such rock removal shall be performed and paid for under Item P-152.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cable(s) cross proposed installations, the Contractor shall insure that these cable(s) are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

1. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.
2. Trenching, etc., in cable areas shall then proceed, with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

**b. Backfilling.** After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall be 3 inches deep, loose measurement, and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. This layer shall not be compacted. The second layer shall be 5 inches deep, loose measurement, and shall contain no particles that would be retained on a 1-inch sieve. The remaining 3<sup>rd</sup> and subsequent layers of backfill shall not exceed 8 inches of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent undisturbed soil, and to the satisfaction of the Engineer. If necessary to obtain the desired compaction, the backfill material shall be moistened or aerated as required.

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be

accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of in accordance with the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the Engineer. If not shown on the plans, the warning tape shall be located six inches above the direct-buried cable or the counterpoise wire if present.

**c. Restoration.** Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the [topsoiling] [fertilizing] [liming] [seeding] [sprigging] [mulching] as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance.

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*Engineer to specify the correct method of turfing and remember to include in the construction documents the appropriate FAA turfing specification for restoration related to the installation of the power cables.*  
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*Under certain conditions, it may be beneficial to install cables by cable plowing. This type of installation method should only be specified where sandy soils are prevalent and with no rocks or other debris that would nick or cut the cable insulation. The engineer should specify the equipment to be used so the cables are placed at a minimum depth of 18 inches below finished grade. The cable should be manually unreeled off the spool as the machine travels, such that the earth is not unreeling the spool.*  
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**108-3.4 CABLE MARKERS FOR DIRECT-BURIED CABLE.** The location of circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4 inches (100 mm) thick, extending approximately 1 inch (25 mm) above the surface. Each cable run from *a*-line of lights *and signs* to the equipment vault shall be marked at approximately every 200 feet (60 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed *directly*-above the cable. The Contractor shall impress the word “*CABLE*” and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep.

The location of each underground cable connection, except at lighting units, or *isolation*-transformers, or *power adapters* shall be marked by a concrete marker slab placed above the connection. The Contractor shall impress the word “*SPLICE*” on each slab. *The Contractor*-also shall impress additional circuit identification symbols on each slab *as directed*-by the Engineer. *All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete.*

**108-3.5 SPLICING.** Connections of the type shown *on*-the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

**a. Cast Splices.** These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured in accordance with manufacturer's instructions and to the satisfaction of the Engineer.

**b. Field-attached Plug-in Splices.** These shall be assembled in accordance with manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. In all cases the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (37 mm) on each side of the joint.

**c. Factory-Molded Plug-in Splices.** These shall be made by plugging directly into mating connectors. In all cases, the joint where the connectors come together shall be wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (37 mm) on each side of the joint.

**d. Taped or Heat-Shrunked Splices.** A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. *Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type.* Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. Throughout the rest of the splice less tension should be used. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately 1 inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

*Heat shrinkable tubing shall be installed following manufacturer's instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminants prior to application.*

### **108-3.6 BARE COUNTERPOISE WIRE INSTALLATION FOR LIGHTNING PROTECTION AND GROUNDING.**

If shown *on*-the plans or *included*-in *the* job specifications, bare *counterpoise* copper wire shall be installed for lightning protection of the underground cables. *Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks which are installed to contain airfield cables. Where the cable or duct/conduit trench runs parallel to the edge of pavement, the counterpoise shall be installed in a separate trench located half the distance between the pavement edge and the cable or duct/conduit trench. In trenches not parallel to pavement edges, counterpoise wire shall be installed continuously a minimum of 4 inches above the cable, conduit or duct bank, or as shown on the plans if greater. Additionally, counterpoise wire shall be installed at least 8 inches below the top of subgrade in paved areas or 10 inches below finished grade in unpaved areas. This dimension may be less than 4 inches where conduit is to be embedded in existing pavement. Counterpoise wire shall not be installed in conduit.*

The counterpoise wire shall be *routed around* to each light fixture base, mounting stake, *or junction/access structures*. The counterpoise wire shall also be *exothermically welded to*-ground rods installed *as shown on the plans but* not more than 500feet (150 m) apart around the entire circuit.

The counterpoise system shall *be continuous and* terminate at the transformer vault or at the power source. *It shall be securely attached to the vault or equipment external ground ring or other made electrode grounding system.* The connections shall be made as shown *on*-the plans and *in the* specifications.

*If shown on the plans or in the specifications, a separate equipment (safety) ground system shall be provided in addition to the counterpoise wire using one of the following methods:*

- (1) A ground rod installed at and securely attached to each light fixture base, mounting stake if painted, and to all metal surfaces at junction/access structures.*
- (2). Install an insulated equipment ground conductor internal to the conduit system and securely attached it to each light fixture base and to all metal surfaces at junction/access structures. This equipment ground conductor shall also be exothermically welded to ground rods installed not more than 500 feet (150 m) apart around the circuit.*

*a. Counterpoise Installation Above Multiple Conduits and Duct Banks. Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete cone of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete cone of protection measured 22 ½ degrees each side of vertical.*

*Where new duct banks pass under existing pavement, the counterpoise shall be run through an uppermost empty conduit and also be bonded exothermically at ground rods, furnished and installed by the Contractor, at each end of the duct bank. Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.*

*b. Counterpoise Installation at Existing Duct Banks. When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. Where approved by the Engineer, the ground rod installation will not be required if the new counterpoise wiring is connected to the existing duct bank counterpoise wiring system.*

**108-3.7 EXOTHERMIC BONDING.** *Bonding of counterpoise wire shall be by the exothermic welding process. Only personnel experienced in and regularly engaged in this type of work shall make these connections.*

*Contractor shall demonstrate to the satisfaction of the Engineer, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:*

*All slag shall be removed from welds.*

*For welds at light fixture base cans, all galvanized coated surface areas and "melt" areas, both inside and outside of base cans, damaged by exothermic bond process shall be restored by coating with a liquid cold-galvanizing compound conforming to U.S. Navy galvanized repair coating meeting Mil. Spec. MIL-P-21035. Surfaces to be coated shall be prepared and compound applied in accordance with manufacturer's recommendations.*

*All buried copper and weld material at weld connections shall be thoroughly coated with heat shrinkable tubing or coated with coal tar bitumastic material to prevent surface exposure to corrosive soil or moisture."*

**108-3.8 TESTING.** *The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits after installation. After installation, the Contractor shall test and demonstrate to the satisfaction of the Engineer the following:*

- a. That all *affected* lighting power and control circuits (*existing and new*) are continuous and free from short circuits.
- b. That all *affected* circuits (*existing and new*) are free from unspecified grounds.
- c. That the insulation resistance to ground of all *new* non-grounded series circuits *or cable segments* is not less than *50* megohms.
- d. That the insulation resistance to ground of all non-grounded conductors of *new* multiple circuits *or circuit segments* is not less than *50* megohms.
- e. That all *affected* circuits (*existing and new*) are properly connected in accordance with applicable wiring diagrams.
- f. That all *affected* circuits (*existing and new*) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.
- g. That the impedance to ground of each ground rod does not exceed 25 ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be utilized, as described by ANSI/IEEE Standard 81, to verify this requirement.*

*Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the Engineer. Where connecting new cable to existing cable, ground resistance tests shall be performed on the new cable prior to connection to the existing circuit.*

### METHOD OF MEASUREMENT

**108-4.1** Trenching shall be measured by the linear feet (meters) of trench, including the excavation, backfill, and *restoration*-, completed, measured as excavated, and accepted as satisfactory.

When specified, separate measurement shall be made for trenches of various specified widths.

**108-4.2** Cable or counterpoise wire installed in trench, *duct bank or conduit* shall be measured by the number of linear feet (meters) of cable or counterpoise wire installed in trenches, *duct bank or conduit, including ground rods and grounding connectors, and trench marking tape* ready for operation, and accepted as satisfactory. Separate measurement shall be made for each cable or counterpoise wire installed in trench, *duct bank or conduit*. *The measurement for this item [shall] [shall not] include additional quantities required for slack.*

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*Engineer to decide if the quantity of cable provided in the bid tabulations includes an estimated quantity for slack. If so, this should be clearly identified on the plans and specifications. If not, add the following language at the end of paragraph 108-4.2:*

*“Cable and counterpoise slack is considered incidental to this item and is included in the contractor’s unit price. No separate measurement or payment will be made for cable or counterpoise slack.”*

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### BASIS OF PAYMENT

**108-5.1** Payment will be made at the contract unit price for trenching, cable and bare counterpoise wire installed in trench (*direct-buried*), or *cable and equipment ground installed in duct bank or conduit*, in place by the Contractor and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation and installation of these materials, and for all labor, equipment, tools, and incidentals, *including ground rods and ground connectors and trench marking tape*, necessary to complete this item.

Payment will be made under:

Item L-108-5.1 Trenching for *direct-buried cable* --per linear foot (meter)

Item L-108-5.2 [No. 8 AWG] [No. 6 AWG] *L-824C* Cable, installed in trench, *duct bank or conduit* --per liner foot (meter)

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*Engineer to specify appropriate size of cable. If more than one size is required on the project, provide additional item nos.; one for each size and type.*  
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Item *L-108-5.3* Bare Counterpoise Wire, installed in trench, *duct bank or conduit*, including ground rods and ground connectors--per linear foot (meter)

*Item L-108-5.4* *Bare or insulated equipment ground, installed in duct bank or conduit including ground rods and ground conductors – per linear foot (meter).*

### MATERIAL REQUIREMENTS

AC 150/5345-7 Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits

AC 150/5345-26 Specification for L-823 Plug and Receptacle Cable Connectors

Fed.Spec. J-C-30 Cable and Wire, Electrical Power, Fixed Installation

*Fed. Spec A-A-55809* Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM B 3 Soft or Annealed Copper Wire

ASTM B 8 Concentric-Lay-Stranded Cooper Conductor, Hard, Medium-Hard, or Soft

*ASTM D 4388* *Rubber tapes, Nonmetallic Semiconducting and Electrically Insulating*

*MIL-I-24391* Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

### REFERENCE DOCUMENTS

*NFPA No. 70* *National Electrical Code (NEC)*

*MIL-S-23586C*

*Sealing Compound, Electrical, Silicone Rubber*

*Building Industry Consulting Service International (BICSI)*

*ANSI/IEEE Std 81*

*IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System*

**END OF ITEM L-108**

## ITEM L-109 AIRPORT TRANSFORMER VAULT AND VAULT EQUIPMENT

### DESCRIPTION

109-1.1 This item shall consist of constructing an airport transformer vault or a prefabricated metal housing these specifications in accordance with the design and dimensions shown in the plans. This work shall also include the installation of conduits in floor and foundation, painting and lighting of the vault or metal housing, and the furnishing of all incidentals necessary to produce a completed unit. Included as a separate part under this item or as a separate item where an existing vault is to be utilized shall be the furnishing of all vault equipment, wiring, electrical buses, cable, conduit, potheads, and grounding systems. This work shall also include the painting of equipment and conduit; the marking and labeling of equipment and the labeling or tagging of wires; the testing of the installation; and the furnishing of all incidentals necessary to place it in operating condition as a completed unit to the satisfaction of the Engineer.

### EQUIPMENT AND MATERIALS

#### 109-2.1 GENERAL.

a. Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

### CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

**109-2.2 CONCRETE.** The concrete for the vault shall be proportioned, placed, and cured in accordance with Item P-610, Structural Portland Cement Concrete, using ¾-inch (18 mm) maximum size coarse aggregate.

**109-2.3 REINFORCING STEEL.** Reinforcing steel bars shall be intermediate or structural grade deformed-type bars and shall meet the requirements of ASTM A 615.

**109-2.4 BRICK.** Brick shall conform to ASTM C 62, Grade SW.

**109-2.5 ASBESTOS CEMENT DUCT.** Asbestos cement duct and fittings shall be in accordance with Fed. Spec. W-C-571.

**109-2.6 RIGID STEEL CONDUIT.** Rigid steel conduit and fittings shall be in accordance with Underwriters Laboratories Standard 6 and 514.

**109-2.7 LIGHTING.** Vault or metal-housing light fixtures shall be of a vaporproof type.

**109-2.8 OUTLETS.** Convenience outlets shall be heavy-duty duplex units designed for industrial service.

**109-2.9 SWITCHES.** Vault or metal-housing light switches shall be single-pole switches.

**109-2.10 PAINT.**

a. Priming paint for ungalvanized metal surfaces shall be a high solids alkyl primer conforming to TT-P-664D.

b. White paint for body and finish coats on metal and wood surfaces shall be ready-mixed paint conforming to Commercial Item Description A-A-3067.

c. Priming paint for wood surfaces shall be mixed on the job by thinning the above specified white paint by adding 1/2 pint (0.06 liter) of raw linseed oil to each gallon (liter).

d. Paint for the floor, ceiling, and inside walls shall be in accordance with Fed. Spec. TT-E-487. Walls and ceiling shall be light gray and the floor shall be medium gray.

e. The roof coating shall be hot asphalt material in accordance with ASTM D 2823.

**109-2.11 HIGH-VOLTAGE BUS.** High-voltage bus shall be standard weight 3/8-inch (9 mm) IPS copper tubing or it may be insulated copper cable of the size and voltage rating specified.

**109-2.12 BUS CONNECTORS.** Connectors shall be similar to Burndy Type NT (or equal) for copper tubing. Connectors for insulated bus cable shall be of the proper size and type for the service intended.

**109-2.13 BUS SUPPORTS.** Bus supports shall be similar to Westinghouse No. 527892 (or equal), insulated for 7,500 volts, single clamp type for 2-bolt flat mounting.

**109-2.14 GROUND BUS.** Ground bus shall be 1/8 - x 3/4-inch (3 x 18 mm) *minimum* copper bus bar.

**109-2.15 SQUARE DUCT.** Duct shall be square similar to that manufactured by the Square D Company (or equal), or the Trumbull Electric Manufacturing Company (or equal). The entire front of the duct on each section shall consist of hinged or removable cover for ready access to the interior. The cross section of the duct shall be not less than 4 x 4 inches (100 x 100 mm) except where otherwise shown in the plans.

**109-2.16 GROUND RODS.** Ground rods shall be copper or copper-clad of the length and diameter specified in the plans.

**109-2.17 POTHEADS.** Potheads shall be similar to G&W Type N, Shape C (or equal), unless otherwise specified. Potheads shall be furnished with plain insulator bushings and conduit couplings. Potheads shall have a rating not less than the circuit voltage.

**109-2.18 PREFABRICATED METAL HOUSING.** The prefabricated metal housing shall be a commercially available unit.

**109-2.19 FAA-APPROVED EQUIPMENT.** Certain items of airport lighting equipment installed in vaults are covered by individual FAA equipment specifications. The specifications are listed below:

AC 150/5345-3	Specification for L-821 Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors

AC 150/5345-13 Specification for L-841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits.

109-2.20 OTHER ELECTRICAL EQUIPMENT. Constant-current regulators, distribution transformers, oil switches, cutouts, relays, terminal blocks, transfer relays, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA equipment specifications shall conform to the applicable rulings and standards of the Institute of Electrical and Electronic Engineers or the National Electrical Manufacturers Association. When specified, test reports from a testing laboratory indicating that the equipment meets the specifications shall be supplied. In all cases, equipment shall be new and a first-grade product. This equipment shall be supplied in the quantities required for the specific project and shall incorporate the electrical and mechanical characteristics specified in the proposal and plans.

109-2.21 WIRE. Wire in conduit rated up to 5,000 volts shall conform to AC 150/5345-7, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits, for rubber insulated neoprene-covered wire, or Fed. Spec. J-C-30, Type RHW, for rubber insulated fibrous-covered wire. For ratings up to 600 volts, thermoplastic wire conforming to Fed. Spec. J-C-30, Types TW, THW, and THWN, shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal.

a. Control Circuits. Unless otherwise indicated on the plans, wire shall be not less than No. 12 AWG and shall be insulated for 600 volts. If telephone control cable is specified, No. 19 AWG telephone cable conforming to ICEA S-85-625-1996 specifications shall be used.

b. Power Circuits.

- (1) 600 volts maximum-Wire shall be No. 6 AWG or larger and insulated for at least 600 volts.
- (2) 3,000 volts maximum-Wire shall be No. 6 AWG or larger and insulated for at least 3,000 volts.
- (3) Over 3,000 volts-Wire shall be No. 6 AWG or larger and insulated for at least the circuit voltage.

CONSTRUCTION METHODS

CONSTRUCTION OF VAULT AND PREFABRICATED METAL HOUSING

109-3.1 GENERAL. The Contractor shall construct the transformer vault or prefabricated metal housing at the location indicated in the plans. Vault construction shall be reinforced concrete, concrete masonry, or brick wall as specified. The metal housing shall be prefabricated equipment enclosure to be supplied in the size specified. The mounting pad or floor details, installation methods, and equipment placement are shown in the plans.

The Contractor shall clear, grade, and seed the area around the vault or metal housing for a minimum distance of 10 feet (3 m) on all sides. The slope shall be not less than 1/2-inch per foot (40 mm per m) away from the vault or metal housing in all directions.

The vault shall provide adequate protection against weather elements, including rain, wind-driven dust, snow, ice and excessive heat. The vault shall have sufficient filtered ventilation, to assure that the interior room temperatures and conditions do not exceed the recommended limits of the electrical equipment to be installed in the vault. Contractor is responsible for contacting the manufacturer of the equipment to be installed to obtain environmental limitations of the equipment to be installed.

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The electrical vault shall provide reasonable protection of the equipment that it is intended to house. As most of the equipment located in the vault is likely housed in NEMA 1 enclosures, the

*vault itself shall be designed to provide sufficient protection against weather elements.*

*Assure that the vault that is to be supplied has sufficient environmental controls to provide adequate ventilation to maintain temperatures within operational requirements of equipment to be installed. In addition, make sure that vault has sufficient seals and/or filters on doors and other openings to assure that wind-driven dust does not affect operation of equipment.*

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**109-3.2 FOUNDATION AND WALLS.**

**a. Reinforced Concrete Construction.** The Contractor shall construct the foundation and walls in accordance with the details shown in the plans. Unless otherwise specified, internal ties shall be of the mechanical type so that when the forms are removed the ends of the ties shall be at least 1-inch (25 mm) beneath the concrete surface; the holes shall be plugged and finished to prevent discoloration. Reinforcing steel shall be placed, as shown in the drawings, and secured in position to prevent displacement during the concrete placement.

The external surfaces of the concrete shall be thoroughly worked during the placing operation to force all coarse aggregate from the surface. Thoroughly work the mortar against the forms to produce a smooth finish free from air pockets and honeycomb.

The surface film of all pointed surfaces shall be removed before setting occurs. As soon as the pointing has set sufficiently, the entire surface inside and outside of the vault shall be thoroughly wet with water and rubbed with a No. 16 carborundum stone, or equal quality abrasive, bringing the surface to a paste. All form marks and projections shall be removed. The surface produced shall be smooth and dense without pits or irregularities. The materials which have been ground into a paste during the rubbing process shall be spread or brushed uniformly over the entire surface (except the interior surfaces that are to be painted shall have all paste removed by washing before painting) and permitted to reset. Final exterior finish shall be obtained by rubbing with No. 30 carborundum stone, or an equal quality abrasive. The surface shall be rubbed until the entire surface is smooth and uniform in color.

**b. Brick and Concrete Construction.** When this type of construction is specified, the foundation shall be concrete conforming to the details shown in the plans. The outer edge of the foundation at the floor level shall be beveled 1-½ inches (37 mm) at 45 degrees. Brick walls shall be 8 inches (200 cm) thick, laid in running bond with every sixth course a header course. Brick shall be laid in cement mortar (1 part masonry cement and 3 parts sand) with full mortar bed and shoved joints. All joints shall be completely filled with mortar, and facing brick shall be back-parged with mortar as work progresses. All joints shall be 3/8 inch (9 mm) thick, exterior joints tooled concave, and interior joints struck flush. Both interior and exterior brick surfaces shall be cleaned and nail holes, cracks and other defects filled with mortar. When specified, a nonfading mineral pigment mortar coloring shall be added to the mortar. Steel reinforcing bars, 3/8-inch (9 mm) in diameter and 12 inches (300 mm) long, shall be set vertically in the center of the brick wall on not more than 2-foot (60 cm) centers to project 2-½(60 mm) inches into the concrete roof slab. Lintels for supporting the brickwork over doors, windows, and louvers shall consist of two 4- x 3- x 3/8-inch (100 x 75 x 9 mm) steel angles. Lintels shall be painted with one coat of corrosion-inhibiting primer before installation, and all exposed parts shall be painted similar to doors and window sash after installation.

Window sills may be concrete poured in place or precast concrete as indicated in the plans. All exposed surfaces shall have a rubbed finish as specified under reinforced concrete construction. After completion, all interior and exterior faces of walls shall be scrubbed with a solution of muriatic acid and water in the proportions of not less than 1 part acid to 10 parts of water. All traces of efflorescence, loose mortar, and mortar stain shall be removed, and the walls washed down with clear water.

**c. Concrete Masonry Construction.** When this type of construction is specified, the foundation shall be concrete conforming to the details shown in the plans. The concrete masonry units shall be standard sizes and shapes and shall conform to ASTM C 90 and shall include the closures, jambs, and other shapes required by the construction as shown in the plans. Standard construction practice shall be followed for this type of work including

mortar, joints, reinforcing steel for extensions into roof slab, etc. Plaster for interior walls, if specified, shall be portland cement plaster.

**109-3.3 ROOF.** The roof shall be reinforced concrete as shown in the plans. Reinforcing steel shall be placed as shown in the drawing and secured in position to prevent displacement during the pouring of the concrete. The concrete shall be poured monolithically and shall be free of honeycombs and voids. The surface shall have a steel-troweled finish and shall be sloped as shown in the drawing. The underside of the roof slab shall be finished in the same manner as specified for walls.

One brush or mop coat of hot asphalt roof coating shall be applied to the top surface of the roof slab. The asphalt material shall be heated to within the range specified by the manufacturer and immediately applied to the roof. The finished coat shall be continuous over the roof surface and free from holidays and blisters. Smears and dribbles of asphalt on the roof edges and building walls shall be removed.

**109-3.4 FLOOR.** The floor shall be reinforced concrete as shown in the drawings. When present, all sod, roots, refuse, and other perishable material shall be removed from the area under the floor to a depth of 8 inches (200 mm), unless a greater depth is specified in the invitation for bids. This area shall be backfilled with materials consisting of sand, cinders, gravel, or stone. Fill shall be placed in layers not to exceed 4 inches (100 mm) and shall be thoroughly compacted by tamping or rolling. A layer of building paper shall be placed over the fill prior to placing concrete. The floor surfaces shall have a steel-troweled finish. The floor shall be level unless a drain is specified, in which case the floor shall be pitched ¼-inch (6 mm) per foot downward toward the drain. A ¼-inch (6 mm) asphalt felt expansion joint shall be placed between floor and foundation walls. The floor shall be poured monolithically and shall be free of honeycombs and voids.

**109-3.5 FLOOR DRAIN.** If shown in the plans, a floor drain and dry well shall be installed in the center of the floor of the equipment room. The dry well shall be excavated 4 x 4 feet (120 x 120 cm) square and to a depth of 4 feet (120 cm) below the finished floor elevation and shall be backfilled to the elevation of the underside of the floor with gravel - which shall all pass a 2-inch (50 mm) mesh sieve and shall all be retained on a ¼-inch (6 mm) mesh sieve. The gravel backfill shall be placed in 6-inch (150 mm) maximum layers, and the entire surface of each layer shall be tamped either with a mechanical tamper or with a hand tamper weighing not less than 25 pounds (11 kg) and having a face area of not more than 36 square inches (234 square cm) nor less than 16 square inches (104 square cm). The drain inlet shall be set flush in the concrete floor. The drain shall have a clear opening of not less than 8 inches (200 mm) in diameter.

**109-3.6 CONDUITS IN FLOOR AND FOUNDATION.** Conduits shall be installed in the floor and through the foundation walls in accordance with the details shown in the plans. All underground conduit shall be painted with a bituminous compound. Conduit shall be installed with a coupling or metal conduit adapter flush with the top of the floor. All incoming conduit shall be closed with a pipe plug to prevent the entrance of foreign material during construction. Space conduit entrances shall be left closed.

**109-3.7 DOORS.** Doors shall be metal-clad fireproof class a doors conforming to requirements of the National Electric Code and local electrical codes.

**109-3.8 PAINTING.** The floor, ceiling, and inside walls of concrete construction shall first be given a hardening treatment, after which the Contractor shall apply two coats of paint as specified below, except that interior face brick walls need not be painted. The hardening treatment shall consist of applying two coats of either a commercial floor hardener or a solution made by dissolving 2 pounds (0.9 kg) of magnesium fluosilicate or zinc sulphate crystals in 1 gallon (liter) of water. Each coat shall be allowed to dry at least 48 hours before the next application. After the second treating coat has dried, the surfaces shall be brushed clean of all crystals and thoroughly washed with clear water. Paint for walls and ceiling shall be a light gray color approved by the Engineer. The floor paint shall be a medium gray color approved by the Engineer. Before painting, the surfaces shall be dry and clean. The first coat shall be thinned by adding 2/3-quart (0.166 liters) of spar varnish and 1/3-quart (0.083 liters) of turpentine to each gallon (liter) of paint. The second coat shall be applied without thinning. All doors, lintels, and windows shall be cleaned to remove any rust or foreign material and shall be given one body and one finish coat of white paint. Bare metal surfaces shall be given a prime coat of corrosion-inhibiting primer prior to the body and finish coats.

**109-3.9 LIGHTS AND SWITCHES.** The Contractor shall furnish and install a minimum of two duplex convenience outlets in the vault room. Where a control room is specified, at least two duplex outlets shall be installed.

## **INSTALLATION OF EQUIPMENT IN VAULT OR PREFABRICATED METAL HOUSING**

**109-3.10 GENERAL.** The Contractor shall furnish, install, and connect all equipment, equipment accessories, conduit, cables, wires, buses, grounds, and support necessary to insure a complete and operable electrical distribution center for the airport lighting system as specified herein and shown in the plans. When specified, an emergency power supply and transfer switch shall be provided and installed.

The equipment installation and mounting shall comply with the requirements of the National Electrical Code and local code agency having jurisdiction.

**109-3.11 POWER SUPPLY EQUIPMENT.** Transformers, regulators, booster transformers, and other power supply equipment items shall be furnished and installed at the location shown in the plans or as directed by the Engineer. The power supply equipment shall be set on steel “H” sections, “I” beams, channels, or concrete blocks to provide a minimum space of 1-½ inches (37 mm) between the equipment and the floor. The equipment shall be placed so as not to obstruct the oil-sampling plugs of the oil-filled units; and name-plates shall, so far as possible, not be obscured.

If specified in the plans and specifications, equipment for an alternate power source or an emergency power generator shall be furnished and installed. The alternate power supply installation shall include all equipment, accessories, an automatic changeover switch, and all necessary wiring and connections. The emergency power generator set shall be the size and type specified.

**109-3.12 SWITCHGEAR AND PANELS.** Oil switches, fused cutouts, relays, transfer switches, panels, panel boards, and other similar items shall be furnished and installed at the location shown in the plans or as directed by the Engineer. Wall or ceiling mounted items shall be attached to the wall or ceiling with galvanized bolts of not less than 3/8-inch (9 mm) diameter engaging metal expansion shields or anchors in masonry or concrete vaults.

**109-3.13 DUCT AND CONDUIT.** The Contractor shall furnish and install square-type exposed metallic ducts with hinged covers for the control circuits in the vault. These shall be mounted along the walls behind all floor-mounted equipment and immediately below all wall-mounted equipment. The hinged covers shall be placed to open from the front side with the hinges at the front bottom.

Wall brackets for square ducts shall be installed at all joints 2 feet (60 cm) or more apart with intermediate brackets as specified. Conduit shall be used between square ducts and equipment or between different items of equipment when the equipment is designed for conduit connection. When the equipment is not designed for conduit connection, conductors shall enter the square-type control duct through insulating bushings in the duct or on the conduit risers.

**109-3.14 CABLE ENTRANCE AND HIGH-VOLTAGE BUS SYSTEM.** Incoming underground cable from field circuits and supply circuits will be installed outside the walls of the transformer vault as a separate item under Item L-108. The Contractor installing the vault equipment shall bring the cables from the trench or duct through the entrance conduits into the vault and make the necessary electrical connections. For the incoming and outgoing high voltage load circuits, the Contractor shall furnish and install rigid metallic vi conduit risers, surmounted by potheads, from floor level to the level as shown in the plans.

The incoming high-voltage power supply service to the vault shall enter below the floor of the vault and shall rise from the floor level in a rigid metallic conduit riser, surmounted by a pothead, as described above. Using insulated high-voltage cable, the incoming power service shall be connected from the pothead to the oil-fused cutouts or to the

specified disconnecting switch or equipment. From the oil-fused cutouts or disconnecting device, the insulated service conductors shall be connected to the overhead voltage bus system of the vault. The high-voltage bus system shall utilize the materials specified and shall be mounted and installed in accordance with the requirements of the National Electrical Code or the local code agency having jurisdiction.

**109-3.15 WIRING AND CONNECTIONS.** The Contractor shall make all necessary electrical connections in the vault in accordance with the wiring diagrams furnished and as directed by the Engineer. In wiring to the terminal blocks, the Contractor shall leave sufficient extra length on each control lead to make future changes in connections at the terminal block. This shall be accomplished by running each control lead the longest way around the box to the proper terminal. Leads shall be neatly laced in place.

**109-3.16 MARKING AND LABELING.** All equipment, control wires, terminal blocks, etc., shall be tagged, marked, or labeled as specified below:

**a. Wire Identification.** The Contractor shall furnish and install self-sticking wire labels or identifying tags on all control wires at the point where they connect to the control equipment or to the terminal blocks. Wire labels, if used, shall be of the self-sticking preprinted type and of the manufacturer's recommended size for the wire involved. Identification -markings designated in the plans shall be followed. Tags, if used, shall be of fiber not less than 3/4-inch (13 mm) in diameter and not less than 1/32-inch (1 mm) thick. Identification markings designated in the plans shall be stamped on tags by means of smalltool dies. Each tag shall be securely tied to the proper wire by a nonmetallic cord.

**b. Labels.** The Contractor shall stencil identifying labels on the cases of regulators, breakers, and distribution and control relay cases with white oil paint as designated by the Engineer. The letters and numerals shall be not less than 1 inch (25 mm) in height and shall be of proportionate width. The Contractor shall also mark the correct circuit designations in accordance with the wiring diagram on the terminal marking strips, which are a part of each terminal block.

## METHOD OF MEASUREMENT

**109-4.1** The quantity of vaults to be paid for under this item shall consist of the number of vaults constructed in place and accepted as a complete unit.

**109-4.2** The quantity of prefabricated metal housings to be paid for under this item shall consist of the number of housings constructed in place and accepted as a complete unit.

**109-4.3** The quantity of vault or prefabricated metal housing equipment to be paid for under this item shall consist of all equipment installed, connected, and accepted as a complete unit ready for operation.

## BASIS OF PAYMENT

**109-5.1** Payment will be made at the contract unit price for each completed and accepted vault or prefabricated metal housing equipment installation. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item L-109-5.1	Construction of Airport Transformer Vault in Place-per unit
Item L-109-5.2	Installation of Airport Transformer Vault Equipment in Place-per unit
Item L-109-5.3	Construction of Prefabricated Metal Housing and Foundation in Place-per unit

Item L-109-5.4 Installation of Prefabricated Metal Housing Equipment in Place-per unit

### **MATERIAL REQUIREMENTS**

AC 150/5345-3	Specification for L-821 Panels for Remote Control of Airport Lighting
AC 150/5345-5	Circuit Selector Switch
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-10	Specification for Constant Current Regulators and Regulator Monitors
AC 150/5345-13A	Specification for L841 Auxiliary Relay Cabinet Assembly for Pilot Control of Airport Lighting Circuits
ANSI/ICEA S-85-625-1996	Aircore, Polyethylene Insulated, Copper Conductor, Telecommunications Cable
ASTM A 615	Specification for Deformed and Plain Billet Steel Bars for Concrete Reinforcement
ASTM C 62	Specification for Building Brick (Solid Masonry Units Made from Clay or Shale)
ASTM C 90	Concrete Masonry Units, Loadbearing
ASTM D 2823	Asphalt Roof-Coating
Commercial Item Description A-A-3067	Paint: Alkyd, Exterior, Low VOC
Fed. Spec. J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)
Fed. Spec. TT-E-487	Enamel, Floor and Deck
Fed. Spec. W-C-571	Conduit and Fittings, Nonmetal, Rigid; (Asbestos-Cement or Fire-Clay Cement), (For Electrical Purposes)

## **ITEM L-110 AIRPORT UNDERGROUND ELECTRICAL DUCT BANKS AND CONDUITS**

### **DESCRIPTION**

*110-1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete) installed in accordance with this specification at the locations and in accordance with the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits. It shall also include all trenching, backfilling, removal, and restoration of any paved areas; concrete encasement, mandreling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables in accordance with the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system.*

### **EQUIPMENT AND MATERIALS**

*110-2.1 GENERAL. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the Engineer.*

*110-2.2 STEEL CONDUIT. Rigid steel conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standard 6, 514B, and 1242.*

*110-2.3 PLASTIC CONDUIT. Plastic conduit and fittings shall conform to the requirements of Fed Spec. W-C-1094 and Underwriters Laboratories Standards UL-651 and UL-65L4 and shall be one of the following, as shown on the plans:*

- a. Type I - Schedule 40 PVC suitable for underground use either direct-buried or encased in concrete.*
- b. Type II - Schedule 40 PVC suitable for either above ground or underground use.*

*Plastic conduit adhesive shall be a solvent cement manufactured specifically for the purpose of gluing the specific type of plastic conduit and fitting.*

*110-2.4 SPLIT CONDUIT. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.*

*110-2.5 CONDUIT SPACERS. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads, They shall be designed to accept No. 4 reinforcing bars installed vertically.*

*110-2.6 CONCRETE. Concrete shall conform to Item P-610, Structural Portland Cement Concrete, using [ ] inch maximum size coarse aggregate with a minimum 28 day compressive strength of [ ] psi.*

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*Typically, the maximum size aggregate should be speed as 1 inch, however, Engineer may specify smaller to accommodate special situations where 1 inch aggregate may he too large*

*Item P-61 0 requires concrete to develop a 28 day compressive strength of 4, 000 psi. Engineer to determine the strength of concrete appropriate for the project and insert in paragraph 110-2.6.*

\*\*\*\*\*

*110-2.5 FLOWABLE BACKFILL. Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153 "Controlled Low Strength Material ".*

**CONSTRUCTION METHODS**

*110-3.1 GENERAL. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The Engineer shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. No duct bank or underground conduit shall be less than 18 inches below finished grade. Where under pavement, the top of the duct bank shall not be less than 18 inches below the subgrade.*

\*\*\*\*\*

*For a closed conduit/duct bank system, the system should be designed to be connected to, and thus drain into, the airfield storm drainage system*

*Engineer needs to be careful to define the term "subgrade" as it relates to pavement construction. In areas of pavement construction requiring the placement of embankment, or in areas requiring over-excavation to remove unsuitable material, the desired location of the top of the duct bank needs to be clearly identified In areas susceptible to frost, the top of the duct bank should be placed at or below the level of the frost line.*

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*The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4-inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.*

*For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a pulling line having a minimum tensile strength of 200 lb. Sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.*

*All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminate from entering the conduits. Any conduit section having a defective joint shall not be installed.*

*Unless otherwise shown on the plans, concrete encased duct banks shall be utilized when crossing under pavements expected to carry aircraft loads.*

*Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.*

*Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.*

*When rock is encountered, the rock shall be removed to a depth of at least 3 inches below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch sieve. Flowable backfill may alternatively be used. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All such rock removal shall be performed and paid for under Item P-152.*

*Underground electrical warning (caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the Engineer. If not shown on the plans, the warning tape shall be located six inches above the duct/conduit or the counterpoise wire if present.*

*Joints in plastic conduit shall be prepared in accordance with the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet.*

*Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.*

*Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the Engineer, the unsuitable material shall be removed in accordance with Item P-152 and replaced with suitable material. Alternatively, additional duct bank supports that are adequate and stable shall be installed, as approved by the Engineer.*

*Unless otherwise specified, excavated materials which are deemed by the Engineer to be unsuitable for use in backfill or embankments shall be removed and disposed of off site.*

*Any excess excavation shall be filled with suitable material approved by the Engineer and compacted in accordance with item P-152.*

*It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall insure that these cable(s) are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:*

*(1) Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred*

(2) *Trenching, etc., in cable areas shall then proceed with approval of the Engineer, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.*

*In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.*

**110-3.2 DUCT BANKS.** *Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (45 cm) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (45 cm) below finished grade where installed in unpaved areas.*

*Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (90 cm) beyond the edges of the pavement or 3 feet (90 cm) beyond any underdrains which may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, proper provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. Where two or more conduits in the duct bank are intended to carry conductors of equal voltage insulation rating, the Contractor shall space the conduits not less than 1-1/2 inches (37 mm) apart (measured from outside wall to outside wall). Where two or more conduits in the duct bank are intended to carry conductors of differing voltage insulation rating, the Contractor shall space the conduits not less than 3 inches apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. End bells or couplings shall be installed flush with the concrete encasement at access points.*

*Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.*

*When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5 foot (150 cm) intervals.*

**110-3.3 CONDUITS WITHOUT CONCRETE ENCASEMENT.** *Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide, and the trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.*

*Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively used.*

*Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits are at least 18 inches (45 cm) below the finished grade.*

*When two or more individual conduits intended to carry conductors of equal voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 2 inches (50 mm)*

apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the Engineer for review prior to use.

**110-3.4 MARKERS.** The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 inches (100 mm) thick extending approximately 1 inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building.

The Contractor shall impress the word “DUCT” or “CONDUIT” on each marker slab. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the Engineer. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2-inch (12 mm) and 1/4-inch (6 mm) deep or as large as the available space permits.

**110-3.5 BACKFILLING FOR CONDUITS.** For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted in accordance with Item P-152 “Excavation and Embankment” except that material used for back fill shall be select material not larger than 4 inches in diameter.

Flowable backfill may alternatively be used

Trenches shall not contain pools of water during back, filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface: except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of in accordance with instructions issued by the Engineer.

**110-3.6 BACKFILLING.** For duct banks, after the concrete has cured, the remaining trench shall be backfilled and compacted in accordance with Item P-152 “Excavation and Embankment” except that the material used for backfill shall be select material not larger than 4 inches in diameter. In addition to the requirements of P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet of duct bank or one work period's construction, whichever is less.

Flowable backfill may alternatively be used



*Underwriters Laboratories  
Standard 514B*

*Fittings for Cable and Conduit*

*Underwriters Laboratories  
Standard 1242*

*Intermediate Metal Conduit*

*Underwriters Laboratories  
Standard 651*

*Schedule 40 and 80 Rigid PVC Conduit (for Direct Burial)*

*Underwriters Laboratories  
Standard 651A*

*Type EB and A Rigid PVC Conduit and HDPE Conduit (for concrete  
encasement)*

***END OF ITEM L-110***

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# ITEM L-115 ELECTRICAL MANHOLES AND JUNCTION STRUCTURES

## DESCRIPTION

**115-1.1** This item shall consist of electrical manholes and junction structures (handholes, pullboxes, junction cans, etc.) installed in accordance with this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the Engineer. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the Engineer.

## EQUIPMENT AND MATERIALS

**115-2.1 CONCRETE STRUCTURES.** Cast-in-place concrete structures shall conform to the details and dimensions shown on the plans.

Provide precast concrete structures where shown on the plans. Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand [ZZZ lb aircraft] loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

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**Engineer to specify load characteristics for precast concrete structure based on design aircraft. It is the intent of this specification for the design engineer to design a cast-in-place structure that is detailed on the plans that will be suitable for the design loads and subgrade soil characteristics. If the Contractor proposes to use a substitute structure design, design calculations shall be submitted according to the procedure in the General Provisions.**

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Threaded inserts and pulling eyes shall be cast in as shown.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the Engineer shall be submitted by the Contractor to allow for a full evaluation by the Engineer. The Engineer shall review in accordance with the process defined in the General Provisions.

**115-2.2 JUNCTION CANS.** Junction Cans shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) cans encased in concrete. The cans shall have a galvanized steel blank cover, gasket, and stainless steel hardware. Covers shall be 3/8" thickness for L-867 and 3/4" thickness for L-868.

**115-2.3 MORTAR.** The mortar shall be composed of one part of portland cement and two parts of mortar sand, by volume. The portland cement shall conform to the requirements of ASTM C 150, Type I. The sand shall conform to the requirements of ASTM C 144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15 percent of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C 6.

*The water shall be clean and free of deleterious amounts of acid, alkalies or organic material. If the water is of questionable quality, it shall be tested in accordance with AASHTO T-26.*

**115-2.4 CONCRETE.** *All concrete used in structures shall conform to the requirements of Item P-610, Structural Portland Cement Concrete.*

**115-2.5 FRAMES AND COVERS.** *The frames shall conform to one of the following requirements:*

- A. *Gray iron castings shall meet the requirements of ASTM A 48.*
- B. *Malleable iron castings shall meet the requirements of ASTM A 47.*
- C. *Steel castings shall meet the requirements of ASTM A 27.*
- D. *Structural steel for frames shall conform to the requirements of ASTM A-283, Grade D.*
- E. *Ductile iron castings shall conform to the requirements of ASTM A 536.*
- F. *Austempered ductile iron castings shall conform to the requirements of ASTM A 897.*

*All castings specified shall withstand a maximum tire pressure of [ZZZ psi] and maximum load of [ZZZ pounds].*

\*\*\*\*\*

***Engineer to specify load characteristics for castings based on design aircraft.***

\*\*\*\*\*

*All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.*

*Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.*

*All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A 123.*

*Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equal. No cable notches are required.*

**115-2.6 LADDERS.** *Ladders, if specified, shall be galvanized steel or as shown on the plans.*

**115-2.7 REINFORCING STEEL.** *All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A 615, Grade 60.*

**115-2.8 BEDDING/SPECIAL BACKFILL.** Bedding or special backfill shall be as shown on the plans.

**115-2.9 FLOWABLE BACKFILL.** Flowable material used to backfill shall conform to the requirements of Item P-153 "Controlled Low Strength Material".

**115-2.10 CABLE TRAYS.** Cable trays shall be of galvanized steel, plastic, or aluminum. Cable trays shall be located as shown on the plans.

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*Engineer to specify cable tray based on type of structure and user preference.*

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**115-2.11 PLASTIC CONDUIT.** Plastic conduit shall comply with Item L-110 - Airport Underground Electrical Duct Banks and Conduits.

**115-2.12 CONDUIT TERMINATORS.** Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

**115-2.13 PULLING-IN IRONS.** Pulling-in irons shall be manufactured with 7/8-inch (22mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch diameter with an ultimate strength of 270,000 psi). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

**115-2.14 GROUND RODS.** Ground rods shall be one piece, [solid stainless steel] [copper] or [copper clad]. The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8-feet (240 cm) long nor less than 5/8 inch (15 mm) in diameter.

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*Engineer should evaluate the soils in the vicinity of proposed counterpoise and ground rod installations and determine if soil conditions would adversely affect copper. Engineer shall specify the type of ground rod and counterpoise wire to be installed in consideration of the soil conditions.*

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**CONSTRUCTION METHODS**

**115-3.1 UNCLASSIFIED EXCAVATION.** It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the Engineer without additional expense to the Owner.

*The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the Engineer. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.*

*Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the Engineer. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.*

*The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.*

*Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.*

*After each excavation is completed, the Contractor shall notify the Engineer. Structures shall be placed after the Engineer has approved the depth of the excavation and the suitability of the foundation material.*

*Prior to installation the Contractor shall provide a minimum of 6 inches of sand or a material approved by the Engineer as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.*

***115-3.2 CONCRETE STRUCTURES.*** *Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the Engineer before the concrete is placed.*

***115-3.3 PRECAST UNIT INSTALLATIONS.*** *Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.*

***115-3.4 PLACEMENT AND TREATMENT OF CASTINGS, FRAMES AND FITTINGS.*** *All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the Engineer and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.*

*Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the Engineer and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor's expense.*

*Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.*

*Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.*

**115-3.5 INSTALLATION OF LADDERS.** *Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.*

**115-3.6 REMOVAL OF SHEETING AND BRACING.** *In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn, unless otherwise directed, before more than six (6) inches of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.*

*The Engineer may order the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.*

**115-3.7 BACKFILLING.** *After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the Engineer.*

*Backfill shall not be placed against any structure until permission is given by the Engineer. In the case of concrete, such permission shall not be given until tests made by the laboratory under supervision of the Engineer establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.*

*Where required, the Engineer may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.*

**115-3.8 CONNECTION OF DUCT BANKS.** *To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.*

**115-3.9 GROUNDING.** *A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (154 mm) above the floor. The ground rod shall be installed within 1 foot of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.*

*A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of 1 foot above the floor of the structure and separate from other cables. No. 2 AWG bare copper pigtailed shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. Hardware connections may be mechanical, using a lug designed for that purpose.*

**115-3.10 CLEANUP AND REPAIR.** *After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound conforming MIL-P-21035. Surfaces shall be prepared and compound applied in accordance with manufacturer's recommendations.*

*Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.*

**115-3.11 RESTORATION.** *After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equal to or better than their original condition.*

*The Contractor shall grade around structures as required to provide positive drainage away from the structure.*

*Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.*

*After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.*

**115-3.12 INSPECTION.** *Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The impedance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested utilizing the fall-of-potential ground impedance test as described by ANSI IEEE Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.*

## **METHOD OF MEASUREMENT**

**115-4.1** *Electrical manholes and junction structures shall be measured by each unit completed in place and accepted. The following additional items are specifically included in each unit.*

- *All Required Excavation*
- *Sheeting and Bracing*
- *All Required Backfilling with On-Site Materials*
- *Restoration of All Surfaces and Finished Grading*
- *All Required Connections*
- *Dewatering If Required*

- *Temporary Cables and Connections*
- *Ground Rod Testing*

**BASIS OF PAYMENT**

*115-5.1 The accepted quantity of electrical manholes and junction structures will be paid for at the Contract unit price per each, complete and in place. This price shall be full compensation for furnishing all materials and for all preparation, excavation, backfilling and placing of the materials, furnishing and installation of appurtenances and connections to duct banks and other structures as may be required to complete the item as shown on the plans and for all labor, equipment, tools and incidentals necessary to complete the structure.*

*Payment will be made under:*

*Item L-115-5.1- Electrical Manhole [size and type] -Per Each*

*Item L-115-5.2- Electrical Junction Structure [size and type] -Per Each*

**MATERIAL REQUIREMENTS**

<i>ANSI/IEEE Std 81</i>	<i>IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System</i>
<i>AC 150/5345-7</i>	<i>Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits</i>
<i>AC 150/5345-26</i>	<i>Specification for L-823 Plug and Receptacle Cable Connectors</i>
<i>Fed. Spec. J-C-30</i>	<i>Cable and Wire, Electrical Power, Fixed Installation</i>
<i>ASTM B.3</i>	<i>Soft or Annealed Copper Wire</i>
<i>ASTM B.8</i>	<i>Concentric-Lay-Stranded Copper Conductor, Hard, Medium-Hard, or Soft</i>

**END OF ITEM L-115**

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## ITEM L-119 AIRPORT OBSTRUCTION LIGHTS

### DESCRIPTION

**119-1.1** This item shall consist of furnishing and installing obstruction lights in accordance with these specifications. Included in this item shall be the furnishing and installing of wood poles, steel or iron pipes, or other supports as required in the plans or specifications.

This item shall also include all wire and cable connections, the furnishing and installing of all necessary conduits and fittings, insulators, pole steps, pole cross arms, and the painting of poles and pipes. In addition, it includes the furnishing and installing of all lamps and, if required, the furnishing and installing of insulating transformers, the servicing and testing of the installation and all incidentals necessary to place the lights in operation as completed units to the satisfaction of the Engineer.

### EQUIPMENT AND MATERIALS

#### 119-2.1 GENERAL.

**a.** Airport lighting equipment and materials covered by Federal Aviation Administration (FAA) specifications shall be certified and listed under Advisory Circular (AC) 150/5345-53, Airport Lighting Equipment Certification Program.

**b.** All other equipment and materials covered by other reference specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the Engineer.

**119-2.2 OBSTRUCTION LIGHTS.** The obstruction lights shall conform to the requirements of AC 150/5345-43, Specification for Obstruction Lighting Equipment.

**119-2.3 ISOLATION TRANSFORMERS.** Where required for series circuits, the *isolation* transformers shall conform to the requirements of AC 150/5345-47, Isolation Transformers for Airport Lighting Systems.

**119-2.4 TRANSFORMER HOUSING.** Transformer housings, if specified, shall conform to AC 150/5345-42, Specification for Airport Light Base and Transformer Housings, Junction Boxes, and Accessories.

**119-2.5 CONDUIT.** Steel conduit and fittings shall be in accordance with Underwriters Laboratories Standard 6, 514, and 1242.

**119-2.6 WIRES.** Wires in conduit rated up to 5,000 volts shall conform to AC 150/5345 7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits, for rubber insulated neoprene covered wire, or Fed. Spec. J-C-30, Type RHW, for rubber insulated fibrous covered wire. For ratings up to 600 volts, thermoplastic wire conforming to Fed. Spec. J-C-30, Types TW, THW, and THWN, shall be used. The wires shall be of the type, size, number of conductors, and voltage shown in the plans or in the proposal. Overhead line wire from pole to pole, where specified, shall conform to ANSI/ICEA S-70-547-1992.

**119-2.7 MISCELLANEOUS.** Paint, poles, pole steps, insulators, and all other miscellaneous materials necessary for the completion of this item shall be new and first-grade commercial products. These products shall be as specified in the plans or specifications.

## CONSTRUCTION METHODS

**119-3.1 PLACING THE OBSTRUCTION LIGHTS.** The Contractor shall furnish and install single-or double-obstruction lights as specified in the proposal and shown in the plans. The obstruction lights shall be mounted on poles, buildings, or towers approximately at the location shown in the plans. The exact location shall be as directed by the Engineer.

**119-3.2 INSTALLATION ON POLES.** Where obstruction lights are to be mounted on poles, each obstruction light shall be installed with its hub at least as high as the top of the pole. All wiring shall be run in not less than 1-inch (25 mm) galvanized rigid steel conduit. If specified, pole steps shall be furnished and installed, the lowest step being 5 feet (150 cm) above ground level. Steps shall be installed alternately on diametrically opposite sides of the pole to give a rise of 18 inches (45 cm) for each step. Conduit shall be fastened to the pole with galvanized steel pipe straps and shall be secured by galvanized lag screws. Poles shall be painted as shown in the plans and specifications.

When obstruction lights are installed on existing telephone or power poles, a large fiber insulating sleeve of adequate diameter and not less than 4-feet (120 cm) long, shall be installed to extend 6 inches (150 mm) above the conductors on the upper cross arm. In addition, the sleeve shall be at least 18 inches (45 cm) below the conductors on the lower crossarm. The details of this installation shall be in accordance with the plans.

**119-3.3 INSTALLATION ON BEACON TOWER.** Where obstruction lights are installed on a beacon tower, two obstruction lights shall be mounted on top of the beacon tower using 1-inch (25 mm) conduit. The conduit shall screw directly into the obstruction light fixtures and shall support them at a height of not less than 4 inches (100 mm) above the top of the rotating beacon. If obstruction lights are specified at lower levels, the Contractor shall install not less than 1-inch (25 mm) galvanized rigid steel conduit with standard conduit fittings for mounting the fixtures. The fixtures shall be mounted in an upright position in all cases. The conduit shall be fastened to the tower members with “wraplock” straps, clamps, or approved fasteners spaced approximately 5 feet (150 cm) apart. Three coats of aviation-orange paint shall be applied (one prime, one body, and one finish coat) to all exposed material installed.

**119 3.4 INSTALLATION ON BUILDINGS, TOWERS, SMOKESTACKS, ETC.** Where obstruction lights are to be installed on buildings or similar structures, the installation shall be made in accordance with details shown in the plans. The hub of the obstruction light shall be not less than 1 foot (30 cm) above the highest point of the obstruction except in the case of smokestacks where the uppermost units shall be mounted not less than 5 feet (150 cm), nor more than 10 feet (3 m) below the top of the stack. Conduit supporting the obstruction light units shall be fastened to wooden structures with galvanized steel pipe straps and shall be secured by 1-½ inch (37 mm) No. 10 galvanized wood screws. Conduit shall be fastened to masonry structures by the use of expansion shields, screw anchors, or toggle bolts using No. 10, or larger, galvanized wood or machine screws. Conduit fastened to structural steel shall have the straps held with not less than No. 10 roundhead machine screws in drilled and tapped holes. Fastenings shall be approximately 5 feet (150 cm) apart. Three coats of aviation-orange paint shall be applied (one prime, one body, and one finish coat) to all exposed material installed.

**119-3.5 SERIES ISOLATION TRANSFORMERS.** The L-810 series obstruction light does not include a film cutout; therefore, an *isolation* transformer is required with each series lamp. Double series units of this type require two series insulating transformers. The transformer shall be housed in a base or buried directly in the earth in accordance with the details shown in the plans.

**119-3.6 WIRING.** The Contractor shall furnish all necessary labor and materials and shall make complete electrical connections from the underground cable or other source of power in accordance with the wiring diagram furnished with the project plans. If underground cable is required for the power feed and if duct is required under paved areas, the cable and duct shall be installed in accordance with (and paid for by) linear foot measurement as described in Item L-108, Underground *Power* Cable for Airports, and Item L-110, Airport Underground Electrical Duct *Banks and Conduit*.

**119-3.7 LAMPS.** The Contractor shall furnish and install in each unit one or two lamps, as required, conforming to the *manufacturer's requirements*.

**119-3.8 TESTS.** The installation shall be fully tested by continuous operation for not less than 1/2 hour as a completed unit prior to acceptance. These tests shall include the functioning of each control not less than 10 times.

## METHOD OF MEASUREMENT

**119-4.1** The quantity of lights to be paid for under this item shall be the number of single- or double-type obstruction lights installed and accepted as completed units, in place, ready for operation.

## BASIS OF PAYMENT

**119-5.1** Payment will be made at the contract unit price for each completed obstruction light installed, in place by the Contractor, and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparation, assembly, and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

Payment will be made under:

Item L-119-5.1	Airport Obstruction Light, in Place-per each
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## MATERIAL REQUIREMENTS

AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-42	Specification for Airport Light Base and Transformer Housing, Junction Boxes, and Accessories
AC 150/5345-43	Specification for Obstruction Lighting Equipment
AC 150/5345-47	Isolation Transformers for Airport Lighting Systems
ANSI/ICEA S-70-547-1992	Weather-Resistant Polyolefin-Covered Wire and Cable
Fed. Spec. J-C-30	Cable and Wire, Electrical (Power, Fixed Installation)