

# Backup Navigation During a GPS Disruption

The Very High Frequency Omni-  
Directional Range (VOR)  
Minimum Operational Network  
(MON)

NextGen Distance Measuring  
Equipment (DME) Program

22 July 2025



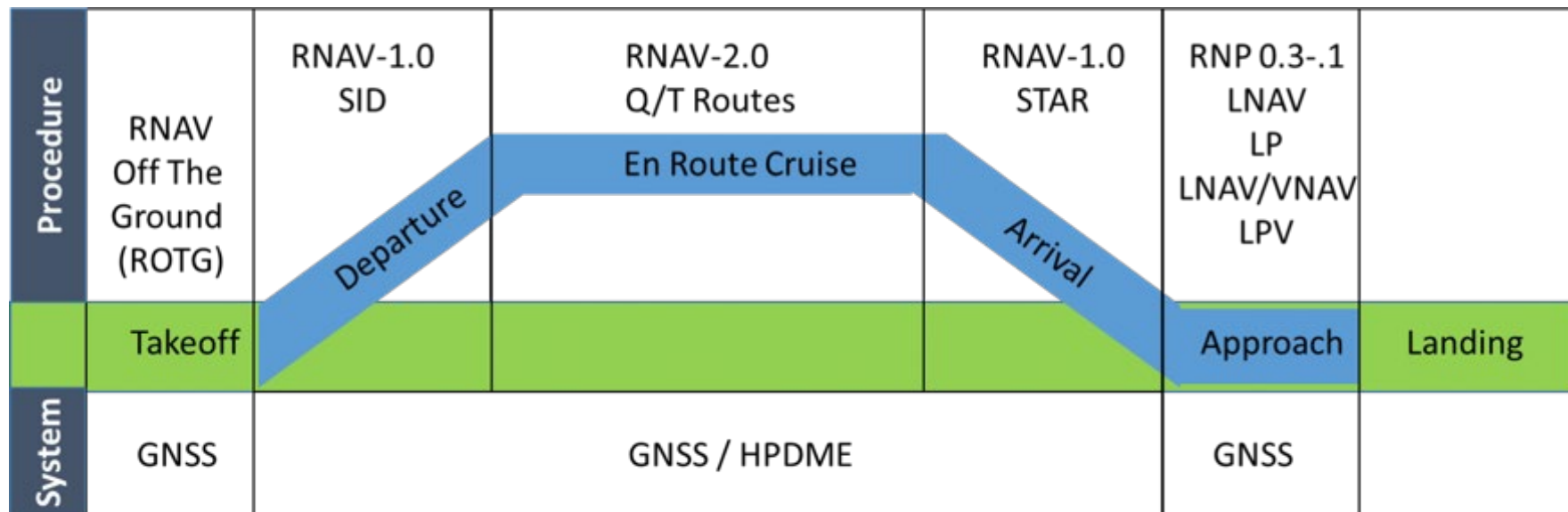
Federal Aviation  
Administration



# Navigation Strategy

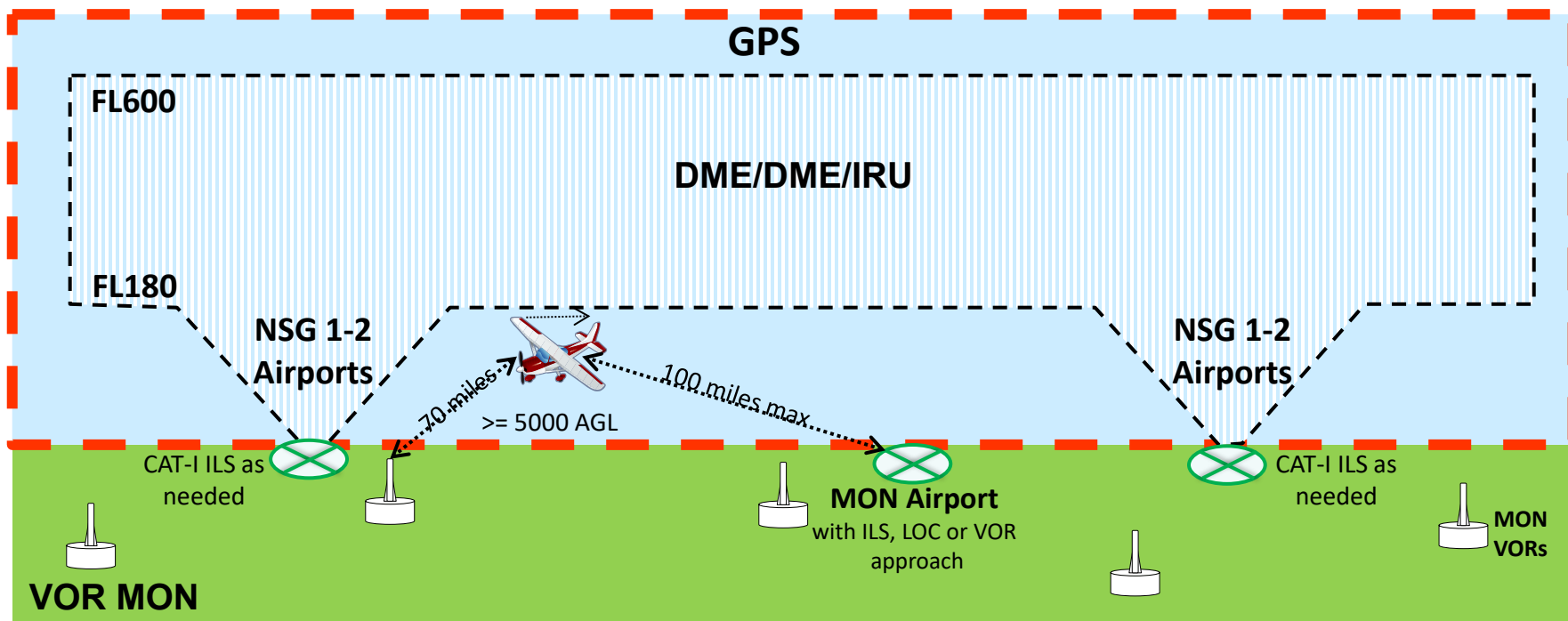
- Provide resilient navigation services per the Performance Based Navigation (PBN) National Airspace System (NAS) Navigation Strategy (2016).
  - The Global Positioning System (GPS) and the Wide Area Augmentation System (WAAS) enable all PBN operations and Automatic Dependent Surveillance Broadcast (ADS-B).
- A major concern is the loss of a reliable GPS signal for navigation.
  - Several recent events have underscored the necessity for resilience, including possible spoofing of GPS signals.
- Resilience to be provided by:
  - VOR MON (primarily for general aviation aircraft).
  - NextGen DME (primarily for air carrier aircraft).
  - Sustainment of legacy conventional navigation aids to provide a resilient NAS infrastructure.

# PBN Implementation in the NAS



- The principal means of navigation is the Global Navigation Satellite System (GNSS).
  - GPS and WAAS are the approved GNSS systems in the U.S.

# Resilient Navigation Services



- GPS is the primary enabler for all PBN (RNAV and Required Navigation Performance (RNP)) and ADS-B accuracy & integrity for all separation levels.
- Distance Measuring Equipment (DME)/DME/IRU (Inertial Reference Unit) provides a backup to GPS.
- The VOR MON can be used by aircraft that are not DME/DME/IRU RNAV equipped or in areas where DME/DME/IRU RNAV service is not available.
- MON airports will have Instrument Landing System (ILS), Localizer (LOC), or VOR approaches for recovery in the event of GPS disruption.

# The VOR MON Program



# Background

- In 2006, the FAA started the transition to Performance Based Navigation (PBN) primarily using the Global Positioning System (GPS) and Area Navigation (RNAV).
  - Although VORs are not used for PBN, a Minimum Operational Network (MON) would need to be retained to provide a backup during a GPS disruption.
- In 2011, the VOR MON concept was published in Federal Register Notice (FRN) 76 FR 77939: *Proposed Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance-Based Navigation (PBN)*.



# Background cont'd

- The FAA considered input from the public, industry, other government agencies (including the military), and the RTCA Tactical Operations Committee (TOC) to develop the criteria for the VOR MON.
- In 2016, the final policy was published in FRN 81 FR 48694: *Provision of Navigation Services for the Next Generation Air Transportation System (NextGen) Transition to Performance-Based Navigation (PBN) (Plan for Establishing a VOR Minimum Operational Network)*.
- The program consists of two Phases:
  - Phase 1 (FY2016 – FY2020): 82 VORs discontinued.
  - Phase 2 (FY2021 – FY2030): 220 VORs planned for discontinuance.



# VOR MON Implementation

- To re-purpose the Contiguous United States (CONUS) VOR network from the primary means of navigation to a backup, nearly continuous VOR signal coverage will be provided starting at 5,000 feet Above Ground Level (AGL).
  - Coverage will exist below 5,000 ft but may not be continuous.
- To provide the required coverage, two new VOR Standard Service Volumes (SSVs) were established.
  - MON VORs will be flight inspected, and their class codes changed to the new SSVs.
  - To Date, 430 out of 502 new VOR SSVs have been published.
- In addition, at least one conventional approach will be available within 100 nautical miles (NM) at designated MON airports.
- VORs that do not meet the VOR MON criteria are targeted for discontinuance.
  - To Date, 200 out of 302 VORs have been discontinued.



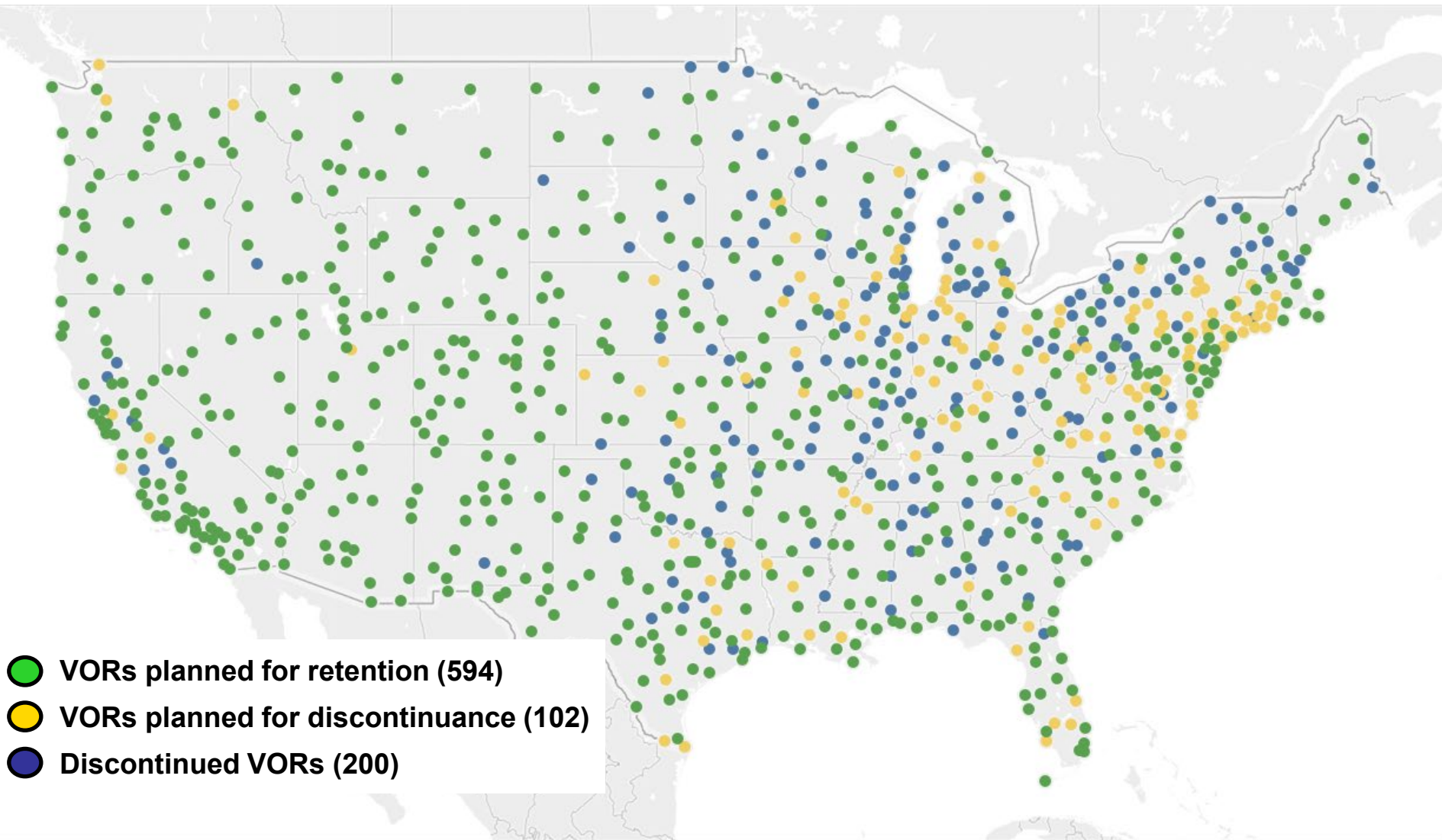


# VOR Discontinuance Process

- Although the VOR MON program addresses a large group of VORs, each VOR discontinuance is a separate action by the FAA in accordance with standard procedures.
- Each VOR undergoes a discontinuance study to identify all published procedures and uses for the VOR.
  - Public comments are solicited.
- When approved, all airway, fix, and procedure changes are implemented.
- When all required changes are published, the VOR is removed from charts and databases.



# VOR Discontinuance Status



# Concept of Operation and Development



# VOR MON Concept of Operation

- During a GPS disruption event in CONUS, pilots can:
  - Tune and identify a VOR at or above 5,000 feet AGL and
  - Navigate VOR-to-VOR or along airways through the disruption,  
or
  - Navigate to an airport within 100 nautical miles to fly an Instrument Landing System (ILS), Localizer (LOC) or a VOR approach.
- Distance Measuring Equipment (DME), Automatic Direction Finder (ADF), surveillance, and GPS will not be required for the approach.

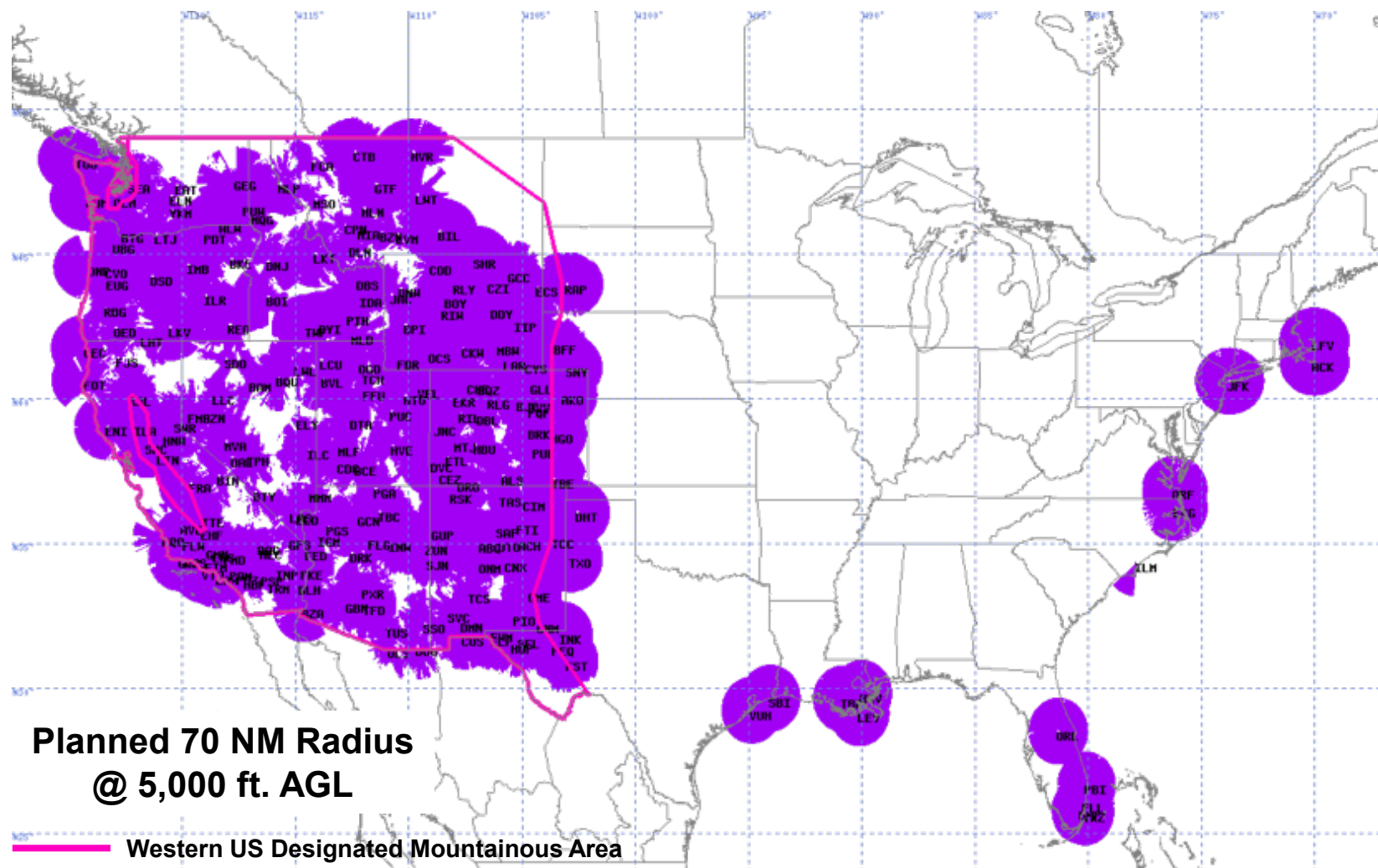


# VOR MON Development

1. Retain most of the VORs in the Western U.S. Mountainous Area.
  - Especially those anchoring Victor airways through high elevation terrain.
2. Retain VORs to support international oceanic arrival routes.
3. Retain VORs to navigate to an ILS, LOC, or VOR approach at a MON airport within 100 NM of any location within CONUS (where the capability currently exists).
  - Approaches will not require ADF, DME, surveillance, or GPS.
4. Retain VORs to provide coverage at and above 5,000 ft. AGL plus some VORs near large airports.

Note: Only FAA-owned VORs in the CONUS were considered.

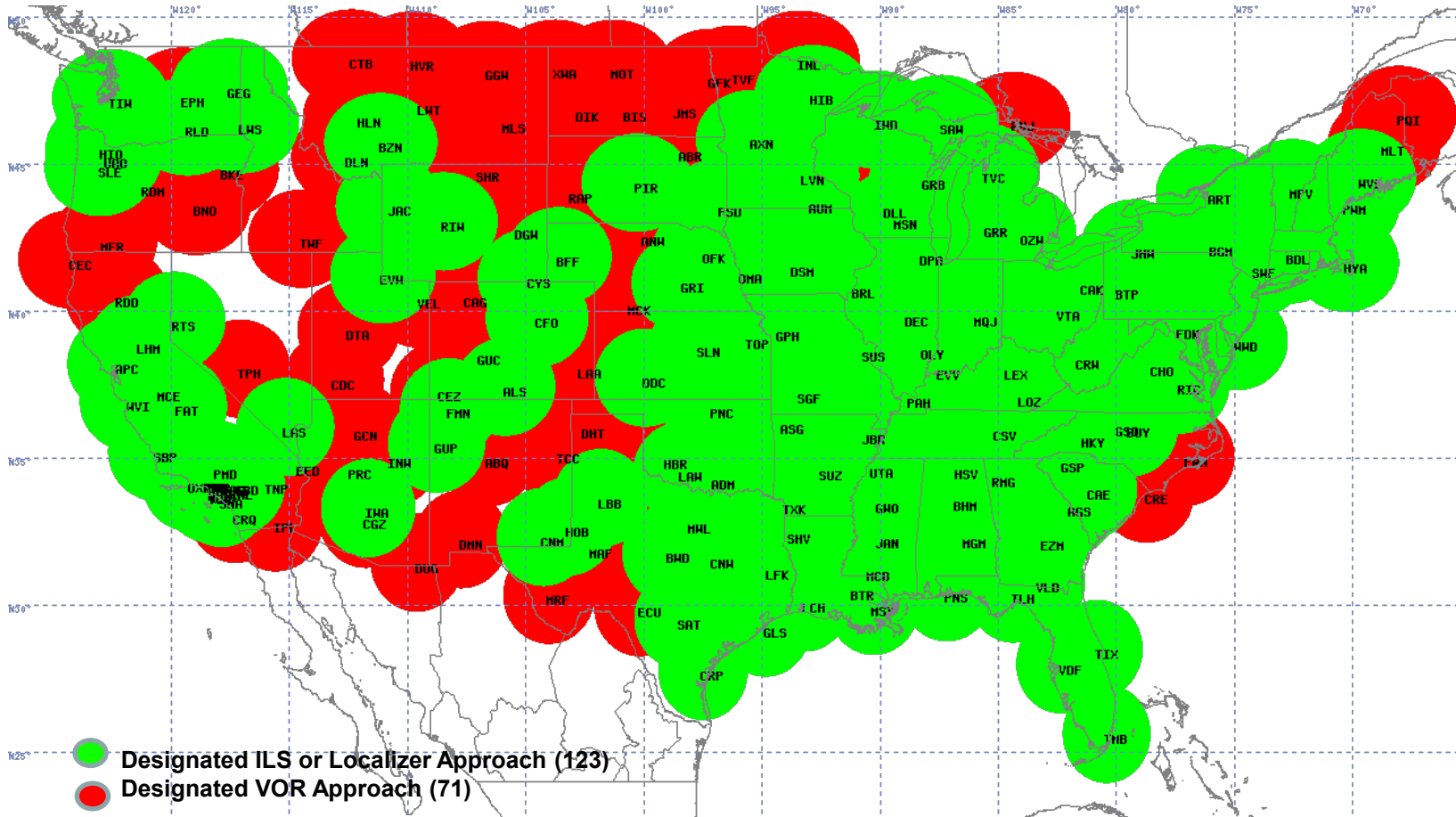
# Retain VORs in Western Mountainous Area and International Air Routes





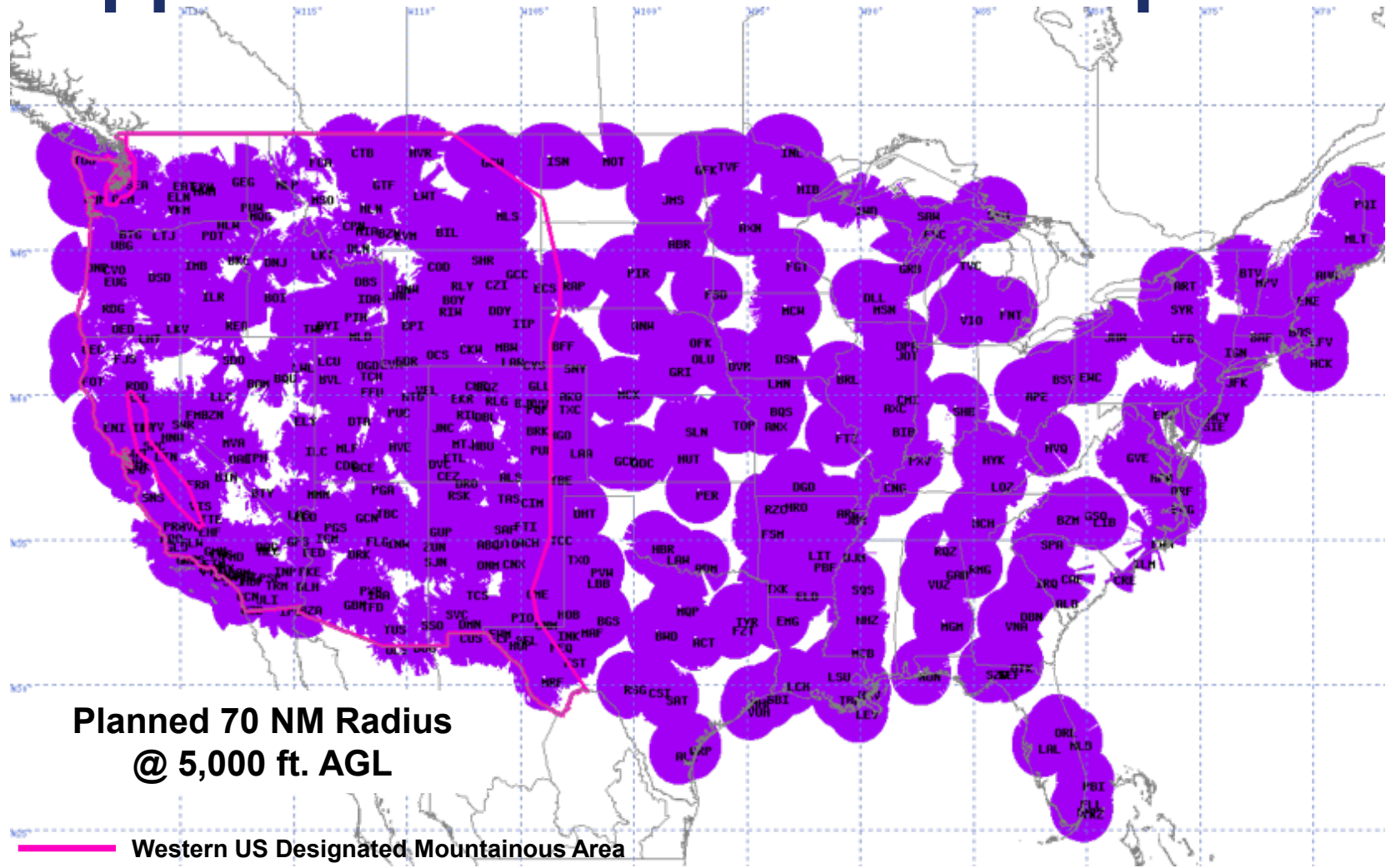
## MON Airports (ILS/LOC or VOR Approaches)

### **100 NM Radius, No Requirement for DME/ADF/surveillance**



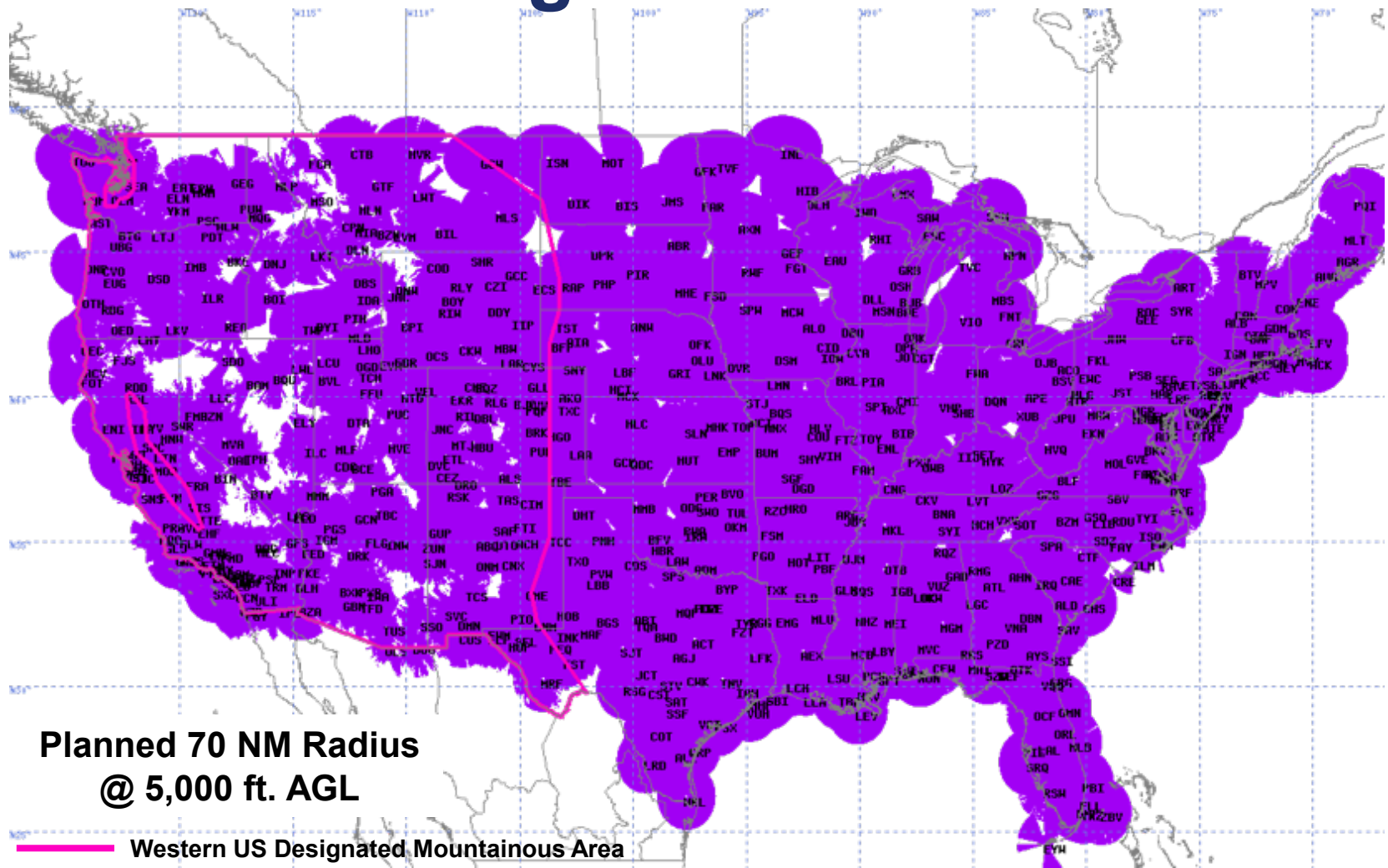
The circles depict 100 nm around the MON airports. MON airports ensure that an aircraft is within 100 nm of a location where an LOC, ILS or VOR approach may be flown, where the capability currently exists.

# Retain VORs Needed for Designated Approaches at VOR MON Airports

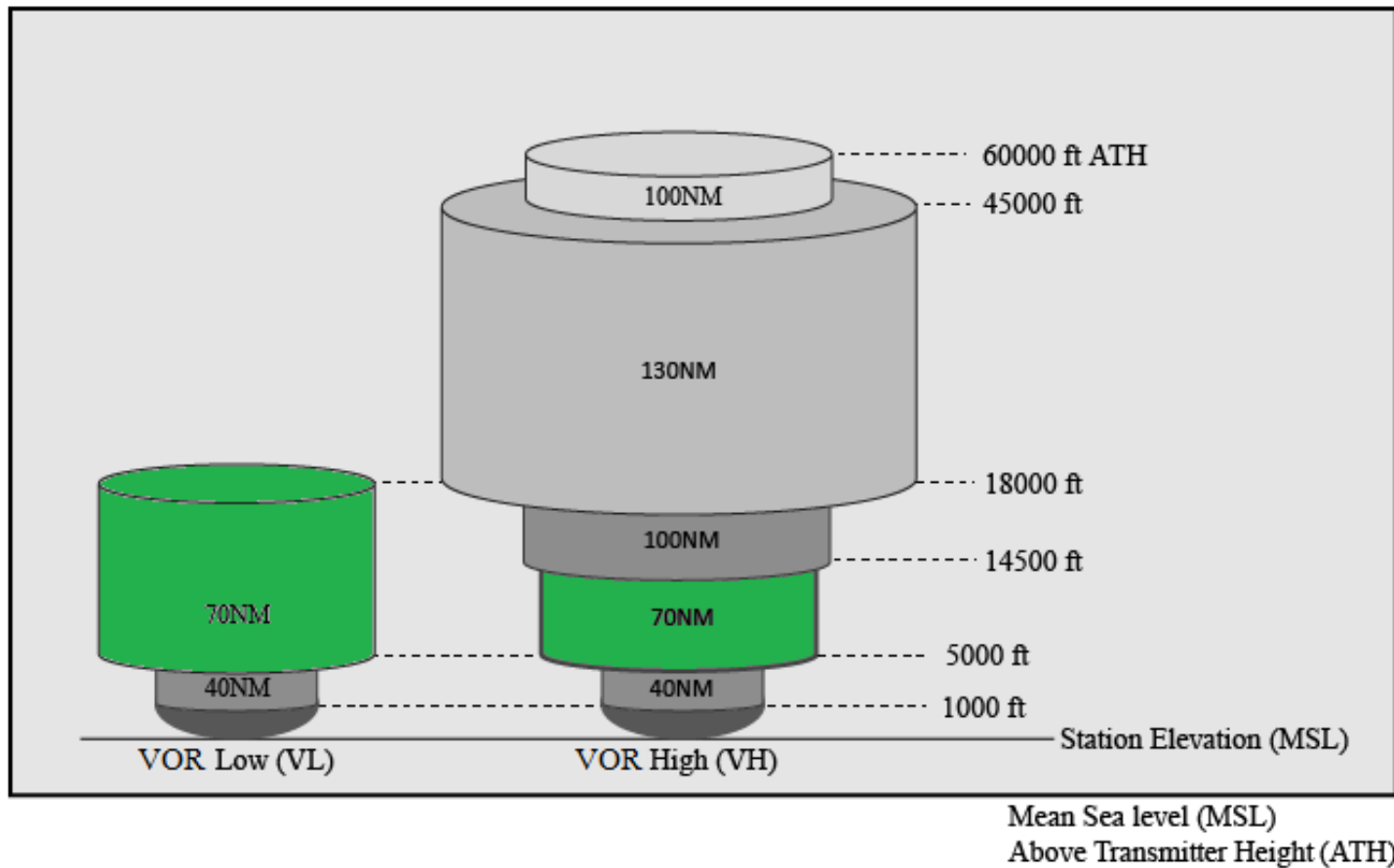




# Retain Gap Fillers to Support 5,000 ft. AGL Coverage and Other Criteria



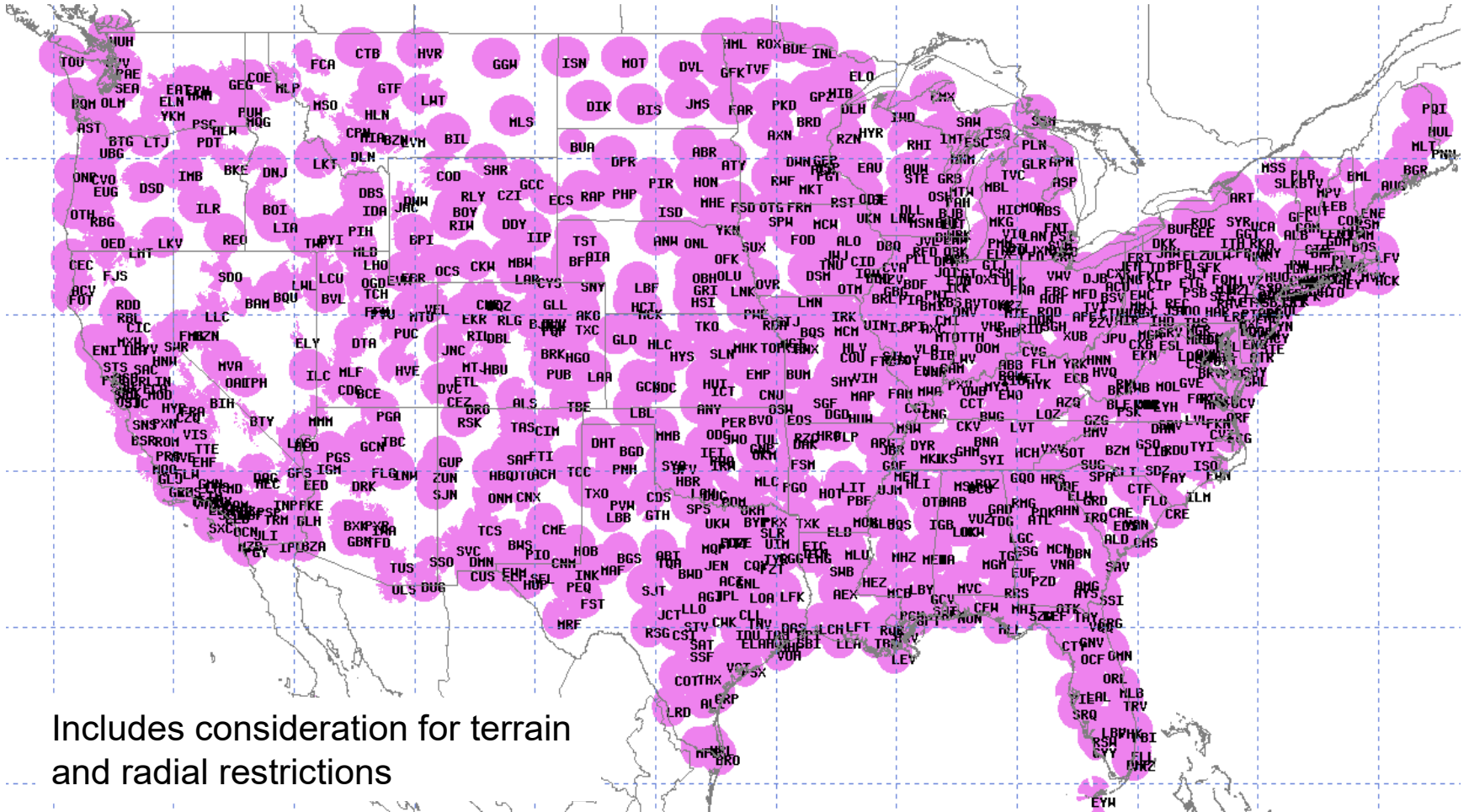
# New VOR Standard Service Volumes



**Note: No avionics changes are required to use the new service volumes.**

# 2015 FAA VOR Network Coverage

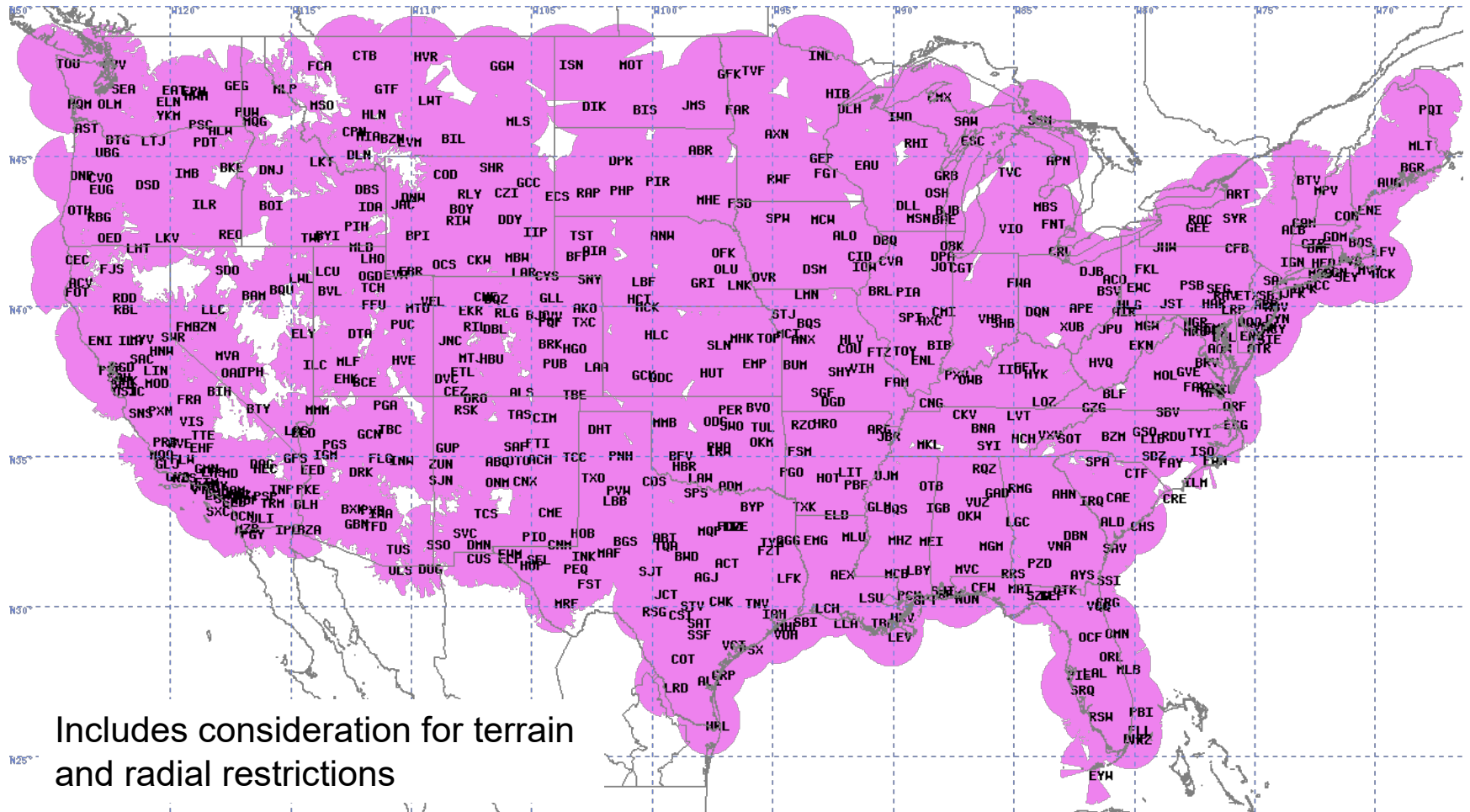
## 40 NM Service Volume at 5,000' AGL



Includes consideration for terrain and radial restrictions

# Planned VOR MON Coverage

*70 NM Service Volume at 5,000' AGL*

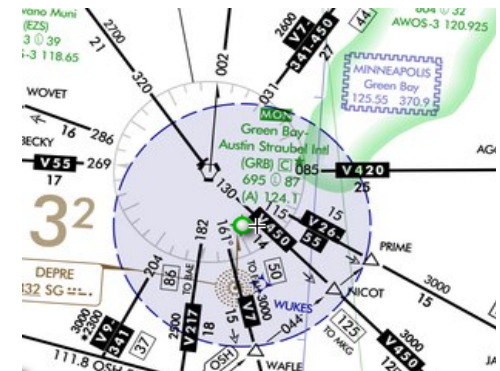


# Charting MON Airports

- The terminology for airports to be used for the VOR MON is “MON Airport” (Capital M-O-N and A) both in the source database and publications.
  - The FAA Chart Supplement has the list of MON Airports.
- MON Airports *are published* on high, low, and area en-route IFR charts. The associated airport text contains “MON” in uppercase.
  - MON Airports *are not published* on charts principally used for VFR flight (e.g., sectionals).



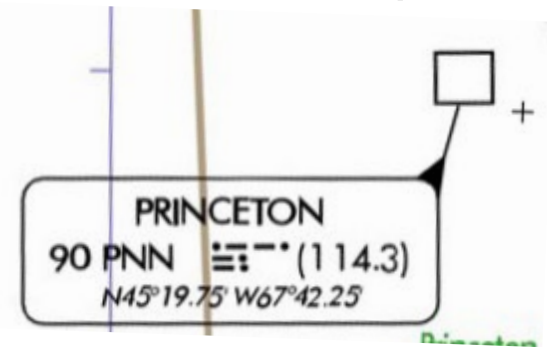
**Examples**  
**FAA High and Low En-route**  
*Other Chart Providers Could be Slightly Different*





# Other Services at VOR Sites

- DMEs and TACANs will generally be retained at sites where the VOR service is removed, and an RNAV waypoint will remain.
- FSS communication provided by non-MON VORs will generally be discontinued (i.e., 122.1 MHz).
  - Equivalent Radio Communications Outlet (RCO) service will be retained.
- Federally owned Automated Weather Observing System (AWOS), Automated Surface Observing System (ASOS), and Automatic Terminal Information Service (ATIS) transmissions over VORs will be moved to a VHF transmitter as required.
- The FAA has discontinued HIWAS.



# No Change to Requirements

- There will be no change in current equipage, fuel reserve, and alternate filing rules:
  - 14 CFR Part 91 (non-Subpart K).
    - Aircraft equipped with non-WAAS GPS will continue to be required to carry an alternate form of navigation appropriate to the route.
    - WAAS-equipped aircraft will continue to not be required to carry an alternate form of navigation (when WAAS is in operation).
  - Others (14 CFR part 121, 135, 91 Subpart K, etc.).
    - Must carry an appropriate independent non-GPS-based navigation system (in addition to GPS and/or WAAS).



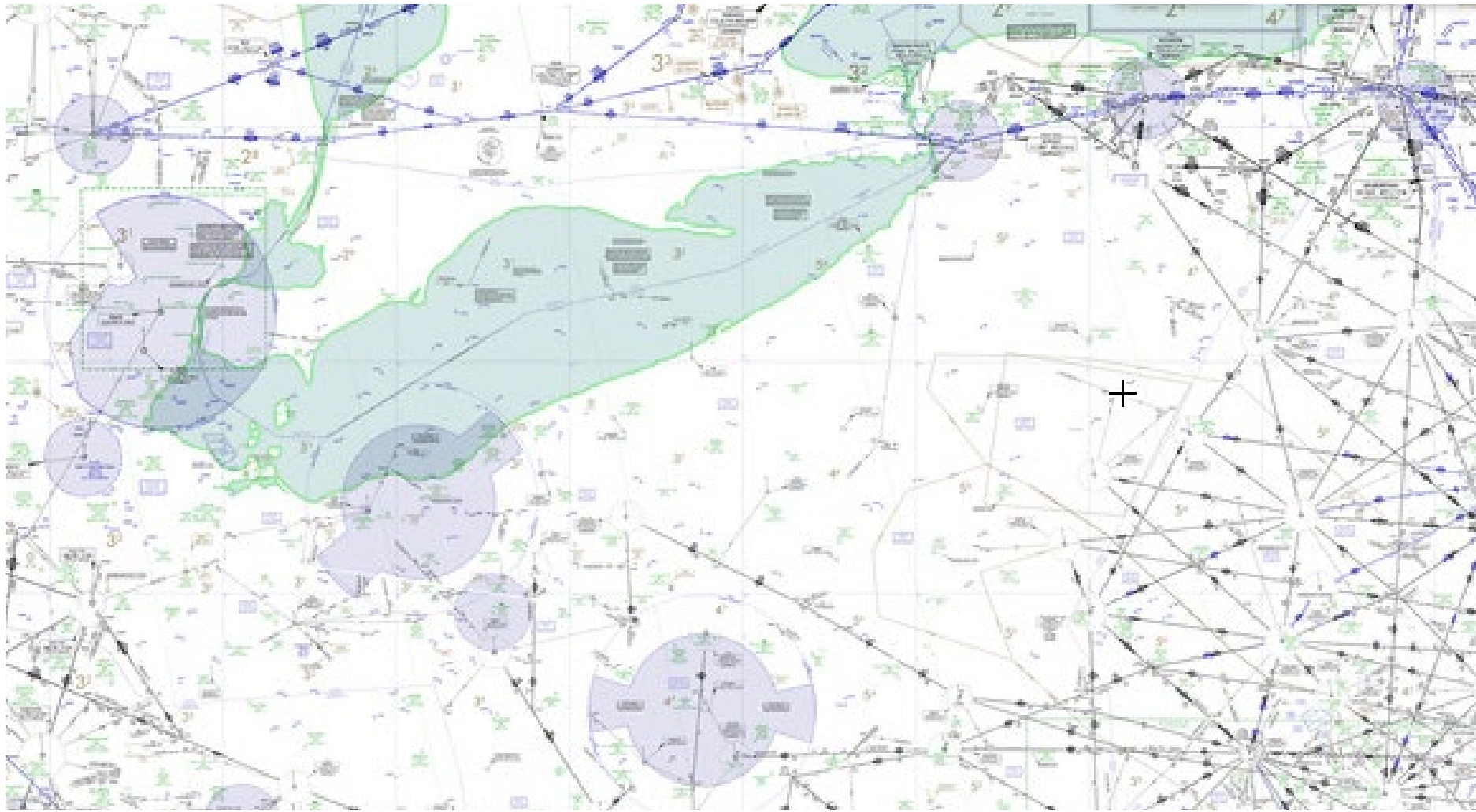
# Changes to Airways

- VOR discontinuation affects the conventional airway network.
  - Jet Routes and Victor Airways are required by law to be defined and anchored by VORs.
  - Conventional fixes along these airways are defined by VORs.
- As the VOR MON program discontinues VORs, the conventional route structure will either be canceled, amended, or replaced by RNAV airways (e.g., T-routes or Q-routes) as needed for air traffic control.





# Airways Already Discontinued



# VOR/ILS Use

- Maintain VOR and ILS proficiency
  - Make a point to conduct a VOR or VOR-to-ILS approach for currency.
    - Don't load the VOR approach into your GPS!!
- Understand what avionics will not be usable during GPS disruption
  - GA aircraft – generally straightforward
    - GPS/WAAS navigation and ADS-B position output will be lost
    - So will position info on your tablet.
  - Larger aircraft – may be more complex
    - Terrain Awareness and Warning System (TAWS), Satnav Comm, clocks, potential issues with DME/DME/IRU navigation, etc. may have issues.




# Summary

- The VOR MON will provide a backup navigation service during GPS disruptions.
- Users can navigate through a GPS disruption area or land at a MON airport without GPS, DME, ADF, or Surveillance.
- Users not equipped with GPS can still operate in the NAS with reduced efficiency.
- There will be no changes to current equipment or flight plan filing requirements.
- Users should maintain VOR and ILS proficiency.



# VOR MON Website

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Ground-Based Navigation Overview

Instrument Landing System (ILS)


Very High Frequency Omni-Directional Range (VOR)

Very High Frequency Omnidirectional Range Minimum Operational Network (VOR MON)

Distance Measuring Equipment (DME)

Contact Us

## Navigation Programs - Very High Frequency Omnidirectional Range Minimum Operational Network (VOR MON)



The FAA is transitioning the National Airspace System (NAS) to Performance Based Navigation (PBN). As a result, the VOR infrastructure in the Contiguous United States (CONUS) is being repurposed to provide a conventional backup navigation service during potential Global Positioning System (GPS) outages. This backup infrastructure is known as the VOR MON.

### Concept of Operation

The VOR MON is designed to enable aircraft, having lost GPS service, to revert to conventional navigation procedures. This will allow users to continue through the outage area using VOR station-to-station navigation or to proceed to a MON airport where an Instrument Landing System (ILS), Localizer (LOC) or VOR approach procedure can be flown without the necessity of GPS, Distance Measuring Equipment (DME), Automatic Direction Finder (ADF), or surveillance. Any airport with a suitable instrument approach may be used for landing, but the VOR MON assures that at least one airport will be within 100 Nautical Miles (NM).

### Current Status

- VOR Candidate Discontinuance List
- VOR Candidate Retention List

### Quick Links

- Proposed Rule FRN (76 FR 77939)
- Disposition of Comments FRN (77 FR 50420)
- Final Policy FRN (81 FR 48694)
- What is the VOR MON? (Video) [or](#)
- VOR MON Summer Safety Series Webinar (Video)
- Aeronautical Information Manual (AIM) [\(go to 1-1-3f\)](#)
- Sum-N-Fun 2024

### Contact Us

- VOR MON Program Office**  
Email: [vormon@faa.gov](mailto:vormon@faa.gov)  
Telephone: (844) 4VORMON  
(844-486-7666)

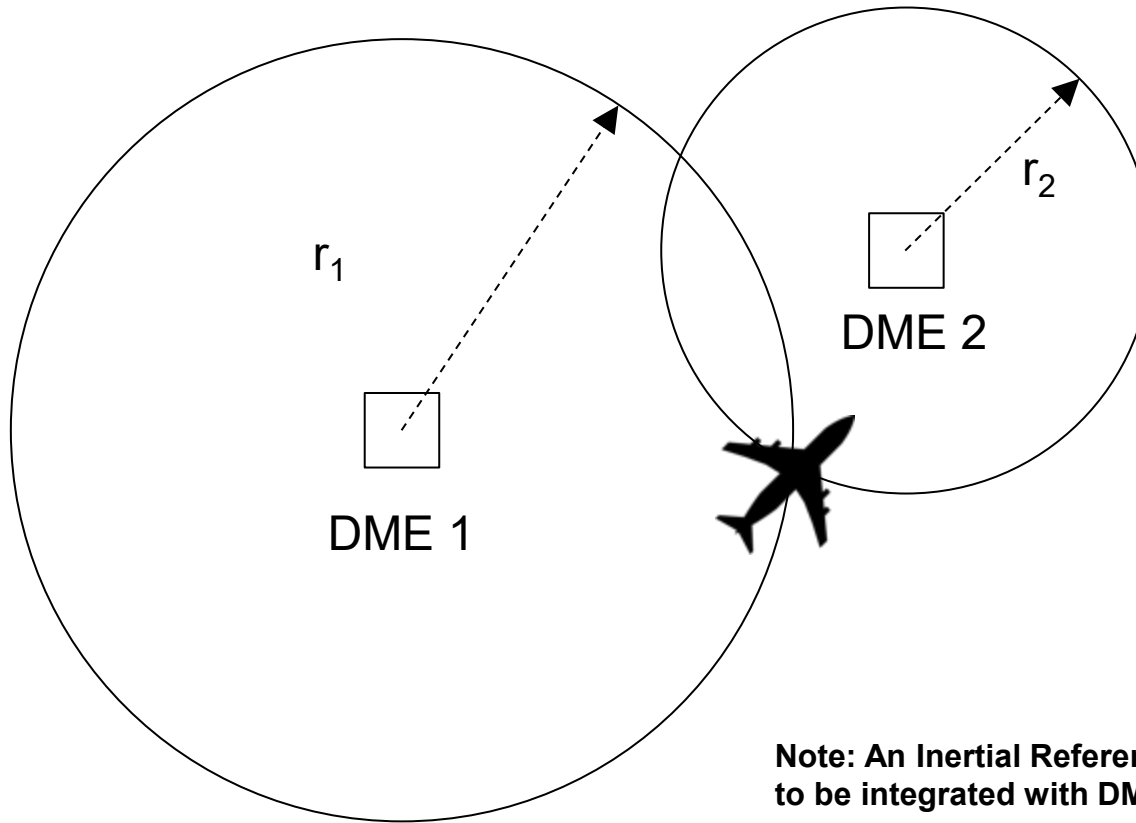
[www.faa.gov/go/VORMON](http://www.faa.gov/go/VORMON)



# The NextGen DME Program



# Area Navigation (RNAV) Using DME/DME



**Note: An Inertial Reference Unit (IRU) is required to be integrated with DME/DME in the U.S.**

# Current Issues with DME/DME Coverage

- DMEs were not sited for DME/DME/IRU use.
  - DMEs were originally co-located with VORs as a source of range information. This includes the DME portion of a TACAN.
- There were gaps in high altitude coverage.
  - There is no complete backup for GPS.
    - Full transition from Jet Routes to RNAV routes (Q-routes) cannot be completed without seamless coverage.
- Gaps in terminal areas result in:
  - Preflight checks of “Critical” DME NOTAMs.
  - Limits in design of arrival and departure procedures that are “GPS Required.”



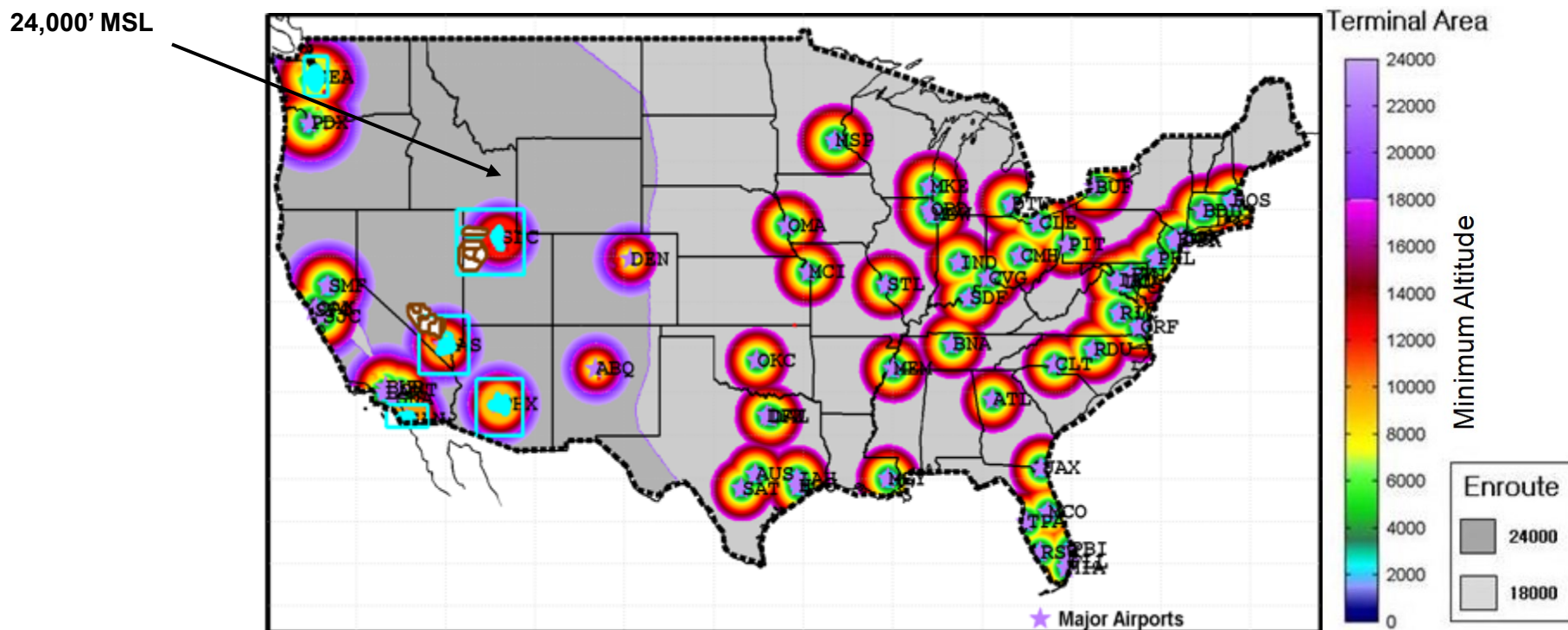
# NextGen DME Program Coverage Objectives

- Redundant DME/DME/IRU RNAV at high altitude for enroute:
  - No single DME outage/failure will result in a loss of coverage.
  - All existing and future Q-routes covered.
    - No “GPS-required” restrictions.
  - Can provide coverage for any dynamic routing.
  - Can eliminate Jet routes.
- DME/DME/IRU RNAV service in 62 major terminal areas.
- No critical DMEs on operationally significant RNAV arrival and departure procedures.

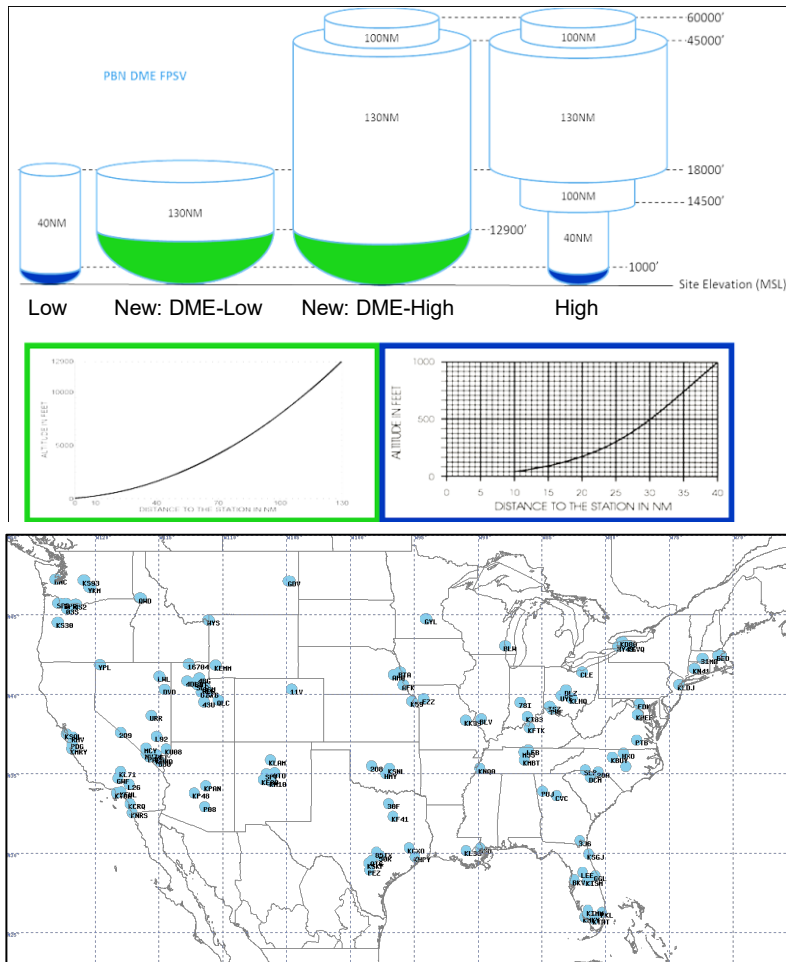


# Minimum Altitude for Future DME/DME

- Colored rings: Terminal area cones
- Gray: En-route 18,000' and 24,000' MSL



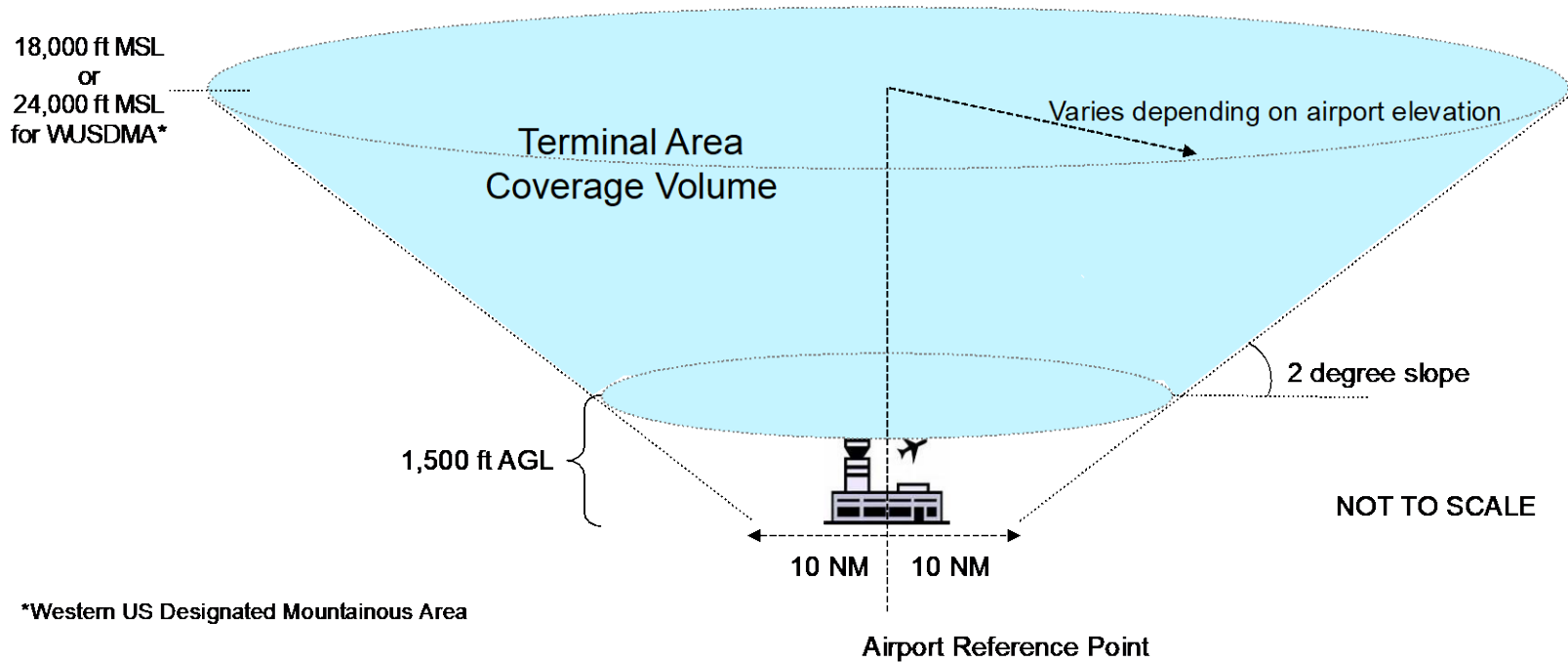
# Changes to Meet NextGen DME Goals



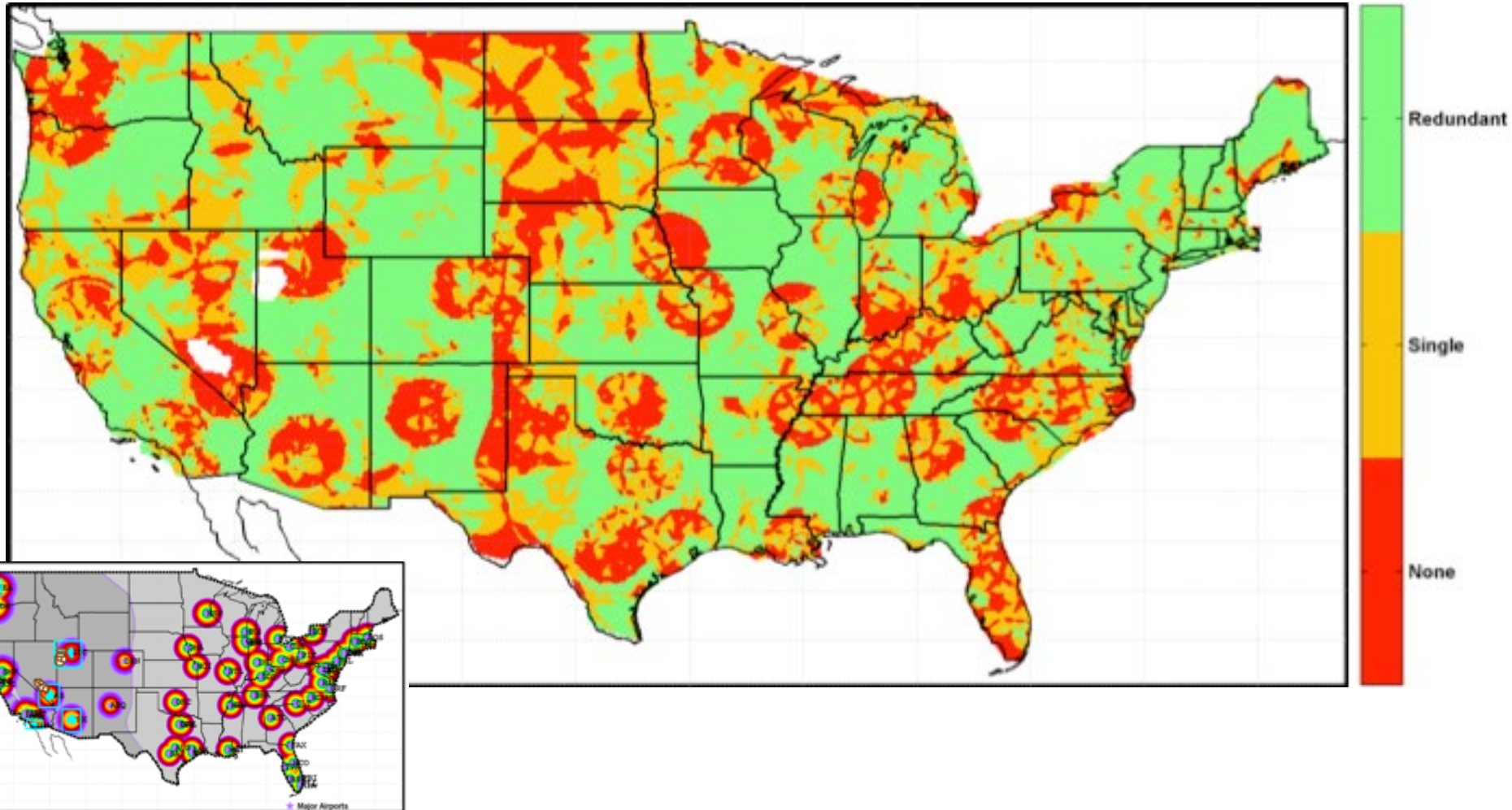
- New DME service volume definitions: “DME High” and “DME Low”.
  - DME service volumes will be separated from VOR service volumes.
- 202 out of 589 new DME service volumes have been published.
- 17 out of 126 new DME sites have been implemented to fill gaps in both en-route and terminal area coverage.
  - 15 new DME sites in segment 1
  - 2 new DME site in segment 2

# Terminal Area Cone

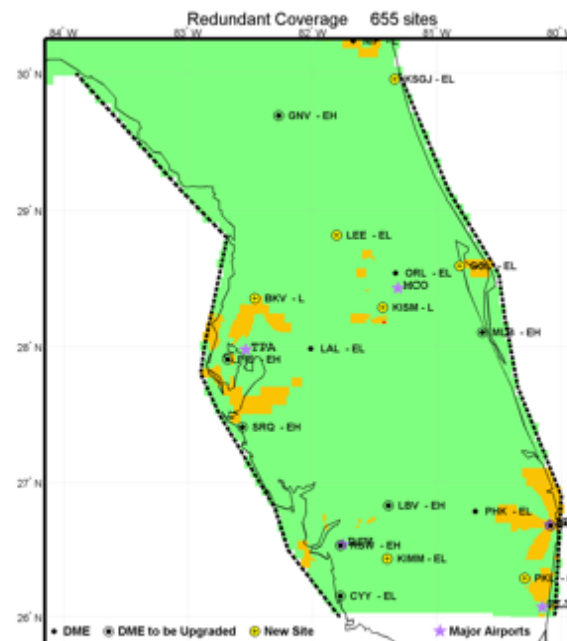
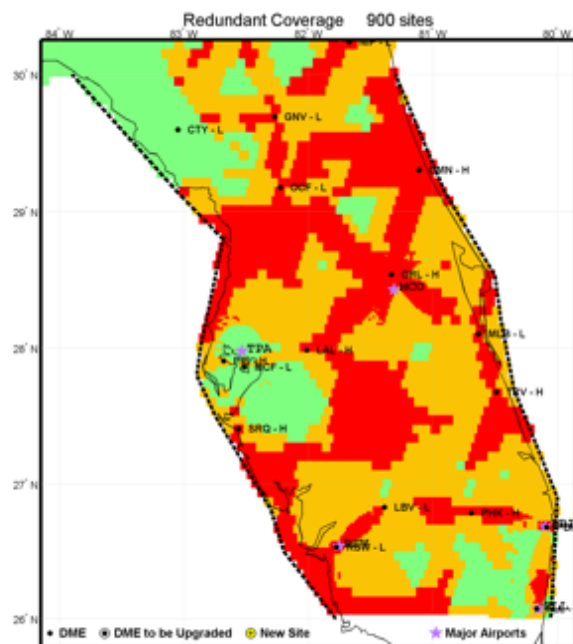
- Busiest 62 airports for DME/DME/IRU equipped aircraft.



# 2015 DME Coverage

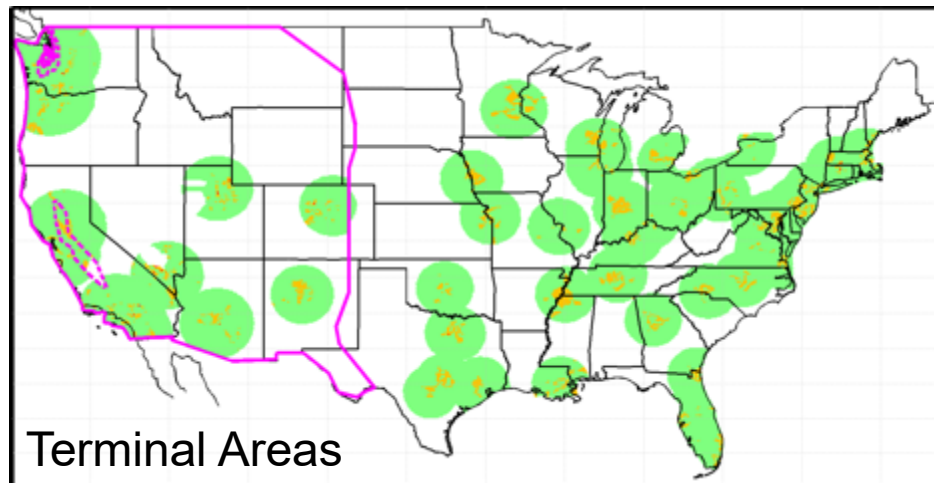
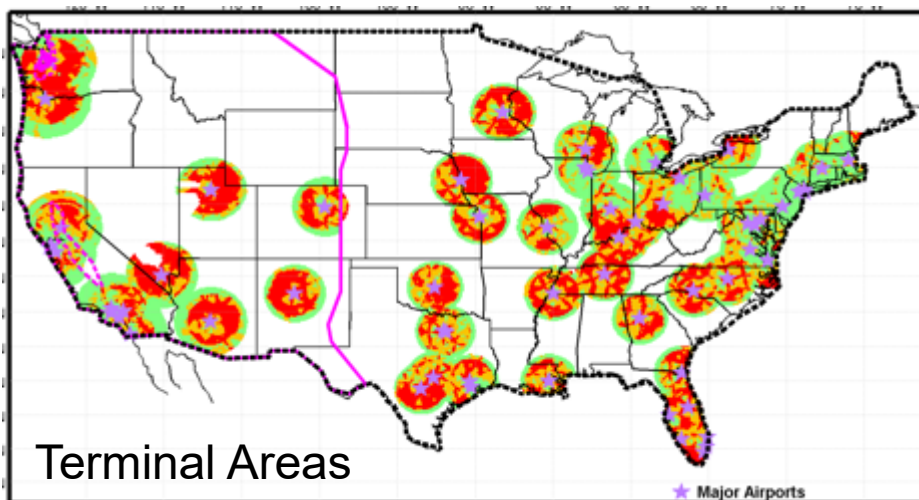
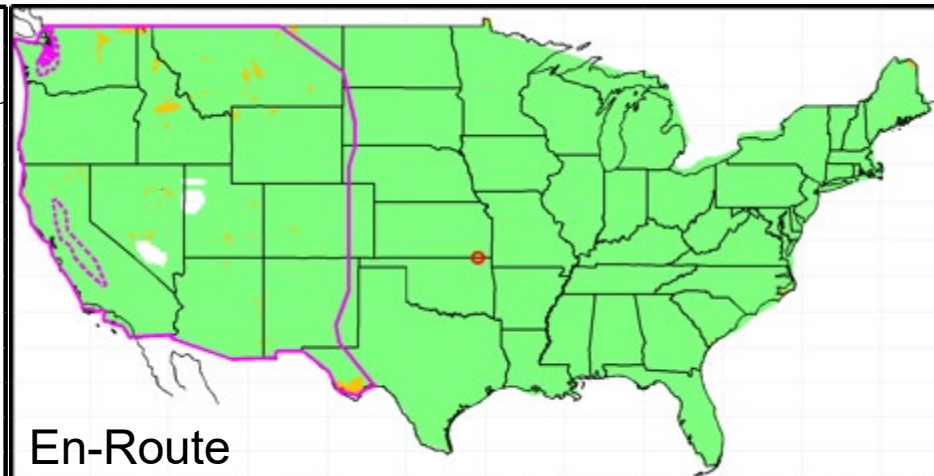
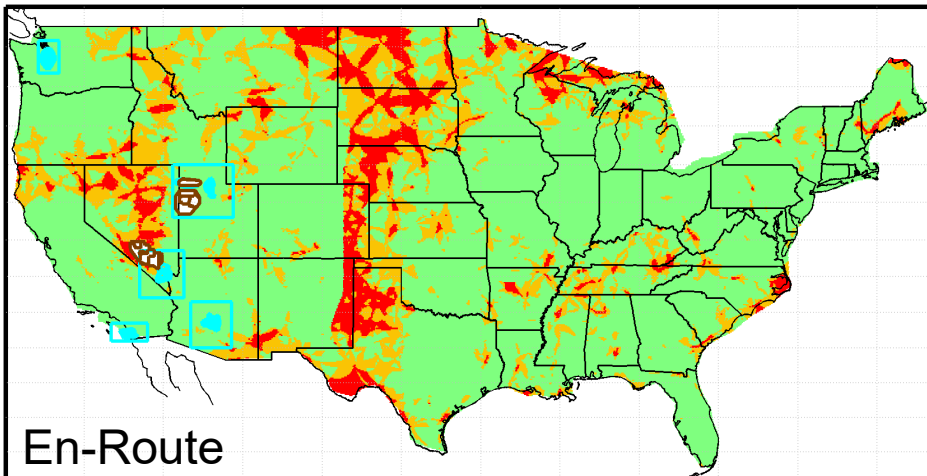


# Terminal Coverage Enhancement





# DME Coverage Before and After

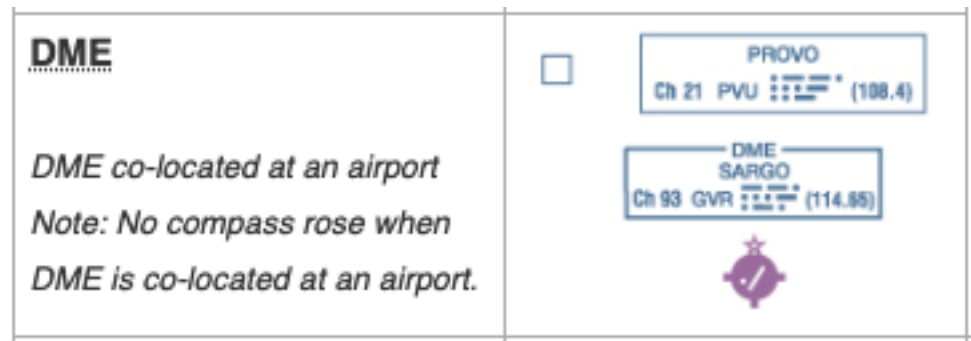


# Charting Changes

- Q13 from central Oregon to Las Vegas had “GNSS REQUIRED” for the entire 591 NM.
  - This has been fixed by the NextGen DME Program (above FL 250).



- Frequencies will need to change for some existing DME and any VOR associated with those DME.
- DME “only” sites.



# Deployment Schedule

- **Segment 1: En-route 2017-2027**
  - Commissioning sixteen (16) new enroute site locations.
  - Changing the service volume for 388 of 589 sites.
- **Segment 2: Busiest terminal areas 2022-2029**
  - Commissioning of 28 new terminal site locations.
  - Terminal areas ranked by number of operations by aircraft equipped to perform DME/DME/IRU RNAV.
  - Provide terminal coverage for Navigation Service Group (NSG-1) and NSG-2 airports.
  - Changing the service volume for 72 of 589 sites.
- **Segment 3: Remaining busy terminal areas 2025-2035**
  - Commissioning of 82 new terminal site locations.
  - Provide terminal coverage for NSG-2 airports.
  - Changing the service volume for 129 of 589 sites.



# VOR/DME/TACAN SSVs

- Remember the previous Standard Service Volumes (SSVs)?

RADIO CLASS DESIGNATIONS		
VOR/DME/TACAN Standard Service Volume (SSV) Classifications		
<u>SSV Class</u>	<u>Altitudes</u>	<u>Distance (NM)</u>
(T) Terminal	1000' to 12,000'	25
(L) Low Altitude	1000' to 18,000'	40
(H) High Altitude	1000' to 14,500'	40
	14,500' to 18,000'	100
	18,000' to 45,000'	130
	45,000' to 60,000'	100

# VOR/DME/TACAN SSVs cont'd

- Current SSVs

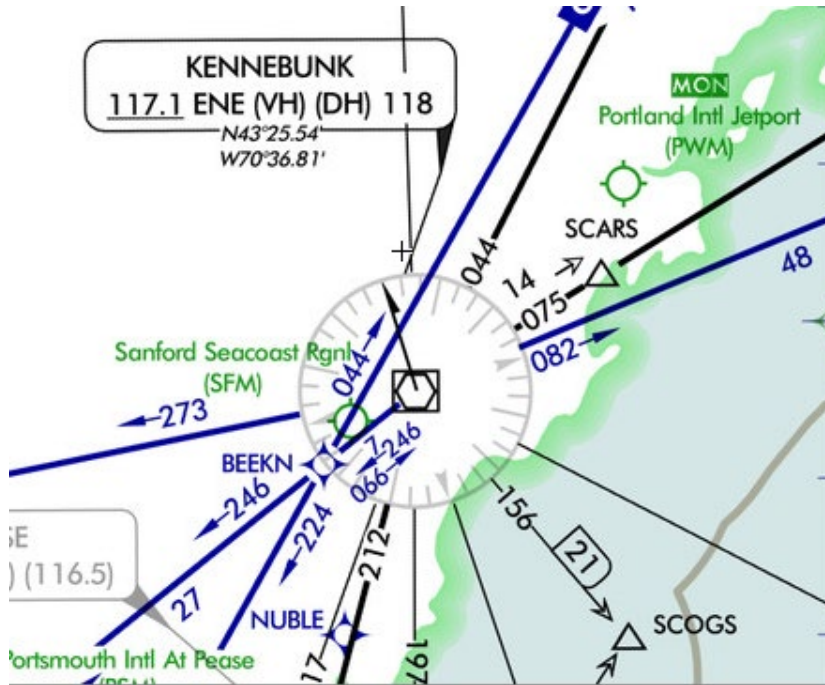
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	14,500' to 18,000'	100
	18,000' to 45,000'	130
	45,000' to 60,000'	100
(VL) VOR Low	1000' to 5,000'	40
	5,000' to 18,000'	70
(VH) VOR High	1000' to 5,000'	40
	5,000' to 14,500'	70
	14,500' to 18,000'	100
	18,000' to 45,000'	130
	45,000' to 60,000'	100
(DL) DME Low & (DH) DME High*	1000' to 12,900'	40 increasing to 130
(DL) DME Low	12,900' to 18,000'	130
(DH) DME High	12,900' to 45,000'	130
	45,000' to 60,000'	100

\*Between 1000' to 12,900', DME service volume follows a parabolic curve used by flight management computers.

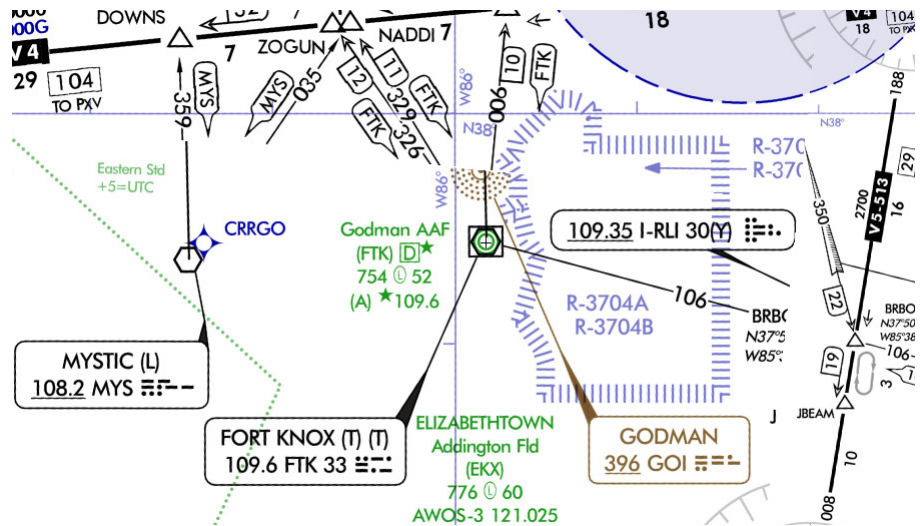
# Charting VOR and DME/TACAN SSVs

- **The VOR and DME/TACAN SSVs were previously the same for each location.**
  - This may still occur at some locations, but generally a collocated VOR and the associated DME/TACAN will not have the same SSV.
  - This is generally due to the longer ranges now used for the DME/TACAN. These ranges are largely driven by DME/DME/IRU RNAV capabilities.

# SSV Chart Depictions



High Enroute Chart



Low Enroute Chart

# Summary

- The FAA is transitioning to PBN.
- Resilient navigation will be provided:
  - GPS and WAAS enable all PBN operations and ADS-B.
  - The NextGen DME Program provides an RNAV backup to mitigate GPS disruption.
  - The VOR MON Program repurposes VORs to provide a backup for non-DME aircraft.
  - Legacy navigation aids will be sustained for the resilient infrastructure.



# *Questions*