

The Benefits and Challenges of Implementing Performance Based Navigation (PBN) Instrument Flight Procedures

Presented to: IFIS 2008

By: Bradley W. Rush

Manager, Quality Oversight and Technical
Advisory Staff

National Flight Procedures Office, FAA

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Federal Aviation
Administration



Introduction

**Presentation of benefits and challenges of
PBN (RNP AR) and lessons learned of
implementing over 100 instrument
approach procedures in the United States**



Overview

- **Benefits**

- Reduced Obstacle Evaluation Area (OEA)
- No secondary areas
- Missed approach segment OEA
- Radius-to-Fix leg types

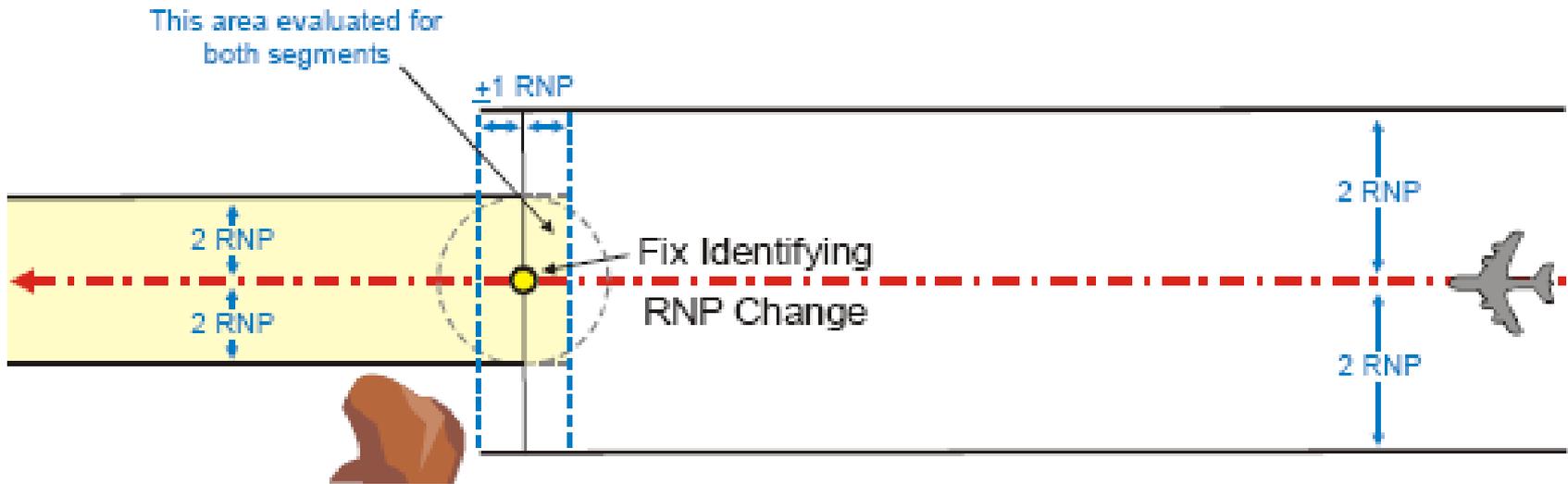
- **Challenges**

- Operator authorization and training
- Air traffic control procedures and training
- RNP criteria application
- Procedure benefit
- Flight inspection technique



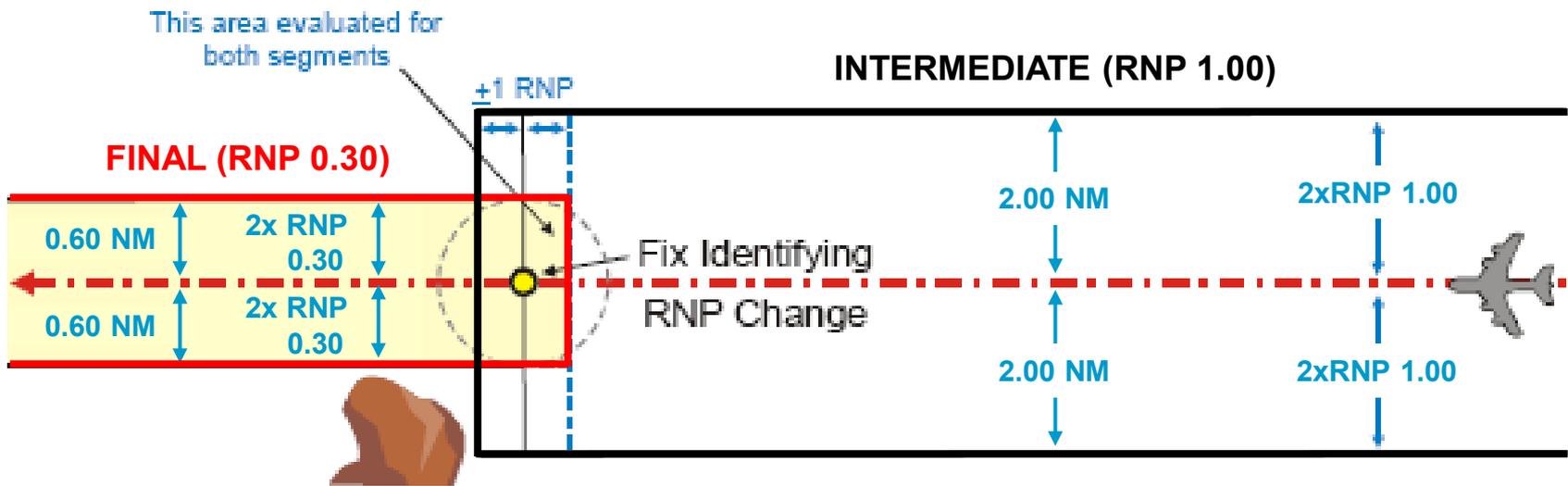
Benefits

- Reduced OEA



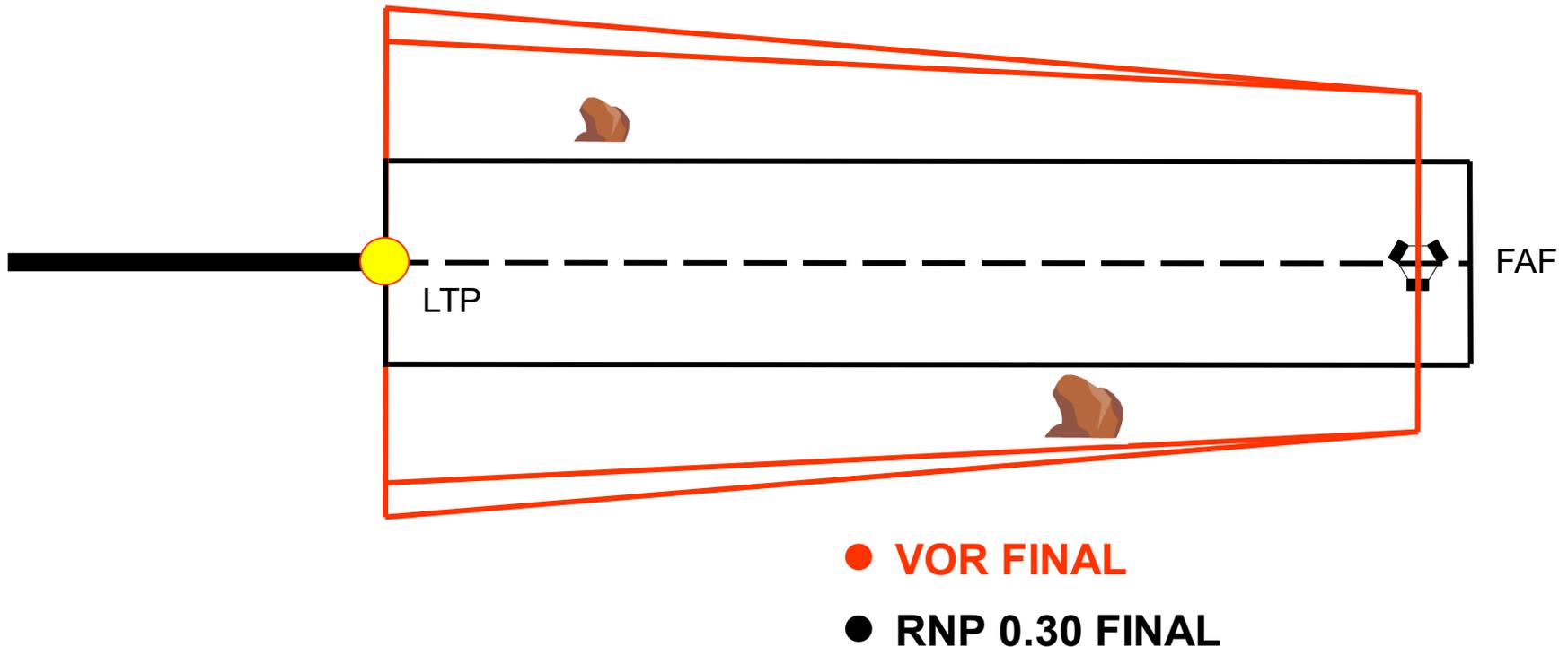
Benefits

- Reduced OEA



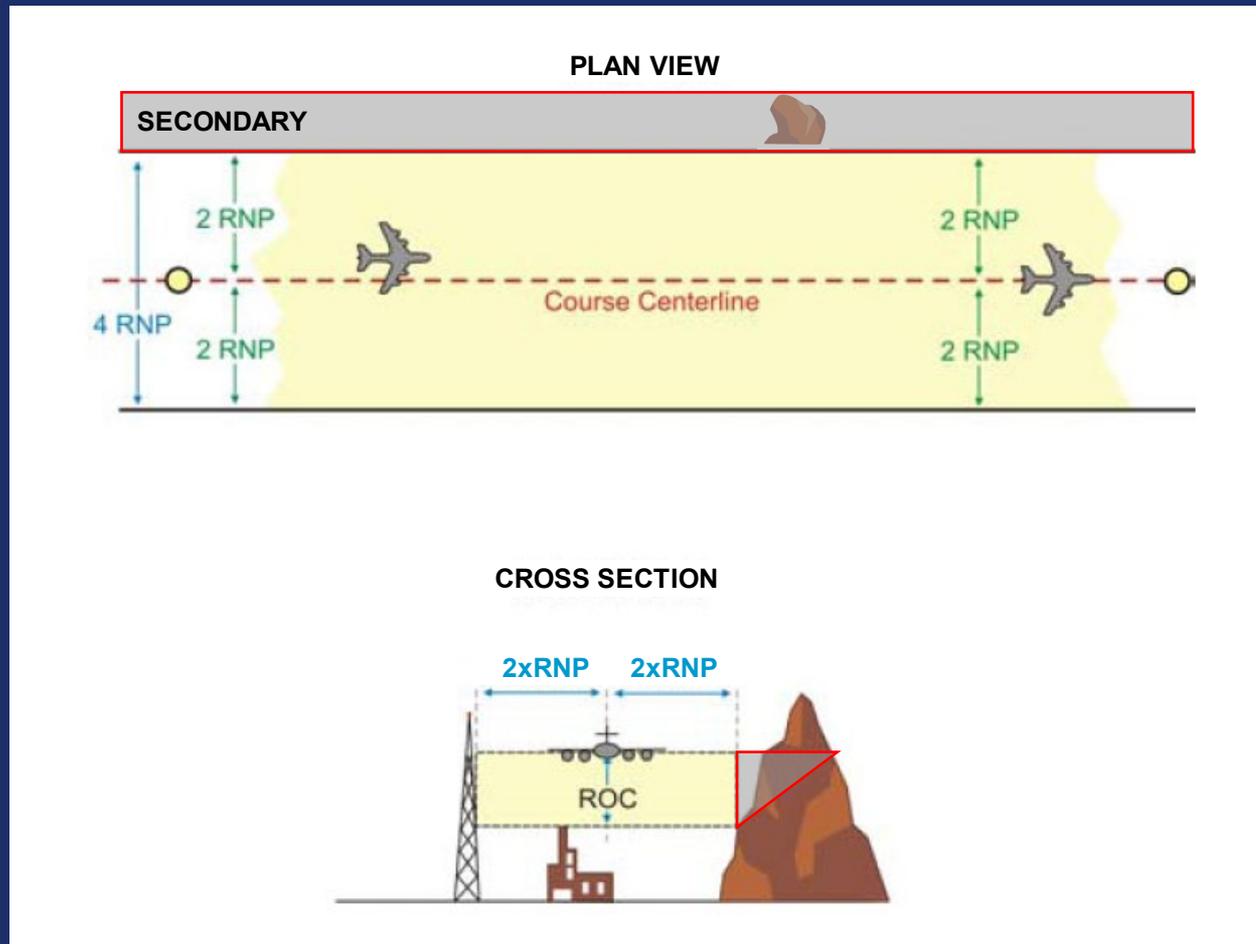
Benefits

- Reduced OEA



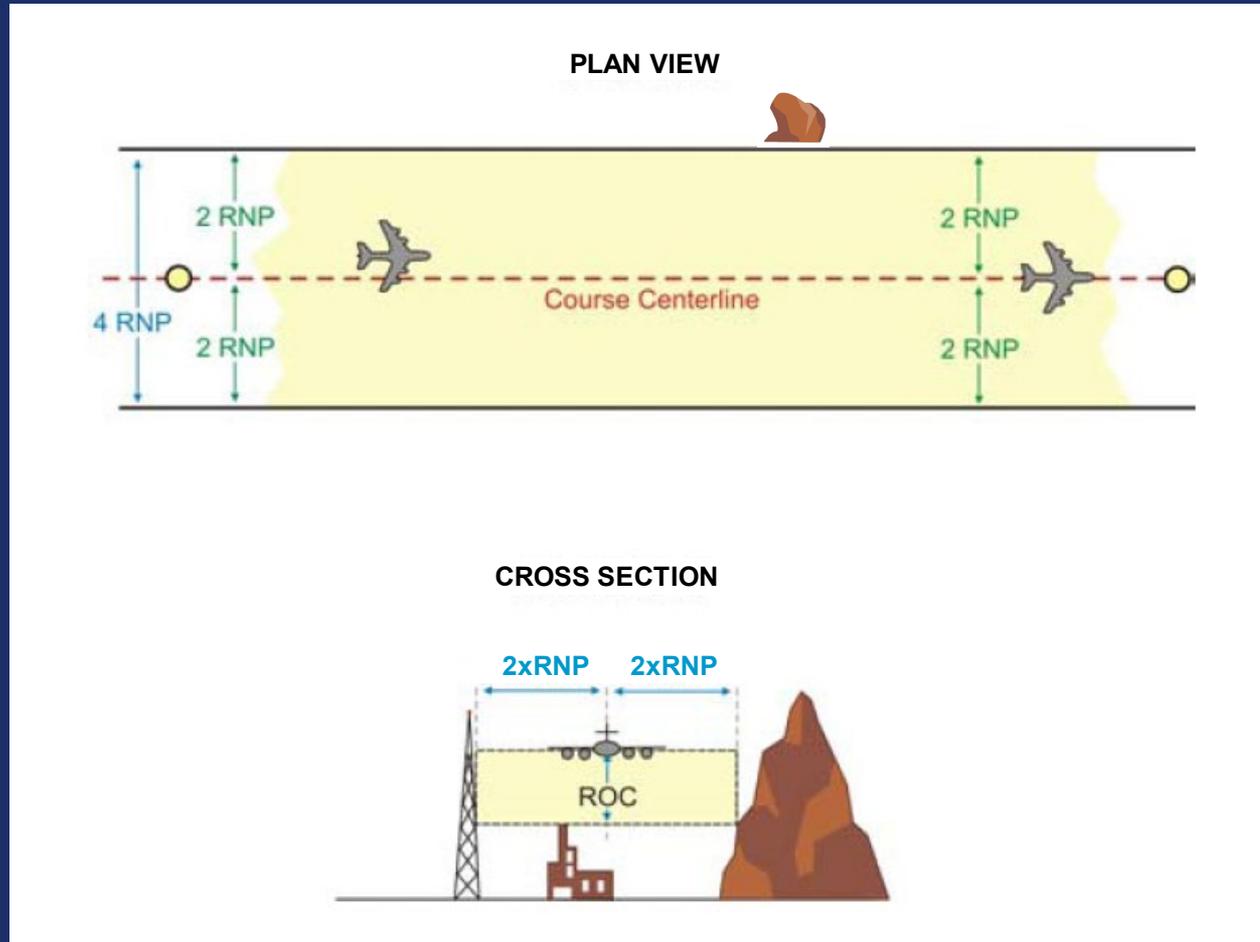
Benefits

- No secondary areas



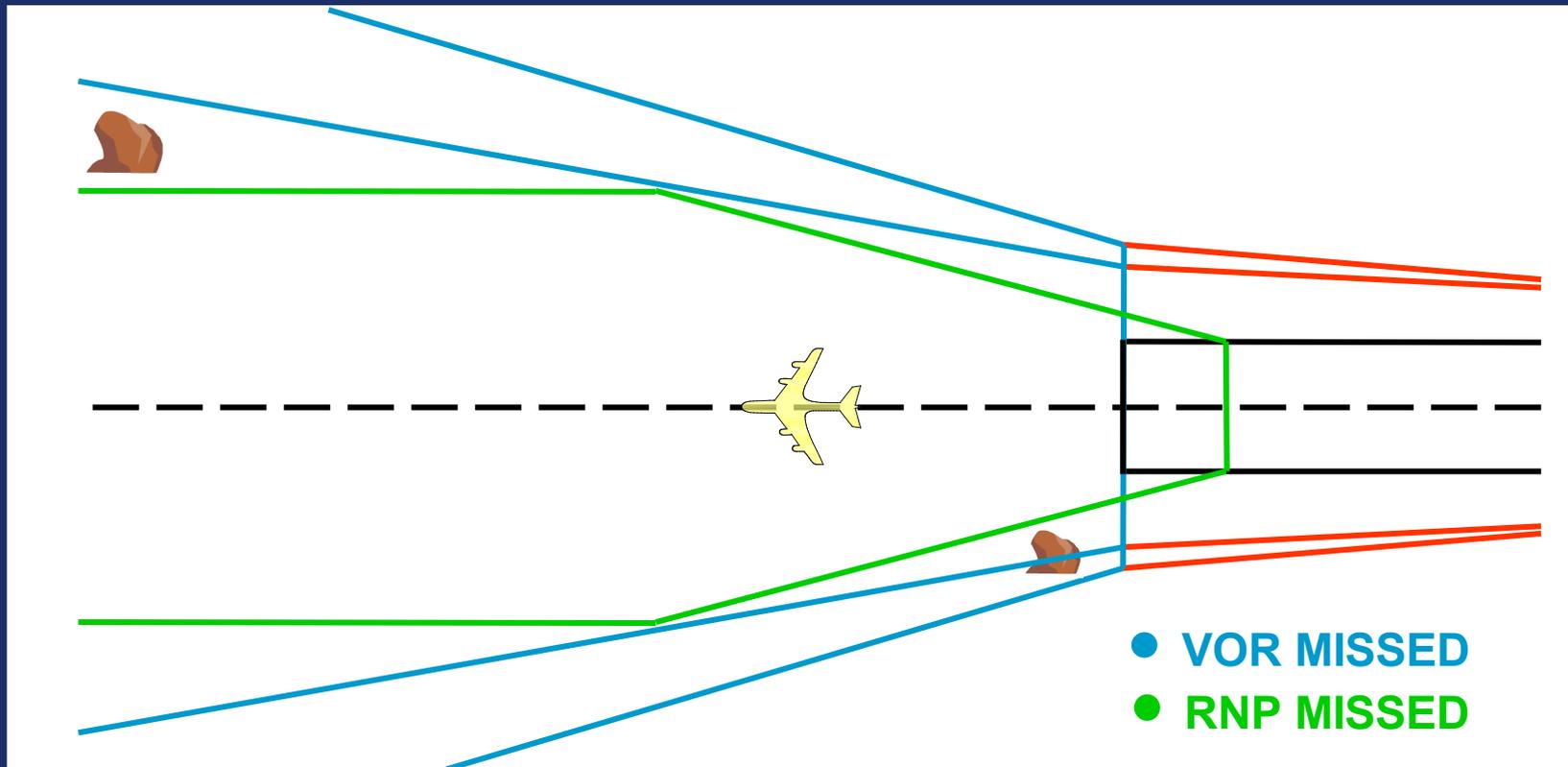
Benefits

- No secondary areas



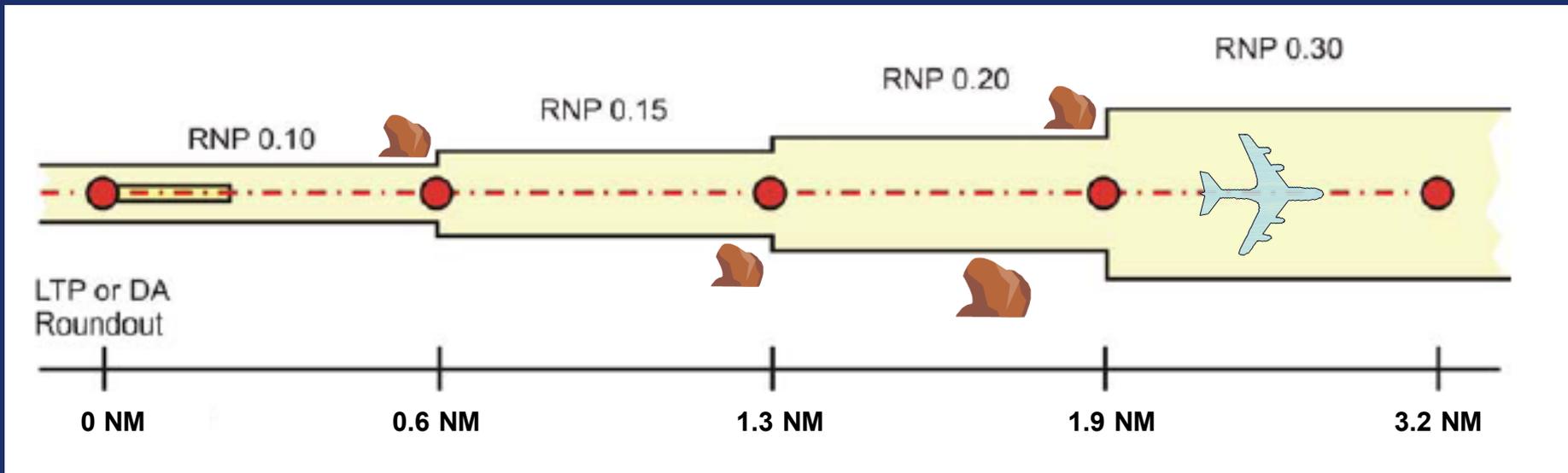
Benefits

- Missed Approach OEA
 - RNP Standard Missed
 - Benefit over ground-based missed approach



Benefits

- **Missed Approach OEA**
 - RNP less than 1.00
 - No secondary areas



Benefits

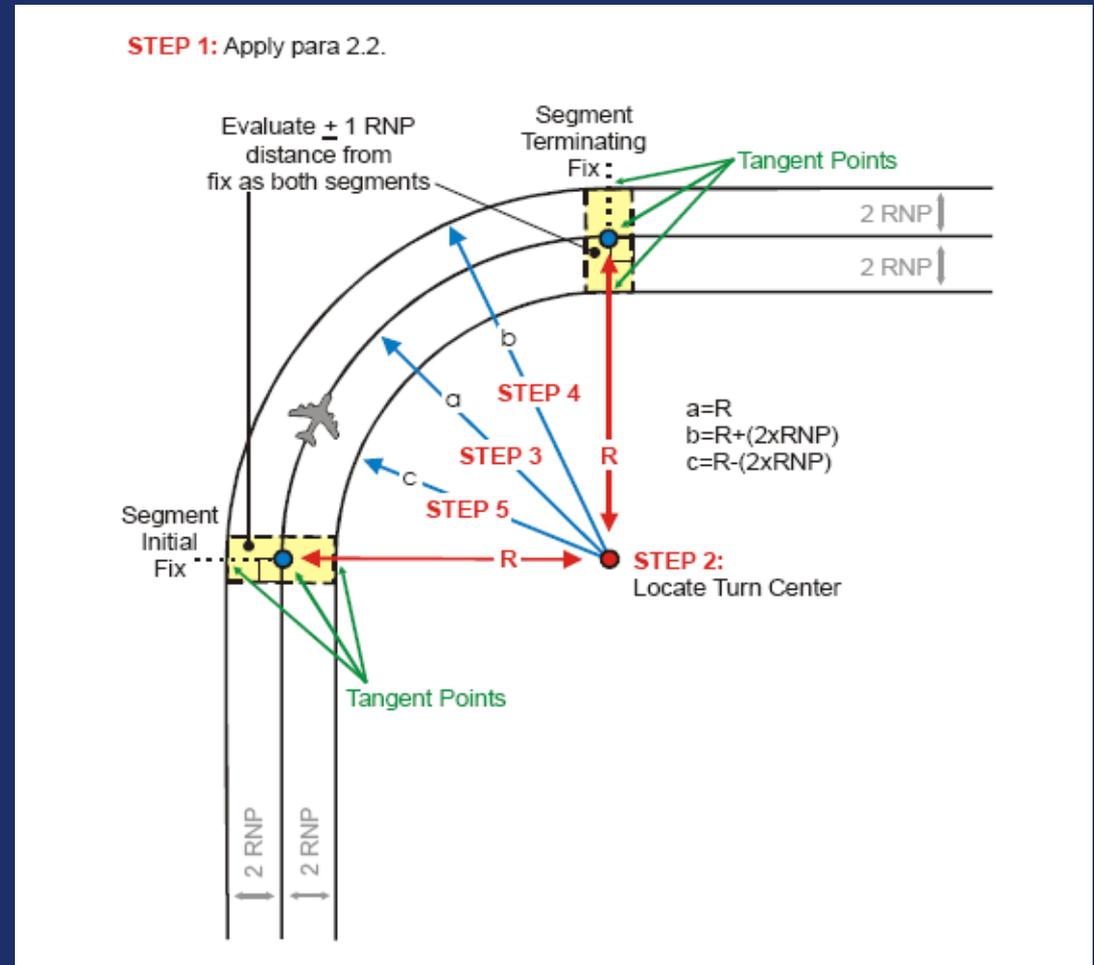
- **Missed Approach OEA (TF application)**
 - RNP Less than 1.00 – RNAV (RNP) Y RWY 31, Hailey, ID



Benefits

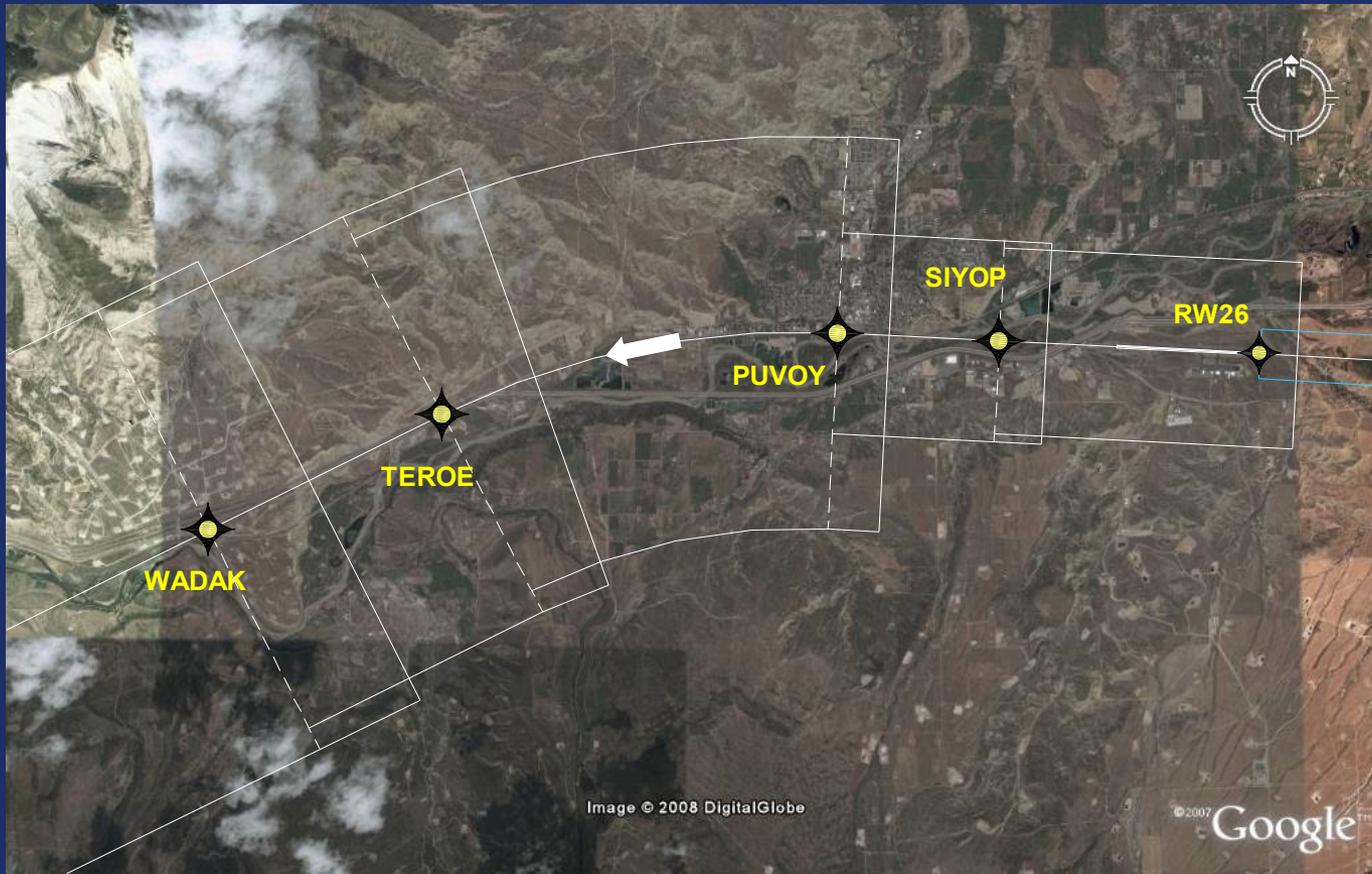
- Radius-to-Fix (RF) path terminators

- Provides a consistently repeatable ground track and smooth transition to next segment



Benefits

- **Missed Approach OEA (RF application)**
 - RNP less than 1.00 – RNAV (RNP) Z RWY 26, Rifle, CO



Challenges

- Operator authorization and training



Advisory Circular

Subject: APPROVAL GUIDANCE FOR
RNP PROCEDURES WITH SAAAR

Date: 12/15/05
Initiated by: AFS-400

AC No: 90-101

1. PURPOSE.

a. This advisory circular (AC) provides airworthiness and operational approval guidance material for aircraft operators conducting Title 14 of the Code of Federal Regulations (14 CFR) part 97 Area Navigation (RNAV) Required Navigation Performance (RNP) instrument approach procedures with Special Aircraft and Aircrew Authorization Required (SAAAR), charted as “RNAV (RNP) RWY XX”. Hereafter, these procedures will be referred to as “RNP SAAAR”.

b. This AC provides a method of compliance with public RNP SAAAR instrument approach procedure (IAP) requirements. In lieu of following this method without deviation, operators may elect to follow an alternative method, provided the alternative method is also found to be acceptable by the Federal Aviation Administration (FAA).

c. Mandatory terms used in this AC such as “must” are used only in the sense of ensuring applicability of these particular methods of compliance when the acceptable means of compliance described herein are used. This AC does not change, add, or delete regulatory requirements or authorize deviations from regulatory requirements.

2. RELATED CODE OF FEDERAL REGULATIONS SECTIONS. 14 CFR

- Part 91, sections 91.175, 91.123, 91.205,
- Part 97, section 97.20,
- Part 121, section 121.349,
- Part 125, section 125.203,
- Part 129, section 129.17, and
- Part 135, section 135.165.

3. DEFINITIONS.

a. **Area Navigation (RNAV).** A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

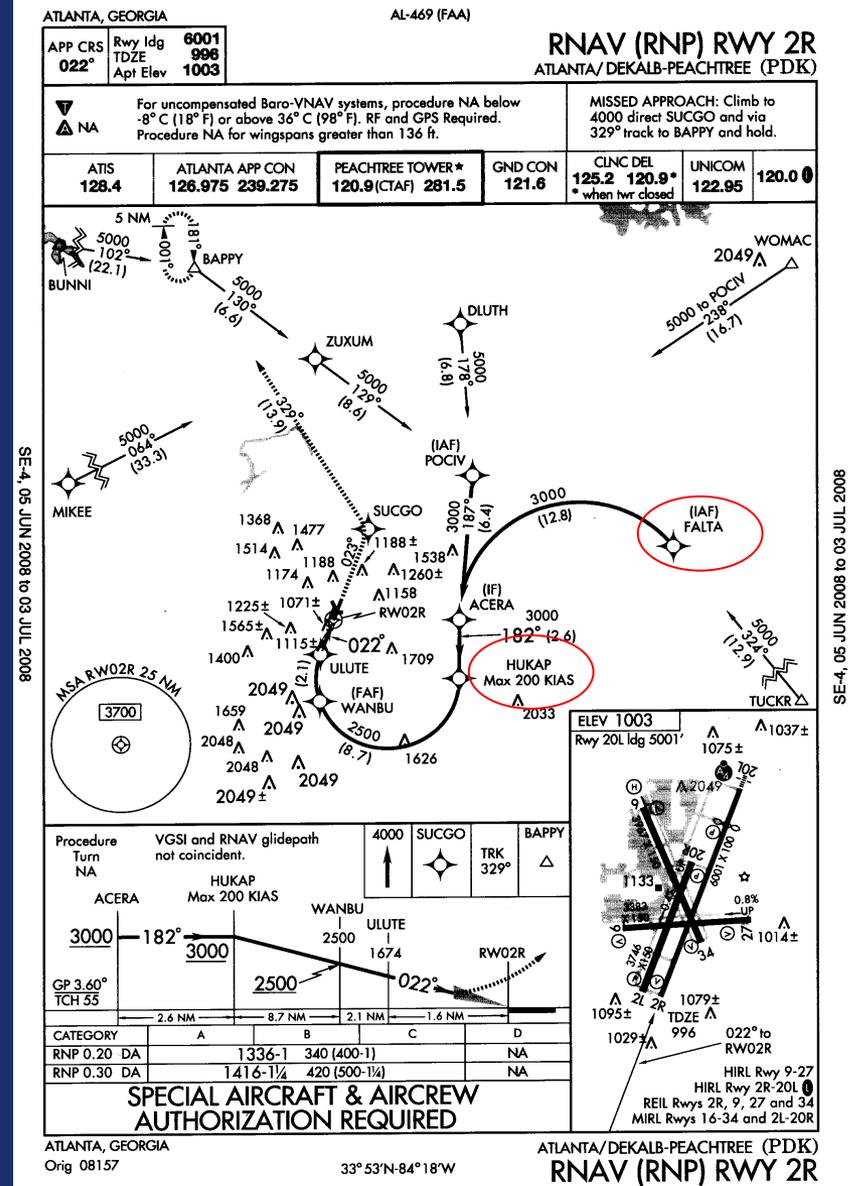
b. **Estimate of Position Uncertainty (EPU).** A measure based on a defined scale in nautical miles, which conveys the current position estimation performance, also known as Actual

http://www.airweb.faa.gov/Regulatory_and_Guidance_Library/rgAdvisoryCircular.nsf/0/821ACA6A248D6AEA862570ED00536340?OpenDocument



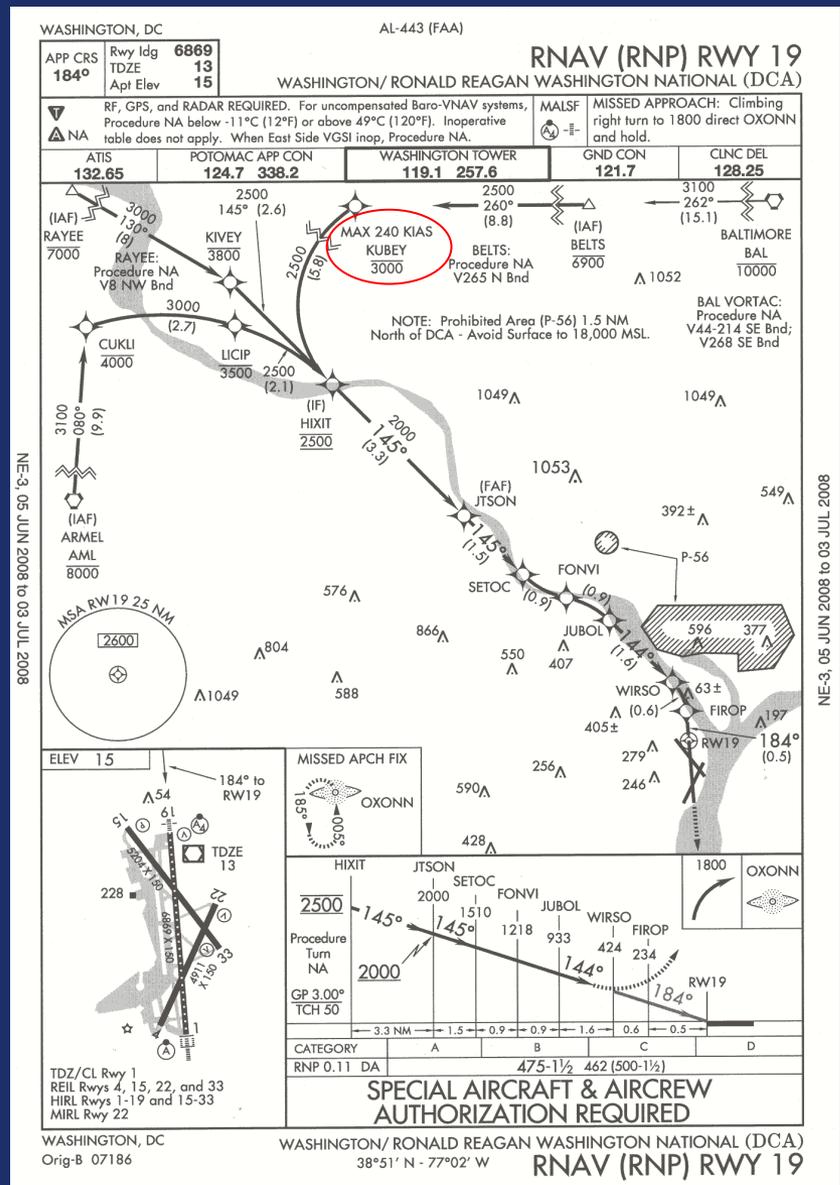
Challenges

- Air Traffic Control procedures and training
 - “Direct” clearances and vectoring involving RF leg types
 - Adherence to published speed restrictions



Challenges

- Air Traffic Control procedures and training
 - “Direct” clearances and vectoring involving RF leg types
 - Adherence to published speed restrictions



Challenges

- RNP criteria application

ORDER

8260.52

UNITED STATES STANDARD
FOR REQUIRED NAVIGATION
PERFORMANCE (RNP) APPROACH
PROCEDURES WITH SPECIAL AIRCRAFT
AND AIRCREW AUTHORIZATION
REQUIRED (SAAAR)



June 3, 2005

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Distribution: A-W(AS/ND/AT/AF/FS)-3; AVN-100 (200 Cys); AMA-200 (80 Cys) Initiated By: AFS-420
A-X(FS/AF/AT/AS)-3; ZVS-827; Special Military and Public Addressees

<http://www.faa.gov/about/office%5Forg/headquarters%5Foffices/avs/offices/afs/afs400/afs420/policies%5Fguidance/orders/media/8260.52.pdf>

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Based Navigation (PBN) Instrument Flight Procedures

June 24, 2008



Federal Aviation
Administration

Challenges

- RNP criteria application

- Application of VEB

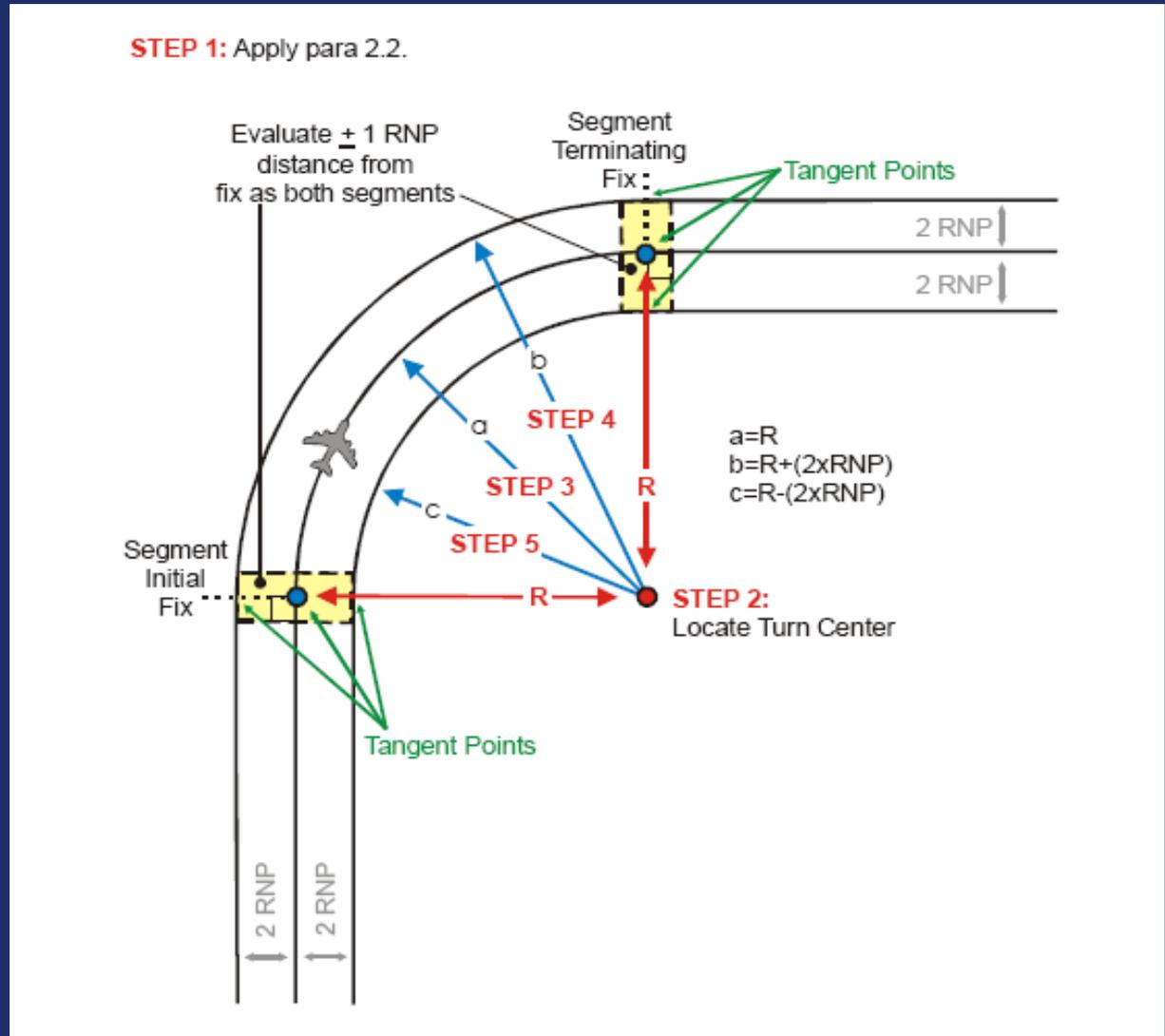
PFAF Calculations		VEB OCS Origin & Slope	
Min Intermediate Segment Alt (a):	1,500.00	Intermediate Segment Altitude:	1500
LTP MSL Elevation (b):	84.40	LTP Elevation:	84.4
TCH:	55.00	Glidepath Angle:	3
Glidepath Angle (θ):	3.00°	TCH:	55
		RNP Value:	0.30
		Δ ISA:	-29.83
Distance from LTP to PFAF (D):	25,659.45	Straight In Segment	
	4.22 NM	(Wingspa = c262) LTP to Origin:	3,801.17'
		(Wingspa = c136) LTP to Origin:	3,584.45'
		OCS Slope Ratio:	21.67 : 1
LTP/FTP Latitude:	029° 58' 39.41"	RF Turn Segment Bank angle:	17.67°
LTP/FTP Longitude:	095° 18' 09.09"	(Wingspa = c262) LTP to Origin:	4,121.10'
True R/WY Bearing/True Course:	269.96	(Wingspa = c136) LTP to Origin:	3,706.69'
		OCS Slope Ratio:	21.67 : 1
PFAF Latitude:	029° 58' 39.50"		
PFAF Longitude:	095° 13' 17.35"		
	<small>Latitude/Longitude valid for straight segment only</small>		
Version 2.0			
VEB Temperature Limits		Intermediate Segment VEB ROC	
Glidepath Angle:	3.00°	Glidepath Angle:	3.00°
Max Glidepath Angle:	3.50°	LTP MSL Elevation:	84.40
PFAF Elevation:	1500	TCH (ft):	55.00
LTP Elevation:	84.4	OCS Slope:	21.67
ACT:	-15.00°C	OCS Origin Distance (ft)	3,801.17
		<i>(measured along-track from LTP)</i>	
Min Glidepath Angle	2.75°	Obstacle Distance (ft)	81,023.66
		<i>(measured along-track from LTP)</i>	
NA Below	-15.00°C	VEB ROC	752
	5.00°F	<i>(at obstacle)</i>	
NA Above	48.53°C	Glidepath MSL altitude at Obstacle:	4,542.98
	119.36°F	OCS MSL altitude at Obstacle:	3,790.86

http://www.faa.gov/about/office_org/headquarters_offices/avs/offices/afs/afs400/afs420/media/RNP%20SAAAR%20v2.0%20Spreadsheet.xls



Challenges

- RNP criteria application
 - RF leg type connections to new and existing fixes



Challenges

- RNP criteria application

- Obtaining Average Cold Temperature (ACT)

PFAF Calculations

Min Intermediate Segment Alt (a):	1,500.00
LTP MSL Elevation (b):	84.40
TCH:	55.00
Glidepath Angle (θ):	3.00°

Distance from LTP to PFAF (D): 25,659.45
4.22 NM

LTP/FTP Latitude:	029° 58' 39.41"
LTP/FTP Longitude:	095° 18' 09.09"
True RWY Bearing/True Course:	269.96

PFAF Latitude: 029° 58' 39.50"
PFAF Longitude: 095° 13' 17.35"

Latitude/Longitude valid for straight segment only

VEB OCS Origin & Slope

Intermediate Segment Altitude:	1500
LTP Elevation:	84.4
Glidepath Angle:	3
TCH:	55
RNP Value:	0.30
Δ ISA:	-29.83

Straight In Segment

(Wingspa = c262) LTP to Origin: 3,801.17'
(Wingspa = c136) LTP to Origin: 3,584.45'
OCS Slope Ratio: 21.67 : 1

RF Turn Segment | Bank angle: 17.67°

(Wingspa = c262) LTP to Origin: 4,121.10'
(Wingspa = c136) LTP to Origin: 3,706.69'
OCS Slope Ratio: 21.67 : 1

Version 2.6

VEB Temperature Limits

Glidepath Angle:	3.00°
Max Glidepath Angle:	3.50°
PFAF Elevation:	1500
LTP Elevation:	84.4
ACT:	-15.00°C
Min Glidepath Angle	2.75°
NA Below	-15.00°C 5.00°F
NA Above	48.53°C 119.36°F

Intermediate Segment VEB ROC

Glidepath Angle:	3.00
LTP MSL Elevation:	84.40
TCH (ft):	55.00
OCS Slope:	21.67
OCS Origin Distance (ft) <i>(measured along-track from LTP)</i>	3,801.17
Obstacle Distance (ft) <i>(measured along-track from LTP)</i>	81,023.66

VEB ROC **752**

(at obstacle)

Glidepath MSL altitude at Obstacle:	4,542.98
OCS MSL altitude at Obstacle:	3,790.86



Challenges

- **RNP criteria application**
 - Achieving benefit
 - Operator certification
 - ATC integration
 - RNP levels
 - ARINC leg types
 - Missed approach climb gradients



Summary

- **Benefits**

- Reduced Obstacle Evaluation Area (OEA)
- No secondary areas
- Missed approach segment OEA
- Radius-to-Fix Leg

- **Challenges**

- Operator authorization and training
- Air traffic control procedures and training
- RNP criteria application
- Procedure benefit
- Flight inspection technique



Questions ?

