StART Aviation Noise Working Group

34R Glideslope Analysis

Port of Seattle®

Agenda

- Runway 34R Instrumentation
  - Instrument Landing System (ILS)
  - Area Navigation (RNAV)
  - Precision Approach Path Indicator
- Alternatives
- Recommendation
- Questions

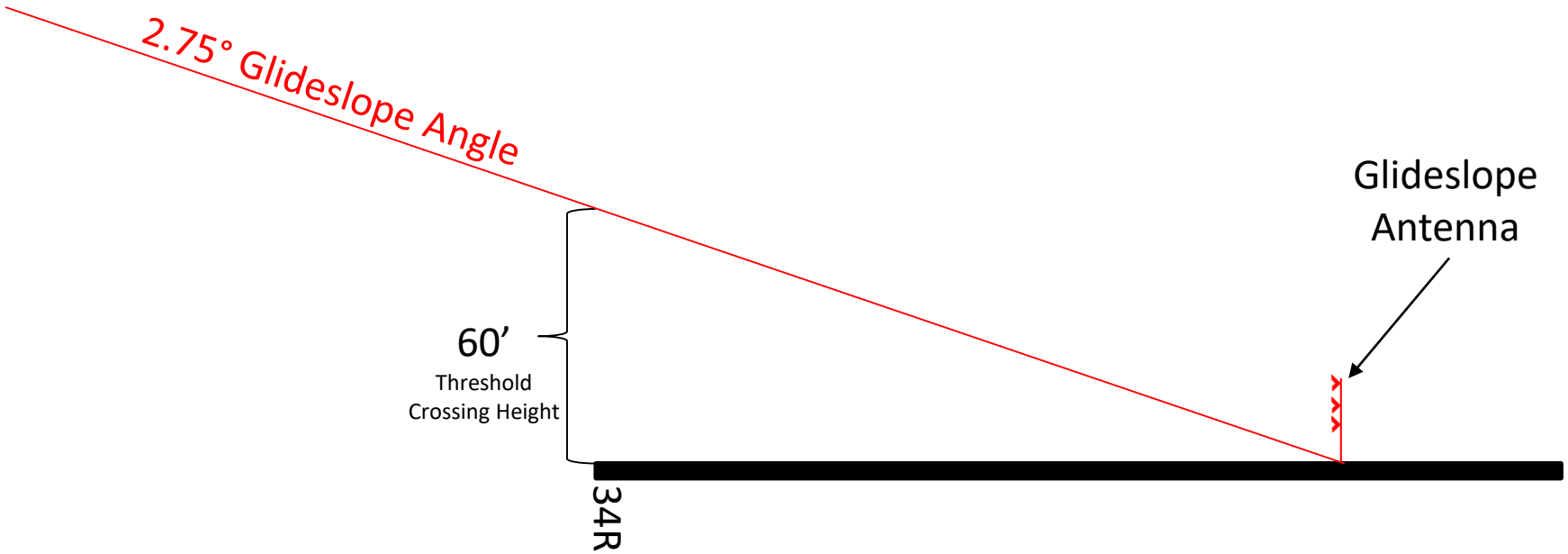
Instrument Landing System

- Instrument Landings Systems are composed of two primary ground components
  - Localizer - provides horizontal information
  - Glideslope (GS) – provides vertical information
    - Primary Siting Standards: 3° glideslope angle & Maximum 60’ Threshold Crossing Height
    - Existing 34R ILS has 2.75° glideslope with 60’ threshold crossing height

3° GS is standard

ILS Glideslope

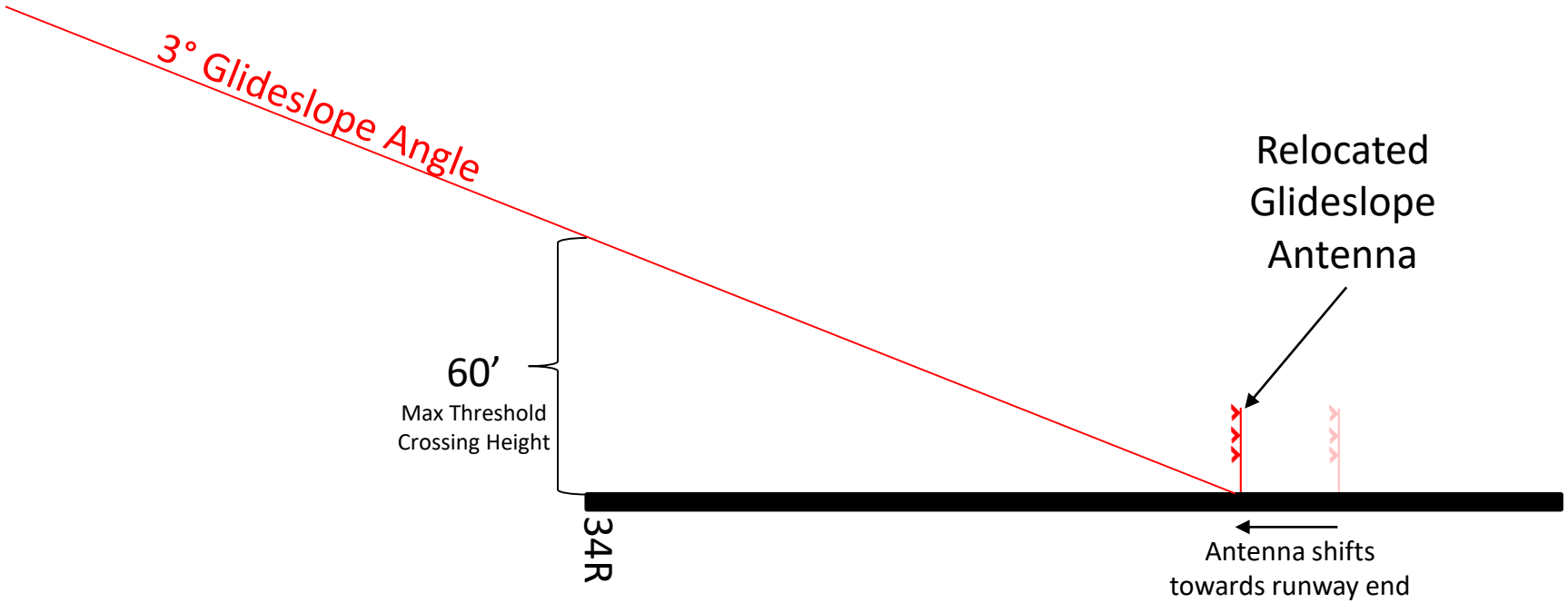
Existing 34R ILS Approach



GS is currently at maximum threshold crossing height

ILS Glideslope

Relocated 34R Glideslope Antenna



Relocation of GS Antenna needed to increase GS angel

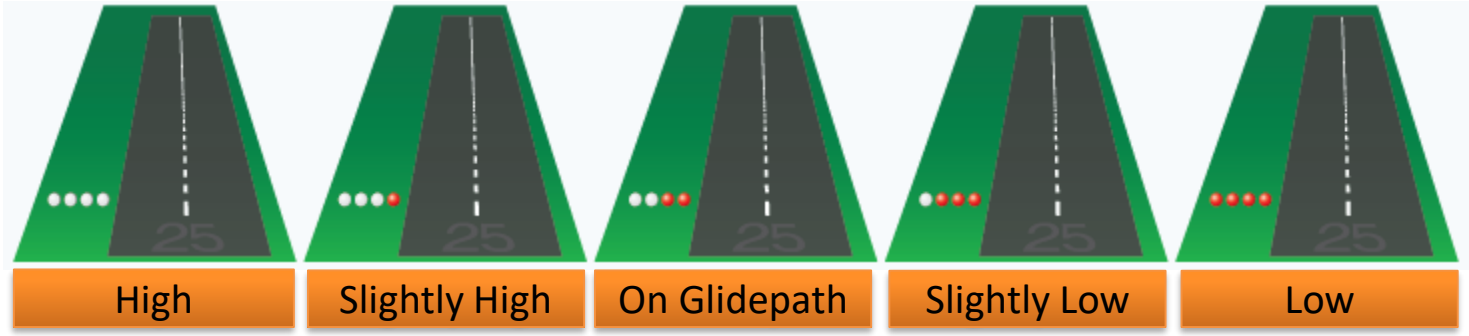
Area Navigation (RNAV)

- RNAV approaches are satellite based and do not relay on a navigational aids located at each runway end
  - Two RNAV procedures are currently published for Runway 34R (1) Required Navigational Performance (RNP) and (2) Global Positioning System (GPS)
  - Both RNAV procedures have glidepaths of 2.75° and 60’ threshold crossing heights

34R RNAV Approaches set to 2.75° GS

Precision Approach Path Indicator (PAPI)

- Precision Approach Path Indicator is a lighting system that provides the pilot with glidepath information
  - 34R PAPI is set to 2.75°
  - Relocation of system needed to achieve 3°



34R PAPI Set to 2.75° GS

34R Glideslope Adjustment Alt. 1

1. Relocate glideslope antenna and PAPI to permanent location
   a) Relocate as part of a future project that impacts the glideslope (34R GS equipment moves to west side of runway)
   b) Adjust RNAV procedures after equipment is relocated

Alternative 1

34R Glideslope Adjustment Alt. 2

2. Relocate glideslope antenna and PAPI
   a) Temporarily Relocate glideslope antenna on east side of Runway (Permanent relocation to follow)
   b) Relocate PAPI to permanent location
   c) Adjust RNAV procedures after equipment is relocated

Alternative 2

34R Glideslope Adjustment Alt. 3

3. Temporarily adjust satellite based procedures only (RNAV/GLS)
   a) Adjust glideslope antenna and PAPI to final location when able

NOTE: For safety, charting, and waypoint concerns it is highly encouraged that all approaches to a given runway end maintain the same glideslope. FAA support is needed to understand the validity of this alternative.

Alternative 3

Glideslope Angle Comparison

	1NM	2NM	3NM	4NM	5NM	6NM	7NM	8NM
2.75°	291'	583'	875'	1,167'	1,459'	1,751'	2,042'	2,334'
3°	318'	636'	955'	1,273'	1,592'	1,910'	2,229'	2,547'
3.1°	329'	658'	987'	1,316'	1,645'	1,974'	2,303'	2,632'
3.2°	339'	679'	1,019'	1,358'	1,698'	2,038'	2,377'	2,717'

- All heights are approximate
- All heights are above runway Threshold elevation (347’ MSL)

Alternatives Matrix

Alternative	Glideslope Angle		
	3°	3.1°	3.2°
Alt. 1 - Relocate GS equipment to permanent location			
Alt. 2 - Temporarily relocate GS equipment			
Alt. 3 - Temporarily adjust satellite based procedures only			

Case Study

Approaches in the United States with greater than 3° glideslope

- CAT II
  - Cleveland: RWY 6R CAT II SA with 3.1° GS
  - Newark: RWY 4L CAT I/II SA with 3.1° GS
- CAT III
  - Of the 128 CAT III approach in the National Airspace System no approach is greater than 3°
  - Only 2 CAT III approaches are less then 3°

Limited cases in U.S. of greater than 3° GS

Alternatives Matrix

Alternative	Glideslope Angle			
	2.95°	3°	3.1°	3.2°
Alt. 1 - Relocate GS equipment to permanent location				
Alt. 2 - Temporarily relocate GS equipment				
Alt. 3 - Temporarily adjust satellite based procedures only				

Alternatives with highest likelihood of running into issues during procedure development and have the lowest likelihood of success

Alt. Comparison Matrix

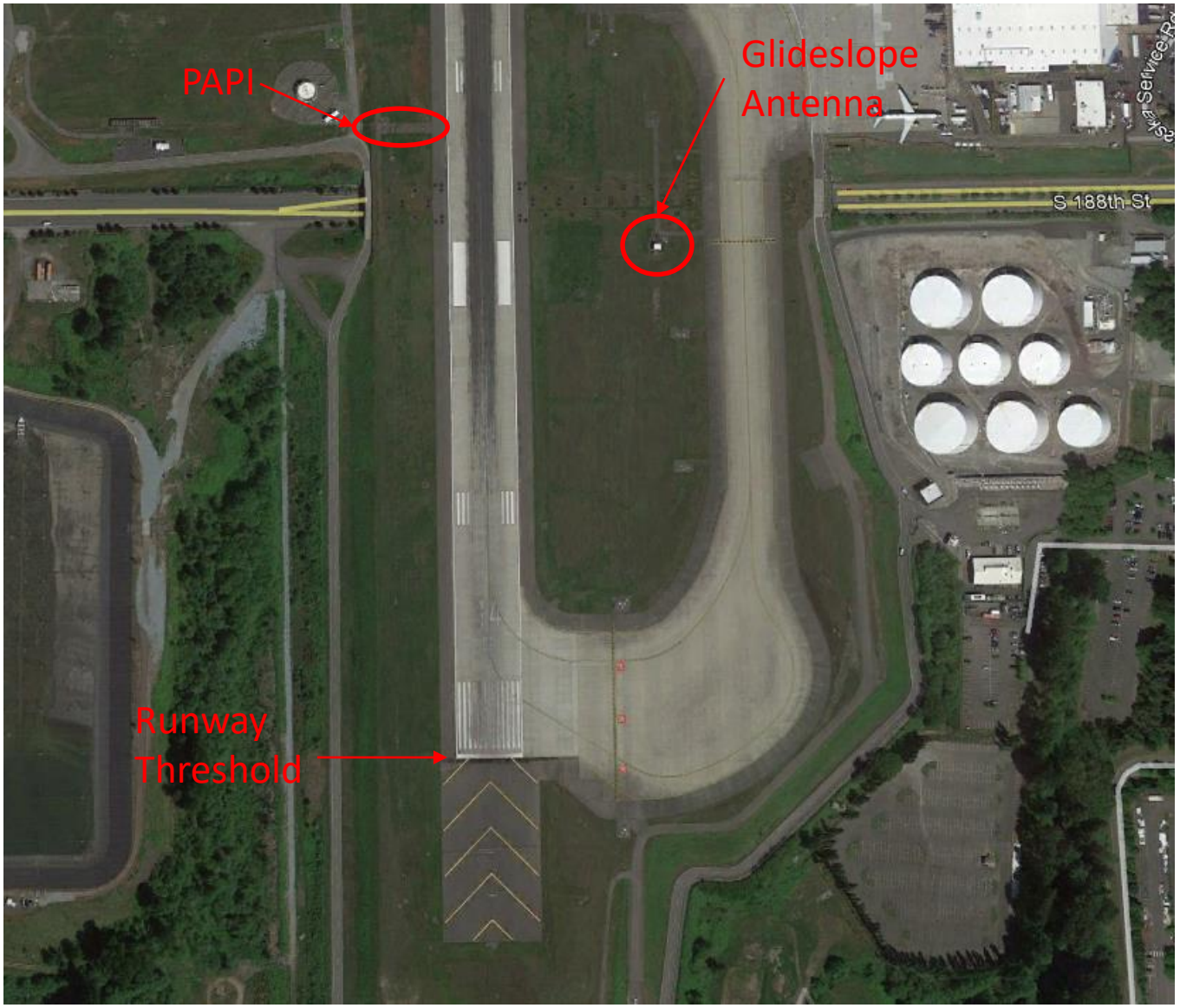
Alternative	Total Cost	Operational Impact	Time To Implement	Procedure Development Priority
Alt. 1 - Relocate GS equipment to permanent location	**Base Cost**	**No Impact clean switch over**	**May take longer then Alt 2 but options available to condense schedule may result in similar time to implement**	**Medium Priority (leverage SAMP efficiency benefit to gain higher priority)**
Alt. 2 - Temporarily relocate GS equipment	**Base Cost + Temp Relocation (Insufficient time to capitalize temp relocation)**	**ILS taken out of service during temp relocation**	**Quickest time to adjusted GS angle**	**Lowest Level Priority (Noise)**
Alt. 3 - Temporarily adjust satellite based procedures only	**Base Cost**	**No Impact**	**No Construction, Procedure Development Only**	**Lowest Level Priority (Noise)**

Working Group Recommendation

- Alternative 1 - Relocate GS equipment to permanent location
- Attempt to obtain a 3.1° glideslope angle
- Look for means to expedite the project
  - Begin Design (Design at Risk)
  - Initiate procedure development as soon as possible

Alternative 1 at 3.1° Glideslope Angle

Questions



Existing Conditions