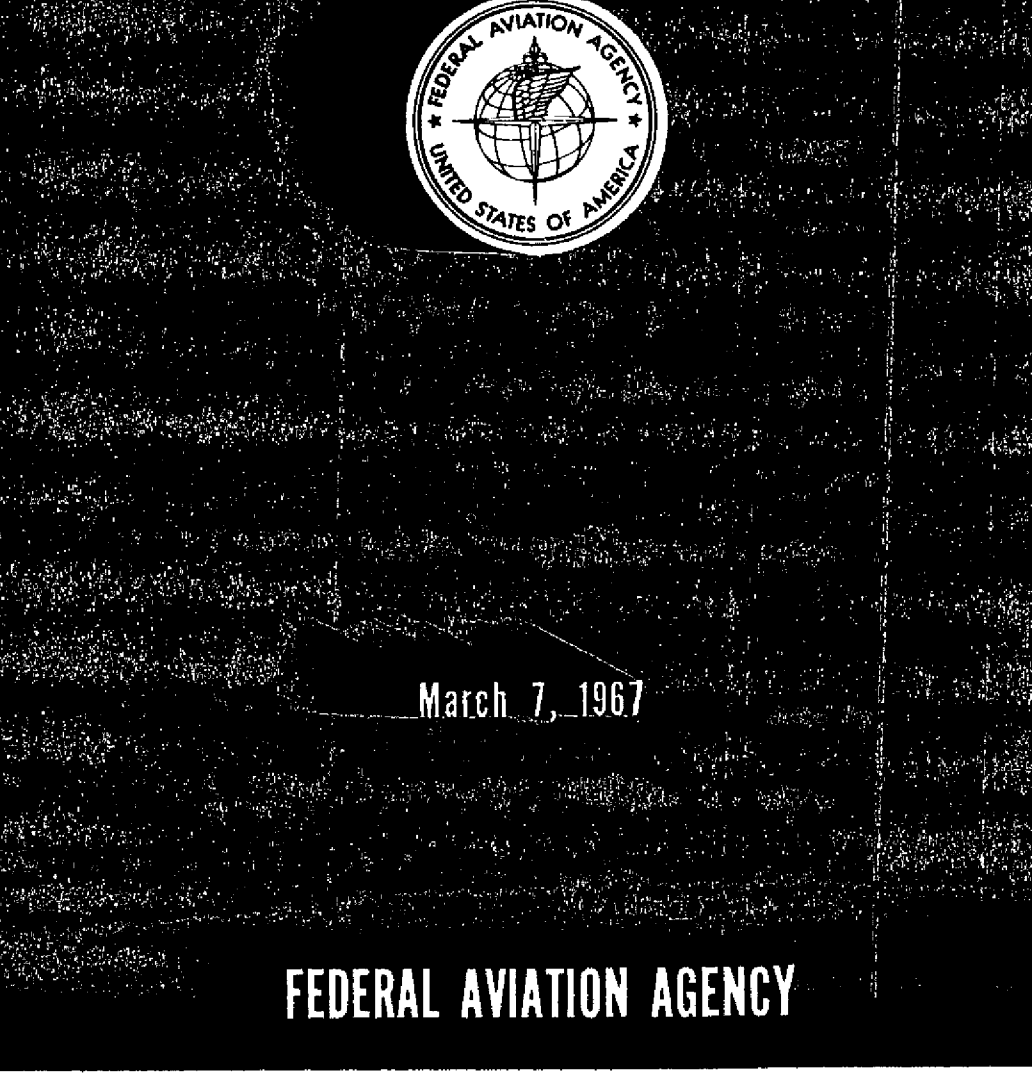
March 7, 1967
FEDERAL AVIATION AGENCY

Federal Aviation Agency

ADVISORY CIRCULAR

AC NO: AC 150/5340-14A
AIRPORTS
EFFECTIVE:
3/7/67

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), runway end identifier light system (REILS), and abbreviated visual approach slope indicator system (AVASI).

2. CANCELLATION. AC 150/5340-14, Economy Approach Lighting Aids, dated June 30, 1965, is cancelled.

3. APPLICABLE PUBLICATIONS. Technical publications listed under Bibliography, Appendix 1, provide guidance and detailed information as may be required.

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

   a. Selection criteria have been included for each system.

   b. Sequenced flashing lights in the inner 800-foot section of the MALS/SF have been deleted.

   c. Details have been added for the AVASI installation.

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

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Director, Airports Service

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1. INTRODUCTION.

   a. The economy approach lighting aids were developed to make available to eligible airports low cost approach visual aids. The design and installation requirements are flexible to permit the equipment to be installed and operated with minimum changes to the power distribution system at the airport.

   b. The technical information required to plan and install a system is included in Figures 1 through 8. These are drawings of TYPICAL installations. Local applications may require variations from the drawings, but no variations in the layout, spacing, and tolerances are permitted. Although it is possible to plan an installation from the drawings, various characteristics affecting the systems and their design, equipment, and installation deserve special consideration.

2. TYPES OF ECONOMY APPROACH LIGHTING AIDS.

   a. 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.

   b. Runway End Identifier Light System (REILS).

   c. Abbreviated Visual Approach Slope Indicator System (AVASI).

3. SELECTION CONSIDERATIONS. The selection of a particular system should be based on an operational requirement for light signals in addition to runway edge lights. The following should be considered when selecting an economy approach lighting aid:

   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 instrument landing system/approach light system (ILS/ALS), runway end identifier lights (REIL), or visual approach slope indicator system (VASI).

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

c. If MALS/SF is to be installed, the airport should have an assigned or have the potential for an instrument approach procedure other than instrument landing system/precision approach radar (ILS/PAR).

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

e. The selection of a particular system should be based on local needs, both operational and environmental. An individual site evaluation is necessary to determine which aid will best serve in reducing the deficiency(s) in a particular area. Reduction to instrument approach minima may be made in accordance with the U.S. Standard for Terminal Instrument Procedures. The following information can be used as a guide for selecting a particular system.

(1) MALS/SF. This system provides early runway lineup and lead-in guidance, runway end identification, and to a degree, roll guidance. The lights are helpful during some periods of restricted visibility. The MALS is beneficial where extraneous lighting prevents the pilot from lining up with the runway centerline or where the surrounding terrain is devoid of lighting and does not provide the cues necessary for proper aircraft attitude control. At locations where approach area identification is difficult at night due to surrounding lights, MALS with sequenced flashing lights installed at the three outermost bars should resolve this problem.

(2) REILS. This system provides early runway and runway end identification and will provide a degree of circling guidance. It is beneficial in areas having a preponderance of lighting or where featureless terrain exists.

(3) AVASI. This system provides descent guidance and may also provide some noise relief. On runways not provided with electronic guidance, it is beneficial in aiding the pilot of an aircraft to determine his correct descent path. The presence of objects in the approach area may involve a serious hazard if an aircraft descends below the normal

approach path. This is especially true where sources of visual reference information are lacking or deceptive, i.e., hilltops, valleys, and remote type airports.

4. CONFIGURATIONS.

a. MALS/SF.

(1) The system has a configuration of steady burning and flashing lights arranged symmetrically about and along the extended runway centerline as shown in Figure 1. The system begins approximately 200 feet from the runway threshold and extends to a distance of 1400 feet.

(2) The system has seven stations. Each station has a bar with five steady burning lights. If required, one flashing light is located at the three outermost stations. 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 but the flashing lights have no intensity control.

b. REILS. The system has two flashing lights located at the end of the runway as shown in Figure 2. 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. The light fixtures are not provided with an optical baffle. 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. These flashing lights emit white light and have no intensity control.

c. AVASI. The system has two light units located 50 feet from the left runway edge when the optical system is viewed from the approach zone. The light units are installed in a line parallel with the runway edge. Each light unit emits a two color (red and white) light beam. When the light units are properly aimed, the optical systems provide visual approach slope information. Aiming criteria for the AVASI are shown in Figure 3.

5. DESIGN.

a. MALS/SF.

(1) General. The MALS and SF are connected to permit simultaneous operation of the steady burning and flashing lights. The sequence flashing light at the three outermost stations should operate when the steady burning lights are energized on the high or low intensity brightness setting.

(2) 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 control are determined by the operational requirements at the airport. The intensity control can be designed to give at least a high-low position (100 percent and approximately 10 percent of lamp brightness). If a 2-step (high-low) intensity control design is selected, the high position can be used during day instrument operations and the low position can be used during night operations.

(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 mechanical 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.

(3) 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 in Figures 4 and 5. When the units are energized, a sequence of flashes is produced having the appearance of a flash of light traveling down part of the system from the outer end to the 1000-foot crossbar.

(4) MALS/SF Power Supplies. The power supplies are rated to supply voltage to the equipment within the specified tolerances. The capacity of the power supplies is sufficient to accommodate all line losses and to supply electrical energy to the equipment continuously, at rated load, without the power supply overheating. It is not required to provide a shelter for power supplies designed and manufactured for outdoor service.

(5) Wire Sizes. Minimum wire sizes required for the circuits are calculated for each installation. Wire size for the magnetic amplifier control circuit is in accordance with the recommendations of the manufacturer of the power supply. If the arrester box (Figure 4) is 500 feet or less from the light bars in a 240-volt single phase system shown, use at least No. 6 AWG wire for the MALS main power and feeder wire runs. See Figure 4 for a sample calculation. 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 circuits may be reduced by using a 240/480-volt, 3-wire system. The type of system to be used at different airports may vary because of airport design, layout, and availability of local electrical power.

(6) Structures.

(a) Frangible fittings are required for all approach light supporting structures located within 1000 feet of the runway threshold.

(b) When the terrain slopes downward from the runway threshold, non-frangible supporting structures may be installed, providing they do not protrude above a horizontal line at the height of the runway threshold.

(c) When the terrain is level with, or slopes upward from the runway threshold, a minimum amount of non-frangible structure should be installed above ground level.

b. REILS.

(1) Units can be obtained for connecting into a series runway lighting circuit that operates within the range of 2.8 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 (see Figure 2). The method selected depends on operational requirements at the airport.

(a) 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. 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).

(b) 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 2) 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. In lieu of the above, remote, manual, or radio control should be selected or the light units should be connected to stay on when the runway lights are on.

c. AVASI.

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

(2) The AVASI may have controls similar to those specified for the REILS in paragraphs 5b(2)(a) and (b). All controls should have an adequate rating for the intended service. Typical wiring diagrams for the controls are shown in Figure 7.

6. EQUIPMENT AND MATERIAL.

a. General.

(1) Equipment and material are covered in the FAA specifications which are listed in the Bibliography, Appendix 1.

(2) Distribution transformers, magnetic amplifier dimmer power supplies, switches, cutouts, relays, terminal blocks, circuit breakers, and all other regularly used commercial items of electrical equipment not covered by FAA specifications which conform to the applicable 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 horizontal bar approximately 10 feet in length. This bar may have two diagonal 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 with each 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 with 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 the 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 or a high quality commercial transformer. If transformers are used, they should be connected to provide a minimum of two brightness settings 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. The transformers may be connected to give 50 percent rated lamp voltage in lieu of 55 percent. If required, a tap is provided to obtain +5 percent of rated output voltage. This tap can be used for line loss compensation.

(b) SF. The system power supply for the three sequenced flashing lights is a high quality commercial distribution transformer. The transformer is capable of supplying at least 1.5 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 in Figure 4.

(6) Lightning 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 intended service.

(7) Wires. The wire size for the MALS/SF circuits 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 shown in Figure 6. The housing for the box shown is 11 gauge steel, galvanized by hot dipping. Other designs and materials may be used providing they are suitable for the intended service.

(9) Concrete. Concrete and reinforcing steel conform to the applicable provisions of Item P-610 of AC 150/5370-1.

c. REILS.

(1) Light Unit. The condenser discharge type light units conform to the requirements of AC 150/5345-24. Fittings are furnished with the equipment to permit installation of the optical system on a standard 2-inch pipe as shown in Figure 8.

(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 AC 150/5345-24. The control box permits the REILS to be turned on or off by energizing or de-energizing the runway edge lighting circuit.

(3) Remote Control. A single pole, single throw switch on an existing panel in accordance with AC 150/5345-3 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 AC 150/5345-24.

(5) Wires.

(a) Series Operation. The 3-1/c wires shown in Figure 2 between light units may be No. 12 AWG (minimum), 600-volt wires.

(b) Multiple Operation. The 4-1/c wires shown in Figure 2 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 in Figure 2.

(6) Concrete. Concrete and reinforcing steel conform to the applicable provisions of Item P-610 of AC 150/5370-1.

d. AVASI.

(1) Light Units. The light unit and accessories are in accordance with the requirements of AC 150/5345-28.

(2) Controls. Switches used to control the equipment should have an adequate rating.

(3) Concrete. Concrete and reinforcing steel used for the equipment foundation conform to the applicable provisions of Item P-610 of AC 150/5370-1.

7. INSTALLATION.

a. MALS/SF.

(1) Existing Installation.

(a) Installations with sequenced flashing lights installed in the inner 800-foot section of the MALS/SF may be modified as shown in Figure 9. This modification would permit the sequenced flashing light at the three outermost light bars to operate at all times when the steady burning lights are energized. The entire system of sequenced flashing lights will operate only when the steady burning lights are on the 100 percent brightness setting.

(b) Disconnect or remove sequenced flashing lights 200 feet from the runway threshold.

(2) New Installations.

(a) Install MALS/SF lights at runway end elevation, preferably in a horizontal plane. See Figures 1 and 8.

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

2 A downward slope of not more than 1 percent may be utilized to reduce the height of supporting structures.

3 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.

(b) If a prefabricated metal housing for electrical equipment (AC 150/5340-9) is required, the enclosure should be installed in a location that will not constitute an obstruction.

(c) Circuit wires are installed and marked in accordance with applicable sections of Item L-108 of AC 150/5370-1. The main circuit wire runs and feeder circuit wire runs may terminate in junction boxes as shown in Figures 4 and 6.

(d) The MALS light bar assemblies, flashing lights, prefabricated metal housing and equipment it encloses are adequately grounded. See Figure 8 for typical grounding and installation details.

(e) 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 as shown in Figure 2.

(2) Typical equipment grounding and installation details are shown in Figure 8.

(3) Primary wires for the multiple system are installed and marked in accordance with applicable sections of Item L-108 of AC 150/5370-1.

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

c. AVASI.

(1) The AVASI light units are installed in the configuration as shown in Figure 3.

(2) Wires for the system circuits are installed and marked in accordance with applicable sections of Item L-108 of AC 150/5370-1.

(3) The AVASI equipment is assembled in accordance with the manufacturer's instructions.

8. INSPECTION.

a. Light Unit. Each light unit should be inspected to determine that the equipment has been installed at the proper location, height, and with the proper light fixture orientation.

b. Wiring and Components. All wiring and electrical components (fuses, circuit breakers, transformers, switches, etc.) are checked to determine if they have the correct rating and that they are installed in accordance with local electrical code requirements.

c. Lamps. The voltage at the lamps installed in the equipment is checked to determine if the supply voltage is within specified tolerance. If a voltage in excess of rated voltage is impressed across a lamp, the life of the lamp will be reduced.

d. Installation. The systems are checked to determine if they have been installed in accordance with installation requirements. The installed equipment is checked to determine if it has been assembled and placed in accordance with the equipment manufacturer's instructions.

9. TESTS.

a. Operational. Each system is operated not less than 1/2 hour. In addition, each control is operated not less than 10 times.

b. Primary Cables. The circuit cables are tested in accordance with the applicable sections of Item L-108 of AC 150/5370-1.

10. MAINTENANCE.

a. General. A maintenance program is necessary at airports with MALS, MALS/SF, REILS, or AVASI 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 system's 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, REILS, or AVASI 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. Lamps and other components with a limited life should be stocked.

APPENDIX 1. BIBLIOGRAPHY

1. Obtain copies of the following publications from the Federal Aviation Agency, Distribution Unit, HQ-438, Washington, D.C. 20553.

   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 150/5345-28, Specification for L-851 Abbreviated Visual Approach Slope Indicator.

2. Obtain copies of AC 150/5370-1, Standard Specifications for Construction of Airports, with Changes 1 and 2, from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Send check or money order with request made payable to the Superintendent of Documents in the amount of $3.10 for each copy. No c.o.d. orders are accepted.

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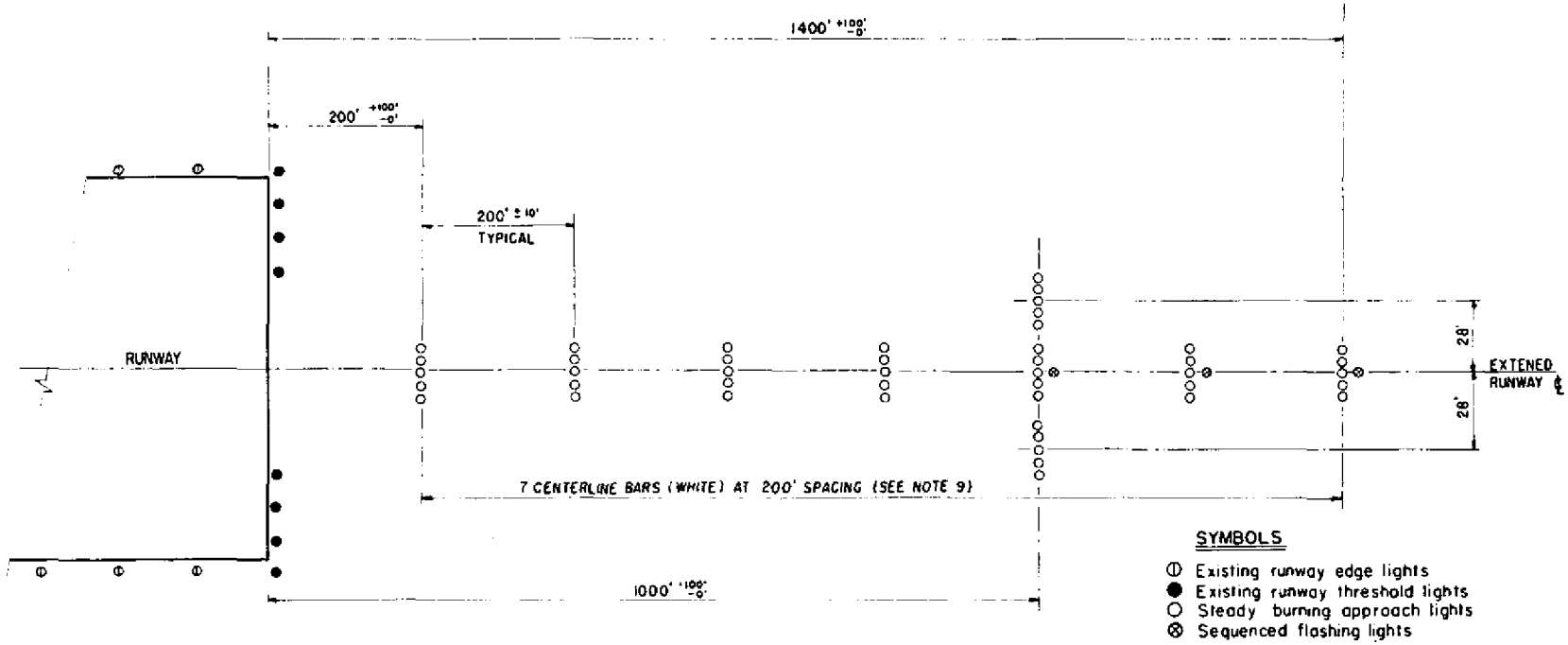
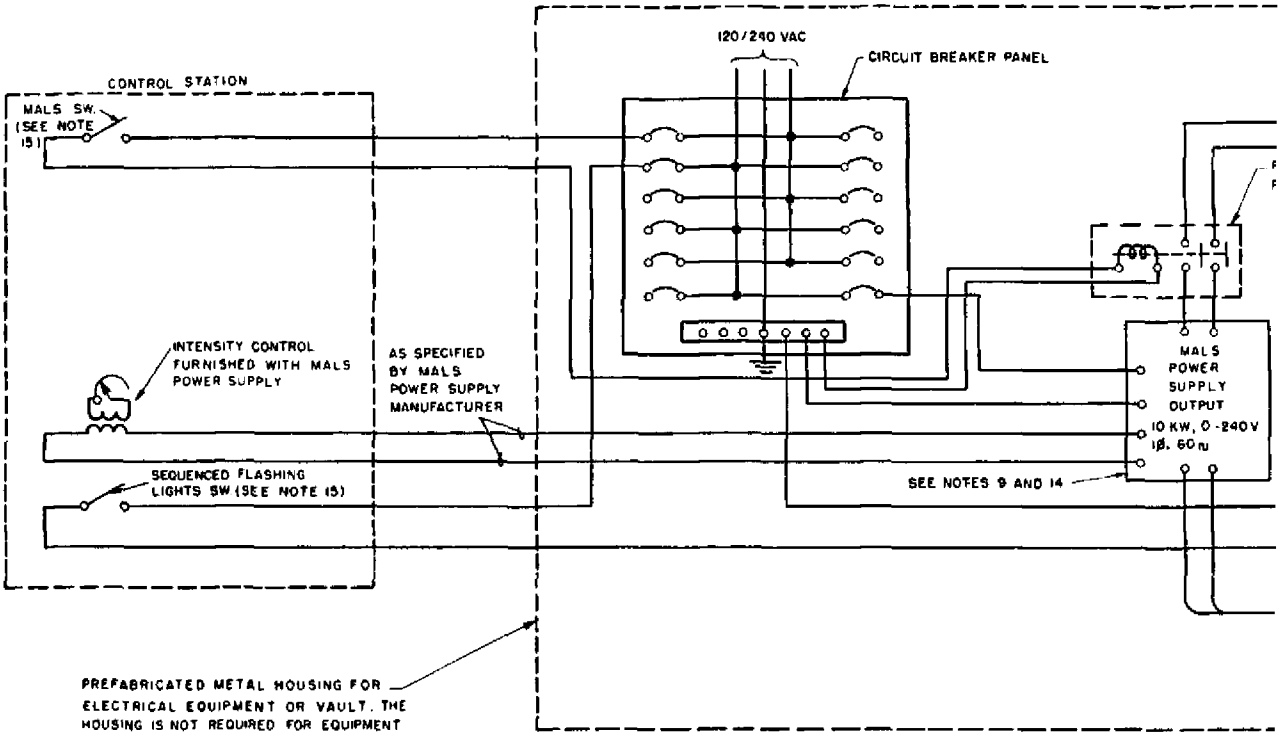


NOTES

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 a horizonal 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 three flashing lights flash in sequence.
9. The MALS light bar closest to the runway threshold is located at a distance of 200 feet $\pm^{100}_{0}$. All other light bars should be installed at 200-foot intervals with a ± 10-foot tolerance at each light bar station. The above tolerances can be used where it is impractical to install the light bars at the optimum locations.

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



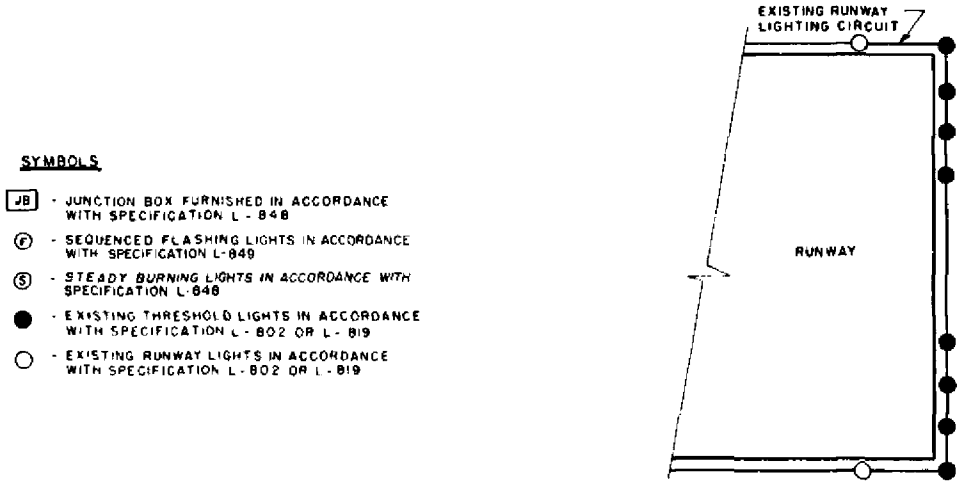


FIGURE 4. TYPICAL WIR
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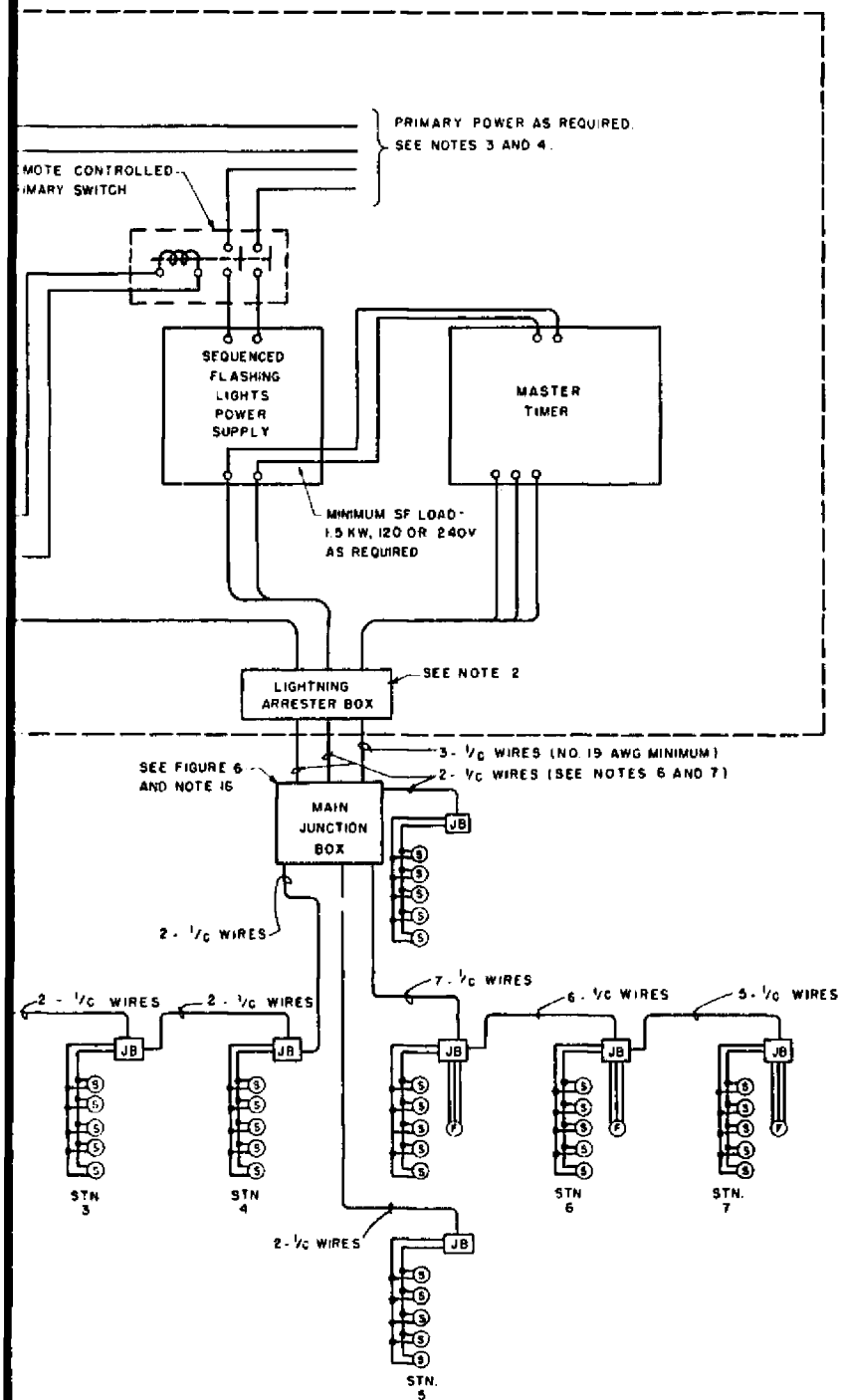


NG DIAGRAM FOR MALS/SF WITH
NUAL CONTROLS

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 120/240 volt AC, 3-wire 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' instructions

9 The MALS power supply is a suitable magnetic amplifier or a tapped transformer as shown in Figure 5.

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 checked 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 installation.

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 V 3-2 = 3.125 amps/bar x 2 bars x 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

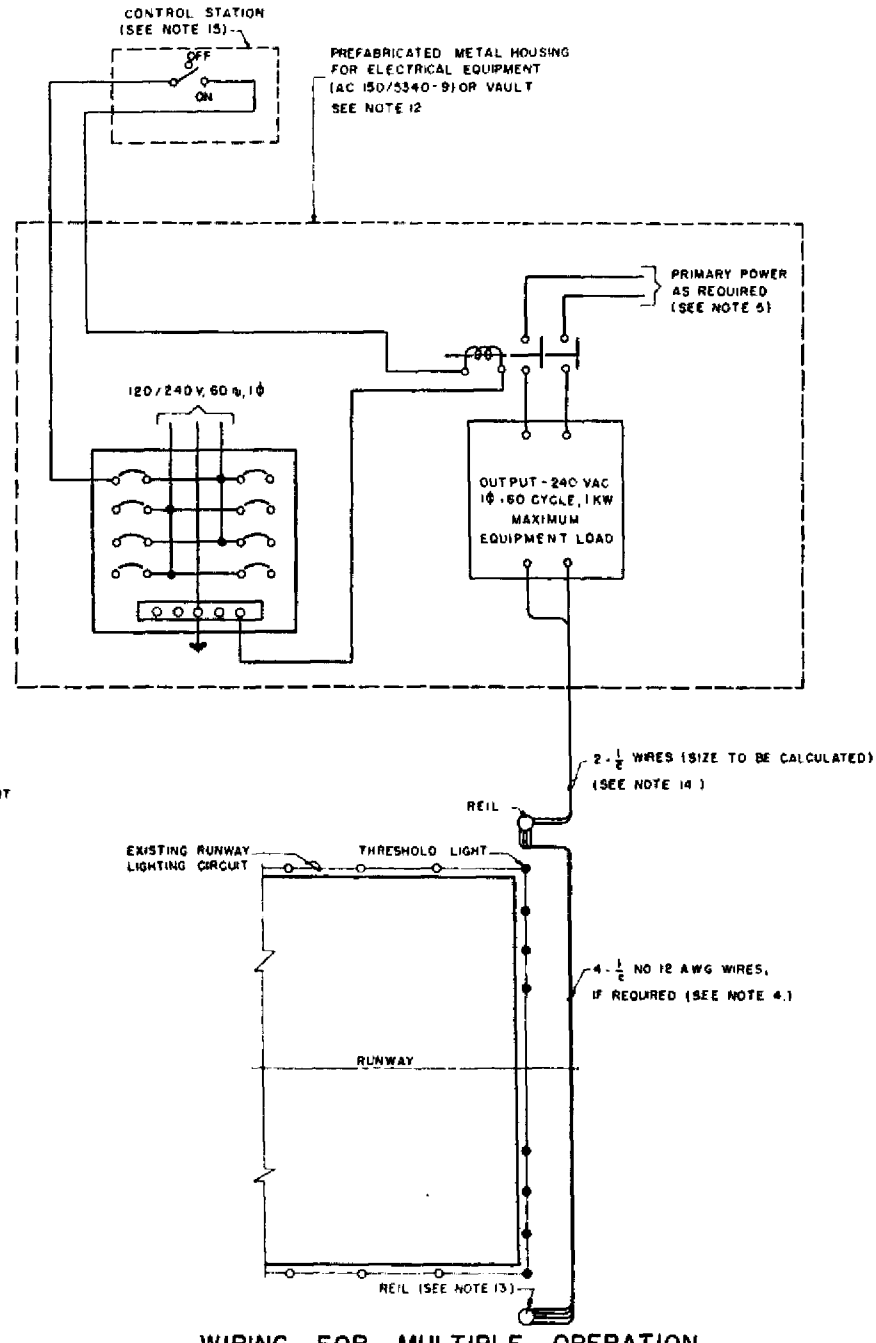
(4) Voltage at station 1 is approximately 240 V - (1.512 V + 1.008 V + 0.504 V) = 236.976 volts if the MALS power supply is set at the voltage tap or position to deliver 240 V + 5%

(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

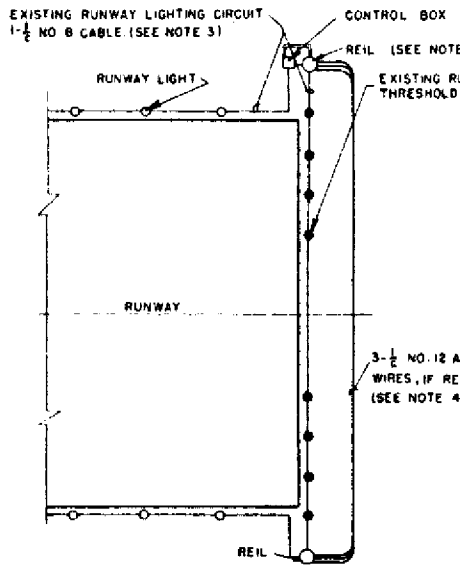


WIRING FOR MULTIPLE OPERATION

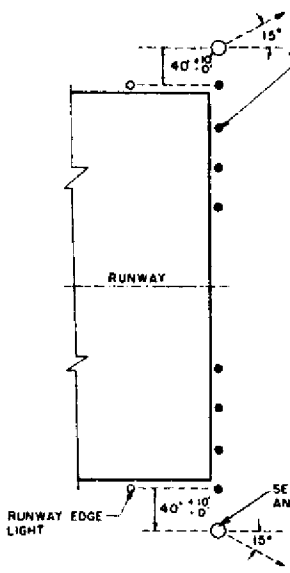
Notes

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) $\frac{500 \text{ watts / light unit} \times 2 \text{ light units}}{240 \text{ volts}} = 4.16$ 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) $\frac{12 \text{ volts permissible VD}}{6.74 \text{ VD/1000'}} = 1780$ 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).

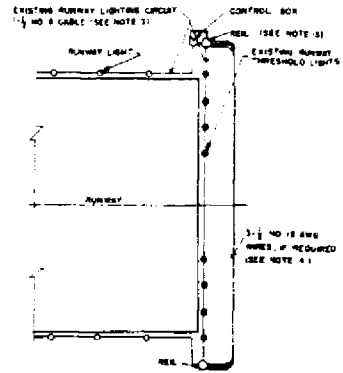
FIGURE 2. TYPICAL LAYOUT AND WIRING DIAGRAM FOR RUNWAY END IDENTIFIER LIGHT SYSTEM



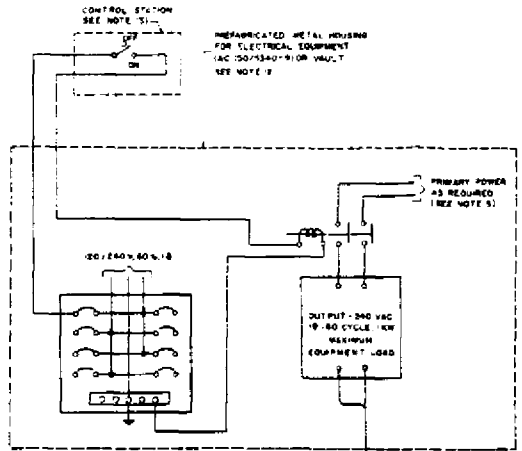
WIRING FOR SERIES OPERATION

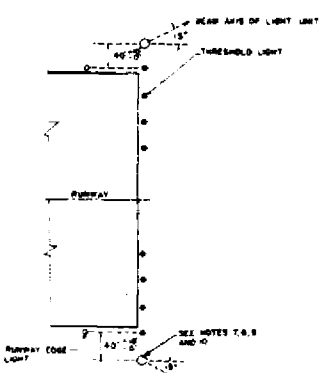


TYPICAL LAYOUT

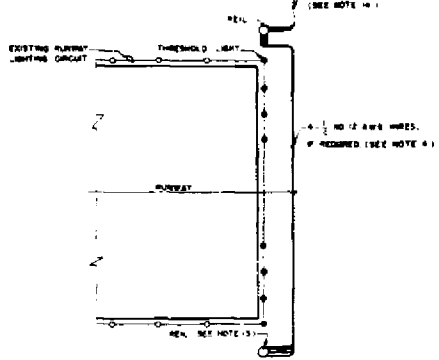


WIRING FOR SERIES OPERATION





TYPICAL LAYOUT



WIRING FOR MULTIPLE OPERATION

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. An isolation transformer may be used but be added to the requirements if the REILs are connected into the runway lighting circuit.
4. The REILs units are connecting into the electrical circuits in accordance with the manufacturer's recommendations.
5. Fuses and circuit breakers should be in accordance with equipment ratings.
6. The runway end identifier light system is provided as identified in the plans for the installation.
7. The optimum aperture for each light unit is as may with the runway threshold of 40 feet from the runway edge light.
8. A one or more 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 elevations of each light unit is aimed 15° outward from a line parallel to the runway centerline and inclined at or an angle 10° above the horizontal.
11. Lamp control can be obtained for REILS if required for the installation. The type of switch is as identified in Spec. L-849.
12. No packaging is required if the equipment stored in the housing is designed for outdoor service.
13. The light units, control box and light unit mount comply are in accordance with Specification L-849.
14. Sample computation to determine the maximum distance between the distribution transformer and the farthest REILS light unit using no.12 AWG wire (resistance = 1.62 ohms/1000'

a. Light intensity

(1) Load of 2 REILS light units - 12.0 Amperes

(2) Available voltage from secondary transformer for REILS - 240 volts ± 5 %

b. Computations

(1) 500 watts / light unit = 2 light units = 4.16 amperes load current
240 volts

(2) 240 x 5 % = 12 volts permissible line loss to meet rated voltage at terminal fixture.

(3) 1.62 ohms / 1000' = 0.74 amperes load current = 0.74 volts / 1000'

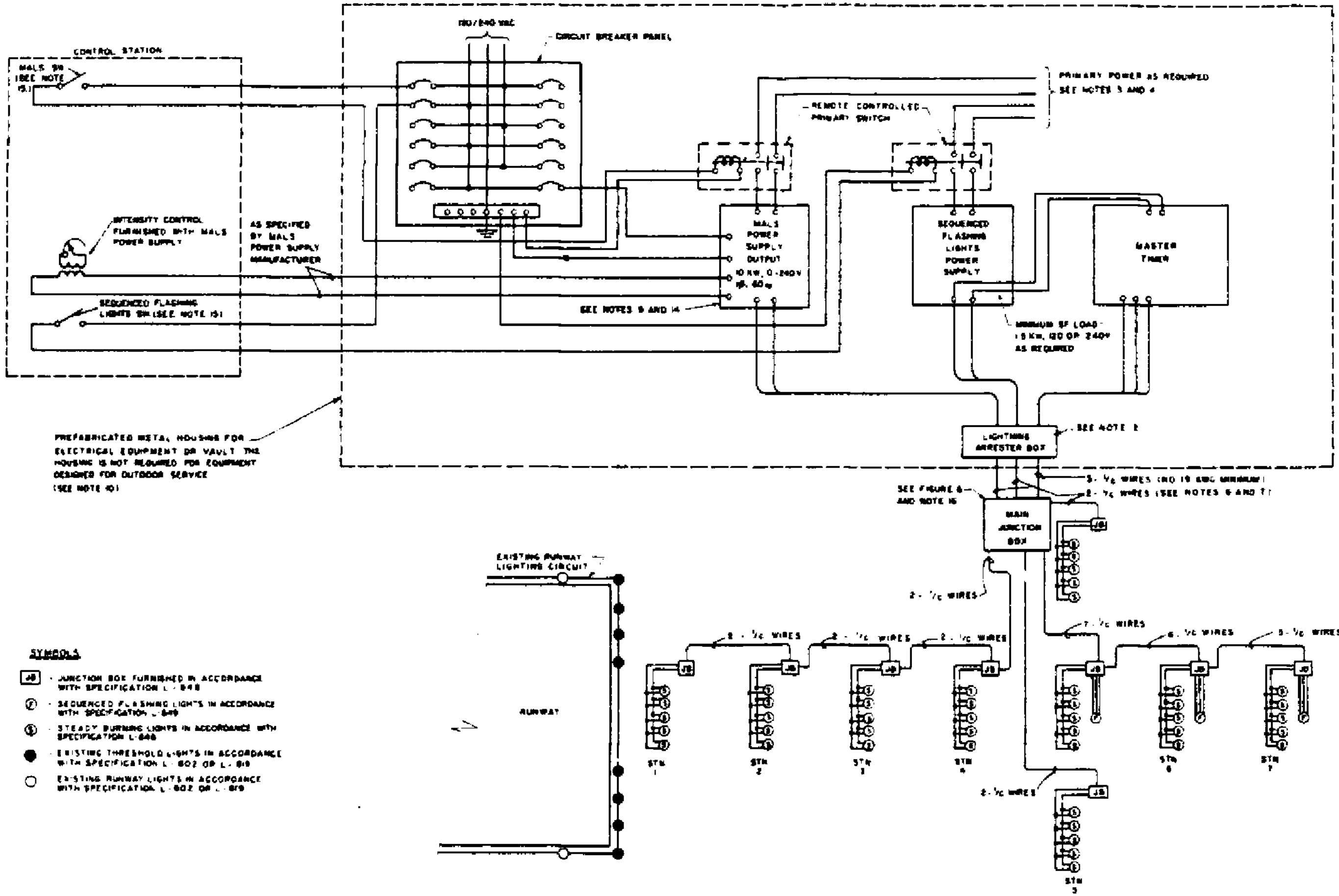
(4) 12 volts permissible VD = 780 feet
0.74 x D / 1000

(5) Since two wires are required the maximum distance is 780 / 2 = 390 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 photoelectric control (photocell or viewing device).

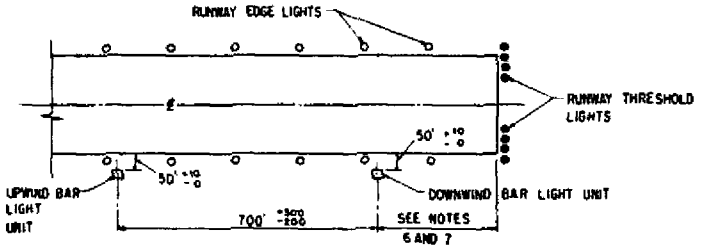
FIGURE 2. TYPICAL LAYOUT AND WIRING DIAGRAM FOR RUNWAY END IDENTIFIER LIGHT SYSTEM



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 [illegible] 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. [illegible]
7. A 120/240 volt AC, 3-wire or a 240/480 volt AC, 3-wire system may be used in lieu of the 240 volt AC, 1Ø system shown.
8. [illegible]
9. The MALS power supply is a suitable magnetic amplifier or a tapped transformer as shown in Figure 5.
10. [illegible] Advisory Circular No. 150/5340-9 "Prefabricated Metal Housing for Electrical Equipment".
11. [illegible] "Standard Specifications for Construction of Airports".
12. [illegible]
13. [illegible] 3.125 amps [illegible]
14. [illegible]
15. [illegible]
16. [illegible]

FIGURE 4. TYPICAL WIRING DIAGRAM FOR MALS/SF WITH REMOTE MANUAL CONTROLS



LEGEND

Angle B - Effective visual approach slope of system.

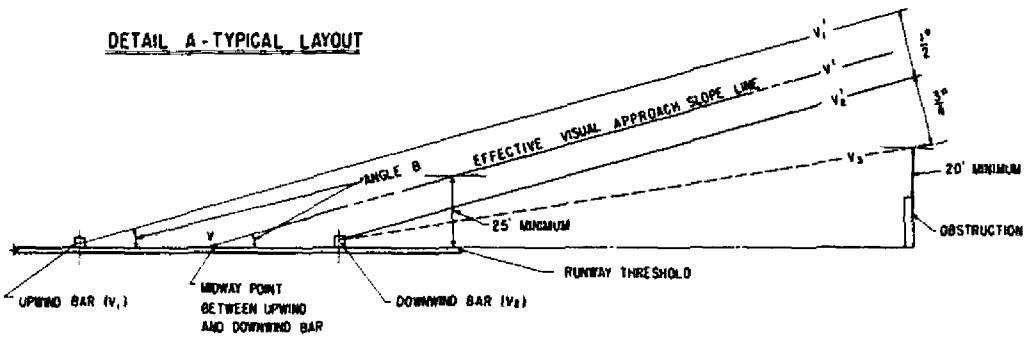
$V - V^1$ - Effective visual approach slope line.

$V_1 - V_1^1$ - Aiming line of upwind bar.

$V_2 - V_2^1$ - Aiming line of downwind bar.

$V_3 - V_3$ - Approach clearance surface line.

DETAIL A - TYPICAL LAYOUT

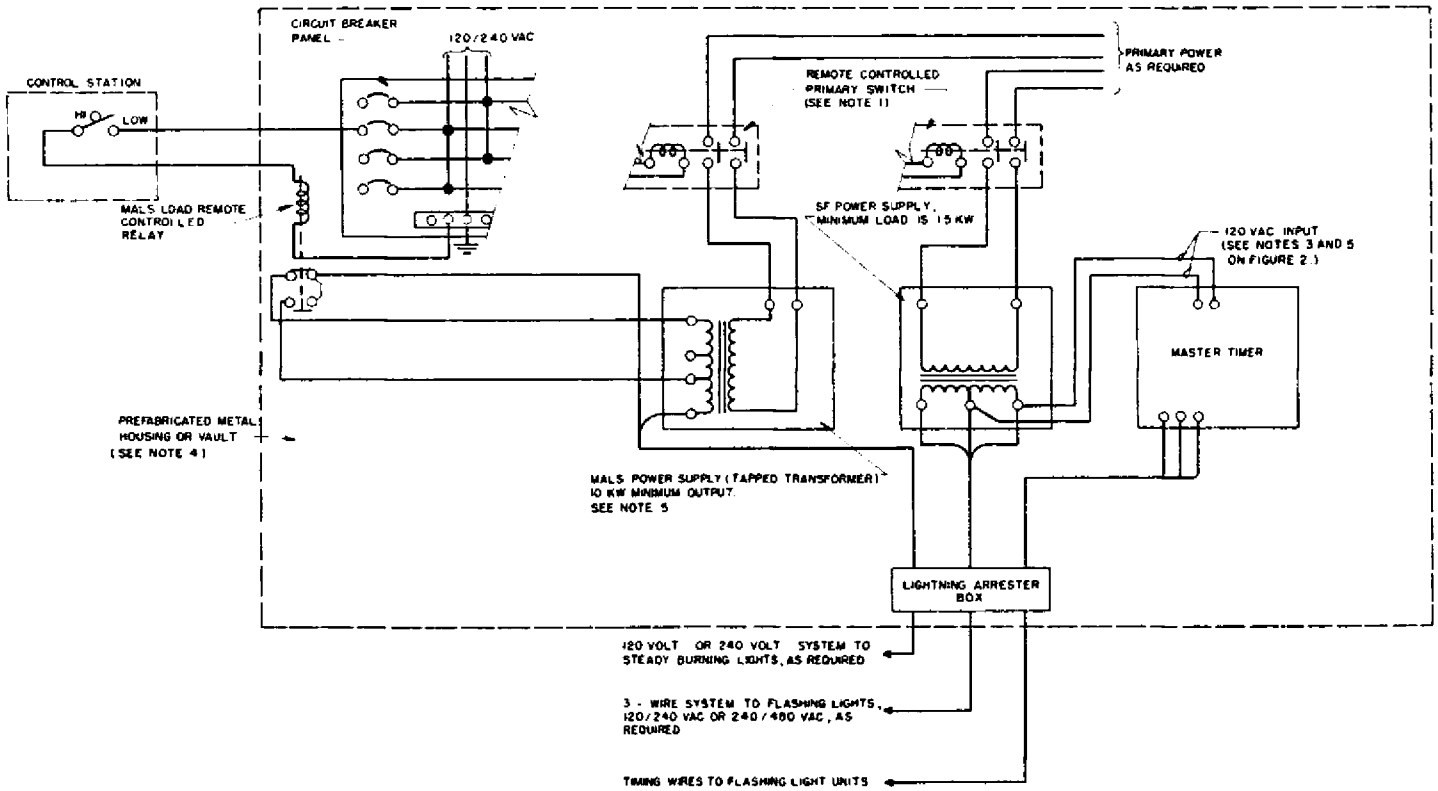


DETAIL B - AIMING CRITERIA

NOTES

1. The upwind and downwind light units are located at the same distance from the runway edge.
2. The center of the optical aperture of the installed downwind and upwind light units is within plus or minus one foot of the runway crown.
3. All obstructions, as determined by applicable criteria for determining obstructions to air navigation, are lighted and marked as required.
4. The downwind and upwind light units shown in Detail B are aimed in accordance with the equipment manufacturer's instructions within plus or minus 2 minutes of the respective angles formed by line $V_2 - V_2^1$ and the runway surface, and line $V_1 - V_1^1$ and the runway surface.
5. The effective visual approach slope of the system can be determined by the steps listed below:
   a. A plot of the approach area showing the location and heights of all obstructions as determined by the applicable criteria should be obtained.
   b. A line should be drawn from the downwind bar location to 20 feet above the most critical obstruction in the area. See line $V_2 - V_3$ of Detail B.
   c. The downwind bar is aimed at an angle equal to that obtained in *note* b, above plus 1/2 degree. See line $V_2 - V_2^1$ of Detail B.
   d. The upwind bar is aimed in accordance with the equipment manufacturer's instructions 1/2 degree above the downwind bar.
   e. The effective approach slope of the system (angle B shown in Detail B) is equal to the aiming of the upwind bar.
6. The optimum location for the downwind bar is from 500 feet to 800 feet from the runway approach threshold. The downwind bar may be located less than 500 feet from the threshold providing the effective approach slope line ($V - V^1$) clears the runway threshold a minimum distance of 25 feet.
7. Where terrain drops off rapidly near the approach threshold and severe turbulence may be experienced, the effective approach slope should be established at its maximum elevation and the downwind bar located at its maximum distance from the landing threshold in order to keep aircraft as high as feasible over the landing threshold.

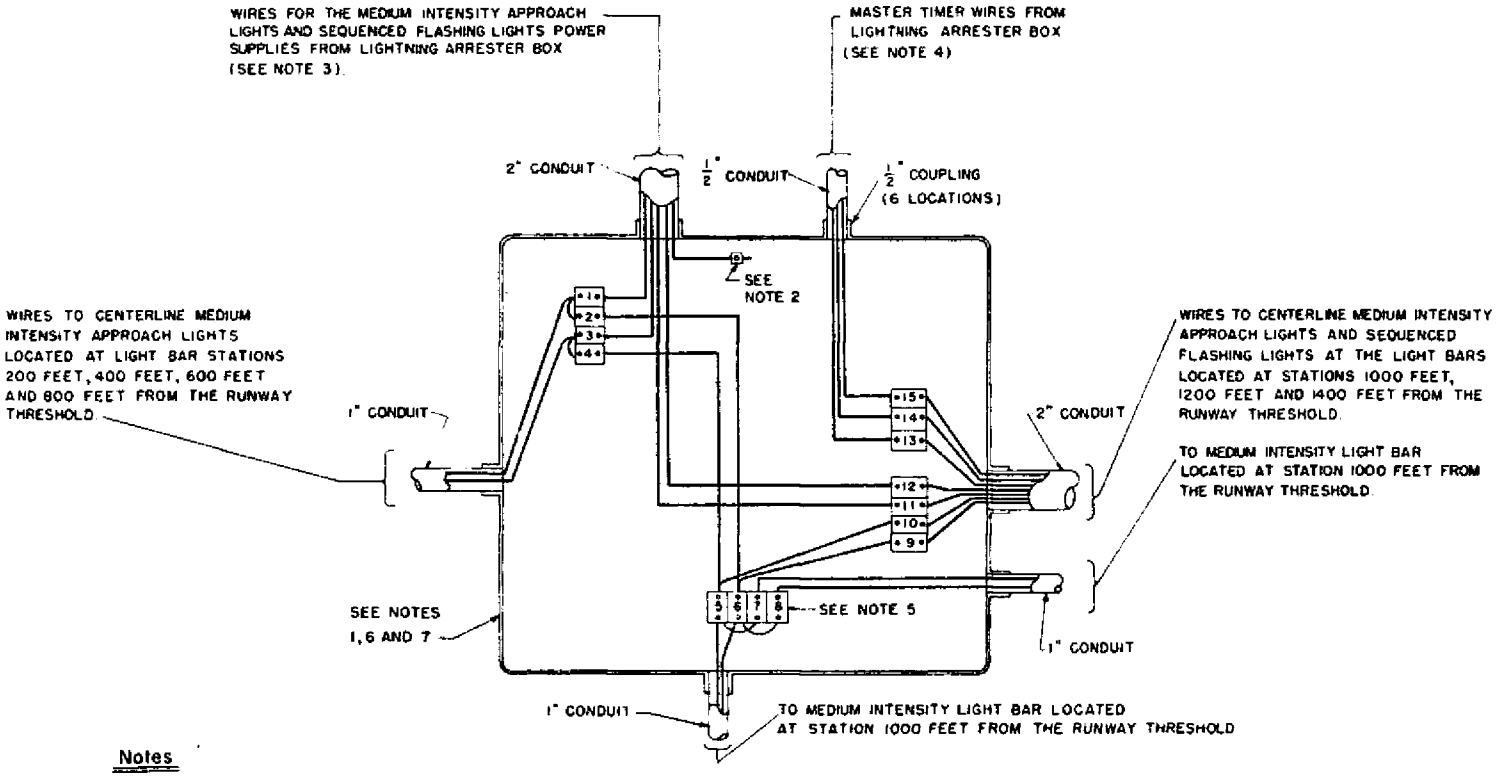
FIGURE 3. AVASI LAYOUT, INSTALLATION, AND AIMING CRITERIA



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, by a photoelectric device or by a timing device.
3. The applicable notes on Figure 4 apply to this figure.
4. An enclosure is not required for equipment designed for outdoor service.
5. Two 5 KW transformers connected as shown in Figure 9 can be used in lieu of a tapped transformer.

FIGURE 5. TYPICAL WIRING DIAGRAM FOR MALS/SF WITH AUTOMATIC OR RADIO CONTROLS



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 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.

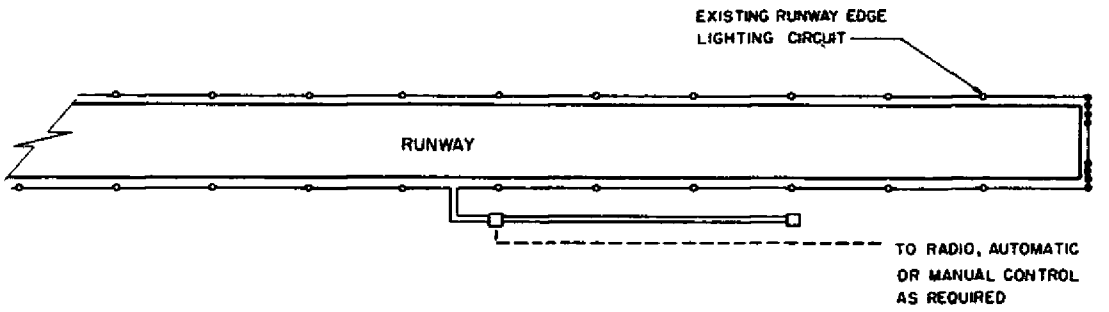
FIGURE 6. TYPICAL DETAILS FOR MAIN JUNCTION BOX

Symbols

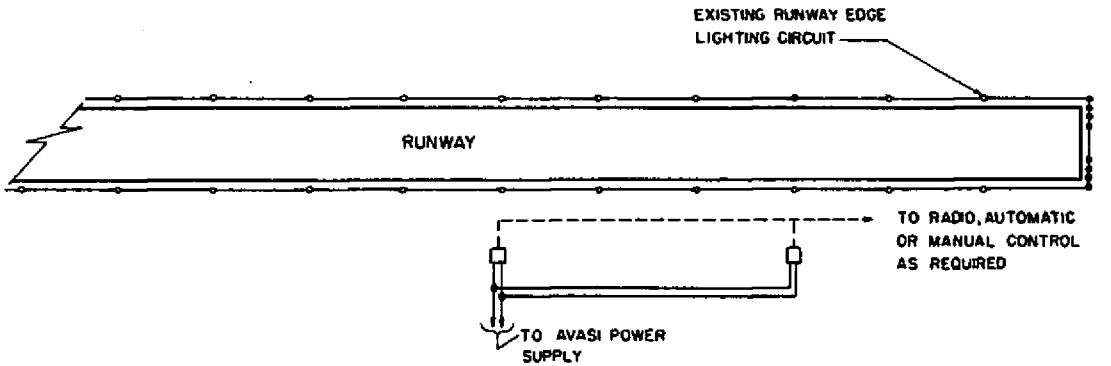
- □ AVASI Light Unit
- ○ Runway Edge Light
- ● Runway Threshold Light

Notes

1. AVASI light units require not more than 1.5 KW.
2. Safety switches and circuit breaker should be in accordance with local code requirements.

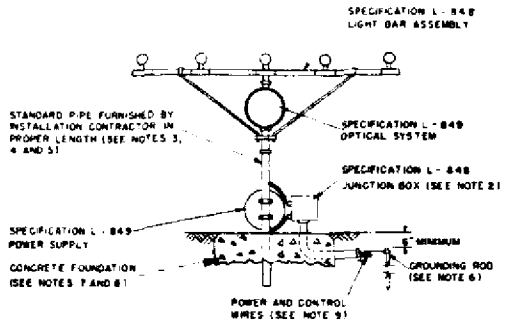


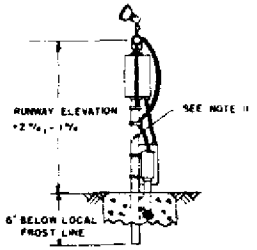
SERIES CIRCUIT INSTALLATION



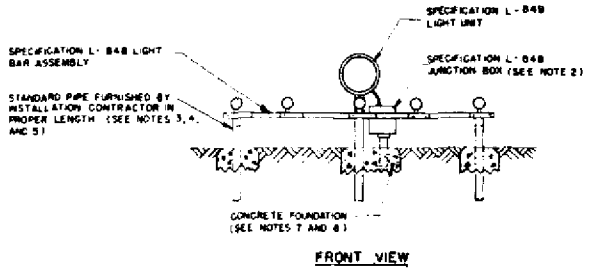
MULTIPLE CIRCUIT INSTALLATION

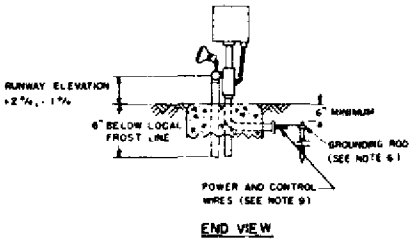
FIGURE 7. TYPICAL WIRING DIAGRAMS FOR AVASI



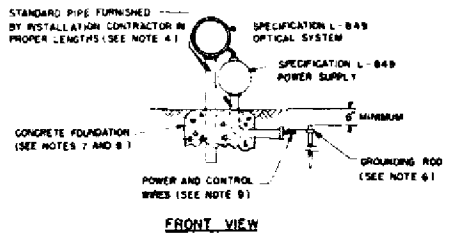


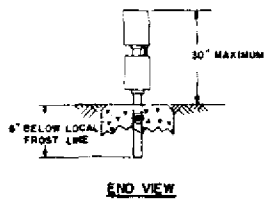
TYPICAL MALS/SF INSTALLATION FOR MOUNTING HEIGHTS 4 TO 10 FEET





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



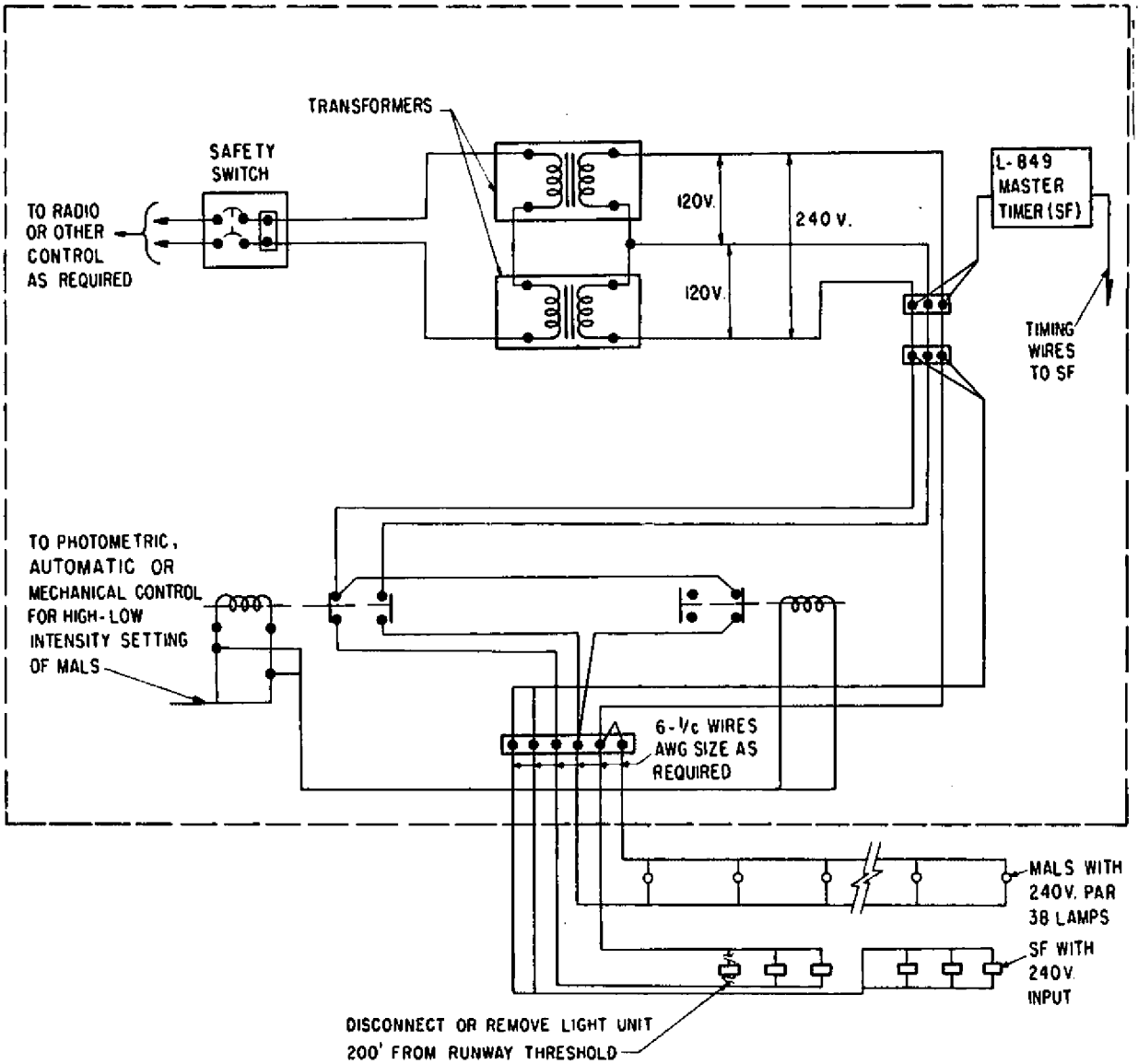


TYPICAL RUNWAY END INDENTIFIER LIGHT UNIT INSTALLATION

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 the L-849 equipment.
5. Frangible fittings are furnished by the installation contractor for all structures within 1000 feet of the runway threshold
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.
11. Structures greater than 10 feet should be designed and constructed to meet local environmental conditions and safety requirements

FIGURE 8. TYPICAL INSTALLATION DETAILS FOR MALS/SF AND REILS EQUIPMENT



Notes:

1. The installations conform to the applicable sections of the National Electrical Code and local codes.
2. Contactors and switches should have an adequate rating for the intended service.

FIGURE 9. MODIFICATIONS FOR EXISTING MALS/SF INSTALLATIONS

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