ADB
A Siemens Company

Style B
L-880/L-881 PAPI
Precision Approach Path Indicator
(Current Powered)

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AC 150/5345-28D

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Record of Changes

Page	Rev	Description	EC No.	Checked	Approved	Date
	A	Released manual.		TN	WT	9/24/97
2-13, 3-16 thru 3-19, 3-32, 7-10, 7-11, 8-1 thru 8-5	B	Deleted references to L-867 base size. Changed transformer wiring requirements on Figures 8-3 and 8-4. Added two figures for 3-lamp external wiring diagrams. Corrected Table 2-3 and modified Table 2-4. Added field splice kit part numbers for L-880 and L-881. Changed Section 8 figures to 11 x 17 landscape. Added Manual Production Instructions page. Added note on external wiring requirements.	3157	TN	WT	12/19/97
7-6, 7-7, 7-10, 7-11, 8-1 thru 8-4	C	Changed part numbers in the master box assembly, slave box assembly, and L-880/L-881 field splice kits parts lists. Updated all wiring diagrams.	3289	TN	VP	3/5/98

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Warranties

Products of ADB manufacture are guaranteed against mechanical, electrical, and physical defects (excluding lamps) for a period of one year from the date of installation or a maximum of two years from the date of shipment and are guaranteed to be merchantable and fit for the ordinary purposes for which such products are made.

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ADB reserves the right to examine goods upon which a claim is made. Said goods must be presented in the same condition as when the defect therein was discovered. ADB furthers reserves the right to require the return of such goods to establish any claim.

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Disclaimers

This manual could contain technical inaccuracies or typographical errors. ADB reserves the right to revise this manual from time to time in the contents thereof without obligation of ADB to notify any person of such revision or change.

Details and values given in this manual are average values and have been compiled with care. They are not binding, however, and ADB disclaims any liability for damages or detriments suffered as a result of reliance on the information given herein or the use of products, processes or equipment to which this manual refers. No warranty is made that the use of the information or of the products, processes or equipment to which this manual refers will not infringe any third party's patents or rights. The information given does not release the buyer from making their own experiments and tests.

Section 1
Safety

1. Introduction

This section contains general safety instructions for using your ADB equipment. Task- and equipment-specific warnings are included in other sections of this manual where appropriate. Note all warnings and follow all instructions carefully. Failure to do so may result in personal injury, death, or property damage.

To use this equipment safely,

- refer to the FAA Advisory Circular AC 150/5340-26, *Maintenance of Airport Visual Aids Facilities*, for instructions on safety precautions.
- observe all safety regulations. To avoid injuries, always remove power prior to making any wire connections and touching any parts. Refer to FAA Advisory Circular AC 150/5340-26.
- read and become familiar with the general safety instructions provided in this section of the manual before installing, operating, maintaining, or repairing this equipment.
- read and carefully follow the instructions given throughout this manual for performing specific tasks and working with specific equipment.
- store this manual within easy reach of personnel installing, operating, maintaining, or repairing this equipment.
- follow all applicable safety procedures required by your company, industry standards, and government or other regulatory agencies.
- obtain and read Material Safety Data Sheets (MSDS) for all materials used.

2. Safety Symbols

Become familiar with the safety symbols presented in this section. These symbols will alert you to safety hazards and conditions that may result in personal injury, death, or property and equipment damage.

WARNING: Failure to observe this warning may result in personal injury, death, or equipment damage.

WARNING: Risk of electrical shock. Failure to observe this warning may result in personal injury, death, or equipment damage.

2. Safety Symbols *(contd.)*

WARNING: Disconnect equipment from line voltage. Failure to observe this warning may result in personal injury, death, or equipment damage.

WARNING: Wear safety goggles. Failure to observe may result in serious injury.

CAUTION: Failure to observe may result in equipment damage.

3. Qualified Personnel

The term *qualified personnel* is defined here as individuals who thoroughly understand the equipment and its safe operation, maintenance, and repair. Qualified personnel are physically capable of performing the required tasks, familiar with all relevant safety rules and regulations and have been trained to safely install, operate, maintain, and repair the equipment. It is the responsibility of the company operating this equipment to see that its personnel meet these requirements.

4. Intended Use

WARNING: Use of this equipment in ways other than described in this manual may result in personal injury, death, or property and equipment damage. Use this equipment only as described in this manual.

ADB cannot be responsible for injuries or damages resulting from nonstandard, unintended applications of its equipment. This equipment is designed and intended only for the purpose described in this manual. Uses not described in this manual are considered unintended uses and may result in serious personal injury, death, or property damage. Unintended uses may result from taking the following actions:

- making changes to equipment that have not been recommended or described in this manual or using parts that are not genuine ADB replacement parts
- failing to make sure that auxiliary equipment complies with approval agency requirements, local codes, and all applicable safety standards
- using materials or auxiliary equipment that are inappropriate or incompatible with your ADB equipment
- allowing unqualified personnel to perform any task

5. Installation

Read the installation section of all system component manuals before installing your equipment. A thorough understanding of system components and their requirements will help you install the system safely and efficiently.

WARNING: Failure to follow these safety procedures can result in personal injury or death.

- Allow only qualified personnel to install ADB and auxiliary equipment. Use only approved equipment. Using unapproved equipment in an approved system may void agency approvals.
- Make sure all equipment is rated and approved for the environment in which you are using it.
- Follow all instructions for installing components and accessories.
- Install all electrical connections to local code.
- Use only electrical wire of sufficient gauge and insulation to handle the rated current demand. All wiring must meet local codes.
- Route electrical wiring along a protected path. Make sure they will not be damaged by moving equipment.
- Protect components from damage, wear, and harsh environment conditions.
- Allow ample room for maintenance, panel accessibility, and cover removal.
- Protect equipment with safety devices as specified by applicable safety regulations.
- If safety devices must be removed for installation, install them immediately after the work is completed and check them for proper functioning.

6. Operation

Only qualified personnel, physically capable of operating the equipment and with no impairments in their judgment or reaction times, should operate this equipment.

Read all system component manuals before operating this equipment. A thorough understanding of system components and their operation will help you operate the system safely and efficiently.

6. Operation *(contd.)*

- Before starting this equipment, check all safety interlocks, fire-detection systems, and protective devices such as panels and covers. Make sure all devices are fully functional. Do not operate the system if these devices are not working properly. Do not deactivate or bypass automatic safety interlocks or locked-out electrical disconnects or pneumatic valves.
- Never operate equipment with a known malfunction.
- Do not attempt to operate or service electrical equipment if standing water is present.
- Use this equipment only in the environments for which it is rated. Do not operate this equipment in humid, flammable, or explosive environments unless it has been rated for safe operation in these environments.
- Never touch exposed electrical connections on equipment while the power is ON.

7. Action in the Event of a System or Component Malfunction

Do not operate a system that contains malfunctioning components. If a component malfunctions, turn the system OFF immediately.

- Disconnect and lock out electrical power.
- Allow only qualified personnel to make repairs. Repair or replace the malfunctioning component according to instructions provided in its manual.

8. Maintenance and Repair

Allow only qualified personnel to perform maintenance, troubleshooting, and repair tasks. Only persons who are properly trained and familiar with ADB equipment are permitted to service this equipment.

- Always use safety devices when working on this equipment.
- Follow the recommended maintenance procedures in your equipment manuals.
- Do not service or adjust any equipment unless another person trained in first aid and CPR is present.
- Connect all disconnected equipment ground cables and wires after servicing equipment. Ground all conductive equipment.
- Use only approved ADB replacement parts. Using unapproved parts or making unapproved modifications to equipment may void agency approvals and create safety hazards.

8. Maintenance and Repair
(contd.)

- Check interlock systems periodically to ensure their effectiveness.
- Do not attempt to service electrical equipment if standing water is present. Do not service electrical equipment in a high-humidity environment.
- Use tools with insulated handles when working with electrical equipment.

Section 2
Description

1. Introduction

See Figures 2-1 and 2-2. This section describes the Style B, L-880 and L-881 Precision Approach Path Indicator (PAPI) systems used to provide visual approach path guidance to pilots of landing aircraft. The PAPI system is designed to operate from an L-828 constant current regulator (CCR) with a maximum output current of 6.6 A.

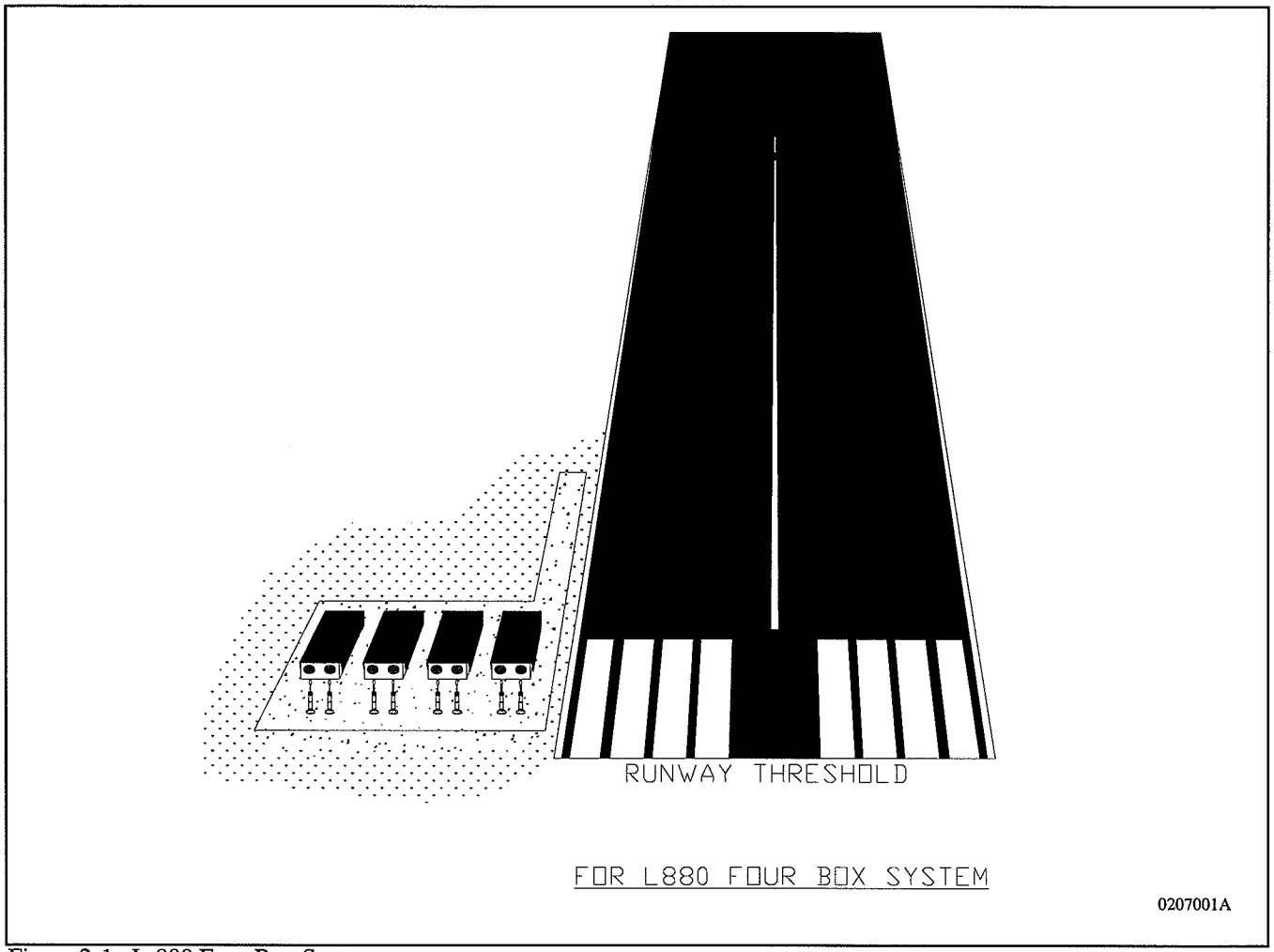


Figure 2-1. L-880 Four-Box System

When used on a 20 A series lighting circuit, L-830-7 isolation transformers must be used to step the current down to 6.6 A. The CCR controls the brightness of the Style B system. The CCR may have three or five brightness steps.

1. Introduction *(contd.)*

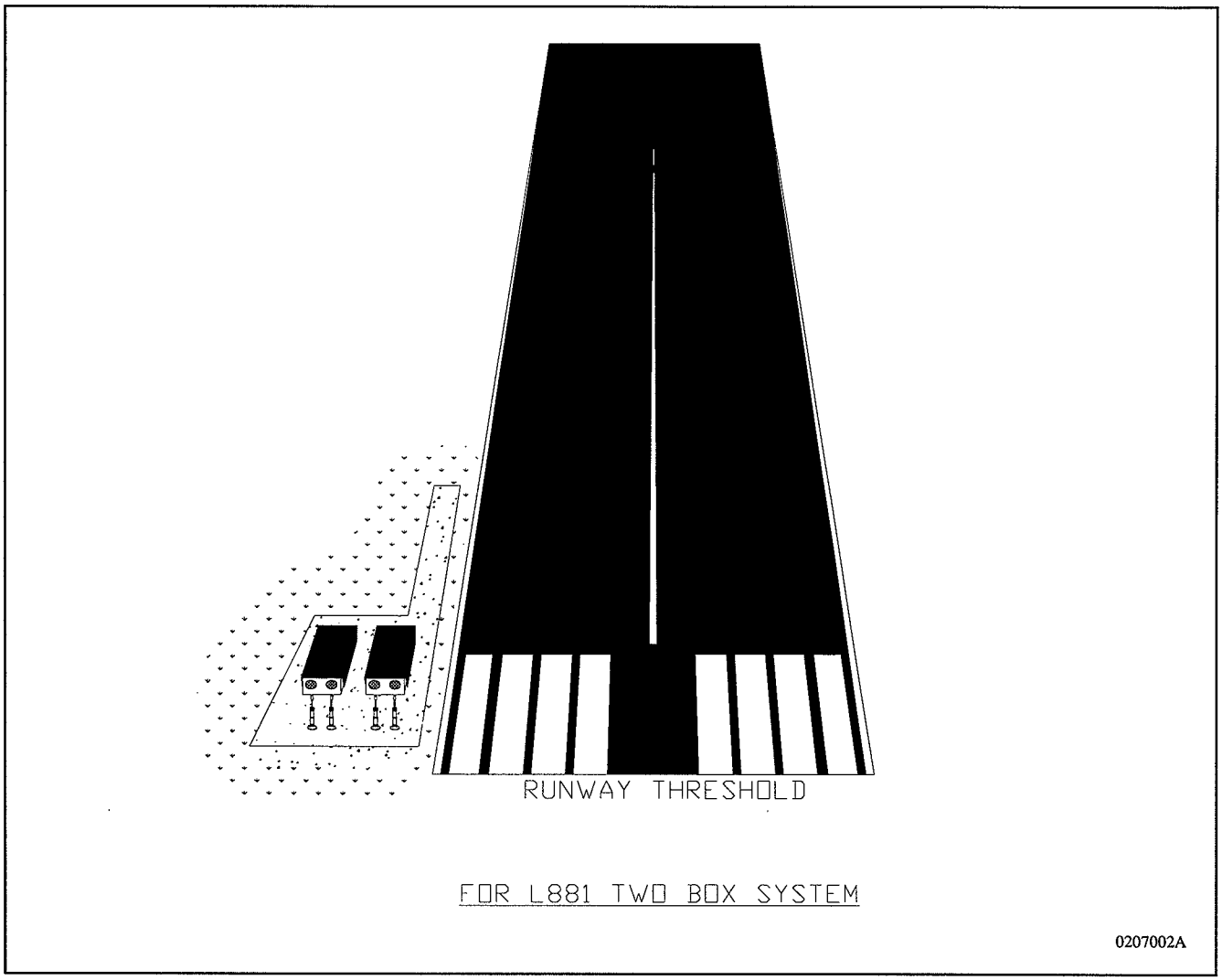


Figure 2-2. L-881 Two-Box System

2. Type L-880 PAPI System

See Figures 2-1, 2-3, and 2-4. The L-880 PAPI system consists of four identical light units that are normally installed on the left side of the runway (viewed from the approach end) in a line perpendicular to the runway centerline.

2. Type L-880 PAPI System
(contd.)

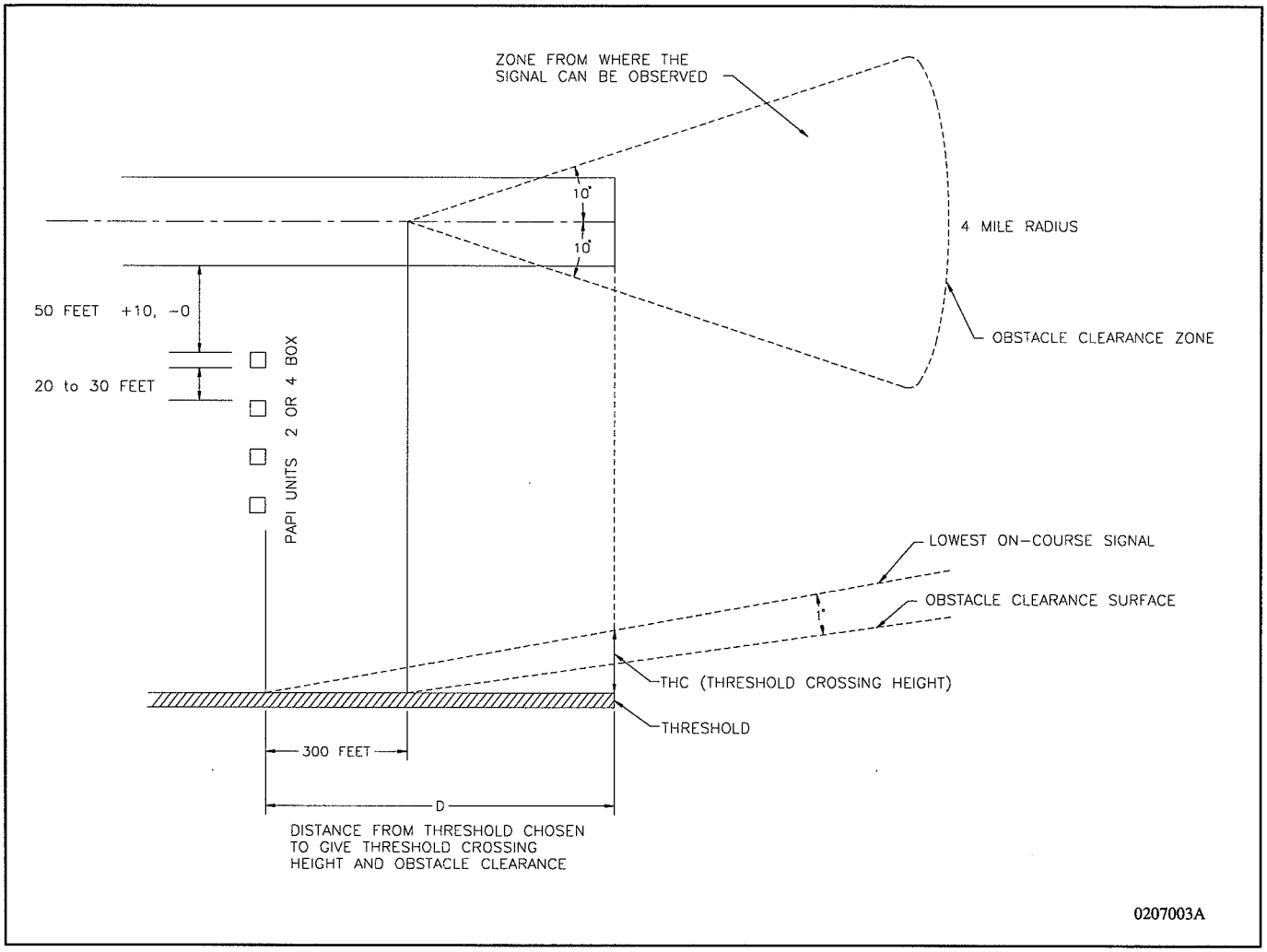


Figure 2-3. PAPI Obstacle Clearance Surface

2. Type L-880 PAPI System
(contd.)

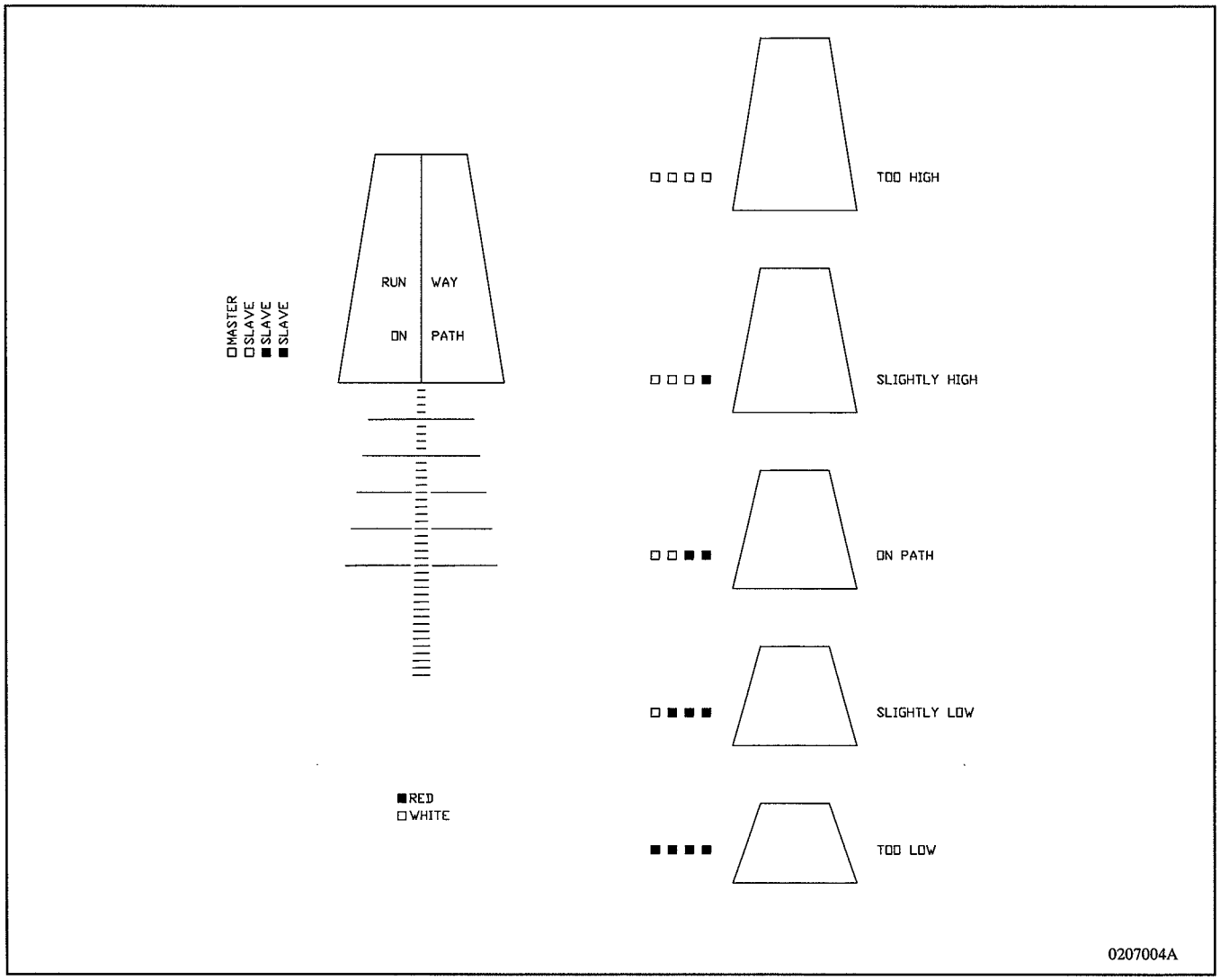


Figure 2-4. L-880 Signal Display

The units are aimed so that during a landing approach the pilot will see the following signal format:

- The inner two units as red and the outer two units as white when the aircraft is close to or on the approach slope.
- The unit nearest the runway as red and the three units farthest from the runway as white when above the approach slope; all four units appear white if the aircraft is excessively above the approach slope;
- The three units closest to the runway are seen as red and the unit farthest from the runway as white if the aircraft is slightly below the approach slope; and still further below, all the units will appear red.

3. Type L-881 PAPI System

See Figures 2-2, 2-3, and 2-5. The L-881 PAPI system consists of two identical light units that are normally installed on the left side of the runway (viewed from the approach end) in a line perpendicular to the runway centerline.

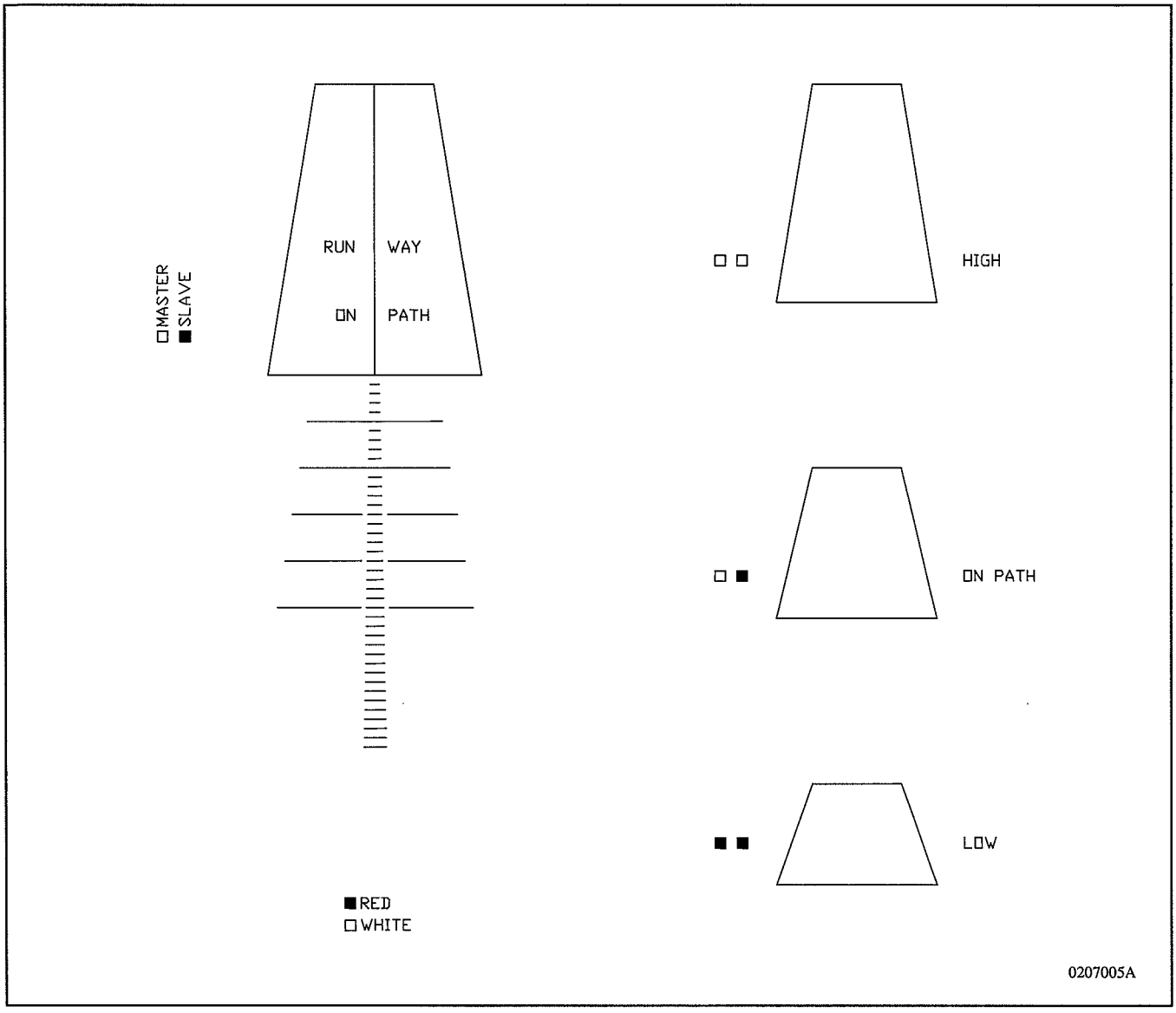


Figure 2-5. L-881 Signal Display

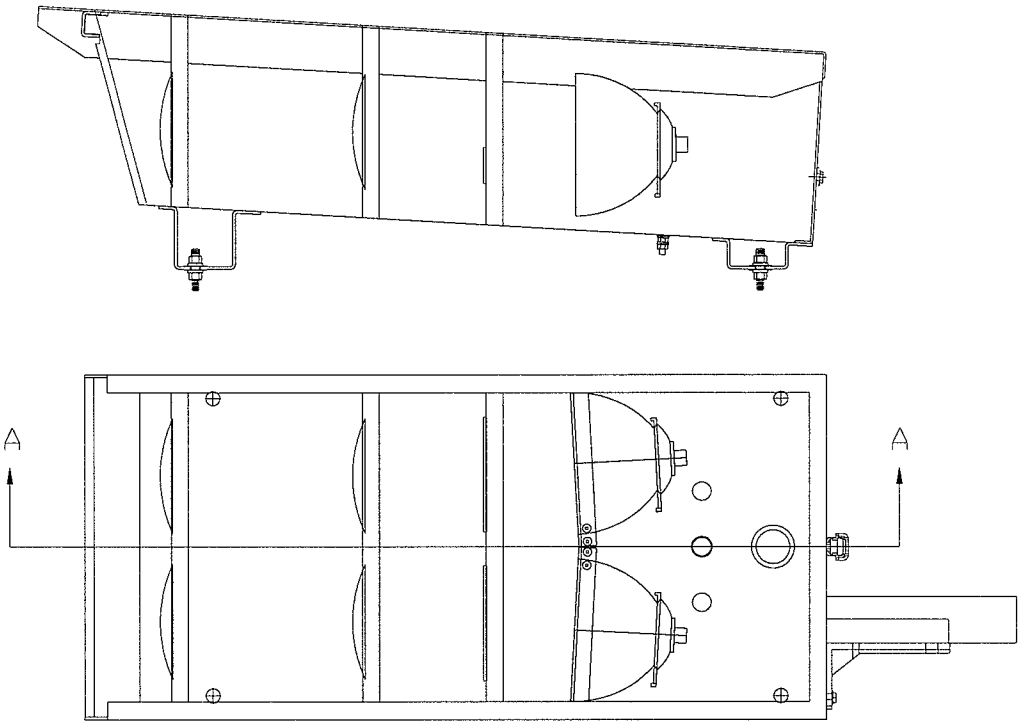
3. Type L-881 PAPI System *(contd.)*

The units are aimed so that during a landing approach the pilot will see the following signal format:

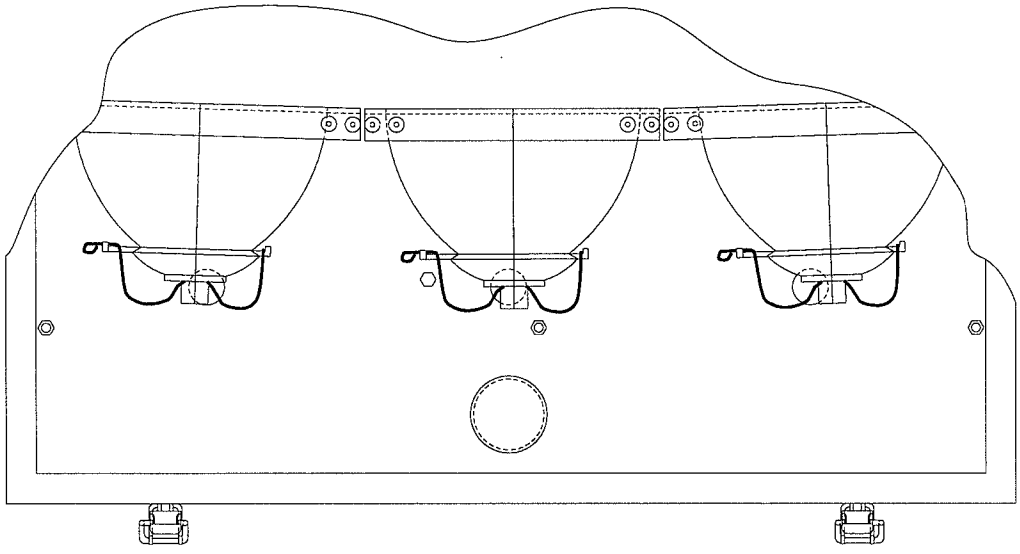
- Both units as red when the aircraft is below the approach slope
- The unit nearest the runway as red and the other unit as white when on or close to the approach slope
- Both units as white when the aircraft is above the approach slope

4. PAPI Light Unit

See Figure 2-6. A single PAPI light unit contains two or three 6.6 A, 200 W lamps, two or three reflectors and red filters, four or six lenses, a lens shield, and a tilt switch assembly attached to the rear of the unit. The PAPI unit is mounted on three or four adjustable legs. Each of these parts is discussed below.



Two Lamps Optical Box



Three Lamps Optical Box

0207006A

Figure 2-6. PAPI Light Unit

4. PAPI Light Unit *(contd.)*

Lamps

Two or three 200-watt prefocused halogen lamps are located in the rear of the unit, each in an indexed lampholder in a reflector and held in place with a forked spring clip. Slip-on type electrical connections permit easy replacement of failed lamps.

Reflector Panel

The reflector panel is fitted with two apertures in which the elliptical reflectors are housed. The reflectors are made of aluminum that is mechanically polished for brilliance and anodized for protection.

Filter Panel

The filter panel houses the two or three red filters. It also has two reference slots, C and D, used to locate the aiming device for making field adjustments of the light unit. These reference slots are precision machined in the factory. Be careful not to damage these machined slots.

Lens Panels

Four or six high optical quality objective lenses are housed in two or three lens panels. The upper rim of the front lens panel is equipped with two reference blocks, A and B, for field adjustment of the light unit. These blocks are precision-adjusted in the factory to be parallel with the optical centerline of the objective lenses.

Lens Shield

The flat glass shield (protective glass) serves to protect the lenses against materials such as sand and stone, and is designed to avoid reflections.

Adjustable Mounting Legs

See Figure 2-7. The three or four adjustable mounting legs are each made up of two screw rods (3, 8) connected by a differential sleeve (4). The upper (smaller diameter) rod is fitted with nuts and locking nuts designed for coarse height setting of the unit. The differential sleeve is used for the fine adjustment setting of the unit. The lower (larger diameter) rod is inserted into a conduit column with frangible coupling held in place by a flange bolted on a concrete pad.

Adjustable Mounting Legs
(contd.)

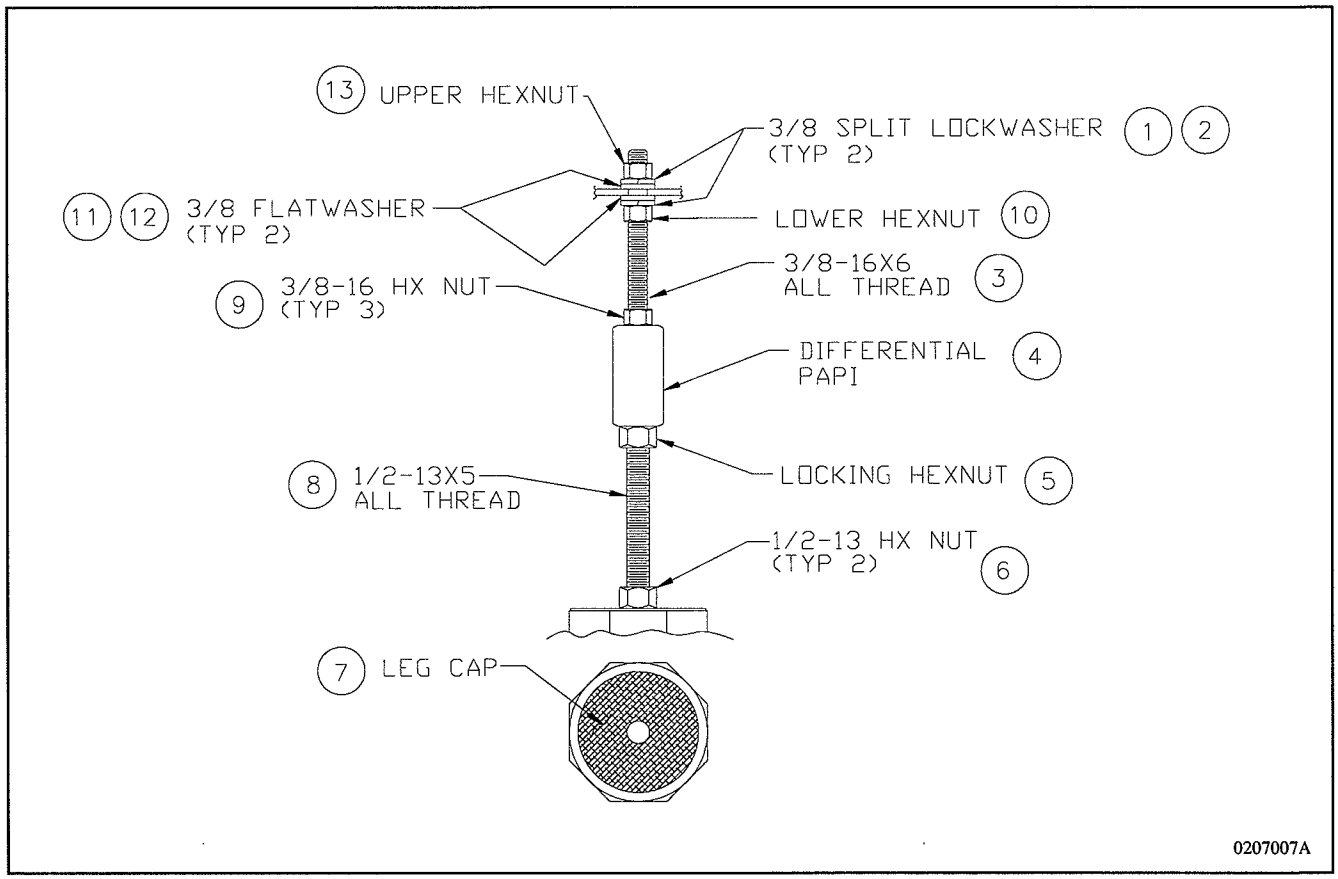


Figure 2-7. Adjustable Mounting Legs

Tilt Switch

The tilt switch assembly is designed to de-energize the lamps if the optical pattern is raised between 1/2 degree and 1 degree or lowered between 1/4 degree and 1/2 degree with respect to the present setting angle of the light unit. A time delay of 10-30 seconds is incorporated to prevent intermittent tilt switch activation due to vibration. The tilt switch assembly has a failsafe operation so that any malfunction of the switch including loss of power de-energizes the lamp circuits controlled by the tilt switch.

5. Theory of Operation

This section describes the L-880/L-881 PAPI system theory of operation. It includes operations of the master, slave, optional heater, and tilt switch.

Master

See Figure 2-8. The isolation transformer supplies power to the master at terminal block TB1-1 and TB1-2. This power is fed to PCB1, which provides +24 Vdc to all relays in the master and slave units. If any PAPI unit is tilted, the tilt switch circuit opens, which causes the time delay PCB2 in the master to de-energize after a nominal 20-second delay. This interrupts (in all PAPI units) the +24 Vdc return on all the lamp relays, thus removing the 6.6 A power to all the lamps in the PAPI system. The PAPI system can not be re-energized until all the PAPI units are in proper alignment.

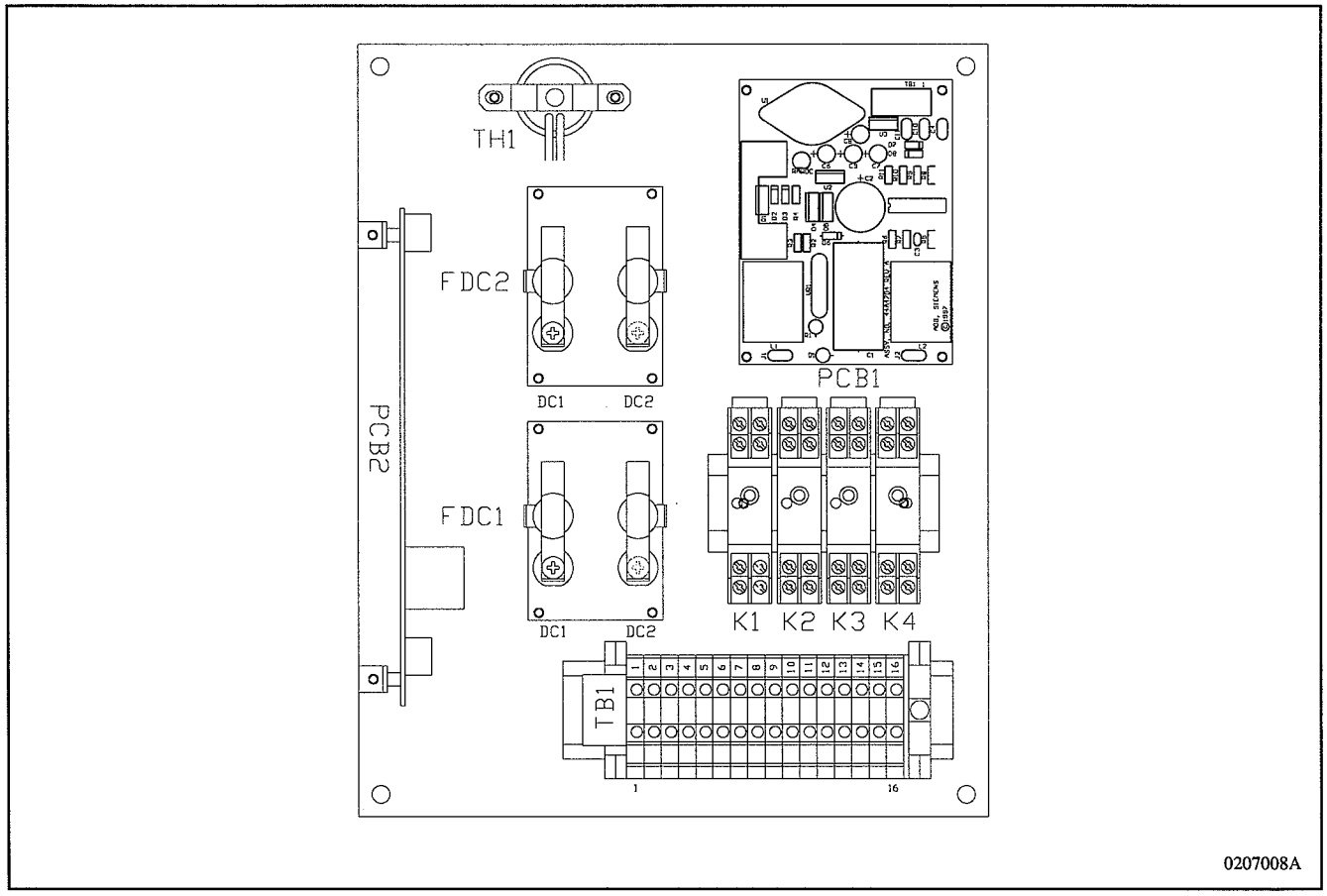


Figure 2-8. Master Operations

Slave

See Figure 2-9. The internal circuitry in the slave units are powered by the master. Each of the lamps in the master and slave units are supplied with 6.6 A via an L-830-6 (6.6 A circuit) or L-830-7 (20 A circuit) isolation transformer as long as the lamp relay in each of the PAPI units is energized, which closes the 6.6 A lamp circuits. If a tilt switch on the master or any slave is moved from proper alignment, the time delay PCB2 in the master is de-energized after a nominal 20-second delay. This interrupts the +24 Vdc return in all the PAPI units, causing all of the lamp relays to de-energize and turns off power to all lamps in the PAPI system.

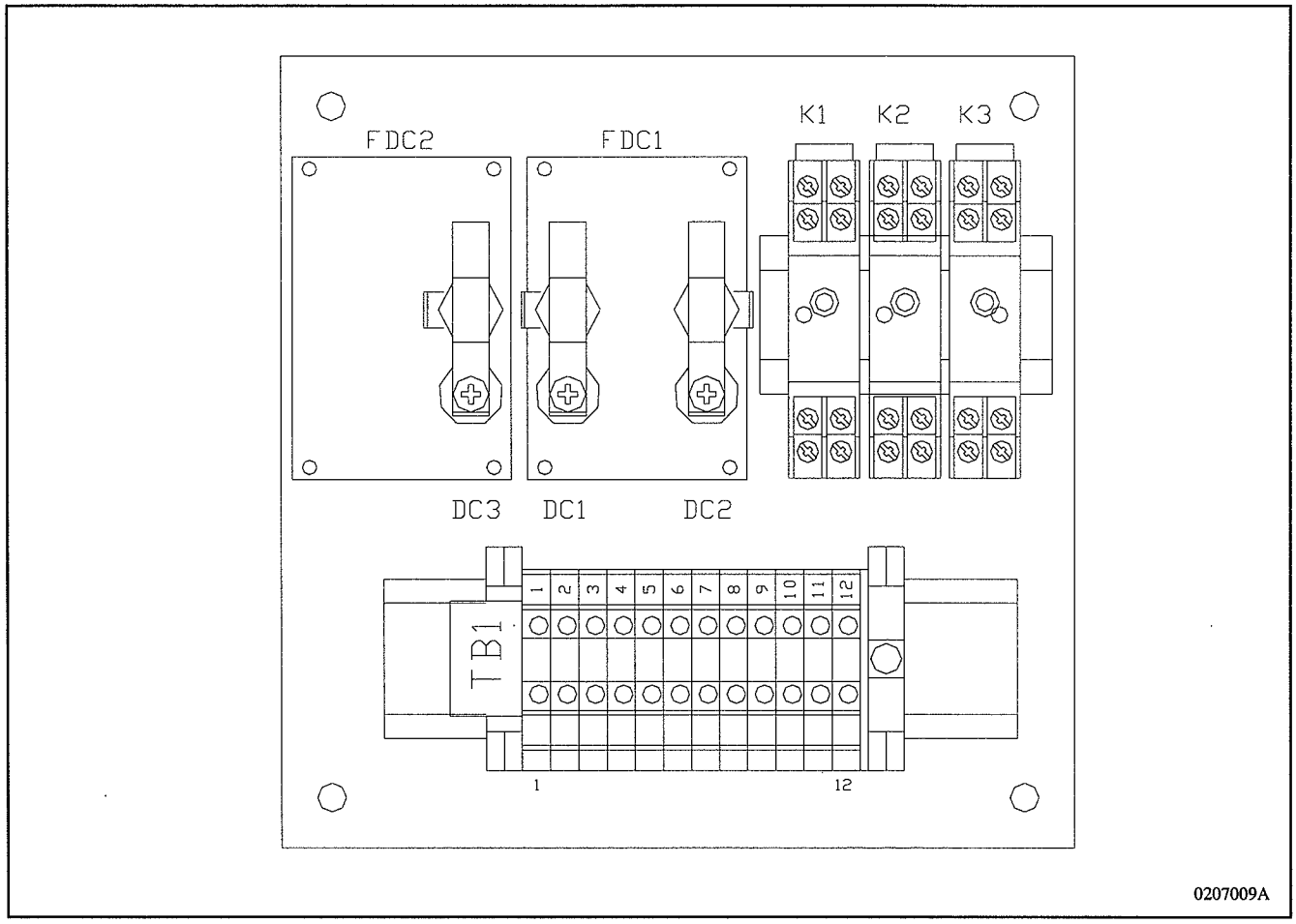


Figure 2-9. Slave Operations

Optional Heater

See Figure 2-8. Thermostat TH1 in the master is used to supply +24 Vdc to relay K1. When the outside air temperature drops below 0 °F, the thermostat turns on. This causes relay K1 to energize. Energizing relay K1 causes 6.6 A current to flow into the heater resistors R1 in the tilt switch boxes. This prevents the mercury in the tilt switches from freezing.

Tilt Switch

The tilt switch circuit is designed so that the tilt switches are a closed circuit as long as they are not inadvertently lowered between 1/4 degree and 1/2 degree or raised between 1/2 degree and 1 degree with respect to the preset aiming angle. If a tilt switch is moved from proper alignment, the time delay PCB2 in the master will de-energize after a nominal 15-second time delay, which deactivates all the lamp relays in all the PAPI units and removes the 6.6 A power supply to all the lamps in the PAPI system.

6. Style B L-880/L-881 PAPI: Required Equipment

Refer to Tables 2-1 and 2-2 for required equipment that is supplied. Refer to Table 2-3 for required equipment that is not supplied. Refer to the *Parts* section for ordering information.

Table 2-1. L-880 PAPI Required Equipment Supplied

Description	Quantity
Master PAPI assembly	1
Slave assembly	3
Instruction manual	1

Table 2-2. L-881 PAPI Required Equipment Supplied

Description	Quantity
Master PAPI assembly	1
Slave assembly	1
Instruction manual	1

6. Style B L-880/L-881 PAPI: Required Equipment
(contd.)

Table 2-3. Required Equipment Not Supplied

Description	Quantity	Note
Constant current regulator	1	
Aiming device kit (optional)	1	One required per airport.
Positioning plate	1	See Figures 3-2 and 3-3 in the *Installation* section.
Field splice kit	1	
Isolation transformers	As required	Refer to Table 2-4.
Survey instrument	1	
L-867 base plate, 3 hub (optional)	As required	One L-867 base plate (3 hub) is required for the L-867 base near each slave and master unit.
L-867 base can (optional)	As required	One L-867 base can per light box.
1-1/2 inch x 1-1/4 inch (38.1 x 31.75 mm) hex reducer bushing	As required	Supplied by contractor. Refer to Table 2-5 for quantities.
1-1/4 inch (31.75 mm) flex conduit/fluid tight	As required	Supplied by contractor. Refer to Table 2-5 for quantities.
Interconnector cable (4-conductor)	As required	Supplied by contractor. Refer to Table 2-5 for quantities.
Interconnector cable (2-connector)	As required	Supplied by contractor. Refer to Table 2-5 for quantities.
Concrete	As required	

Table 2-4. Number of Required L-830 Isolation Transformers

PAPI System	Number of L-830-6 tranformers on 6.6 A	Number of L-830-7 transformers on 20 A	Number of L-830-1 or L-830-2 transformers
L-880	8 transformers for 2 lamps 12 transformers for 3 lamps	8 transformers for 2 lamps 12 transformers for 3 lamps	1 transformer for 2 and 3 lamps
L-881	4 transformers for 2 lamps 6 transformers for 3 lamps	4 transformers for 2 lamps 6 transformers for 3 lamps	1 transformer for 2 and 3 lamps

6. Style B L-880/L-881 PAPI: Required Equipment
(contd.)

Table 2-5. Contractor-Supplied Connectors, Conduit, Cable, and Bushings

	L-880 PAPI				L-881 PAPI	
Description	Master	Slave	Slave	Slave	Master	Slave
1 1/4 flex conduit male connector	6	6	6	6	6	6
1 1/2 x 1 1/4 hex reducer bushing	3	3	3	3	3	3
1 1/4 flex conduit/liquid tight (length as required)	3	1	3	3	3	3
Interconnector cable (4-conductor)	1	1	1	None	1	None
Interconnector cable (2-conductor)	1	None	None	None	1	None

NOTE: The nominal L-823 cordset length is 72 inches (1829 mm). Since the length required for installation will depend on the height of the PAPI unit and the distance of the bottom of the unit from the wire entry point in the can or conduit, the customer should check the length required. If a longer cordset is required, the wires may be spliced (in accordance with local codes) or a longer cordset may be ordered. Contact ADB Sales Department.

7. Specifications

This subsection describes the specifications for the L-880 (four-box) and L-881 (two-box) PAPI systems. Refer to the *Parts* section for part numbers.

Input Power

6.6 A

Lamps

Two or three 200 W, 6.6 A quartz lamps per PAPI unit

Rated lamp life:	1000 hours
Luminous intensity (white light):	138, 500 cd (peak)
	135,200 cd (average, 10 degree horizon beam spread)

Transmission Factor of Red Sector	At least 15%
Transmission Sector	Three minutes of arc over full beam spread
Visual Acquisition Range	7.1 miles within an approach envelope of ±5 degrees from the approach axis
Transient Suppression	Solid state equipment is capable of withstanding lightning transient consisting of a 10 x 20 microsecond current surge of 15,000 amperes with the subsequent power-follow current and voltage surge of 10 kV/microsecond. System also will withstand without damage the repeated application of an overvoltage transient on the input power lines equal to 500 volts peak for a duration of 50 milliseconds.
Tilt Switch	De-energizes all lamps in the PAPI system if optical pattern of any light unit is raised between 1/2 degree and 1 degree or lowered between 1/4 degree and 1/2 degree.
Mean Time Between Failures	Six months (minimum) between failures for all components (excluding lamps)
Environmental Operating Conditions	The environmental operating conditions includes temperature range of operation, humidity, and wind.

Temperature Range of Operation

Class	Operating Temperature Range (Celsius)	Operating Temperature Range (Fahrenheit)
Class 1	-35 to +55 °C	-31 to +131 °F
Class 2	-55 to +55 °C	-67 to +131 °F

Humidity

0 to 100%

Wind

Velocities up to 100 mph (161 km/h)

Mounting Provisions

Three or four mounting legs

Weight

93 lb (42.6 kg) (approximate) per light unit; 145 lb (65.8 kg) (approximate) for master

Dimensions

See Figures 2-10 and 2-11. Refer to the table below.

NOTE: Figures 2-10 and 2-11 show three-leg PAPI B. Four-leg PAPI B has the same dimensions as the three-leg.

PAPI Type	Width	Height	Length
L-880/L-881 two lamps	15.63 in. (39.7 cm)	40 in. (101.6 cm)	35 in. (88.9 cm)
L-880/L-881 three lamps	25.74 in. (165.3 cm)	40 in. (101.6 cm)	39.28 in. (100.57 cm)

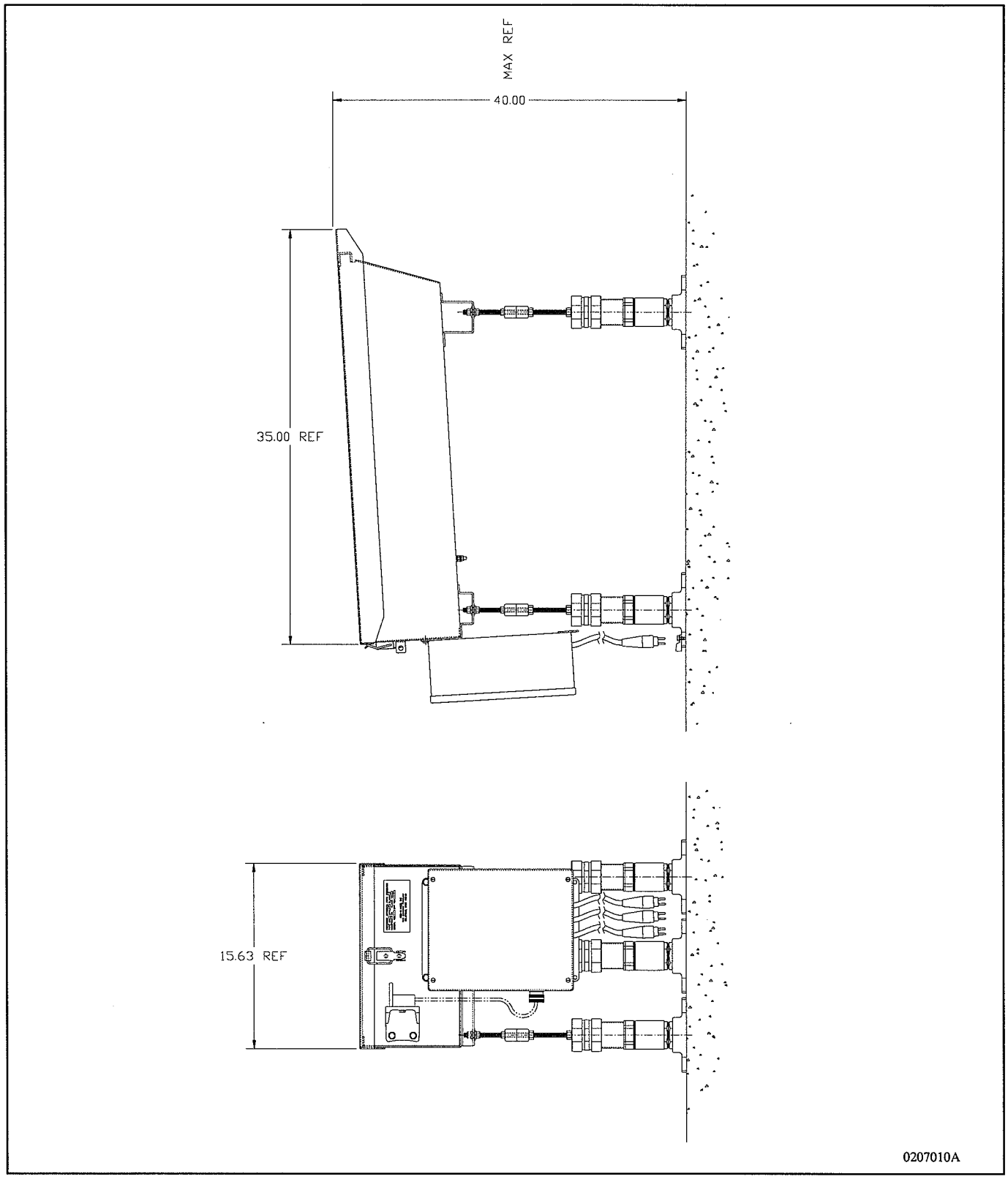


Figure 2-10. PAPI B (Two Lamps) Dimensions

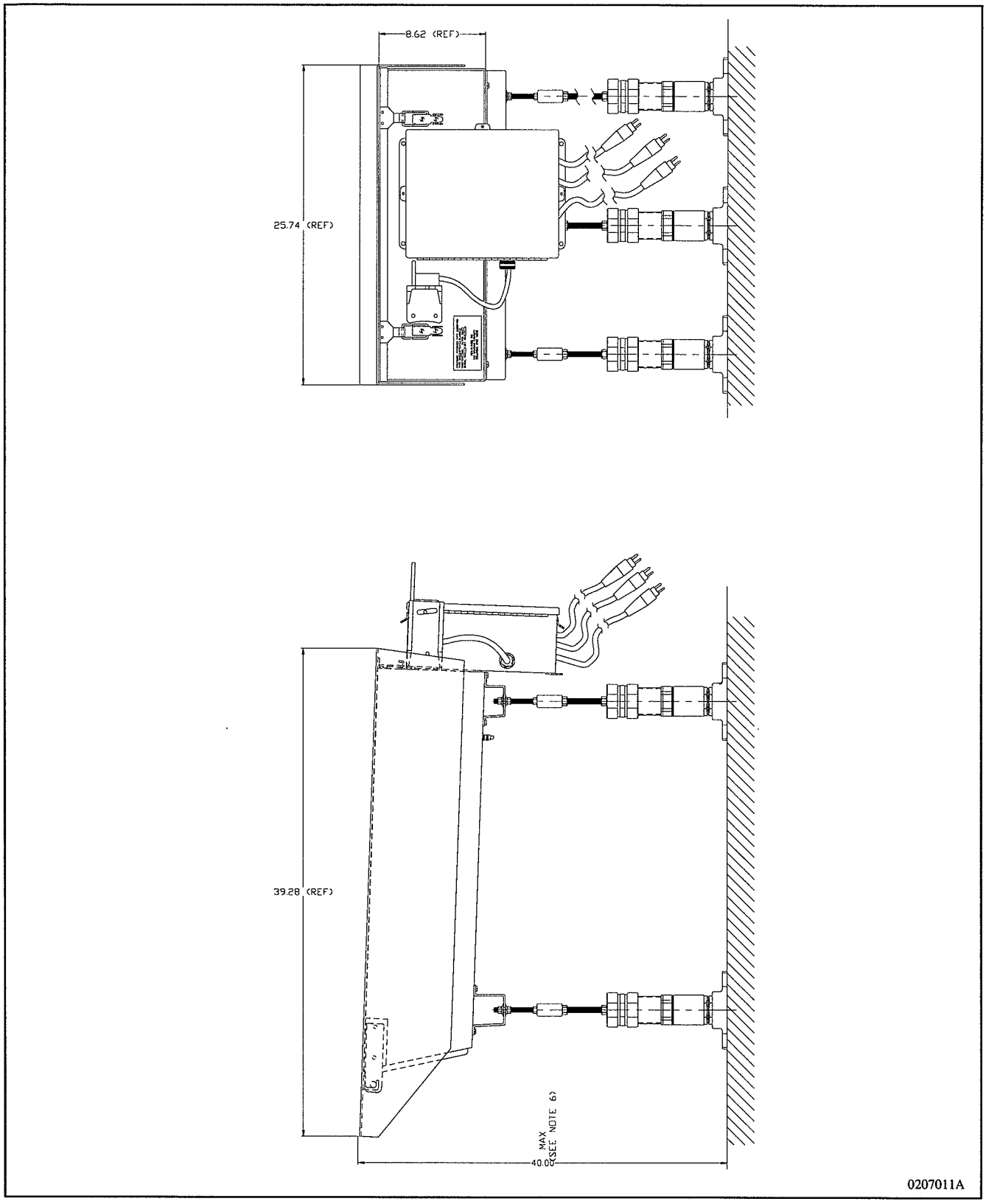


Figure 2-11. PAPI B (Three Lamps) Dimensions

Photometrics

Each light unit used in the L-880/L-881 PAPI systems has two/three lamps and provides a beam of light split horizontally to produce white light in the top sector and red light in the bottom sector. When viewed by an observer at a distance of 1000 feet (304.8 m), the transition from red light to white light occurs within an angle of three minutes of arc at the beam center and within an angle of five minutes of arc at the beam edges.

Section 3
Installation

1. Introduction

WARNING: Allow only qualified personnel to perform the following tasks. Observe and follow the safety instructions in this document and all other related documentation.

This section provides instructions for the installation of the PAPI system. Refer to the airport project plans and specifications for the specific installation instructions.

2. Unpacking

Handle equipment very carefully to prevent component damage. Note any exterior damage to the crate that might lead to detection of equipment damage. If you note any damage to any equipment, file a claim with the carrier immediately. The carrier may need to inspect the equipment.

3. Instruments for Installation and Verification

The instruments below are required for installing, leveling, setting, and checking the elevation setting of the light units.

- One survey instrument (aiming device) for azimuth and elevation setting
- One precision bubble level for leveling the units
- One checking stick for routine checks of the elevation setting

Aiming Device

See Figures 3-1, 3-2, and 3-3. The aiming device consists of

- one base to rest on reference block B and slot C; and two movable arms to rest on reference block A and slot D
- two graduated scales for elevation setting
- one bar used for the longitudinal horizontal reference required to set both azimuth and elevation

NOTE: Figure 3-1 shows the aiming device on the three-lamp PAPI. This figure also applies to the two-lamp PAPI.

Aiming Device *(contd.)*

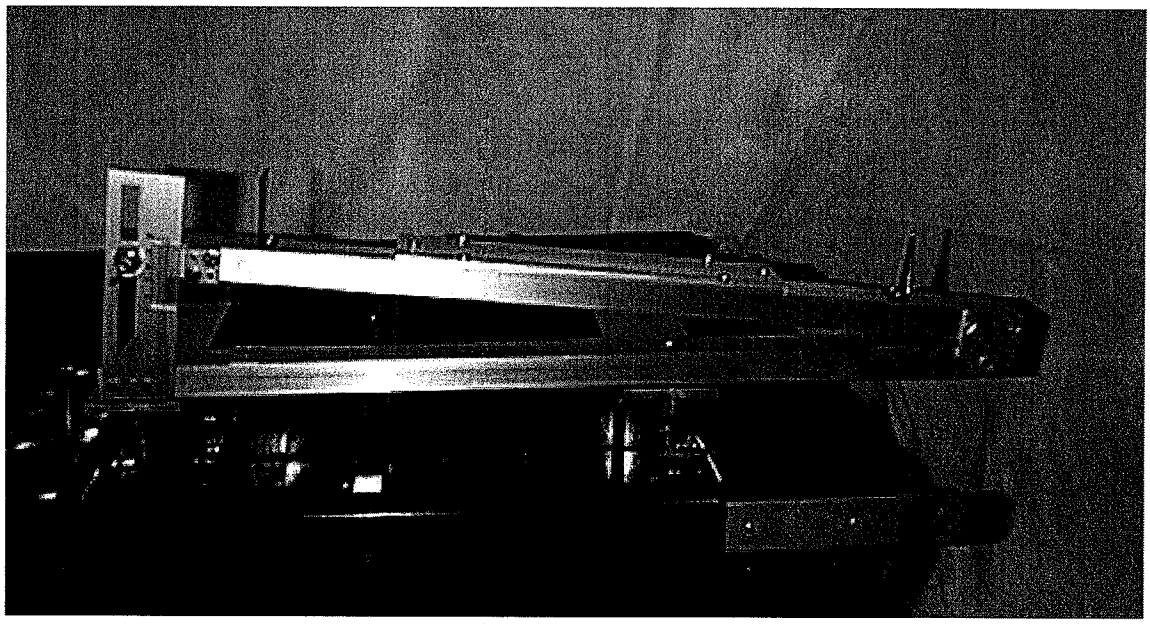


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Figure 3-1. Side View of Aiming Device for Three-Lamp PAPI (Part 1 of 2)

The two movable arms increase the stability of the aiming device and are used to establish the transverse horizontal references. Screws are provided on the bar and on the movable arms to guarantee an exact positioning of the level during setting and adjustment. This exact positioning is required to have a perfect match between the level and the longitudinal and transverse horizontal references. The two V-sites on the bar of the aiming device are for azimuth alignment.

Aiming Device *(contd.)*

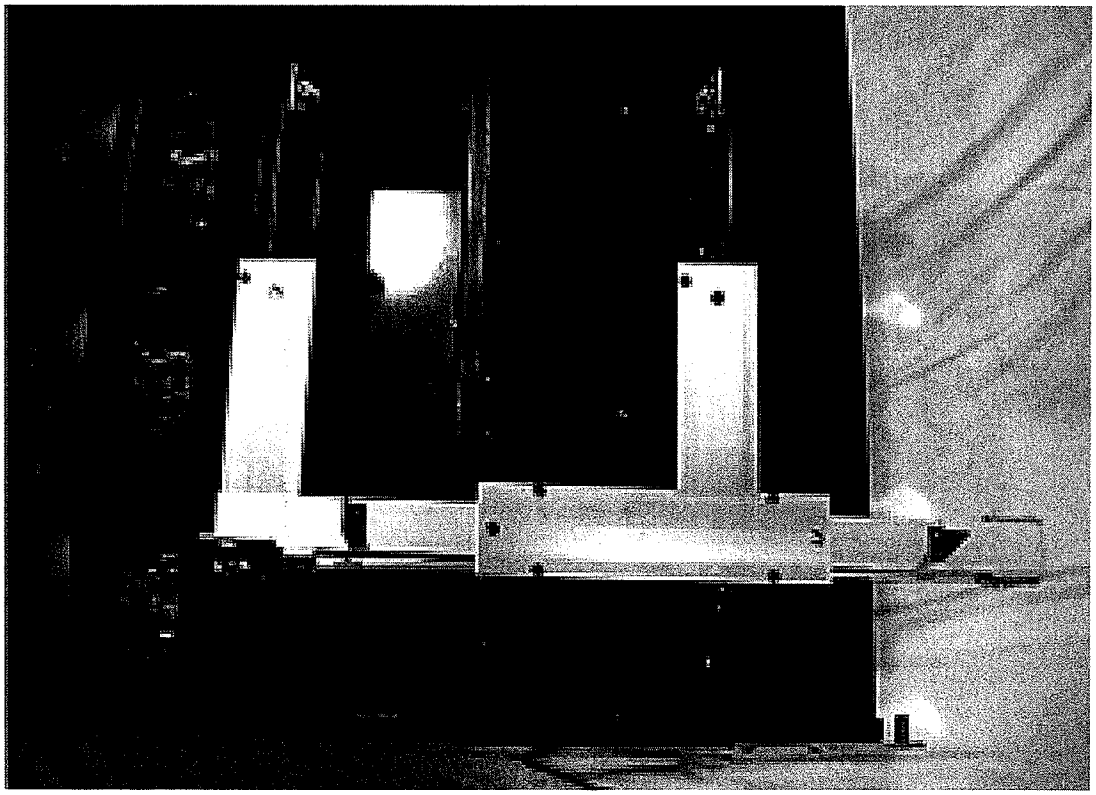

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Figure 3-1. Top View of Aiming Device for Three-Lamp PAPI (Part 2 of 2)

Aiming Device *(contd.)*

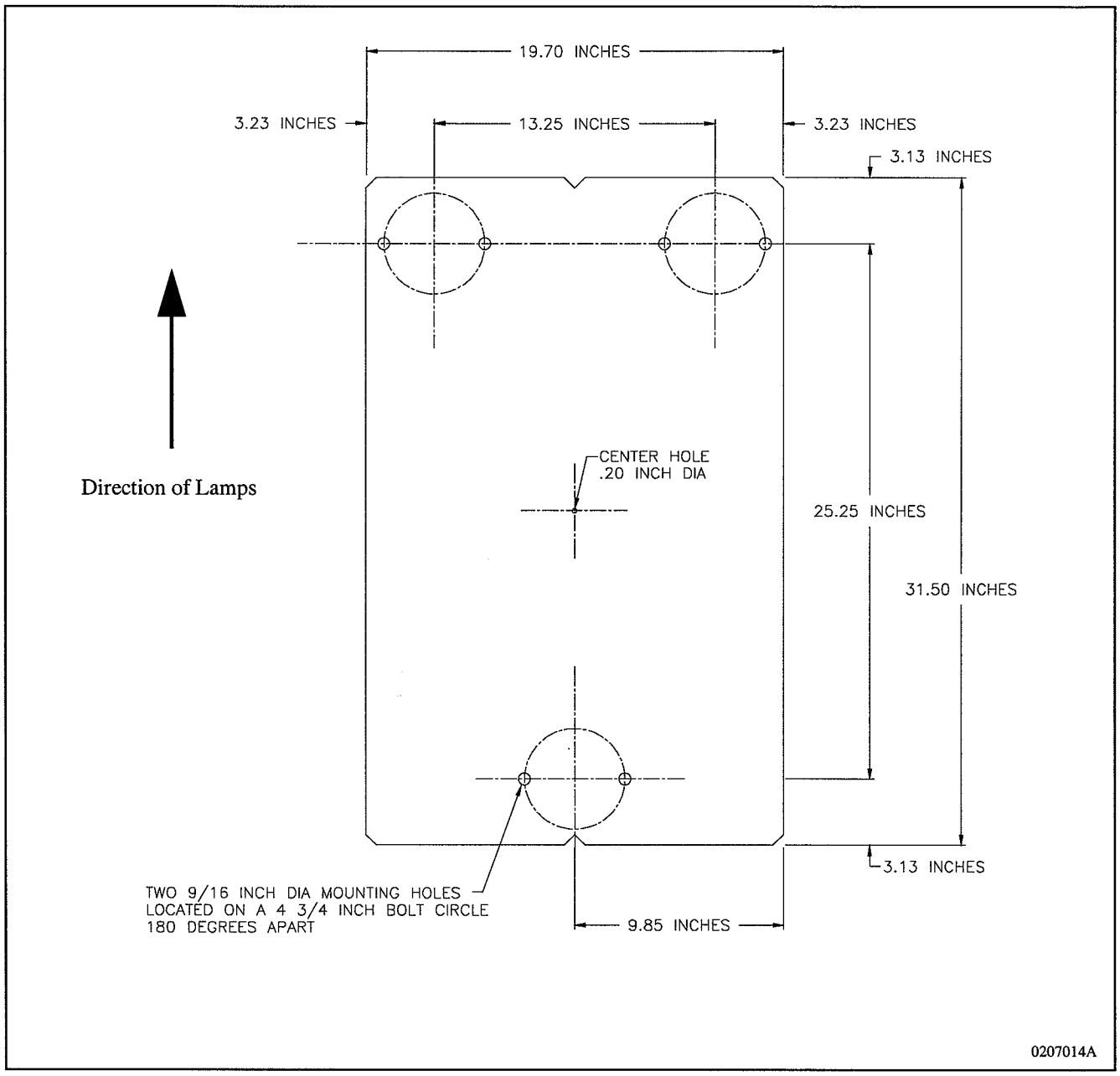


Figure 3-2. Positioning Plate (Two Lamps/Three Legs) (Part 1 of 2)

Aiming Device *(contd.)*

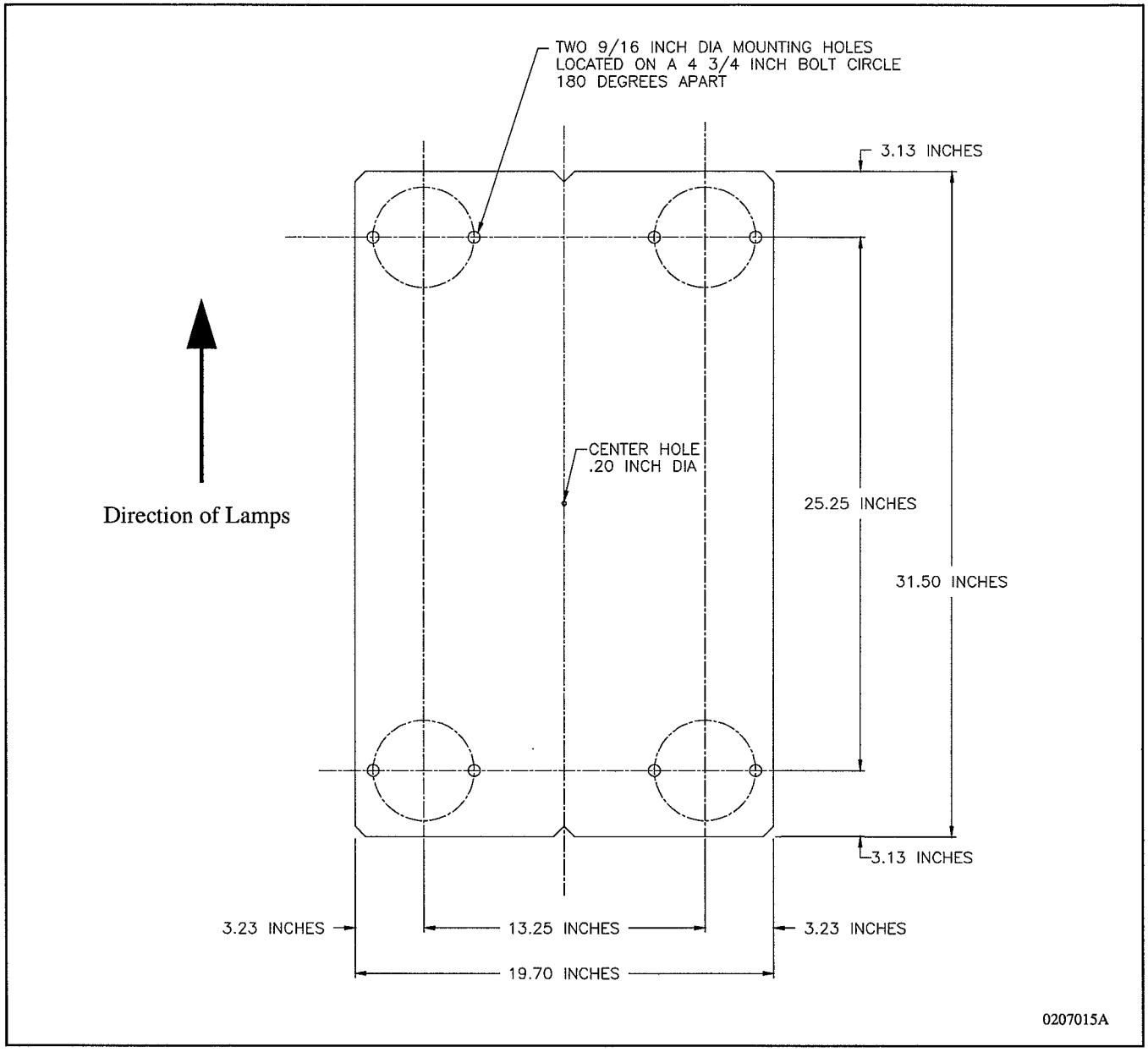


Figure 3-2. Positioning Plate (Two Lamps/Four Legs) (Part 2 of 2)

Aiming Device *(contd.)*

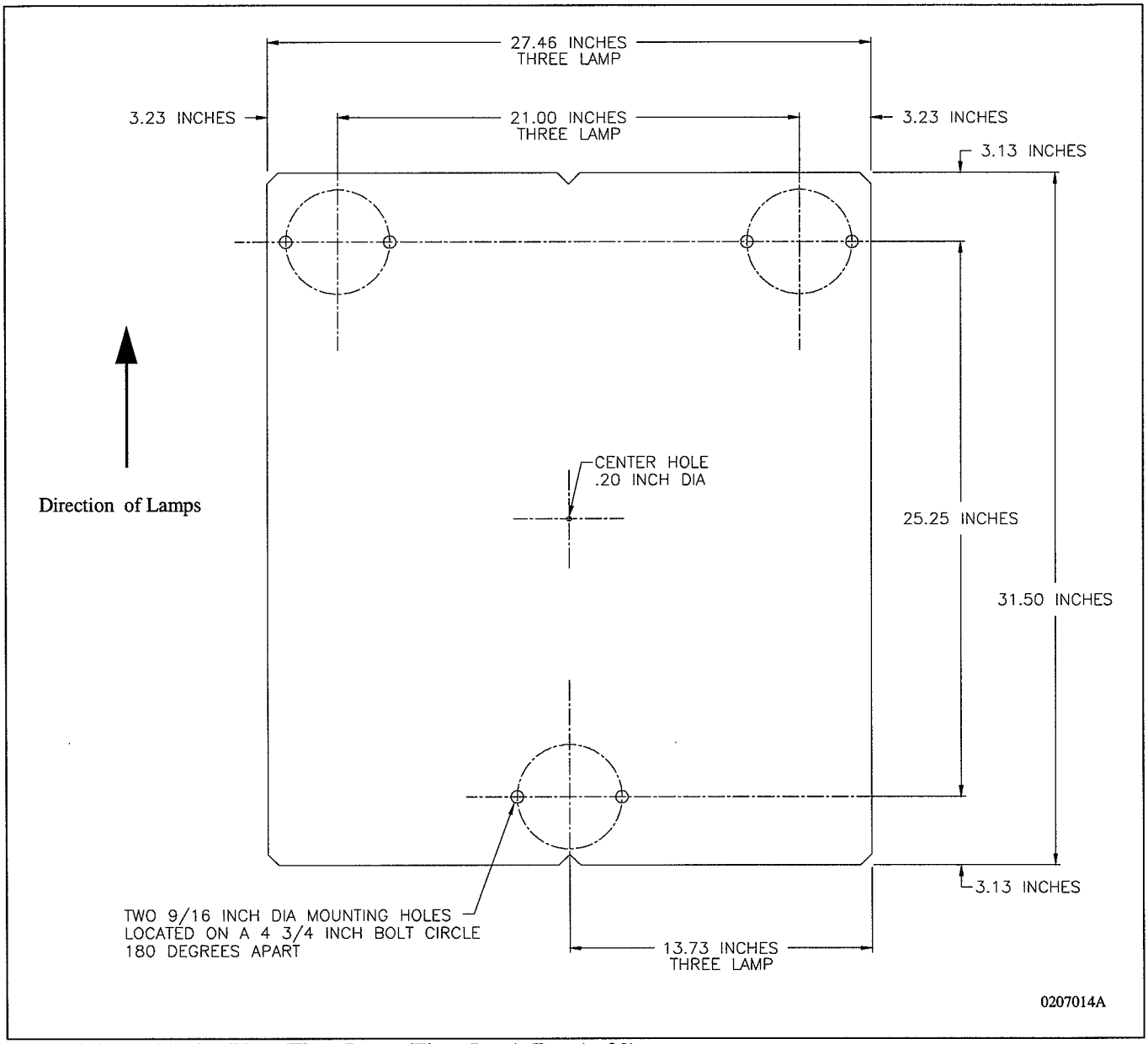


Figure 3-3. Positioning Plate (Three Lamps/Three Legs) (Part 1 of 2)

Aiming Device *(contd.)*

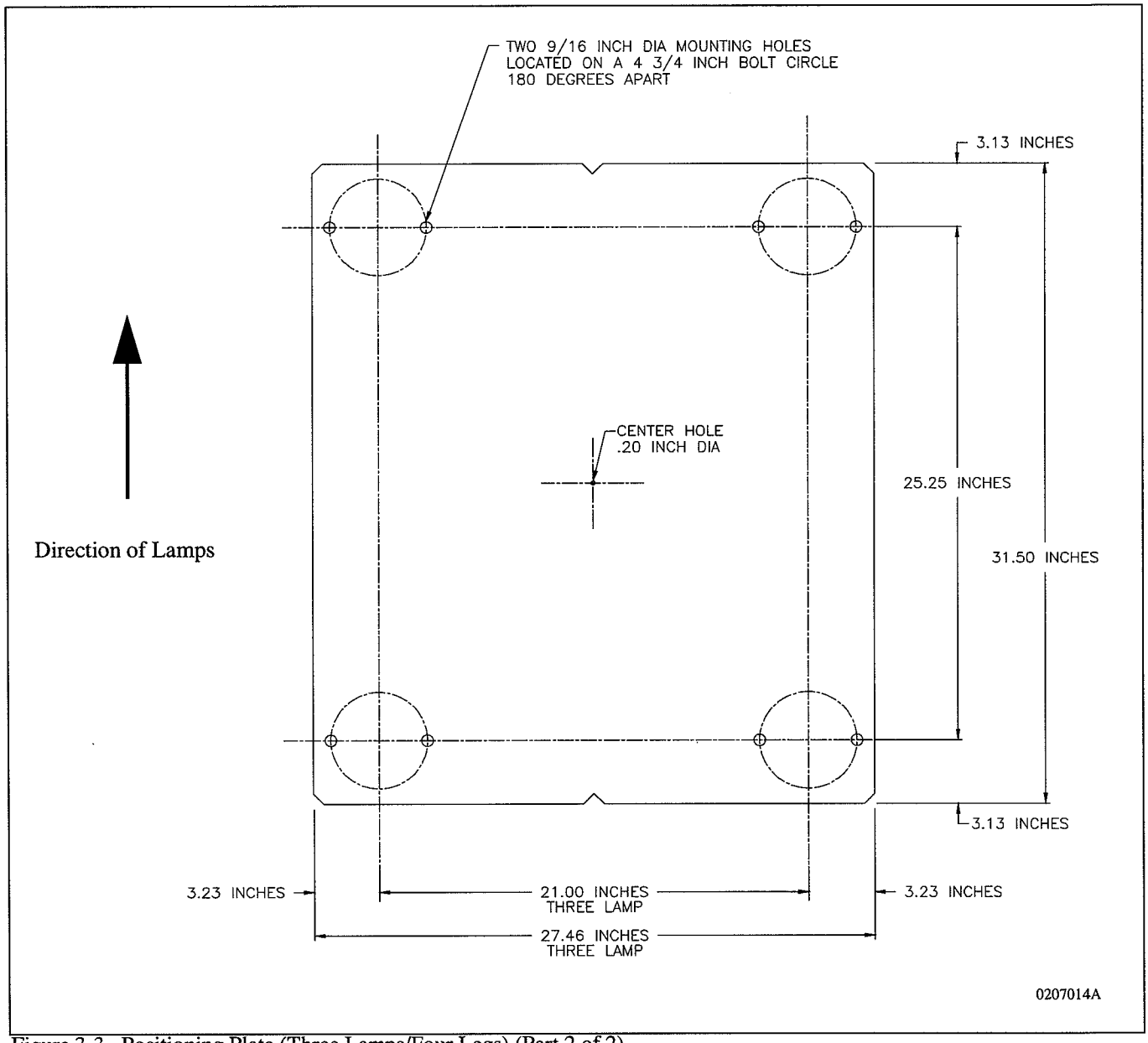


Figure 3-3. Positioning Plate (Three Lamps/Four Legs) (Part 2 of 2)

Bubble Level

This instrument has a 0.004 in/ft (0.3 mm/m) degree of precision which allows a very precise setting (within one minute of arc) compatible with the design precision of the PAPI light unit.

Checking Stick

See Figure 3-4. The checking stick is used to make routine checks of the elevation setting of the PAPI units. It consists of a small transparent screen attached to a lightweight rod. The screen has two horizontal lines 23 mm (0.09 in.) apart to correspond to approximately 3 minutes of arc at 25 m (82 ft). Refer to *Reference Bases for Checking Stick* in this section for instructions on using the checking stick.

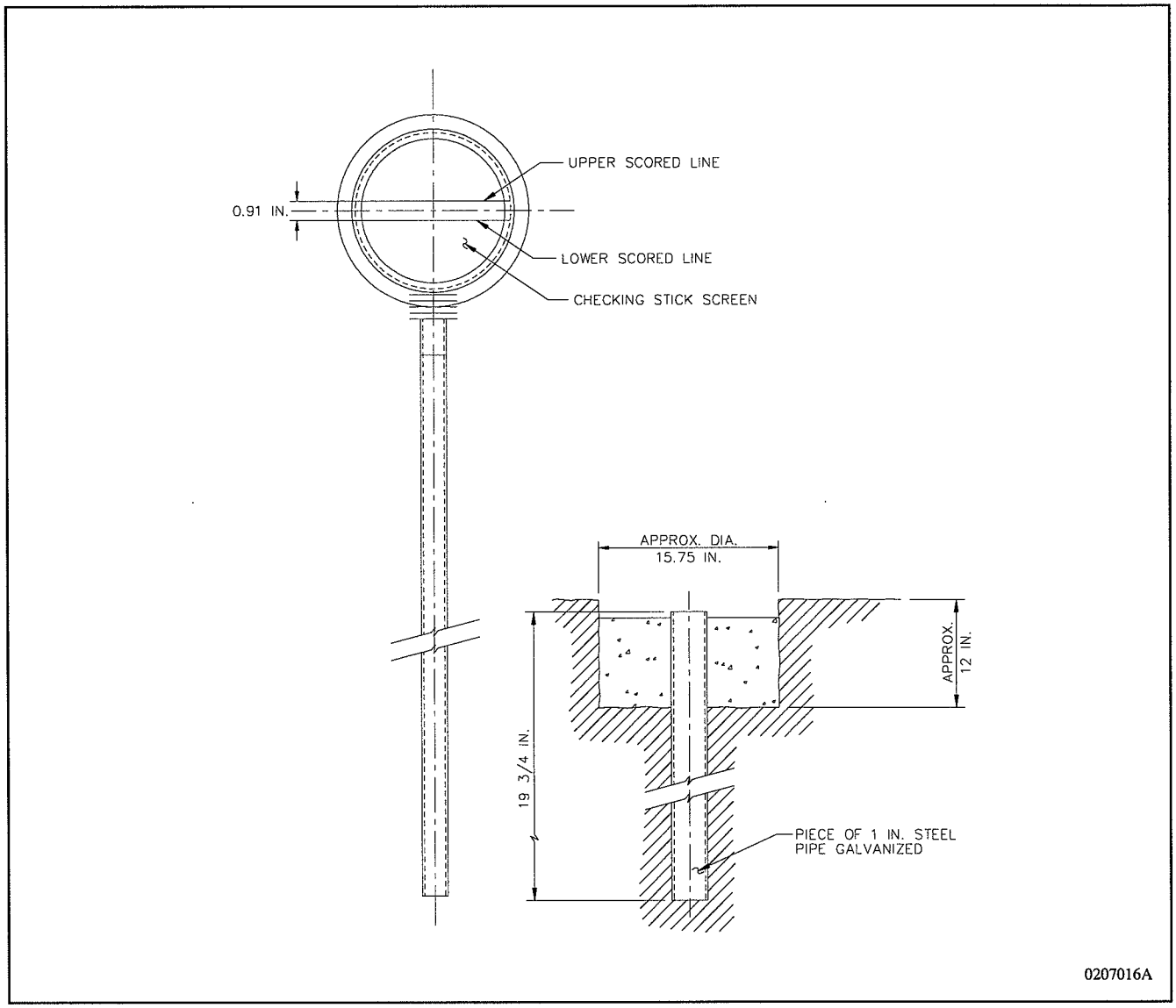


Figure 3-4. Checking Stick

4. Siting Considerations

When viewed from the approach end, the PAPI system shall be located on the left-hand side of the runway as shown in Figure 2-3. The PAPI may be located on the right side of the runway if siting problems exist, such as conflicts with runways or taxiways. The PAPI must be sited and aimed so that it defines an approach path with adequate clearance over obstacles and a minimum threshold crossing height.

If the runway has an established ILS glideslope, refer to *Siting PAPI with ILS Glideslope* in this section. The PAPI must be installed so that the visual glideslope coincides (as much as possible) with the electronic glideslope. If there is no ILS on the runway, refer to *Siting PAPI on Runways Without an ILS* in this section. The PAPI's glideslope must be chosen to ensure the on-course signal of the PAPI provides adequate clearance over obstacles.

Distance of PAPI Units from Runway Edge

See Figure 2-3. The light unit nearest to the runway shall be no closer than 50 feet (15.24 m) (+10, -0 feet) (+3.048, -0 m) from the runway edge or to other runways or taxiways. This distance may be reduced to 30 feet (9.144 m) for small general aviation runways used by non-jet aircraft.

Lateral Spacing of PAPI Units

The PAPI units shall have a spacing between units of 20 to 30 feet (6.096 to 9.144 m). The distance between boxes shall not vary by more than 1 foot (304.8 mm).

5. Siting PAPI with ILS Glideslope

When a runway has an established ILS electronic glideslope, the PAPI on-slope signal should coincide, as much as possible, with that for the ILS. To accomplish this, place the PAPI at the same distance (tolerance of ±30 feet or ±9.144 m) from the threshold as the virtual source of the ILS glideslope and aim at the same angle as the ILS glideslope.

Refer to Table 3-1. This procedure must be modified for runways that serve aircraft in height group 4 because of the eye-to-antenna distance. For these runways, the distance of the PAPI from the threshold shall equal the distance to the virtual source of the ILS glideslope plus an additional 300 feet (91.44 m) (+50 ft, -0 ft) (+15.24 m, -0 m). Calculations should be performed to ensure that the site chosen provides adequate obstacle clearance and threshold crossing height.

Table 3-1. Threshold Crossing Height

Type of Aircraft	Cockpit-to-Wheel Height	Visual Threshold Crossing Height	Remarks
Height Group 1 (General aviation, small commuters, corporate turbojets)	10 feet (3.048 m) or less	40 feet (12.2 m) (+5 ft, -20 ft) (+1.524 m, -6.1 m)	Many runways less than 6,000 ft (1828.8 m) long with reduced widths and/or restricted weight bearing which would normally prohibit landings by larger aircraft
Height Group 2 (F-28, CV-340/440/580, B-737, DC-8/9)	15 feet (4.6 m)	45 feet (13.7 m) (+5 ft, -20 ft) (+1.524 m, -6.1 m)	Regional airport with limited air carrier service
Height Group 3 (B-707/720/727/757)	20 feet (6.1 m)	50 feet (15.24 m) (+5 ft, -15 ft) (+1.524 m, -4.6 m)	Primary runways not normally used by aircraft with ILS glideslope-to-wheel heights exceeding 20 ft (6.1 m)
Height Group 4 (B-747/767, L-1011, DC-10, A-300)	Over 25 feet (7.6 m)	75 feet (22.9 m) (+5 ft, -15 ft) (+1.524 m, -4.6 m)	Most primary runways at major airports.

6. Siting PAPI on Runways Without ILS

When the runway doesn't have an ILS glideslope, the PAPI must be sited and aimed so that it defines an approach path which will produce the required threshold crossing height and clearance over any obstacles in the approach area.

Threshold Crossing Height (TCH)

See Figure 2-3. The TCH is the height of the lowest on-course signal at a point directly above the threshold and the runway centerline. The minimum allowable TCH depends on the height group of the aircraft using the runway, and is shown in Table 3-1. The glideslope of the PAPI must provide the proper TCH for the most demanding aircraft height group using the runway.

Glideslope Angle

The standard visual glideslope angle for the PAPI is 3 degrees. For non-jet runways, this may be raised to 4 degrees if required to provide obstacle clearance.

Distance of PAPI from Threshold

The following method can be used to determine the PAPI installation distance from the runway threshold provided there are no obstacles in the area from which the PAPI signals can be observed, no differences in elevation between the threshold and the installation zone of the PAPI or between the units, or reduced length of runway. The distance of the PAPI units from the threshold (D1) can be calculated from the equation:

D1 = TCH x cotan (angle of lowest on-course signal)

where the TCH is the threshold crossing height for the most demanding aircraft using the runway. Refer to Table 3-1. The angle of the lowest on-course signal is determined as follows:

- For the L-880 PAPI system the angle of the lowest on-course signal will be the aiming angle of the third light unit from the runway minus 1.5 minutes or arc.

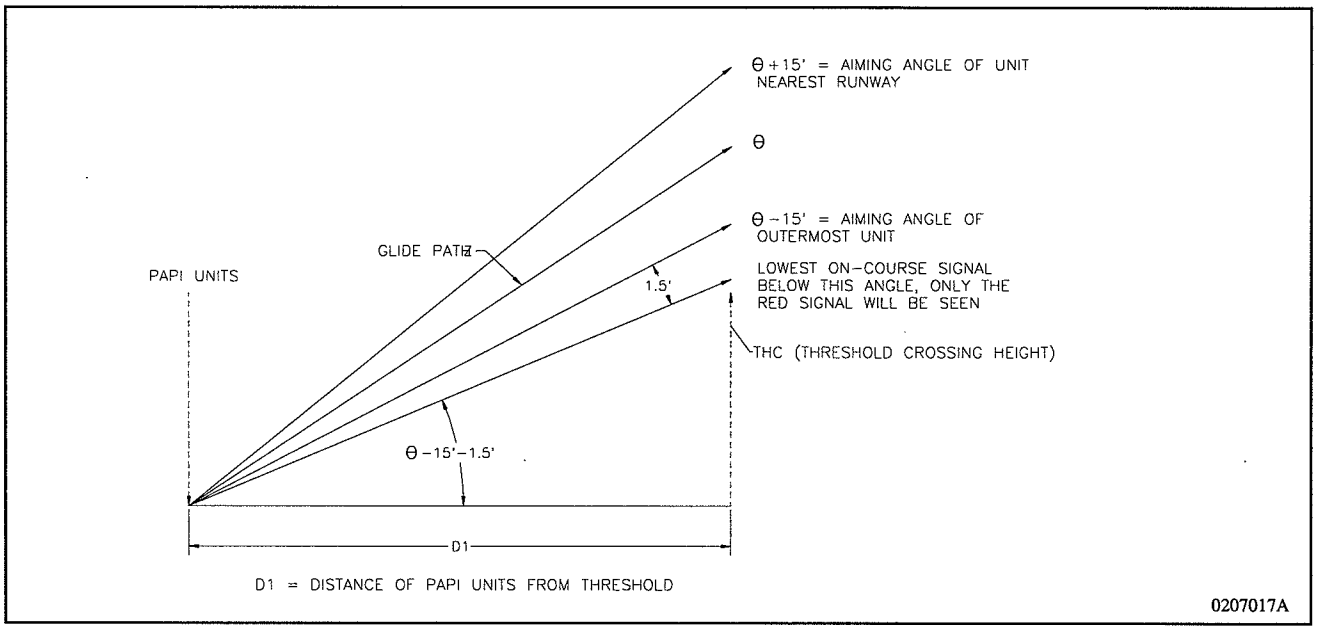
  NOTE: The subtraction of 1.5 minutes of arc takes into account the width of the transition sector (3 minutes of arc) between the white and red part of the PAPI light beam. The lowest possible on-course signal is 3'/2 = 1.5' lower than the aiming angle.

- For the L-881 PAPI system this angle will be the aiming angle of the outside light unit minus 1.5 minutes of arc.

Obstacle Clearance Surface

Position and aim the PAPI so that no risk exists of an obstruction being located in an area where the PAPI signals can be observed. Make a survey of the site to determine if an obstacle is present in the area where you can observe the PAPI signals.

See Figure 2-3. This obstacle clearance surface begins 300 feet (91.44 m) in front of the PAPI units (closer to the threshold) and proceeds outward into the approach area at an angle of 1 degree less than the lowest on-course signal. This surface extends 10 degrees on either side of the runway centerline to a distance of 4 miles (6.44 km) from the point of origin. If an obstruction penetrates the obstacle clearance surface and cannot be removed, then the re-aim the glideslope angle or move the PAPI system further from the threshold. By moving or re-aiming the PAPI, re-position the obstacle clearance surface so that it will not be penetrated by an obstruction. See the figure below.



The 1.5' is one-half the width of the transition sector of the light beam. The transition between the white to red part of the beam is 3 minutes of arc (3'). Hence the additional 1.5' must be taken into account in calculating D1.

For L-881: D1 = TCH x cotan (Θ - 15' - 1.5')

NOTE: For the L-880 PAPI system, the lowest on-course signal will be the aiming angle of the third light unit from the runway minus 1.5'. For a standard L-880 installation the lowest on-course signal will be Θ -10' - 1.5'. For Height Group 4 aircraft this angle will be Θ - 15' - 1.5'.

For L-880 (Standard Installation): D1 = TCH x cotan (Θ - 10' - 1.5')

For L-880 (Ht. Group 4 aircraft): D1 = TCH x cotan (Θ - 15' - 1.5')

Reduction of Beam Coverage for Obstacle Avoidance

A PAPI system may require a reduction of the horizontal beam coverage because of an obstacle in the approach area. If this is the case, special consideration should be given to the following factors when determining the required system cutoff angle(s):

- Type and location of the obstacle with respect to the area where the PAPI signals can be observed
- Wingspan of aircraft using the runway
- Vertical pitch of the glideslope
- Installation tolerances
- Position of the PAPI system
- Additional safety considerations
- Manufacturing tolerances are +0.0° to -0.4°
- Origin of the cutoff angle should be either the outermost or innermost unit (whichever is closest in azimuth to the obstacle)
- Cutoff angles should be FAA approved

When ordering a PAPI system with a reduced horizontal beam coverage from ADB, the following information is required:

- Number of systems required
- Type of system -- L-880 or L-881; Style A or Style B
- Required cutoff angle (from pilot's viewpoint and tolerance)

  NOTE: For example, if the nominal required cutoff is 7°, the cutoff angle which would be ordered is 7.2° (+0.0°, -0.4°). The additional 0.2° is added to the nominal value because it is the midpoint of the manufacturing tolerance (+0.0°, -0.4°). The sales order would say, for example, cutoff = 7° Right (from pilot's viewpoint).

- Left/right cutoff (from pilot's viewpoint when landing)

7. Siting Tolerances

Siting tolerances involve azimuthal aiming, mounting height tolerance, PAPI tolerance along a line perpendicular to the runway, and correction for the runway longitudinal gradient.

Azimuthal Aiming

Each light unit shall be aimed outward into the approach zone on a line parallel to the runway centerline within a tolerance of ±1/2°.

Mounting Height Tolerance

The beam centers of all light units shall be within ±1 inch (25.4 mm) of a horizontal plane. This plane shall be within ±1 foot (304.8 mm) of the elevation of the runway centerline at the intercept point of the visual approach angle with the runway except for additional siting considerations. Refer to *Additonal Siting Considerations* in this section.

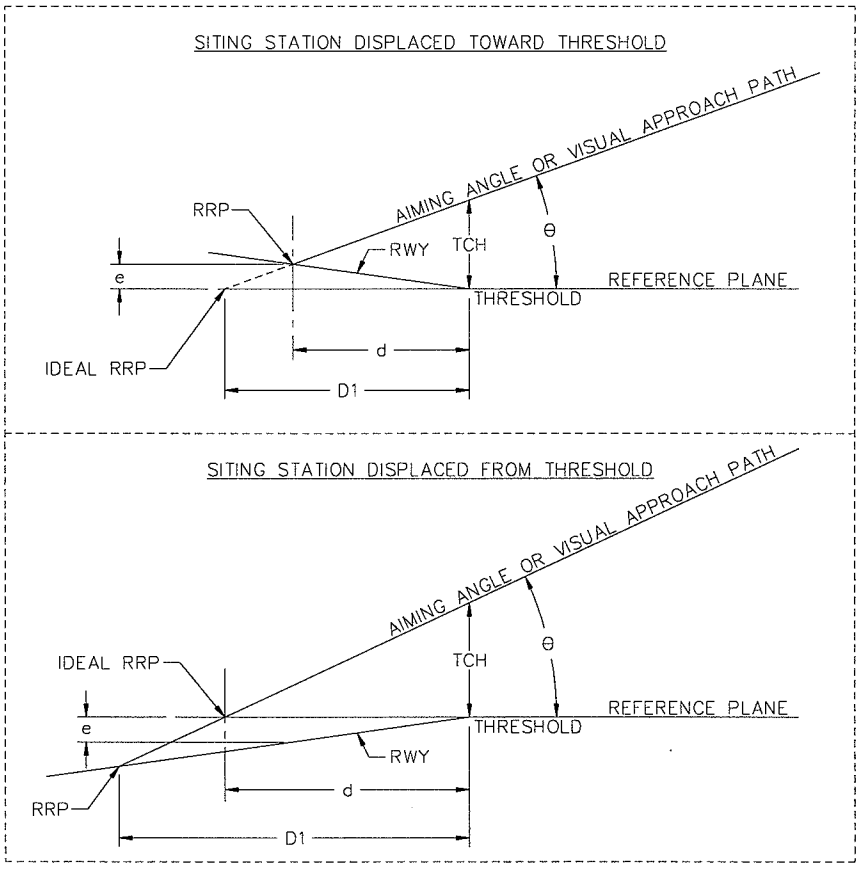
PAPI Tolerance Along Line Perpendicular to Runway

The front face of each light unit in a bar shall be located on a line perpendicular to the runway centerline within ±6 inches (152.4 mm).

Correction for Runway Longitudinal Gradient

See Figure 3-5. Refer to AC 150/5435-28D. On runways where a difference exists in elevation between the runway threshold and the elevation of the runway centerline adjacent to the PAPI, you may need to adjust the location of the light units with respect to the threshold to meet the required obstacle clearance and TCH.

Correction for Runway Longitudinal Gradient *(contd.)*



SYMBOLS

RWY = RUNWAY LONGITUDINAL GRADIENT
TCH = THRESHOLD CROSSING HEIGHT
RRP = RUNWAY REFERENCE POINT (WHERE AIMING ANGLE OR VISUAL APPROACH PATH INTERSECTS RUNWAY PROFILE)
D1 = IDEAL (ZERO GRADIENT DISTANCE OF PAPI UNITS FROM THRESHOLD)
d = ADJUSTED DISTANCE OF PAPI UNITS FROM THRESHOLD
e = ELEVATION DIFFERENCE BETWEEN THRESHOLD AND RRP
θ = AIMING ANGLE

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Figure 3-5. Correction for Runway Longitudinal Gradient

Correction for Runway Longitudinal Gradient *(contd.)*

If the condition exists, perform the following steps to compute the change in the distance from the threshold required to preserve the proper geometry:

1. Obtain the runway longitudinal gradient. This can be done by survey or obtained from airport obstruction charts or as-built drawings.
2. Determine the ideal (zero gradient) distance from the threshold in accordance with the preceding instructions.
3. Assume a level reference plane at the runway threshold elevation. Plot the location determined in Step 2 above.
4. Plot the runway longitudinal gradient.
5. Project the visual glideslope angle to its intersection with the runway longitudinal gradient. Then solve for the adjusted distance from the threshold either mathematically or graphically. Refer to *Mounting Height Tolerance* in this section.
6. Verify the calculated location gives the desired threshold crossing height.

8. Additional Siting Considerations

Below are additional siting considerations.

- Where the terrain drops off rapidly near the approach threshold and severe turbulence is experienced, locate the PAPI farther from the threshold to keep the aircraft at the maximum possible threshold crossing height.
- On short runways, the PAPI should be as near the threshold as possible to provide the maximum amount of runway for braking after landing.
- See Figure 3-6. At locations where snow is likely to obscure the light beams, install the light units up to a maximum height of 6 feet (1.83 m) above ground level. This may require installing the light units farther from the runway edge to ensure adequate clearance for the most critical aircraft. Refer to *Additional Siting Considerations* in this section.

  Since increasing the height of the light units also increases the threshold crossing height of the visual glideslope, you may need to relocate the lights closer to the threshold to remain within the specified tolerance.
- Since the effectiveness of the PAPI system is dependent on the optical red and/or white signal pattern from the light units, make sure that no other lights are close enough to confuse the pilot.

8. Additional Siting Considerations *(contd.)*

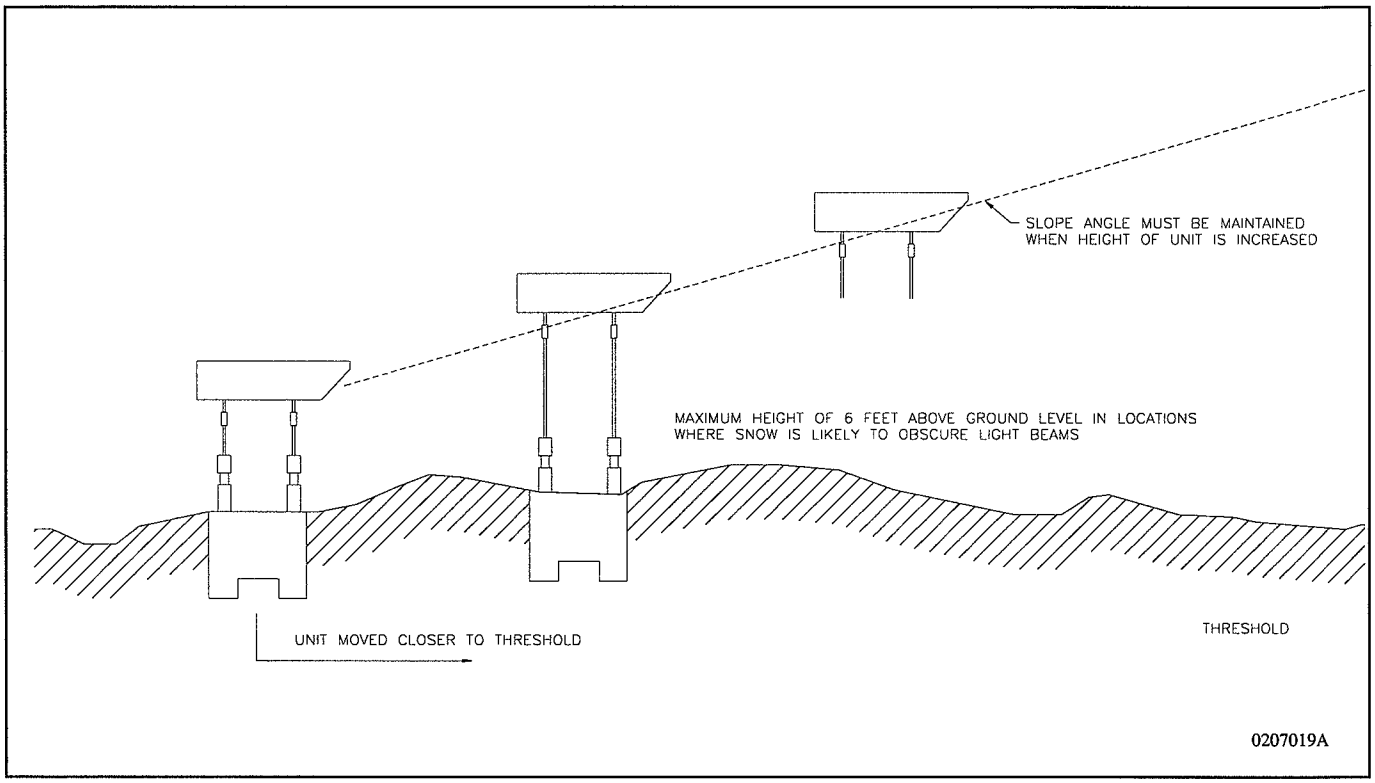

Figure 3-6. Relocating PAPI Units

9. PAPI Foundations

The PAPI units shall be installed on concrete pads at ground level with frangible couplings. The foundation should extend at least 12 inches (304.8 mm) below the frost line and at least 1 foot (304.8 mm) beyond the light unit to minimize damage from mowers. Figures 3-7 and 3-8 show dimensions that are generally acceptable for the concrete pad for the two-lamp and three-lamp PAPI respectively.

9. PAPI Foundations *(contd.)*

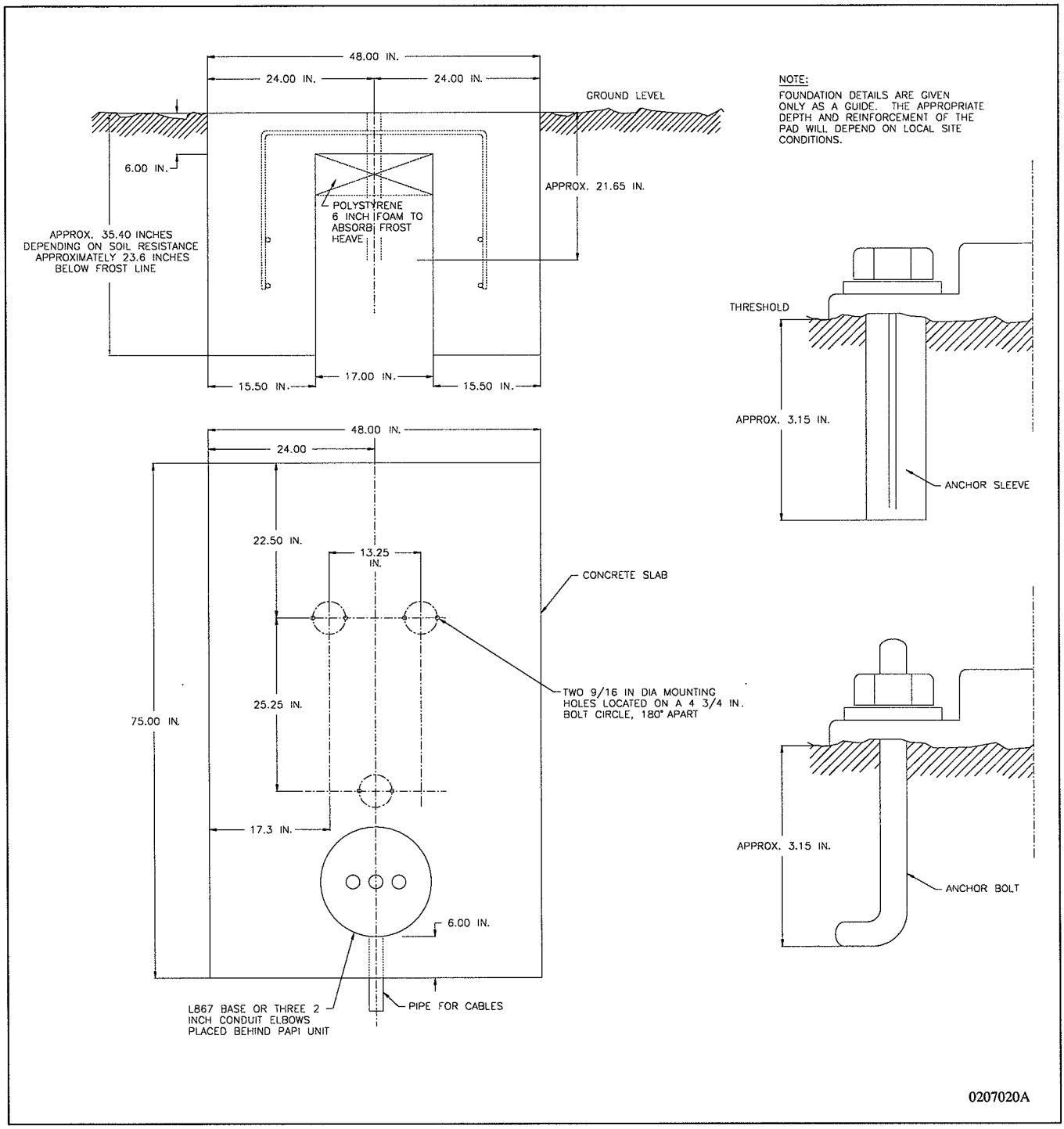

Figure 3-7. Installation on Concrete Pad (Two-Lamp, Three-Leg PAPI B) (Part 1 of 2)

9. PAPI Foundations *(contd.)*

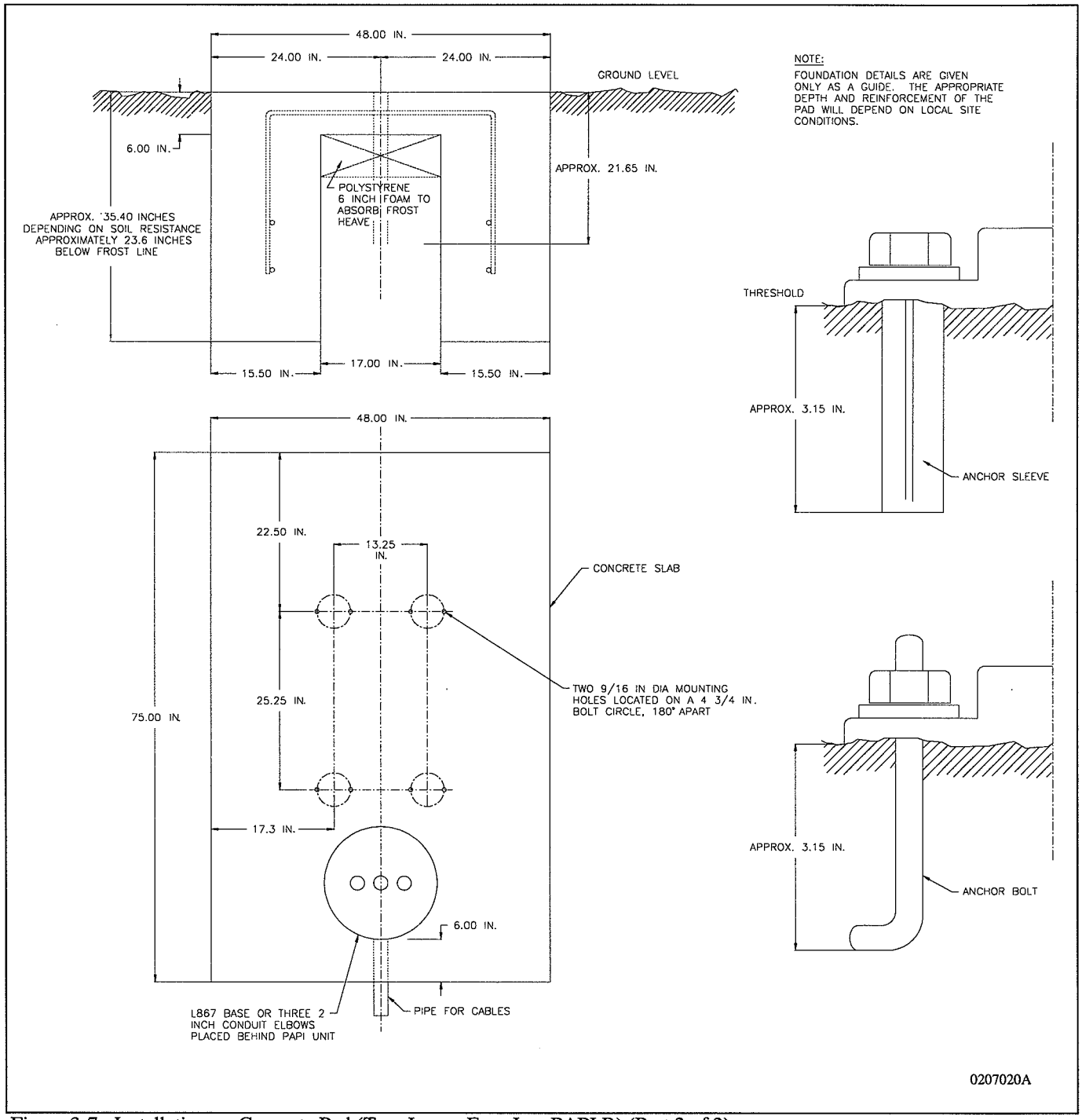

Figure 3-7. Installation on Concrete Pad (Two-Lamp, Four-Leg PAPI B) (Part 2 of 2)

9. PAPI Foundations *(contd.)*

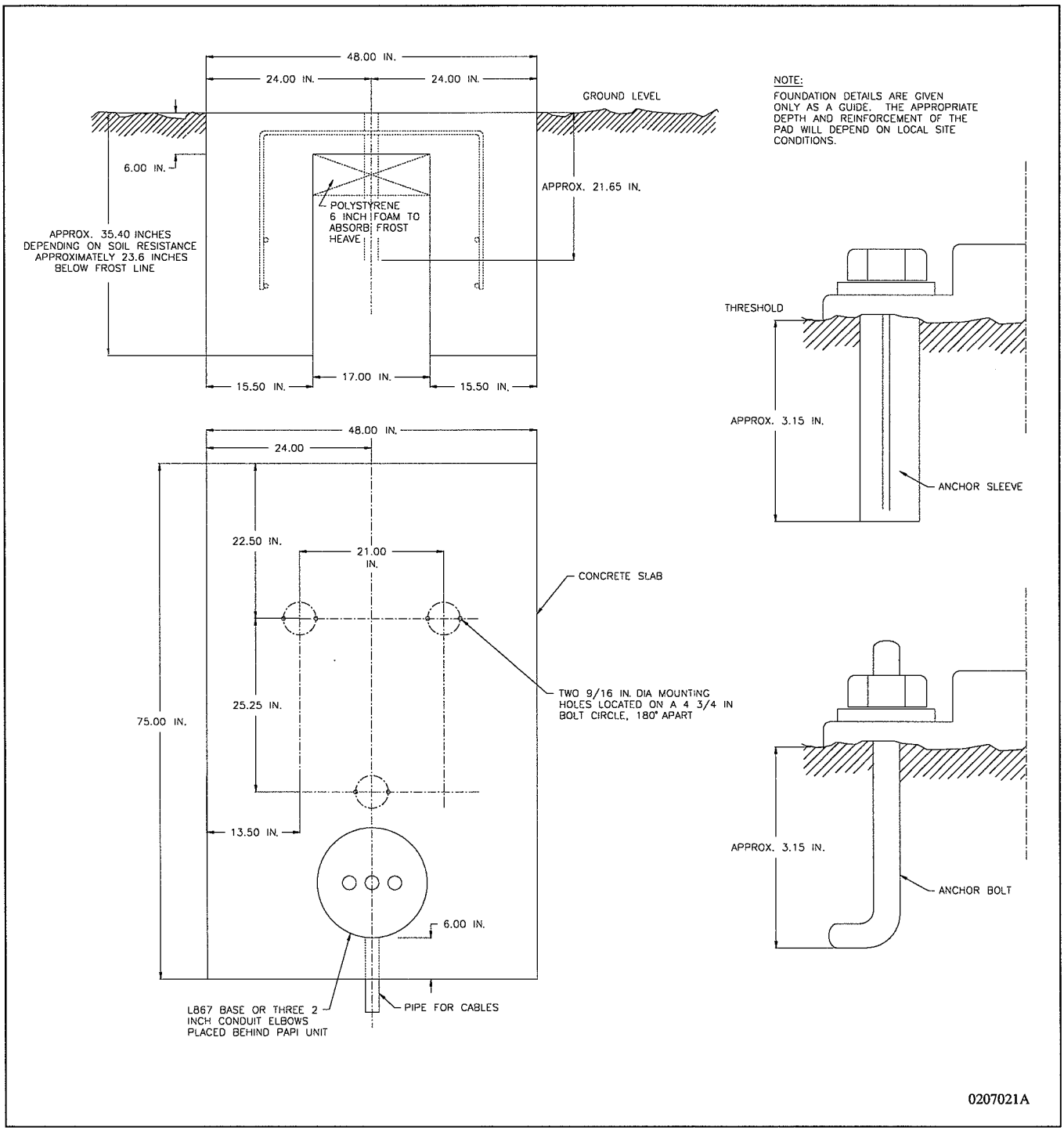

Figure 3-8. Installation on Concrete Pad (Three-Lamp, Three-Leg PAPI B) (Part 1 of 2)

9. PAPI Foundations *(contd.)*

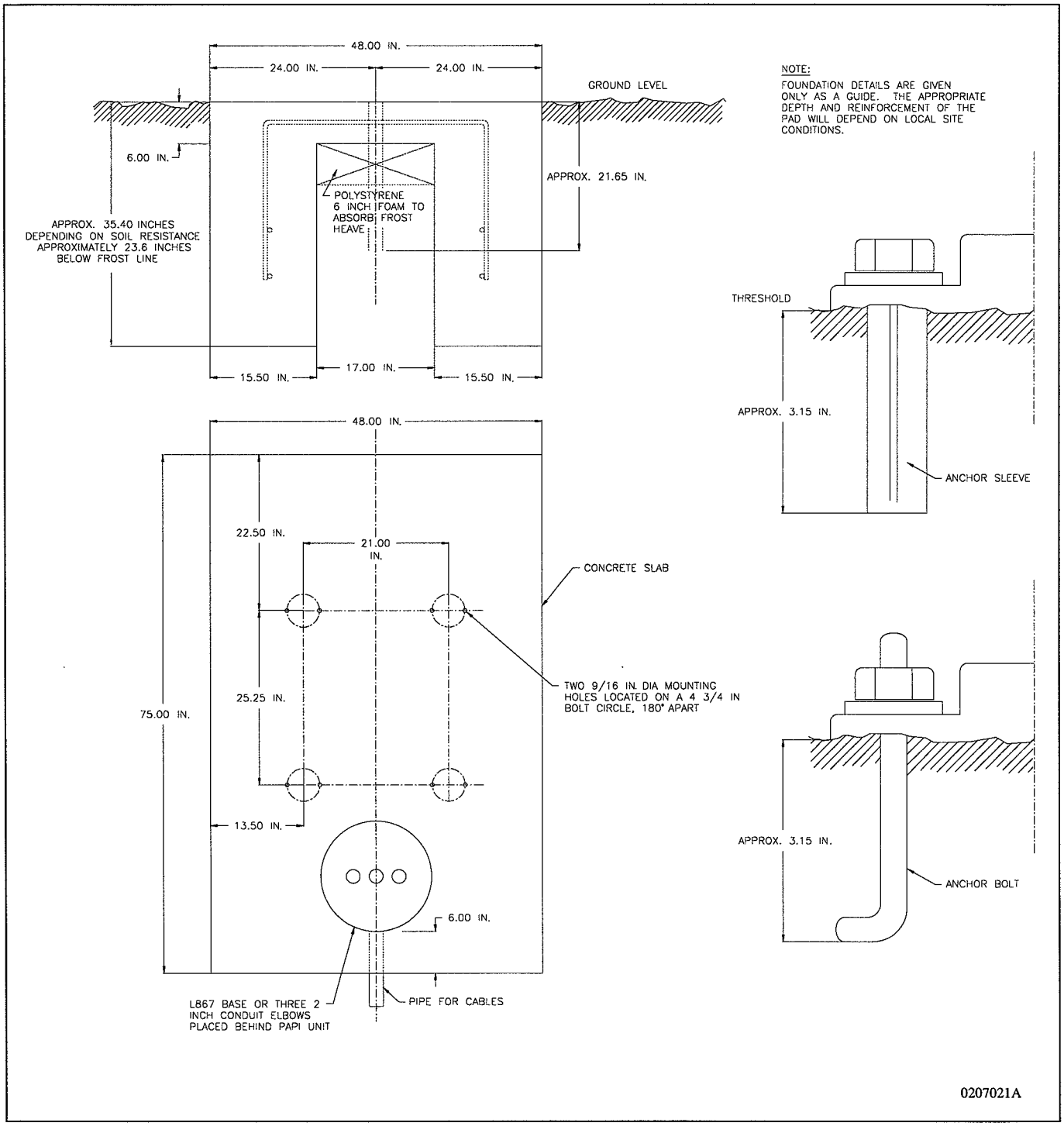

Figure 3-8. Installation on Concrete Pad (Three-Lamp, Four-Leg PAPI B) (Part 2 of 2)

9. PAPI Foundations *(contd.)*

To cast the concrete pad and anchor the support fixtures, perform the following procedure:

1. Stake out the longitudinal axis of the light units parallel to the runway centerline.

2. Dig the foundation hole per Figure 3-7 for the two-lamp and Figure 3-8 for the three-lamp.

3. Place foam in pit to absorb frost heave below the central part of the slab. Place L-867 light base/conduit elbows or pipes for cables. Place bars for reinforcement of concrete.

4. Pour in concrete and allow it to harden for at least one day.

5. After concrete sets up, using chalk draw a longitudinal axis (in accordance with the axis staked out on the ground) on the upper surface of the pad. Draw a transverse axis perpendicular to the other axis.

6. See Figure 3-2 for the two-lamp/three- and four-leg and Figure 3-3 for the three-lamp/three- and four-leg PAPI. Lay a positioning plate on the pad; center it by positioning the central hole at the intersection of both axes; align the plate along the longitudinal axis using the V-notches in the plate.

7. Mark the eight locations of the screws on the slab; drill the eight holes to the diameter and depth required for the expansion sleeves and insert the sleeves.

8. Place and fasten the flanges with two screws.

9. Install the frangible couplings. Make sure to place the second nut, ferrule compression joint, and ferrule ring on the bottom of the EMT tube first before screwing the tube with nuts, joints, and rings onto the frangible coupling. See Figure 3-9.

   NOTE: The contractor supplies and installs the 2-inch (50.8 mm-) diameter (2–3/16 OD) EMT tube. Determine length at installation to adjust for uneven elevation above the runway. The 2-inch EMT tube extends into the frangible coupling 3.25 inches (82.55 mm) and 1-1/2 inches (38.1 mm) into the nut and ferrule compression joint to ensure stable installation. Paint the tube according to Federal standard 595A, color #12197, international orange, to reduce corrosion.

   NOTE: Instead of expansion sleeves, cast 3/8–16 x 6-inch anchor j-bolts into the concrete at the proper locations on a 4 3/4 in.-(120.65 mm-) diameter bolt circle, in two places.

9. PAPI Foundations *(contd.)*

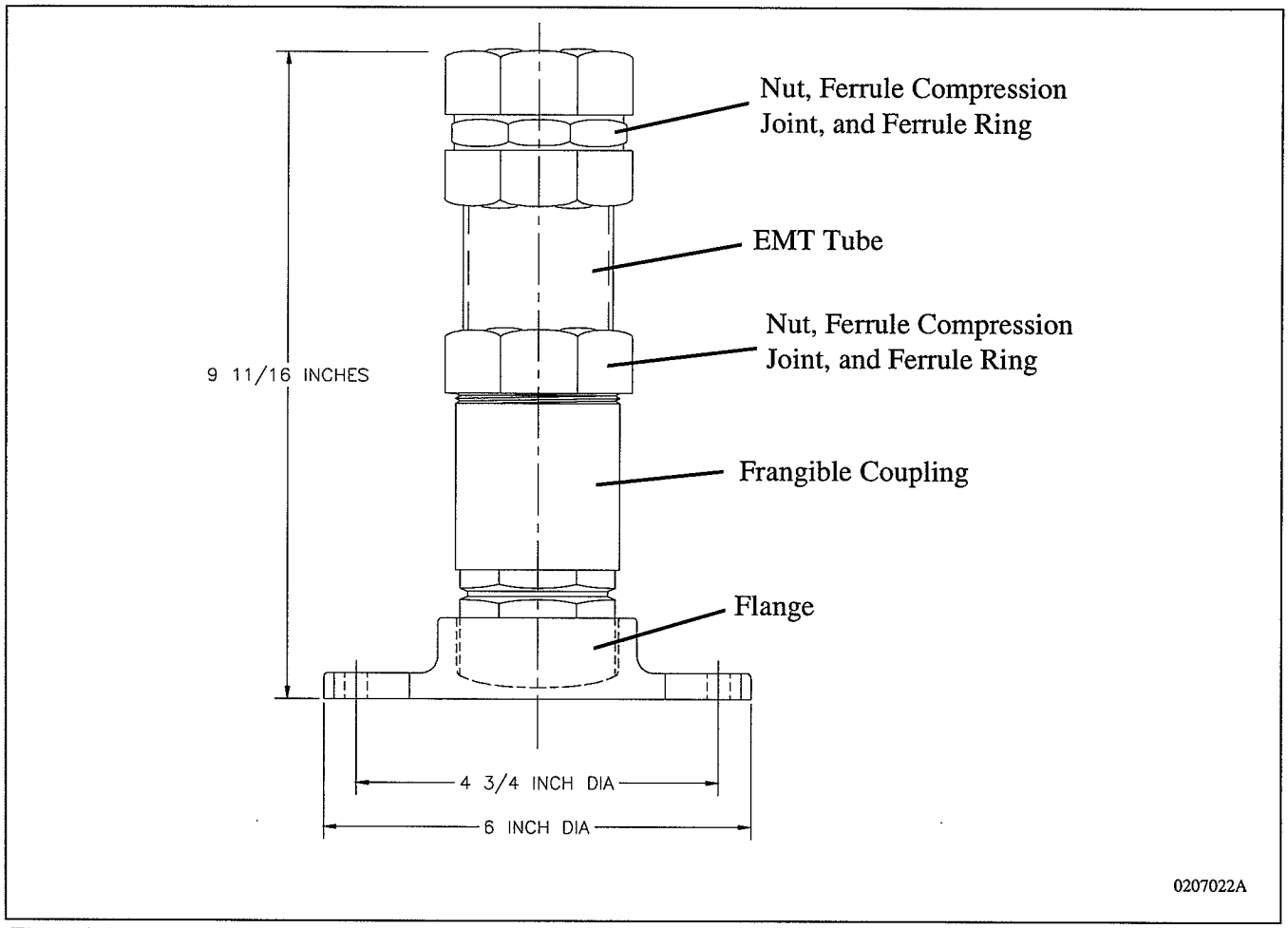

Figure 3-9. Frangible Coupling

10. PAPI Aiming Angles

Refer to Tables 3-2 and 3-3 for the aiming angles for the L-880 and L-881 PAPI light units.

Table 3-2. Aiming Angles for L-880 PAPI Units

L-880 (4 box) PAPI	Aiming Angle (Minutes of Arc) (Standard Installation)	Aiming Angle (Minutes of Arc) (Height Group 4 Aircraft* on Runway with ILS)	Note
Unit nearest runway	30' above glide path	35' above glide path	A
Next adjacent unit	10' above glide path	15' above glide path	A
Next adjacent unit	10' below glide path	15' below glide path	A
Next adjacent unit	30' below glide path	35' below glide path	A
NOTE A: Refer to Table 3-1 in *Siting PAPI with ILS Glideslope* in this section.			

10. PAPI Aiming Angles *(contd.)*

Table 3-3. Aiming Angles for L-881 PAPI Units

L-881 (2 box) PAPI	Aiming Angle (Minutes of Arc) (Standard Installation)
Unit nearest runway	15' above glide path
Unit farthest from runway	15' below glide path

NOTE: 60 minutes of arc = one degree (60' = 1°)

11. Assembling Adjustable Legs

Assemble the legs for each PAPI unit as follows:

1. See Figure 2-7. Screw threaded rods (3, 8) into differentials (4) and assemble legs.

   NOTE: Do not assemble upper hex nut (13), lockwasher (1), and flatwasher (12). These items will be installed after the PAPI unit is mounted on the legs.

2. Screw front and rear leg assemblies into the frangible couplings installed on concrete pad.

12. Mounting Unit

To mount the unit, perform the following procedure:

1. See Figures 2-7 and 3-10. Gently mount PAPI unit on the three or four legs so that the unit rests on the top of the lower flatwasher (11), lockwasher (2), and hex nut (10).

   NOTE: Figure 3-10 shows the two-lamp PAPI. The three-lamp PAPI is similar.

12. Mounting Unit *(contd.)*

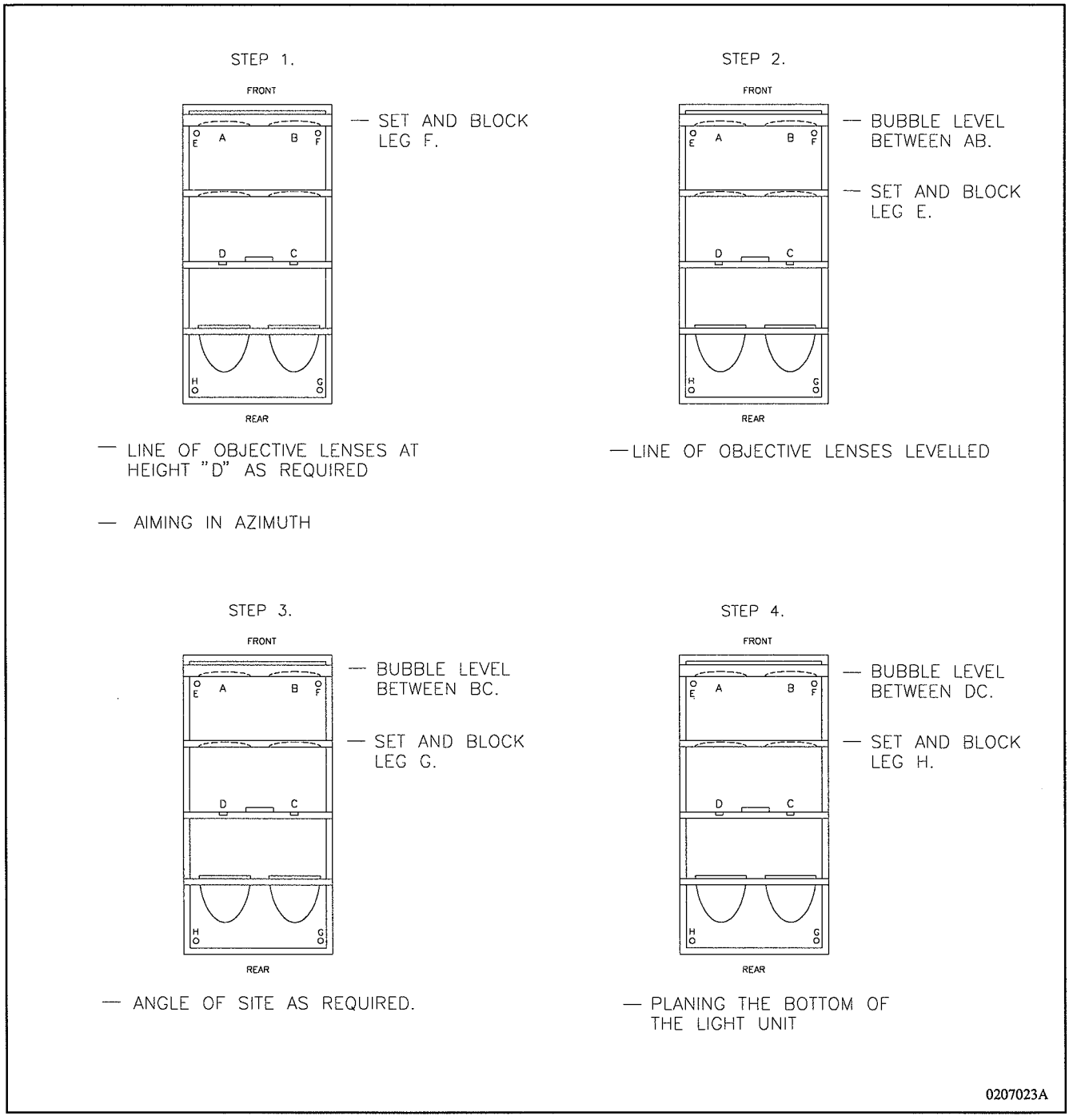

Figure 3-10. Elevation Setting Sequence

12. Mounting Unit *(contd.)*

2. Install the upper flatwasher (12), lockwasher (1), and hex nut (13) on the threaded rod. Do not tighten nuts.

3. Make sure the bottom of the unit is resting on the top of the lower flatwasher (11) of the right front leg F.

4. Make sure all locking nuts on the frangible couplings are tightened.

13. Aligning Units

The alignment of units involves using the aiming device, performing horizontal aiming, performing rough elevation setting, checking he horizontal aiming, and performing fine elevation setting.

Using Aiming Device

See Figure 3-1. The aiming device has two graduated scales, a large metallic scale and a plastic scale (on the upper arm of the aiming device) which are used to set the aiming angle.

The ***metallic scale*** is calibrated in ***10 minutes of arc*** from 0° to 10°. Since there are 60 minutes of arc in one degree (60'= 1° or 30'= 1/2°), there are 6 divisions (0-10', 10-20', 20-30', 30-40', 40-50', 50-60') between each degree tic mark on the scale. Note the 30 minute or 1/2 degree tic mark between each degree tic mark (0 to 1°, 1 to 2°, 9 to 10°) on the metallic scale is slightly longer than the 10', 20' or 40' and 50' tic marks.

The ***plastic scale*** is calibrated in ***minutes of arc*** from 0 to 10 minutes. If an angular setting of, for example, 3° 30' is desired, the setting on the aiming device is obtained by moving the upper bar of the aiming device with the attached plastic graduate scale so that the *0 line on the plastic scale lines up exactly with the 3° 30' tic mark on the metallic scale* (the 30 minute (30') tic mark is midway between the 3 degree and 4 degree tic marks). After obtaining this setting, tighten the locking screw on the upper arm to secure the angular setting.

Suppose now that an angle of 3° 35' is desired. To obtain this setting, perform the following procedure:

1. Set the 0 line on the plastic scale at the 3° 30' tic mark as described above.

2. Locate the 5 minute line on the plastic scale. It will not be lined up with any of the tic marks on the metallic scale.

Using Aiming Device *(contd.)*

3. To obtain the desired setting of 3° 35', slowly move the 5 minute line upward until it lines up exactly with the **next tic mark** on the metallic scale. The 5 minute line on the plastic scale will be exactly lined up with the 4° 20' tic mark on the metallic scale when the aiming device is set for 3° 35'.

   NOTE: The 0° line on the bottom of the plastic scale will be centered between 3° 30' tic mark and 3° 40' tic mark on the metallic scale. Tighten the locking screw on the upper arm to secure the arm's angular setting.

4. Practice using the aiming device to obtain the following angular settings: 3° 33' and 3° 38'.

   NOTE: The 3° 33' angular setting is obtained when the 3 minute line on the plastic scale is lined up with the 4 degree tic mark on the metallic scale; the 3° 38' angular setting is obtained when the 8 minute line on the plastic scale is lined up with the 4° 50' tic mark on the metallic scale.

Preliminary Remarks

The remarks below should be kept in mind in all the following operations: aligning horizontal cutoffs to aiming device, adjusting rough elevation setting, and checking horizontal aiming.

- When handling the unit and, in particular, during installation and aiming, avoid movement of the reference adjusting screws in blocks A and B.

  NOTE: Any accidental movement of these screws will require resetting in the factory by specialized personnel.

- When placing the aiming device on the PAPI unit, make sure the holes and slots in the movable arms of the aiming device are properly inserted over the screw heads in the reference blocks (A and B) and into reference slots (C and D).

- The bubble level should be carefully positioned between the locator screws on the bar of the aiming device or against the locator screws on the movable arms.

- When working with the fastening nuts and locknuts on the legs, make sure that the threaded rod does not rotate.

Aligning Horizontal Cut-Offs to Aiming Device

See Figure 3-10, Step 1. Horizontal cut-offs are aligned to the aiming device, not the PAPI box. Refer to *Aiming Devices* in *Instruments for Installation and Verification* in this section.

To align the horizontal cut-offs, perform the following procedure:

1. Set the aiming device at the required aiming angle for the unit.

2. Open up the two movable arms and place the instrument on the reference blocks A, B, and slots C and D with graduated scale near reference slot C. Carry out the following aiming procedure:

   a) Place rod at 164 feet (50 m) in front of the PAPI unit at the same distance from the runway centerline as reference block B and slot C.

   b) Check the alignment through the V-sites on bar of aiming device. Use the sighting picture given in Figure 3-1. See Figure 2-7. If necessary, adjust alignment of unit by a small movement of the lower hex nut (10).

   c) Tighten upper hex nut (13) on the right front leg F.

   d) Do not tighten lower hex nut (10). Leg F will be the pivot during the following operations.

Adjusting Rough Elevation Setting

NOTE: If the legs of the unit are installed at the same height and are level, the unit will be aimed at approximately 3 degrees.

To adjust the coarse setting of the unit, perform the following procedure:

1. See Step 2, Figure 3-10. Place the bubble level between locator screws on the movable arm resting on reference blocks A and B.
2. See Figures 2-7 and 3-10. Level by adjusting the hex nuts (10, 13) on the left front leg E.
3. Tighten hex nuts (10, 13) simultaneously.
4. See Step 3, Figure 3-10. Place level between locator screws on the bar of the aiming device resting on reference block B and slot C.
5. See Figures 2-7 and 3-10. Level by adjusting hex nut (9) of the right rear leg G. During this operation, the rigid bottom of the unit must be free from hex nut (1) on the left rear leg H.
6. Position upper hex nut (13) on leg G against upper flatwasher (12). Simultaneously tighten hex nuts and on leg G.
7. See Step 4, Figure 3-10. Place level between locator screws on the movable arm resting on reference slots C and D.
8. See Figures 2-7 and 3-10. Level by adjusting hex nut (10) on the left rear leg H. Some adjustment of the upper hex nut (13) may also be required.
9. Position hex nut on leg H against upper flatwasher (12). Simultaneously tighten hex nuts (10, 13).
10. Tighten lower hex nut (10) on leg F.

    NOTE: No further adjustment is required on the hex nuts.

Checking Horizontal Aiming

See Figure 2-7. Make sure rod at 164 feet (50 m) from the unit is still properly aligned with the V-sites on aiming bar. If not, loosen upper hex nut (13). Align the unit. Refer to *Aligning Horizontal Cut-Offs to Aiming Device* in this section. Repeat the operations in the preceding section.

NOTE: It is not necessary for the alignment to be absolutely perfect. An error of 20 inches (508 mm) at 164 feet (50 m) yields an error of 0.5°, which is within tolerance. Refer to *Azimuthal Aiming* in *Siting Tolerances* this section.

Adjusting Fine Elevation Setting

To adjust the fine elevation settings using the differential, perform the following procedure:

1. Place aiming device on unit so that it rests on the screws of reference blocks A and B, and slots C and D.

2. See Figure 3-10, Step 1 and Figure 2-7. Make sure the locking hex nuts (5, 9) for the differential (4) on right front leg F are tightened. The locking hex nuts (5, 9) for the differentials on the other legs have to remain loose.

3. See Figure 3-10, Step 2 and Figure 2-7. Place level on the arm of the aiming device resting on reference blocks A and B. Level by turning the differential on left front leg E in the proper direction. Tighten locking hex nuts (5, 9) on the differential on leg E when leveled.

4. See Figure 3-10, Step 3 and Figure 2-7. Place bubble level on the bar of the aiming device resting on reference block B and slot C. Proceed with the leveling procedure by adjusting the differential on rear legs G and H, turning both differentials in the same direction with equal amplitude. Tighten locking hex nuts (5, 9) on differential on leg G when leveling is completed.

5. See Figure 3-10, Step 4 and Figure 2-7. Place level on movable arm resting on slots C and D. Level by turning differential of left rear leg H in the appropriate direction. Tighten locking hex nuts on differential on leg H when leveling is completed.

6. Repeat the above fine elevation adjustment steps 2 through 5. If the setting is still not correct, go back and repeat the rough elevation adjustment steps and then the fine adjustment steps until the correct setting is obtained.

Installing Master and Slave Box Assemblies

See Figure 3-11. The master and slave box assemblies have been packaged separately for shipment and must be installed on the rear of the PAPI units. Use the flatwashers, hex-head screws, hex nuts and split lockwashers (2 each per unit (supplied); to attach box assemblies to the PAPI units.

NOTE: Figure 3-11 shows the two-lamp PAPI. The three-lamp PAPI is similar.

Installing Master and Slave Box Assemblies *(contd.)*

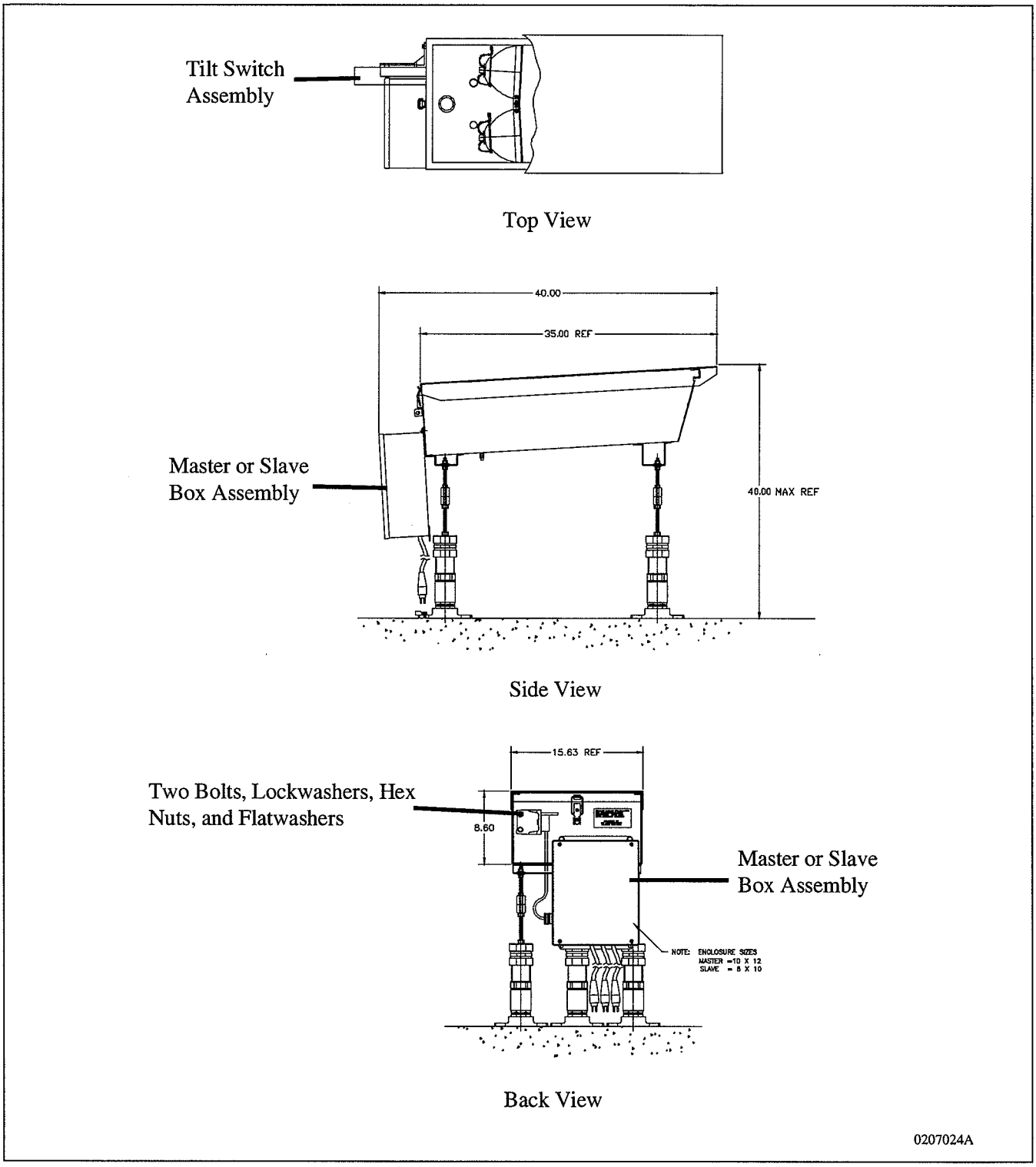

Figure 3-11. L-880/L-881 Final Assembly

Installing Master and Slave Box Assemblies *(contd.)*

The master box is installed on the master PAPI unit, which is the unit furthest from the runway. After installation of boxes, remove the front covers of the boxes to make wire connections to terminal block TB1. See Figures 8-1 through 8-4 in the *Wiring Schematics* section for master and slave wire connections.

Installing Tilt Switches

The tilt switches for the PAPI units are packaged separately for shipment and must be installed on the units. The tilt switch must be installed on the rear of the PAPI unit (on the outside) so that the two black arrows on the tilt switch label are pointing upward. See Figure 3-11. Two bolts, lockwashers, hex nuts, and flatwashers are supplied for installation.

NOTE: It is important that the tilt switch wires be free from nicks and routed in such a manner as to minimize conducted interference between adjacent wires.

To install the tilt switch, perform the following procedure:

1. See Figure 3-11. Place the bracket with the tilt switch over the two holes on the left rear of the unit (on the outside near leg H). The bracket is in the correct position if the black arrows on the tilt switch label are pointing upward.

2. Install bolt through flatwasher and then through tilt switch bracket and through one of the two holes on the PAPI frame, and place lockwasher and nut on the bolt. Do not tighten completely.

3. Install the other bolt through the second hole of the tilt switch bracket and tighten both bolts so that the bracket is secure against the PAPI frame.

4. Refer to Tables 3-4 through 3-7. Route tilt switch wire through watertight cable connector on the side of the master or slave box assembly, and make connections to TB1 as indicated in Figures 8-1 and 8-2 in the *Wiring Schematics* section.

Installing Tilt Switches *(contd.)*

Table 3-4. Master Box Tilt Switch Connections

Tilt Switch Wires	Master Box Connections
Wire #104 white	TB1-9
Wire #101 Black	TB1-10
Wire #102 green	TB1-12
Wire #103 red	TB1-13

Table 3-5. Master Box Lamp Wire Connections

When connecting this lamp wire...	Connect to Female Connector on...
DS1 lamp wire male terminal	Wire #211
DS1 lamp wire male terminal	Wire #214
DS2 lamp wire male terminal	Wire #215
DS2 lamp wire male terminal	Wire #218
DS3 lamp wire male terminal	Wire #221
DS3 lamp wire male terminal	Wire #222

Table 3-6. Slave Box Tilt Switch Connections

Tilt Switch Wires	Master Box Connections
Wire #103 red	TB1-9
Wire #102 green	TB1-10
Wire #101 black	TB1-11
Wire #104 white	TB1-12

Table 3-7. Slave Box Lamp Wire Connections

When connecting this lamp wire...	Connect to Female Connector on...
DS1 lamp wire male terminal	Wire #211
DS1 lamp wire male terminal	Wire #214
DS2 lamp wire male terminal	Wire #215
DS2 lamp wire male terminal	Wire #218
DS3 lamp wire male terminal	Wire #221
DS3 lamp wire male terminal	Wire #222

5. To level the tilt switch, place a precision bubble level on top of the tilt switch (with metal plate attached to hold level). Loosen bolts and adjust the up/down position of the tilt switch until level reads true. Tighten the locking bolts.

   NOTE: Use a precision level such as the ±0.004 in/ft degree of precision level used for leveling the PAPI units.

14. Connecting Series Circuit

WARNING: Before making any wire connections, make sure that you turn off the constant current regulator. Failure to observe this warning may result in personal injury, death, or equipment damage.

This subsection describes series circuit wiring requirements.

Grounding Units

Each PAPI unit must be grounded. To ground each unit: Attach a ground wire AWG #12 (minimum) to the ground lug located on the floor flange on the rear PAPI unit leg.

Using Isolation Transformers

An L-830 isolation transformer is required to connect the series lighting circuit to each of the two/three lamps in each PAPI unit. An L-830 30/45W isolation transformer is required to connect the series lighting circuit to the +24 Vdc power supply PCB1 and the heater in each of the tilt switch.

NOTE: Use L-830-6 (6.6A/6.6A, 200W) and L-830-1 (6.6/6.6A 30/45W) isolation transformers on a 6.6A series circuit and L-830-7 (20A/6.6A, 200 W) and L-830-2 (20/6.6A 30/45W) isolation transformers for 20A series lighting circuits. An L-867 base installed in the pad near each PAPI unit is used to house the two transformers.

Connecting External Wiring

All installation wiring should conform to the applicable sections of the National Electric Code and Local Codes. Make wire connections as shown in Figures 8-1, 8-2 and 8-3 for the L-880 PAPI system or in Figures 8-1, 8-2 and 8-4 for the L-881 PAPI system. Route cable through the bottom holes of the box assemblies.

NOTE: All external wiring must be a minimum of 16 AWG/600 V.

See Figures 3-12 and 3-13 for suggested method of connecting the wires between the transformer housing and the PAPI unit and the equipment that the contractor supplies. A field splice kit is available for L-880 installation and for L-881 PAPI installation. Each field splice kit provides enough items for entire installation. Refer to the *Parts* section for ordering information.

NOTE: It is important that the tilt switch wires be free from nicks and routed in such a manner as to minimize conducted interference between adjacent wires.

NOTE: After making all wiring connections and checking the operation of the units, install duct seal or RTV in all conduit entrances.

Connecting External Wiring
(contd.)

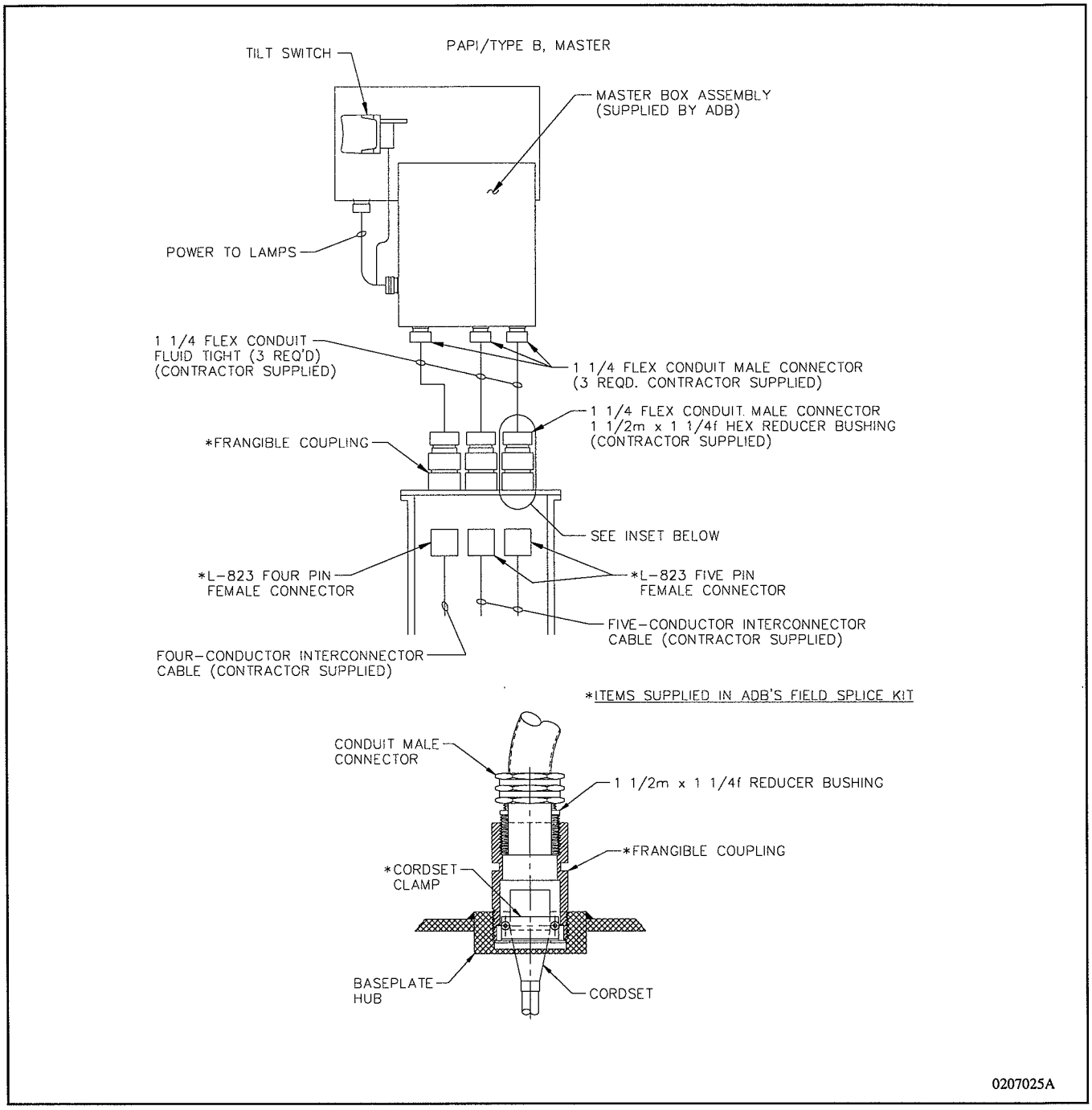

Figure 3-12. L-880/L-881 Master External Connections

Connecting External Wiring
(contd.)

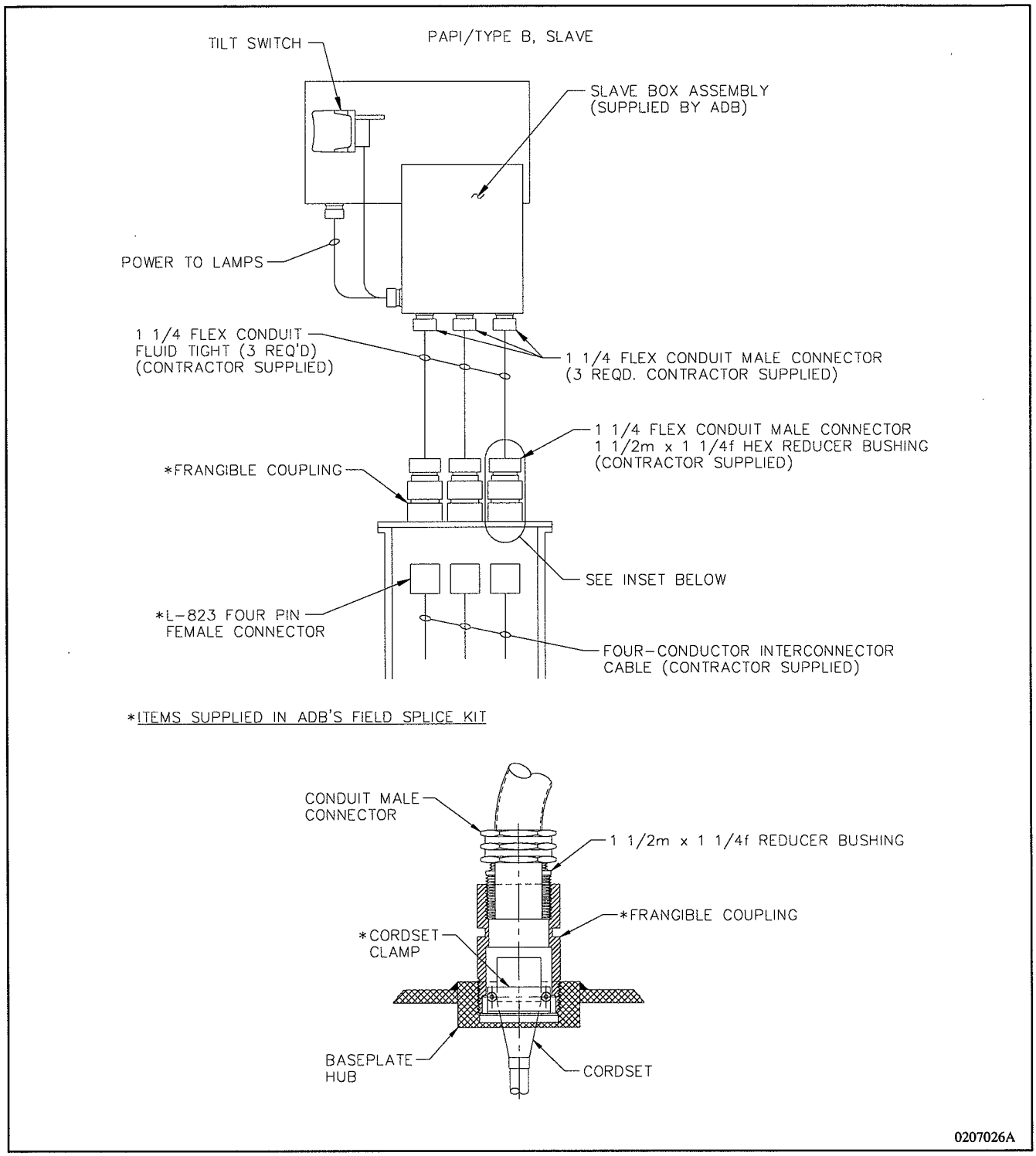

Figure 3-13. L-880/L-881 Slave External Connections

15. Checking Slope Angles of PAPI Units

It may be requested that when the equipment is put initially into operation and at regular intervals thereafter, the cut-off angle of the units be checked. To make this measurement, it will be necessary to use a surveying instrument or a bubble level with telescope and a surveyor's stake.

To check the slope angles of the PAPI units, perform the following procedure:

1. See Figure 3-14. Place the surveying instrument 6 to 10 feet (1.83 to 3.05 m) behind the unit pointing down beam.

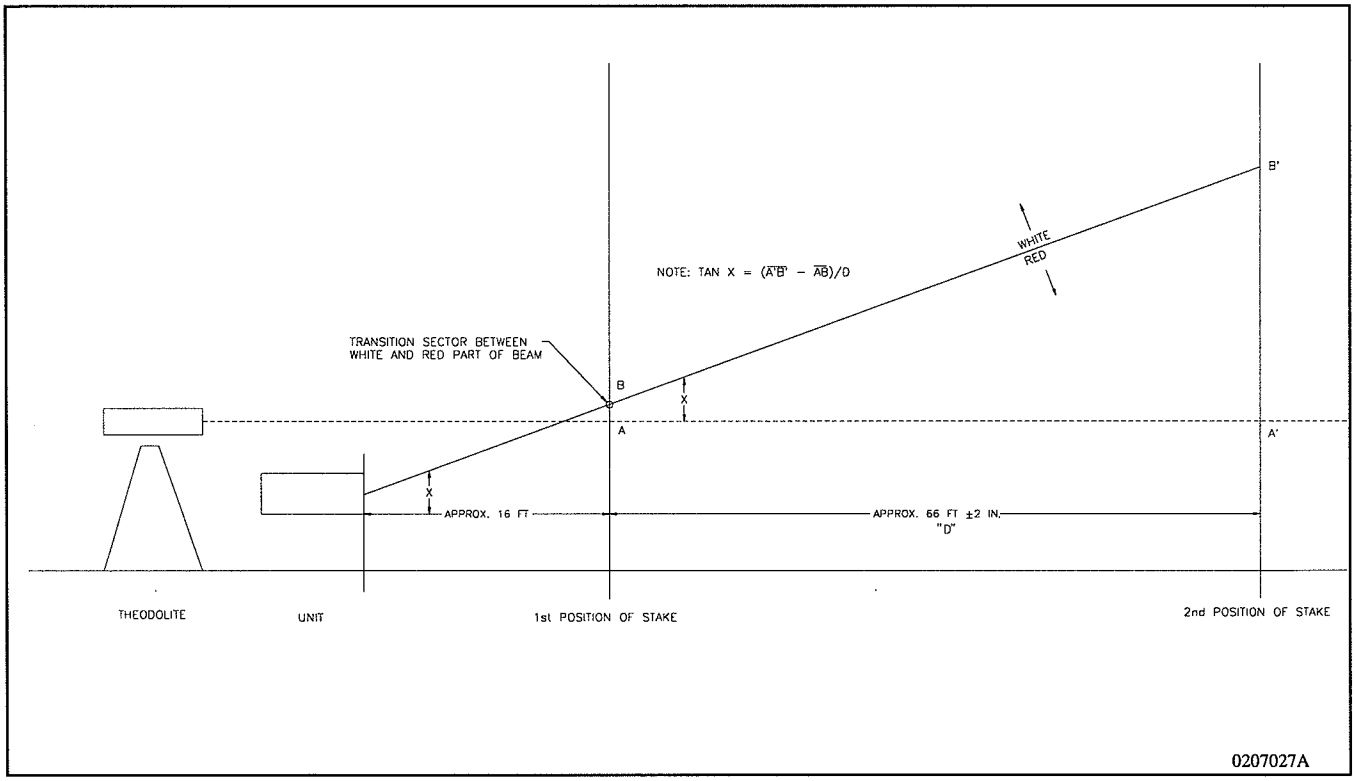

Figure 3-14. Checking Slope Angles

15. Checking Slope Angles of PAPI Units *(contd.)*

2. A surveyor's stake is held by an assistant approximately 16 feet (4.88 m) in front of the unit.

3. Take reading *A* for the intersection of the horizontal of the telescope with the stake.

4. Take reading *B* for the intersection of the cut-off plane of the light beam with the surveyor's stake.

5. The assistant should now move a precisely measured distance of about 50 to 66 feet (15 to 20 m) (±0.25%) down beam and take the same measurements A' and B', as in steps 3 and 4 above.

   NOTE: The angle x of the beam cut-off to the horizontal is found from the following formula:

$$\tan x = \overline{(A'B'} - \overline{AB)} / D$$

   NOTE: The overline (¯) denotes length

   where D is the horizontal distance between the two stake positions. If similar checks are to be scheduled in the future, a small concrete pad holding a galvanized pipe may be installed in front of each unit at the distances used above.

16. Using Reference Bases for Checking Stick

See Figure 3-4. As soon as the system is found to be operationally acceptable in all respects, install permanent sighting bases in front of each light unit to allow for routine checks of the elevation setting using the checking stick.

Locating Reference Bases

To locate a reference bases, perform the following procedure:

1. Locate a concrete sighting base on the extended centerline of each unit.
2. When the PAPI is switched on, walk along the centerline of the unit observing it from time to time through the screen on the checking stick until the lower limit of the white sector is about to disappear under the lower scored line.
3. At this point, dig a hole approximately 16 inches (406.4 mm) square and 12 inches (304.8 mm) deep.
4. See Figure 3-2 for the two-lamp/three- and four-leg and Figure 3-3 for the three-lamp/three- and four-leg PAPI. Drive a steel pipe vertically in the center of the hole until its top is at ground level.
5. Place the bottom end of the checking stick on top of the pipe and observe the light unit through the screen.
6. Gradually drive the pipe into the hole, while frequently observing the light unit through the screen, until the light beam no longer appears completely white just below the upper line of the screen.
7. Repeat this procedure for the other units, using the same observer.

Making Observations with Checking Stick

See Figure 3-4. Refer to *Reference Bases for Checking Stick* in this section. Place the checking stick on concrete sighting base in front of the light unit and switch the PAPI system on. Observe the light unit through the screen. Just below the upper line of the screen, the light beam should no longer appear completely white. If this is not the case, the unit is out of alignment and requires resetting. Refer to *Aligning Units* in this section.

Making Flight Checks for Reduced Horizontal Coverage

A flight check is required for the PAPI system when there is reduced horizontal coverage to determine if all horizontal cutoffs of the PAPI beams are properly located relative to any obstacles. If horizontal realignment is required, the upper an lower locknuts on all PAPI legs must be loosened and the unit realigned. Refer to *Aligning Horizontal Cut-Offs to Aiming Device* in this section.

Section 4
Operation

1. Introduction

The operating conditions for the PAPI system are discussed below.

2. Normal Operation

The PAPI system must operate continuously as long as the runway is in service. At night the system may operate continuously at any intensity selected by the CCR.

3. Regions with Heavy Snowfall

Units should operate continuously at normal standby brightness even when the runway is not in use. Any snow will thus melt and drain off. When snowfall is expected to bury the units, the location of the units should be marked with sticks or flags (approximately 7 feet high) (2.13 m) to prevent damage to the units by snow removal equipment.

4. Criteria for System Deactivation

Pending repair and provided it is continually monitored, a unit in which one of the lamps has failed can still be regarded as operational. Should the system show more serious defects, it must be put out of operation.

Section 5
Maintenance

1. Introduction

This section provides maintenance information for the L-880/L-881 PAPI systems.

2. Maintenance Schedule

Refer to Table 5-1 for L-880/L-881 maintenance schedule.

Table 5-1. L-880/L-881 PAPI Maintenance

Interval	Maintenance Task	Action
After initial installation (during first few weeks)	(1) Check elevation angle of units.	(1) Use checking stick. Reset any units out of alignment
	(2) Check output current.	(2) Calibrate, if necessary.
Daily	(1) Check to ensure all lamps are lighted and illuminated evenly.	(1) Replace burned-out lamps. Clean any dirty glassware
	(2) Check for an apparent evidence of damage to unit.	(2) Repair or replace any damaged components.
	(3) Check all control equipment for proper operation.	(3) Repair or replace any damaged components
Weekly (more frequently during rainy season)	(1) Clean outer surface of protective glass.	(1) Use a soft cotton cloth moistened with alcohol.
	(2) Check elevation angle of units.	(2) Use checking stick. Reset any units out of alignment

Continued on next page

Table 5-1. L-880/L-881 PAPI Maintenance

Interval	Maintenance Task	Action
Monthly	(1) Inspect housing and closure system, lamps, electrical connections, filters, and protective glass for damage, breakage, or warpage.	(1) Repair or replace any damaged parts.
	(2) Clean interior.	(2) Remove any foreign matter. Clean both sides of the protective glass, color filters, lenses and reflectors. Use a soft cotton cloth moistened with alcohol.
	(3) Make sure mounting is rigid.	(3) Tighten any loose hardware, nuts, screws, etc. Realign unit if hardware has loosened.
	(4) Make sure no vegetation obscures the light beams.	(4) Remove vegetation. Use weed killer to prevent any additional growth.
	(5) Make flight check of system, if possible.	(5) Verify units give proper approach path indication.

3. Maintenance Procedures

Refer to maintenance procedures below.

Replacing Lamp

To replace a lamp, perform the following procedure:

1. Turn off CCR that powers the PAPI system.
2. De-energize circuit by placing S1 to OFF and turn circuit breaker CB1 to OFF.
3. Remove the electrical slip-on fitting on burned-out lamp, swing back the spring-loaded fork and remove lamp from the reflector.
4. Reverse Step 1 to install a new lamp.

Replacing Lamp *(contd.)*

5. Orientate lamp to match index slots in lamp base with index tabs in lampholder (one tab/slot is square, the other tab/slot is circular). Hold lamp in place by placing the forked spring clip over lamp base and locking spring clip in place by latching forked spring clip behind the locking ears located on side of lampholder.

CAUTION: Wear cotton gloves when handling the lamps. Touching the quartz bulb with bare fingers may seriously shorten lamp life. If the quartz bulb has been touched, wipe it carefully with lens cleaning tissue or similar material moistened with isopropyl alcohol.

NOTE: It is recommended that a systematic replacement of all lamps be made after a service period of approximately 800 hours at the 100% brightness level. An elapsed-time recorder connected to the constant current regulator may be used to determine the time for replacement.

Replacing Objective Lens

The objective lenses are precisely positioned in the unit and are not field repairable since the optical center of the lens must be realigned after replacement. Whenever an objective lens is damaged, the PAPI light unit must be returned to the factory for repair and adjustment. Contact ADB, Inc. Sales Department for details.

Replacing Filters

The filters must be perfectly clean. Use a soft cotton cloth moistened with alcohol to clean filters, and wear cotton gloves when handling filters.

NOTE: When cleaning filters, make sure each filter is returned to the same filter holder from which it was removed.

Each filter is held in place in the filter holder by two springs.

To remove or replace a filter, perform the following procedure:

1. Remove the two springs using a small pliers.
2. Unclip the lower end of each spring from the hole in the panel and pull upward on the other end of the spring to remove.
3. Remove the filter by sliding it upward out of the holder.
4. To reinstall filter, reverse the removal steps. The filter must be installed in the holder so that the lower edge (dull edge) of the filter is down.

Section 6
Troubleshooting

1. Introduction

WARNING: Allow only qualified personnel to perform the following tasks. Observe and follow the safety instructions in this document and all other related documentation.

WARNING: De-energize the circuit and lock out the circuit or regulator so that the circuit cannot be energized by remote means before attempting to service the fixture.

This section provides troubleshooting procedures.

2. Troubleshooting

Refer to Table 6-1.

Table 6-1. L-880/L-881 PAPI Troubleshooting

Problem	Possible Cause	Solution
All lamps out	PAPI boxes tilt	Realign PAPI boxes.
	Tilt switch not level	Realign tilt switch.
	Power input	Repair or replace loose or broken wire.
	All lamps failed	Replace lamps. Check output current level. Calibrate, if necessary.
	Time delay PCB2 in master failed	Replace PCB2.
	+24 Vdc PCB1 in master failed	Replace PCB1.
Lamp(s) dim	Dirty lens shield	Clean with soft cotton cloth moistened with alcohol.
	Lamp not properly seated in reflector	Re-seat lamp in reflector. Replace lamp socket, if necessary.
	Current level too low	Calibrate, if necessary.
	Lens is improperly aligned	Replace lens if loose in ring.
	Unit improperly aligned	Use check stick to check alignment.
Short lamp life	Current level is too high	Check output current level. Calibrate, if necessary.
Tilt switch circuitry tilted	Tilt switches incorrectly wired	Correct wiring.

Section 7
Parts

1. Introduction

To order parts, call ADB Customer Service Center or your local ADB representative. Use this four-column parts list, and the accompanying illustration, to describe and locate parts correctly.

2. Using the Illustrated Parts List

The Item column numbers correspond to the numbers that identify parts in illustrations following each parts list. NS (not shown) indicates that a listed part is not illustrated.

The Description column gives the part name, as well as its dimensions and other characteristics when appropriate. Indentions show the relationships between assemblies, subassemblies, and parts.

The Part Number column gives the ADB part number.

Item	Description	Part Number	Quantity	Note
NS	Assembly	xxxxxxxx	2	A
T1	Assembly			
	Part	xxxxxxxx		
	Part	xxxxxxxx		

The number in the quantity column is the quantity required per unit, assembly, or subassembly.

The Note column contains letters that refer to notes at the end of each parts list. Notes contain special ordering information.

3. L-880/L-881 Style B Part Numbering System

Refer to Tables 7-1 and 7-2 for all replaceable parts for each replaceable component or assembly for the L-880 and L-881 Style B PAPI systems.

Figure 7-1 shows how to determine the part number for a particular L-880/L-881 PAPI system.

NOTE: Substitution of electrical components may be done only if substitution is the exact physical equivalent (body or case size) and equal, or better electrical characteristics with respect to tolerance, failure rate, and/or reliability.

Table 7-1. L-880 PAPI System

Component	Part Number
Master box assembly	44A4729-1XXX
Slave box #1	44A4729-2XXX
Slave box #2	44A4729-2XXX
Slave box #3	44A4729-2XXX

Table 7-2. L-881 PAPI System

Component	Part Number
Master box assembly	44A4729-1XXX
Slave box #1	44A4729-2XXX

3. L-880/L-881 Style B Part Numbering System *(contd.)*

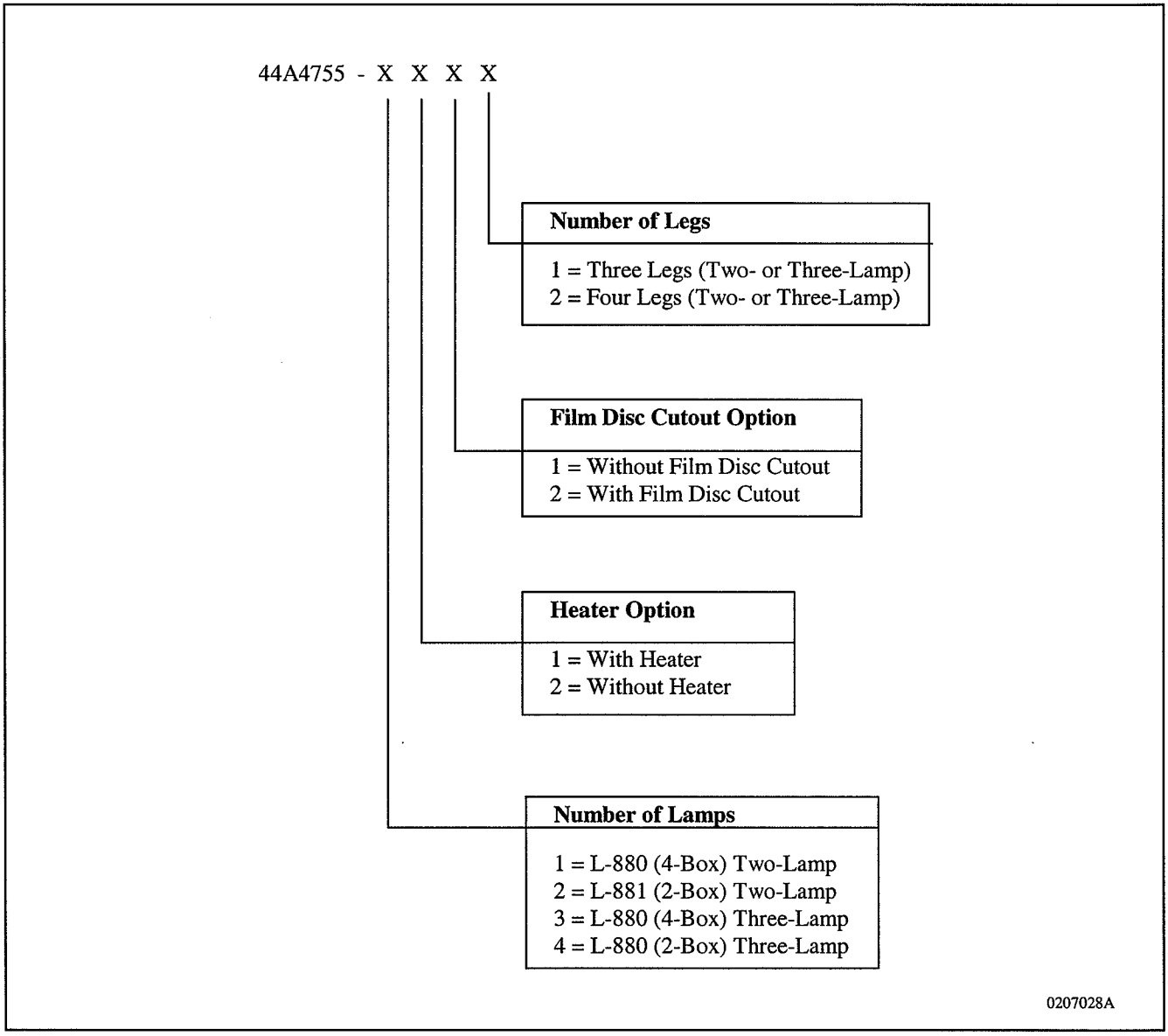

Figure 7-1. PAPI B L-880/L-881 Part Numbers

4. L-880/L-881 PAPI Style B Optical Box Final Assembly Parts List

See Figure 7-2.

Item	Description	Part Number	Quantity	Note
1	Light box	60A2354-X	1	
2	Tilt switch assembly			
	Tilt switch assembly, Class I, -35 °C	44C2607	1	
	Tilt switch assembly, Class II, -55 °C	44C2607-1	1	
3	Lamp, 200 W, 6.6 A, Osram 64382	48A0077		
	Two lamps		2	
	Three lamps		3	
4	Master box assembly			
	Master box assembly, Class I, -35 °C	44A4730-X1X	1	
	Master box assembly, Class II, -55 °C	44A4730-X2X	1	
	Slave box assembly	44A4731-XX	1	
5	Adjustable leg assembly	44C2362		
	Three-leg assembly		3	
	Four-leg assembly		4	
6	Frangible coupling assembly	44B0180		
	Three-leg coupling assembly		3	
	Four-leg coupling assembly		4	
7	Coupling, Neer TC616	77A0009		
	Three-leg coupling		3	
	Four-leg coupling		4	
8	Base flange	62B0107-2		
	Three-leg flange		3	
	Four-leg flange		4	
NS	Plug			
	Plug, two light	63B0371-21	2	
	Plug, three light	63B0371-23	2	

NS: Not Shown

4. L-880/L-881 PAPI Style B Final Assembly Parts List
(contd.)

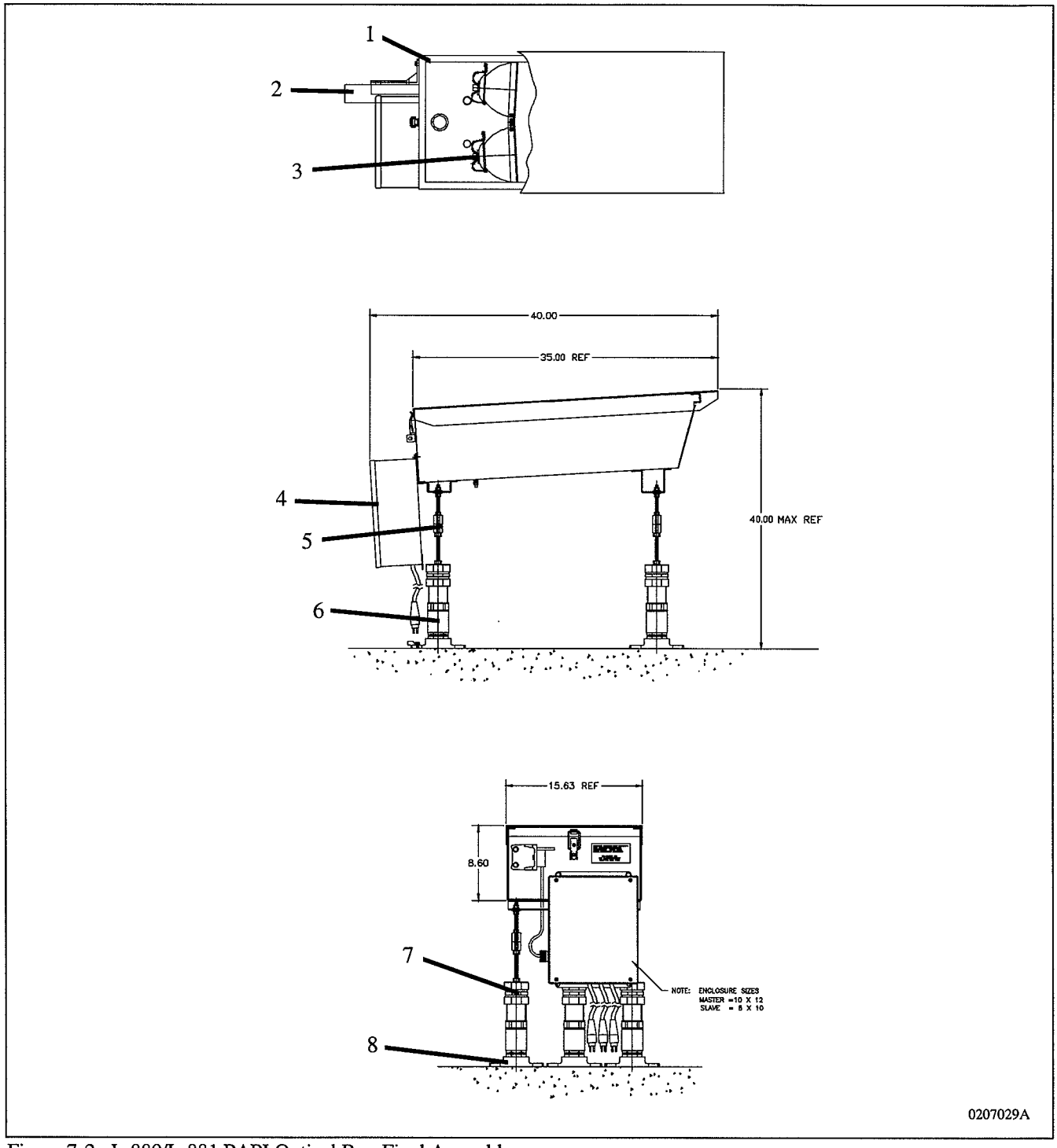

Figure 7-2. L-880/L-881 PAPI Optical Box Final Assembly

5. PAPI Style B Master Box Assembly Parts List

Item	Description	Part Number	Quantity	Note
NS	Panel assembly	44C2605-XXX	1	
NS	5-pin connector, male	73A0132	2	
NS	4-pin connector, male	73A0105	1	
NS	Enclosure	60A2359	1	
NS: Not Shown				

6. PAPI Style B Master Panel Assembly Parts List

See Figure 7-3.

Item	Description	Part Number	Quantity	Note
1	Thermostat (Therm-O-Disc #37121)	54A0007	1	
2	+24 Vdc PCB	44A4704-1	1	
3	Relay socket (Potter & Brum. #27E1039)	49A0279	As required	
4	Relay (Potter & Brum. #RKS5DW24)	53A0365	As required	
5	Film disc cutout (GE #4815920 G-2) Two-lamp cutout Three-lamp cutout	44A2267	 1 2	
6	Time delay PCB	44C2455-1	1	

6. PAPI Style B Master Panel Assembly Parts List *(contd.)*

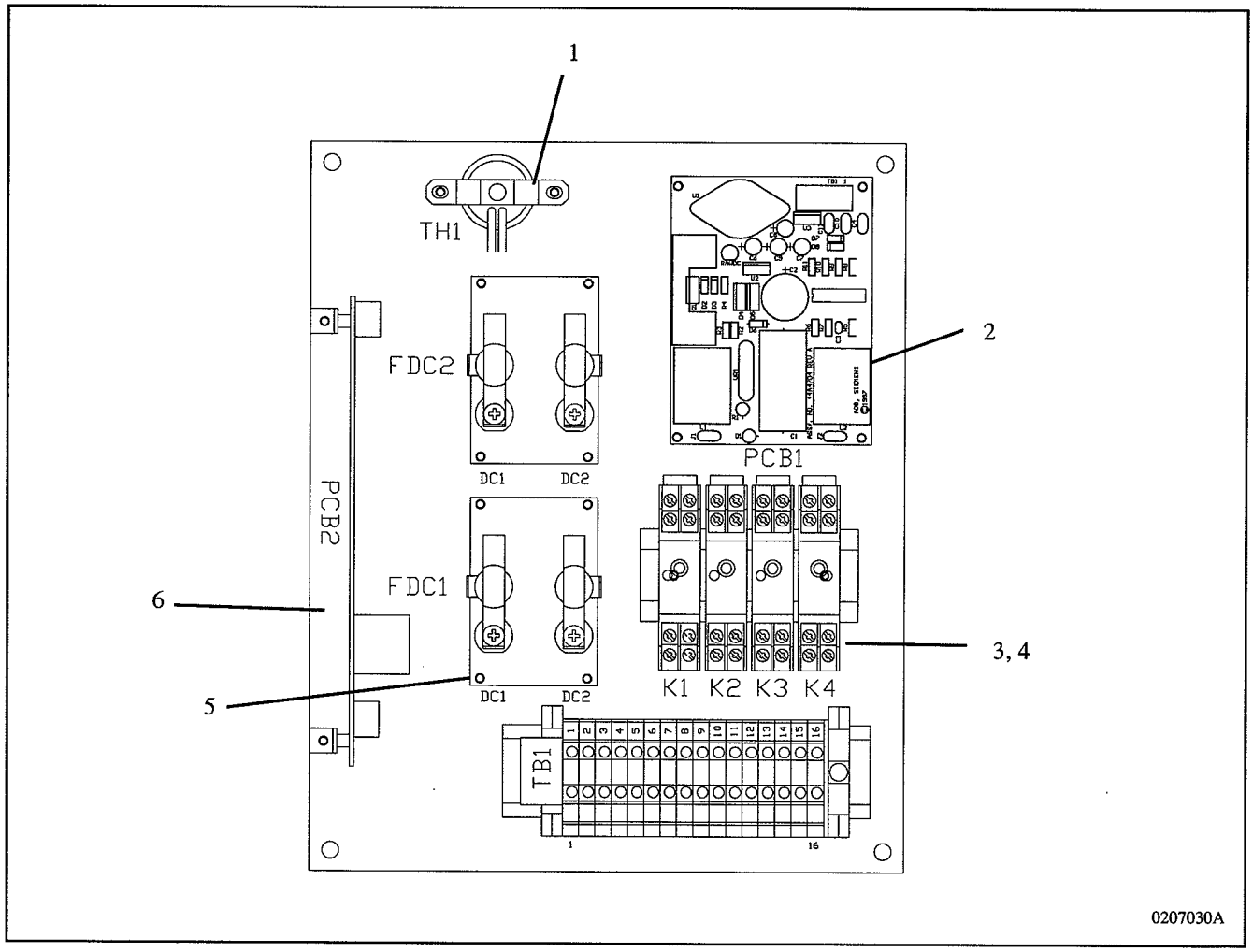

Figure 7-3. Master Panel Assembly

7. PAPI Style B Slave Box Assembly Parts List

Item	Description	Part Number	Quantity	Note
NS	Panel assembly	44C2606-XX	1	
NS	4-pin connector, male	73A0105	3	
NS	Enclosure	60A2358	1	
NS: Not Shown				

8. PAPI Style B Slave Panel Assembly Parts List

See Figure 7-4.

Item	Description	Part Number	Quantity	Note
1	Film disc cutout (GE #4815920 G-2)	44A2267	2	
2	Relay (Potter & Brum. #RKS5DW24)	53A0365	3	
3	Relay socket (Potter & Brum. #27E1039)	49A0279	3	

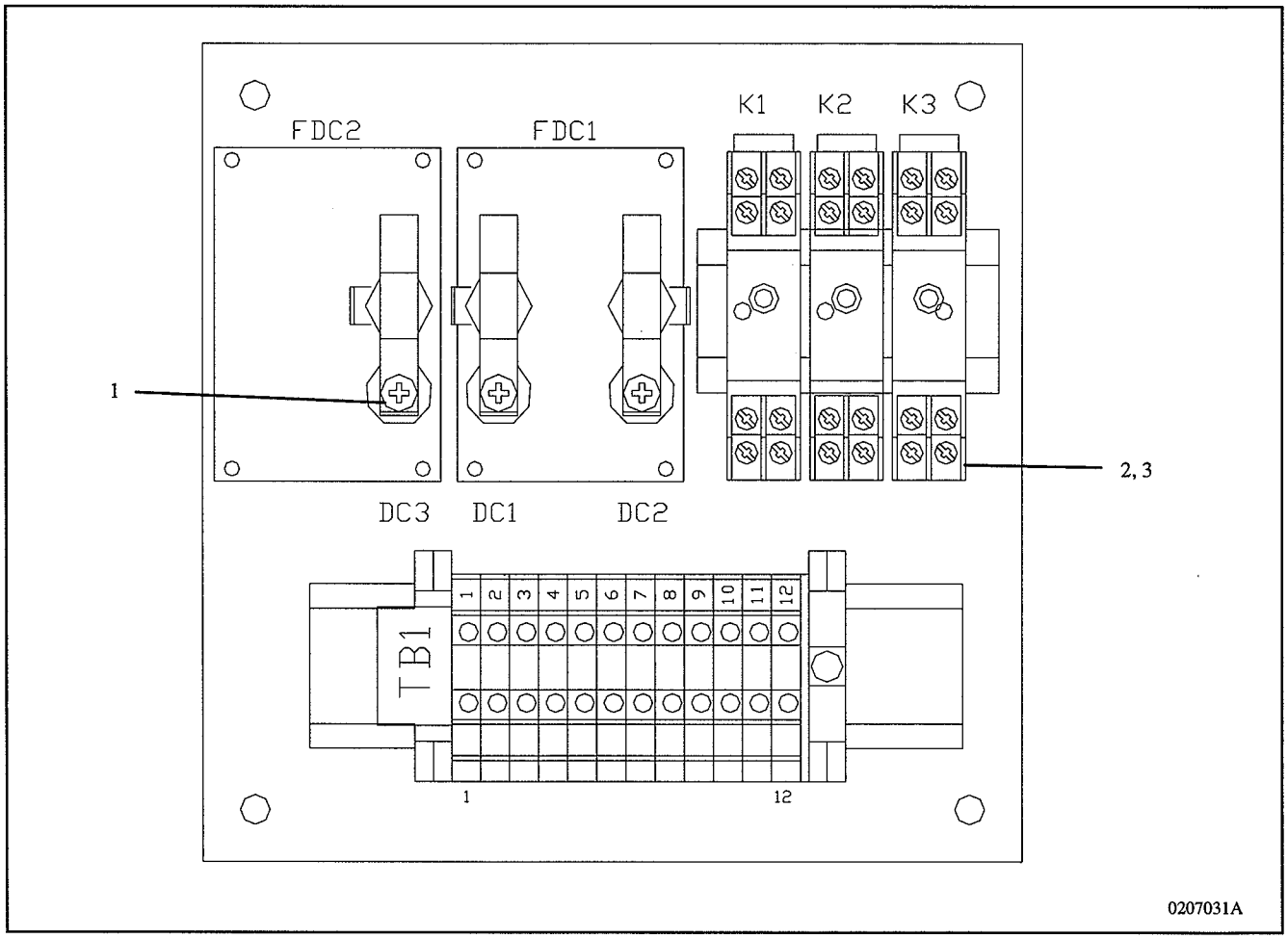

Figure 7-4. Slave Panel Assembly

9. PAPI Style B Optical Assembly Parts List

Item	Description	Part Number	Quantity	Note
NS	Protective glass	63A0360	1	
NS	Gasket	63A0359	1	
NS	Lens in ring (factory installation only)	44B1039		
	Two-lamp lens		2	
	Three-lamp lens		3	
NS	Filter, red	63A0356		
	Two-lamp filter		2	
	Three-lamp filter		3	
NS	Reflector	61B0128		
	Two-lamp reflector		2	
	Three-lamp reflector		3	
NS: Not Shown				

10. PAPI Style B Adjustable Leg Parts List

See Figure 7-5.

Item	Description	Part Number	Quantity	Note
1	Split lockwasher, 3/8	66A0026-29	2	
2	Threaded rod, 3/8–16 x 6 in.	64A0210	1	
3	Differential	85B0057	1	
4	Hex nut, 1/2–13	65A0015-33	2	
5	Leg cap	61A0111	1	
6	Threaded rod, 1/2–13 x 5 in.	64A0211	1	
7	Hex nut, 3/8–16	65A0015-29	3	
8	Flatwasher, 3/8	66A0015-31	2	

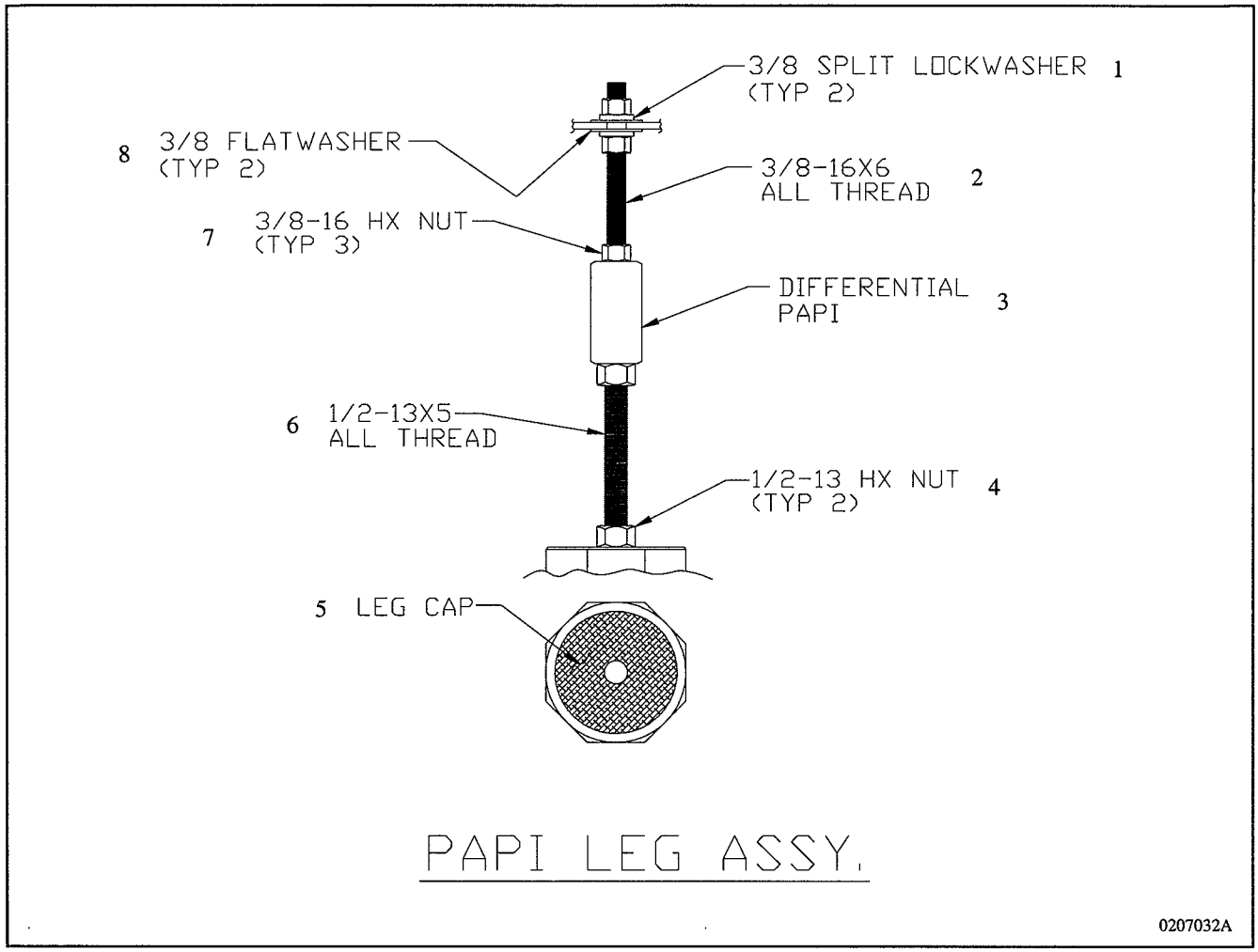

Figure 7-5. Adjustable Leg

11. PAPI Style B L-880 Field Splice Kit Parts List

Item	Description	Part Number	Quantity	Note
NS	L-880 field splice kit	94A0232-1	1	
NS	• Frangible coupling	62A0711	12	
NS	• 5-pin female plug	73A0131	2	
NS	• 4-pin female plug	73A0106	10	
NS	• Cable clamp assembly	44A4739	12	
NS	• Transformer connector kit	70A0050	13	
NS: Not Shown				

12. PAPI Style B L-881 Field Splice Kit Parts List

Item	Description	Part Number	Quantity	Note
NS	L-881 field splice kit	94A0232-2	1	
NS	• Frangible coupling	62A0711	6	
NS	• 5-pin female plug	73A0131	2	
NS	• 4-pole female plug with cord	73A0106	4	
NS	• Cable clamp assembly	44A4739	6	
NS	• Transformer connector kit	70A0050	7	
NS: Not Shown				

13. PAPI Style B Aiming Device Kit Parts List

Item	Description	Part Number	Quantity	Note
NS	Aiming Device Kit	44A0933		
NS: Not Shown				

14. Recommended Spare Parts

Item	Description	Part Number	Quantity	Note
NS	Lamp, 200 W, 6.6 A	48A0077	As required	
NS	Tilt switch assembly			
	Tilt switch assembly, Class I, -35 °C	44C2607	As required	
	Tilt switch assembly, Class I, -55 °C	44C2607-1	As required	
NS	Film disc cutout	44A2267	As required	
NS	Relay	53A0365	As required	
NS	Time delay PCB	44D2455-1	As required	
NS	+24 Vdc PCB	44A4704-1	As required	
NS: Not Shown				

Section 8
Wiring Schematics

1. Introduction

This subsection provides internal and external wiring schematics for the L-880/L-881 PAPI B systems.

2. Internal and External Wiring

This subsection provides the master and slave internal wiring diagrams.

See Figure 8-1 for the master internal wiring diagram and Figure 8-2 for the slave internal wiring diagram. See Figure 8-3 for the two-lamp and three-lamp L-880 external wiring. See Figure 8-4 for the two-lamp and three-lamp L-881 external wiring.

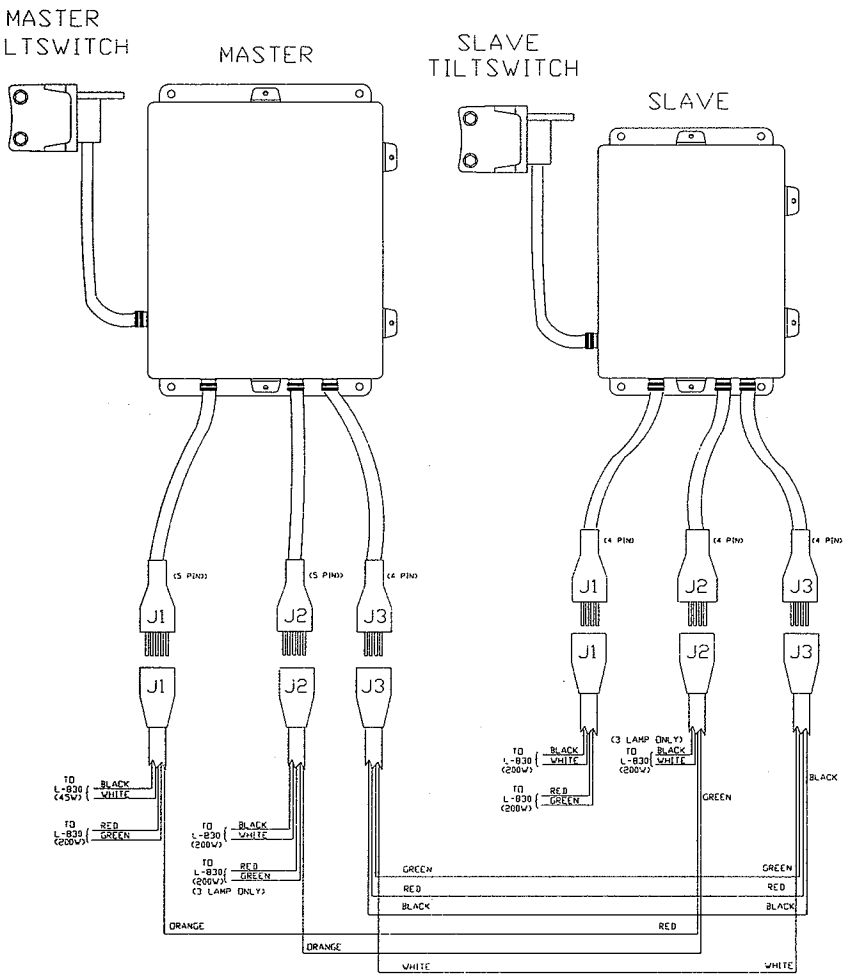

Figure 8-4. L-881 External Wiring (Two and Three Lamps)

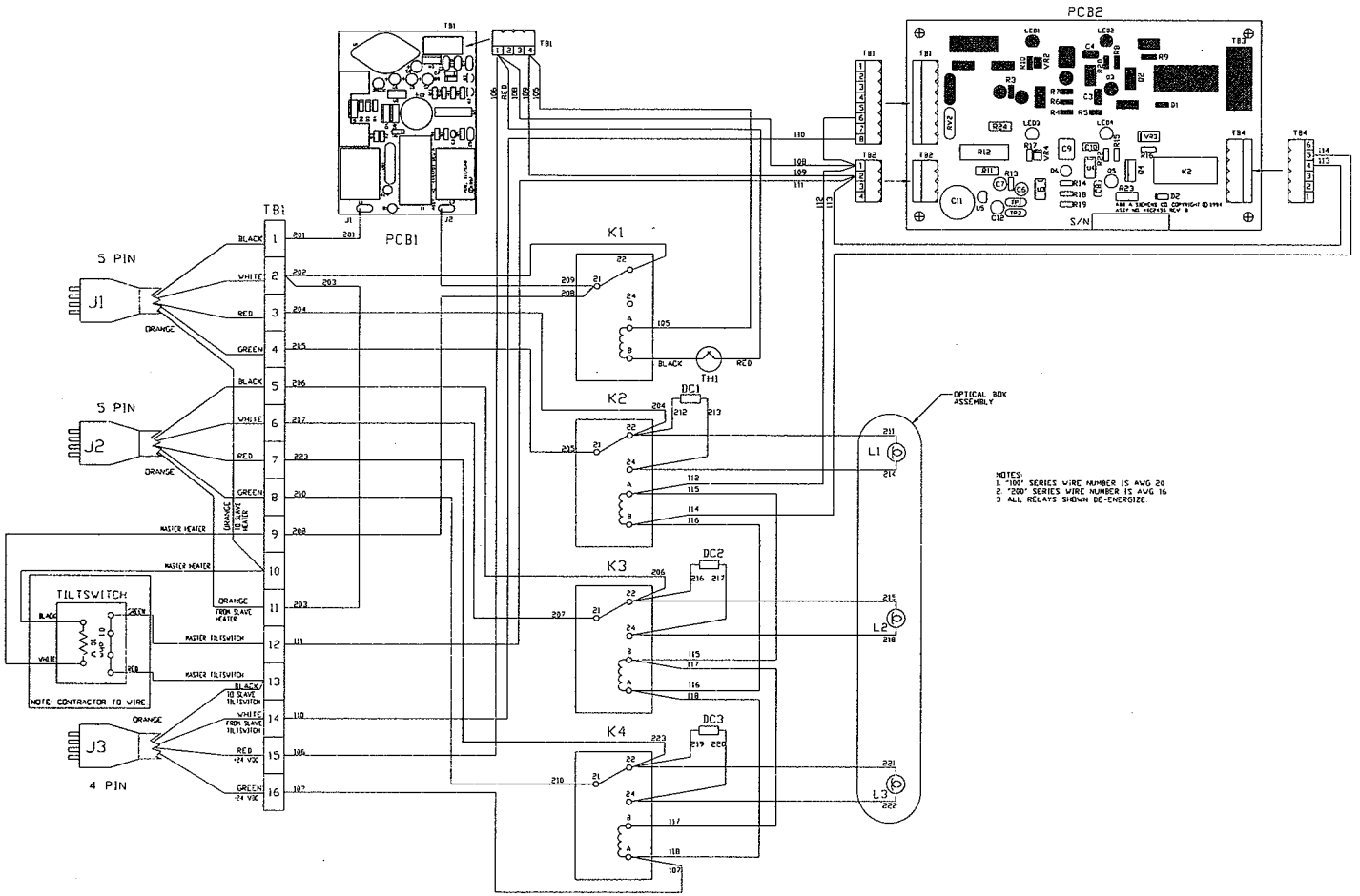

Figure 8-1. Master Internal Wiring Schematic

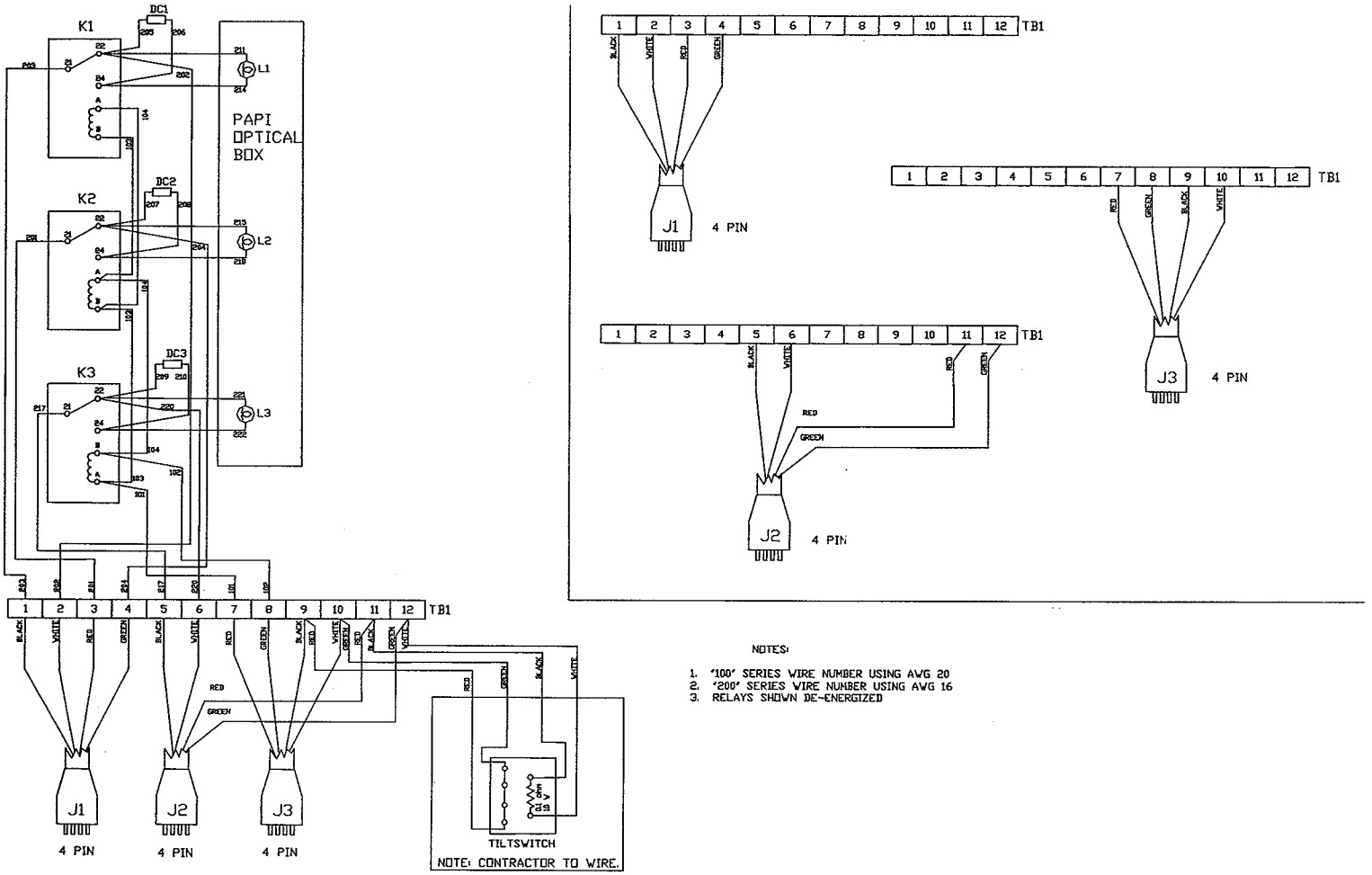

Figure 8-2. Slave Internal Wiring Schematic

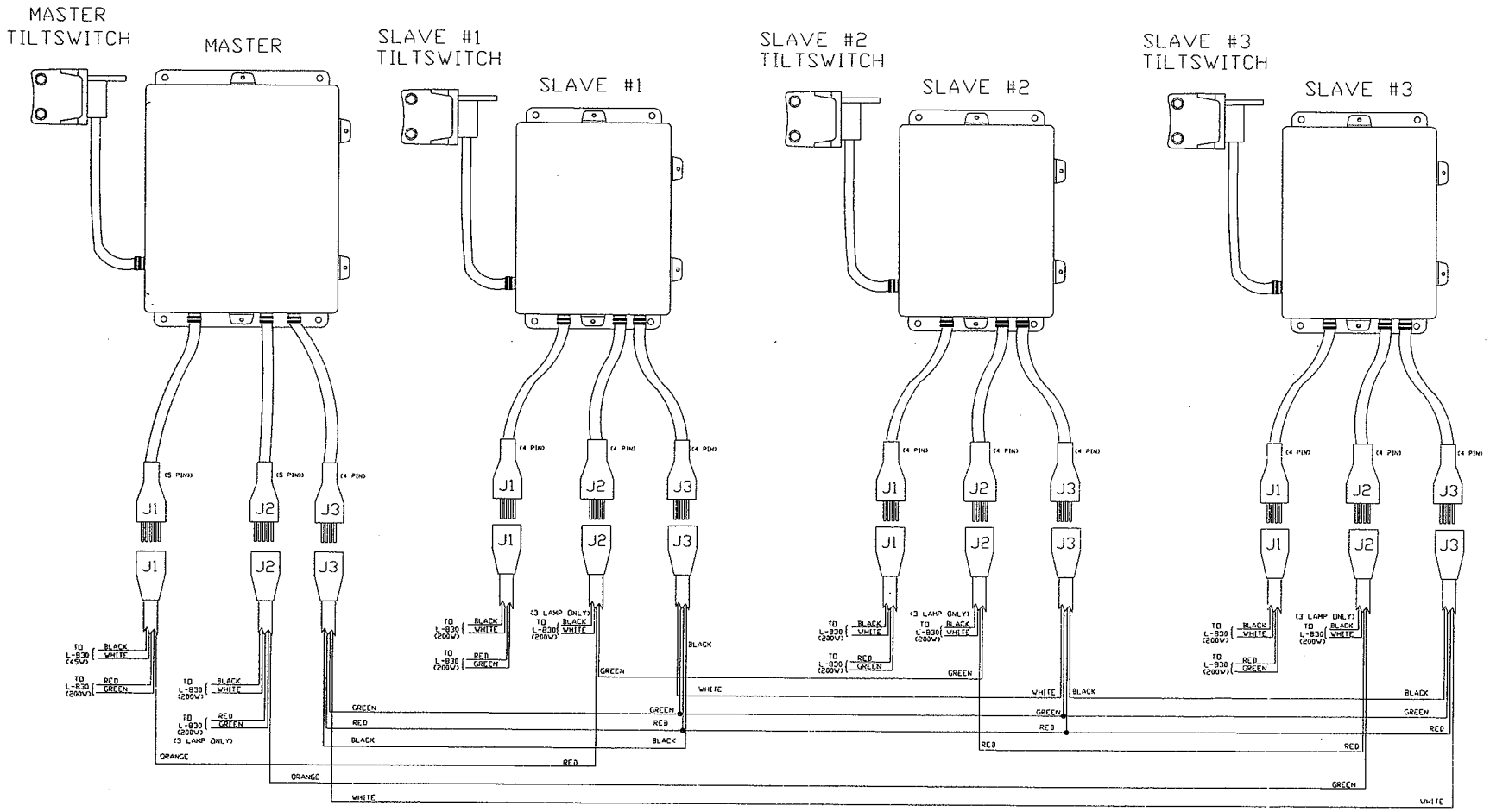

Figure 8-3. L-880 External Wiring Schematic (Two and Three Lamps)