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ADVISORY CIRCULAR

HIGH INTENSITY RUNWAY LIGHTING SYSTEM

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAS-550

AC NO: 150/5340-13B

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ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: HIGH INTENSITY RUNWAY LIGHTING SYSTEM

1. PURPOSE. This advisory circular describes standards for the design, installation, and maintenance of high intensity runway lighting systems.

2. CANCELLATION. Advisory Circular 150/5340-13A, High Intensity Runway Lighting System, dated 14 April 1967.

3. REFERENCES. The publications listed under Bibliography, Appendix 1, provide guidance and detailed information.

4. EXPLANATION OF REVISIONS. In addition to minor changes in the text and figures, the following changes have been made:

   a. Red runway end lights added to basic lighting configuration.

   b. Lighting signals for displaced thresholds revised.

   c. Details added for step-type L-828 regulator and stepless regulator deleted.

   d. Curve for estimating physical distance between control panel and regulator changed.

   e. Details added for semiflush intersection light to have metal-to-metal contact.

   f. Maintenance requirements revised.

Initiated by: AAS-550

5. HOW TO OBTAIN THIS CIRCULAR. Obtain additional copies of this circular, Advisory Circular 150/5340-13B, High Intensity Runway Lighting System, from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

CLYDE W. PACE, JR.
Director, Airports Service

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1. INTRODUCTION. High intensity runway lights are used to outline the edges of paved runways during periods of darkness and restricted visibility conditions. The light fixtures are usually elevated units. Each unit has a specially designed lens which projects two main light beams. These beams are toed-in 3-1/2 degrees toward the runway centerline and elevated 5 degrees above the horizontal. Lower values of light are emitted from other sections of the lens. In general, high intensity runway lights are installed on designated instrument runways or on runways that are approved for straight-in approach procedures. At airports where traffic congestion exists and visibility conditions less than visual flight rules (VFR) are prevalent, high intensity runway lights may be installed on noninstrument runways.

2. BACKGROUND. Originally there were three types of elevated high intensity runway light fixtures used for airport lighting installations. They were the Specification L-818, L-819, and L-820 fixtures. Now, only the L-819 (Advisory Circular 150/5345-9C) fixtures are approved for new installations. The L-818 and L-820 fixtures are no longer manufactured by previous suppliers. This publication presents guidance for the design, installation, and maintenance of high intensity runway lighting systems using L-819 fixtures.

3. CONFIGURATION.

   a. General. A basic runway lighting system consists of two straight lines of runway edge lights defining the lateral limits of the runway. The longitudinal limits of the runway are defined by two straight lines of threshold runway end lights. The runway edge lights are aviation white, except that aviation yellow is substituted on take-off side for aviation white on the last 2,000 feet of an instrument runway for indicating the caution zone. The threshold lights are aviation green and the runway end lights are aviation red. See Figure 1 for typical configurations.

   b. Edge Lights.

      (1) Locate each line of the runway lights not more than 10 feet from the edge of the full strength pavement which is designated for runway use.

      (2) Make the longitudinal spacing of the light fixtures 200 feet maximum. Locate a light on one side of the runway with respect to its companion light on the opposite side so that a line joining the two is at a right angle to the runway centerline.

(3) Reference the location of the first runway edge light from the threshold lights. Space the lighting fixtures uniformly except where the spacing must be interrupted at intersections. When a runway is intersected by other pavements, it may be lighted by either of the following methods:

(a) Install a Type I semiflush light as described in Advisory Circular 150/5345-19, Type I unit, in the paved area of the intersection in order to maintain the uniform spacing. Select fixture designed for metal-to-metal contact with the supporting base.

(b) Space elevated lights uniformly within the individual sections of the runway. In addition, add single elevated lights to avoid gaps in excess of 400 feet where the matching of lights on opposite sides of the runway cannot be accomplished.

c. Threshold and Runway End Lights.

(1) Locate the combination threshold lights and runway end lights on a line perpendicular to the runway centerline not less than 2 nor more than 10 feet from the designated threshold of the runway. If a situation exists that makes the installation of the lights between the specified limits impractical, install the threshold lights not more than 50 feet from the designated threshold of the runway.

(2) The combination threshold and runway end lighting consists of two groups of lights located symmetrically about the runway centerline. Each group contains not less than four lights uniformly spaced if the runway width is 100 feet or greater. In this case, a gap of at least 80 feet is provided between the two groups of lights. If the runway width is less than 100 feet, each group contains not less than three lights uniformly spaced. A gap of at least 40 feet is provided between the two groups of lights when the runway width is less than 100 feet. In either of the above cases, locate the outermost threshold and runway end light combination in each group in line with the rows of runway edge lights.

d. Displaced Threshold.

(1) The lighting of displaced thresholds is more than simply relocating lights. Consider all phases of operations on a runway before determining the lighting requirements.

(2) When the threshold is displaced from the extremity of the runway, make the threshold lighting a line of lights outboarded on each side of the runway. Extend these lights at least 40 feet outward from and at right angles to the line of runway lights. If the area created by the displaced threshold is usable for specific operations (take-off only, taxiing) and denied for others, light it to indicate the correct signal to the pilot for the operation. Light denied and unusable areas by adding split-colored filters and/or obscuring portions of light fixtures. The fixtures indicate a green signal at the threshold area; a red signal to denote end of runway and for denied areas; a white signal for usable runway areas, except a yellow signal is substituted for the white signal on the last 2,000 feet of an instrument runway to indicate a caution zone; and a blue signal for usable taxiing areas. Typical examples of displaced threshold lighting are shown in Figures 2 and 3 of Appendix 2.

4. DESIGN.

a. General. Coordinate the lighting system design with the airport paving and drainage. The drainage design may influence the lighting ducts and cable installations. If the lighting system design is coordinated with the paving design, the required conduits and duct can be provided under the paved areas. The number and size of ducts should be adequate for both present and future systems. It is extremely expensive to increase the number of ducts under an existing paved area.

b. Electrical Power. The high intensity lighting system may be designed for a 6.6-ampere or a 20.0-ampere series primary circuit depending on the KW load involved and the length of the homerun cables. The 6.6-ampere primary circuit is preferred due to the excessive line loss inherent with a 20.0-ampere circuit. A light fixture installed in an intersection, paragraph 3b(3)(a), requires a 300-watt insulating transformer with a 20.0-ampere output. All other lamp loads in the series circuit are supplied through either 6.6/6.6-ampere or 20.0/6.6-ampere, 200-watt insulating transformers. Figure 4, Appendix 2, may be used to estimate the total power requirements for a series circuit and the size cables required. See Figures 5 and 6 for typical configuration and fixture wiring diagrams, respectively.

c. Electrical Control.

(1) Typical wiring details are shown in Figures 7 and 8, Appendix 2, for regulators with external remote primary oil switch and internal control power and primary oil switch, respectively. See Figure 9 for procedures for ganging the controls of regulators and Figure 11 for interfacing stepless regulator with step type control.

(2) See Figure 10 for curves for estimating the maximum physical distance recommended between the control panel and regulator.

(3) Provide adequate spare wires in the control cables to permit the addition of new circuits after the initial installation. Spare wires are also useful for maintenance purposes. If trouble is experienced in the control wires between the control tower and vault, the components in the circuit can be connected to the spare wires.

(4) Provide lightning protection for control cables.

d. Ducts. Utilize the design considerations for duct systems contained in Item L-110 of Advisory Circular 150/5370-1A, Standard Specifications for Construction of Airports. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and interferences are avoided.

e. Vaults. Utilize design considerations for vaults and transformer housings contained in Item L-109 of Advisory Circular 150/5370-1A. Provide at least 2 square feet net vent area per 100 KVA installed transformer capacity in the vault where the 24-hour average ambient temperature does not exceed 86°F. If the average ambient temperature exceeds 86°F., auxiliary means should be provided for removing excess heat.

f. Code. The installation should conform with the National Electrical Code and local code requirements.

g. RVR. Where runway visual range (RVR) equipment is to be installed, provide two No. 12 AWG wires for 120-volt control, or two No. 19 wires if 48-volt control is used, between the control tower and the vault. The ends of the wires are taped or sealed until connections are to be made. This seal prevents the entrance of moisture. The

wires in the vault connect to an interface unit provided with the RVR equipment. The wires in the tower connect to RVR equipment. All connections are made by personnel responsible for the RVR in accordance with instructions provided with the system.

5. EQUIPMENT AND MATERIAL.

a. General.

(1) Equipment and material covered by the Federal Aviation Administration specifications are specified by advisory circular numbers.

(2) 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 specifications conform to the applicable standards of the electrical industry.

b. Light Fixtures. The fixtures are furnished unassembled ready for assembling and installation on a base.

(1) The elevated edge lights and the combination threshold and runway end lights conform to the requirements of Advisory Circular 150/5345-9C. The light consists essentially of an optical system, lamp, lampholder mounted in a suitable housing, and a mounting assembly.

(2) The semiflush light fixtures used in intersections conform to the requirements of Advisory Circular 150/5345-19, Type I unit. The unit consists of an optical system, housing, lampholder, connecting leads, and connectors. Provisions are made for metal-to-metal contact of the fixture with the supporting base.

c. Insulating Transformers.

(1) These transformers serve as a means for isolating the light unit from the high voltage characteristics of the series circuit.

(2) The transformers used with Advisory Circular 150/5345-19, L-838 Type I, semiflush light units conform to the requirements of Advisory Circular 150/5345-34, L-839, 6.6/20 amperes.

Transformers used with Advisory Circular 150/5345-9C, L-819 light units conform to Advisory Circular 150/5345-22, L-834, 6.6/6.6 amperes or Advisory Circular 150/5345-33, L-844, 20/6.6 amperes.

d. Bases. The bases conform to the requirements of Advisory Circular 150/5345-42. The light fixtures are mounted on the bases. The bases also serve as an insulating transformer housing. The light base and transformer housing consist of a cylindrical body with top flange and cable entrance hubs. Requirements for an internal grounding lug and a plug drain hole in the bottom of the base are included which may be optionally specified by the user. This internal grounding lug is used where bases are interconnected with the duct and the ground wire is installed through the duct system. See Figure 6 for the application of the Advisory Circular 150/5345-42, Type I and Type II bases.

e. Regulator. The constant current regulator conforms to the requirements of Advisory Circular 150/5345-10C. The regulator is designed for step brightness control without interrupting load current. The assembly has lightning arresters, open circuit and overcurrent protecting devices, and a local control switch included as part of the equipment. All parts are suitably enclosed for indoor or outdoor service. The equipment is wired at the factory as a complete assembly. Various sizes and ratings may be obtained in accordance with the specification requirements.

f. Control Panel. The remote control panel conforms to the requirements of Advisory Circular 150/5345-3B. The panel consists of a top panel plate and a housing. In addition, it has toggle switches, terminal boards, and brightness control, as required. The number of components to be mounted on the panel are specified when the equipment is ordered.

g. Auxiliary Relay Cabinet. An auxiliary relay cabinet assembly conforming to Advisory Circular 150/5345-13 is required when 48-volt DC control is used. The assembly consists of an enclosure containing a DC power supply, control circuit protection, and 20 pilot relays.

h. Cables.

(1) Primary Cable. The primary cable conforms to the requirements of Advisory Circular 150/5345-7B.

(2) Control Cable. Control cable containing No. 12 AWG wires conforms to the requirements of Advisory Circular 150/5345-7B. The control cable containing No. 19 AWG wires conforms to the requirements of Rural Electrification Administration Bulletin 345-14.

i. Connectors. Connectors attached to the transformer primary and secondary leads for splices conform to the requirements of Advisory Circular 150/5345-26A.

j. Tapes. Plastic electrical insulating tape is the type specified in Item L-108 of Advisory Circular 150/5370-1A. Rubber and synthetic rubber tapes conform to industry standards.

k. Conduit and Duct. Conduit and duct conform to those specified in Item L-110 of Advisory Circular 150/5370-1A.

l. Concrete. Concrete and reinforcing steel conform to the applicable provisions of Item P-610 of Advisory Circular 150/5370-1A.

6. INSTALLATION.

a. General. Install cable, vault and vault equipment, and underground electrical duct as specified in Items L-108, L-109, and L-110, respectively, of Advisory Circular 150/5370-1A.

b. Light Base and Transformer Housing.

(1) The base for the elevated light unit is installed on undisturbed soil at the specified location. If the soil is unsuitable, then an adequate depth of soil should be removed and replaced with acceptable material. The cable entrance hubs are oriented in the proper direction. With the base properly oriented and held at the proper elevation, place approximately 4 inches of concrete backfill around the outside of the base. The top of the concrete is sloped away from the flange portion of the base so the sloped outer edges of the concrete are at surface grade.

(2) The base for the semiflush fixture is supported in the leave-out or excavated area in a position as shown in Figure 12. The concrete backfill around the outside of the base is approximately 4 inches. Orient the cable entrance hubs on the base properly prior to placing the concrete backfill.

c. Light Fixtures.

(1) Assemble, level, and adjust the light fixtures in accordance with the manufacturer's instructions. The fixtures are leveled and aligned within 1 degree. The maximum height of the top of the fixture is 14 inches from the finished grade.

(2) Assign an identification number to each light unit. Install the numbers by one of the following methods:

(a) Stencil numbers with black paint on the runway side of the base plate. The minimum height of the numbers is 2 inches.

(b) Attach a noncorrosive disc with permanent numbers to the fixture. The minimum height of the numbers is 2 inches.

(c) Impress numbers on a visible portion of the concrete backfill. The minimum height of the numbers is 3 inches.

d. Cable.

(1) Install the cables between the regulator and control panel and the regulator and field circuits in accordance with the requirements of Item L-108 of Advisory Circular 150/5370-1A.

(2) Install the primary cable in the light base and transformer housing as shown in the plans. If specified, the cable entrance is sealed with squeeze connectors. Provide squeeze connectors similar and equal to Crouse Hinds Type CGK, with a rubber bushing of the correct size to fit the outside diameter of the cable. Tighten the connectors to provide a watertight seal without deforming the insulation and sheath of the cable.

(3) Provide slack cable inside the light base and transformer housing to permit connections of the primary cable and the insulating transformer primary leads to be made above ground. Connect the transformer secondary leads to the lamp leads with a disconnecting plug and receptacle. The secondary connection is not taped. Make the taped cable connections to the insulating transformer's leads as specified in Item L-108 of Advisory Circular 150/5370-1A. Wrap the connector joints in the primary circuit 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.

(4) Tape or seal ends of cables until the splice is made to prevent the entrance of moisture.

e. System. Typical fixture and duct details are shown in Figure 5, Appendix 2.

7. INSPECTION.

a. Inspect each light fixture to determine that it is installed correctly, at the proper height, and in line with the other fixtures.

b. Check the light fixtures' lenses to determine that the glassware is properly oriented with respect to the runway longitudinal sides and the threshold. Check threshold lights for alignment.

c. Check the identification number for each light unit to determine that the number at the installation is as assigned in the plans.

d. Check equipment covered by FAA specifications to determine if the manufacturers have supplied approved equipment. The equipment is also checked for general conformance with specification requirements.

e. Inspect all cables, wiring, and splices to obtain assurance that the installation is in accordance with Advisory Circular 150/5370-1A, National Electrical Code, and local codes. Inspect and test insulation resistance of underground cables before backfilling.

f. Check all ducts and duct markers to determine that the installation is in accordance with Advisory Circular 150/5370-1A. Inspect underground ducts before the installation is completed.

g. Check the input voltage at the regulator's power and control circuits to determine that the voltage is within limits required for proper equipment operation.

h. Check fuses and circuit breakers to determine if they are of the proper rating.

i. Check base plate for damage during installation and refinish according to manufacturer's instructions.

8. TESTS.

a. Test the installation by operating the system continuously for at least one-half hour. In addition, operate each control not less than 10 times.

b. Test the completed circuits in accordance with the requirements of Item L-108 of Advisory Circular 150/5370-1A. This includes testing the insulation resistance of circuit conductors. Minimum acceptable resistance to ground is 50 megohms.

c. Test the vault equipment as specified in Item L-109 of Advisory Circular 150/5370-1A. This test includes a check to determine that the resistance to ground of any part of the grounding system will not exceed 10 ohms.

d. Subject the regulators and other applicable equipment to performance tests specified in the manufacturer's instructions for the initial installation.

9. MAINTENANCE.

a. General. A maintenance program is necessary at airports with high intensity runway edge lights to insure proper operation and dependable service from the equipment. Although the system may be of the highest order of reliability, its effectiveness will soon depreciate unless it is properly maintained.

b. Operational Check. Make a daily operational check of all lighting fixtures. If any lamps are out, the locations of the fixtures are recorded and the lamps replaced at a time when the fixture is deenergized. The lamp socket and electrical contacts should be checked before replacing the lamp and reenergizing the system.

c. Lens. Check the light fixture lens periodically to determine if the glassware has been cracked or pitted beyond use by debris. Clean the lens periodically to permit the units to operate at maximum efficiency. The regularity and type of cleaning will be dictated by local conditions. Check lens for alignment.

d. Snow Removal. Remove snow from around the lighting fixtures as soon as possible after a snowfall to prevent obscuring the light fixtures. Maintenance personnel should familiarize themselves with local agreements regarding snow removal and govern themselves accordingly.

e. Bases. The high intensity fixture and base installation are designed to exclude both ground and surface water from entering the base. For varying reasons, small amounts of water sometimes enter and can become a serious problem, particularly where temperatures below freezing are encountered. If the bases are allowed to fill with water, freezing may result that can cause damage. To prevent this damage, establish a regular maintenance schedule to inspect each base for the presence of water especially during the fall and winter months. A regular schedule for tightening cover holddown bolts is recommended. If any of the bases contain water, remove the water and replace gasket if necessary. The use of a base with a drain hole in the bottom may eliminate this problem in some areas.

f. Grass. Establish a regular schedule for removing grass or other vegetation near the lighting fixtures.

g. Cable. Check the initial condition of homerun cables with a insulation resistance tester. Keep records of the initial resistance values. Check the condition of the system periodically by comparing monthly resistance readings with the initial values. In an acceptable system, the initial megohm resistance values are not less than 50 megohms. If the monthly resistance checks reveal progressive deterioration or faults, take corrective steps promptly. The most common faults in series underground cables are opened or grounded circuits.

(1) Perform monthly insulation resistance checks by deenergizing the regulator, disconnecting the series cable leads at the regulator, and connecting one lead of the resistance instrument to the series cable and the other lead to a proven ground.

(2) Advise maintenance personnel that high open circuit voltage may be present when the secondary of an energized series lighting regulator is opened.

h. Spare Parts. Stock adequate spare parts for maintenance purposes. See individual manufacturers' instructions for recommended comments. At least 10 percent spare lamps should be available with the initial installation.

i. Vault. Keep the vault (Advisory Circular 150/5370-1A, Item L-109) clean and uncluttered to prevent dirt from accumulating in control compartments and to allow equipment to be accessible at all times. Make warning signs legible and mount them in conspicuous locations. An "as constructed" electrical diagram of the lighting system should be displayed in the vault. Protect the diagram with glass, plastic or other transparent material.

APPENDIX 1. BIBLIOGRAPHY

1. Obtain copies of the following Federal Aviation Administration publications from the Department of Transportation, Distribution Unit, TAD-484.3, Washington, D.C. 20590.

   a. Advisory Circular 150/5345-1C, Approved Airport Lighting Equipment.

   b. AC 150/5345-3B, Specification for L-821 Airport Lighting Panel for Remote Control of Airport Lighting.

   c. AC 150/5345-7B, Specification for L-824 Underground Electrical Cables for Airport Lighting Circuits.

   d. AC 150/5345-9C, Specification for L-819 Fixed Focus Bidirectional High Intensity Runway Light.

   e. AC 150/5345-10C, Specification for L-828 Constant Current Regulator.

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

   g. AC 150/5345-19, Specification for L-838 Semiflush Prismatic Airport Light.

   h. AC 150/5345-22, Specification for L-834 Individual Lamp Series-To-Series Type Insulating Transformer for 5,000-Volt Series Circuit.

   i. AC 150/5345-26A, Specification for L-823 Plug Receptacle, Cable Connectors.

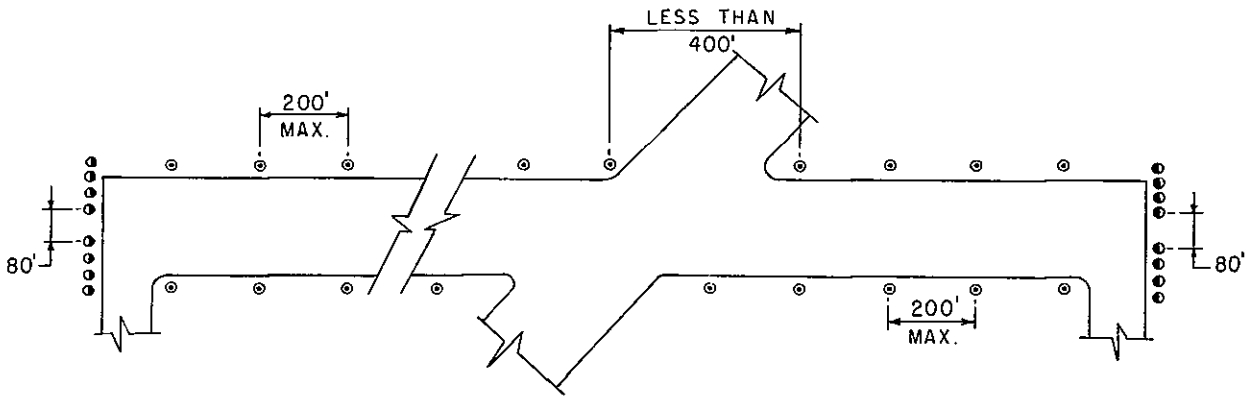
   j. AC 150/5345-33, Specification for L-844 Individual Lamp Series-To-Series Type Insulating Transformer for 5,000-Volt Series Circuit 20/6.6 Amperes 200 Watt.

   k. AC 150/5345-34, Specification for L-839 Individual Lamp Series-To-Series Type Insulating Transformer for 5,000-Volt Series Circuit 6.6/20 Amperes 300 Watt.

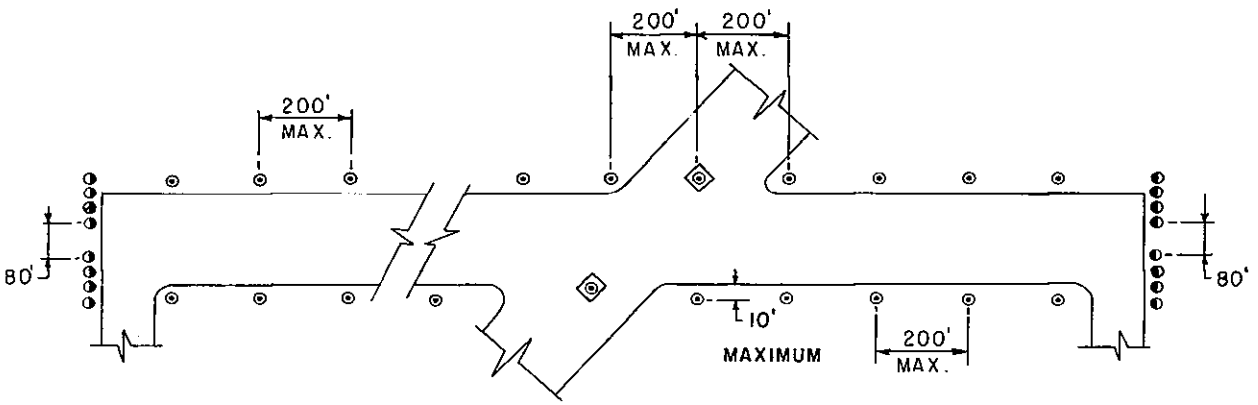
   l. AC 150/5345-42, FAA Specification L-857, Airport Light Bases, Transformer Housing, and Junction Boxes.

2. Obtain copies of AC 150/5370-1A, Standard Specifications for Construction of Airports, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Send check or money order with your request made payable to the Superintendent of Documents in the amount of $3.50 for each copy. No c.o.d. orders are accepted.

3. Obtain copies of Rural Electrification Administration (REA) Bulletin 345-14, REA Specification for Fully Color-Coded, Polyethylene Insulated, Double Polyethylene-Jacketed Telephone Cables for Direct Burial, from the U.S. Department of Agriculture, Rural Electrification Administration, Information Services Division, Washington, D.C. 20250.



APPLICATION OF SINGLE ELEVATED LIGHTS



APPLICATION OF SINGLE ELEVATED LIGHTS AND SEMIFLUSH LIGHTS

LEGEND:

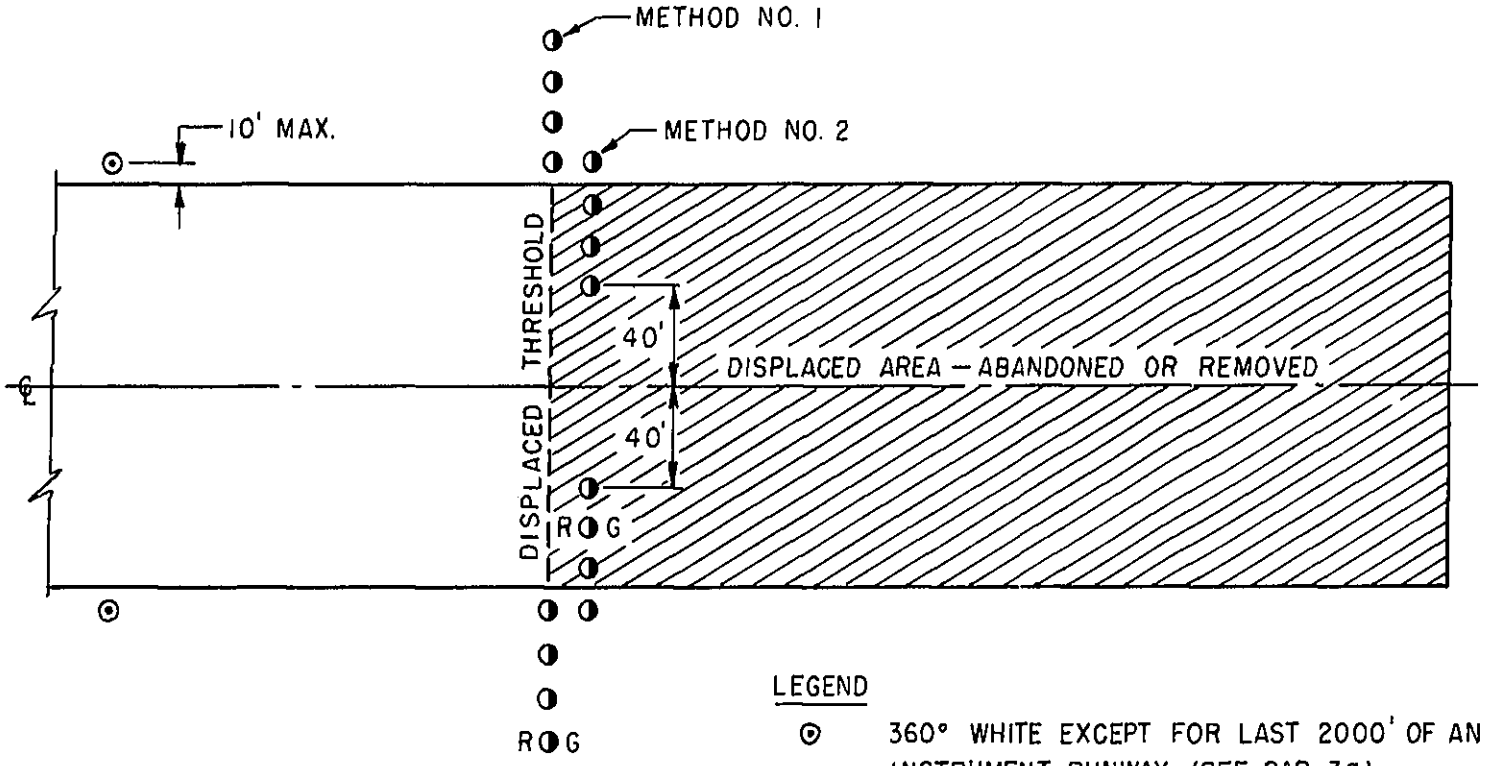
⊙--- 360° WHITE, EXCEPT FOR THE LAST 2,000' OF THE INSTRUMENT RUNWAY (SEE PAR 3a)

R◐G--RED 180° AND GREEN 180°

◈-- SEMIFLUSH FIXTURE BIDIRECTIONAL WHITE

NOTE: SPACING OF ALL LIGHTS IN ACCORDANCE WITH PARAGRAPH 3, PAGE 1.

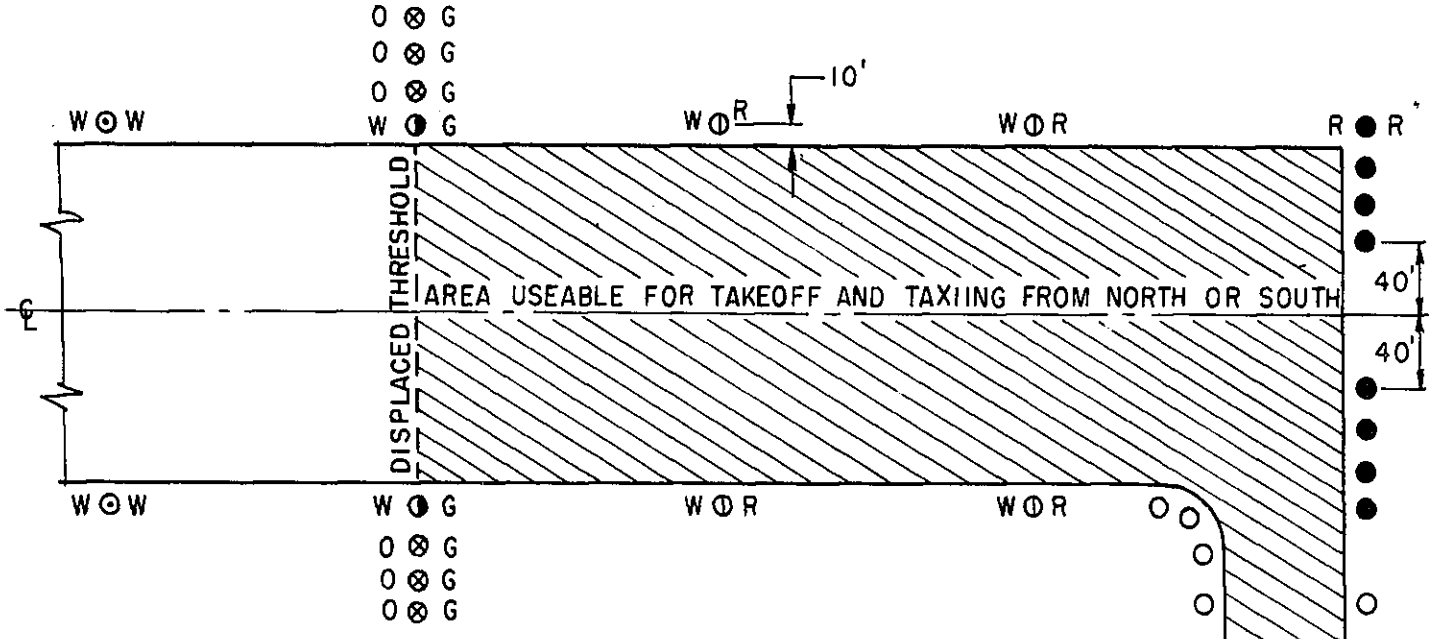
FIGURE 1. TYPICAL HIRL CONFIGURATIONS



NOTES:

1. METHOD NO. 1 FOR ABANDONED AREA WHERE PAVED AREA IS LEFT IN PLACE.
2. METHOD NO. 2 FOR ABANDONED AREA WHERE PAVED AREA IS REMOVED.
3. SPACING OF RUNWAY LIGHTS SHALL BE IN ACCORDANCE WITH PAR 30.
4. ALL LIGHTS ARE ELEVATED.

FIGURE 2. DISPLACED THRESHOLD - UNUSABLE AREA ABANDONED OR REMOVED



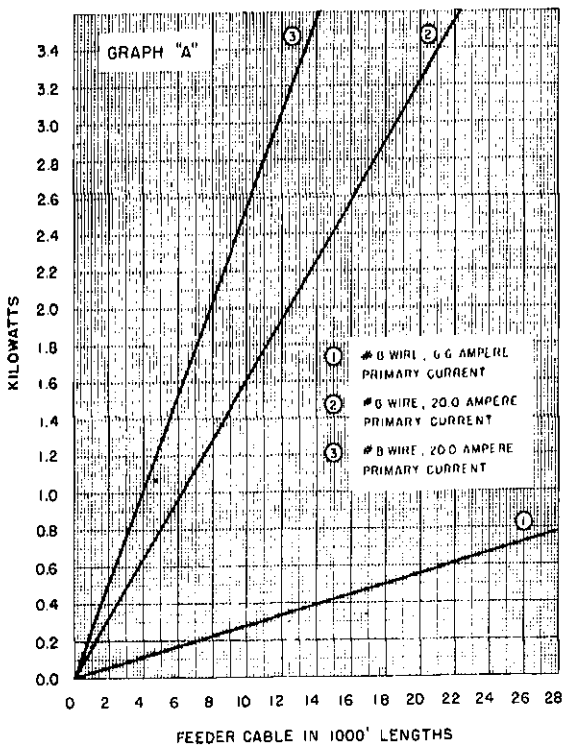
LEGEND

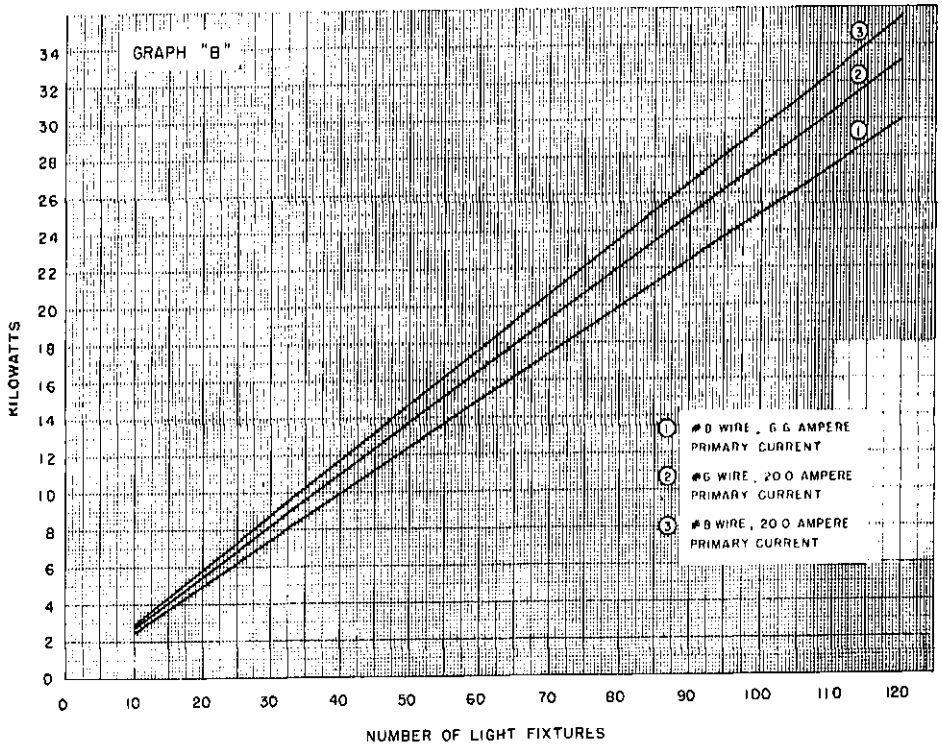
O	360° BLUE
W ◑ R	180° WHITE AND 180° RED } EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY (SEE PAR-3a).
⊙	360° WHITE EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY (SEE PAR-3a).
●	360° RED
O ⊗ G	180° OBSCURED AND 180° GREEN
W ◑ G	180° WHITE AND 180° GREEN } EXCEPT FOR LAST 2000' OF AN INSTRUMENT RUNWAY (SEE PAR.-3a).

NOTES:

1. SPACING OF RUNWAY LIGHT SHALL BE IN ACCORDANCE WITH PARAGRAPH 3a.
2. SPACING OF TAXIWAY LIGHTS SHALL BE IN ACCORDANCE WITH AC 150/5340-15B.
3. ALL LIGHTS ARE ELEVATED.

FIGURE 3. DISPLACED THRESHOLD - AREA USABLE FOR TAXIING AND TAKEOFF





HOW TO DETERMINE TOTAL LOAD

1. Multiply the distance between the vault and the runway by 2 to get the length of the feeder cable. Determine the KW power required for the feeder cable by getting the coordinate point on the applicable kilowatt-feeder cable line of GRAPH "A".
2. Determine KW power required for the number of fixtures to be installed by getting the coordinate point on the applicable kilowatt-number of light fixtures line of GRAPH "B". Curves based on use of 200W lamps.
3. Add kilowatts obtained from GRAPHS "A" and "B" to determine the total KW load required.

FIGURE 4. CURVES FOR ESTIMATING LOADS IN HIGH INTENSITY SERIES CIRCUITS

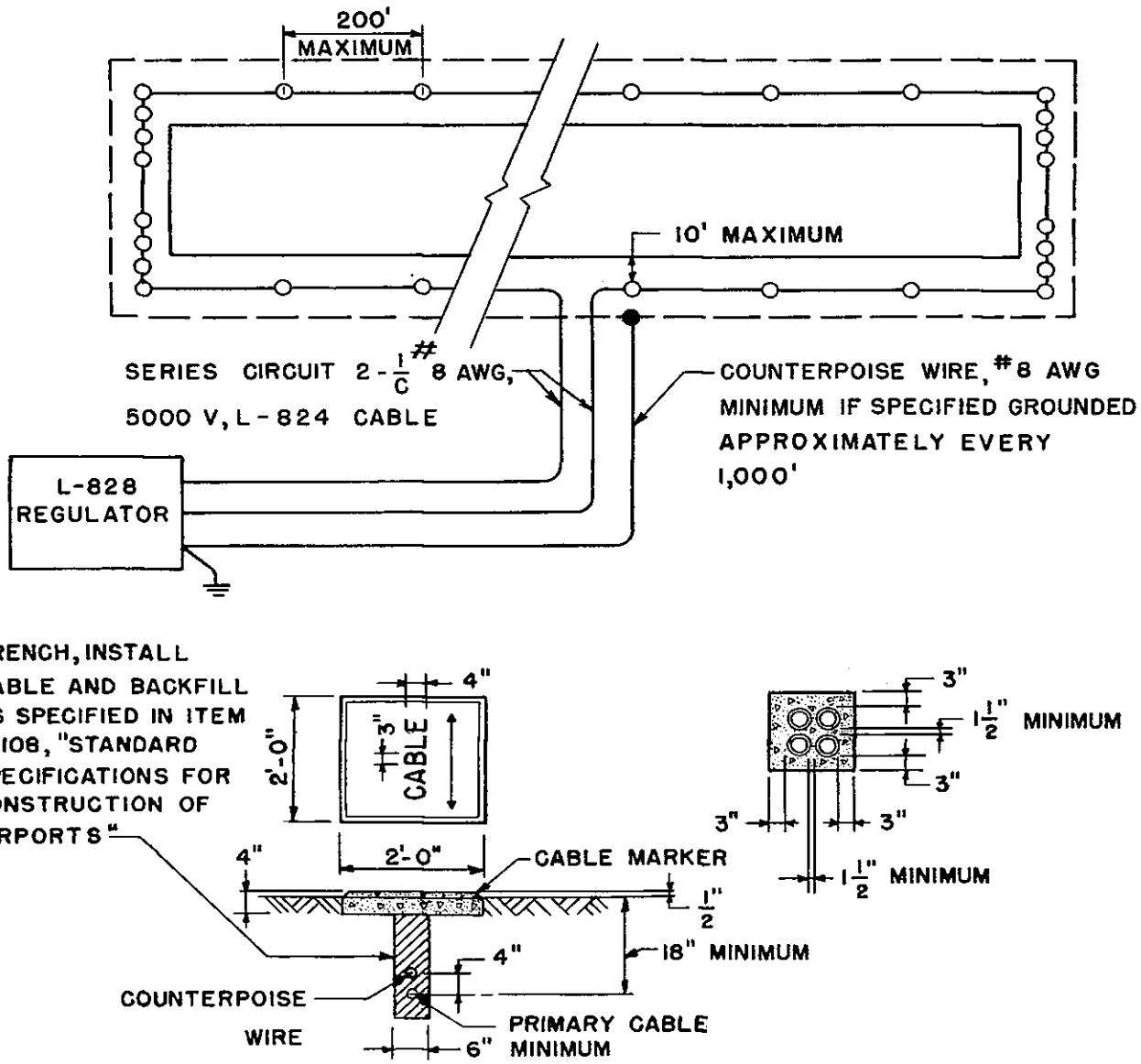


FIGURE 5. TYPICAL LIGHTING CONFIGURATION WIRING DIAGRAM

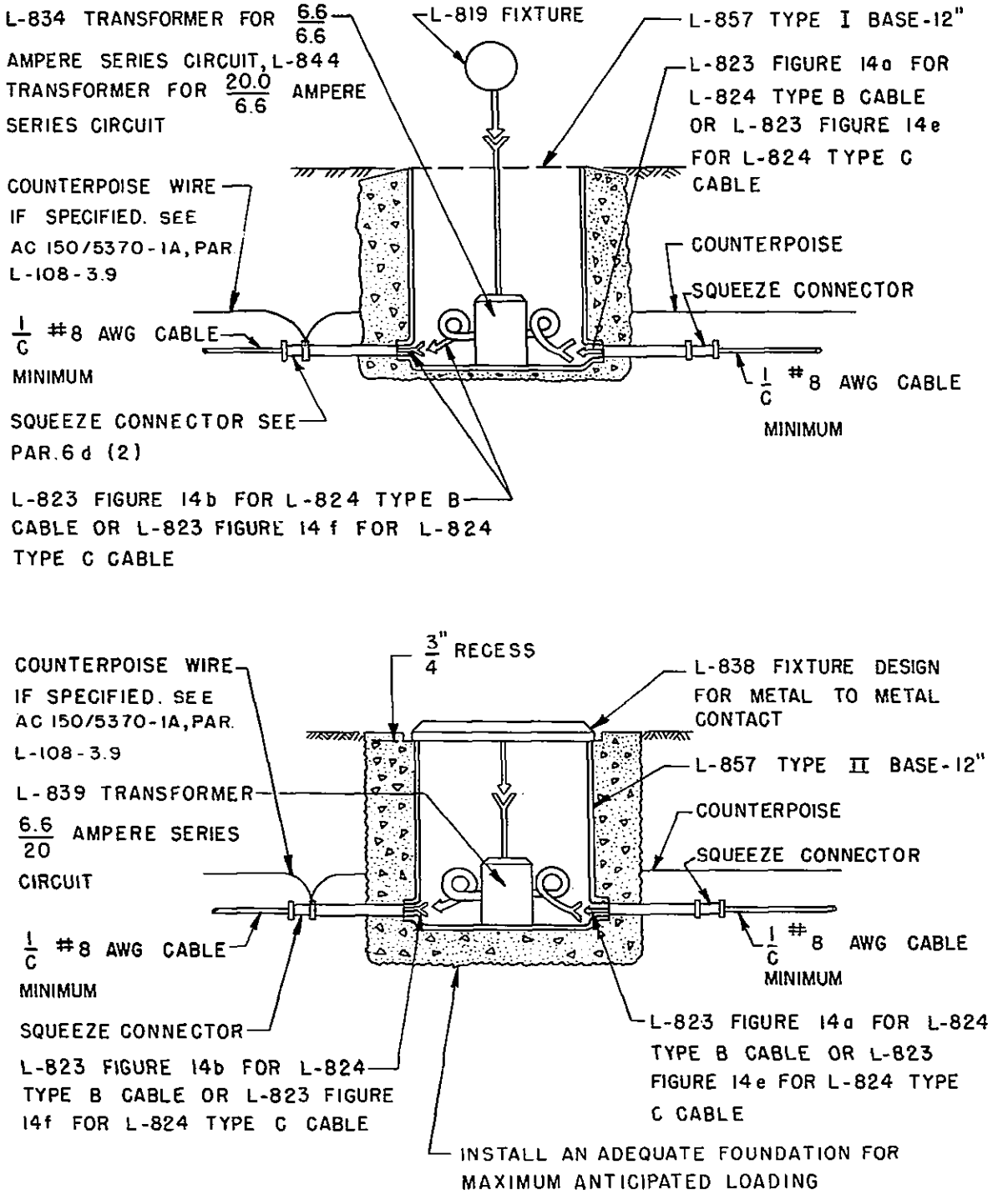
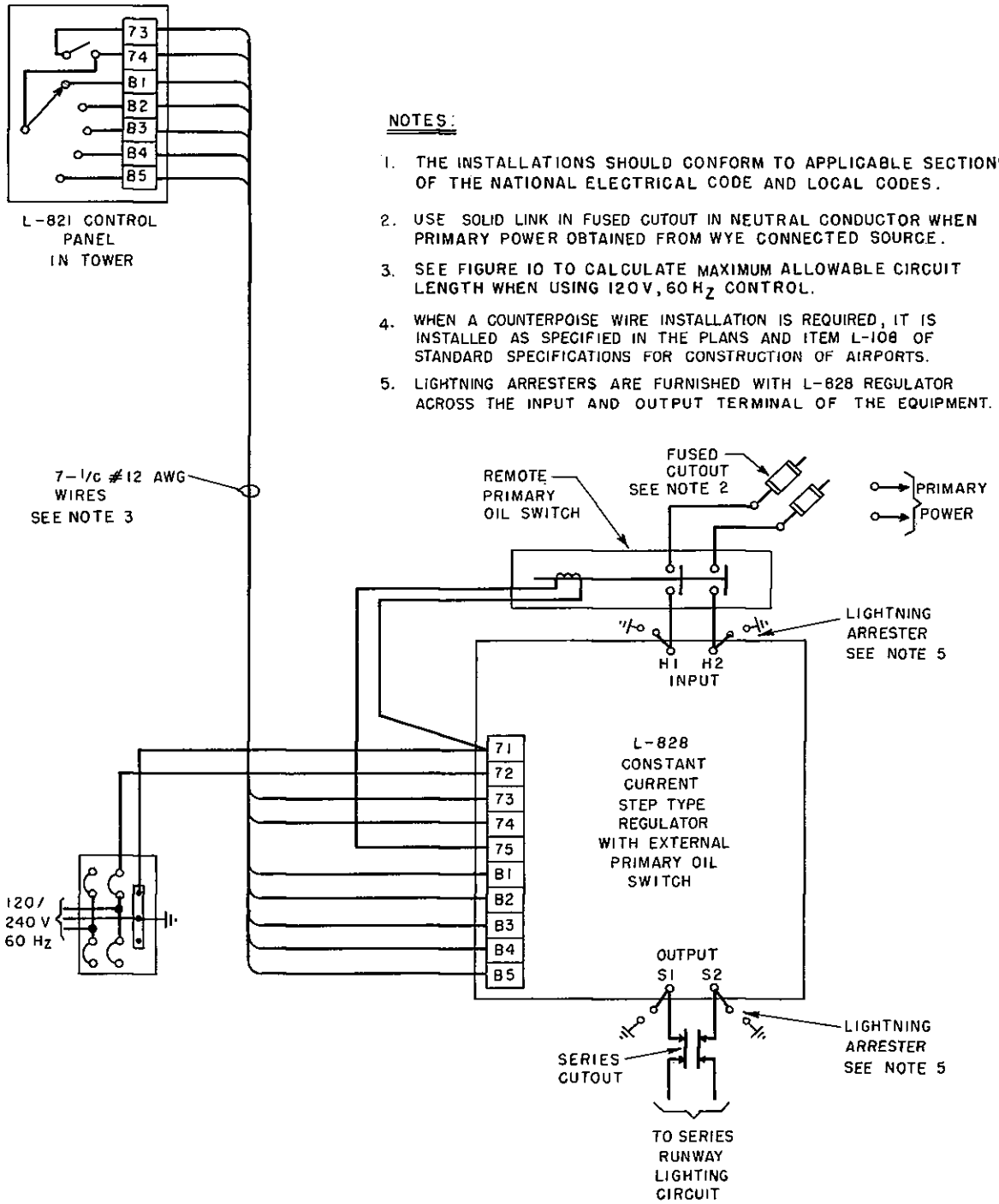


FIGURE 6. TYPICAL FIXTURE, TRANSFORMER AND BASE INSTALLATION DETAILS



NOTES:

1. THE INSTALLATIONS SHOULD CONFORM TO APPLICABLE SECTIONS OF THE NATIONAL ELECTRICAL CODE AND LOCAL CODES.
2. USE SOLID LINK IN FUSED CUTOUT IN NEUTRAL CONDUCTOR WHEN PRIMARY POWER OBTAINED FROM WYE CONNECTED SOURCE.
3. SEE FIGURE 10 TO CALCULATE MAXIMUM ALLOWABLE CIRCUIT LENGTH WHEN USING 120 V, 60 H_Z CONTROL.
4. WHEN A COUNTERPOISE WIRE INSTALLATION IS REQUIRED, IT IS INSTALLED AS SPECIFIED IN THE PLANS AND ITEM L-108 OF STANDARD SPECIFICATIONS FOR CONSTRUCTION OF AIRPORTS.
5. LIGHTNING ARRESTERS ARE FURNISHED WITH L-828 REGULATOR ACROSS THE INPUT AND OUTPUT TERMINAL OF THE EQUIPMENT.

FIGURE 7. TYPICAL HIRL WIRING DIAGRAM UTILIZING L-828 STEP-TYPE REGULATOR WITH EXTERNAL REMOTE PRIMARY OIL SWITCH

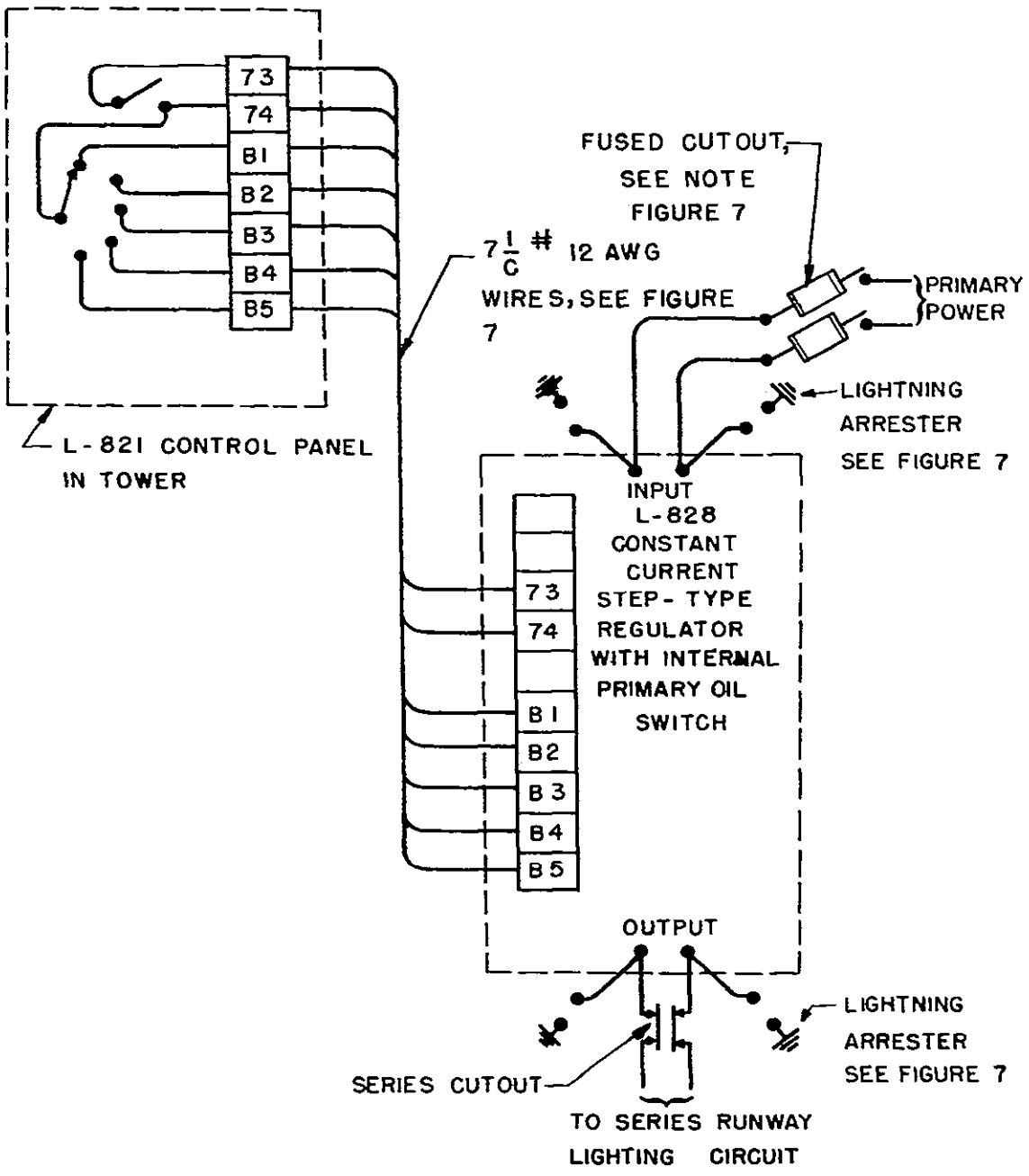


FIGURE 8. TYPICAL HIRL WIRING DIAGRAM UTILIZAING L-828 STEP-TYPE REGULATOR WITH INTERNAL CONTROL POWER AND PRIMARY OIL SWITCH

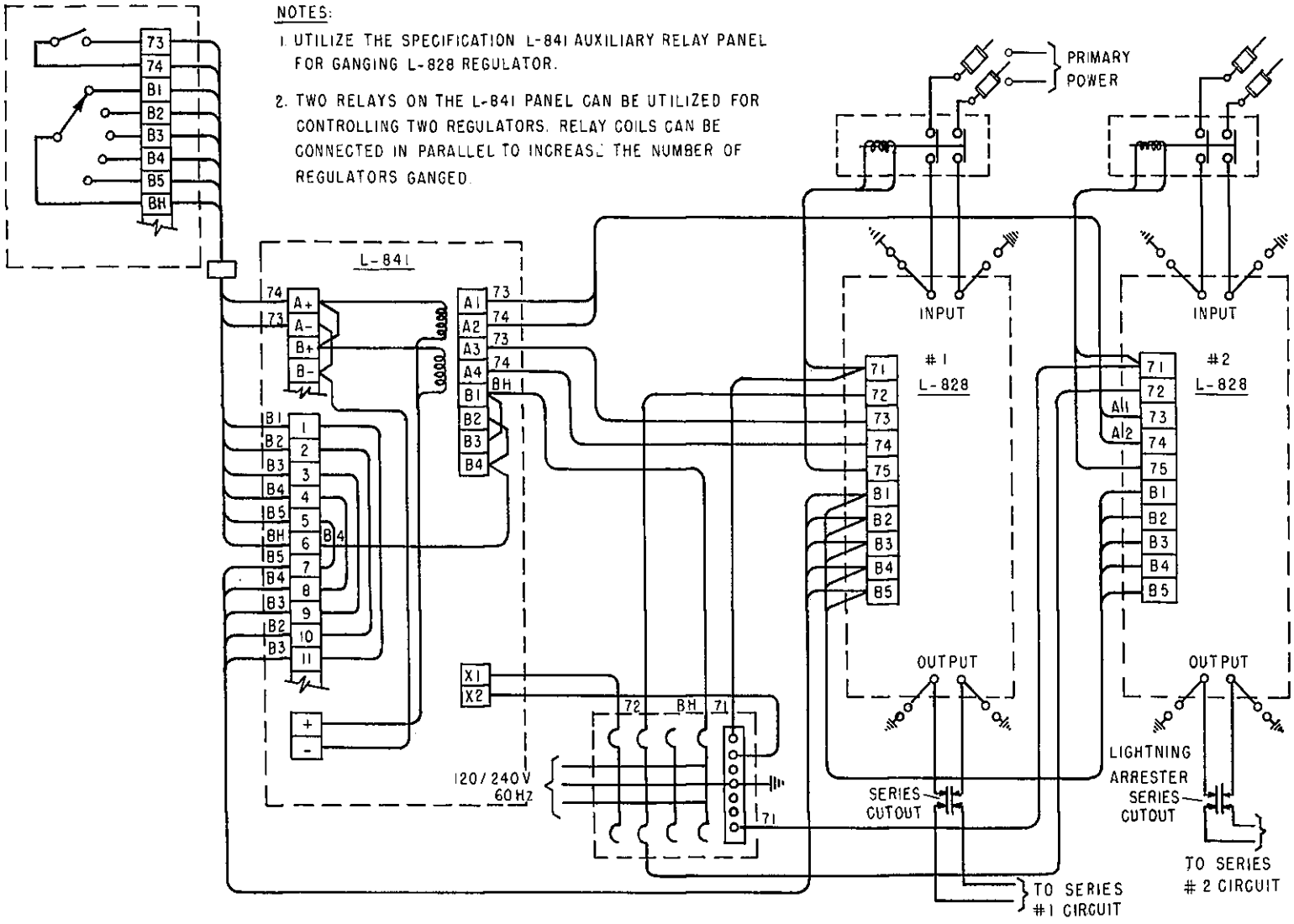


FIGURE 9. TYPICAL DETAILS FOR GANGING L-828 STEP-TYPE REGULATORS

HOW TO DETERMINE MAXIMUM PERMISSIBLE VOLTAGE DROP, 120-VOLT AC. CONTROL

1. DETERMINE ONE-WAY CIRCUIT LENGTH BETWEEN CONTROL PANEL AND REGULATOR.
2. FIND THE COORDINATE ON GRAPH OF VOLT DROP AND ONE-WAY CIRCUIT LENGTH.
3. SUBTRACT VOLTAGE DROP OBTAINED IN STEP 2 FROM THE AC VOLTAGE AVAILABLE IN THE VAULT AT THE REGULATOR'S CONTROL CIRCUIT TERMINALS.
4. THE VOLTAGE OBTAINED IN STEP 3 SHOULD BE 100 VOLTS OR GREATER FOR THE REGULATOR TO FUNCTION PROPERLY.
5. IF THE VOLTAGE OBTAINED IN STEP 3 IS LESS THAN 100 VOLTS, CONSIDERATION SHOULD BE GIVEN TO SELECTING AUXILIARY DC OR AC PILOT RELAYS.
6. THIS CURVE IS BASED ON A CIRCUIT WITH TWO NO.12 AWG WIRES INSTALLED BETWEEN THE CONTROL TOWER AND REGULATOR.
7. CURVE IS BASED ON THE TOTAL INRUSH CURRENT IN THE CIRCUIT ACROSS THE L-821 PANEL'S TERMINALS 73 AND 74 WILL NOT EXCEED I AMPERES

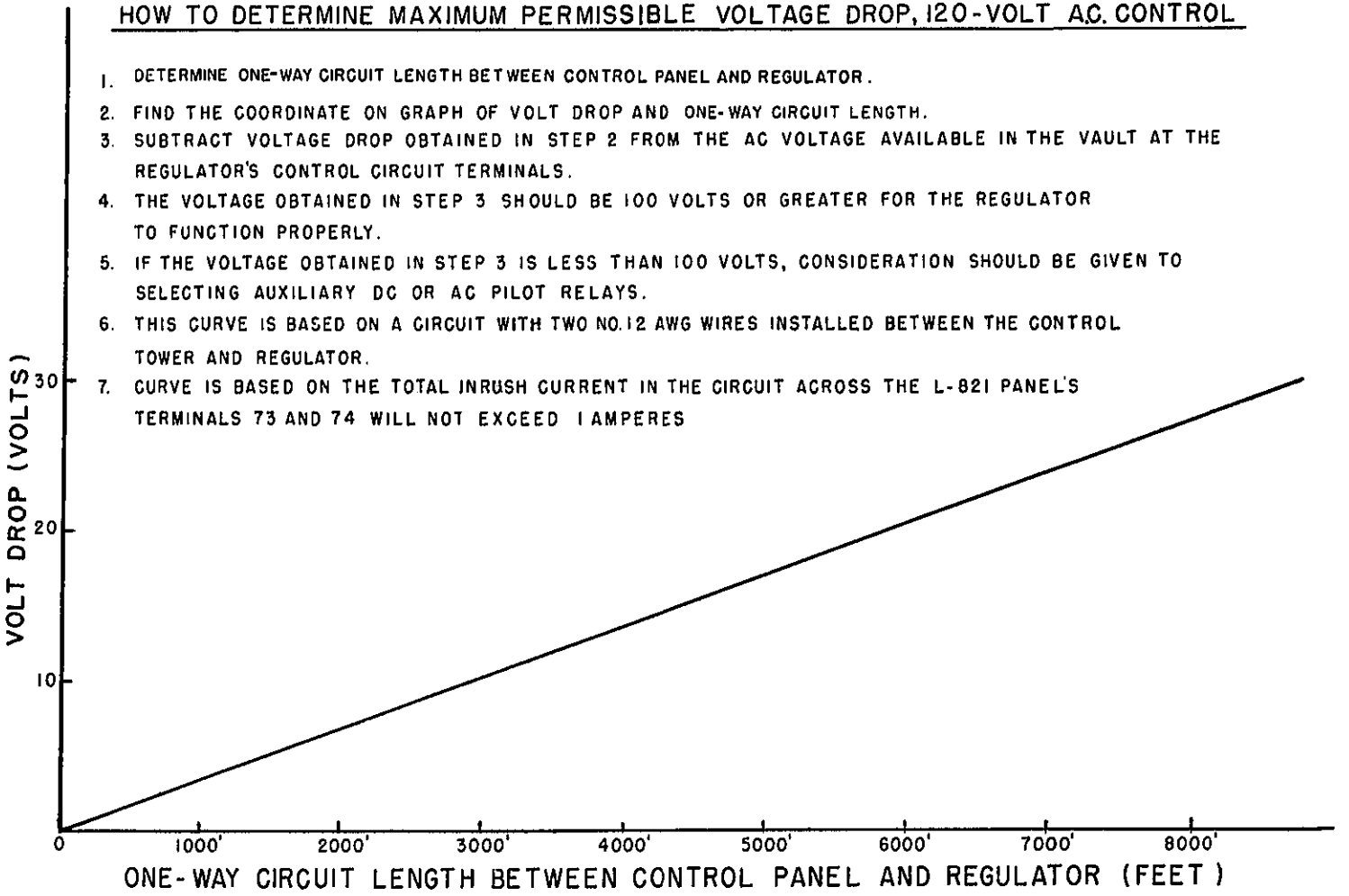


FIGURE 10. CURVE FOR ESTIMATING VOLTAGE DROP - 120-VOLT AC CONTROL

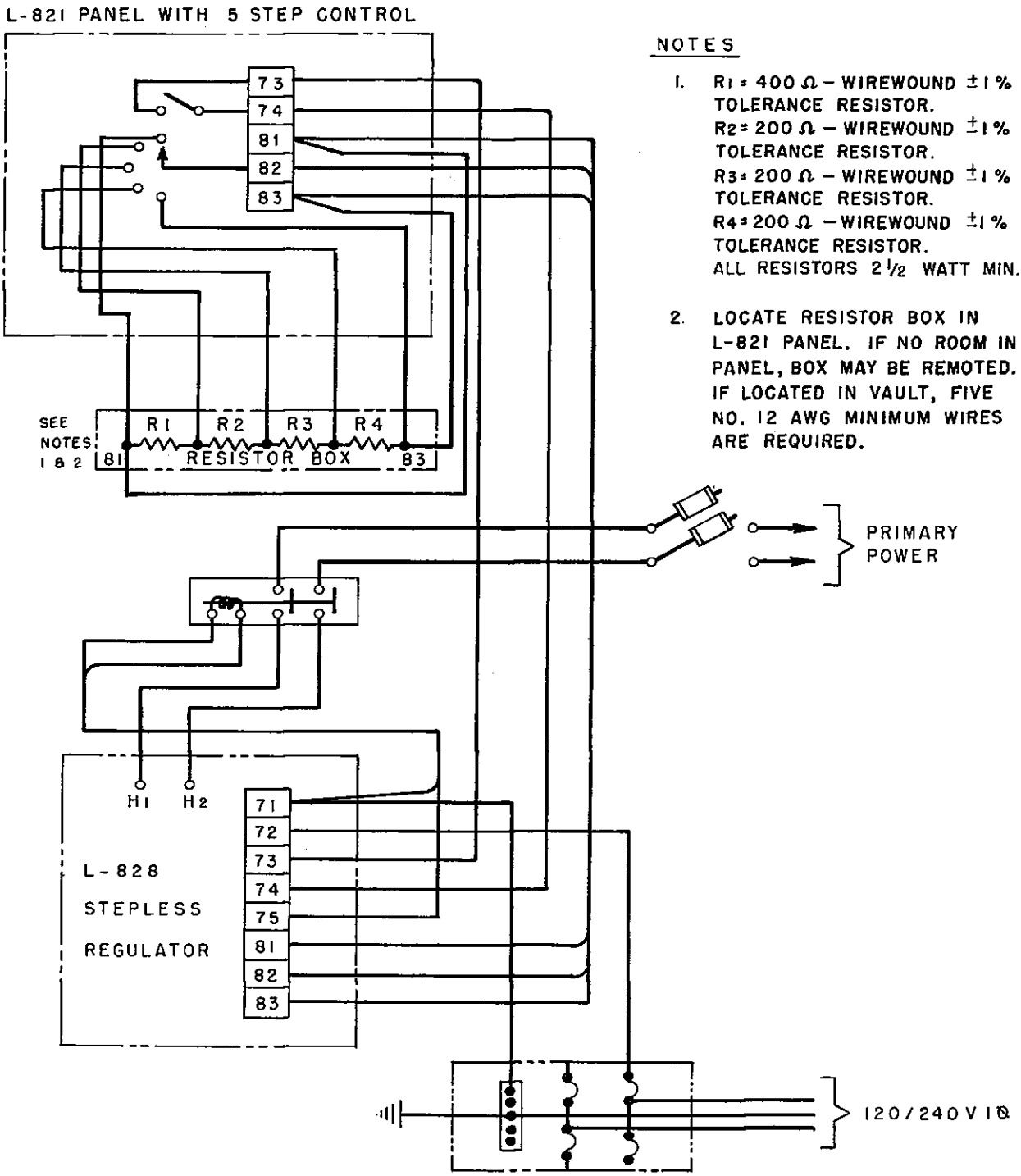


FIGURE 11. TYPICAL DETAILS FOR INTERFACING THE L-828 STEPLESS REGULATOR WITH STEP-TYPE CONTROLS

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