Precision Approach Path Identifiers (PAPI) From Design to Commissioning

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Outline

- Overview
- Design
  - Reference Materials
  - Siting
  - Surface Clearance
- FAA Flight Inspection
  - Reimbursable Agreements
  - On-Site During Flight Inspection

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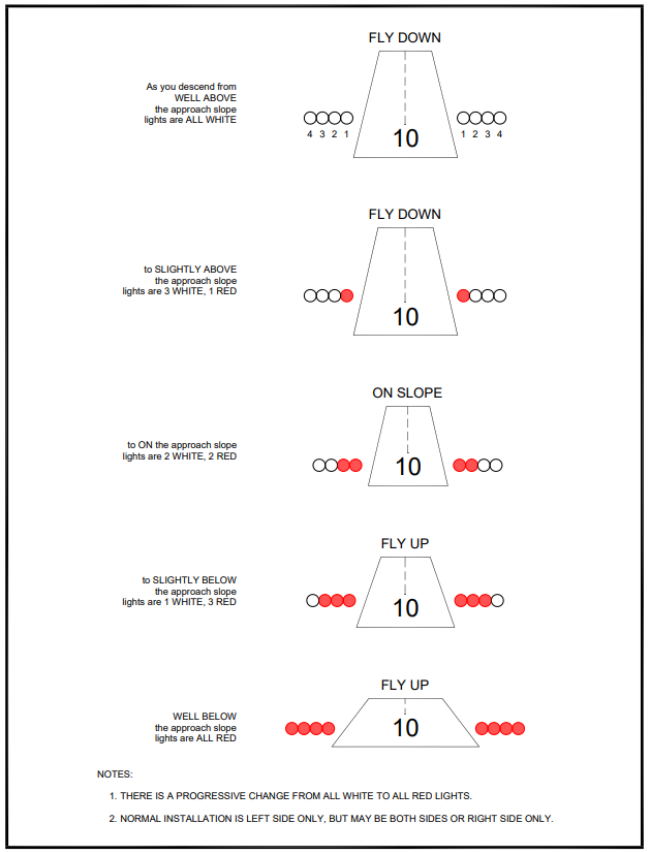
Introduction to PAPI Systems



PAPI Signal Presentation (Figure A-82 From FAA AC 150/5340-30J)

- PAPIs provide visual approach slope guidance to assist pilots in flying a stabilized approach
- The PAPIs present a row of lights that assist in determining if the pilot is above or below the angle of approach
- PAPIs have an effective visual range of 3 miles during the day and 20 miles at night
- 2-Box or 4-Box
- Operation Options

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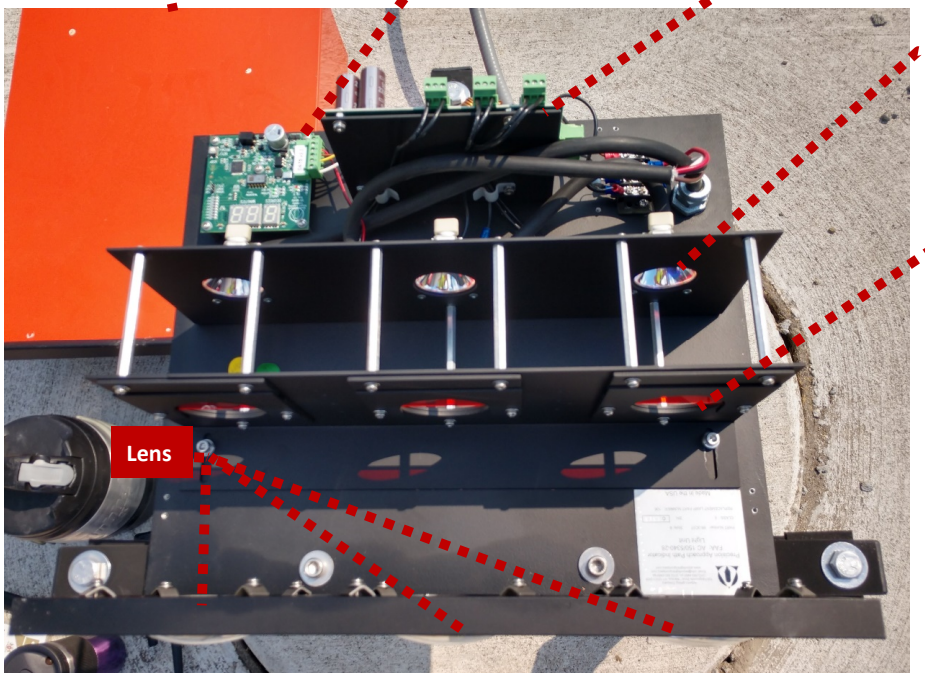
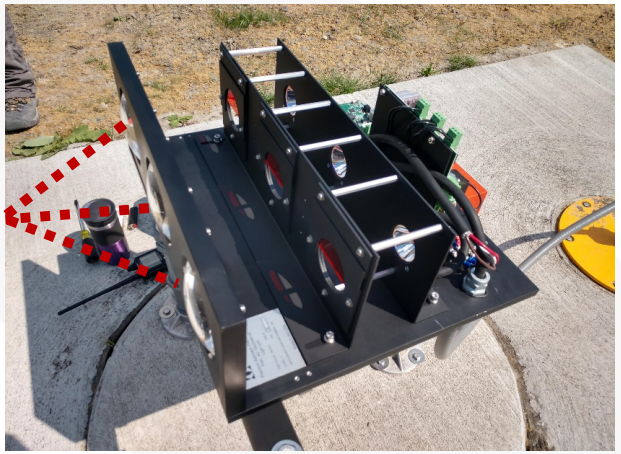
PAPI System Internals



PAPI Internals

*Models/Styles May Vary



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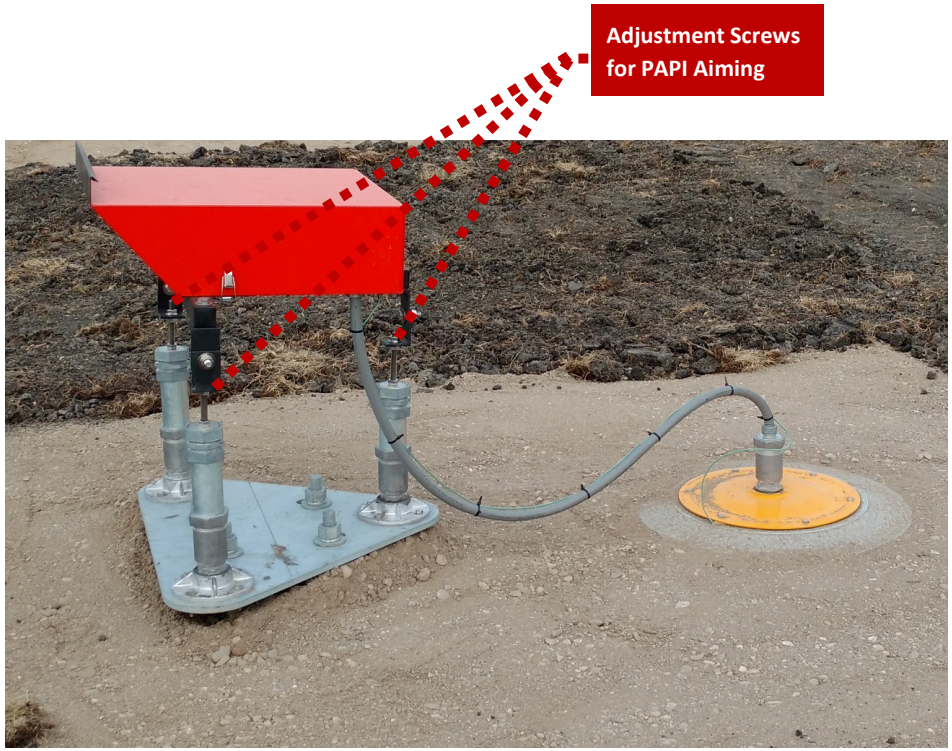
PAPI Legs and Foundation



PAPI Installed on Screw Anchor

PAPI Installed on Concrete Foundation

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Section I:
PAPI Design

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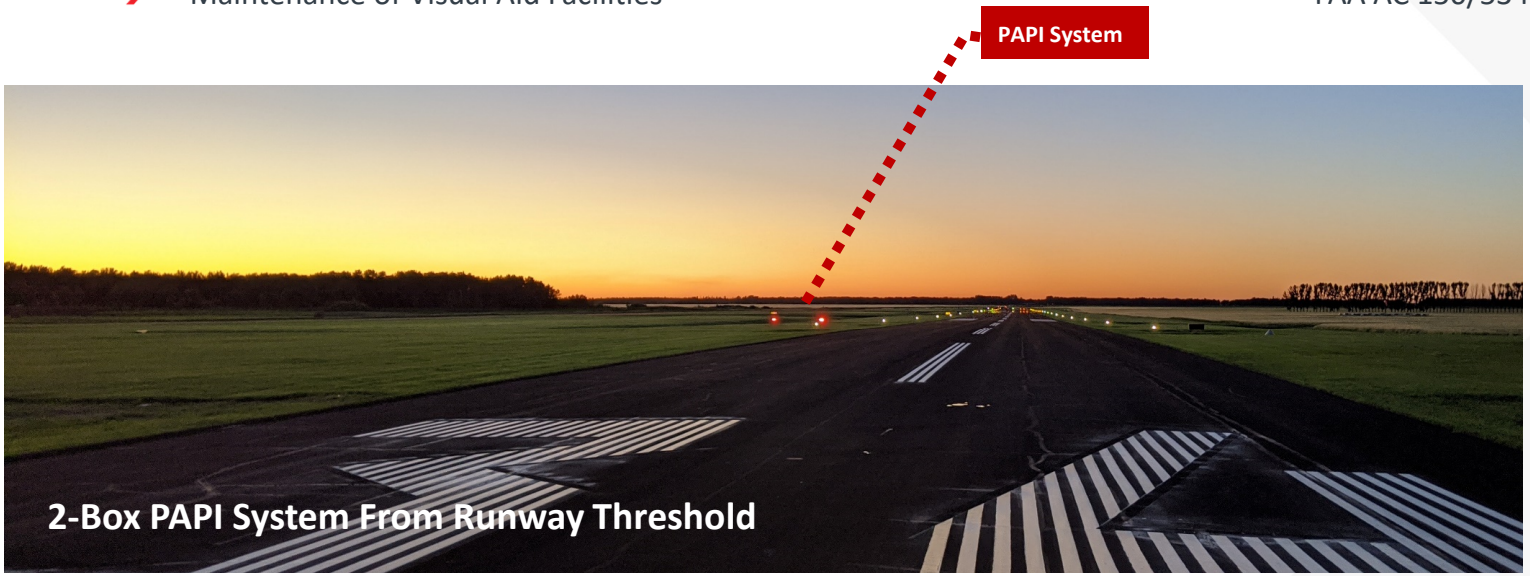
Design – Reference Materials

- Reference Materials
  - "Design and Installation Details for Airport Visual Aids" — FAA AC 150/5340-30J (or current edition)
  - "Visual Guidance Lighting Systems" — FAA Order JO 6850.2B (or current edition)
  - "Additional Siting and Survey Considerations for Precision Path Indicator (PAPI) and Other Visual Glide Slope Indicators" — FAA Engineering Brief EB95
  - "US Standard Flight Inspection Manual with CHG 1" — FAA Order 8200.1D
  - "Precision Approach Path Identifier (PAPI) Systems — FAA AC 150/5345-28H (or current edition)
  - "Maintenance of Visual Aid Facilities" — FAA AC 150/5340-26C (or current edition)



2-Box PAPI System From Runway Threshold

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Design – General Siting Process

- General Siting Process
  1. Determine General PAPI System Requirements – Type/Style/Class
     - Type: 2-Box (L-881) or 4-Box (L-880) System
     - Style: Voltage (Style A) or Current (Style B) System
     - Class: Min. Operating Temp. → -31°F (Class I) or -67°F (Class II)
  2. Calculate Ideal Distance from Runway Threshold (D1)
  3. Correction for Runway Longitudinal Gradient

4-Box PAPI System

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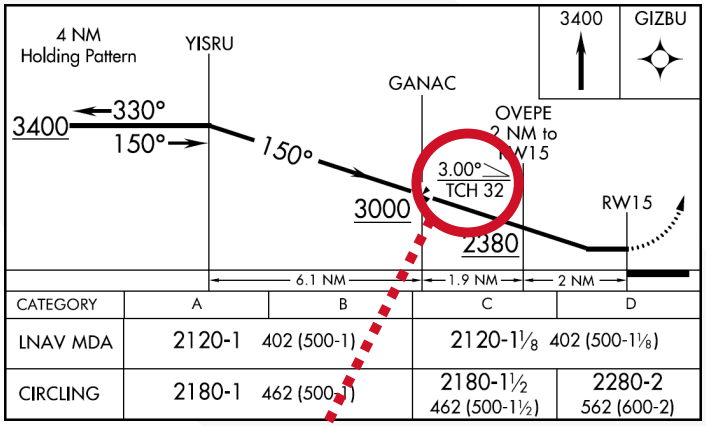
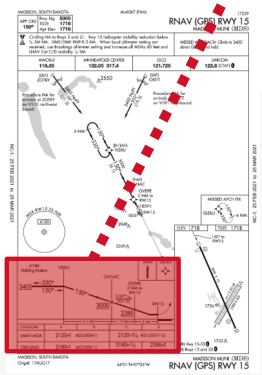
Design – General Siting Process

- Calculating Ideal Distance from Runway Threshold (D1)
  - Determine Lowest On-Course Signal
    - Typical Glide Slope = 3.00°
    - 15’ Below Glide Slope for 2-Box Unit (Typically 2° 45’)
    - 10’ Below Glide Slope for 4-Box Unit (Typically 2° 50’)
  - Determine Threshold Crossing Height (TCH)
    - Table 7-1 in AC 150/5340-30J
    - Check existing approach plates
  - Solve for Ideal Distance from Runway Threshold:
    - D1 = TCH x cotangent (lowest on-course angle)



CATEGORY	A	B	C	D
LNAV MDA	2120-1	402 (500-1)	2120-1⅛	402 (500-1⅛)
CIRCLING	2180-1	462 (500-1)	2180-1½ 462 (500-1½)	2280-2 562 (600-2)

Example Approach Plate With TCH of 32’



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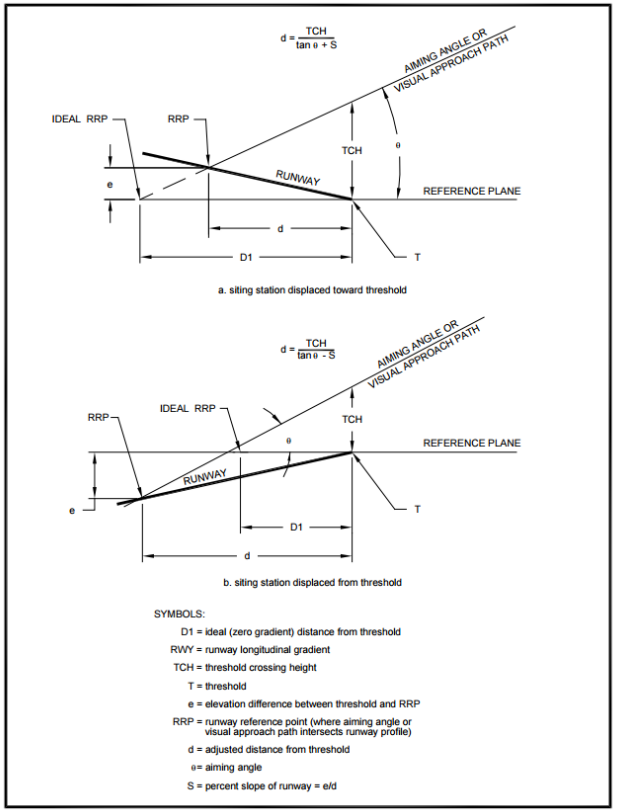
Design – General Siting Process



Correction for Runway Longitudinal Gradient (Figure A-83 From FAA AC 150/5340-30J)

- Correcting for Runway Gradient
  - Runway gradient impacts the siting of the PAPI system in most occasions
  - Potentially need to revise runway slope gradient in calculation if runway slope is non-linear
    - Grade Changes
    - Vertical Curves

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Design – General Siting Process

PAPI Siting Calculations

Item	Symbol	Value	Units	Notes
Threshold Crossing Height	TCH	40.00	Feet	alue Calculated from Goal Seek (Requred to be 20'-45' for Height Group 1)
Aiming Angle	θ	3	degrees	Typical Glide Slope
Aiming Angle	θ	0.0524	radians	
Lowest On-Course Signal	N/A	2.75	degrees	ng angle for 2 box PAPI (10' less than Aiming angle for 4 Box PAPI)
Lowest On-Course Signal	N/A	0.0480	radians	
Ideal (zero gradient) Distance from Threshold	D1	832.8	Feet	

Determine TCH (40’)

Determine PAPI Type (2-Box)

Calculate D1 (833’ From Runway Threshold)

Correction for Runway Longitudinal Gradient

Item	Symbol	Value	Units	Notes
Elevation at Runway 12 Threhold	N/A	1060.01	Feet	From EG
Elevation at D1	N/A	1058.02	Feet	From EG
Slope of Runway	S	0.24%	%	stance (assumed level reference plane per AC 5340-30H)
Elevation difference between threshold and Reference Point	e	1.99	Feet	The Reference Point I used is at D1. Not the RRP shown in Figure 82 in AC 5340-30H as this point is self referencing (i.e. cannot be calculated)
Calculated Adjusted Distance From Threshold	d	874.4	Feet	
Goal-Seek equation	N/A	1.000	Feet	

Calculate Runway Gradient (0.24%)

Use Goal Seek to Determine Design Location (874’ from Runway Threshold)

Example PAPI Siting Calculation

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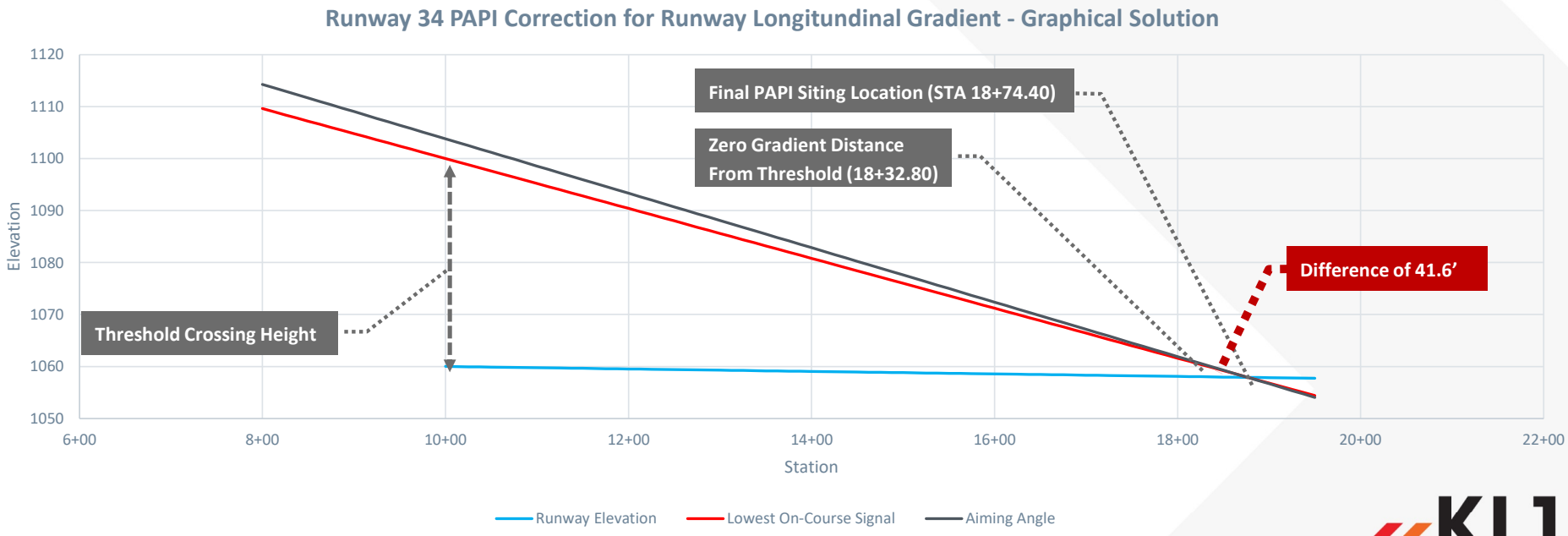
Design – General Siting Process

- Plot on-course signal and runway gradient to confirm solution



Example Runway Correction Graph

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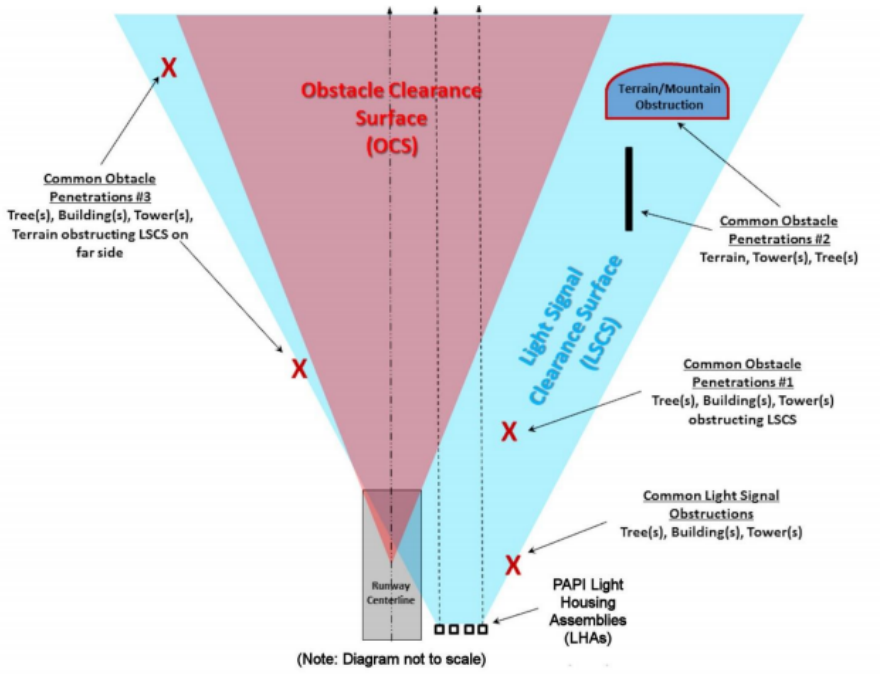
Design – Surface Clearance



Common LSCS Obstacles

(Figure 4 From FAA Engineering Brief No. 95)

- A PAPI Obstacle Clearance Surface (OCS) & Light Signal Clearance Surface (LSCS) survey needs to be completed as part of design
  - Out to 8 nautical miles for 4-box
  - Out to 4 nautical miles for 2-box
  - Common obstacles: Trees, Towers, Buildings, High Terrain, etc.
- Engineering Brief No. 95 outlines options for mitigating obstructions to LSCS

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Design – Additional Considerations

- PAPI Leg Height
  - Typically 2’ to 3’
  - Berms can be used to reduce leg height
- Foundation/Anchor Depth
- PAPI Unit lateral Light Separation
- Light Beam Height
- Location of Power Control Unit (PCU)
- Preference to Match PAPI Glide Slope with RNAV Approach Slope
- Runways with ILS must coincide with ILS Glide Slope

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Section II:
FAA Flight Inspection

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FAA Flight Inspection – Reimbursable Agreements

- Process for Reimbursable Agreement (RA):
  1. Initial communication with FAA Flight Program Operations
  2. FAA provides draft RA for sponsor review
  3. Sponsor reviews and provides any comments on draft RA
  4. FAA sends final RA for sponsor signature and prepayment
  5. Upon Agreement execution and payment receipt, Sponsor to request flight inspection
  6. FAA refunds unused funds associated with Flight Inspection

- Variable Glide Slope Indicator (VGSI) Data Form
  - Form required to be submitted to FAA
  - Coordinate with FAA Flight Program Operations for current version

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FAA Flight Inspection – Reimbursable Agreements

- Required information for Reimbursable Agreement (RA) at initial request:
  - Sponsor Name
  - Flight Inspection Type: (commissioning or special – See Order 8200.1D)
  - Agreement POC Information
  - Invoicing POC Information
  - Agreement Signature Authority
  - Sponsor Tax ID Number
  - Sponsor DUNs Number
  - Estimated Construction Start Date
  - Estimated Flight Inspection Date
  - Project Funding Rates
  - Is this agreement in whole or in part funded with funding from an FAA Airport Improvement Project (AIP) grant?
  - AIP Grant Agreement Date
  - AIP Grant Number

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FAA Flight Inspection – Commissioning Flight

- Items to Verify Prior to Flight Inspection:
  - Is the PAPI's Aiming Angle Correct?
  - Are Baffles Installed if Needed? Are they Installed Correctly?
  - Are All Bulbs Working?
  - Does PAPI Operate Properly with Photo Eye and Pilot Control Lighting?

Baffles Incorrectly Installed In PAPI

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FAA Flight Inspection – Commissioning Flight

- On-Site During Flight Inspection:
  - Monitor Radio – The flight inspectors will likely use alternative frequency other than CTAF for communication
  - Record Results from Flight Inspection
    - Lateral Angle/Aiming Angle
    - Verify with flight inspectors if the results meet standards
  - Coordinate with On-Site Contractor
    - Adjustments may be needed to bring PAPI Units within standards

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Questions

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