

**MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF AERONAUTICS - STANDARD SPECIFICATION
L-108
Installation of Underground Cable for Airports**

DESCRIPTION

1.1 This item shall consist of underground cable furnished and installed in accordance with this specification at the locations and in accordance with the design, dimensions, and details shown in the plans. This item shall include the installation of cable and counterpoise wire. Installation of cable or counterpoise shall be in trench, duct or conduit or by plowing in place. It shall include splicing, cable marking, and testing of the installation 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 the duct or conduit.

EQUIPMENT AND MATERIALS

2.1 General.

(a) Airport lighting equipment and materials covered by the FAA specifications shall have the prior approval of the Federal Aviation Administration, Airports Service, Washington, D.C. 20591, and shall be listed in the most recent Advisory Circular 150/5345-1, Approved Airport Lighting Equipment.

(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.

2.2 Cable. Underground cable shall conform to the requirements of Specification for L-824, Underground Electrical Cables for Airport Lighting Circuits. The following classifications apply in Specification L-824:

Type A--Single and multiple conductor

cable rated 600 volt and 5000 volts having rubber insulation and an overall jacket.

Type B--Single and multiple conductor cable rated 600 volts and 5000 volts having ethylene propylene insulation and an overall jacket.

Type C--Single and multiple conductor cables rated 600 volts and 5000 volts having cross-linked polyethylene insulation. Multiple conductor cables shall have an overall jacket.

For power cable, conductor size shall not be smaller than No. 8 AWG. For control cable, conductor size shall be not less than No. 12 AWG. When specified in the plans or documents, No. 14 AWG cable, of the type therein noted, may be used as control cable for connection to relays designed to operate at less than 100 volts. These limits on conductor sizes shall not apply to leads furnished by manufacturers on transformers and fixtures.

If telephone control cable is specified, copper shielded, polyethylene insulated and jacketed, No. 19 AWG telephone cable conforming to the United States Department of Agriculture, Rural Electrification Administration (REA) Bulletin 345-14, REA Specification for Fully Color-coded, Polyethylene Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial, shall be used.

Where counterpoise conductors are to be installed and where soil conditions would adversely affect bare copper wire, thermoplastic wire conforming to Fed. Spec. J-C-30, Type TW, 600 volt, may be used.

2.3 Bare Copper Wire (Counterpoise).

Bare copper wire for counterpoise installations shall be stranded wire conforming to ASTM

Specifications B-3 and B-8.

2.4 Cable Connections. In-line connections of underground primary cables shall be of the type called for in the plans or in the proposal, and shall be one of the types listed below. Splices shall be made in accordance with Sec. 3.9.

(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 (3M-Co.), "Scotchcast" Kit No. 82-A, or as manufactured by Hysol Corporation, "Hyseal Epoxy Splice" Kit No. #1135, for potting the splice is approved. 89-D1 is an approved splice kit for telephone control cable.

(b) **The Vulcanized Splice.** A vulcanized splice employing Joy Manufacturing Company's Vulcanizing Kit No. X-1604-8 or equal is approved for field vulcanized splices. The proper molds for various cables sizes shall be used.

(c) **The Field-attached Plug in Splice.** Figure 14 of Specification for L-823 Plug and Receptacle, Cable Connectors, employing connector kits, is approved for field attachment to single conductor cable.

(d) **The Factory-molded Plug in Splice.** Specification for L-823 Connectors, Factory-Molded to Individual Conductors, are approved.

(e) **The Taped Splice.** Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape are approved. The rubber tape should meet the requirements of Mil. Spec. MIL-I-3825 and the plastic tape should comply with Mil. Spec. MIL-I-7798 or Fed. Spec. HH-1-595. 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. No. 19 AWG telephone control wire may be connected

by means of wrapped and soldered splice, 3M Company Moisture Proof UR Type Connector, or equal, or by a method approved by the Engineer.

(f) Unless otherwise specified, the use of the various types of splices are limited as follows:

1. The cast splice--Home runs, extensions to existing cables.
2. The vulcanized splice--No limitations.
3. The field attached plug in splice--No limitations.
4. The factory-molded plug in splice--No limitations.
5. The taped splice--in manholes and vaults.

2.5 Concrete. Concrete for cable markers shall conform to Specification Item P-610, "Structural Portland Cement Concrete."

CONSTRUCTION METHODS

3.1 General. The Contractor shall install the specified cable at the approximate locations indicated in the airport lighting layout plans. The Engineer shall indicate specific locations.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the Individual insulating 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 in the plans.

3.2 Installation in Duct or Conduit. This item includes the installation of the cable in duct or conduit as described below. The maximum number and voltage ratings of cables installed in each duct shall be in accordance with the latest

National Electric Code, or the code of the local agency having jurisdiction.

The Contractor shall make no connections or joints of any kind in cables installed in conduits or ducts.

The duct or conduit shall be installed as a separate item in accordance with Item L-110, "Installation of Airport Underground Electrical Duct." The Contractor shall make sure that the duct is open, continuous, and clear of debris before installing cable. 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 before pulling into conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a duct under the same contract, all cable shall be pulled in the duct at the same time. The pulling of a cable through ducts or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Pulling tensions should be governed by recommended standard practices for straight pulls or bends. A lubricant recommended for the type of cable being installed shall be used where pulling lubricant is required. Duct or conduit markers temporarily removed for excavations shall be replaced as required.

3.3 Trenching. If specified, the existing sod 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 shoulder surface is disturbed. Road patrols or 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:

(a) When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches unless otherwise specified.

(b) 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. The trench shall be widened where more than two cables are to be installed parallel in the same trench. Unless otherwise specified in the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock excavation 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. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be unclassified.

3.4 Installation in Trenches. The Contractor shall not use a cable plow for installing the cable. Mechanical cable laying equipment may be used in conjunction with a trenching machine if specified on project plans and specifications; and it shall provide for physical inspection of cable prior to backfilling. Sharp bends or kinks in the cable shall not be permitted.

Cables shall be unreeled in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end.

Where two or more cables are laid parallel in the same trench, they shall be placed laterally a minimum distance of 3 inches apart, and the trench shall be widened sufficiently to accomplish this.

Cables crossing over each other shall have a minimum of 3 inch vertical displacement with the topmost cable kept at or below the minimum required depth below finished grade.

Not less than 1 foot of cable slack shall be left on each side of all connections, insulating transformers, light units, and at all other points where the cable is connected to field equipment. The slack cable shall be placed in the trench in a series of S curves. Additional slack cable shall be left in runway light bases, handholes, manholes, etc., where it is required to bring the cables above ground level to make connections. The amount of slack cable shall be stipulated by the Engineer, or as shown in the plans and specifications.

3.5 Backfilling. After the cable has been installed, the trench shall be backfilled. The first layer of backfill shall be 4 inches deep, loose measurement, and shall be 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 4 inches deep, loose measurement, and shall be either sand or earth containing no particles that would be retained on a 1 inch sieve. The requirement for sand may be waived by the Engineer if the existing soil is sand meeting the backfill specification. The remainder of the backfill shall be excavated or imported material and shall not contain stone or aggregate larger than 4 inches maximum diameter. The third and subsequent layers of the backfill shall not exceed 8 inches in maximum depth, loose measurement.

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 be excessively wet and 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 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.

3.6 Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the trenching, storing or dirt, cable laying, pad construction, and other work shall be restored to its original condition. The restoration shall include any necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. All such work shall be performed in accordance with the FAA Standard Turfing Specifications. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance.

Restoration of turfed areas shall be accomplished by using a seed mixture and fertilizer specified in Standard Specification T-901 at the rates specified therein.

3.7 Cable Plowing Cable plowing when specified shall be accomplished using equipment and construction methods meeting the following specifications:

Equipment:

The plowing equipment shall be of the vibratory type with a vibrating rate of at least 1,200 cycles per minute. The vibrating unit shall be attached to a tractor unit in such a manner that the tractor does not dampen the vibration.

The plow blade shall be of sufficient length to permit installation of the cable at the specified depth. The shoe throat shall be sized for the number and size cables specified. The cable way and guides shall be smooth, free of obstructions and sharp edges and shall not cause bending of the cable at shorter than 3" radius, nor cause excessive cable strain.

When several conductors, including counterpoise, are installed in a single operation, the plow shall have feeds for each wire to provide specified separation.

Installation:

Cable routing shall be offset by 2 feet from the light line (on side away from runways and taxiways). A hole shall be dug in the cable route at each light location.

Cable reels may be mounted on the tractor or cable unreeled along the proposed cable route before plowing. In the former case, unreeling of the cable shall not cause excessive tension in the cable.

After the tractor and plow are positioned at the beginning of a run, sufficient cable slack shall be pulled through the throat. The plow shall be lowered into the hole and the cable hand held for the start of plowing.

At each light hole, plow movement and vibration shall be stopped, the plow raised and the required amount of slack cable hand pulled. Care shall be taken during this operation that the cable at the entrance into the light hole shall not be pulled from the specified depth. Plowing shall be continued by lowering the plow, starting it and holding the cable by hand until it is firmly in place.

The plow shall not be backed onto the cable.

If an underground obstruction is encountered, the plow shall be lifted out of the ground and the obstruction removed by hand digging. Care must be taken that the cable has no bends sharper than 3" radius and is not subject to excessive tension.

After installation of cable by plowing, the disturbed earth shall be leveled and, if necessary, compacted by a device approved by the Engineer.

Ends of cable shall be taped immediately after

cutting to prevent moisture from entering the cable.

Personnel:

Plow operators shall be experienced and qualified by schooling and/or experience. Proof of such qualification may be required from the Contractor.

3.8 Cable Markers. The location of runway light circuits shall be marked by a concrete slab marker, 2 feet square and 4 inches thick, extending approximately 1 inch above the surface. Each cable run from the line of runway lights to the equipment vault shall be marked at a maximum of every 200 feet along the cable run, with an additional marker at each change of direction of cable run. All other cable buried directly in the earth shall be marked in the same manner. The Contractor shall not install slab markers where cables lie in straight lines between obstruction light poles which are spaced 300 feet apart, or less. Cable markers shall be installed immediately 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 high and 3 inches wide, with width of stroke 1/2 inch and 1/4 inch deep.

The location of each underground cable connection, except at lighting units or insulating transformers, shall be marked by a concrete marker slab placed above the connection. The Contractor shall impress the work "SPlice" on each slab. He or she also shall impress additional circuit identification symbols on each slab if so desired by the Engineer.

3.9 Splicing. Connections of the type shown in 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 joining 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) Vulcanized Splices. These shall be made by using crimp connectors for joining conductors. The splice shall be made, using compounds furnished by the manufacturer, in accordance with his or her instructions and to the satisfaction of the Engineer.

(c) 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 and 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 on each side of the joint.

(d) 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 on each side of the joint.

(e) Taped 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 of bare conductor on each side of the connector. Use a sharp knife to pencil insulation and jacket at approximately the same angle as a pencil point. Care must be taken to avoid nicking or injuring the conductor during removal of insulation or penciling. 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 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 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.

If shielded cable is to be spliced, prepare cable as for a regular taped splice, except that the neoprene jacket shall be removed a distance not less than 5 inches from the beginning of the penciled portion. Carefully unwrap the shielding tape from that portion where jacket has been removed and cut off so that it extends about 1 inch from end of the jacket. Proceed with the taped splice as described above and tape up to 1/4 inch from the shield on both ends. Build up rubber tape to a thickness equal to the insulation thickness or 5/16 inch over connector.

Next wrap one-half lapped layer of semi-conducting tape (Scotch No. 13 Semi-Conducting Tape, or equal) over splicing tape and 1/4 inch onto the shielding tape. Wrap a fine, flat shielding braid one-half lapped over the splice extending 1/2 inch onto the metallic shielding. Solder ends of braid to metallic shielding tape. A bonding wire, (Minimum No. 14 stranded copper) equal to the current carrying

capacity of the metallic shield, should have the individual strands wrapped around the metallic shield at both ends of the splice. These strands should be tack soldered to the shield in several places. The cable sheath should be replaced by wrapping with two one-half lapped layers of vinyl tape extending 2 inches onto the cable jacket.

The above described splice is for a straight-through splice with continuity of shielding.

3.10 Bare Counterpoise Wire Installation and Grounding for Lightning Protection. If shown in the plans or specified in job specifications, a stranded bare copper wire, No. 8 AWG minimum size, shall be installed for lightning protection of the underground cables. The bare counterpoise wire shall be installed in the same trench for the entire length of the insulated cables it is designed to protect, and shall be placed at a distance of approximately 4 inches from the insulated cable. The counterpoise wire shall be securely attached to each light fixture base, or mounting stake. The counterpoise wire shall also be securely attached to copper or copper-clad ground rods installed not more than 1,000 feet apart around the entire circuit. The ground rods shall be of the length and diameter specified in the plans, but in no case shall they be less than 8 feet long nor less than 5/8 inch in diameter.

The counterpoise system shall terminate at the transformer vault or at the power source. It shall be securely attached to the vault or equipment grounding system. The connections shall be made as shown in the project plans and specifications

Bare counterpoise wires shall be securely bonded together at all locations where two or more wires intersect, cross or join.

3.11 Testing. The Contractor shall furnish all necessary equipment and appliances for testing the underground cable circuits after installation. The Contractor shall test and demonstrate to the satisfaction of the Engineer

the following:

- (a) That all lighting power and control circuits are continuous and free from short circuits.
- (b) That all circuits are free from unspecified grounds.
- (c) That the insulation resistance to ground of all non-grounded series circuits is not less than 50 megohms.
- (d) That the insulation resistance to ground of all non-grounded conductors of multiple circuits is not less than 50 megohms.
- (e) That all circuits are properly connected in accordance with applicable wiring diagrams.
- (f) That all circuits are operable. Tests shall be conducted that include operating each control not less than 10 times and each lighting and power circuit shall be operated continuously at least one hour at each step without any interruption.

METHOD OF MEASUREMENT

4.1 The quantity of trench to be paid for shall be the linear feet of trench, of the minimum widths and depths specified, including the excavation, backfill, and restoration, completed, measured as excavated and accepted as satisfactory. Separate measurement shall be made for trenches of the various widths listed under "Basis of Payment." No separate measurement will be made for various depth unless otherwise specified.

4.2 The footage of cable or counterpoise wire, plowed, installed in trench, duct, or conduit, to be paid for, shall be the number of linear feet of cable or counterpoise wire, of each size or type, plowed, installed in trench, duct, or conduit, measured in place, completed, ready for operation, and accepted as satisfactory. The measurements shall be made from point to point,

such as fixture to duct end or cable turn to vault wall. No measurement or payment will be made for slack or loops, or for offsets to fixtures of 24 inches or less. Such extra cable shall be considered as incidental to the work.

HH-1-595 Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic, for Low-Temperature Application

Separate measurement shall be made for each cable or counterpoise wire, plowed in place, installed in trench, duct or conduit.

ASTM SPECIFICATIONS

B-3 Soft or Annealed Copper Wire
 B-8 Concentric-Lay-Stranded Copper Conductor, Hard, Medium-Hard, or Soft

BASIS OF PAYMENT

5.1 Payment will be made at the contract unit price per linear foot for cable trench of the width and depths specified; for cable and bare counterpoise wire of the sizes and types specified; constructed or installed, and accepted by the Engineer. This price shall be full compensation for furnishing all materials and for all preparations and installation of these materials, and for all labor, equipment, tools, and incidentals necessary to complete this item.

MILITARY SPECIFICATIONS

MIL-1-3825 Insulation Tape, Electrical, Self-Fusing, For Use in Electronics, Communications, and Allied Equipment
 MIL-1-7798 Insulation Tape, Electrical Pressure-Sensitive Adhesive, Plastic

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for cable plowing/trenching, cable trench, underground cable (size and type), and bare counterpoise wire (size), per linear foot, as applicable.

NOTE: Others as required by referenced Specifications. Cross-referenced Specifications required: P-610, T-901.

The first three digits of any item for work included under this specification shall be 108, i.e. 108XXXX.

FAA SPECIFICATIONS

<u>Number</u>	<u>Title</u>
AC 150/5345-7	Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits
AC 150/5345-26	Specifications for L-823 Plug and Receptacle Cable Connectors
J-C-30	Cable and Wire, Electrical Power, Fixed Installation