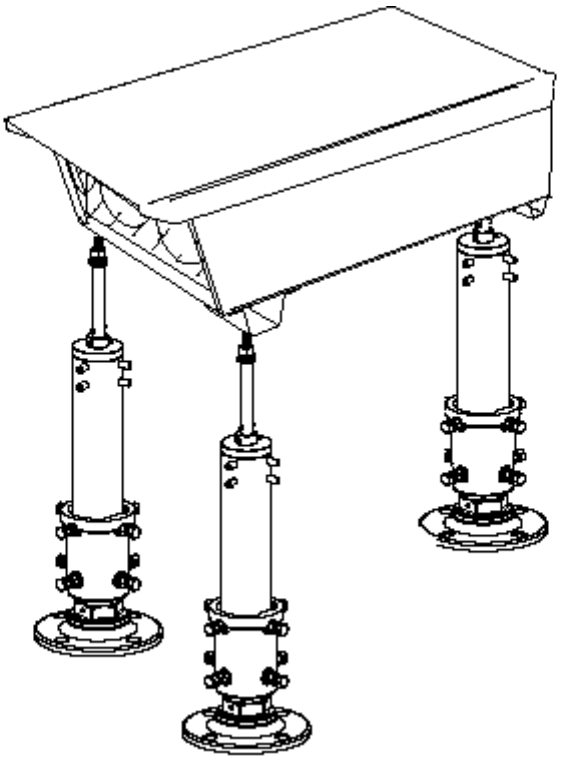
ADB
Airfield Solutions

Instruction Manual

AM.02.512e Edition 4.5

Precision Approach Path Indicator (P.A.P.I.)



Type
PPL 400/3
PPL 600/3

Record of Changes AM.02.512e

Edition	Description	Editor	Checked	Date
1.0	First edition	TXA	WL	
2.0	Lay out modified	TXA	WL	6/ 98
3.0	Inclusion of PPL600/2 in manual	MR	VI/WL	6/00
4.0	New version PPL400/3 – PPL600/3	MR	WL/WM	11/01
4.1	Corrections	MR / ET		09/02
4.2	Corrections	BUG	MR	10/03
4.3	Rebranding	EV		12/09
4.4	Reinforced cover	BUG	LM, JBE, JBU	
4.5	Rebranding, new schemas	JVI	BUG	03/14

Safety Instructions

Safety precautions

Operating and maintenance personnel should refer to ICAO Annex 14 chapter 9, Airport Services Manual Part 9, “Airport Maintenance Practices” and to FAA Advisory Circular AC 150/5340-26 "Maintenance of Airport Visual Aid Facilities" for instructions on maintenance requirements and on safety precautions. Personnel must always observe the safety regulations. The equipment has been designed and manufactured to allow safe and secure operation, however, the following rules must be strictly observed.

Keep away from live circuits

Operating and maintenance personnel must always observe all safety regulations.

Do not change lamps or components or make adjustments to equipment when the light circuit is switched on.

See FAA Advisory Circular AC 150/5340-26 concerning safety.

Resuscitation

Operating and maintenance personnel should get acquainted with the resuscitation techniques described in the First Aid Instruction Manual as issued by the Red Cross Organisation or similar.

Use Restriction Notice and Warranty

Use restriction notice

This Instruction Manual is the property of

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Warranty

ADB guarantees that the performance of the PAPI units described in this manual, when sold by ADB or its licensed representatives, meets the requirements of ICAO Annex 14 volume 1 and FAA specification AC 150/5345-28D, except for the tilt switch.

Any defect in design, material or workmanship, which may occur during proper and normal use over a period of one (1) year from date of shipment, will be repaired or replaced by ADB free of charge, ex works. Operational failure resulting from lamp burnt out, improper maintenance or installation, damage due to runway maintenance equipment, is not considered a result of proper use and is beyond the scope of the warranty.

Warranty does not cover natural wear and tear nor damage arising after delivery owing to faulty or negligent handling, excessive strain, unsuitable materials for Operation, deficient civil engineering Work, unsuitable soil conditions, and such chemical, electrochemical or electrical influences as were not assumed at the time of the Contract.

All liability for consequences of any inexpert alterations or repairs carried out by Purchaser or a third party shall be waived.

ADB shall in no event be liable to Purchaser for any further claims, particularly claims for damages not affecting the goods themselves.

The above constitutes the limits of ADB’s liabilities in connection with the PAPI units covered by this manual.

Information About this Manual

Chapter overview

Each chapter starts with an overview of the topics of that chapter.

Using icons

Icons are used to attract the reader's attention to specific information. The meaning of each icon is described in the table below:

Icon	Type of information	Description
	Note	A 'note' provides information that is not indispensable, but may nevertheless be valuable to the reader, such as hints and tips.
	Caution	A 'caution' is used when there is danger that the reader, through incorrect manipulation, may damage equipment, get an unexpected result or has to restart (part of) a procedure.
	Warning	A 'warning' is used when there is danger of personal injury.
	Reference	A 'reference' guides the reader to other places in this manual, where he/she will find additional information on a specific topic.

Parts Identification

Parts identification symbols, e.g. (3), (11) … appearing in the text refer to the exploded views, pages 48 and 49.

Comments and Proposals

This manual has been compiled with all possible care and in view of providing a valuable and practical tool to Contractors and to Airport Maintenance personnel.

We encourage customers to address us their comments and proposals for improving further the contents of this manual.

Communications should be addressed to the "**after sales department**" of ADB:

Table of contents

Chapter 1: General Information and Requirements

Overview

Introduction

In this chapter you will find all the information about the supplied and not-supplied (but necessary) equipment for installation and maintenance of the ADB PAPI units PPL 400/3 and PPL 600/3.

Contents

This chapter contains the following topics.

General information

Application

Annex 14 Part **5.3.5.1** lists the conditions where a visual approach slope indicator system should be provided:

a) Runways used by turbojet or other aeroplanes with similar approach guidance requirements;

b) The pilot of any aeroplane may have difficulty in judging the approach due to:

1) Inadequate visual guidance - water, featureless terrain by day or the absence of sufficient extraneous lights in the approach area by night, or

2) Misleading information produced by deceptive surrounding terrain or runway slopes;

c) The presence of objects in the approach area, involving serious hazard if the aeroplane descends below normal approach path;

d) Physical conditions at either end of the runway presenting a serious hazard in the event of an aeroplane undershooting or overshooting the runway; and

e) Terrain or prevalent meteorological conditions are such that the aeroplane may be subjected to unusual turbulence during approach.

PAPI's may either be installed on the left side of the approached runway (=Unilateral PAPI) on each side of it (=Bilateral PAPI). Bilateral PAPI's are recommended to gain visual roll guidance in VFR or non-precision approach systems

What makes the PAPI so successful?

The features that make a PAPI system so successful are:

- Digital feature of the sharp transition which enables the pilot to know his precise position on the approach slope and to detect immediately and distinctively any deviation from the correct path.
- The concentrated origin of the information which defines a narrow channel, the height of which reducing as the range reduces, and allows for compatibility with ILS, down to less than 1000 feet from touchdown.

Purpose of this manual

This manual provides general, operation, troubleshooting, maintenance and installation information.

Refer to the **Table of Contents** to locate the information you need.

Scope of this manual

This manual covers the ADB type PPL 400/3 and PPL 600/3 PAPI units, designed to be in full compliance with the requirements of ICAO Annex 14, Volume I, 5.3.5.23 to 5.3.5.45.

They also comply with FAA L-880, specification AC 150/5345-28D except for the tilt switch (which is available as an option) and with NATO STANAG 3316.

Equipment data

Equipment supplied

A PAPI system consists of 4 units (or 2 in case of an APAPI). Each unit consists of a main housing bearing two (PPL 400/3) or three (PPL 600/3) optical channels. The units are supplied with a fully gasketed cover, mounting legs (without anchors) and connection cables.

Most of the components are made of aluminium protected against corrosion, optical glassware and stainless steel.

The units are supplied precisely calibrated, with the lamps installed.

Equipment required, but not supplied

The table below lists the optional equipment, normally required for installation, but not supplied with the PAPI units.

Description	Quantity
Spanner, open ended, (for 2" cap) 67mm	1
Spanner, open ended, (breakable coupling) 54mm	1
Set of standard open ended, metric spanners for hexagon head screws.	1 set
Set of Allen keys	1 set
Aiming device, spirit level, mobile setting device, checking stick.	1 set
Drilling jig	1
Primary connector kit	1 per PAPI unit
Connection kit (optional) containing: - Flexible metal tubing for mechanical protection of power supply cables.	1 kit per PAPI unit.
Depending on the system design: - 2 or 3 conduit elbows with stoppers, or: - L-867-B base with cover	1 set per PAPI unit
200W 6,6/6,6A RST type series transformers	2 or 3/ PAPI unit

Note: Where approach slope angles higher than normal (> 5°) are required (stolports and heliport applications), a set of bias washers will be required for each unit.

Equipment data, *continued*

PAPI data

The technical characteristics of both the PPL 400/3 and PPL 600/3 are indicated below.

Overview

The table below lists technical data of the PPL 400/3 and PPL 600/3:

Data	**Specifications**	
Type	**PPL 400/3**	**PPL 600/3**
Lamps	2 × 200W quartz per unit	3 × 200W quartz per unit
Input current	6,6 A	6,6 A
Rated lamp life	1000 hours	1000 hours
Luminous intensity in red light	+/- 20000 Cd Max. 15000Cd min over –7° to +7° Horizontal and 4° Vert.	+/-22000 Cd Max 15000Cd min over –7° to +7° Horizontal and 4° Vert.
Transmission factor of red sector	> 15%	> 15%
Transition sector	3’ arc over the full horizontal beam spread	3’ arc over the full horizontal beam spread
Temperature range for operation	- 35°C to + 55°C	- 35°C to + 55°C
Relative Humidity	0% to 100%	0% to 100%
Wind	velocities up to 161 km per hour	velocities up to 161 km per hour
Degree of Protection	IP34	IP34

Ordering codes and reference data pertinent to the equipment are listed in the tables and drawings at the end of this manual.

Note :

In order to better match the light output of other AGL sub-systems, the PAPI units may be equipped with 100W lamps (luminous intensity reduced by ~ 50%).
This may be the case in medium or low intensity airport lighting systems, as well as for the use as APAPI.

Operational conditions

Introduction

The operational conditions for the PAPI /APAPI systems are explained below.

Normal operation

The PAPI system must operate continuously when the runway is in use.

When	Intensity setting
During the day: • When aircraft are approaching • When no aircraft are approaching	 Use the high intensity setting (100%). Reduce to the normal standby setting.
At night	The system may operate continuously at 30% brightness or less.

1) Failure to adopt this practice will result in an increased consumption of lamps.
2) At brightness settings below 30%, colour discrimination becomes critical since the white sector becomes yellowish.

Regions with heavy snowfall and frost

Units should operate continuously at normal standby brightness, even when the runway is not in use. Any snow will thus melt and drain away, and build-up of condensation on the front lenses and glass will be avoided.

To achieve this, install separate constant current regulators (CCR's) for each PAPI system (instead of a CCR + circuit selector combination) so that all the systems can be kept warm under snowstorm or moist conditions.

When snowfall is expected to bury the units, their location should be marked with sticks or flags (approx. 2 m high), to prevent damage to the units by snow removal equipment.

As an option, ADB provides PAPI units with a heating system or with a special coated frontglass

What the pilot sees.

Introduction

The PAPI system consists of a bar of four units, each one producing a light beam divided into an upper white and a lower red sector.

Colour transition

When viewed by an observer at a distance of 300m (1000 feet), the transition from red light to white light does not exceed an angle of three minutes of arc over the whole width of the useful beam.

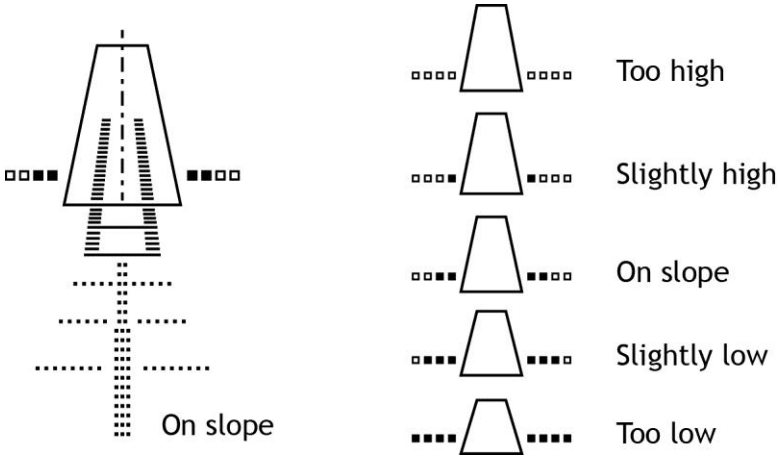
Installation

The units are installed on a line perpendicular to the runway centre line and are set in elevation at varying angles, the difference between adjacent units is normally 20' of arc.

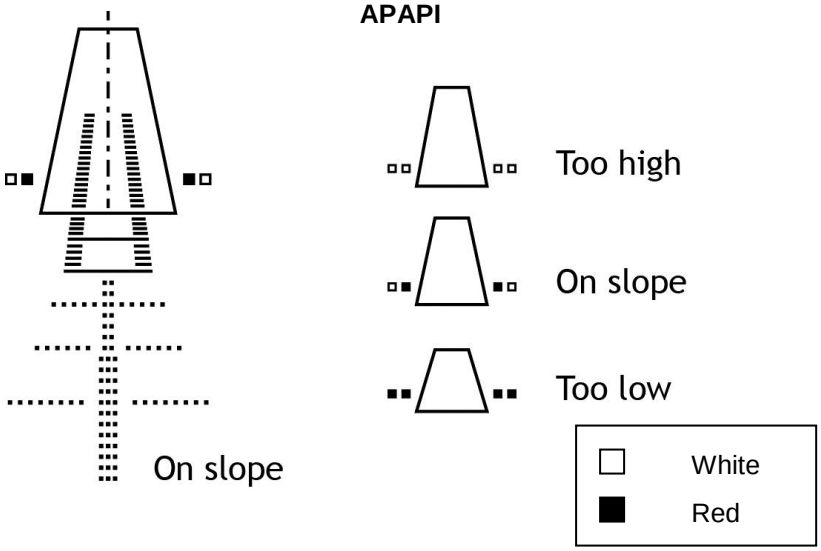
Illustration

This is what the pilot sees during the approach phase of the landing procedure:

PAPI



APAPI



What the pilot sees, *Continued*

Introduction

The approach slope is	The pilot will see
> 30’ (35’) of arc away from the correct slope	The four units in the same colour. I.e. red below the correct slope and white above.
> 10’ (15’) and < 30’ (35’) of arc from the correct slope	Three units of the same colour and only one of the other colour.
Correct	Two red lights on the runway side and two white lights outwards.

Values between brackets are the deviations generally adopted in order to improve the harmonisation with the ILS.

Bilateral PAPI’s (=a 4-box PAPI system on each side of the runway) are recommended to gain visual roll guidance under VFR or non-precision approach conditions.

Chapter 2: PAPI or APAPI location and installation

Overview

Introduction

This chapter explains how to determine the correct location of PAPI/APAPI systems and how to install the PPL 400/3 and PPL 600/3 units.

Receiving, storage and unpacking

1. Upon receipt of goods at the site store, check every package for visible damage. Every damaged box should be opened and its content inspected for damage.

   If equipment is damaged, a claim form shall be filed with the carrier immediately. It may then be necessary for the carrier to inspect the equipment.

2. Store each unit preferably in its original packing in a protected area. When stored unpacked, please take care not to damage the cables and front glass.
3. Unpack the units preferably at the installation site to avoid damage during transportation and handling.

Contents

This chapter contains the following topics:

Location of a PAPI / APAPI on a runway without ILS

Introduction

When a runway is not provided with an ILS, it is vital to ensure that an adequate wheel clearance over threshold is provided by the PAPI/APAPI.

To comply with specifications of threshold wheel clearance, aircraft have been classified in four groups, according to their eye-to-wheel height (EWH).

Eye to wheel group selection

The table below lists the aircraft wheel clearance over threshold for PAPI and APAPI as per ICAO Annex 14, Table (5-2).

Eye to wheel height of aeroplane in the approach configuration (1)	Desired wheel clearance (2)	Minimum wheel clearance (3)
Up to but not including 3 m	6m	3m
3 m up to but not including 5 m	9m	4m
5 m up to but not including 8 m	9m	5m
8 m up to but not including 14 m	9m	6m

For selecting the "eye-to-wheel height (EWH)" group, only aeroplanes meant to use the system on a regular basis shall be considered. The most demanding amongst such aeroplanes shall determine the eye-to-wheel height group (EWH).

Desired wheel clearances shown in column 2 shall normally be provided. The wheel clearances in column 2 may be reduced to those in column 3 where an aeronautical study indicates that such reduced wheel clearances are acceptable.

Eye to wheel and eye to aerial heights

Refer to Appendix 6 of Aerodrome Design Manual, Part 4, to find the eye-to-wheel and eye-to-aerial heights of aeroplanes.

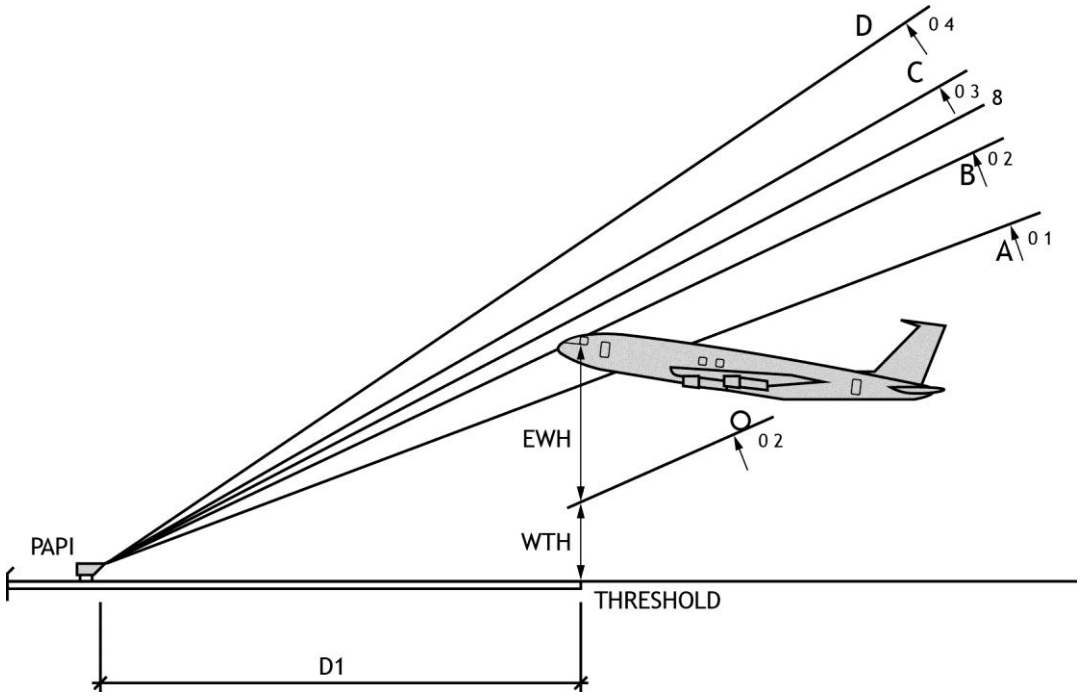
Location of a PAPI / APAPI on a runway without ILS, *continued*

Theoretical location of system

The theoretical location of the system can be calculated by following the procedure below:

Step	Action
1	Select the class of the aircraft (Appendix 6 of Aerodrome Design Manual Part 4) to determine the EWH (eye-to-wheel height)
2	Determine WTH (wheel-to-threshold height), according to the EWH selected (see previous page, columns 2 or 3)
3	Theoretical distance from threshold to PAPI is calculated from the formula: **D1 = (EWH + WTH). cotg (θ2 –2')** in which: • EWH is the eye-to-wheel height • WTH is the wheel-to-threshold height • θ2 is the setting angle of unit B in a PAPI (glide path angle minus 10 minutes) or is the setting angle of unit A in an APAPI (glide path angle minus 15 minutes)

Illustration

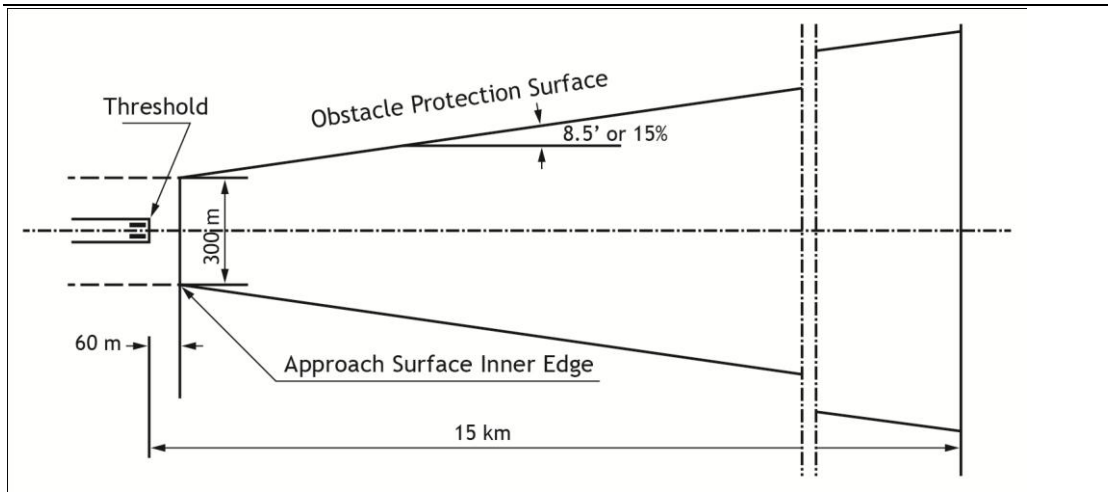


Location of a PAPI / APAPI on a runway without ILS, *continued*

Checking interferences

For checking possible interferences with obstructions located in the approach area, ICAO has defined an obstacle protection surface (OPS).

Refer to the pictures below and table 5.3 in Annexe14, Volume I.

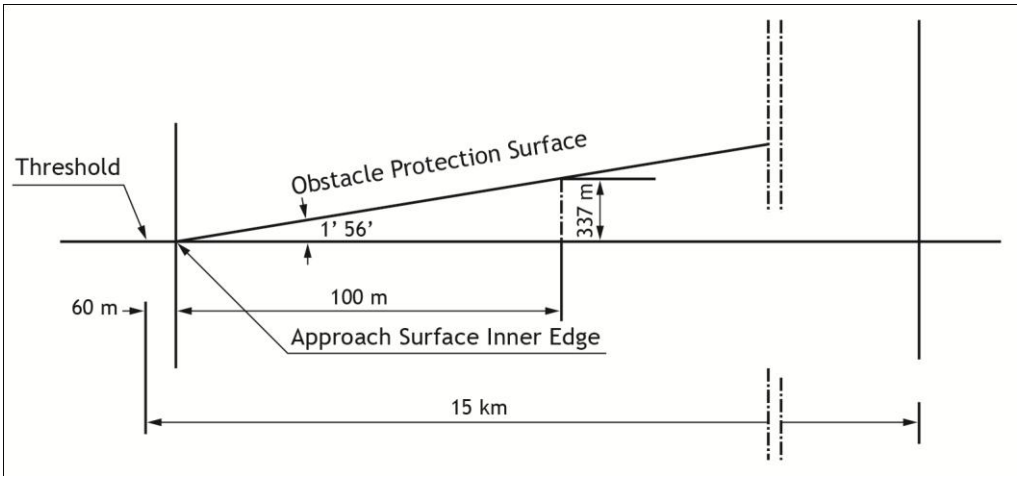


Obstacle Protection Surface (OPS)

This surface has an inner edge length of 300 m at a distance from threshold of 60m. The length of the surface is 15 km and the horizontal divergence is 8.5° or 15%.

Obstacle Protection Surface Slope Angle

Typical case: definition of the OPS slope in case of an APAPI installation on a code I or II runway



The slope of the surface can be calculated by the following formula: **θ2 – 0.9°.**

θ2 corresponds to the setting angle of unit B. If the glide path is 3°, the slope of the OPS shall be 2°45' – 54' = 1°56'. It shall be checked whether an object protrudes above that surface.

Location of a PAPI / APAPI on a runway without ILS, *continued*

Obstacles above surface

Adaptation of the PAPI/APAPI location to obstructions.

If obstacles project above the OPS, one of the following measures must be taken:

- Remove the obstacle if practicable.
- The approach slope of the system may be suitably raised.
- The axis of the system and its associated obstacle protection surface may be displaced by no more than 15° (an aeronautical study shall be conducted).
- The threshold may be suitably displaced.
- The system may be suitably displaced upwind of the threshold to provide an increase in threshold crossing height equal to the height of the obstacle penetration.

Formula

APAPI: H = L- (D-60).tan (θx – 0,9°)

PAPI: H= L- (D-60) .tan (θx– 0.57°)

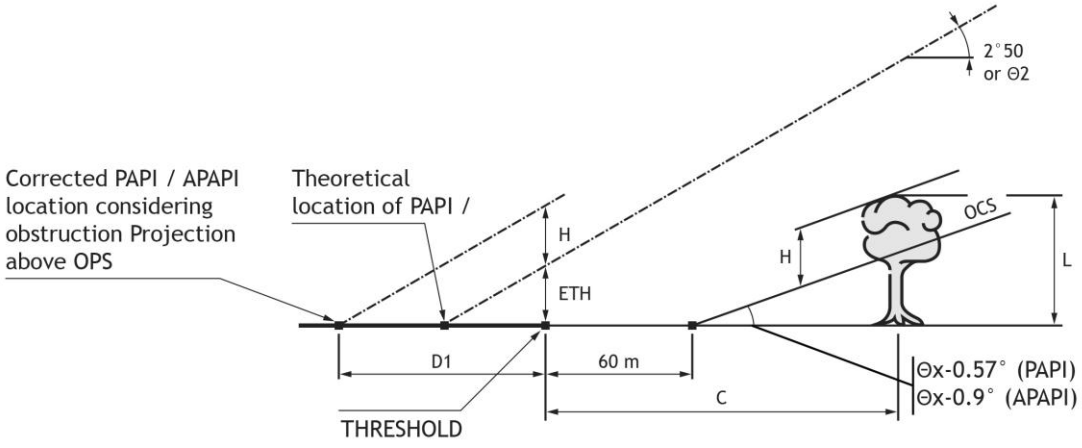
Suppose an object at a distance D with its top at a level L above the threshold:

H	Height of projection above the OPS
D	Horizontal distance between the object and the threshold
θx	setting angle of the unit on which the calculations are based (unit B in case of a PAPI, unit A in case of an APAPI)
L	height of the object above the threshold level

The new theoretical PAPI location will be in this case:

D1 = (EWH + WTH + H). cotg θx

Illustration



Harmonisation of the PAPI / APAPI location with the ILS

Harmonisation of PAPI / APAPI and ILS

A harmonisation between ILS and PAPI is necessary.

In installing a PAPI or APAPI on runways equipped with an ILS, it is desirable that there be harmonisation between indications of the visual and non-visual approach aids. The difference between the position of the pilot's eye and the position of the aircraft's glide path antenna created a difficulty in achieving this goal.

It is agreed that it is difficult to achieve harmonisation down to the touchdown point but compatibility shall be obtained as close as possible down to the threshold.

A good method, recommended by ICAO, is to classify the aeroplanes in three groups according to their eye-to-aerial height, and to calculate the horizontal distance between ILS glide path origin and the theoretical PAPI/APAPI location. This distance (D2) is to be taken farther away from threshold than the ILS glide path point of origin.

Eye-to-aerial height range	Class of aircraft
3.7 to 6.7 m	Large aircraft
1.3 to 3.7 m	Medium aircraft
Up to 1.3 m	Small aircraft

D2 = distance between ILS glide path point of origin and theoretical PAPI location

Θ= glide slope angle

AEAHR=Average Eye to Aerial Height in m (see table above)

D2 is determined as follows**:** **D2 = AEAHR x cotg θ**

For a large aircraft, and a glide slope of 3°, **D2=1/2 (3.7 + 6.7).cotg 3° = 100m**

Usually, the ILS glide path point of origin is adjusted for the aircraft to pass over the threshold with a 15m wheel clearance, so its distance from threshold can be calculated as follows:

D3= 15m / tg 3° =286m

The corrected PAPI distance from threshold will be : D4=D2+D3= 100+286=386m

CAUTION!

ICAO recognizes that this method provides harmonization for the greatest number of aircraft types but express concern that this might lead to an unacceptably low wheel clearance over threshold for the most critical aircraft types. So, re-checking the wheel clearance (**WTH**) is mandatory.

Harmonisation of the PAPI / APAPI location with the ILS, *continued*

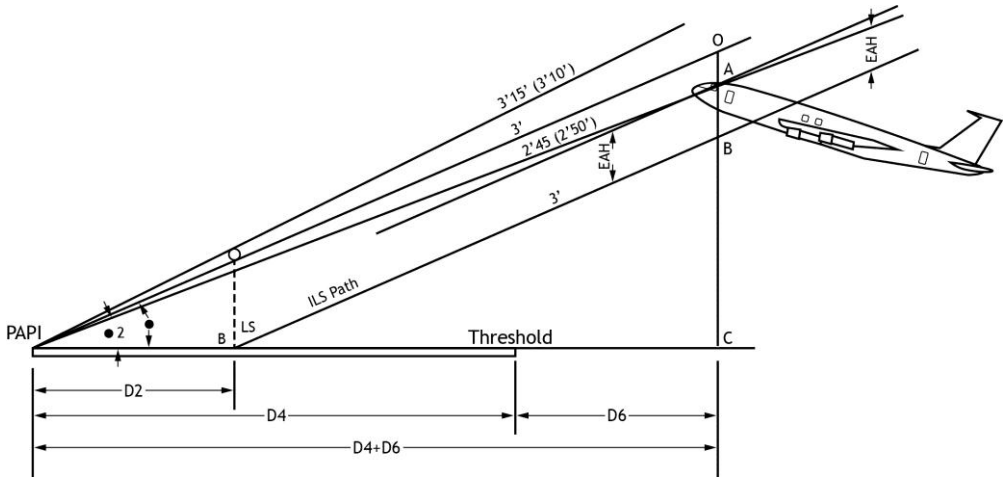
CHECKING THE HARMONIZATION BY THE METHOD OF THE MOST CRITICAL AIRCRAFT

The practical formulas given by ICAO assume that aircraft of different eye-to-aerial height (**EAH**) are using the runway. As the formula is giving a location which is the result of an **EAH** range average, a quick check for the most critical aircraft of the group can eventually be carried out.

The figure below summarizes at a glance the theory of harmonization and establishes the formula which determines distance **D5,** from which the pilot's eye leaves the "on slope" PAPI signal and gets into the "fly down" or "fly up" sector, while the antenna still follows the ILS path signal.

If distance **D5** appears as negative, harmonization will be ensured beyond the threshold.

Illustration



Harmonisation of the PAPI/APAPI location with the ILS, *continued*

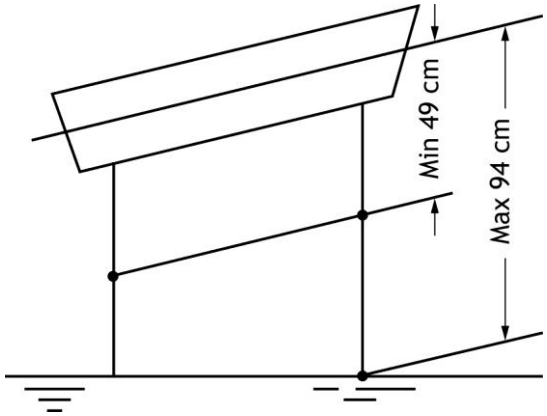
Level Differences Compensation

All previous calculations assume that the PAPI unit's light beam axis are at the same level as the threshold reference level. In fact, longitudinal and transverse slopes exist on all runways, runway shoulders and runway strips and they are to be compensated by an adequate shift of the PAPI units.

- This shift shall be towards the threshold when the theoretical location is higher than the threshold and away from the threshold if the location is lower.
- This shift shall also take into account the lens-to-ground distance of the PAPI units.

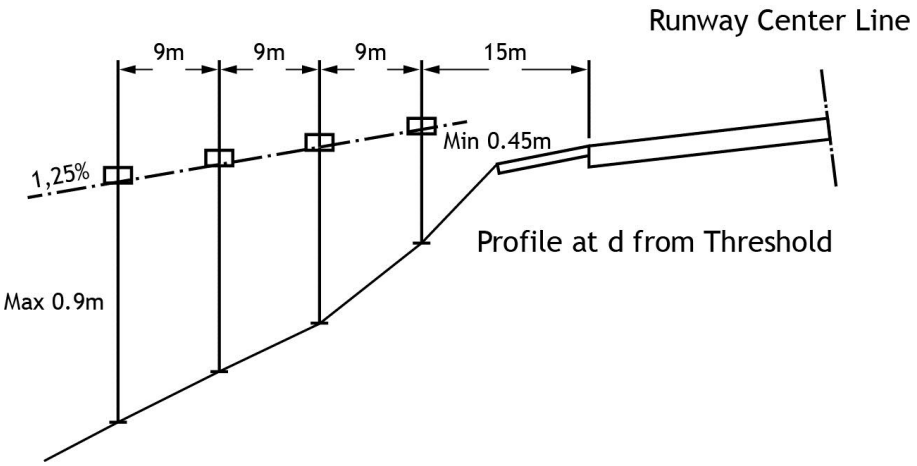
Beam height adjustment

The figure below shows that, when installed on breakable couplings , featuring adjustable leg length, the light beam axis of an ADB PPL 400/3 or PPL 600/3 can be set at any elevation, above the concrete mounting slab, between 49 cm and 94 cm. Thus any ground level difference up to 45cm can be compensated.



Harmonisation of the PAPI / APAPI location with the ILS, *continued*

Beam height adjustment, *cont.*



Sometimes, when the transverse slopes of the runway strips are important, it is necessary to locate the PAPI units on a sloped line as shown in the figure to fit with the leg length limits, while keeping the four PAPI units aligned on a same perpendicular axis to the runway.

Technical Assistance

1) The Technical Department of ADB is at the disposal of Airport Authorities and Contractors for providing technical assistance and advice and also for calculating PAPI units locations, on basis of data provided by the Client. APPENDIX 1 to this Manual indicates the basic data necessary to carry-out the calculations.

2) Guidance information as well as detailed calculation methods may be found in the following ICAO publications:

- ANNEX 14 - Volume 1 – 3rd edition – July 1999: para. 5.3.5.23 to 5.3.5.45 and Appendix 1, Para. 12.
- AERODROME DESIGN MANUAL – Part 4 – Visual Aids - 3rd edition – 1993: chapter 8, Para. 8.4, and Appendix 6.

3) Prior to system installation, it is the responsibility of the Airport Authority to have all calculations checked and approved by the country's Responsible Competent Authority (e.g. the Civil Aviation Administration).

Installation

Introduction

The preferred method of installation for PPL 400/3 and PPL 600/3 is on concrete slabs at ground level, with frangible couplings.

The concrete is cast directly into the foundation pit so that the slab rests on firm soil below the frost line.

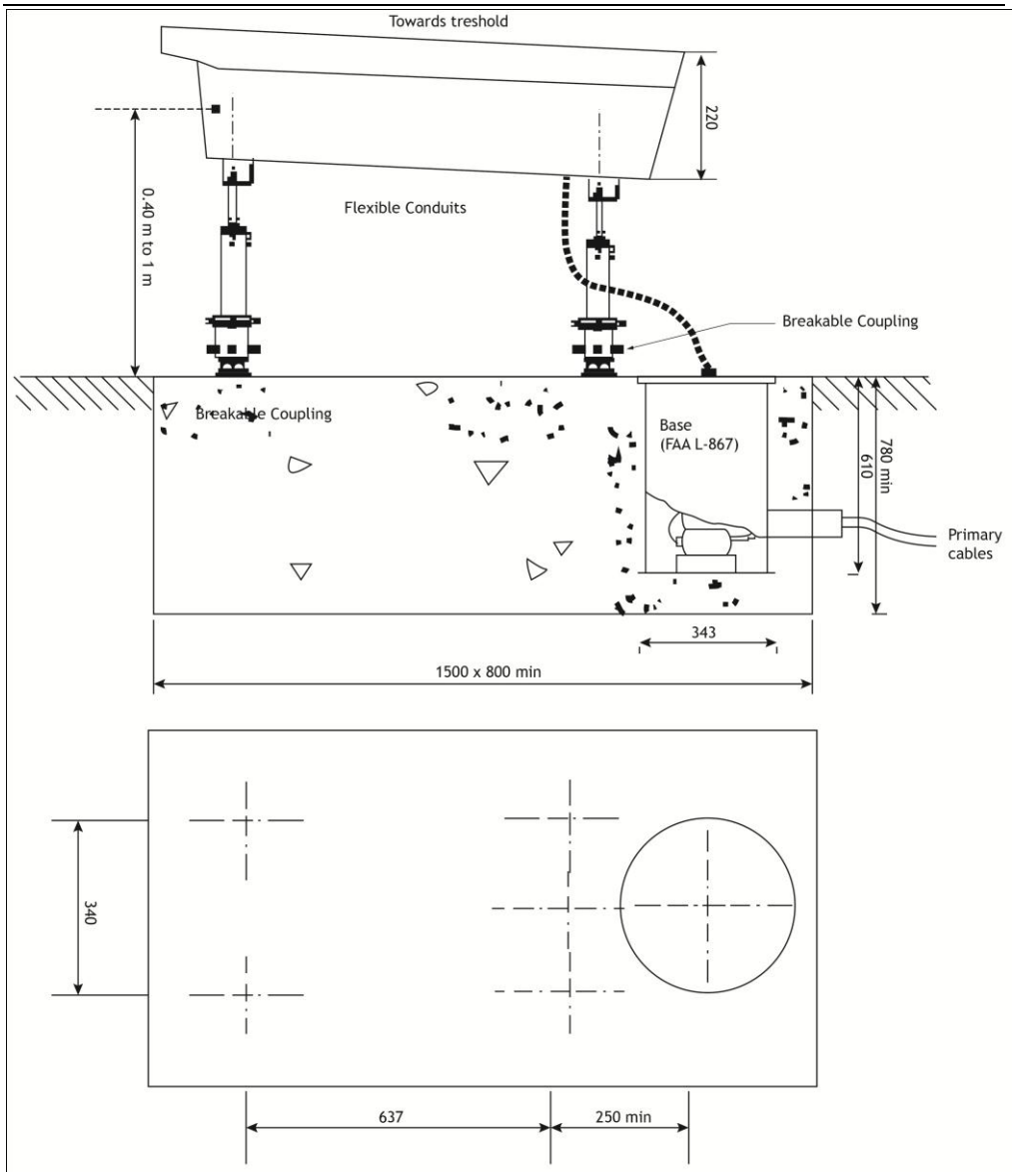
The figure below shows dimensions, which are generally acceptable but can be modified to fit, for example, soil strength characteristics or other local conditions.

Before starting

- Take care not to distort the PAPI-unit frame when positioning it on to the legs. Besides problems appearing when levelling the units, twisting the frame may lead to cracks in the lenses.
- Especially, in case of installation close to the ground, make sure that all steps of the installation procedure are carried out methodically and with accuracy.

Installation, *continued*

Illustration of a typical PPL400/3 installation



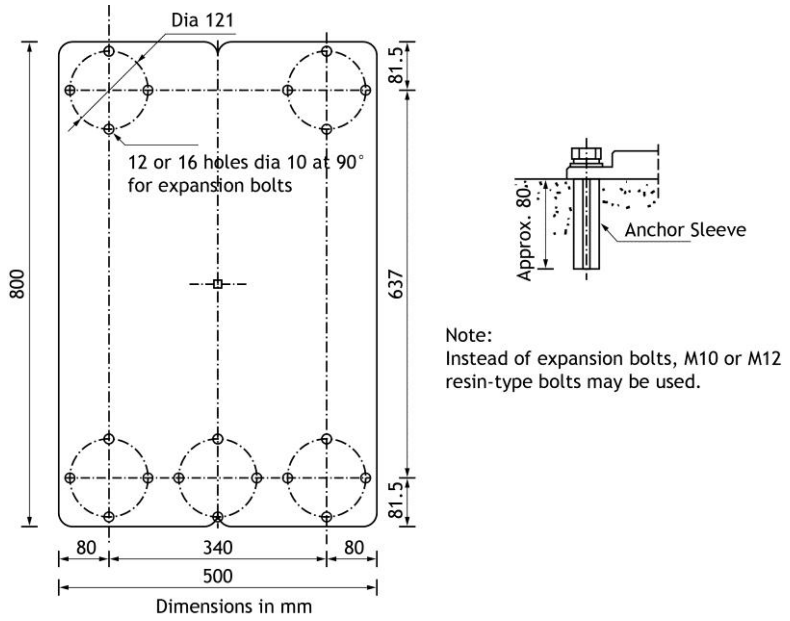
Note : the FAA L-867 base can also be replaced by conduit elbows leading, via conduits, to a transformer housing installed further away from the PAPI unit.

Installation, *continued*

Casting the concrete slab In - situ

The following table instructs you on how to cast the concrete slabs and to anchor the mounting flanges (13).

Step	Action
1	Stake out the longitudinal axis of the light units parallel to the runway centreline.
2	Dig the foundation hole to the min. dimensions given on figure page 25.

3	If used, position the FAA L-867 transformer housing at the rear of the PAPI unit, in accordance with manual AM.05.120.
4	Pour in the concrete and allow it to harden for at least one day. **Note: Make sure that the upper surface of the concrete slab is substantially flat, smooth and horizontal (max. allowed tolerance = 10mm)**
5	After the concrete has set, draw (using chalk) a longitudinal axis (in accordance with the axis staked out on the ground) on the upper surface of the slab. Draw a transverse axis perpendicular to the other axis.
6	Lay the drilling jig on the slab; centre it by positioning the central hole at the intersection of both axes. Align the jig along the longitudinal axis using the V-notches provided.
7	Holding the jig securely in position, drill the 12 (or 16), 10mm dia. holes to the depth required for the expansion bolts used and insert the sleeves. See the picture below:  (Drawing typical for PPL400/3)
8	Position and fasten the flanges (13), each with four bolts. Make sure that the bottom flange face is in close contact with the concrete at all 4 bolts locations. If not, install shims or washers to compensate for dips. Although leg verticality can be achieved via the 8 screws of the breakable coupling, it is good practice to install the flanges as horizontal as possible. To check this, screw a piece of 2” gas pipe in the flange.

Installation, *continued*

Installation of the PAPI units

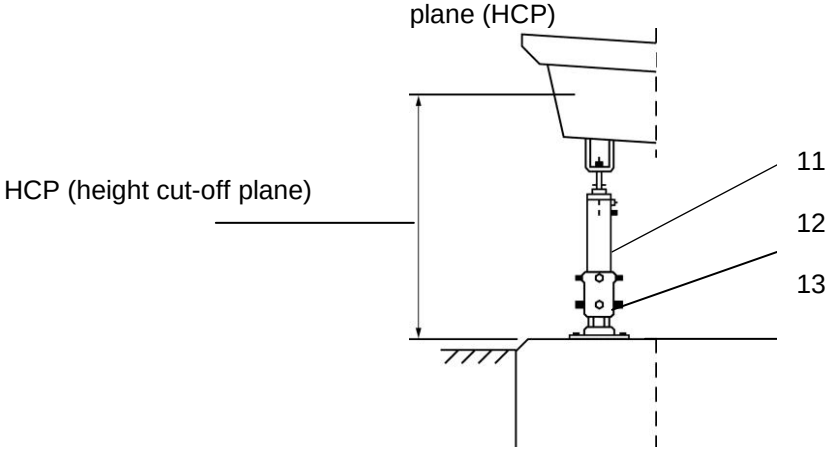
The following table instructs you on how to install the PPL 400/3 and PPL 600/3

Step	Action
1	Install and tighten the frangible couplings (12) on the flanges (13).

2	Out of factory, the legs have a length sufficient to install the unit with the cut-off plane (plane passing through the centre of the objective lenses and the lower end of the red filters) located up to +/- 940 mm above the ground. If the cut-off plane at the calculated location of the PAPI unit is lower, the leg tubing can be cut to the required length **(L)** using the following formula: **L= height of the cut-off plane – 345mm** **The height of the cut off plane (HCP) being the vertical distance between the pop nail (indicating the location of the cut off plane) and the ground level. See figure below.** **L should be minimum 150mm** Place the bottom part (11) of the leg assemblies in the breakable couplings (12)
3	Adjust the eight screws on each breakable coupling (12) until the legs are vertical and, if possible, well centred inside the couplings. Do not block the screws and locknuts at this stage.
4	Place a (thick) flat washer on top of each rod.
5	Remove the cover from the PAPI unit and gently install the unit on the legs. Act on the breakable coupling screws if necessary to slightly move the legs sideward.
6	Install on top of each rod, successively: one (thick) flat washer, one lock washer and one M10 nut. Do not tighten at this stage.
7	Make sure that the unit rests on the lower washer of the right front leg. Check that **HCP** is according to calculations. Tighten all screws and locknuts on the breakable couplings.

Illustration

The drawing shows details of the leg assembly and how to measure the height of the cut-off plane (HCP)



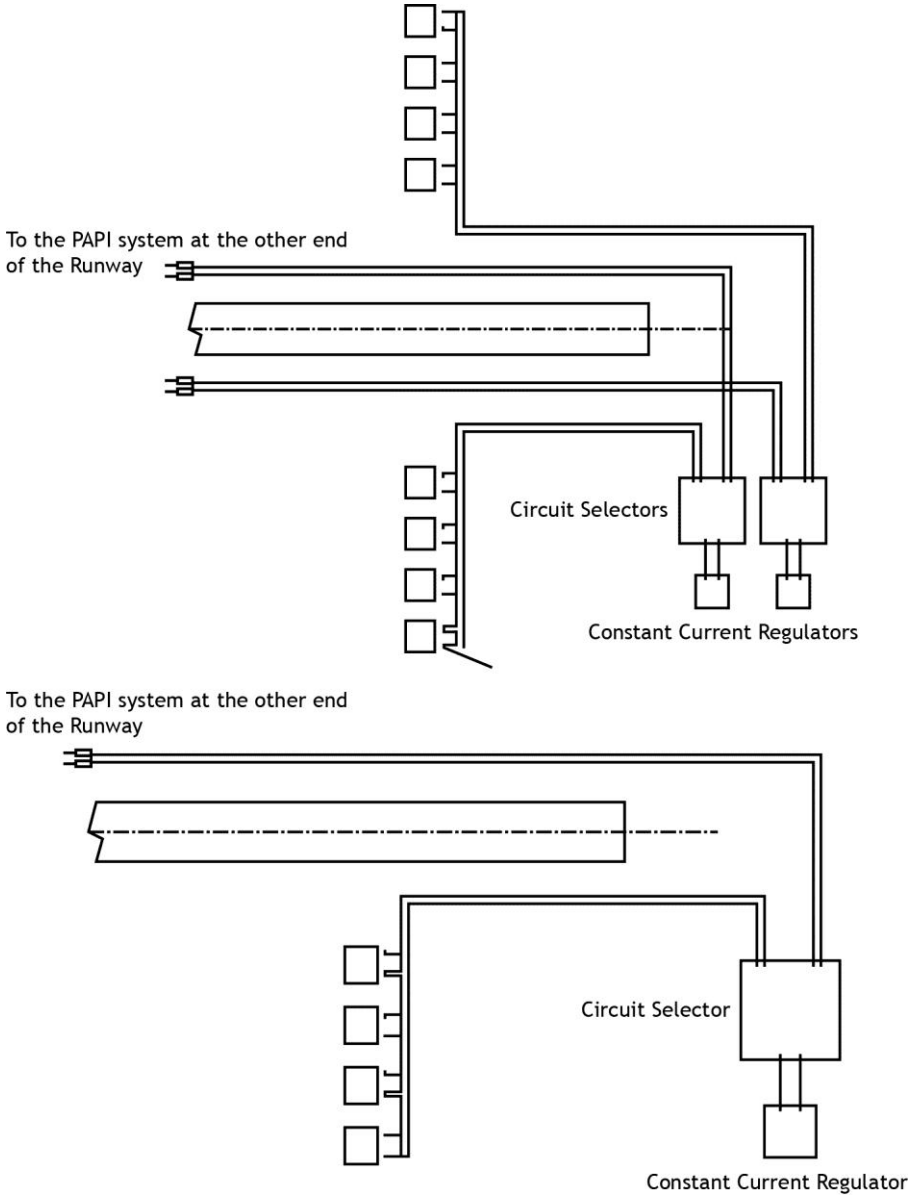
PAPI wiring

Introduction

The following diagrams show different PAPI wiring methods.

The four units at each side of the runway are wired into a series circuit. Two independent circuits are used to feed bilateral PAPI systems. Each lamp is fed through an isolating transformer.

Illustration of typical wiring (for PPL400/3)



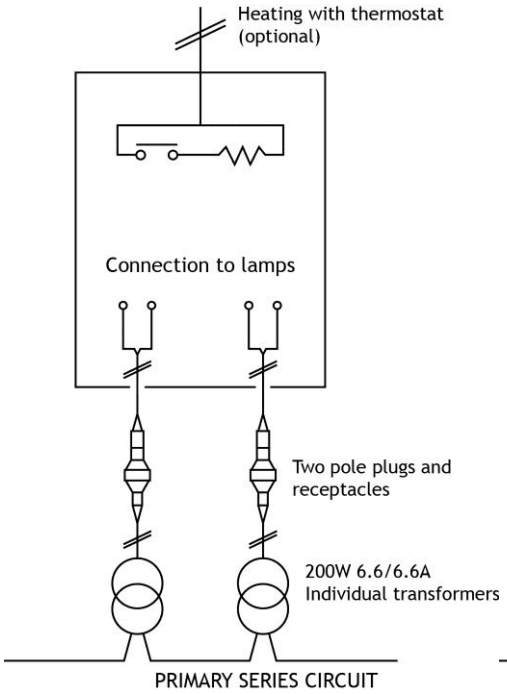
PAPI wiring, *Continued*

Single unit wiring

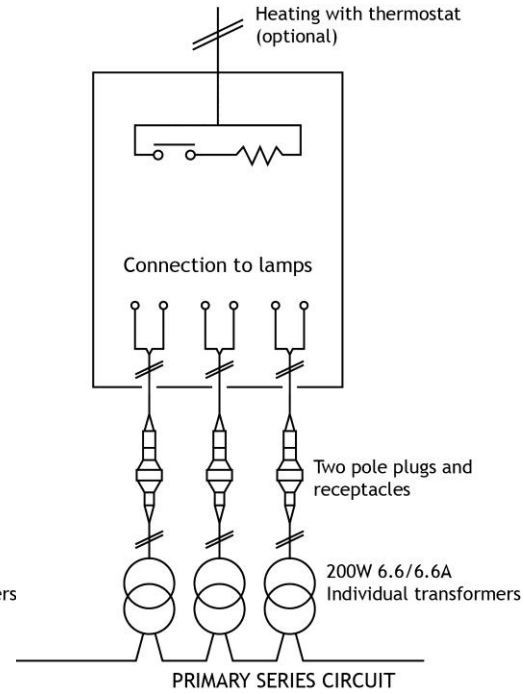
The illustration below shows the wiring diagram of a single unit with the optional heating system.

Illustration

PPL 400/3



PPL 600/3



Note

Regions with frequent snowfalls and frost

It is recommended to operate continuously, at reduced brightness, all PAPI units, even those serving runways not currently in use. This in order to melt any falling snow immediately.

In order to achieve this, each series loop should be fed by a separate constant current regulator (CCR) rather than via a CCR + circuit selector combination.

Levelling of units

Definitions

The elevation **setting angle** of the PAPI units is the angle between a horizontal plane and the cut-off plane.

The **cut-off plane** is the plane passing through the centre of the objective lenses and the lower edge of the red filters and lies parallel to the reference plane passing through the reference screws A, B, and the machined slots C and D (see figure next page).

Setting angles

If θ is the established **glide path angle** for the runway, and the units are set at angles progressively staggered by 20 minutes of arc, the setting angles of the units will be as follows:

Unit n°	Angle
1	θ - 30 minutes of arc (unit farthest from runway)
2	θ - 10 minutes of arc
3	θ + 10 minutes of arc
4	θ + 30 minutes of arc (unit closest to runway)

If the centre channel is widened to 30 minutes of arc, the setting angles of the units will be as follows:

Unit n°	Angle
1	θ - 35 minutes of arc (unit farthest from runway)
2	θ - 15 minutes of arc
3	θ + 15 minutes of arc
4	θ + 35 minutes of arc (unit closest to runway)

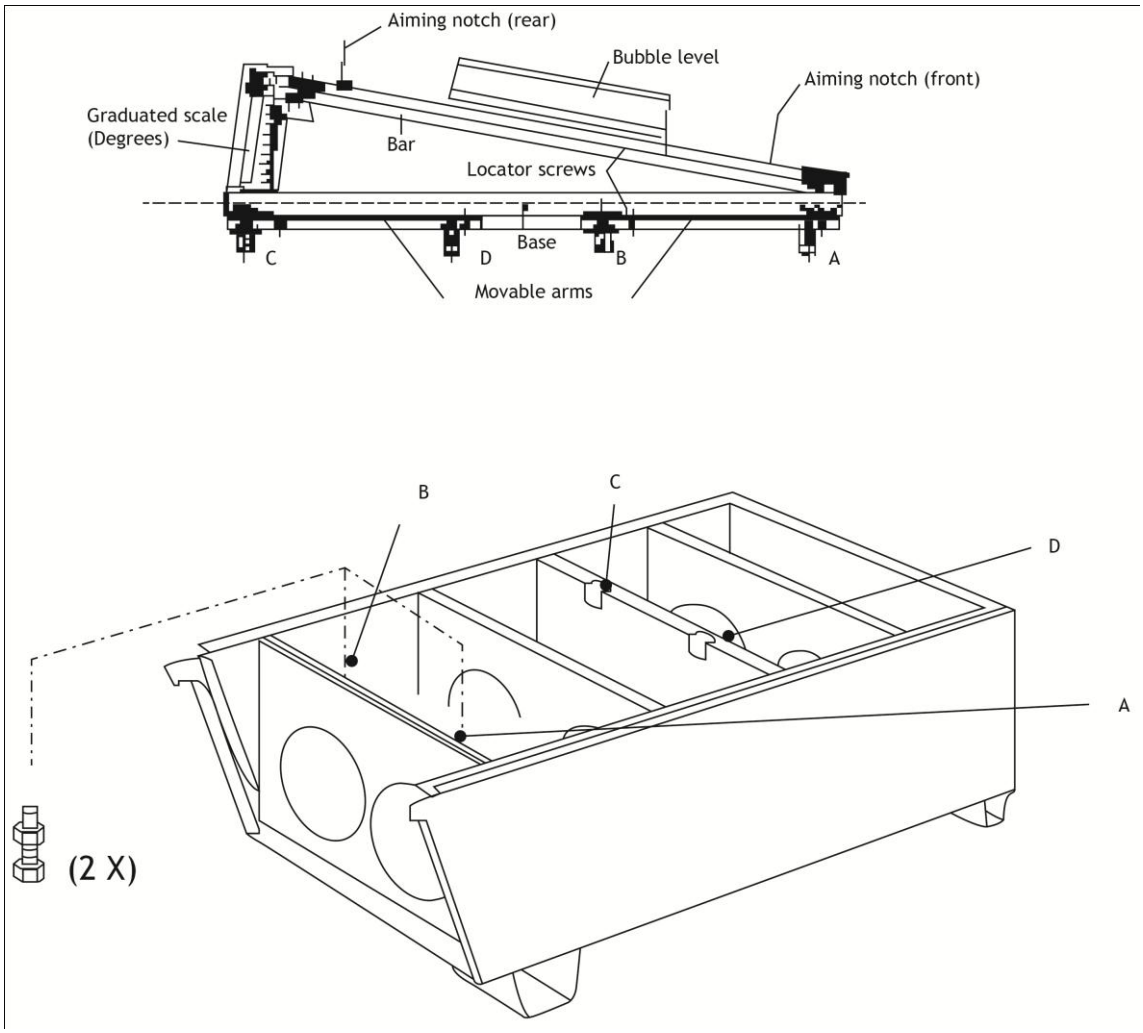
Remark

When handling the unit, and in particular during installation and setting, rotating the reference screws A and B is prohibited.
Any accidental movement of these screws will require re-calibration in the factory by specialised personnel.
The levelling procedures are identical for PPL400/3 and PPL600/3. The drawings in this chapter are typical for the PPL400/3.

Levelling of units, *Continued*

Aiming device

This illustration shows the aiming device used for adjusting the units in elevation.



Positioning the Aiming Device

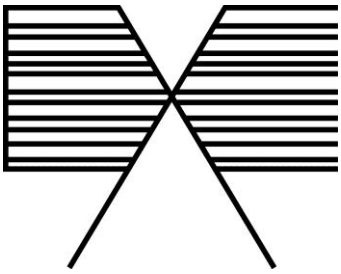
To install the aiming device, proceed as follows:

Step	Action
1	Set the aiming device at the required setting angle for the unit
2	Open the light unit
3	Open up the two movable arms on the instrument, and place it on the light unit with the graduated scale near point C. Refer to the picture above: A and B correspond to the two reference screws and C and D correspond to the two machined slots.
4	Carefully position the precision bubble level between the locator screws on the upper bar (for elevation angle adjustment) or against the locator screws on the moveable arms (for cross-levelling of unit).

Levelling of units, *Continued*

Aiming in Azimuth

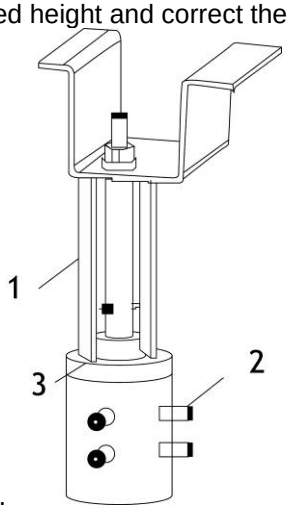
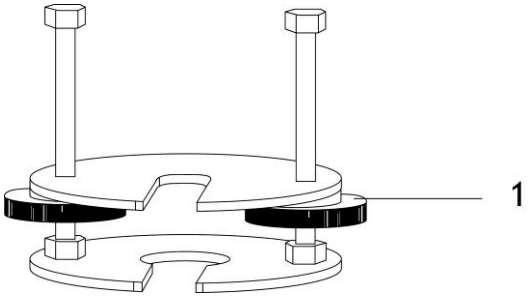
To aim the PAPI unit in azimuth, proceed as follows:

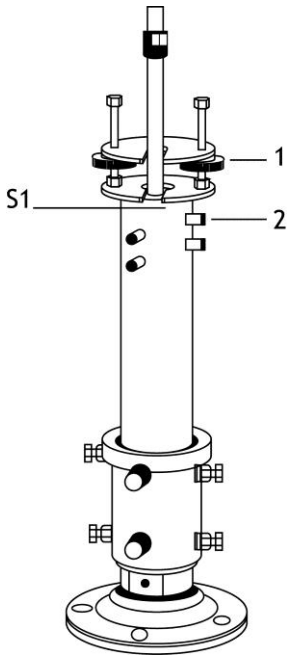
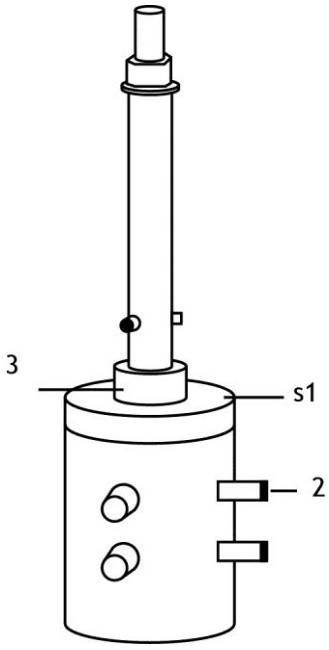
Step	Action
1	Install the aiming device on the PAPI unit, as explained above.
2	Place a surveyor's stake 50 m away from the unit, towards threshold, and at the same distance from the runway edge as the reference line B-C.
3	Check the alignment through the V-sights of the bar of the aiming device. Use the sight picture:  If necessary, adjust the unit alignment in azimuth. Loosen the 4 hex nuts on top of the legs, move the unit horizontally as required and tighten the 4 nuts at the specified torque. **NOTE** It is not mandatory for the azimuth alignment to be absolutely perfect. For example, a lateral error of 0.5m at 50m yields an angular error of 0.5°, which would still be of no practical significance.

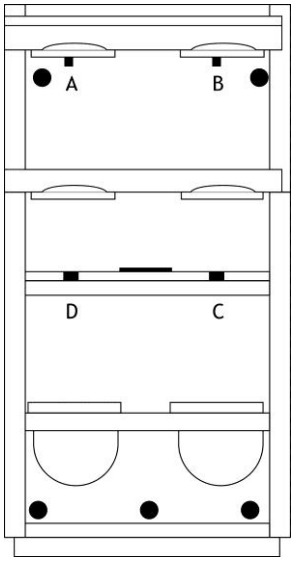
Levelling of units, *Continued*

Elevation setting

Tools required	Where used	Specified Torque
Allen key 3mm	for Allen screw (3) in the locking nut	1.3 Nm
Allen key 4mm	for Allen screws (2) in the legs	4.9 Nm
Flat (and socket) spanners 17mm	M10 nut on top of the slides	21 Nm

Step	Action
1	Cut the legs to the right height as per page 27
2	Install the PAPI units on the 3 or 4 legs (with one flat washer underneath).
3	Select the front leg with the longest lower leg portion and put the U-shaped (1) spacer between the PAPI unit and the lower leg. (see fig.) Measure the total height from top of concrete mounting slab up to the axis of the light beam (indicated on each side, at the front end of the PAPI, by means of a Pop-nail). If the height is equal or smaller than the calculated height, you can proceed with the following steps. If not, check if the leg is bottomed into the frangible coupling. If it is properly mounted, this means that it has been cut too long. Review the calculated height and correct the length of the leg.  Go therefore back to step one.
4	Remove the U-shaped spacer. Consider the selected front leg as the **reference leg** and adjust to the calculated height by means of the “mobile setting device” (see fig below) supplied with the levelling tools. Mobile Setting Device 

	Therefore, insert the setting device between the top surface S1 of the lower leg portion and the elastic pin in the sliding bar. (See fig. below). Place in this order a flat washer, a lock washer and a M10 hex nut on the top of the sliding bars. Torque down the nut on top of this particular leg only. Adjust the height by simultaneously turning the two knurled discs (1) of the mobile setting device. 
5	Secure the locking nut down against the surface **S1** by means of the hex socket set screw (3). Secure the four hex socket set screws (2) in the lower leg portion. 
6	Place the ‘mobile setting device” on the other front leg and proceed as in 4 and 5 above. Check if the PAPI is horizontal transversally by means of the spirit level installed correctly between the reference points A and B on the movable arm of the levelling device.

7	Proceed, depending on the location of the reference leg, clockwise or anti-clockwise with the rear legs
8	Change the position of the spirit level from AB to BC or AD.  Make sure that the angle installed on the levelling device is correct and proceed again as in 4 and 5 above.
9	In case of a hyper static execution (4 legs) proceed as per 4 and 5 for the fourth leg and check if the back-plane of the PAPI is horizontal with the precision spirit level installed between C and D.
10	Make sure all hex socket set screws (2) in legs and (3) in locking nuts as well as M10 hex nuts on the sliding bars are properly torqued.
11	Check again, with the precision spirit level if the PAPI is properly adjusted and levelled (front side, rear side, longitudinal).

Checking Azimuth setting

Make sure that the surveyor's stake located at 50 m from the unit is still properly aligned with the V-sights on the aiming device installed between B and C. If not, loosen all four M10 nuts.
Align the unit in azimuth and repeat the previous operations.

It is not necessary for the alignment to be absolutely perfect. An error of 50 cm at 50 m yields an error of only 0.5°, which would still be acceptable.

Bilateral systems

In case of bilateral systems, the corresponding units at each side of the runway shall be set consecutively **without disturbing the setting of the aiming device.**

This will ensure a perfect synchronisation of the units on both sides of the runway.

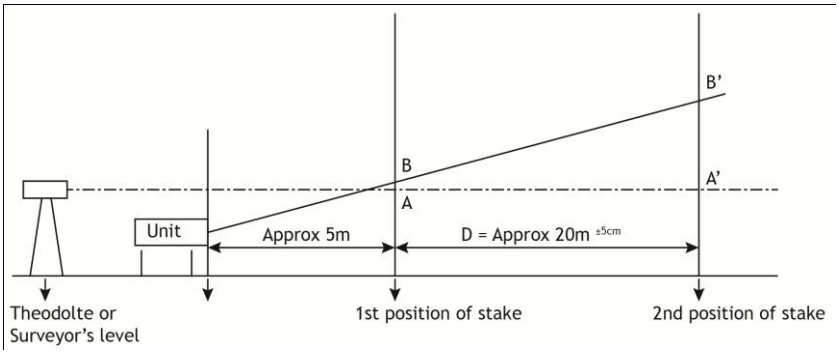
Checking cut-off angles of the light beams

Introduction

It may be requested, when the equipment is put initially into operation, and at regular intervals thereafter, that the cut-off angle of the units be checked. This measurement necessitates the use of a surveyor's level (or a theodolite) and a surveyor's stake.

Procedure

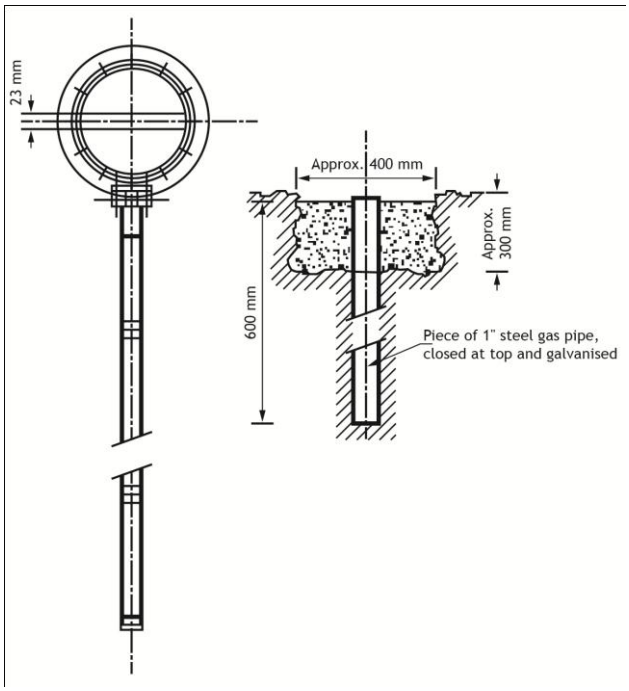
The procedure is as follows:

Step	Action
1	Position the surveying instrument 2 to 3m behind the PAPI unit.
2	An assistant approximately 5m in front of the unit holds a surveyor's stake.
3	Take reading A for the intersection of the horizontal of the surveyor's level 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 D of about 20 metre (±0.25%) down beam and take the same measurements A' and B'
6	The angle x of the beam cut-off to the horizontal is found from: $\tan x = (A'B' - AB)/D$ Where D is the horizontal distance between the two stake positions. If similar checks are to be scheduled in the future, a small concrete slab holding a galvanised pipe may be installed in front of each unit at the distances used above. 
7	According to the ICAO, prior to commissioning a PAPI or APAPI system, a visual flight check should be carried-out by the local Civil Aviation or by the Airport Authorities.

Reference bases for checking stick

Introduction

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



Locating reference bases

Step	Action
1	A concrete sighting base should be located on the extended centre line of each unit.
2	When the PAPI is switched on, walk along the centreline of the unit observing it from time to time through the screen until the lower limit of the white sector is about to disappear under the first scored line.
3	At this point, dig a hole approximately 400 mm square and 300 mm deep. Drive in a 1"steel pipe vertically in the centre of the hole until its top is at ground level. Place the bottom end of the checking stick on top of the pipe and observe the light unit through the screen. 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.
4	Repeat this procedure for the other units, using the same observer.
5	Pour concrete in the holes.

Observations with checking stick

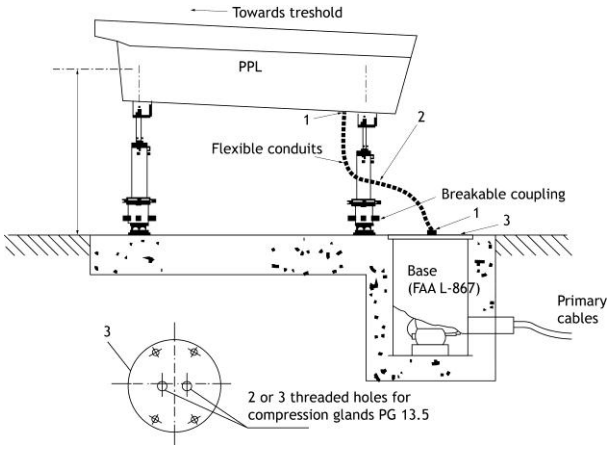
Place checking stick on the concrete sighting base in front of the light unit and switch the PAPI system on. Observe the light unit through the screen. Just below the upper line of the screen, the light beam should no longer appear completely white. If this is not the case, the unit is out of alignment and requires resetting.

Distance from unit will vary according to ground elevation and unit angle setting.

Electrical connection

Connection Kit

Using the connection kit described below the picture, operate as follows:



Item	Designation	Qty/Unit		Remarks
		PPL400/3	PPL600/3	
1	Gland (PG 13,5) for flexible conduit	4	6	Supplied
2	Flexible conduit (1m long)	2	3	Supplied
3	Steel cover 10mm with 2 or 3 holes for gland 13.5	1 (2 holes)	1 (3 holes)	Optional

Procedure

Step	Action
1	Enlighten the compression glands PG16 (A) and remove the two feeder cables with FAA 2-pole plug (B) from the PAPI unit.
2	Cut the 1m long flexible conduits at the desired length (according to the PPL height).
3	Put the special glands for flexible (2) on each end of the conduits (1).
4	Fasten one end of the conduit fitted with the gland (1) on the steel cover (3).
5	Put the reducer PG16/PG13.5 (1) on the other end of the flexible conduit.
6	Fasten the reducer to the PPL unit by means of the nut (A') removed from the compression gland (A). Starting at the steel cover end, insert the cables through the conduits.
7	Connect the cable ends to the fast-on connectors of the lamp. Connect the FAA-L823 plug (on the other side of the feeder cable) to the transformer secondary female connector (5). If local regulations so require, the unit should be electrically grounded, using the grounding terminal located between the two compression glands.
8	Close the base; tighten the 6 screws at the specified torque (20Nm).

Chapter 3: Maintenance

Overview

Introduction

In order to reduce maintenance to a minimum, ADB has adopted the simplest possible design and has used the best materials and protective treatments.

The light unit will give the best results only if handled with great care and well maintained throughout its lifetime.

Contents

This chapter contains the following topics.

 The front protection glass should always be present and replaced if damaged to avoid subsequent lens damage.

Lenses cannot be field replaced as they need to be factory-calibrated to guarantee the unit's performance.

Preventive maintenance

Preventive maintenance tasks

In the table below you will find a checklist of preventive maintenance tasks:

Interval	Check	Action
Daily *	Check elevation angle of units (first few weeks after commissioning only)	Reset units if out of alignment (see Checking cut-off angles of the light beams page 37).
	Check equipment for proper operation.	Repair, adjust or replace.
Weekly **	Using soft cotton cloth moistened with alcohol, clean outer surface of front protection glass.	
Monthly	Inspect housing and closure system, lamps, electrical connections, filters and protective glass for damage, breakage or warp age.	Repair or replace.
	Clean interior surface of housing; remove any foreign matter. Use soft cotton cloth moistened with alcohol to clean both sides of the protective glass, colour filters, lenses and reflectors.	
Twice Yearly	Make sure unit mounting is rigid.	Tighten loose nuts, screws, etc. Realign unit if hardware has loosened.
	Make sure no vegetation obscures the light beam.	Remove growth in the vicinity of equipment. Use weed killer.
Yearly	Make flight check of system if possible.	Observe proper approach angle.

* When the light unit has stabilised, checks may be made weekly.

** More frequently during the rainy season and when there is bare soil in front of the light units

How to replace a lamp

Procedure

The following table instructs you on how to replace a lamp:

Step	Action
1	De-energize the circuit.
2	Open the PAPI unit.
3	Remove the electrical fast-on connectors from the lamp (8). Check condition of the cable and fast-on connectors and replace if necessary.
4	Swing back the spring loaded fork (9).
5	Remove the lamp from the reflector (7).
6	A new lamp can be installed by reversing this procedure.

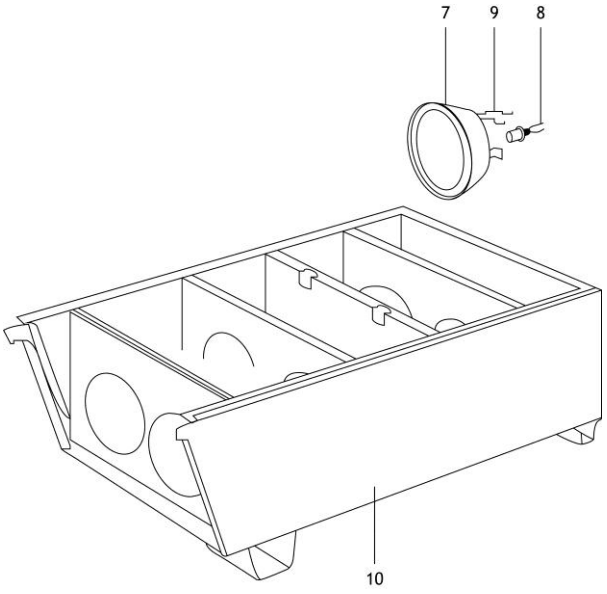
Caution: Wear cotton gloves when handling the lamps. Touching the quartz bulb with your bare fingers may seriously shorten the lamp life. If the quartz bulb has been touched, wipe it carefully with lens cleaning tissue or similar material moistened with isopropyl alcohol or methylated spirit.

It is recommended that a systematic replacement of all the lamps be made after a service period of approx. 800 hours at the 100% brightness level. An elapsed time recorder on the constant current regulator is useful to determine the time for replacement.

Illustration

The illustration below clarifies the procedure:

(PPL 400/3)



How to replace a filter

Procedure

The following table instructs you on how to replace a filter:

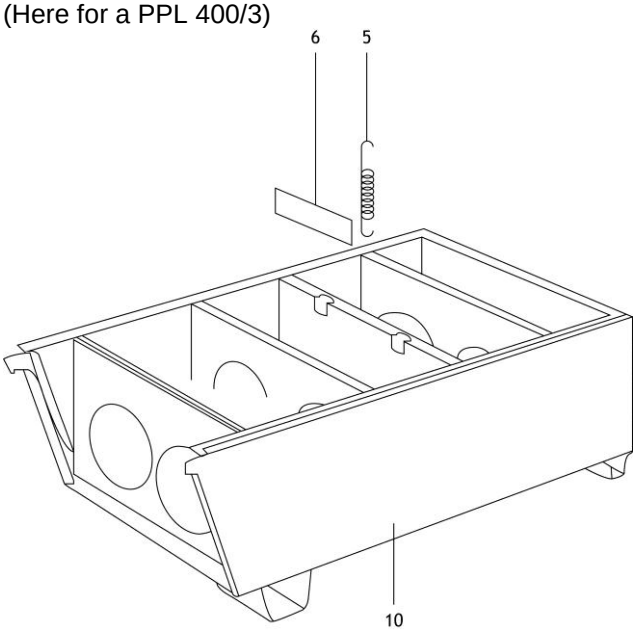
Step	Action
1	De-energize the circuit.
2	Open the light unit.
3	Remove the two springs (5)
4	Remove the broken filter (6)
5	Place a new filter in its holder **with the side without chamfer down**.
6	Reverse this procedure.

The filters must be perfectly clean.

Use a soft cotton cloth moistened with alcohol or methylated spirit to clean filters and wear cotton gloves when handling filters

Illustration

The illustration below clarifies the procedure:
(Here for a PPL 400/3)



Chapter 4: Troubleshooting

Troubleshooting table

In the table below a number of problems are listed in the first column. The second column, lists the possible causes of the problem, and the third column the proposed cure.

 Before attempting to service, de-energise and lockout the circuit or the regulator so that the fixture can not be energised by remote means.

Problem	Possible cause	Solution
All lamps out	No power supply	Repair or replace loose or broken electrical connection, defective transformer. Check CCR operation.
	All lamps burned out	Replace bulbs. Check input current level (see below).
Light signal is dim	Dirty front glass	Clean with soft cotton cloth moistened with alcohol or methylated spirit.
	Lamp not properly seated in reflector	Re-seat lamp in reflector.
	Current level too low	Check with true RMS ammeter
	Broken lens, front glass, or filter.	Replace broken element. If a lens is broken, the unit must be sent back to the factory for recalibration.
Short lamp life	Current level too high	Check input current level at lamp and output current at CCR. Use true RMS ammeter Check isolating transformer for proper ratio.
In case they are installed: Heater will not operate.	Thermostat defective	Replace thermostat.
	Defective heater	Replace heater.
	Loose or broken electrical connection.	Repair or replace.

Chapter 5: Assemblies and Exploded Views

Overview

Introduction

This chapter contains an overview of the main sub-assemblies and also the exploded views of the PPL 400/3 and PPL 600/3 PAPI units.

Contents

This chapter contains the following topics.

Assemblies

Spare parts

In order to limit the MTTR (Mean Time To Replace) of this vital equipment, it is recommended to keep a sufficiently large stock of spares. It will mainly consist of consumables like lamps. Other components that may need replacement, such as filters and hardware, should be stocked in smaller quantities. The quantities recommended as spares holding in Table 1 are for one 4-box PAPI system.

List of tables

Below is a list of the tables in this chapter:

Assemblies, *continued*

Table 1: Main parts

The table below lists all parts of the PPL units.

References		Qty/unit		Description
Ref	**Code number**	**PPL 400/3**	**PPL 600/3**	
-	**1434.20.043**	**1**		**PPL 400/3 unit without mounting legs**
-	**1434.30.022**		**1**	**PPL 600/3 unit without mounting legs**
11	**1439.11.150**	**3 or 4**	**4**	**height adjustable mounting leg. assembly**
1	4071.92.732	1		Cover assembly PPL 400/3
	4070.95.570		1	Cover assembly PPL 600/3
2	6830.11.321	1		Clear front protection glass PPL400/3
	6830.11.360		1	Clear front protection glass PPL600/3
3	Not available as spare	-	-	Outer lens
4	Not available as spare	-	-	Inner lens
5	4070.64.230	4	6	Retaining spring for filter
6	1438.12.220	2	3	Red filter
7	1434.20.420	2	3	Reflector assy.
8	2990.48.310	2	3	Pre-focus halogen lamp 200W-6,6A Pk30d
9	4070.04.902	2	3	Lamp retaining spring
10	Not available as spare	1	1	Folded alu housing with lockable latch
12	1409.05.027	3 or 4	4	Breakable coupling MR/F2
13	4070.36.640	3 or 4	4	Mounting flange
14	6126.01.230	2	3	Compression bushing PGW13.5
15	1458.06.100	2	3	Cable assembly
17	4071.12.350	1		Gasket for front glass
16	7092.32.222	4m	6m	Gasket between cover and housing

Assemblies, *continued*

Table 2:

Optional parts

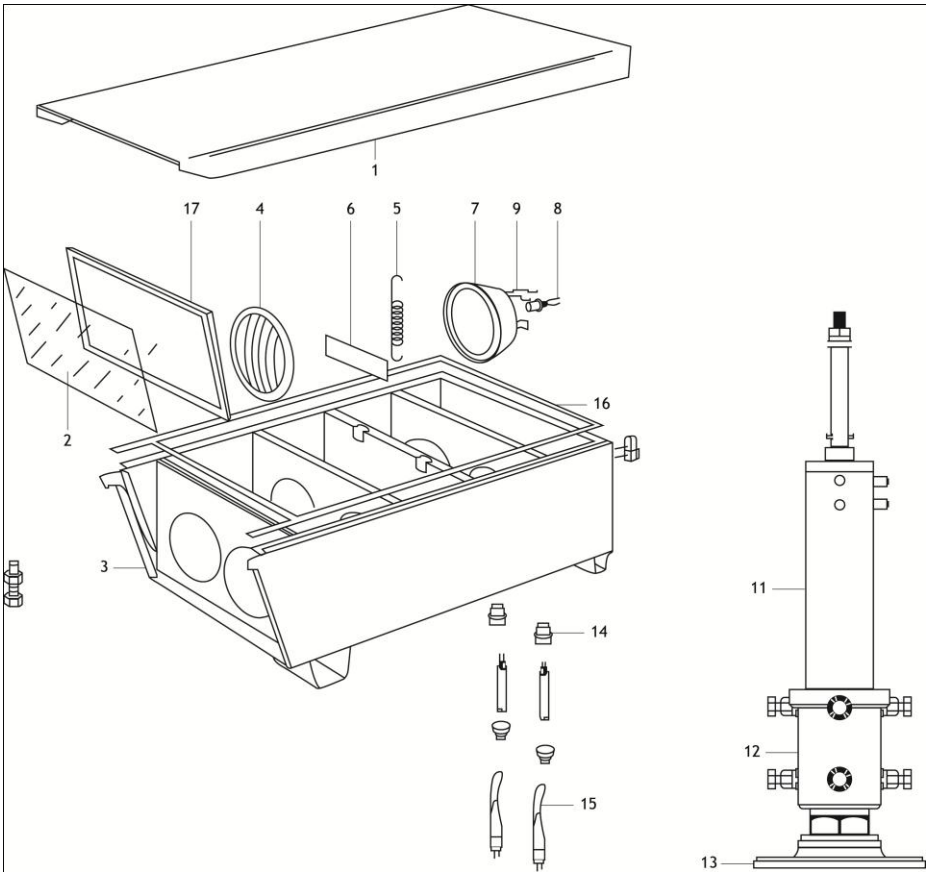
References		Qty / unit		Description
Ref	Code number	PPL 400/3	PPL 600/3	
-	1434.20.910	1	-	Heater, anti condensation, with thermostat, 220V.
-	1434.20.920	1	-	Heater, anti condensation, with thermostat, 110V.
8	2990.48.320	2	3	Pre-focus halogen lamp, 100W – 6.6A-Pk30d – 1000H.
-	4070.93.370	12 or 16	16	Anchor bolts
(2)	6830.11.325	1	-	Anti-condensation front glass PPL400/3

Table 3: Tools

References		Qty		Description
Ref	Code number	PPL 400/3	PPL 600/3	
-	1439.05.230	1	1	Carrying box with installation tools for PPL 400/3 and PPL 600/3, **without** checking stick.
-	1439.05.222	1	1	Carrying box with installation tools for PPL 400/3 and PPL 600/3, **with** checking stick.
-	1439.10.020	1	-	drilling template for PPL 400/3.
-	1439.10.030	-	1	drilling template for PPL 600/3.
-	1439.05.300			Checking stick. (incl. in 1439.05.222)
-	1439.11.300			Mobile setting device, incl. U spacers. (incl. in 1439.05.230 & 1439.05.222)

Exploded view PPL 400/3

PPL 400/3 Below is the exploded view of the PPL 400/3 PAPI unit.



Exploded view PPL 600/3

PPL 600/3 Below is the exploded view of the PPL 600/3 PAPI unit.