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Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 150/5340-14
AIRPORTS
EFFECTIVE: 6/30/65

SUBJECT: ECONOMY APPROACH LIGHTING AIDS

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1. PURPOSE. This advisory circular describes standards for the design, installation, and maintenance of economy approach lighting aids, i.e., medium intensity approach light system with sequenced flashing lights (MALS/SF) and runway end identifier light system (REILS). The abbreviated visual approach slope indicator system (AVASI) is discussed briefly in paragraph 3a(3). These standards are required for Federal-aid Airport Program projects.

2. REFERENCES. The following publications and drawing provide guidance and detailed technical information.

   a. AC 150/5340-9, Prefabricated Metal Housing for Electrical Equipment.

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

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

   d. AC 150/5345-24, Specification for L-849 Condenser Discharge Type Flashing Light.

   e. AC 150/5345-25, Specification for L-848 Medium Intensity Approach Light Bar Assembly.

   f. AC 150/5370-1, Standard Specifications for Construction of Airports, with Supplement No. 2.

   g. FAA Drawing No. D-5747-1 - Visual Approach Slope Indicator System Standard Layout and Installation Criteria.

3. INTRODUCTION.

a. Economy approach lighting aids are of several types:

(1) Medium Intensity Approach Light System With or Without Sequenced Flashing Lights (MALS/SF or MALS). If medium intensity lights are to be installed without sequenced flashing lights, only the applicable portions of the paragraphs for MALS/SF should be applied.

(2) Runway End Identifier Light System (REILS).

(3) Abbreviated Visual Approach Slope Indicator System (AVASI). Details of the AVASI are not covered in this Advisory Circular at this time. During the interim, a modification of the Visual Approach Slope Indicator System shown on Drawing No. D-5747-1, "Visual Approach Slope Indicator System Standard Layout and Installation Criteria", may be considered. The modified VASI consists of two light units. The two light units are located 50 feet from the left runway edge when the system is viewed from the approach zone. One light unit is in the upwind bar and the remaining unit in the downwind bar. The installation criteria for the equipment is shown on Drawing No. 5747-1.

b. The technical information required to plan and install a system is included in Figures 1 through 6. These are drawings of typical installations; local applications will require variations from the drawings, but the layout, spacing, and tolerances will apply. Although it is possible to plan an installation from the drawings, various characteristics affecting the systems and their design, equipment, and installation deserve special comments. These comments follow the discussion of selection considerations.

4. SELECTION CONSIDERATIONS. In the installation of economy approach lighting aids the following should be considered:

a. The airport's current operations and forecasts for three years indicate that the airport will not meet the criteria under the Agency's planning standards for the installation of an ILS/ALS, REIL, or VASI.

b. The runway to be served has at least a medium intensity runway lighting system.

c. If MALS/SF are to be installed, the airport should have assigned or the potential for a nonprecision instrument approach procedure.

d. MALS/SF and REILS are not installed on the same end of a runway. AVASI may be installed with either MALS/SF or REILS.

e. The selection of a particular system should be based on local needs and resources.

5. CONFIGURATION.

a. MALS/SF.

(1) In plan view, the system has a configuration of steady burning and flashing lights arranged symmetrically about and along the extended centerline of the runway. This system begins 200 feet from the runway threshold and terminates at a distance 1400 feet from the runway threshold.

(2) The system has seven stations. Each station has a bar with five steady burning lights and one flashing light. The station, 1000 feet from the runway threshold, has two additional bars (one on each side of the centerline bar) each with five steady burning lights.

(3) All lights in the system emit white light. The steady burning lights are controlled in intensity while the flashing lights are not so controlled.

(4) See Figure 1 for a layout drawing.

b. REILS.

(1) In plan view, the system has two flashing lights located at the end of the runway. The optimum location for the light sources is in line with the runway threshold 40 feet out on each side of the runway edge lights. This distance may be increased to 50 feet. The tolerance for alignment with the runway threshold is plus-or-minus 200 feet. The beam axis of each unit is oriented 15° outward from a line parallel to the runway centerline and inclined at an angle of 10° above the horizontal.

(2) The flashing lights emit white light and have no intensity control.

(3) See Figure 5 for a layout drawing.

6. DESIGN.

a. MALS/SF.

(1) MALS Controls. The steady burning lights are controlled with an "on-off" switch and an intensity control switch. Switches may be obtained for manual, automatic, or radio operation, the location and type of controls being determined by the operational requirements of the airport. The intensity control can be designed to give a high-low position (100 percent and approximately 10 percent of lamp brightness) or control in steps. If a 2-step (high-low) intensity control design is selected, the high position can be used for day and night instrument operations. The low position can be used for night visual flight rules operations. See Figures 2 and 3 for control wiring diagrams.

(a) Manual Switch. The manual "on-off" switch is a two position switch of the proper rating located at a remote or local control station. If 2-step brightness control is selected, a switch of the proper rating with two positions may be used in conjunction with a relay.

(b) Automatic Switch. The automatic "on-off" controls may be a standard industrial photoelectric or astronomic time control switch.

(c) Radio Control. The system may be designed to operate ("on-off") with radio controls. At some locations it might be desirable to set the intensity of the lights manually and use radio or automatic controls to turn the system on and off.

(2) SF Controls. The "on-off" operation of the sequence flashing lights may be controlled with a manual switch, automatic switch, or a radio-controlled switch. The sequencing of the lights is controlled by a master timer of the type shown on Figures 2 and 3. When the units are energized, a sequence of flashes is produced having the appearance of a flash of light traveling down the system from the outer end to the inner end twice a second.

(3) Wire Sizes. Minimum wire sizes required for primary circuits are calculated for each installation. Wire sizes for the control circuits follow the recommendations of the manufacturer of the power supply. If the arrester box (Figure 2) is

500 feet or less in a 240 volt single phase system, as shown, use at least No. 6 AWG wire for the MALS main power and feeder wire runs. See Figure 2 for a sample calculation of wire size determination. The timing wires from the master timer to the flashing lights are No. 19 AWG wires or larger. The wire size required for the main power and feeder wire runs in the primary circuit may be reduced by using a 240/480 volt, 3-wire system. The type of system to be used may have to vary because of airport design, layout, and availability of local electrical power.

b. REILS.

(1) Units can be obtained for connecting into a series runway lighting circuit which operates within the range of 2.8 through 6.6 amperes or 4.8 through 6.6 amperes. Units may also be obtained for connecting into a 120 volt AC ±5% multiple circuit, or a 240 volt AC ±5% multiple circuit.

(2) The REILS connected for series or multiple operation can be controlled by the methods listed below. The method selected depends on operational requirements at the airport.

(a) For multiple operation from a remote location, see Figure 5. The installation of two wires between the control point and equipment is required for this installation.

(b) Control can be provided at a local station for series or multiple units with a local control switch or by connecting an automatic timer, photocell, or radio control into the flasher control circuit (see Figure 5). These types of controls eliminate the cost involved in installing wires between the remote control station and the light units. (The local control switch should be included in the procurement specification.)

(c) The light units connected for series operation can be automatically controlled by the "on-off" operation of the runway circuit. Each time the runway circuit is energized, the control box (see Figure 5) either energizes or disconnects the two flashing lights. At airports having both runway ends equipped with a lighted visual approach aid, this type of automatic control is not recommended. Remote, manual, or radio control should be used or the light units should be connected to stay on when the runway lights are on.

(3) The two runway end identifier light units are flashed twice a second simultaneously at the end of the runway.

7. EQUIPMENT AND MATERIAL.

a. General.

(1) Equipment and material covered by FAA specifications are noted in paragraph 2, "References".

(2) Distribution transformers, oil switches, cutouts, relays, photocells, astronomic time control switches, radio controls, terminal blocks, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA specifications which conform to the applicable rulings and standards of the electrical industry are satisfactory.

b. MALS/SF.

(1) Approach Light Bar Assembly. The approach light bar assembly conforms to the requirements of AC 150/5345-25. It consists of a 2-inch standard pipe approximately 10 feet in length. This bar may have two diagonal metal pipe support braces. Five PAR 38, 120 volt or 240 volt, 150 watt spotlight lamps are spaced on the bar in adjustable lampholders. A junction box is furnished with each light bar assembly. An aiming device is furnished for the lighting system.

(2) Flashing Light. The condenser discharge type flashing light conforms to the requirements of AC 150/5345-24. Fittings are furnished with the light unit to permit attaching the optical system to the approach light bar assembly described in AC 150/5345-25. Provisions are made for adjusting and aiming the optical system. An aiming device is furnished for the lighting system.

(3) Master Timer. The master timer is part of and conforms to the requirements of AC 150/5345-24. The timer is capable of operating not less than 10 condenser discharge light units in sequence.

(4) MALS/SF Power Supplies.

(a) MALS. The power supply for medium intensity approach lights may be a 10 KW minimum, single phase, 60 cycles, variable output magnetic amplifier dimmer, subject to

approval by the engineer, or a high quality commercial tap transformer. If a tap transformer is used, it should be provided with a minimum of two brightness taps to give 100 percent and approximately 10 percent of the steady burning lamp intensity. Ten percent of the steady burning lamp intensity is obtained when the voltage across the lamp is 55 percent of rated value. A tap may be provided to give 50 percent rated lamp voltage in lieu of 55 percent. In addition, a tap is provided to obtain +5 percent of rated output voltage. This tap can be used for line loss compensation, if required.

(b) SF. The system power supply for the seven sequenced flashing lights is a high quality commercial distribution transformer with taps to give ± 5 percent of the rated output voltage. The output of the transformer has a rating of 120 VAC or 240 VAC. The transformer is capable of supplying at least 4 KW at the rated current and voltage.

(5) Prefabricated Metal Housing. A prefabricated metal housing for electrical equipment (AC 150/5340-9) may be used to house the system power supplies and other items shown in the enclosure on Figure 2.

(6) Lighting Arrester Box. The lightning arrester box should be of sturdy construction. The housing should hold its shape under normal methods of installation and field maintenance. The housing should be suitably protected for the service intended.

(7) Wires. The wire size for the MALS/SF primary circuit should be calculated for each installation. The wires from the master timer to the light units should be No. 19 AWG (or larger) wires.

(8) Main Junction Box. The main junction box, if required, is constructed as shown on Figure 4. The housing for the box is 11 gauge steel, galvanized by hot dipping.

(9) Concrete. Concrete and reinforcing steel conform to the applicable provisions of Item P-610 of "Standard Specifications for Construction of Airports", AC 150/5370-1.

c. REILS.

(1) Light Unit. The condenser discharge type light units conform to the requirements of AC 150/5345-24, "Specification for L-849 Condenser Discharge Type Flashing Light". Fittings are furnished with the equipment for installation of the optical system on a standard 2-inch pipe as shown on Figure 6.

(2) Field Control Box. A control box is furnished with the REILS (if specified with the order) to be connected into the series runway circuit. This box conforms to the requirements specified in "Specification for L-849 Condenser Discharge Type Flashing Light". The control box permits the REILS to be turned on or off by energizing or de-energizing the runway circuit.

(3) Remote Control. A single pole, single throw switch on an existing panel in accordance with AC 150/5345-3, "Specification for L-821 Airport Lighting Panel for Remote Control of Airport Lighting", may be used to control the REILS connected for multiple operation. If there is no existing panel, a single pole, single throw switch of the proper rating can be used.

(4) Local Control. The local control switch for the REILS is in accordance with "Specification for L-849 Condenser Discharge Type Flashing Light".

(5) Wires.

(a) Series Operation. The 3-1/c wires shown on Figure 3 between light units may be No. 12 AWG (minimum), 600 volt wires.

(b) Multiple Operation. The 4-1/c wires shown on Figure 3 between light units may be No. 12 AWG (minimum), 600 volt wires. The primary wires between the light units and the distribution transformer should be calculated for each installation. Calculations can be based on a 1 KW, 120 volt AC load or a 1 KW, 240 volt load, according to the type equipment specified for the installation. A sample calculation for line loss is shown on Figure 5.

(6) Concrete. Concrete and reinforcing steel conform to the applicable provisions of Item P-610 of "Standard Specifications for Construction of Airports", AC 150/5370-1.

8. INSTALLATION.

a. MALS/SF.

(1) Install MALS/SF lights at runway end elevation, preferably in a horizontal plane. See Figures 1 and 6.

(2) A maximum upward longitudinal slope tolerance of 2 percent may be utilized to place the light plane above objects within its area.

(3) A maximum downward slope of 1 percent may be utilized to reduce the height of supporting structures.

(4) Both steady burning and flashing lights are aligned with their beam axis parallel with the runway centerline and intercepting the established glide slope at a horizontal distance of 1600 feet in advance of the light.

(5) The location of the prefabricated metal housing for electrical equipment (AC 150/5340-9) is determined by the minimum overall cost of the system. This location should not constitute an obstruction as determined by applicable criteria. In no case is the prefabricated metal housing placed closer than 400 feet to the runway centerline extended when located between the runway end and the 1000-foot crossbar. Beyond the 1000-foot crossbar, the prefabricated metal housing may be located adjacent to the centerline bars provided its height is less than the height of the adjacent approach light bar.

(6) Primary circuit wires are installed and marked in accordance with applicable sections of Item L-108 of "Standard Specifications for Construction of Airports". The main wire runs and feeder wire runs may terminate in junction boxes as shown on Figure 2 and 4.

(7) The MALS light bar assemblies, flashing lights, prefabricated metal housing and equipment it encloses are adequately grounded. See Figure 6 for typical grounding and installation details.

(8) The MALS/SF equipment shall be assembled in accordance with the manufacturer's instructions.

b. REILS.

(1) The REILS are installed at the end of a runway in the configuration shown on Figure 5.

(2) Typical equipment grounding and installation details are shown on Figure 6.

(3) Primary wires for the multiple system are installed and marked in accordance with applicable sections of Item L-108 of "Standard Specifications for Construction of Airports".

(4) The REILS equipment is assembled in accordance with the manufacturer's recommendations.

9. TESTS.

a. General.

(1) Check to determine if installation meets the tolerances shown on Figures 1, 5, and 6.

(2) Check the alignment of all lighting fixtures.

(3) Inspect all electrical wiring before energizing the circuits to determine if the connections are tight and the wiring is in accordance with the plans for the installation.

b. Operational. The MALS/SF or REILS are tested in the manner prescribed under the applicable sections of Item L-108 of "Standard Specifications for Construction of Airports". Operate not less than ½ hour as a completed system prior to acceptance. Operate each control not less than 10 times.

c. Primary Cables. The primary cables are tested in accordance with the applicable sections of Item L-108 of "Standard Specifications for Construction of Airports".

10. MAINTENANCE.

a. General. A maintenance program is necessary at airports with MALS, MALS/SF or REILS to insure proper operation and dependable service. An improperly maintained system may cause equipment failure at a critical time or cause rapid deterioration of the systems effectiveness.

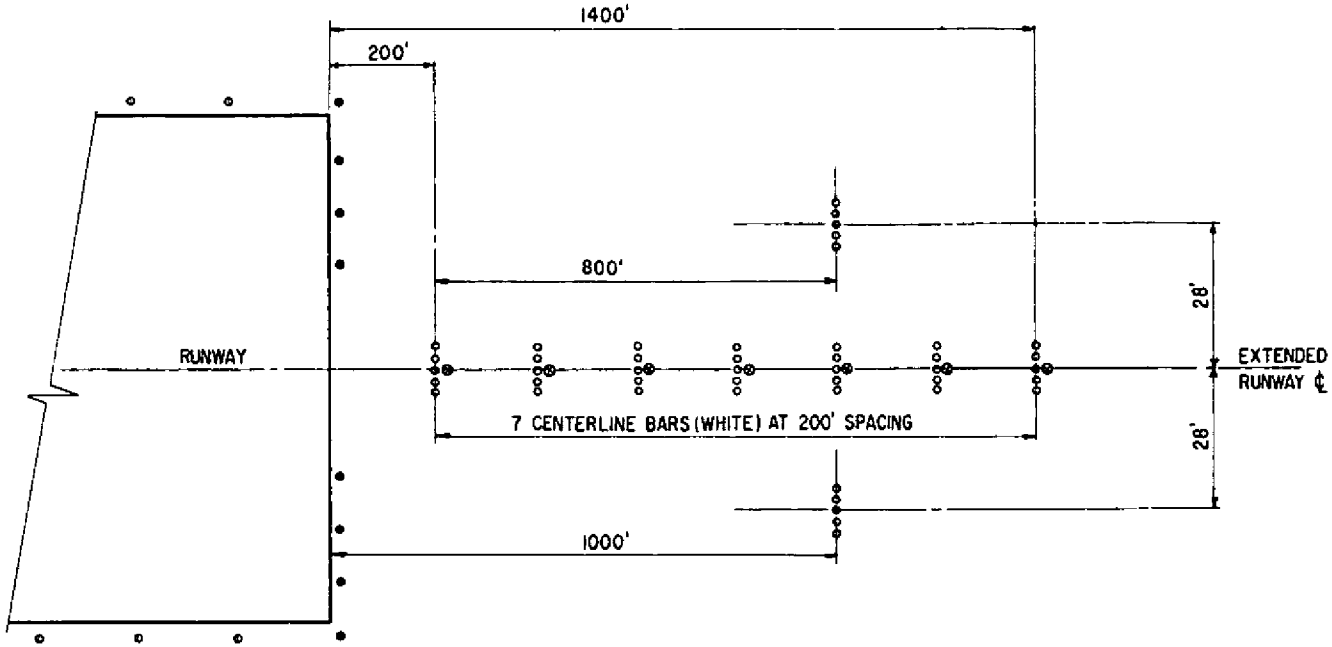
(1) A daily operational check should be made of all fixtures to locate and replace defective or burned out lamps.

(2) Regular cleaning of the MALS, MALS/SF or REILS optical lens or lamps is necessary in order that the equipment can operate at maximum efficiency. Cleaning should be in accordance with the equipment manufacturer's recommendations.

b. Spare Parts. Stock adequate spare parts.

11. HOW TO GET THIS CIRCULAR. Obtain additional copies of this circular AC 150/5340-14, "Economy Approach Lighting Aids", from the Federal Aviation Agency, Distribution Section, HQ-438, Washington, D. C. 20553.

Cole Morrow, Director
Airports Service



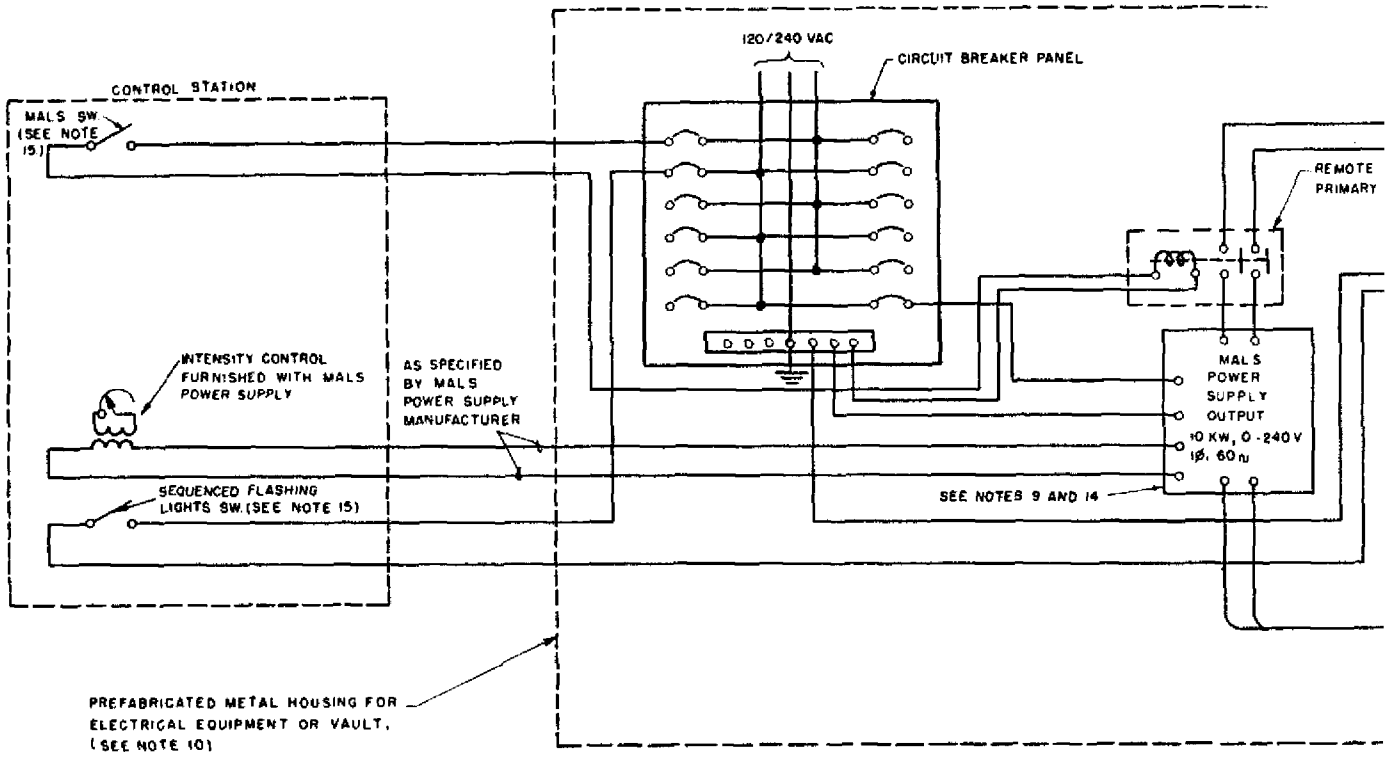
Symbols

- ⊕ Existing runway edge lights
- ● Existing runway threshold lights
- ○ Steady burning approach lights
- ⊗ Sequenced flashing lights

Notes

1. The optimum location of the approach lights is in a horizontal plane at runway end elevation.
2. A maximum 2 percent upward longitudinal slope tolerance may be used to raise the light pattern above objects within its area.
3. A maximum 1 percent downward longitudinal slope tolerance may be used to reduce the height of supporting structures.
4. All steady burning and flashing lights are aimed with their beam axes parallel to the runway centerline and intercepting the established approach slope at horizontal distance of 1600' feet in advance of the light.
5. All obstructions, as determined by applicable criteria for determining obstructions to air navigation are lighted and marked as required.
6. All steady burning and flashing lights in the system emit white light.
7. Intensity control is provided for the steady burning lights.
8. The flashing lights flash in sequence at the rate of two flashes per second.

FIGURE 1. TYPICAL LAYOUT FOR MEDIUM INTENSITY APPROACH LIGHT SYSTEM WITH SEQUENCED FLASHING LIGHTS



SYMBOLS

- JB - JUNCTION BOX FURNISHED IN ACCORDANCE WITH SPECIFICATION L-848
- (F) - SEQUENCED FLASHING LIGHTS IN ACCORDANCE WITH SPECIFICATION L-849
- (S) - STEADY BURNING LIGHTS IN ACCORDANCE WITH SPECIFICATION L-848
- ● - EXISTING THRESHOLD LIGHTS IN ACCORDANCE WITH SPECIFICATION L-802 OR L-819
- ○ - EXISTING RUNWAY LIGHTS IN ACCORDANCE WITH SPECIFICATION L-802 OR L-819

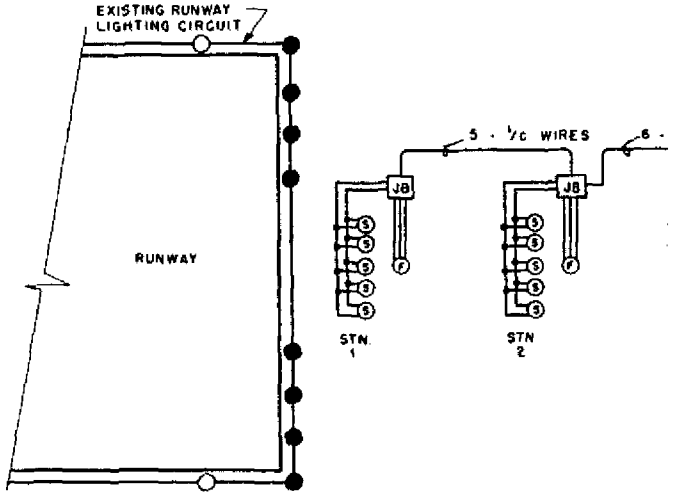
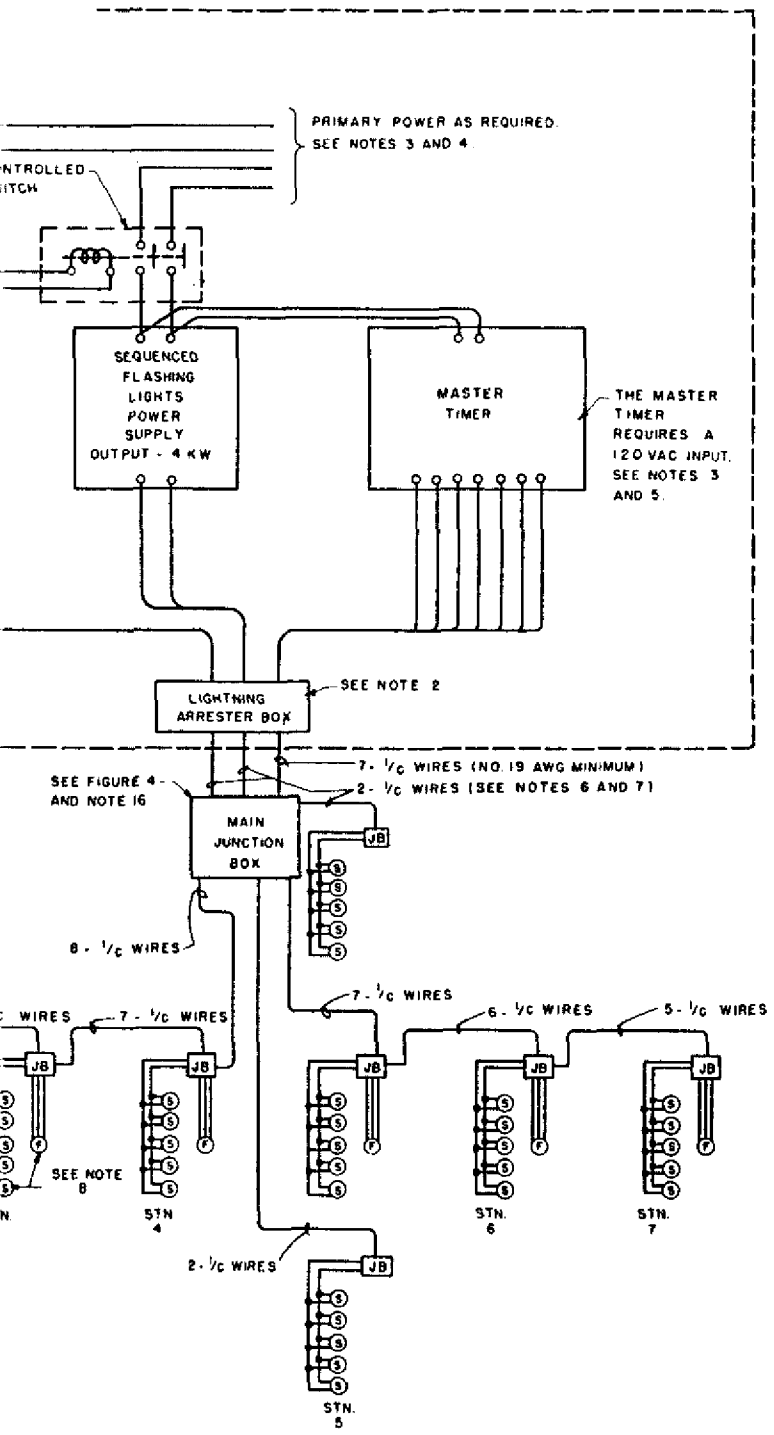


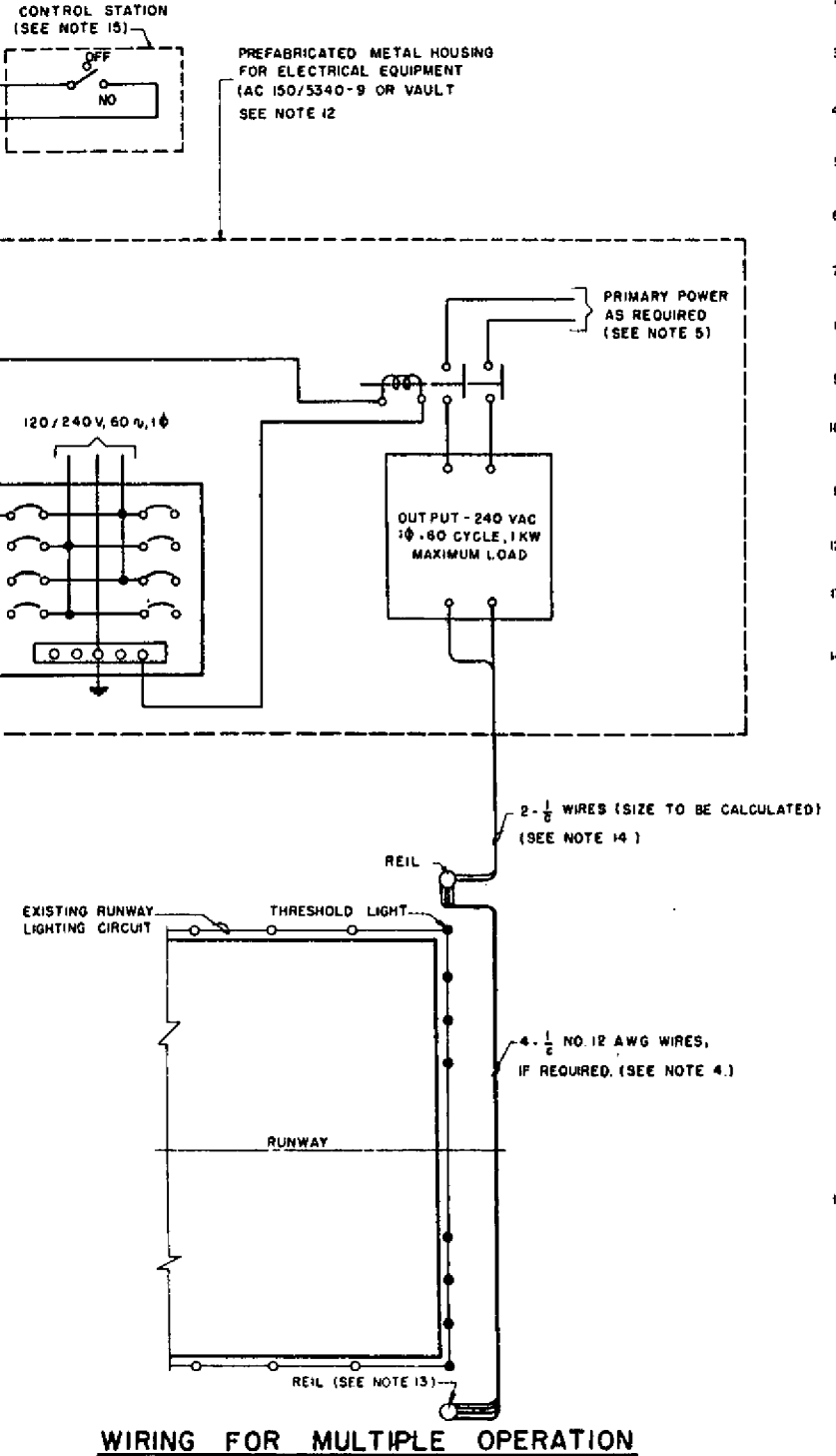
FIGURE 2. TYPICAL WIRING DIAGRAM FOR MEDIUM INTENSITY APPROACH LIGHT SYSTEM WITH SEQUENCED FLASHING LIGHTS



M INTENSITY APPROACH
FLASHING LIGHTS

Notes

1. The installation should conform to the applicable sections of the National Electrical Code and local codes.
2. Lightning arresters for power and control lines should be installed as required.
3. Additional isolating devices should be installed as required.
4. Fuses, circuit breakers, and cutouts should be in accordance with equipment ratings.
5. The master timer is in accordance with Specification L - 849.
6. The minimum wire size to be used between the power supplies, main junction box, and light bars should be calculated for each installation.
7. A 120 volt AC, 1Ø system or a 240/480 volt AC, 3-wire system may be used in lieu of the 240 volt AC, 1Ø system shown.
8. The steady burning and flashing lights are connected into the electrical circuits in accordance with the equipment manufacturers recommendations.
9. The MALS power supply is a magnetic amplifier acceptable to the engineer in charge or a tapped transformer as shown on figure 3.
10. The installation of the prefabricated metal housing and equipment it encloses should be in accordance with applicable sections of Advisory Circular No 150/5340-9 "Prefabricated Metal Housing for Electrical Equipment."
11. The underground cables are installed and tested in accordance with the applicable sections of Item L-108 of "Standard Specifications for Construction of Airports."
12. Each light bar and flashing light is grounded as specified in the plans for the site.
13. Sample calculation to determine line loss for the installation shown on this drawing. To simplify calculations, the current required for each MALS light bar is taken to be $I = \frac{150 \text{ watts / lamp} \times 5 \text{ lamp/bar}}{240 \text{ volts}} = 3.125$ amps.
    The use of 3.125 amps will eliminate the necessity of determining the lamp characteristics at reduced voltages. See Figure 1 for spacing between light bars.
    a. Total lamp load is W = 150 watts / lamp x 5 lamps / bar x 9 bars = 6.75 KW.
    b. Total lamp load current is I = 3.125 amps / bar x 9 bars = 28.125 amps.
    c. Permissible line loss for homerun leads is V = 240 volts x 5 % = 12 volts.
    d. Maximum resistance of homerun leads is $R = \frac{V}{I} = \frac{12 \text{ volts}}{28.125 \text{ amps}} = 0.427$ ohms.
    e. Since the resistance of No 6 AWG wire is 0.403 ohms / 1000', No 6 AWG wires may be used if a 500' separation is desired between the MALS power supply and the lamp loads.
    f. The voltage at station 1 can be estimated by the following procedure:
    (1) Line loss between stations 3 and 4 is V4-3 = 3.125 amps / bar x 3 bars x 0.1612 ohms / 400' of No 6 wire = 1.512 volts.
    (2) Line loss between station 3 and 2 is V3-2 = 3.125 amps / bar x 2 bars = 0.1612 ohms / 400' of No 6 wire = 1.008 volts.
    (3) Line loss between station 2 and 1 is V2-1 = 3.125 amps / bar x 0.1612 ohms / 400' of No 6 wire = 0.504 volt.
    (4) Voltage at station 1 is approximately 240 V - (1.512 V + 1.008 V + 0.504 V) = 236.976 volts if the MALS power supply is set at the voltage tap or position to deliver 240 V + 5%.
    (5) Since the line losses to station 5 and station 7 will be less than those to station 1 for this installation, they are not calculated.
14. A 10 KW minimum power supply is recommended for the MALS to make available adequate power for the lamp load, lamp tolerances, line losses, and other variables.
15. Radio control may be used in lieu of MALS and sequenced flashing lights switches. If radio control is used, the steady burning and flashing lights are activated simultaneously.
16. The main junction box may not be required if the MALS / SF power supplies are near the approach lights.

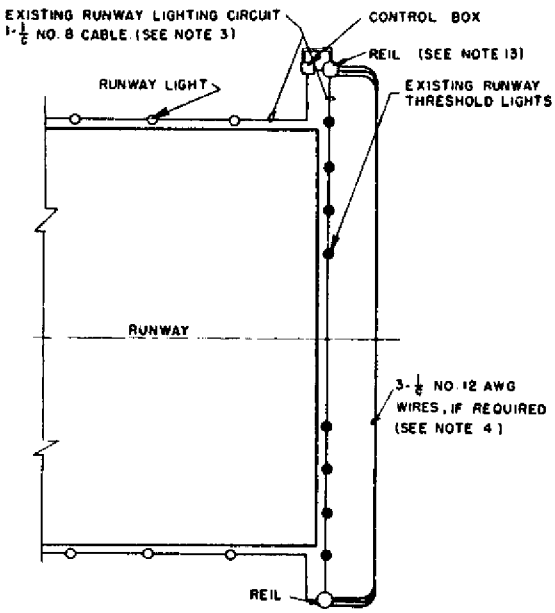


WIRING FOR MULTIPLE OPERATION

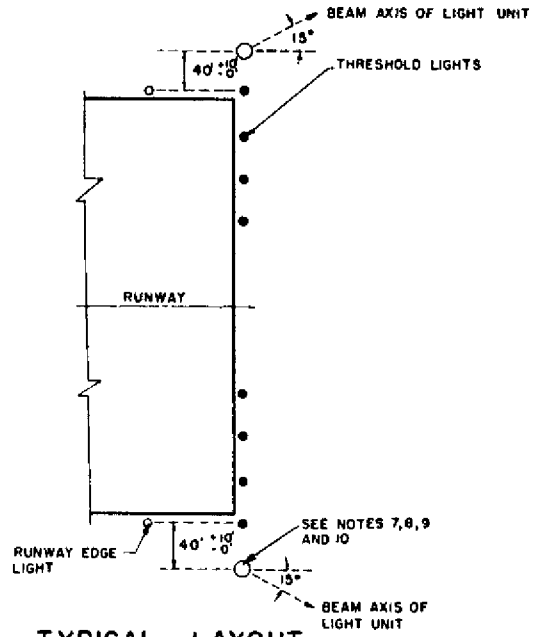
CAL LAYOUT AND WIRING DIAGRAM FOR RUNWAY END IDENTIFIER LIGHT SYSTEM

Notes

1. The installations should conform to the applicable sections of the National Electrical Code and local codes.
2. Lightning arresters for power and control lines should be installed as required.
3. An additional 1KW load will be added to the regulator if the REILS units are connected into the runway lighting circuit.
4. The REILS units are connected into the electrical circuits in accordance with the equipment manufacturers recommendations.
5. Fuses and circuit breakers should be in accordance with equipment ratings.
6. The runway end identifier light system is grounded as specified in the plans for the installation.
7. The optimum location for each light unit is in line with the runway threshold at 40 feet from the runway edge light.
8. A plus or minus 200 foot tolerance is permitted in locating the light units in line with the runway threshold.
9. The light units are equally spaced, with respect to each other, from the runway threshold.
10. The beam centerline of each light unit is aimed 15° outward from a line parallel to the runway centerline and inclined at at an angle 10° above the horizontal.
11. Local control can be obtained for REILS if required for the installation. The local switch is as specified in Spec. L-849.
12. No enclosure is required if the equipment shown in the housing is designed for outdoor service.
13. The light units, control box and light unit local controls are in accordance with Specification L - 849.
14. Sample calculation to determine the maximum distance between the distribution transformer and the furthest REILS light unit using no.12 AWG wire (resistance = 1.62 ohms/1000').
    a. Local conditions
    (1) Load of 2 REILS light units - 1KW maximum.
    (2) Available voltage from distribution transformer for REILS - 240 volts ± 5 %.
    b. Calculations
    (1) $\frac{500 \text{ watts / light unit} \times 2 \text{ light units}}{240 \text{ volts}} = 4.16 \text{ amperes load current}$
    (2) 240 x 5 % = 12 volts permissible line loss to have rated voltage at furthest fixture.
    (3) 1.62 ohms / 1000' x 4.16 amperes load current = 6.74 volts / 1000'.
    (4) $\frac{12 \text{ volts permissible VD}}{6.74 \text{ VD}/1000'} = 1780 \text{ feet}$
    (5) Since two wires are required the maxium distance is $\frac{1780}{2} = 890$ feet.
    (6) To determine the maximum distance using other wire sizes, obtain the resistance of the wire per 1000' and follow the above procedure.
15. The control station may be a remote controlled switch, radio control, or automatic control (photocell or timing devices).

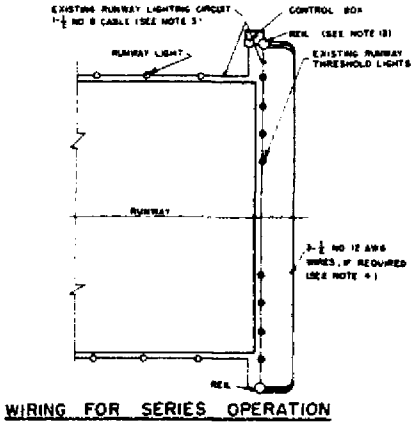


WIRING FOR SERIES OPERATION

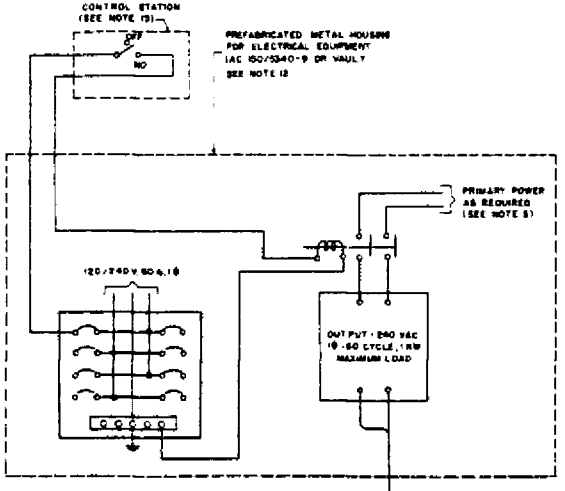


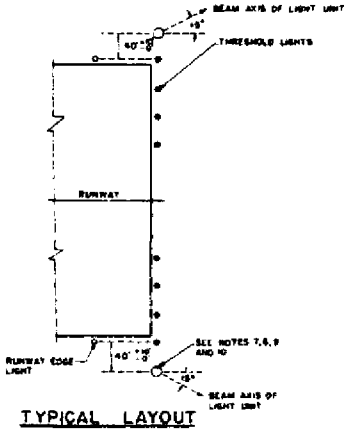
TYPICAL LAYOUT

FIGURE 5. TYP

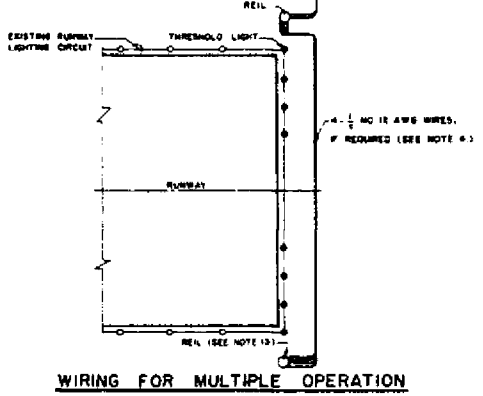


WIRING FOR SERIES OPERATION





TYPICAL LAYOUT



WIRING FOR MULTIPLE OPERATION

Notes

1. The installations should conform to the applicable portions of the National Electrical Code and local codes.
2. Lightning arresters for power and control lines should be installed as required.
3. An additional 1 KW load will be added to the regulator if the REILS units are connected into the runway lighting circuit.
4. The REILS units are connected into the electrical circuits in accordance with the equipment manufacturers recommendations.
5. Fuses and circuit breakers should be in accordance with equipment ratings.
6. The runway and downwind light system is grounded as specified in the plans for the installation.
7. The optimum exposure for each light unit is in line with the runway threshold at 40 feet from the runway edge light.
8. A plus or minus 200 foot tolerance is permitted in keeping the light units in line with the runway threshold.
9. The light units are equally spaced, with respect to each other, from the runway threshold.
10. The beam centerline of each light unit is aimed 15° outward from a line parallel to the runway centerline and aimed at an angle 10° above the horizontal.
11. Local control can be provided for REILS if required for the installation. The local switch is to be specified in Spec. L-849.
12. No enclosure is required if the equipment shown in the housing is designed for outdoor service.
13. The light units, control box and light unit controls are in accordance with Specification L-849.
14. Sample calculation to determine the maximum distance between the distribution transformer and the furthest REILS light unit using no 12 AWG wire (resistance = 1.62 ohms/1000'):
    a. Local conditions:
    (1) Load of 2 REILS light units - 1 KW maximum.
    (2) Available voltage from distribution transformer for REILS - 240 volts ± 5 %.
    b. Calculations:
    (1) $\frac{500 \text{ watts / light unit} \times 2 \text{ light units}}{240 \text{ volts}} = 4.16$ amperes load current.
    (2) 240 ± 5 % = 12 volts permissible line loss to have rated voltage at farthest fixture.
    (3) 1.62 ohms / 1000' x 4.16 amperes load current = 6.74 volts / 1000'.
    (4) $\frac{12 \text{ volts permissible VD}}{6.74 \text{ VD/1000}} = 1780$ feet.
    (5) Since two wires are required the maximum distance is $\frac{1780}{2} = 890$ feet.
    (6) To determine the maximum distance using other wire sizes, obtain the resistance of the wire per 1000' and follow the above procedure.
15. The control station may be a remote controlled switch, radio control, or automatic control (photocell or timing device).

FIGURE 1. TYPICAL LAYOUT AND WIRING DIAGRAM FOR RUNWAY END IDENTIFIER LIGHT SYSTEM

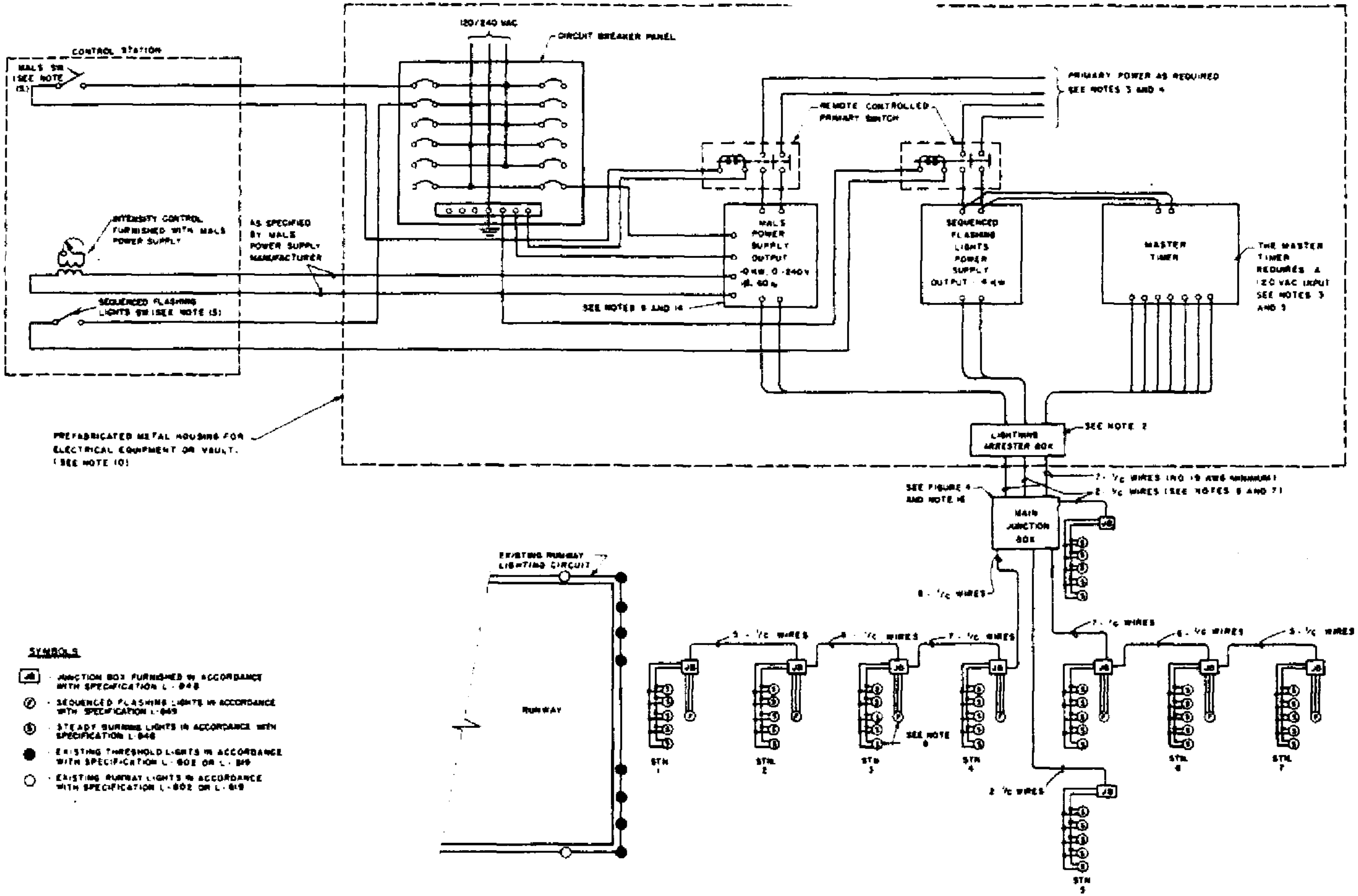


FIGURE 2. TYPICAL WIRING DIAGRAM FOR MEDIUM INTENSITY APPROACH LIGHT SYSTEM WITH SEQUENCED FLASHING LIGHTS

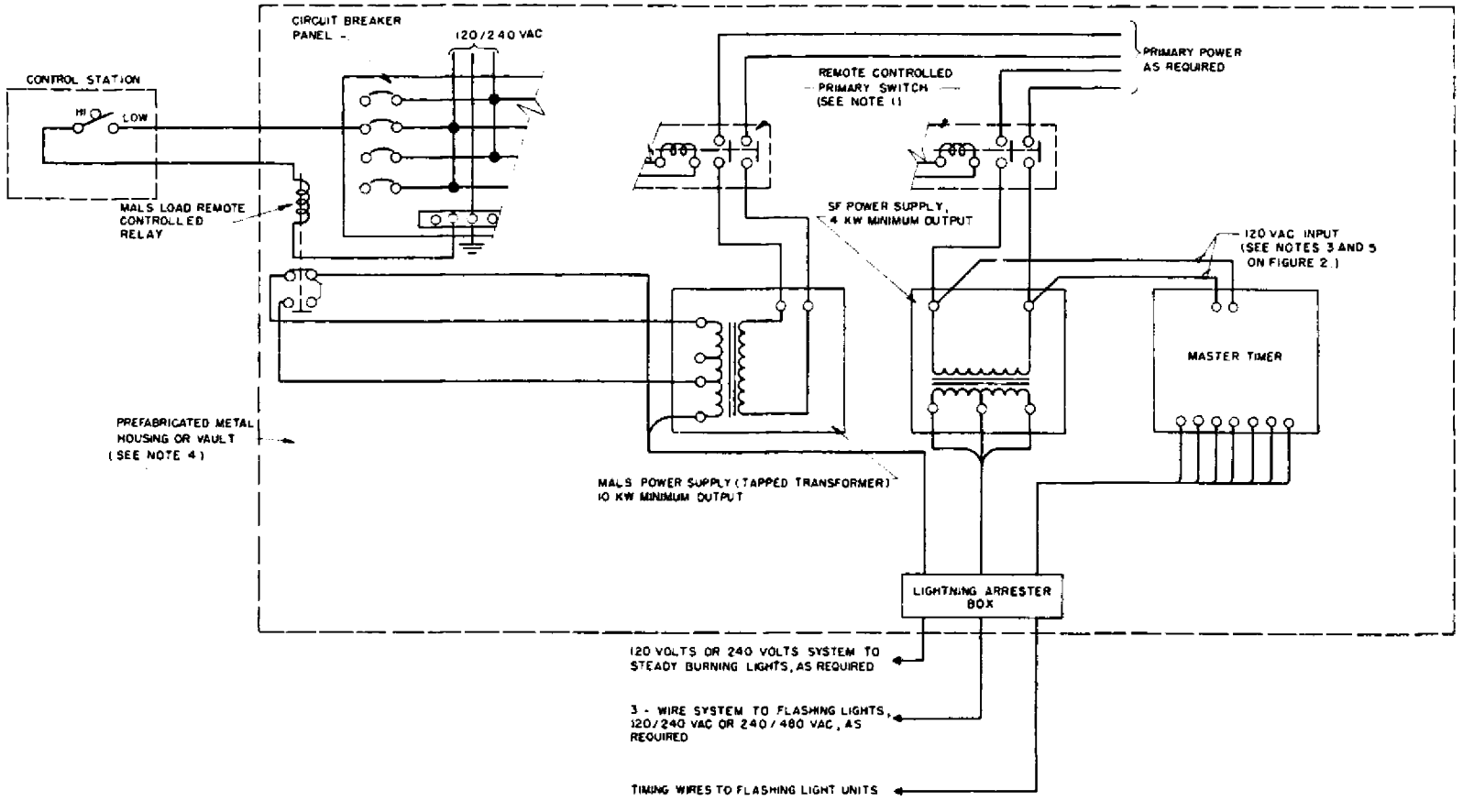
Notes

1. The installation should conform to the applicable sections of the National Electrical Code and local codes.
2. Lightning arresters for power and control lines should be installed as required.
3. Additional isolating devices should be installed as required.
4. Fuses, circuit breakers, and cutouts should be in accordance with equipment ratings.
5. The master timer is in accordance with Specification L-849.
6. The minimum wire size to be used between the power supplies, main junction box, and light bars should be calculated for each installation.
7. A 120 volt AC, 1Ø system or a 240/480 volt AC, 3-wire system may be used in lieu of the 240 volt AC, 1Ø system shown.
8. The steady burning and flashing lights are connected into the electrical circuits in accordance with the equipment manufacturers recommendations.
9. The MALS power supply is a magnetic amplifier acceptable to the engineer in charge or a tapped transformer as shown on figure 3.
10. The installation of the prefabricated metal housing and equipment it encloses should be in accordance with applicable sections of Advisory Circular No. 150/5340-9 "Prefabricated Metal Housing for Electrical Equipment."
11. The underground cables are installed and tested in accordance with the applicable sections of item L-108 of "Standard Specifications for Construction of Airports."
12. Each light bar and flashing light is grounded as specified in the plans for the site.
13. Sample calculation to determine line loss for the installation shown on this drawing. To simplify calculations, the current required for each MALS light bar is taken to be $I = \frac{150 \text{ watts/lamp} \times 5 \text{ lamps}}{240 \text{ volts}}$ = 3.125 amps.

    The use of 3.125 amps will eliminate the necessity of determining the lamp characteristics at reduced voltages. See Figure 1 for spacing between light bars.

    a. Total lamp load is W = 150 watts/lamp x 5 lamps/bar x 9 bars = 6750 watts
    b. Total lamp load current is I = 3.125 amps/bar x 9 bars = 28.125 amps
    c. Permissible line loss for homerun leads is V = 240 volts x 5% = 12 volts
    d. Maximum resistance of homerun leads is $R = \frac{V}{I} = \frac{12 \text{ volts}}{28.125 \text{ amps}} = 0.427$ ohm
    e. Since the resistance of No. 6 AWG wire is 0.403 ohms/1000', No. 6 AWG wires may be used if a 500' separation is desired between the MALS power supply and the lamp leads.
    f. The voltage at station 1 can be estimated by the following procedure:

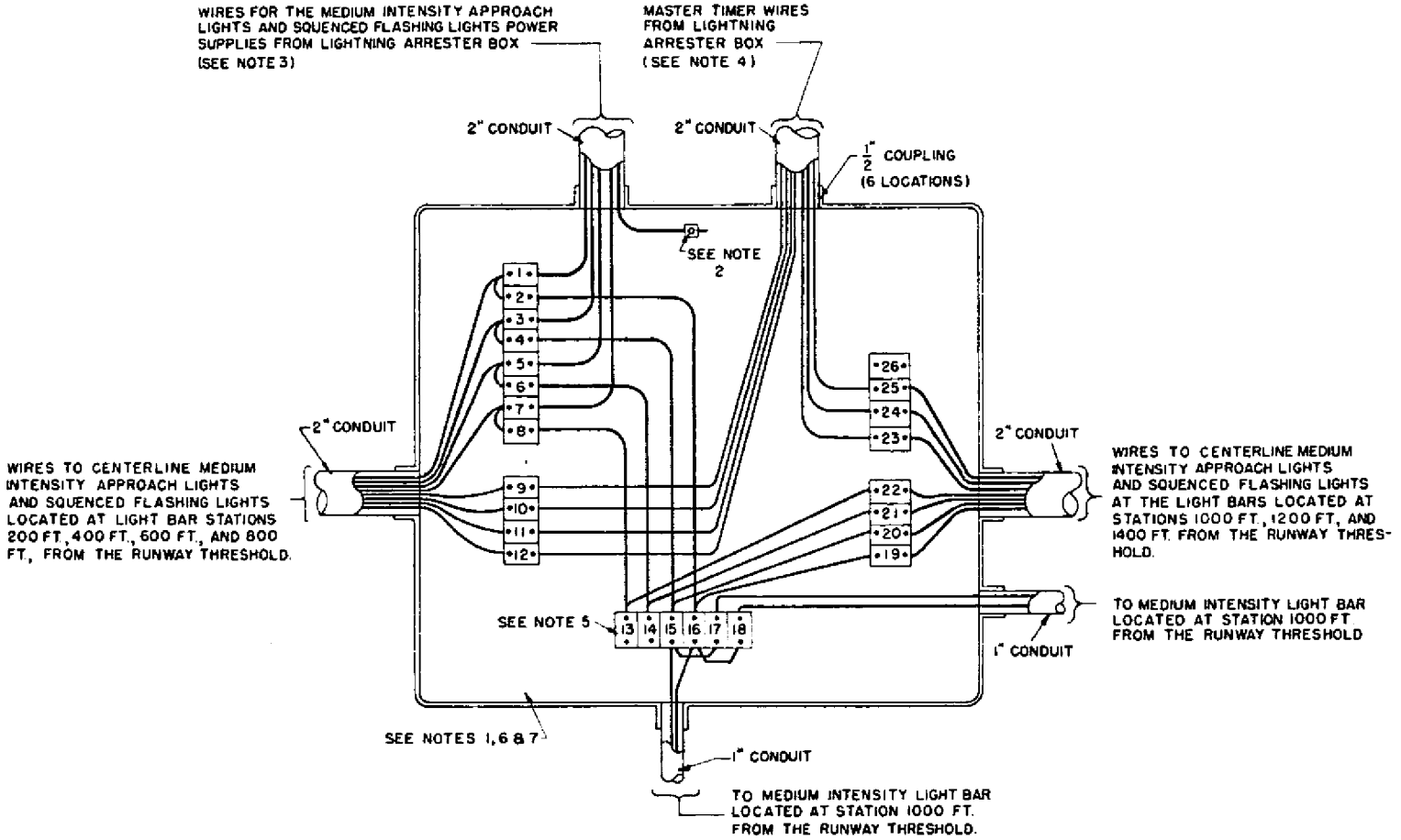
    (1) Line loss between stations 3 and 4 is V4-3 = 3.125 amps/bar x 3 bars x 0.1612 ohms/400' of No. 6 wire = 1.512 volts
    (2) Line loss between station 3 and 2 is V3-2 = 3.125 amps/bar x 2 bars x 0.1612 ohms/400' of No. 6 wire = 1.008 volts
    (3) Line loss between stations 2 and 1 is V2-1 = 3.125 amps/bar x 0.1612 ohms/400' of No. 6 wire = 0.504 volt
    (4) Voltage at station 1 is approximately 240 V - (1.512 V + 1.008 V + 0.504 V) = 236.976 volts if the MALS power supply is set at the voltage tap or position to deliver 240 V ± 5%.
    (5) Since the line losses to station 5 and station 7 are less than those to station 1 for this installation, they are not calculated.
14. A 10 KW minimum power supply is recommended for the MALS to make available adequate power for the lamp load, lamp tolerances, line losses, and other variables.
15. Radio control may be used in lieu of MALS and sequenced flashing lights switches. If radio control is used, the steady burning and flashing lights are activated simultaneously.
16. The main junction box may not be required if the MALS / SF power supplies are near the approach lights.



Notes

1. The remote controlled primary switches are used to control the "ON - OFF" operation of the MALS/SF. These switches may be radio controlled.
2. The "HI" position in the control station can be used for day and night - instrument operations and the "LOW" position for night VFR operations. This switch may be controlled manually, be a photoelectric device or by a timing device.
3. The applicable notes on figure 2 apply to this figure.
4. An enclosure is not required for equipment designed for outdoor service.

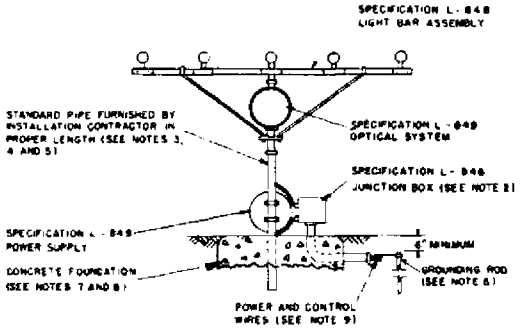
FIGURE 3. DAY, NIGHT, AND NIGHT-INSTRUMENT BRIGHTNESS CONTROL FOR MEDIUM INTENSITY APPROACH LIGHT SYSTEM



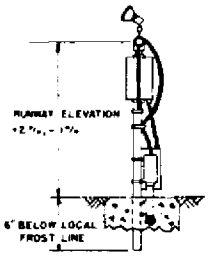
Notes:

1. The housing for the junction box is 11 gauge steel, galvanized by hot dipping.
2. A grounding lug is provided inside the housing. The lug should be adequate for a No. 6 AWG conductor.
3. The four wires for the medium intensity approach lights and sequenced flashing lights from the lightning arrester box may be No. 6 AWG, 600 volt wires.
4. The seven master timer wires from the lightning arrester box may be No. 19 AWG conductors.
5. All terminal blocks are the pressure type.
6. The junction box is provided with a removable top cover
7. The junction box is designed for underground installation.

FIGURE 4. TYPICAL DETAILS FOR MAIN JUNCTION BOX

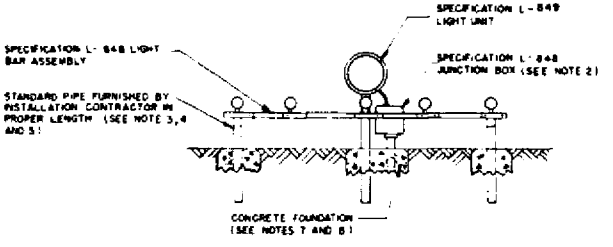


FRONT VIEW

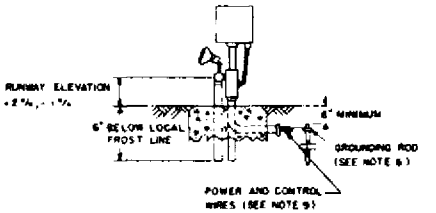


END VIEW

TYPICAL MALS/SF INSTALLATION FOR MOUNTING HEIGHTS 4 TO 10 FEET

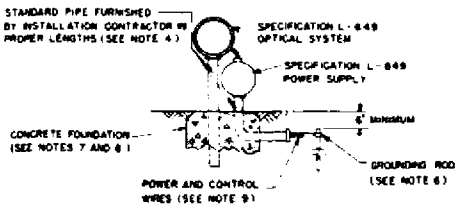


FRONT VIEW

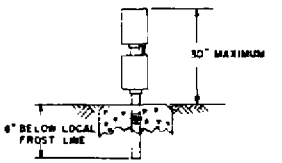


END VIEW

TYPICAL MALS/SF INSTALLATION FOR MOUNTING HEIGHTS UP TO 4 FEET



FRONT VIEW



END VIEW

TYPICAL RUNWAY END INDENTIFIER LIGHT UNIT INSTALLATION

Notes

1. The installations conform to the applicable sections of the National Electrical Code and local codes.
2. The L-848 junction box may be installed as an integral part of the light bar assembly to permit wires to be enclosed
3. High grade commercial pipe is furnished by the installation contractor to permit the installation of the L-848 light bar assembly at the elevation indicated on the plans.
4. Unless otherwise specified, standard 2 inch pipe is used for mounting the L-848 and L-849 equipment.
5. Frangible fittings are furnished by the installation contractor as required.
6. Each L-848 light bar assembly and L-849 flashing light unit is adequately grounded. The ground rod and its installation are in accordance with the applicable sections of Item L-108 of Standard Specifications for Construction of Airports
7. The size of the concrete foundation is as indicated on the plans
8. The material for the concrete foundation is as specified in Item P-610 of Standard Specifications for Construction of Airports.
9. The installation of power and control wires is in accordance with the applicable sections of Item L-108 of Standard Specifications for Construction of Airports.
10. The L-848 and L-849 units are assembled in accordance with the manufacturer's instructions

FIGURE 6. TYPICAL EQUIPMENT INSTALLATION DETAILS FOR MALS/SF AND REILS

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