Virginia Department of Aviation

FACILITIES AND EQUIPMENT (F&E)
NAVAID STUDY
TECHNICAL REPORT

September 2025

WOOLPERT

EXECUTIVE SUMMARY

The 2025 Facilities and Equipment NAVAID Study provides a twenty-year outlook for the Virginia Department of Aviation (DOAV) and an updated approach to its ownership and maintenance of navigational support systems within the Commonwealth.

The study considers NAVAIDs as a broader shift within aviation, an evolution from the use of ground-based navigation that relies on an older vintage of technologies to a performance-based system that leverages GPS and modern avionics.

It is important to note that the Department's implementation of the NAVAID Study does not occur within a vacuum, but is instead designed to integrate with and support the FAA's Minimum Operational Network. Virginia's system of equipment serves as an additional layer of redundancy within the National Airspace System, ensuring a resilient network of traditional NAVAIDs in the event of technological disruption within the satellite-based navigation network.

Weather reporting systems are available at sixty-two of the sixty-five airports in the Virginia Air Transportation System Plan (VATSP) and are anticipated to remain an integral element of maintaining a safe operating environment for all users. The system of Commonwealth-owned NAVAIDs, including localizers, glideslopes, distance measuring equipment, approach lighting systems, and non-directional beacons, is anticipated to change over the next five, ten, and twenty years as equipment requires replacement or decommissioning.

Over the next twenty years, Advanced Air Mobility and Unmanned Aircraft Systems are expected to continue evolving, potentially necessitating an expansion of the existing scope of the Facilities and Equipment Program to accommodate emerging technologies. Overall, DOAV must remain flexible while managing this unique program within the ever-changing aviation landscape.

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Acronyms

AAM	Advanced Air Mobility
ACIP	Airport Capital Improvement Plan
ADF	automatic direction finder
ADO	airports district office
AGL	above ground level
AIP	Airport Improvement Program
ALP	Airport Layout Plan
ALS	approach landing system
ALSF-2	Approach lighting system with sequenced flashers II
APV	approach with vertical guidance
ASOS	Automated Surface Observing Systems
ASTM	American Society for Testing and Materials
ATC	air traffic control
AURA	Advanced Ultra Reliable Aviation
AWOS	Automated Weather Observing Systems
Baro-	barometric
BVLOS	beyond visual line of sight
C2	command and control
CIP	capital investment plan
CIT	Center for Innovative Technology
CONUS	Continental United States
DA	decision altitude
DCA	Ronald Reagan National Airport
DFR	drone as first responder
DH	decision height
DME	distance measuring equipment
DOAV	Department of Aviation
DoD	Department of Defense
DVT	DME/VOR/TACAN
EA	enterprise architecture
eCTOL	electric conventional takeoff and landing vehicles
eSTOL	electric short takeoff and landing aircraft
eVTOL	electric vertical takeoff and landing vehicles
F&E	Facilities and Equipment
FAA	Federal Aviation Administration
FIXM	Flight Information eXchange Model
FSS	Flight Service Stations
FRED	Federal Reserve Bank of St. Louis
GBAS	ground-based augmentation system
GBN	ground-based navigation
GLS	GBAS landing system
GPS	global positioning system
GS	glideslopes
HAA	height above airport
HAT	height above touchdown
HPDME	High-Power DME
IAD	Washington Dulles Airport
IAF	initial approach fix
IAP	instrument approach procedures
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
LAAS	local area augmentation system
LDA	localizer directional aid
LNAV	lateral navigation
LOC	localizers
LPDME	Low-Power DME
LPV	localizer performance with vertical guidance
MAAP	Mid-Atlantic Aviation Partnership
MALS	Medium-Intensity Approach Lighting System
MALSF	Medium-Intensity Approach Light System with Sequenced Flashers
MALSR	Medium-Intensity Approach Lighting System With Runway Alignment Indicator
MDA	minimum descent altitude
METAR	Meteorological Terminal Aviation Route Weather Report
MON	Minimum Operational Network
MSL	mean sea level
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NAVAID	navigational aid
NDB	non-directional beacon

NextGen	Next Generation Air Transportation System
NM	nautical miles
NPA	non-precision approach
NPIAS	National Plan of Integrated Airport Systems
NWS	National Weather Service
ODALS	omnidirectional approach lighting systems
OEM	original equipment manufacturer
PA	precision approach
PAR	precision approach radar
PBN	Performance-Based Navigation
RF	radio frequency
RNAV	area navigation
RNAV (GPS)	area navigation global positioning system approaches
RNP	required navigation performance
RVR	runway visual range
RVV	runway visibility value
SM	statute miles
SSV	standard service volumes
STAR	standard terminal arrival route
STEM	science, technology, engineering, and mathematics
STOL	short takeoff and landing
sUAS	small unmanned aircraft systems
SVO	simiplified vehicle operation
TACAN	tactical air navigation
UHF	ultra-high frequency
UAS	unmanned aircraft systems
UTM	UAS traffic management
VA	Commonwealth of Virginia
VATSP	Virginia Air Transportation System Plan
VFR	visual flight rules
VH	high VOR
VHF	very high frequency
VIPA	Virginia Innovation Partnership Authority
VIPC	Virginia Innovation Partnership Corporation
VL	low VOR
VNAV	vertical navigation
VOR	VHF omni-directional range
WAAS	Wide Area Augmentation System
WIPS	weather information providers
WUSMA	Western U.S. Mountainous Area

1 STUDY OVERVIEW

The 2025 Commonwealth of Virginia (VA) Department of Aviation (DOAV) Facility and Equipment (F&E) Navigational Aid (NAVAID) Study is a product that evolved from a similar effort in 2010. The aviation landscape within the United States, as well as in Virginia, has changed dramatically since that time. This study builds on the outputs from the previous effort and provides further guidance to Virginia on its NAVAID system as the Federal Aviation Administration (FAA) implements its Minimum Operational Network (MON) plan.

There are 102 NAVAID facilities in Virginia that DOAV maintains, and nearly 250 instrument approach procedures (IAP) support safe and efficient aircraft operations at aviation facilities across the Commonwealth. The study includes an inventory of these NAVAIDs and IAPs, an assessment of condition and utility, and recommendations for implementing improvements to the Commonwealth's air transportation system.

The study is intended for DOAV reference as it implements improvements to its air transportation system. The recommendations contained herein are not intended to be independent of other federal, state, and local initiatives and must be considered along with other DOAV reports, individual airport studies, and published FAA guidance. Ultimately, the FAA Airports District Office (ADO) and DOAV will work with airports on an individual basis through the capital improvement plan (CIP) planning process to implement any identified improvements.

All images used throughout are attributed at the conclusion of the report and referenced by caption and page number. A reference list is also included for sourced information.

1.1 Goals and Objectives

The primary goal of the Virginia Facilities and Equipment NAVAID Study is to define and understand the value of ground-based navigational aids within the Commonwealth's air transportation system. The findings from this study will also assist in the continued improvement of satellite-based navigation and emerging technologies, including Advanced Air Mobility (AAM).

The study aims to provide DOAV with a tool that helps lower maintenance expenses without compromising procedure availability at Commonwealth airports. The study provides recommendations for establishing a minimum operational, non-federal NAVAID network to maximize value for DOAV and its system of airports. A secondary output of the study is a comprehensive inventory and assessment of approach procedures that identify opportunities to improve landing minimums and include recommendations for entirely new procedures.

The study aims to develop sound and defensible recommendations for the ongoing sustainment and meaningful investment in the ground-based network, ensuring continued safe operations and adequate service levels within the Commonwealth. These improvements will be achieved through a comprehensive implementation plan that will include prioritization, scheduling, and budgeting considerations.

Overall, Virginia aims to maintain and support a network of NAVAIDs that supports federal initiatives in the National Airspace System (NAS), enhances access to the Commonwealth's public-use airports, and considers the efficient and effective use of funding. Simultaneously, the NAVAID network needs to be adapted to the future of air navigation, including considerations such as the FAA's MON plan for ground-based NAVAIDs and an increased reliance on satellite-based Global Positioning System (GPS) navigational networks.

Past studies provide important benchmarks to compare the current state of the system. These studies include the 2010 version of this report and the 2016 Virginia Air Transportation System Plan (VATSP).

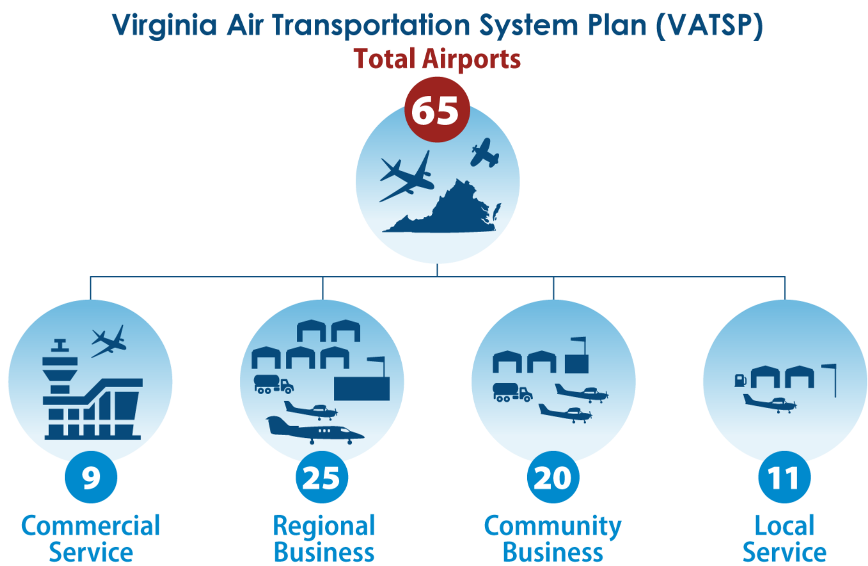
The VATSP stated that reliable access at public-use airports in Virginia is important. The VATSP identified two mechanisms to increase reliability and accessibility: on-site weather reporting and at least one runway approach supported by vertical guidance. As of this study, three airports remain without on-site weather reporting, and twenty-one airports lack an approach with vertical guidance.

The VATSP also had an objective for every airport in the Commercial Service, Reliever, and General Aviation-Regional roles to maintain an approach with vertical guidance. When the VATSP was published, the only airports in those roles lacking an approach with vertical guidance were Culpeper and Virginia Highlands, which have since been remedied. In the current system, forty-three airports maintain an approach with vertical guidance, including seven airports in the Community Business role.

1.2 System Definition

This study focuses on airports included in the VATSP. *As shown in **Figure 1***, the system consists of sixty-five airports, divided into four role categories:

- Commercial Service (9)
- Regional Business (25)
- Community Business (20)
- Local Service (11)



As shown in ***Figure 2***, forty-seven facilities are also included in the National Plan of Integrated Airport Systems (NPIAS). Eighteen are not included in NPIAS and are thus ineligible for FAA grant funding.

- **Primary/Commercial Service (9):** Airports that provide air carrier service.
- **Reliever (6):** Airports that provide general aviation aircraft facilities to reduce congestion at commercial service airports.
- **General Aviation (32):** Airports that offer facilities and services for general aviation users.
- **Non-NPIAS (18):** Airports that are public use but ineligible for FAA funding.

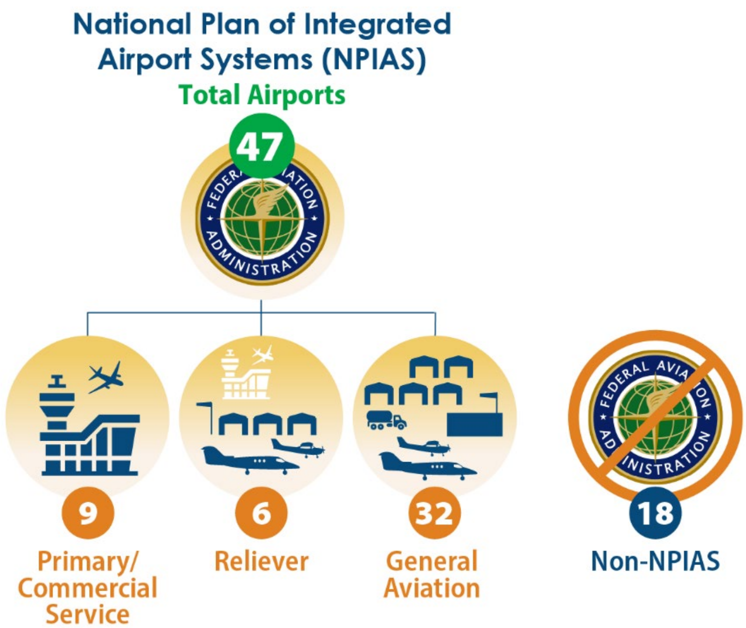


Figure 2: Number of airports in the NPIAS.

While considered in a specific context for this study, no analyses or recommendations were completed for the NAVAIDs or IAPs serving Washington Dulles International Airport (IAD) and Ronald Reagan National Airport (DCA), as a robust system of equipment and approaches already supports these airports.

Study airports are depicted in ***Figure 3*** and are sorted by role in the VATSP and NPIAS hierarchy in ***Table 1***.

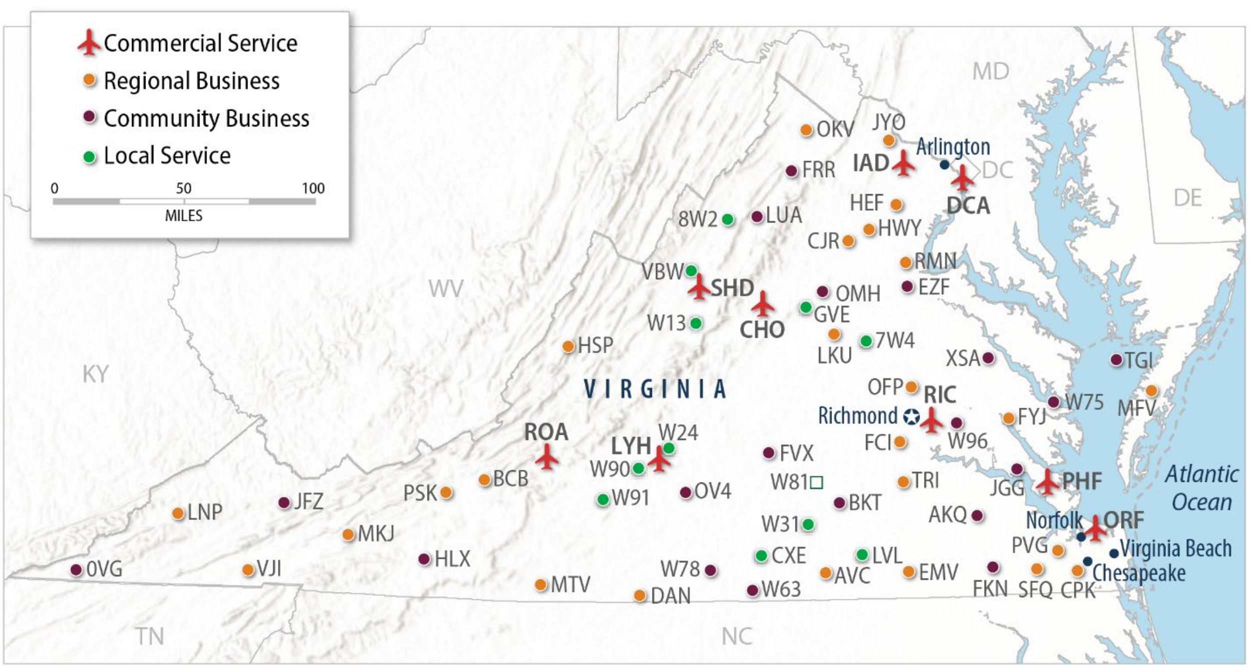


Figure 3: Virginia Air Transportation System map.

Table 1: Virginia Air Transportation System facilities.

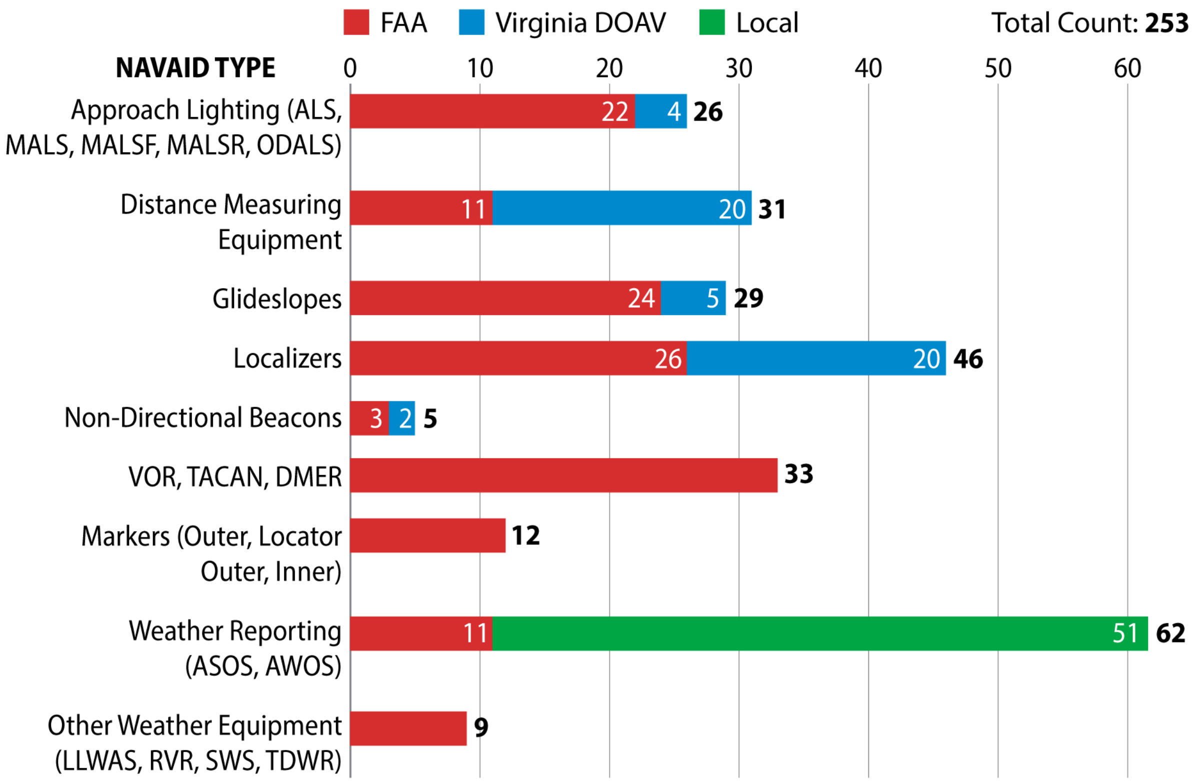
P: Primary CS: Commercial Service R: Reliever GA: General Aviation

ID	Airport	City	VA role	NPIAS role
CHO	Charlottesville-Albemarle	Charlottesville	Commercial Service	P-Nonhub
DCA	Ronald Reagan Washington National	Washington, D.C.	Commercial Service	P-Large
IAD	Washington Dulles International	Washington, D.C.	Commercial Service	P-Large
LYH	Lynchburg Regional	Lynchburg	Commercial Service	P-Nonhub
ORF	Norfolk International	Norfolk	Commercial Service	P-Small
PHF	Newport News-Williamsburg International	Newport News	Commercial Service	P-Nonhub
RIC	Richmond International	Richmond	Commercial Service	P-Medium
ROA	Roanoke-Blacksburg Regional	Roanoke	Commercial Service	P-Nonhub
SHD	Shenandoah Valley Regional	Staunton	Commercial Service	CS-Regional
AVC	Mecklenburg-Brunswick Regional	South Hill	Regional Business	GA-Local
BCB	Virginia Tech-Montgomery Executive	Blacksburg	Regional Business	GA-Regional
CJR	Culpeper Regional	Culpeper	Regional Business	GA-Regional
CPK	Chesapeake Regional	Norfolk	Regional Business	GA-Regional
DAN	Danville Regional	Danville	Regional Business	GA-Regional
EMV	Emporia-Greensville Regional	Emporia	Regional Business	GA-Basic
FCI	Richmond Executive-Chesterfield County	Richmond	Regional Business	R-Regional
FYJ	Middle Peninsula Regional	West Point	Regional Business	GA-Local
HEF	Manassas Regional	Manassas	Regional Business	R-National
HSP	Ingalls Field	Hot Springs	Regional Business	GA-Basic
HWY	Warrenton-Fauquier	Warrenton	Regional Business	R-Regional
JYO	Leesburg Executive	Leesburg	Regional Business	R-National
LKU	Louisa County	Louisa	Regional Business	GA-Local
LNP	Lonesome Pine	Wise	Regional Business	GA-Local
MFV	Accomack County	Melfa	Regional Business	GA-Local
MKJ	Mountain Empire	Marion	Regional Business	GA-Basic
MTV	Blue Ridge	Martinsville	Regional Business	GA-Regional
OFP	Hanover County Municipal	Richmond	Regional Business	GA-Regional
OKV	Winchester Regional	Winchester	Regional Business	GA-Regional
PSK	New River Valley	Dublin	Regional Business	GA-Local
PTB	Dinwiddie County	Petersburg	Regional Business	GA-Regional

PVG	Hampton Roads Executive	Norfolk	Regional Business	R-Regional
RMN	Stafford Regional	Stafford	Regional Business	R-Local
SFQ	Suffolk Executive	Suffolk	Regional Business	GA-Regional
VJI	Virginia Highlands	Abingdon	Regional Business	GA-Regional
0V4	Brookneal-Campbell County	Brookneal	Community Business	GA-Unclassified
0VG	Lee County	Jonesville	Community Business	GA-Basic
AKQ	Wakefield Municipal	Wakefield	Community Business	Non-NPIAS
BKT	Allan C. Perkinson Municipal	Blackstone	Community Business	Non-NPIAS
EZF	Shannon	Fredericksburg	Community Business	Non-NPIAS
FKN	Franklin Regional	Franklin	Community Business	GA-Basic
FRR	Front Royal-Warren County	Front Royal	Community Business	GA-Local
FVX	Farmville Regional	Farmville	Community Business	GA-Basic
HLX	Twin County	Galax-Hillsville	Community Business	GA-Local
JFZ	Tazewell County	Richlands	Community Business	GA-Basic
JGG	Waltrip Williamsburg Executive	Williamsburg	Community Business	Non-NPIAS
LUA	Luray Caverns	Luray	Community Business	GA-Local
OMH	Orange County	Orange	Community Business	GA-Local
TGI	Tangier Island	Tangier	Community Business	GA-Basic
W31	Lunenburg County	Kenbridge	Community Business	Non-NPIAS
W63	Lake Country Regional	Clarksville	Community Business	Non-NPIAS
W75	Hummel Field	Saluda	Community Business	Non-NPIAS
W78	William M. Tuck	South Boston	Community Business	GA-Local
W81	Crewe Municipal	Crewe	Community Business	Non-NPIAS
W96	New Kent County	Quinton	Community Business	GA-Local
XSA	Tappahannock-Essex County	Tappahannock	Community Business	GA-Local
7W4	Lake Anna	Bumpass	Local Service	Non-NPIAS
8W2	New Market	New Market	Local Service	Non-NPIAS
CXE	Chase City Municipal	Chase City	Local Service	Non-NPIAS
GVE	Gordonsville Municipal	Gordonsville	Local Service	Non-NPIAS
LVL	Brunswick County	Lawrenceville	Local Service	Non-NPIAS
VBW	Bridgewater Air Park	Bridgewater	Local Service	Non-NPIAS
W13	Eagle's Nest	Waynesboro	Local Service	Non-NPIAS
W24	Falwell	Lynchburg	Local Service	Non-NPIAS
W90	New London	Forest	Local Service	Non-NPIAS
W91	Smith Mountain Lake	Moneta	Local Service	Non-NPIAS

Source: FAA and DOAV

As shown in ***Figure 4***, the Virginia NAVAID network consists of 253 pieces of equipment that support nearly 250 IAPs.



Source: FAA and DOAV

Figure 4: NAVAID ownership in Virginia.

1.3 Report Structure

The report begins with an assessment of all NAVAIDs in Virginia, and a summary of how each equipment type is utilized for air navigation. This section provides important context for considerations such as condition, technology, and performance of specific NAVAIDs. A gap analysis then reviews airport accessibility and individual IAP capabilities. It is intended to highlight where existing NAVAIDs are adequate, redundant, or may no longer be necessary based on the coverage provided by performance-based navigation. The study then defines the FAA's MON plan and its corresponding impact on NAVAIDs and IAPs within the Commonwealth. This section provides an overview of the importance of resiliency within the navigational network, specifically in the event of a GPS outage. Following the overview of the MON plan, several scenarios are presented and assessed to arrive at an essential NAVAID network in Virginia. Finally, an implementation plan outlines estimated costs and the timeframe for potential improvements. Ultimately, the purpose of this report is to provide Virginia DOAV with a framework for improving air navigation across the Commonwealth through:

- Improved access to its public-use airport system.
- Increased reliance on and utilization of GPS.
- A smooth transition from ground-based to performance-based navigation.
- Alignment with federal initiatives to improve the NAS.

2 COMMONWEALTH NAVAID NETWORK

For the purposes of this study, the Commonwealth NAVAID network consists of all relevant NAVAIDs within Virginia, regardless of ownership. While the recommendations for the study ultimately pertain to facilities and equipment owned and maintained by the DOAV, it is essential to understand the complete operational structure for air navigation within the Commonwealth. This section provides important details that will assist in identifying those navigational aids required for adequacy, redundancy, and functionality within the Virginia Air Transportation System.

A robust NAVAID database was developed at the onset of the study and is included as an appendix to this report. Information in the database includes:

- Type
- Identifier
- Owner
- Location/nearest city
- Latitude and longitude
- Model
- Commission date
- Equipment decade
- Maintenance response time
- Runway served
- Airport served
- Approach type
- Approach minimums
- Role on approach plate

2.1 NAVAID Inventory

The NAVAID network facilities and equipment that are being assessed as part of this study include:

- **Weather Reporting Systems: Automated Weather Observing Systems (AWOS) and Automated Surface Observing Systems (ASOS)** Sensors in an ASOS measure wind speed and direction, dew point, air temperature, station pressure, as well as other critical data points.[1] An AWOS reports similar data to an ASOS but differs in its reporting frequency, with an AWOS providing weather conditions every minute while an ASOS provides hourly information. Compared to the detailed reporting delivered by ASOS, an AWOS is limited in the specificity of precipitation and visibility.
- **Localizers (LOC)** and **Glideslopes (GS)** are components of an Instrument Landing System (ILS), which provides lateral and vertical guidance for landing aircraft. The localizer emits very high frequency (VHF) signals between 108.1 MHz and 111.95 MHz to provide lateral guidance, while the glideslope emits ultra-high frequency (UHF) signals between 329.15 and 335.0 MHz to provide vertical guidance. This system ensures controlled descent and runway centering, facilitating safe landings in various conditions. The localizer and glideslope transmit radio signals along the extended centerline of a runway, which is then received in an aircraft with proper navigation equipment.
- **Distance Measuring Equipment (DME):** DME measures the slant range between the aircraft and the facility, and it operates in the UHF band between 960 and 1215 MHz. The aircraft's receiver

[1] https://www.ncei.noaa.gov/news/whats-automated-surface-observing-system-asos

calculates the slant range by measuring the time delay between sent and received radio frequency (RF) pulses. DMEs can be independent but are usually collocated with VORs or ILS systems. The NextGen DMEs support Performance-Based Navigation (PBN) by providing a DME/DME area navigation (RNAV) capability in the event of a GPS outage. The NextGen DMEs sustain High-Power DMEs (HPDMEs) required for RNAV en route procedures as a resilient backup for GPS navigation. Notably, all DMEs owned and maintained by the Commonwealth are Low-Power DMEs (LPDMEs). High-Power and Low-Power DMEs primarily differ by range, with HPDMEs extending to higher altitudes and further distances than LPDMEs. For example, DME services volumes for those collocated at VORs are illustrated in ***Figure 10****.*

- **Approach Lighting:** Approach lighting systems provide the basic means to transition from instrument flight to visual flight for landing. Operational requirements dictate the sophistication and configuration of the approach lighting for a particular runway. They are comprised of signal lights starting at the landing threshold and extending 2,400 to 3,000 feet into the approach area for precision instrument runways and 1,400 to 1,500 feet for non-precision instrument runways. Some systems include sequenced flashing lights, which appear to the pilot as a ball of light traveling towards the runway at high speed.
- **VHF Omni-Directional Ranges (VOR) and Tactical Air Navigation (TACAN):** VORs operate in the 108.0 to 117.95 MHz band and provide pilots in aircraft equipped with proper avionics the ability to determine the direction the aircraft would fly to the VOR, or the direction the aircraft is flying from a VOR. VORs support non-precision (lateral guidance only) approach and en route procedures and provide guidance along low-altitude Victor airways, high-altitude jet routes, conventional standard terminal arrival route (STAR) procedures, and departure procedures (DPs). VORs are also used to define Class B airspace sectors or the volume of airspace controlled by an air traffic controller. VORs are often collocated with TACAN and DME. TACAN operates in the UHF range, between 960 and 1215 MHz, and provides direction and distance information.
- **Non-Directional Beacon (NDB):** An NDB is a radio transmitter that emits a signal in all directions, allowing an aircraft equipped with automatic direction-finding (ADF) equipment to determine its bearings relative to the beacon. Compared to VORs, NDBs can be received at greater distances and lower altitudes; however, the signal can be affected by atmospheric conditions, mountainous terrain, coastal refraction, and electrical storms, especially when transmitting over longer distances. NDBs transmit a unique identifier using Morse code, which pilots can verify using instrument approach plates.

2.1.1 Weather Reporting Systems (ASOS and AWOS)

Weather reporting provides pilots with valuable, real-time information for safe and efficient aircraft operations. Two of the most common weather reporting systems in use are Automated Weather Observing Systems (AWOS) and Automated Surface Observing Systems (ASOS). These systems generally provide the same functionality, offering weather data, but differ slightly in the type of information and frequency of reporting.

ASOS

- Generally, report hourly.
- Issue special observations whenever weather criteria thresholds are met.
- Report AWOS information as well as precipitation type and intensity, precipitation accumulation, fog, and haze.

AWOS

- Report every minute to twenty minutes.
- Typically include ceiling, visibility, temperature, dew point, and wind speed.
- Typically owned by airport sponsor.

ASOS is a more modern technology than AWOS and serves as the primary climatology observation network in the United States. ASOS operate as a collaborative effort between the FAA, the National Weather Service (NWS), and the Department of Defense (DoD). They are scattered around the country, with locations both on and off airport property. AWOS, however, are operated and controlled by the FAA and are only located at airports. There are several different variations of AWOS, each with different reporting capabilities, which include:

- AWOS A: Altimeter setting only.
- AWOS A/V: Altimeter and visibility.
- AWOS I: Altimeter, density altitude, dew point, temperature, and wind data.
- AWOS II: AWOS I data plus visibility.
- AWOS III: AWOS II data plus cloud/ceiling.
- AWOS IIIP: AWOS III data plus precipitation type identification.
- AWOS IIIT: AWOS III data plus thunderstorm/lightning.
- AWOS IV: AWOS III data plus precipitation occurrence/type/accumulation, freezing.

Pilots obtain weather data from ASOS and AWOS through various formats such as radio, phone recordings, coded reports via ADS-B receivers, or in text format via a Meteorological Terminal Aviation Routine Weather Report (METAR). A pilot can typically utilize these systems by tuning the aircraft radio to the designated frequency for the system at the desired airport. For instance, pilots who wish to obtain the weather near Chesapeake Regional Airport tune to 123.675 to listen to the broadcast. To obtain the weather in preflight planning, the pilot can also call the associated phone number to listen to the weather recording broadcast. Each airport has a different radio frequency/phone number associated with its weather monitoring system. This information can be found on the VFR Sectional, Airport Diagram, Airport Facility Directory, the Approach Plate, or the FAA Weather System Map website.

Weather reporting systems are critical in providing the necessary information for pilots to initiate an instrument approach procedure. This information includes visibility, ceiling, decision altitude or height, and minimum descent altitude. On instrument approach procedures, these values are also known as "minimums." Approaches with lateral and vertical guidance, such as a precision approach or an approach with vertical guidance, have lower approach minimums than non-precision approaches. Pilots use weather reports to choose the best approach based on the prevailing weather conditions.

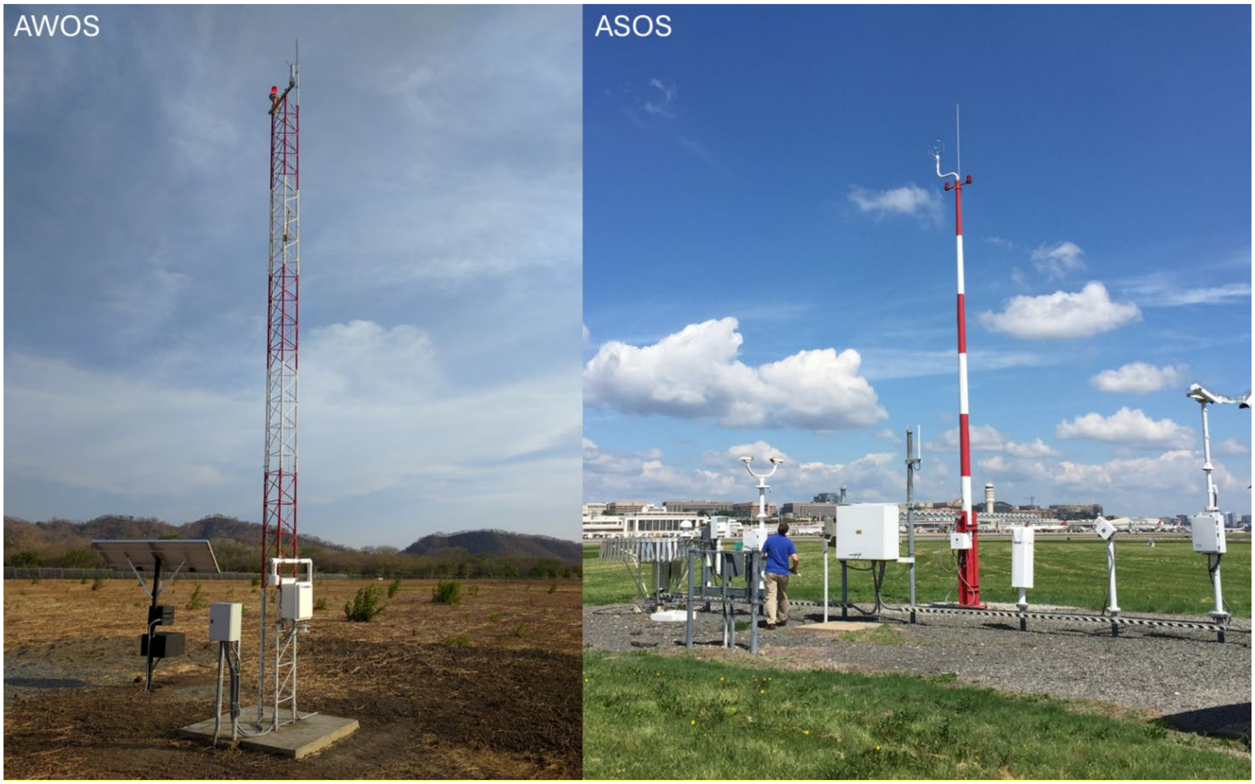


Figure 5: Examples of AWOS and ASOS.

There are sixty-two weather reporting stations at Virginia system airports. Fourteen sites are equipped with ASOS, while the remaining forty-eight airports are equipped with AWOS. Alternatives to traditional weather systems are evaluated in a later portion of the study and include weather cameras and back-up AWOS. ***Figure 6*** shows the location of weather systems in Virginia.

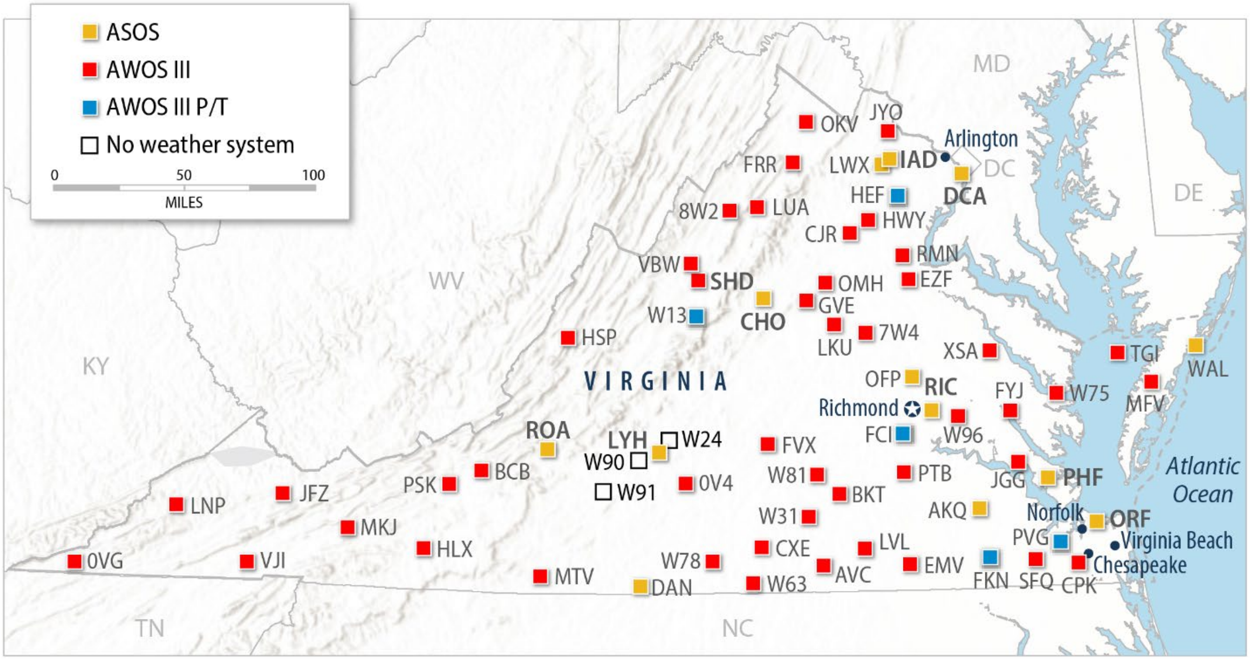


Figure 6: Weather systems in Virginia.

All ASOS are operated and maintained through a collaboration between the FAA, NWS, and DoD. Most AWOS are owned by each airport sponsor, except for three FAA systems. While the sponsor owns the systems, the DOAV funds the ongoing maintenance, repair, and upgrade of AWOS. DOAV largely bears this cost at ninety-five percent, while the sponsor contributes the remaining five percent.

Table 2 lists the weather facilities in Virginia, along with the activation year and owner. Airports are sorted first by system type, then alphabetically by FAA identifier.

Table 2: Weather reporting facilities in Virginia.

ID	Location	Type	Year	Owner	Last Study
AKQ	Wakefield Municipal	ASOS	-	FAA	-
CHO	Charlottesville-Albemarle	ASOS	1998	FAA	-
DAN	Danville Regional	ASOS	1999	FAA	-
DCA	Washington Reagan	ASOS	-	FAA	-
IAD	Washington Dulles International	ASOS	-	FAA	-
LYH	Lynchburg Regional	ASOS	-	FAA	-
OFP	Hanover County Municipal	ASOS	2001	FAA	-
ORF	Norfolk International	ASOS	1996	FAA	-
PHF	Newport News-Williamsburg International	ASOS	2000	FAA	-
RIC	Richmond International	ASOS	2004	FAA	-
ROA	Roanoke-Blacksburg Regional	ASOS	-	FAA	-
0V4	Brookneal-Campbell County	AWOS III	2013	Local	New
0VG	Lee County	AWOS III	2010	Local	-

ID	Location	Type	Year	Owner	Last Study
7W4	Lake Anna	AWOS III	2013	Local	New
8W2	New Market	AWOS III	2013	Local	New
AVC	Mecklenburg-Brunswick Regional	AWOS III	1992	Local	-
BCB	Virginia Tech-Montgomery Executive	AWOS III	1991	Local	-
BKT	Allan C. Perkinson Municipal	AWOS III	2013	Local	New
CJR	Culpeper Regional	AWOS III	1997	Local	-
CPK	Chesapeake Regional	AWOS III	1995	Local	-
CXE	Chase City Municipal	AWOS III	2013	Local	New
EMV	Emporia-Greensville Regional	AWOS III	2000	Local	-
EZF	Shannon	AWOS III	1992	Local	-
FCI	Richmond Executive-Chesterfield County	AWOS III P/T	1991	FAA	-
FKN	Franklin Municipal	AWOS III P/T	1991	Local	-
FRR	Front Royal-Warren County	AWOS III	2013	Local	New
FVX	Farmville Regional	AWOS III	1991	Local	-
FYJ	Middle Peninsula Regional	AWOS III	2003	Local	-
GVE	Gordonsville Municipal	AWOS III	2013	Local	New
HEF	Manassas Regional	AWOS III P/T	1991	FAA	-
HLX	Twin County	AWOS III	1992	Local	-
HSP	Ingalls Field	AWOS III	1992	Local	-
HWY	Warrenton-Fauquier	AWOS III	2007	Local	-
JFZ	Tazewell County	AWOS III	1997	Local	-
JGG	Waltrip Williamsburg Executive	AWOS III	2024	Local	-
JYO	Leesburg Executive	AWOS III	1992	Local	-
LKU	Louisa County	AWOS III	1996	Local	-
LNP	Lonesome Pine	AWOS III	1992	Local	-
LUA	Luray Caverns	AWOS III	2010	Local	New
LVL	Brunswick County	AWOS III	2013	Local	New
MFV	Accomack County	AWOS III	1992	Local	
MKJ	Mountain Empire	AWOS III	1992	Local	-
MTV	Blue Ridge	AWOS III	1992	Local	-
OKV	Winchester Regional	AWOS III	1991	Local	-
OMH	Orange County	AWOS III	1999	Local	-
PSK	New River Valley	AWOS III	1992	Local	-
PTB	Dinwiddie County	AWOS III	1990	Local	-
PVG	Hampton Roads Executive	AWOS III P/T	1990	FAA	-

ID	Location	Type	Year	Owner	Last Study
RMN	Stafford Regional	AWOS III	2003	Local	-
SFQ	Suffolk Executive	AWOS III	1996	Local	-
SHD	Shenandoah Valley Regional	AWOS III	1990	Local	-
TGI	Tangier Island	AWOS III	2014	Local	New
VBW	Bridgewater Air Park	AWOS III	2014	Local	New
VJI	Virginia Highlands	AWOS III	2025	Local	-
W13	Eagle's Nest	AWOS III P/T	2014	Local	New
W31	Lunenburg County	AWOS III	2014	Local	New
W63	Lake Country Regional	AWOS III	2013	Local	New
W75	Hummel Field	AWOS III	2014	Local	New
W78	William M. Tuck	AWOS III	2013	Local	New
W81	Crewe Municipal	AWOS III	2013	Local	New
W96	New Kent County	AWOS III	2013	Local	New
XSA	Tappahannock-Essex County	AWOS III	2008	Local	-

Source: FAA and DOAV

COMPARISON TO THE 2010 STUDY

In the 2010 study, three AWOS III facilities were recommended at William M. Tuck (W78), Luray Caverns (LUA), and Tangier Island (TGI); all three airports now have Commonwealth-supported AWOS. Since the previous study, eighteen new systems have been installed across the Commonwealth. Only three system airports remain without weather reporting: Falwell (W24), New London (W90), and Smith Mountain Lake (W91). While these airports have been offered weather reporting systems, they have declined installation. These airports are privately owned and are included in the Local Service role.

2.1.2 Instrument Landing Systems (ILS)

ILS primarily consists of localizers (LOC) and glideslopes (GS) and are often supplemented by DME and approach lighting systems (ALS). The following sections outline this equipment and its corresponding role in air navigation.

LOCALIZERS AND GLIDESLOPES

The LOC and GS are the central components of the precision approach (PA) ILS, with the localizer providing horizontal guidance and the glideslope providing vertical guidance. The localizer can be utilized as a separate non-precision approach (NPA). In many instances, distance measuring equipment (DME) is collocated with the localizer, providing slant range from the localizer for aircraft. Airports with approaches that feature localizers are often supported by space-based approaches with similar minimums. Many of the localizers are also collocated with distance measuring equipment (DME). ***Figure 7*** illustrates the locations of a glideslope, localizer, and DME at an airport.

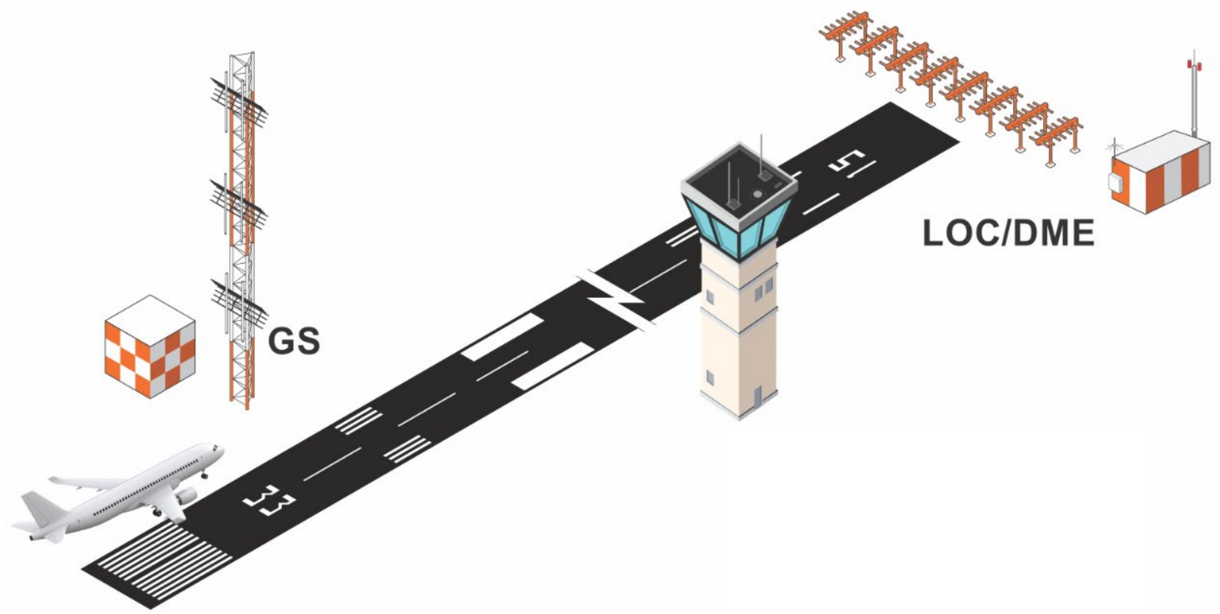
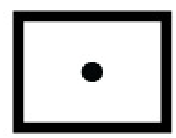


Figure 7: FAA ILS equipment diagram.

DISTANCE MEASURING EQUIPMENT

DME Symbology



Distance Measuring Equipment (DME) is a ground-based NAVAID that measures the slant range between an aircraft and the DME facility. The aircraft's receiver calculates this by measuring the time delay between sent and received radio frequency (RF) pulses. DMEs can be independent but are usually collocated with VOR or ILS systems.

APPROACH LIGHTING

Approach light systems are critical to support instrument approaches and, as such, are located primarily at the Commercial Service and Reliever airports. These systems are vital safety tools during the flight approach and landing phases when pilots must clearly identify the runway environment. The lights can also provide pilots with visual information on runway alignment, height perception, roll guidance, and horizontal references to support the visual portion of an instrument approach. The Commonwealth owns three types of approach lighting systems: medium-intensity approach lighting system (MALS), medium-intensity approach lighting system with sequenced flashing lights (MALSF), and medium-intensity approach lighting system with runway alignment indicator lights (MALSR). ***Figure 8*** illustrates the various visual guidance lighting systems and their corresponding configurations.

Runways equipped with MALSRs typically permit visibility minimums as low as a half-mile or 2,400-foot runway visual range (RVR), which is one of the most relevant benefits of these systems when assessing the long-term viability of these facilities. Visibility minimums are discussed in further detail in Chapter 3.

There are twenty airports with approach lighting systems. Five airports have runways with approach lighting systems owned and maintained by the Commonwealth, while fifteen other airports have systems owned by the FAA or the airport itself. These include:

- Six ALSF-2 owned by the FAA.
- Six omnidirectional approach lighting systems (ODALS) owned by the airport sponsor.

- One MALS owned by the Commonwealth.
- One MALSF owned by the FAA.
- Eighteen MALSR, three owned by the Commonwealth, and fifteen owned by the FAA.

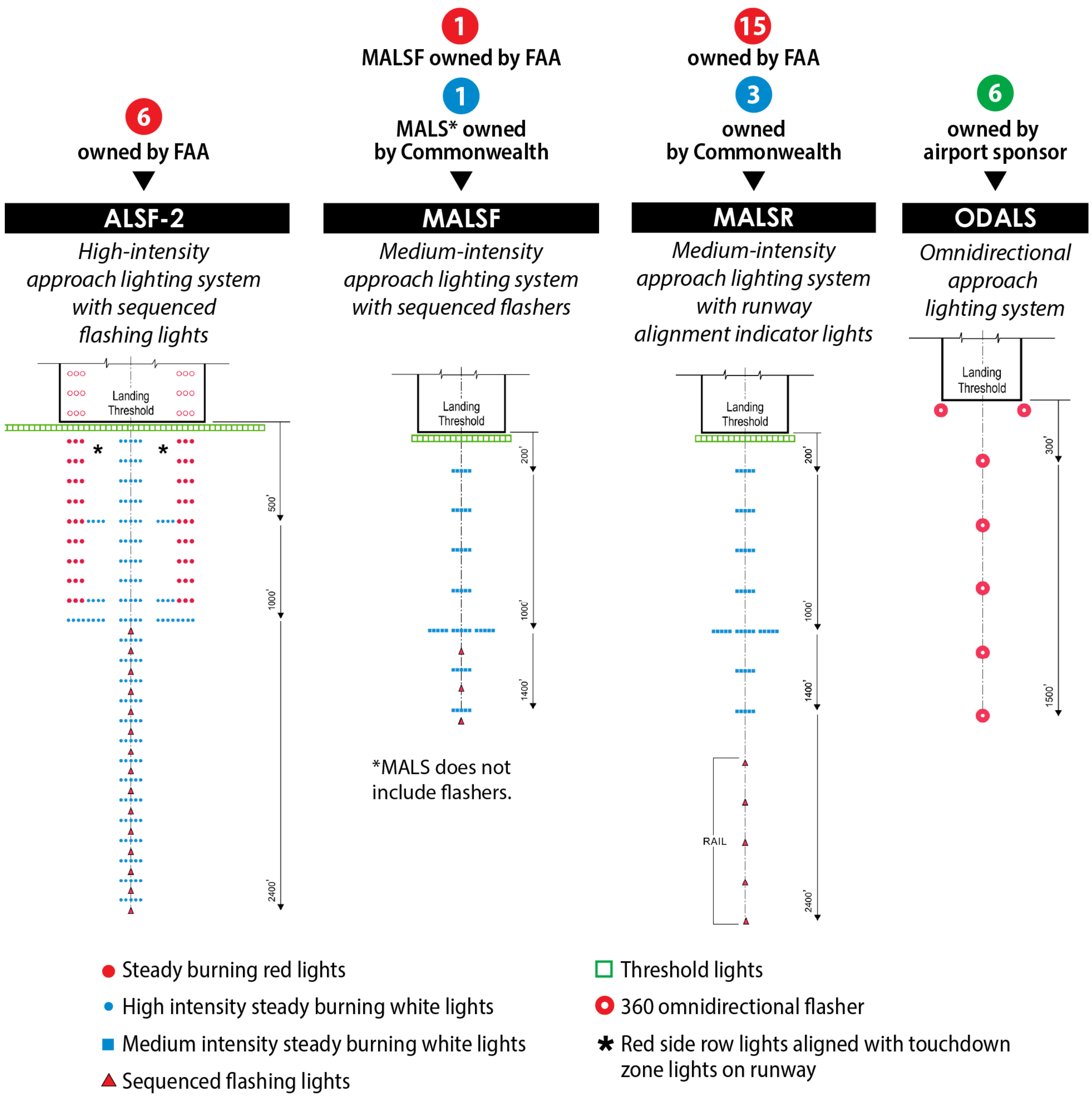


Figure 8: FAA visual guidance lighting systems.

COMPARISON TO THE 2010 STUDY

Since the 2010 study, a localizer was added to Runway 20 at Newport News (PHF); the result is the creation of a new LOC RWY 20 approach. ILS equipment was also installed at Hampton Roads Executive (PVG) in Portsmouth, where there is now an ILS or LOC approach to Runway 10. Localizers and DMEs were added at Richlands (JFZ) and West Point (FYJ). The same seventeen airports noted in the 2010 study, and included here in ***Table 3,*** have maintained precision approach procedures with no additional changes.

There were twenty-four approach lighting systems in Virginia as of the 2010 study, not including those at Dulles (IAD) and Reagan (DCA).

Table 3 lists airports in Virginia with runways supported by typical ILS components. ***Figure 9*** shows the locations of the ILS components and the owner, color-coded by type of approach.

Table 3: Airports and runways with ILS components in Virginia.

FAA ID	Airport	Runway	Approach	Owner	LOC	DME	GS	ALS
AVC	Mecklenburg-Brunswick County	1	LOC	VA	✓	✓		
BCB	Virginia Tech-Montgomery Executive	13	LOC	VA	✓	✓		✓*
CHO	Charlottesville-Albemarle	3	ILS or LOC	FAA	✓		✓	✓
CJR	Culpeper Regional	4	LOC	VA	✓	✓		
CPK	Chesapeake Regional	5	ILS or LOC	VA	✓	✓	✓	✓
DAN	Danville Regional	2	ILS or LOC	FAA	✓		✓	✓
EMV	Emporia-Greensville Regional	34	LOC	VA	✓	✓		
FCI	Richmond Executive-Chesterfield County	33	ILS or LOC	VA	✓	✓	✓	✓
FYJ	Middle Peninsula Regional	10	LOC	VA	✓	✓		
HEF	Manassas Regional	16L	ILS or LOC	FAA	✓		✓	✓
HSP	Ingalls Field	25	ILS or LOC	FAA	✓		✓	
HWY	Warrenton-Fauquier	15	LOC/DME	VA	✓	✓		
JFZ	Tazewell County	25	LOC/DME	VA	✓	✓		
JYO	Leesburg Executive	17	ILS or LOC	FAA	✓	✓	✓	✓*
LKU	Louisa County	27	LOC	VA	✓	✓		
LNP	Lonesome Pine	24	LOC	FAA	✓	✓		✓*
LYH	Lynchburg Regional	4	ILS or LOC	FAA	✓		✓	✓
MFV	Accomack County	3	LOC	VA	✓	✓		
MKJ	Mountain Empire	26	LOC	VA	✓	✓		
MTV	Blue Ridge	31	LOC	VA	✓	✓		✓*
OFP	Hanover County Municipal	16	LOC	VA	✓	✓		
PHF	Newport News-Williamsburg International	7	ILS or LOC	FAA	✓	✓	✓	✓
PHF	Newport News-Williamsburg International	25	ILS or LOC	FAA	✓	✓	✓	
PHF	Newport News-Williamsburg International	20	LOC	FAA	✓			

FAA ID	Airport	Runway	Approach	Owner	LOC	DME	GS	ALS
OKV	Winchester Regional	32	ILS or LOC	VA	✓	✓	✓	✓
ORF	Norfolk International	5	ILS or LOC	FAA	✓	✓	✓	✓
ORF	Norfolk International	23	ILS or LOC	FAA	✓		✓	✓
PSK	New River Valley	6	ILS or LOC Y/Z	FAA	✓		✓	✓
PTB	Dinwiddie County	5	LOC	VA	✓	✓		✓*
PVG	Hampton Roads Executive	10	ILS or LOC	VA	✓	✓	✓	
RIC	Richmond International	2	ILS or LOC	FAA	✓		✓	✓
RIC	Richmond International	16	ILS or LOC	FAA	✓		✓	✓
RIC	Richmond International	34	ILS or LOC	FAA	✓		✓	✓
RMN	Stafford Regional	33	ILS or LOC	VA	✓	✓	✓	✓
ROA	Roanoke-Blacksburg Regional	6	LDA Y/Z	FAA	✓	✓	✓	✓
ROA	Roanoke-Blacksburg Regional	34	ILS or LOC	FAA	✓		✓	✓
SFQ	Suffolk Executive	4	LOC	VA	✓	✓		
SHD	Shenandoah Valley Regional	5	ILS or LOC	FAA	✓		✓	✓
VJI	Virginia Highlands	24	LOC	VA	✓	✓		✓*

Source: FAA, DOAV, AirNav
IAD and DCA not included
** ODALS owned by airport sponsor*

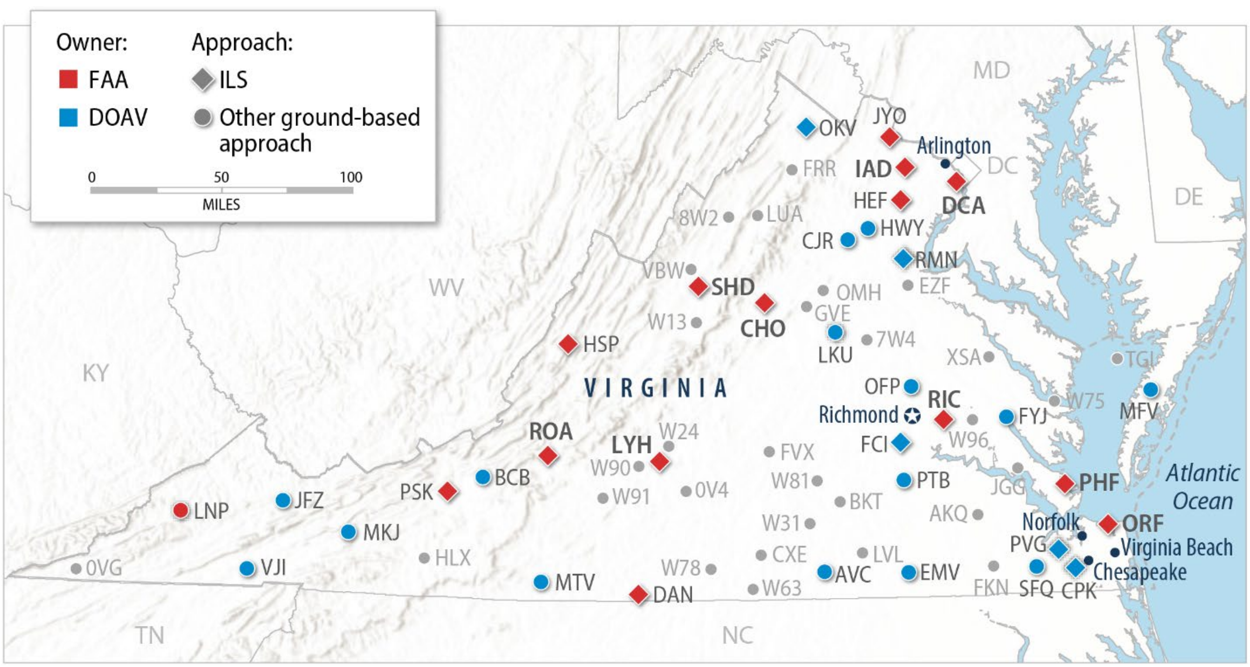


Figure 9: ILS components in Virginia.

2.1.3 VOR, VORTAC, and VOR/DME Systems

A VOR enables pilots to identify the course, or the radial, from its position. Historically, VORs connected Victor airways, or point-to-point routes, across the U.S. airspace. As shown in ***Figure 10***, VOR types are separated by service volume: VOR Low (VL) provides navigation up to forty nautical miles (NM) outward and from 1,000 to 18,000 feet above the site. VOR High (VH) incorporates multiple layers with different ranges. The FAA has introduced new standard service volumes (SSV) that increase the usability of VORs beyond traditional ranges at lower heights above each VOR transmitter. These new SSVs expand usability from forty to seventy NM between 5,000 and 18,000 feet for VL and between 5,000 and 14,500 feet for VH.

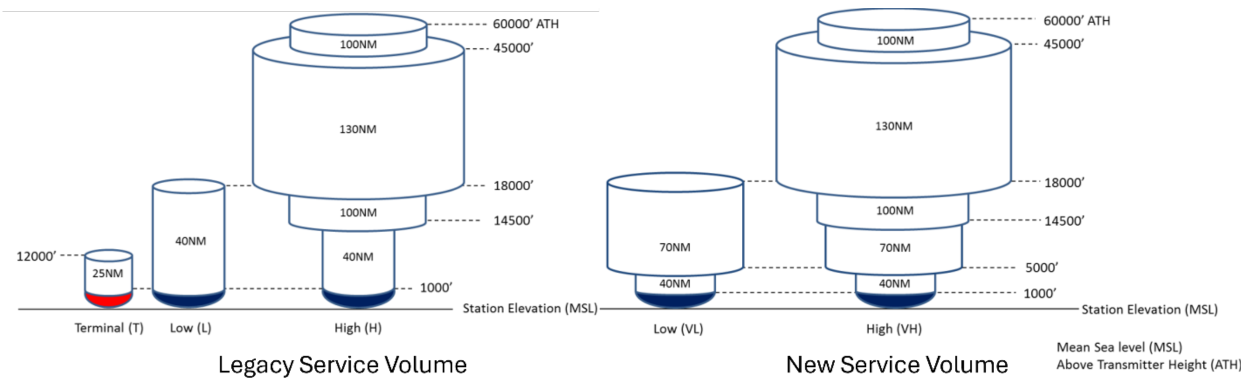
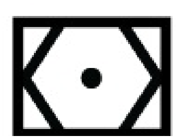


Figure 10: FAA VOR standard service volumes.

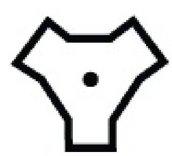
All VORs in the Commonwealth are owned and maintained by the FAA and are often collocated with TACAN or DME. These are defined as:

VOR Symbology

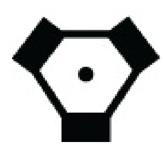
- **VOR:** A VOR is a ground-based electronic navigational aid that transmits very high-frequency navigation signals, 360 degrees in azimuth, oriented from the magnetic north. It is used as the basis for navigation in the National Airspace System. The VOR periodically identifies itself using Morse code and may have an additional voice identification feature. Air traffic control (ATC) or the Flight Service Stations (FSS) may use voice features to transmit instructions/information to pilots. VORs without voice capability are indicated by the letter "W" (without voice) included in class identification (VORW).



- **VOR/DME:** A VOR with equipment (airborne and ground) used to measure, in nautical miles, the slant range distance of an aircraft from the DME navigational aid.



- **TACAN:** A TACAN is an ultra-high-frequency aid that provides equipped aircraft with continuous direction and distance information to the TACAN station.



- **VORTAC:** A VORTAC is a navigation aid providing VOR azimuth, TACAN azimuth, and TACAN distance measuring equipment (DME) at one site, also known as a collocated VOR and TACAN.

Figure 11: Example of VOR site.

COMPARISON TO THE 2010 STUDY

There were twenty-two VORs in Virginia at the time of the 2010 NAVAID study publication. Since that time, three have been decommissioned: Danville, Franklin, and Lawrenceville. The 2010 study noted that many of the VORs existed with published restrictions and unusable radials and altitudes.

Table 4 lists the eighteen active VORs in Virginia and their status within the FAA's Minimum Operational Network (MON) plan. The table also indicates whether the VOR is included in a published instrument approach procedure (IAP) and whether it serves a primary role.

Table 4: VOR facilities in Virginia.

ID	Name	Type	Appearance on approach
AML	Armel	L-VORW/DME	1 (1 as Primary)
BRV	Brooke	L-VORTAC	4 (1 as Primary)
CCV	Cape Charles	L-VORTAC	5 (1 as Primary)
CSN	Casanova	H-VORTAC	13 (2 as Primary)
DCA	Washington	L-VORW/DME	-
FAK	Flat Rock	H-VORTAC	3 (0 as Primary)
GVE	Gordonsville	H-VORTAC	8 (1 as Primary)
GZG	Glade Spring	L-VOR/DME	1 (0 as Primary)
HCM	Harcum	L-VORTAC	10 (2 as Primary)
HPW	Hopewell	L-VORTAC	8 (2 as Primary)
LDN	Linden	L-VORTAC	5 (1 as Primary)
LYH	Lynchburg	L-VORW/DME	6 (2 as Primary)
MOL	Montebello	L-VOR/DME	2 (0 as Primary)
ORF	Norfolk	H-VORTAC	7 (3 as Primary)
PSK	Pulaski	H-VORTAC	7 (3 as Primary)
RIC	Richmond	H-VORTAC	11 (5 as Primary)
ROA	Roanoke	L-VORW/DME	2 (1 as Primary)
SBV	South Boston	L-VORTAC	6 (1 a Primary)

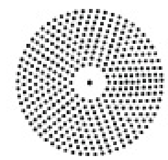
Source: FAA

The FAA's MON plan outlines the shift from ground-based navigation using VORs and other NAVAIDs to performance-based navigation, which relies on GPS. Within the Commonwealth, VORs will be discontinued in the first five- and ten-year periods following this NAVAID study, requiring amendments to, or removal of, existing procedures. The FAA MON plan is discussed in further detail in Chapter 4.

2.1.4 Non-Directional and Marker Beacons

A non-directional beacon (NDB) provides a pilot bearing from a point. Marker beacons provide similar assistance but function within an ILS approach. In Virginia, there are five NDBs, two owned and maintained by DOAV. There are eight marker beacons. Two marker beacons were managed by DOAV and supported the approaches at Blue Ridge Airport (MTV), but these were decommissioned in 2025.

NDB Symbology



COMPARISON TO THE 2010 STUDY

As of the 2010 study, there were seventeen active Commonwealth-owned NDBs, representing a drastic reduction in their availability and utility over the past fifteen years since the previous study. NDBs continue to be decommissioned, so removal or amendments to existing procedures will be necessary. When considering decommissioning, it is important that the FAA, DOAV, and the affected airport are informed about how the removal will impact their published approach procedures. The remaining NDBs and marker beacons in Virginia are listed in ***Table 5****.*

Table 5: Non-directional and marker beacons in Virginia.

Identifier	Location	Equipment	Install year	Owner
GTN	Arlington	Non-Directional Beacon	1953	FAA
BKT	Blackstone	Non-Directional Beacon	1963	FAA
EZF	Fredericksburg	Non-Directional Beacon	1989	VA
VIT	Vinton	Non-Directional Beacon	1981	FAA
AKQ	Wakefield	Non-Directional Beacon	1970	VA
HSP	Hot Springs	Outer Marker	1970	FAA
LYH	Lynchburg	Locator Outer Marker	1993	FAA
LYH	Lynchburg	Outer Marker	1964	FAA
PSK	Pulaski	Outer Marker	1972	FAA
ROA	Roanoke	Outer Marker	1967	FAA
SZK	Roanoke	Outer Marker	1977	FAA
SHD	Staunton	Locator Outer Marker	1970	FAA
SHD	Staunton	Outer Marker	1970	FAA

Source: FAA and DOAV

2.2 NAVAID Condition and Maintenance

An important consideration in assessing the non-federal NAVAID network in Virginia is the ongoing cost of maintaining a safe and efficient air navigation environment. Generally, minor repairs will have a relatively minimal impact on the DOAV's sustainment budget, while replacement costs represent a more significant investment. This section reviews the equipment types in use, the general quality and age of the systems, and the current maintenance protocols. It also summarizes the importance of reliable NAVAIDs.

2.2.1 Weather Reporting Systems

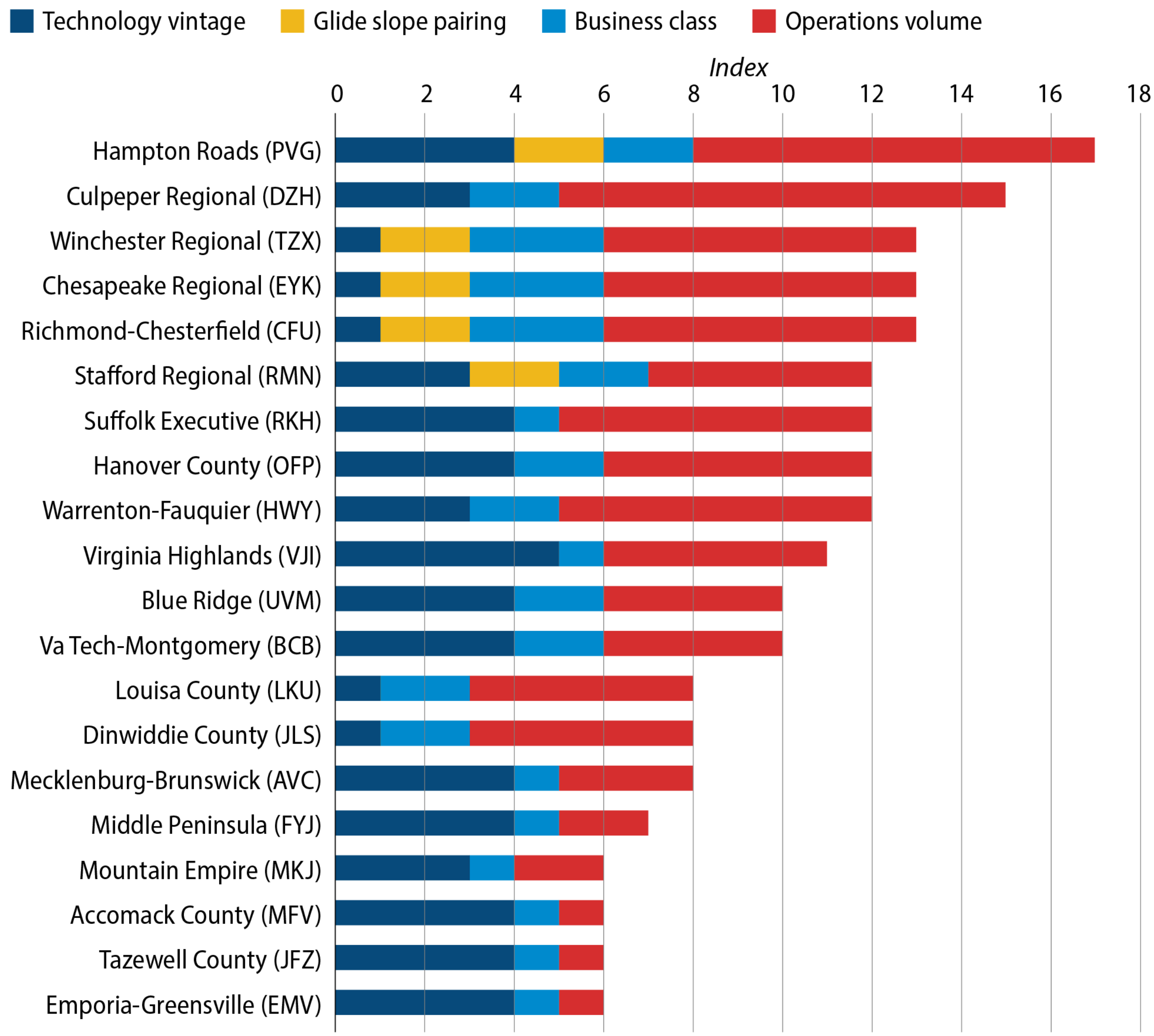
The Commonwealth undertook an extensive update to its weather systems in 2013, installing seventeen AWOS, primarily at smaller Local Service airports within the system. The annual maintenance cost for one AWOS is approximately $3,500, while the replacement cost for an AWOS is approximately $250,000. Most ASOS and AWOS within the Virginia system were installed in the 1990s or early 2000s. These facilities remain in adequate condition; however, full replacement should be planned and coordinated as airports develop their Airport Capital Improvement Plans (ACIPs) and Airport Layout Plans (ALPs). The Airport Improvement Program (AIP) Handbook for the FAA and the Airport Program Manual in Virginia define the typical useful life of an AWOS as twenty years, indicating when a facility may next be eligible for replacement. The equipment often lasts well beyond the listed useful life and is maintained and supported with replacement parts. While AWOS in Virginia are owned by the sponsor, the DOAV funds the ongoing maintenance, repair, and upgrade of AWOS at ninety-five percent, with the remaining five percent contributed by the sponsor. Of Virginia's sixty-two airport weather stations, thirty-seven are twenty years or older, and twenty-eight are sponsor-owned.

2.2.2 Instrument Landing System Components

When determining the Commonwealth's localizer needs, it is imperative to establish a hierarchy of restoration priorities and link these priorities to long-term decision-making. The team assessed the Commonwealth's localizers using an index that considered the following criteria:

- Equipment age
- Airport status (whether it is classified as Virginia Business Class)
- Number of based aircraft
- Number of daily operations
- Presence of a glideslope associated with the localizer

Parts availability will eventually become a concern for older localizer models. Parts availability is an issue currently faced by Commonwealth NAVAID maintenance contractors. As these units deteriorate over time, maintenance will become increasingly necessary. Therefore, the guiding principle for each scenario is to favor decommissioning when practical if a localizer is nearing the end of its service life and replacement is imminent, while retaining those units that are still operational and within their optimal life cycle. Occasional equipment damage due to storms or lightning is an issue that's difficult to plan for, but is considered in the recommendations. ***Figure 12*** presents the results of the localizer assessment using detailed inputs.



Source: Woolpert

Figure 12: DOAV Localizer Assessment Index.

All Virginia-owned localizers are collocated with DME. Five airports (Chesapeake Regional (CPK/EYK); Richmond Executive-Chesterfield County (FCI/CFU); Winchester Regional (OKV/TZX); Hampton Roads Executive (PVG); and Stafford Regional (RMN)) with localizers also have glideslopes and approach lighting systems, placing them in the top six of the localizer assessment shown in ***Figure 12***. The localizer assessment is considered more deeply in a subsequent chapter as scenarios for a future NAVAID system are developed.

Over the past several decades, FAA procurement processes have evolved, resulting in multiple vintages of localizers being used. These multiple vintages complicate maintenance and investment in the NAVIAD system.

Table 6 lists the Commonwealth-owned localizer models, listed from oldest to newest:

Table 6: Age of Commonwealth-owned localizer models.

Model	Age	Number owned
Mark 1F	1980-90	4
Mark 10	1990-00	1
Mark 20A	2010-2020	10
Selex 2100/2800	2020-	5

While the Mark 1F localizers are the oldest systems and part sourcing is beginning to be a concern, they are still maintainable, and the Commonwealth's maintenance processes have included some parts storage. Additionally, although the Mark 1F localizers are no longer being produced and parts are not being restocked, the FAA still has several new Mark 1F systems in its logistics inventory and has not eliminated those from consideration as new installations.

Infrastructure and equipment performance assessments were conducted for airports with Commonwealth-owned NAVAIDs. Infrastructure considerations included site accessibility, environmental site conditions, building quality, and reliability of communication and power. Equipment performance considered the need for replacement or refurbishment and the condition of associated support structures and foundations. ***Table 7*** presents the condition assessment of DOAV-owned localizers.

Table 7: DOAV localizer equipment condition assessment.

Equip. ID	Airport	LOC model	Assessment
CFU (FCI)	Richmond Executive-Chesterfield County	Mark 1F	Older model localizer that will be replaced as part of a future runway extension project.
EYK (CPK)	Chesapeake Regional	Mark 1F	Aging equipment, generally good site conditions, and equipment performance considering localizer model.
JLS (PTB)	Dinwiddie County	Mark 1F	The support building requires improvements. Power to the site is unreliable, and the localizer will need new batteries. This model relies on parts from older systems that have been decommissioned.
TZX (OKV)	Winchester Regional	Mark 1F	Aging equipment, generally good site conditions and equipment performance considering localizer model.
LKU	Louisa County	Mark 10	Localizer and support equipment is in good condition.
AVC	Mecklenburg-Brunswick Regional	Mark 20A	Support building requires upkeep, including pressure washing, but equipment is otherwise in good condition.
BCB	Virginia Tech-Montgomery Executive	Mark 20A	Upgraded to a Mark 20A localizer during 2020 runway extension.
EMV	Emporia-Greensville Regional	Mark 20A	Support structure requires maintenance, but otherwise, the localizer and equipment are in good condition.

Equip. ID	Airport	LOC model	Assessment
FYJ	Middle Peninsula Regional	Mark 20A	The localizer and support equipment are in good condition.
JFZ	Tazewell County	Mark 20A	The support building needs repair, but the equipment is in good condition.
MFV	Accomack County	Mark 20A	Power to the site is subject to issues during major storms, but the batteries have been recently replaced. Equipment is generally in good condition.
OFP	Hanover County Municipal	Mark 20A	The equipment at Hanover County is in good condition. There is also a complete set of spare parts available.
PVG	Hampton Roads Executive	Mark 20A	All related equipment was installed in 2020 and remains in good condition.
RKH	Suffolk Executive	Mark 20A	The localizer and support equipment are in good condition.
UVM (MTV)	Blue Ridge	Mark 20A	The support building requires maintenance, but the equipment is in good condition.
DZH (CJR)	Culpeper Regional	Selex 2100	Upgrading the LOC RWY 4 approach to a LOC/DME following installation of new DME.
HWY	Warrenton-Fauquier	Selex 2100	This model localizer is approximately fifteen years old and is in generally good condition. There has been a flight check restriction for the last two years. It also has remote status monitoring to reduce unnecessary site visits.
MKJ	Mountain Empire	Selex 2100	The support building needs repair, but the equipment is in good condition.
RMN	Stafford Regional	Selex 2100	Newer model installed following runway extension
VJI	Virginia Highlands	Selex 2100	Newer model installed following runway extension

Source: Contractor Assessment

Parts availability will eventually become an issue for all the older vintages of localizers. Degradation and damage to equipment are the main contributing factors to repair and eventual replacement. Therefore, as part of this study, it is important to establish a priority of restoration and connect those priorities to efficient and effective long-term decisions.

2.2.3 Non-Directional and Marker Beacons

All NDBs in the Commonwealth were manufactured by Southern Avionics, have low power output (under fifty watts), and have a twenty-five-mile range. In several instances, NDBs are unusable beyond a certain range due to terrain, reducing their utility. For example, the NDB serving Shannon is unusable beyond fifteen NM. Maintenance response time is typically within twenty-four hours for NDBs. DOAV spends approximately $2,000 per NDB for annual maintenance. ***Table 8*** provides further detail on DOAV-owned NDBs.

Table 8: DOAV non-directional beacons.

ID	Airport served	Location	Year	Appearance on approaches
AKQ	Wakefield Municipal	On-Airport	1970	NDB RWY 20
EZF	Shannon	On-Airport	1989	NDB RWY 24

Source: DOAV

The DOAV previously managed two marker beacons serving Blue Ridge Airport, but these were decommissioned in 2025. It is not anticipated that new marker beacons will be installed due to the overall shift from ground-based to satellite-based navigation.

2.3 Summary

The NAVAID network in Virginia is a robust, ground-based system that helps support instrument approach procedures (IAPs). The following section assesses approach procedures available at Virginia airports to identify potential gaps in accessibility and to better define an essential network of Virginia-owned NAVAIDs over the next twenty years.

3 APPROACH PROCEDURE ANALYSIS

This section assesses the relationship between ground-based NAVAIDs and published instrument approach procedures (IAPs) in Virginia, as well as opportunities where the Commonwealth can assist airports with improving specific IAPs or developing entirely new approaches. This analysis provides further context to inform the development of different NAVAID network scenarios over the next twenty years. **Notably, all airports considered in the study maintain at least one IAP, which represents an improvement from the 2010 study, when seven airports did not have an available IAP.**

3.1 Overview

An IAP is a critical flight operation that facilitates the transition from the en route phase of an aircraft's operation to a point where a safe and standard landing can be executed. In the United States, the FAA designs and approves approaches for public-use airports, tailoring them to each airport, runway end, and specific procedures. While these procedures are applicable in good weather, they are particularly important during instrument meteorological conditions (IMC), when low cloud ceilings or poor visibility require operations conducted under instrument flight rules (IFR). In such conditions, pilots must rely on published instrument approach procedures to safely transition to the landing phase. To ensure safety, the FAA sets specific minimums for ceiling and visibility for each approach procedure. The following sections provide an overview of the general types of approaches available, and the criteria used to guide pilots in safe decision-making while flying an approach.

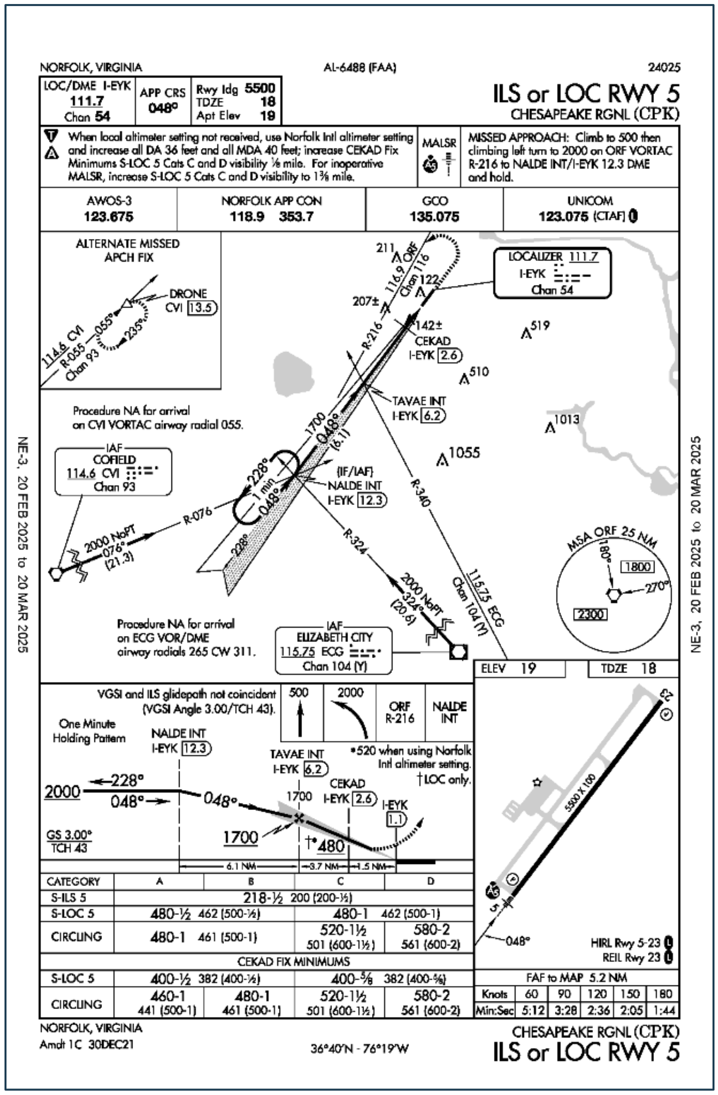


Figure 13: Instrument approach procedure at Chesapeake Regional (CPK).

3.1.1 Approach Classifications

Instrument approach procedures can be broadly classified into three categories. While all these procedures offer horizontal guidance, they are differentiated by the type of vertical guidance they provide. If there is no available approach procedure at an airport or a pilot is not instrument-rated, the alternative is to fly under visual flight rules (VFR).

PRECISION APPROACH (PA)

Precision approaches rely on a navigation system that provides course and glide path deviation information, adhering to precision standards. The most common example of a precision approach is an ILS. Other approaches in this category are the ground-based augmentation system (GBAS) landing system (GLS) and precision approach radar (PAR) approaches.

APPROACH WITH VERTICAL GUIDANCE (APV)

This category of instrument approach uses a navigation system that provides both course and glide path deviation information, although it does not meet the precision approach standards. RNAV (GPS) localizer performance with vertical guidance (LPV), lateral navigation/vertical navigation (LNAV/VNAV), and required navigation performance (RNP) procedures are examples of approaches with vertical guidance.

NON-PRECISION APPROACH (NPA)

This type of instrument approach relies on a navigation system that offers course deviation information but lacks glide path deviation information. Examples of NPA procedures include VOR, TACAN, LNAV, LP, NDB, LOC, and ASR approaches.

3.1.2 Approach Maneuvers

Approach maneuvers are critical for ensuring safe landings. They guide the aircraft from the en route phase to the landing phase, ensuring alignment with the runway and proper descent rates. Proper execution of these maneuvers helps avoid obstacles and other airspace obstructions that may protrude into the approach path.

Fixes are predetermined points in the flight path used for navigation and ensuring the aircraft is on the correct approach path. Each approach plate includes specific fixes that pilots must follow, helping maintain the proper altitude and heading during the approach. The roles of fixes on approach plates are to monitor the aircraft's position and make necessary adjustments to the flight path to ensure the appropriate heading and descent rate. Some approaches have fixed minimums. These are not mandatory to execute the root approach, but can offer lower minimums if additional navigational equipment is utilized. For instance, when flying a VOR approach with a fixed minimum requiring a DME, having a DME allows for lower minimums during that approach.

STRAIGHT-IN

A straight-in approach refers to an instrument approach where the aircraft transitions directly to the final approach phase without performing a procedure turn. The height above touchdown (HAT) is the vertical distance from the minimum descent altitude (MDA) or decision altitude (DA) to the highest point on the runway's first 3,000 feet. HATs are specified for straight-in procedures.

CIRCLING

Approaches that deviate more than thirty degrees from the runway alignment in their final segment are classified as circling approaches. If the approach clearance does not specify a landing runway, the pilot can choose any suitable runway for landing. Circling approaches are particularly hazardous, especially at night or in poor weather conditions. As an extension of an instrument approach, a circling approach involves flying a visual segment at low altitude and airspeed without lateral or vertical guidance to the runway. The height above airport (HAA) is the height of the MDA above the published airport elevation. HAAs are specified for circling procedures. The visibility published on an approach chart is dependent on many variables. These variables include HAT or HAA, approach lighting system coverage, type of approach procedure, and obstructions to the approach surfaces.

3.1.3 Landing Minimums

VISIBILITY

Visibility, as defined by the FAA, "is the ability, as determined by atmospheric conditions and expressed in units of distance, to see and identify prominent unlighted objects by day and prominent lighted objects by night. Visibility is reported as statute miles, hundreds of feet, or meters."

The overarching goal is to provide the lowest possible landing minimums without compromising safety, thereby enhancing the airport's accessibility and utility during adverse weather conditions. Standard instrument approach procedures are developed using either on-airport or nearby NAVAIDs or the GPS, which offers satellite-based navigation. The type and designation of each procedure are determined by the underlying navigational system or equipment used.

Prevailing visibility, often reported in statute miles (SM), is the horizontal distance over which objects or bright lights can be seen and identified over at least half of the horizon circle. It provides a general sense of the visibility conditions in the vicinity of the airport.

Runway visibility value (RVV) measures the distance a pilot can see unlighted objects down the runway. It is reported in statute miles for individual runways and is derived from a transmissometer specific to that runway. When available, RVV is used instead of prevailing visibility to determine specific runway minimums, as it provides a more precise measurement of visibility along the runway.

Runway visual range (RVR) is an instrumentally derived value based on standard calibrations, representing the horizontal distance a pilot can see down the runway from the approach end. It is determined by the sighting of either high-intensity runway lights or the visual contrast of other targets, whichever yields the greater visual range. Unlike prevailing visibility or RVV, RVR is based on what a pilot in a moving aircraft should see looking down the runway. RVR is reported in hundreds of feet and measured by transmissometers near the runway. If multiple transmissometers are installed, they provide RVR reports for runway thirds, including touchdown, mid-point, and rollout RVR.

CEILING

Ceiling minimums are essential for ensuring safe flight operations, particularly during instrument approaches. Ceiling minimums refer to the lowest altitude at which a pilot can descend during an instrument approach procedure while maintaining obstacle clearance. Precision and APV approaches are flown to a decision altitude (DA), whereas non-precision approaches are flown to a minimum descent altitude (MDA). Both elevation values are expressed in mean sea level (MSL).

Decision altitude (DA) applies to precision approaches and approaches with vertical guidance. The DA is the altitude at which a pilot must decide to proceed with the approach or initiate a missed approach, called a go-around. **Decision height (DH)** is used in Category II and III ILS approaches, which are only available at IAD, DCA, and RIC.

Minimum descent altitude (MDA) applies to non-precision approaches. The MDA is the lowest permissible altitude without visual confirmation of the runway, after which the pilot proceeds to land.

The MDA is specified for non-precision approaches, while the DA is designated for precision approaches and those with vertical guidance. Both MDAs and DAs are measured in MSL and are crucial for determining whether a pilot can safely proceed with landing.

The HAT and HAA provide further context for ceiling minimums that reflect elevation above ground level (AGL). HAT refers to the height of the MDA or DA above the highest runway elevation within the first 3,000 feet of the runway, and it is used for straight-in procedures. HAA indicates the height of the MDA above the published airport elevation and is used for circling procedures. These measurements ensure pilots clearly understand the altitude constraints during the approach phase, enhancing safe landing operations.

AIRCRAFT APPROACH CATEGORY

Landing minimums on approach procedures are published based on aircraft approach speeds.

- **Category A:** Less than 91 knots.
- **Category B:** 91 knots or more but less than 121 knots.
- **Category C:** 121 knots or more but less than 141 knots.
- **Category D:** 141 knots or more but less than 166 knots.

It is important to note that the minimums associated with these categories should be chosen based on the actual approach speed, not the certified category of the aircraft flown. Generally, minimums included in this analysis reflect Category B unless otherwise noted.

Table 9: Example of aircraft approach categories and fixed minimums.

CATEGORY	A	B	C	D
S-ILS 5	218-½ 200 (200-½)			
S-LOC 5	480-½ 462 (500-½)		480-1 462 (500-1)	
CIRCLING	480-1 461 (500-1)		520-1½ 501 (600-1½)	580-2 561 (600-2)
CEKAD FIX MINIMUMS				
S-LOC 5	400-½ 382 (400-½)		400-⅝ 382 (400-⅝)	
CIRCLING	460-1 441 (500-1)	480-1 461 (500-1)	520-1½ 501 (600-1½)	580-2 561 (600-2)

Source: FAA

3.1.4 Specific Procedure Types

GROUND-BASED APPROACHES

Ground-based approaches are typically published as ILS, ILS or LOC, LOC, LOC/DME, NDB, VOR, or VOR/DME approach types. These approaches are either precision or non-precision approaches based on the availability of vertical guidance.

PERFORMANCE-BASED APPROACHES

Performance- or satellite-based navigation is derived from GPS, a U.S.-owned system of satellites that calculate an object's location in space, in this case, the location of an airplane. Building on the GPS system, the FAA developed the wide area augmentation system (WAAS) and local area augmentation system (LAAS). WAAS is well established, having reached full operational capability in 2008. WAAS augments GPS with three geostationary satellites to correct GPS time errors, thereby providing high accuracy and preventing errors. LAAS is now more commonly referred to as GBAS or the ground-based augmentation system. GBAS is still in development, with its first certifications for Category I approaches being achieved in 2020. GBAS transmits differential corrections, error bounds, and approach guidance information to nearby local aircraft via a VHF data broadcast that uses the existing ILS localizer frequency band (108 –118 MHz). It is considered the most accurate form of civil satellite navigation. Precision-based navigation (PBN) approach types include LPV, LP, LNAV/VNAV, LNAV, and RNP. LPV and LNAV/VNAV approaches are typical approaches with vertical guidance (APVs), while LP and LNAV are common examples of non-precision RNAV (GPS) approaches.

RNAV refers to "area navigation." There are many different authorization levels for the use of RNAV approach systems. Factors determining the level of authorization include the type of equipment installed in the aircraft, the redundancy of that equipment, its operational status, the level of flight crew training, the level of the operator's FAA authorization, etc.

- **LNAV:** Lateral navigation (LNAV) represents minimums provided for RNAV systems with only lateral guidance. Because vertical guidance is not provided, the procedure's minimum altitude is published as an MDA. These minimums are used similarly to non-precision approach minimums.
- **VNAV:** Vertical navigation (VNAV) provides a glide path for aircraft descent and is often used in conjunction with LNAV to provide horizontal and vertical guidance.
- **LPV:** Localizer performance with vertical guidance (LPV) refers to minimums for approaches with vertical guidance that use WAAS to provide electronic vertical guidance capability. Aircraft must have WAAS-approved avionics equipment to fly to LPV minimums associated with these approaches.
- **LNAV/VNAV:** Minimums listed as LNAV/VNAV are APV minimums used by aircraft with RNAV equipment that provides both lateral and vertical information in the approach environment. The equipment includes WAAS avionics approved for LNAV/VNAV approaches, certified barometric-VNAV (Baro-VNAV) systems with an IFR-approach-approved GPS, certified Baro-VNAV systems with an IFR-approach-approved WAAS system, or approach-certified RNP 0.3 systems. Minimums are shown as DAs because the approaches are flown using an electronic glide path. Other RNAV systems require special approval.
- **RNP:** Required navigation performance (RNP) defines navigation performance for operations within specific airspace. RNP offers enhanced accuracy, resulting in greater precision and lower minimums compared to conventional RNAV. In addition to lower minimums, RNP provides improved obstacle clearance limits. The inclusion of curved flight tracks in RNP procedures allows aircraft to avoid critical terrain or conflicting airspace. RNP procedures require special training and authorization for both aircraft and aircrew.

Table 10 outlines the approach availability at each Virginia system airport. Highlighted rows indicate airports with DOAV NAVAID ownership.

Table 10: Virginia airport approach availability.

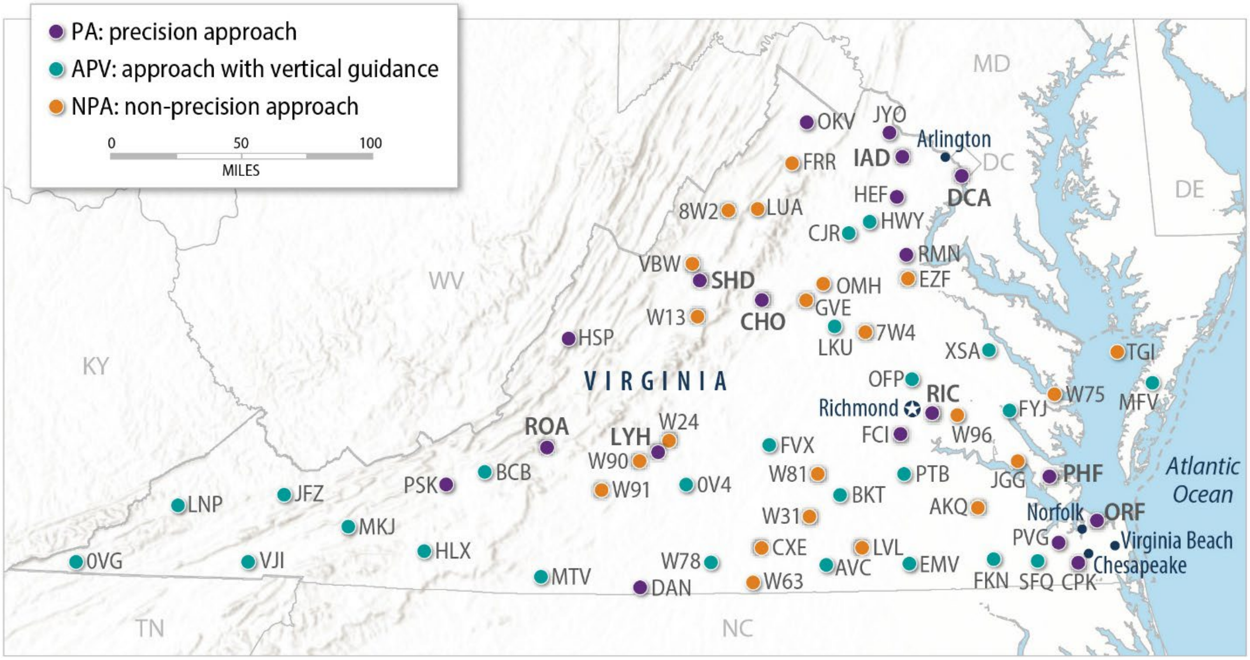
PA = precision approach APV = approach with vertical guidance NPA = non-precision approach

ID	Airport	PA	APV	NPA
CHO	Charlottesville-Albemarle	✓	✓	✓
CPK	Chesapeake Regional	✓	✓	✓
DAN	Danville Regional	✓	✓	✓
DCA	Ronald Reagan Washington National	✓	✓	✓
FCI	Richmond Executive-Chesterfield County	✓	✓	✓
HEF	Manassas Regional	✓	✓	✓
HSP	Ingalls Field	✓	✓	✓
IAD	Washington Dulles International	✓	✓	✓
JYO	Leesburg Executive	✓	✓	✓
LYH	Lynchburg Regional	✓	✓	✓
PHF	Newport News-Williamsburg International	✓	✓	✓
PSK	New River Valley	✓	✓	✓
OKV	Winchester Regional	✓	✓	✓
ORF	Norfolk International	✓	✓	✓
PVG	Hampton Roads Executive	✓	✓	✓
RIC	Richmond International	✓	✓	✓
RMN	Stafford Regional	✓	✓	✓
ROA	Roanoke-Blacksburg Regional	✓	✓	✓
SHD	Shenandoah Valley Regional	✓	✓	✓
0V4	Brookneal-Campbell County		✓	✓
0VG	Lee County		✓	✓
AVC	Mecklenburg-Brunswick Regional		✓	✓
BCB	Virginia Tech-Montgomery Executive		✓	✓
BKT	Allan C. Perkinson Municipal		✓	✓
CJR	Culpeper Regional		✓	✓
EMV	Emporia-Greensville Regional		✓	✓
FKN	Franklin Municipal		✓	✓
FVX	Farmville Regional		✓	✓
FYJ	Middle Peninsula Regional		✓	✓
HLX	Twin County		✓	✓
HWY	Warrenton-Fauquier		✓	✓
JFZ	Tazewell County		✓	✓

ID	Airport	PA	APV	NPA
LKU	Louisa County		✓	✓
LNP	Lonesome Pine		✓	✓
MFV	Accomack County		✓	✓
MKJ	Mountain Empire		✓	✓
MTV	Blue Ridge		✓	✓
OFP	Hanover County Municipal		✓	✓
PTB	Dinwiddie County		✓	✓
SFQ	Suffolk Executive		✓	✓
VJI	Virginia Highlands		✓	✓
W78	William M. Tuck		✓	✓
XSA	Tappahannock-Essex County		✓	✓
7W4	Lake Anna			✓
8W2	New Market*			✓
AKQ	Wakefield Municipal			✓
CXE	Chase City Municipal			✓
EZF	Shannon			✓
FRR	Front Royal-Warren County*			✓
GVE	Gordonsville Municipal*			✓
JGG	Waltrip Williamsburg Executive*			✓
LUA	Luray Caverns			✓
LVL	Brunswick County*			✓
OMH	Orange County			✓
TGI	Tangier Island*			✓
VBW	Bridgewater Air Park			✓
W13	Eagle's Nest			✓
W24	Falwell			✓
W31	Lunenburg County*			✓
W63	Lake Country Regional			✓
W75	Hummel Field			✓
W81	Crewe Municipal*			✓
W90	New London			✓
W91	Smith Mountain Lake			✓
W96	New Kent County			✓
Total		**19**	**43 (24)**	**65 (22)**

Source: FAA

**Circling-only approach*



Source: FAA and Woolpert

Figure 14: Airports by procedure capability.

3.2 Airport Approach Procedures

3.2.1 Ground-Based Navigation (GBN)

Virginia has eighty-four IAPs that primarily rely on ground-based navigation. ***Table 11*** lists the nineteen approach types at Dulles (IAD) and Reagan (DCA) airports, as well as the remaining sixty-five across the Commonwealth.

Table 11: Approach types in Virginia.

Types	Number at IAD and DCA	Number in rest of Commonwealth
ILS	8	2 (RIC only)
ILS or LOC	7	22
LDA	2	2 (ROA only)
LOC		15
LOC/DME	1	2 (HWY and JFZ)
NDB		3
VOR		15
VOR/DME	1	4
TOTAL	**19**	**65**

ILS, ILS OR LOC, LDA

There are ten ILS approaches in Virginia, all of which are located at either Washington Dulles International (IAD), Ronald Reagan Washington National (DCA), or Richmond International (RIC). There are another twenty-six ILS or LOC and LDA approaches at Virginia airports analyzed as part of this study.

A standard decision height and visibility for ILS approaches is 200 feet above ground level (AGL) and a ½ statute mile (SM). In Virginia, fifteen of the twenty-four precision approaches meet this standard. Of the nine airports that do not meet this standard, five have ceiling heights higher than 200, and seven have visibility minimums higher than a ½ SM.

Localizer directional aid (LDA) approaches are only available at Roanoke-Blacksburg Regional Airport (ROA). These approaches are most common in areas with terrain that impacts the localizer antenna location, which is a prominent factor at that airport. The LDA approaches at ROA incorporate a glideslope, thereby providing both lateral and vertical guidance. This runway is also equipped with a MALSR, which allows for lower minimums. In this instance, as well as at other airports with Y and Z approach variations, the Z approach incorporates lower minimums and is specific to aircraft and pilots with certain equipment and certifications. The ILS or LOC approaches at runways with DOAV-owned NAVAIDs all incorporate a localizer, glideslope, distance measuring equipment, and approach lighting systems.

Table 12: ILS, ILS or LOC, and LDA approaches.

ID	Airport	Approach	Minimums	NAVAID owner
CHO	Charlottesville-Albemarle	ILS or LOC RWY 3	200 | ½	FAA
CPK	Chesapeake Regional	ILS or LOC RWY 5	200 | ½	VA
DAN	Danville Regional	ILS or LOC RWY 2	200 | ½	FAA
FCI	Richmond Executive	ILS or LOC RWY 33	200 | ½	VA
HEF	Manassas Regional	ILS or LOC RWY 16L	200 | ½	FAA
HSP	Ingalls Field	ILS or LOC RWY 25	300 | ⅞	FAA
JYO	Leesburg Executive	ILS or LOC RWY 17	300 | ¾	FAA
LYH	Lynchburg Regional	ILS or LOC RWY 4	200 | ½	FAA
OKV	Winchester Regional	ILS or LOC RWY 32	200 | ½	VA
ORF	Norfolk International	ILS or LOC RWY 5	200 | ½	FAA
ORF	Norfolk International	ILS or LOC RWY 23	200 | ½	FAA
PHF	Newport News-Williamsburg International	ILS or LOC RWY 7	200 | ½	FAA
PHF	Newport News-Williamsburg International	ILS or LOC RWY 25	200 | ¾	FAA
PSK	New River Valley	ILS or LOC Y RWY 6	200 | 1	FAA
PSK	New River Valley	ILS or LOC Z RWY 6	200 | 1	FAA
PVG	Hampton Roads Executive	ILS or LOC RWY 10	200 | ¾	VA
RIC	Richmond International	ILS RWY 34 (SA Cat. I)	150 | 1400 RVR	FAA
RIC	Richmond International	ILS RWY 34 (Cat. II & III)	100 | 1200 RVR	FAA
RIC	Richmond International	ILS or LOC RWY 2	300 | ¾	FAA
RIC	Richmond International	ILS or LOC RWY 16	200 | ½	FAA
RIC	Richmond International	ILS or LOC RWY 34	200 | ½	FAA

ID	Airport	Approach	Minimums	NAVAID owner
RMN	Stafford Regional	ILS or LOC RWY 33	300 | ¾	VA
ROA	Roanoke-Blacksburg Regional	ILS or LOC RWY 34	500 | ⅞	FAA
ROA	Roanoke-Blacksburg Regional	LDA Y RWY 6	700 | 2	FAA
ROA	Roanoke-Blacksburg Regional	LDA Z RWY 6	300 | ½	FAA
SHD	Shenandoah Valley Regional	ILS or LOC RWY 5	200 | ½	FAA

Source: FAA

LOC AND LOC/DME

Localizer (LOC) or LOC/DME approaches are available at seventeen airports in Virginia. Typical approach minimums for LOC and LOC/DME approaches are 400 feet AGL ceiling and 1 SM visibility. Seven of the LOC or LOC/DME approaches meet this standard, while the remaining approaches have increased ceiling minimums, ranging from 500 to 900 feet AGL. All but one airport, Abingdon (VJI), meets the 1 SM visibility standard. Commonwealth-owned localizers and DME support fifteen of the seventeen LOC or LOC/DME approaches.

Visibility of less than one statute mile is only present at Blue Ridge Airport (MTV) and is available to Category A and B aircraft. These minimums are available as this runway is equipped with an omnidirectional approach lighting system (ODAL). Approach lighting systems are installed at five of the airports with LOC approaches, presenting a potential opportunity for reduced visibility minimums.

Table 13: LOC or LOC/DME approaches.

ID	Airport	Approach	Minimums	NAVAIDs	ALS
AVC	Mecklenburg-Brunswick Regional	LOC RWY 1	400 | 1	VA (LOC, DME)	
BCB	Virginia Tech-Montgomery Executive	LOC RWY 13	400 | 1	VA (LOC, DME)	ODALS
CJR	Culpeper Regional	LOC RWY 4	400 | 1	VA (LOC, DME)	
EMV	Emporia-Greensville Regional	LOC RWY 34	400 | 1	VA (LOC, DME)	
FYJ*	Middle Peninsula Regional	LOC RWY 10	400 | 1	VA (LOC, DME)	
LKU	Louisa County	LOC RWY 27	400 | 1	VA (LOC, DME)	
LNP	Lonesome Pine	LOC RWY 24	500 | 1 (A/B)	FAA	ODALS
MFV	Accomack County	LOC RWY 3	500 | 1 (A/B)	VA (LOC, DME)	
MKJ	Mountain Empire	LOC RWY 26	700 | 1 (A/B)	VA (LOC, DME)	
MTV	Blue Ridge	LOC RWY 31	700 | ¾ (A/B)	VA (LOC, DME)	ODALS
OFP	Hanover County Municipal	LOC RWY 16	500 | 1 (A/B)	VA (LOC, DME)	
PHF	Newport News-Williamsburg	LOC RWY 20	400 | 1	FAA	
PTB	Dinwiddie County	LOC RWY 5	500 | 1	VA (LOC, DME)	ODALS
SFQ	Suffolk Executive	LOC RWY 4	600 | 1 (A/B)	VA (LOC, DME)	
VJI	Virginia Highlands	LOC RWY 24	900 | 1 ¼ (B)	VA (LOC, DME)	ODALS
HWY	Warrenton-Fauquier	LOC/DME RWY 15	500 | 1 (A/B)	VA (LOC, DME)	

ID	Airport	Approach	Minimums	NAVAIDs	ALS
JFZ	Tazewell County	LOC/DME RWY 25	600 | 1 (A/B)	VA (LOC, DME)	

Source: FAA
**Alternate Fix Minimums*

On LOC and LOC/DME approaches, VORs and NDBs typically serve as the missed approach fix or alternate missed approach fix. Approach plates may require amendments to reflect any changes in VOR or NDB status. Amendments to the approaches at Blacksburg (BCB), Culpeper (CJR), Blue Ridge (MTV), and Warrenton (HWY) have occurred or will be required due to the decommissioning of the TECH (TEC) and NAILR (MSQ) NDBs and the BALES (UV) LOM.

All seventeen LOC or LOC/DME approaches have a corresponding RNAV (GPS) approach with similar visibility and improved ceiling minimums, typically by 100 feet or more.

NDB

Over the course of the study, several DOAV-owned NDBs were either decommissioned or designated for future decommissioning. These include the NDBs at Culpeper (CJR) and Luray (LUA), as well as the Outer and Locator Outer Markers serving Blue Ridge Airport (MTV). Only two DOAV NDBs remain, including Wakefield (AKQ) and Shannon (EZF). These NDBs support the NDB RWY 20 approach at AKQ and the NDB RWY 24 approach at EZF. These approaches have relatively high minimums, with a ceiling height of 1,100 feet AGL and a visibility of 3 SM.

The approach at Blackstone (BKT) is supported by a FAA-owned NDB located off airport. The BKT NDB approach offers slightly better minimums than those served by DOAV-owned NDBs, but still fall short compared to the available performance-based approaches at these airports. ***Table 14*** provides a summary of the NDB approaches in Virginia.

Table 14: NDB approaches.

ID	Airport	Approach	Minimums	NAVAID
AKQ	Wakefield Municipal	NDB RWY 20	1100 | 3	VA (AKQ NDB)
BKT	Allan C. Perkinson Municipal	NDB-A	700 | 2 ¼ (A/B/C)	FAA (BKT NDB)
EZF	Shannon	NDB RWY 24	1100 | 3	VA (EZF NDB)

Source: FAA

At Wakefield and Shannon, there are RNAV (GPS) approaches to each respective runway with the same approach minimums provided in the NDB approaches, making the NDB approaches largely redundant. Each airport lacks an instrument approach procedure to the reciprocal runway end, which could be considered a potential gap. Overall, the NDB approaches do not offer better minimums than their RNAV (GPS) counterparts and could likely be considered for decommissioning.

For Perkinson, better circling minimums are offered on the RNAV (GPS) approaches to Runways 4 and 22, and each has a PV variation. This indicates that the NDB-A approach is largely redundant. At Shenandoah Valley, there is both an ILS or LOC and RNAV (GPS) approach to Runway 5 with better published minimums.

VOR OR VOR/DME

There are nineteen VOR or VOR/DME approaches to runways at Virginia airports, with eight of the nineteen approaches published as circling only. Minimums on these approaches range from as low as 400 feet AGL and 1 mile SM to 1,600 feet AGL and 1½ SM. It is important to note that VOR and VOR/DME approaches do not provide vertical guidance. The minimum descent altitude on a VOR approach can be as low as 250 feet, although none of the approaches reach that threshold. As outlined earlier, the FAA owns all VORs; therefore, subsequent decisions regarding the usefulness and viability of the VOR and VOR/DME approaches will ultimately be left to the FAA and the airport sponsor. ***Table 15*** lists the VOR or VOR/DME approaches in Virginia.

Table 15: VOR or VOR/DME approaches.

ID	Airport	Approach	Minimums	Primary NAVAID
CJR	Culpeper Regional	VOR-A	700 | 1 (A/B)	CSN L-VORTAC*
FYJ	Middle Peninsula Regional	VOR-A	600 | 1 (B)	HCM L-VORTAC
HWY	Warrenton-Fauquier	VOR RWY 15	800 | 1 ¼ (B)	CSN H-VORTAC*
JGG	Waltrip Williamsburg Executive	VOR-B	1100 | 3	HCM L-VORTAC
LYH	Lynchburg Regional	VOR RWY 22	900 | 1 ¼ (B)	LYH L-VORW/DME*
OFP	Hanover County Municipal	VOR RWY 16	800 | 1 ¼ (B)	RIC H-VORTAC
ORF	Norfolk International	VOR RWY 14	500 | 1 (A/B)	ORF H-VORTAC
PTB	Dinwiddie County	VOR RWY 23	600 | 1 (A/B)	HPW L-VORTAC
RIC	Richmond International	VOR RWY 2	500 | ¾ (A/B)	RIC H-VORTAC
RIC	Richmond International	VOR RWY 16	500 | ¾ (A/B/C)	RIC H-VORTAC
RIC	Richmond International	VOR RWY 20	500 | 1 (A/B)	RIC H-VORTAC
RIC	Richmond International	VOR RWY 34	400 | ½ (A/B)	RIC H-VORTAC
RMN	Stafford Regional	VOR RWY 33	600 | ¾ (A/B)	BRV L-VORTAC
W78*	William M. Tuck	VOR-A	600 | 1 (A/B)	SBV L-VORTAC
W96	New Kent County	VOR-A	600 | 1 (A/B)	RIC H-VORTAC
LUA	Luray Caverns	VOR/DME-B	1300 | 1 ½ (B)	LDN L-VORTAC*
OKV	Winchester Regional	VOR/DME-A	500 | 1 (B)	MRB L-VORTACW (WV)
OMH	Orange County	VOR/DME-A	1600 | 1 ½ (B)	GVE H-VORTAC
ORF	Norfolk International	VOR/DME RWY 32	500 | 1 (A/B)	ORF H-VORTAC

Source: FAA

**Alternate Fix Minimums*

Four of the six VORs scheduled for decommissioning as part of the MON plan directly support VOR approaches to Virginia airports.

The Waltrip Williamsburg Executive (JGG) VOR-B approach has the same minimums as the RNAV (GPS)-C approach; there may be an opportunity to improve the RNAV (GPS) minimums or add straight-in approaches to each runway end.

3.2.2 Performance-Based Navigation (PBN)

In the 2010 study, there were eighty satellite-based approach procedures, and only twenty-nine with vertical guidance (seventeen VNAV and twelve LPV).

At the publication of this study, there are over 150 satellite-based approaches available across the Commonwealth:

- RNAV (GPS) – 143
- RNAV (RNP) – 9

Performance-based approaches will be largely used in comparison to ground-based approaches at Virginia airports to illustrate the increased capabilities offered by these approaches, as well as the significant level of redundancy within the air transportation system.

3.3 Review of Recommendations from Previous Study

The 2010 study recommended the commissioning of twenty-two new IAPs. ***Table 16*** lists the recommended approaches. The highlighted approaches indicate that the approach has since been commissioned and is active. Nearly all approaches commissioned are performance-based. These approaches are easier to implement as they do not rely on installing or maintaining any new NAVAIDs. **Table 16** highlights those approach procedures recommended from the 2010 study, as well as those approaches that were subsequently implemented.

Table 16: Recommended IAPs from 2010 study.

ID	Airport	2010 proposed procedure	Current approach
BCB	Virginia Tech-Montgomery Executive	RNAV (GPS) RWY 30	RNAV (GPS) RWY 31
CHO	Charlottesville-Albemarle	LOC RWY 3	ILS or LOC RWY 3
CHO	Charlottesville-Albemarle	LOC RWY 21	Not implemented
EMV	Emporia-Greensville Regional	RNAV (GPS) RWY 15	RNAV (GPS) RWY 16
JYO	Leesburg Executive	RNAV (GPS) RWY 35	Not implemented
LKU	Louisa County	RNAV (GPS) RWY 9	RNAV (GPS) RWY 09
LYH	Lynchburg Regional	LOC RWY 22	Not implemented
MKJ	Mountain Empire	LOC/DME RWY 26	LOC RWY 27
MFV	Accomack County	RNAV (GPS) RWY 21	RNAV (GPS) RWY 21
PHF	Newport News	LOC RWY 20	LOC RWY 20
PVG	Hampton Roads Executive	LOC RWY 10	ILS or LOC RWY 10
PVG	Hampton Roads Executive	RNAV (GPS) RWY 2	Not implemented
OMH	Orange County	RNAV (GPS) RWY 26	RNAV (GPS) RWY 26
JFZ (6V3)	Tazewell County	RNAV (GPS) RWY 7	RNAV (GPS) RWY 7
OFP	Hanover County Municipal	RNAV (GPS) RWY 34	RNAV (GPS) RWY 34
W78	William M. Tuck	RNAV (GPS) RWY 19	Not implemented
RMN	Stafford Regional	RNAV (GPS) RWY 15	Not implemented

ID	Airport	2010 proposed procedure	Current approach
SFQ	Suffolk Executive	RNAV (GPS) RWY 22	RNAV (GPS) RWY 22
XSA	Tappahannock-Essex County	LOC RWY 28	Not implemented
FYJ	Middle Peninsula Regional	LOC RWY 27	Not implemented
LUA (W45)	Luray Caverns	LOC RWY 4	Not implemented

Source: 2010 VA F&E NAVAID Study

Twelve of the recommended IAPs have been commissioned since the last study. A significant trend identified in this analysis is the relative feasibility of implementing performance-based approaches compared to ground-based approaches that involve installing and maintaining NAVAID equipment.

3.4 Gap Analysis and Performance Evaluation

As part of the gap analysis, airports were evaluated for performance based on published minimums. The objective of the analysis was to determine the best available approach at each airport and whether it was performance-based or ground-based. With the overall shift to performance-based navigation, an airport would ideally have its best minimums available on the PBN approach. Although efficient performance-based approaches are present throughout the Commonwealth, it is still expected that an adequate level of redundancy is provided through legacy ground-based approaches.

Certain airports are equipped with approach procedures that rely entirely on FAA-owned NAVAIDs or are solely supported by performance-based approaches. While still being analyzed, these airports do not have approaches that rely on Virginia-owned NAVAIDs, so they are not prioritized in the gap analysis of approach procedure capabilities. ***Table 17*** outlines the best available approaches at Virginia system airports and published minimums.

Table 17: Comparison of best available performance- and ground-based approaches.

GBN = ground-based navigation PBN = performance-based navigation

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
CHO	Charlottesville-Albemarle	RNAV (GPS) RWY 3	200 | ½	ILS or LOC RWY 3	200 | ½	Equal
CPK	Chesapeake Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
DAN	Danville Regional	RNAV (GPS) RWY 2	200 | ½	ILS or LOC RWY 2	200 | ½	Equal
FCI	Richmond Executive-Chesterfield County	RNAV (GPS) RWY 33	300 | ½	ILS or LOC RWY 33	200 | ½	GBN
HEF	Manassas Regional	RNAV (GPS) RWY 16L	300 | ½	ILS or LOC RWY 16L	200 | ½	GBN
HSP	Ingalls Field	RNAV (GPS) RWY 25	400 | 1 ¼	ILS or LOC RWY 25	300 | ⅞	GBN
JYO	Leesburg Executive	RNAV (GPS) RWY 17	300 | ¾	ILS or LOC RWY 17	300 | ¾	Equal

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
LYH	Lynchburg Regional	RNAV (GPS) RWY 4	300 | ½	ILS or LOC RWY 4	200 | ½	GBN
OKV	Winchester Regional	RNAV (GPS) RWY 32	200 | ¾	ILS or LOC RWY 32	200 | ½	GBN
ORF	Norfolk International	RNAV (GPS) Z RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
PHF	Newport News-Williamsburg	RNAV (GPS) RWY 7	300 | ½	ILS or LOC RWY 7	200 | ½	GBN
PSK	New River Valley	RNAV (GPS) RWY 6	200 | 1	ILS or LOC Z RWY 6	200 | 1	Equal
PVG	Hampton Roads Executive	RNAV (GPS) RWY 10	200 | ¾	ILS or LOC RWY 10	200 | ¾	Equal
RIC	Richmond International	RNAV (GPS) Z RWY 16	200 | ½	ILS or LOC RWY 16	200 | ½	Equal
RMN	Stafford Regional	RNAV (GPS) RWY 33	300 | ¾	ILS or LOC RWY 33	200 | ¾	GBN
SHD	Shenandoah Valley Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
ROA	Roanoke-Blacksburg Regional	RNAV (RNP) Z RWY 6	300 | ½	LDA Z RWY 6	300 | ¾	PBN
AVC	Mecklenburg-Brunswick Regional	RNAV (GPS) RWY 1	300 | 1	LOC RWY 1	400 | 1	PBN
BCB	Virginia Tech-Montgomery Executive	RNAV (GPS) RWY 31	300 | ⅞	LOC RWY 13	400 | 1	PBN
CJR	Culpeper Regional	RNAV (GPS) RWY 4	300 | 1	LOC RWY 4	400 | 1	PBN
EMV	Emporia-Greensville Regional	RNAV (GPS) RWY 34	300 | 1	LOC RWY 34	400 | 1	PBN
FYJ	Middle Peninsula Regional	RNAV (GPS) RWY 10	300 | 1	LOC RWY 10	400 | 1	PBN
LKU	Louisa County	RNAV (GPS) RWY 27	300 | ¾	LOC RWY 27	400 | 1	PBN
LNP	Lonesome Pine	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	PBN
MKJ	Mountain Empire	RNAV (GPS) RWY 26	600 | 1	LOC RWY 26	700 | 1	PBN
MTV	Blue Ridge	RNAV (GPS) RWY 31	300 | ¾	LOC RWY 31	500 | 1	PBN
OFP	Hanover County Municipal	RNAV (GPS) RWY 34	300 | 1	LOC RWY 16	500 | 1	PBN
PTB	Dinwiddie County	RNAV (GPS) RWY 23	300 | 1	LOC RWY 5	500 | 1	PBN

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
SFQ	Suffolk Executive	RNAV (GPS) RWY 4	300 | ⅞	LOC RWY 4	600 | 1	PBN
VJI	Virginia Highlands	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	PBN
HWY	Warrenton-Fauquier	RNAV (GPS) RWY 15	200 | ¾	LOC/DME RWY 15	500 | 1	PBN
JFZ	Tazewell County	RNAV (GPS) RWY 7	500 | 1	LOC/DME RWY 25	600 | 1	PBN
AKQ	Wakefield Municipal	RNAV (GPS) RWY 20	1100 | 3	NDB RWY 20	1100 | 3	Equal
BKT	Allan C. Perkinson Municipal	RNAV (GPS) RWY 4	1100 | 3	NDB-A	700 | 2 ¼	GBN
EZF	Shannon	RNAV (GPS) RWY 24	1100 | 3	NDB RWY 24	1100 | 3	Equal
JGG	Waltrip Williamsburg Executive	RNAV (GPS)-C	1100 | 3	VOR-B	1100 | 3	Equal
LUA	Luray Caverns	RNAV (GPS) RWY 22	600 | 1	VOR/DME-B	1300 | 1 ¼	PBN
MFV	Accomack County	RNAV (GPS) RWY 3	300 | 1	LOC RWY 3	500 | 1	PBN
OMH	Orange County	RNAV (GPS) RWY 8	600 | 1	VOR/DME-A	1600 | 1 ¼	PBN
W78	William M. Tuck	RNAV (GPS) RWY 1	300 | 1	VOR-A	600 | 1	PBN
W96	New Kent County	RNAV (GPS) RWY 11	500 | 1	VOR-A	600 | 1	PBN
0V4	Brookneal-Campbell County	RNAV (GPS) RWY 6	300 | 1	-	-	PBN Only
0VG	Lee County	RNAV (GPS) RWY 7	300 | 1	-	-	PBN Only
7W4	Lake Anna	RNAV (GPS) RWY 8	1100 | 3	-	-	PBN Only
8W2	New Market	RNAV (GPS)-A	1100 | 3	-	-	PBN Only
CXE	Chase City Municipal	RNAV (GPS) RWY 18	1100 | 3	-	-	PBN Only
FKN	Franklin Municipal	RNAV (GPS) RWY 9	300 | 1	-	-	PBN Only
FRR	Front Royal-Warren County	RNAV (GPS)-A	1200 | 1 ¼	-	-	PBN Only
FVX	Farmville Regional	RNAV (GPS) RWY 21	300 | 1	-	-	PBN Only
GVE	Gordonsville Municipal	RNAV (GPS)-A	1100 | 3	-	-	PBN Only

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
HLX	Twin County	RNAV (GPS) RWY 1	300 | 1	-	-	PBN Only
LVL	Brunswick County	RNAV (GPS)-A	1100 | 3	-	-	PBN Only
TGI	Tangier Island	RNAV (GPS)-B	600 | 1	-	-	PBN Only
VBW	Bridgewater Air Park	RNAV (GPS) RWY 33	700 | 1	-	-	PBN Only
W13	Eagle's Nest	RNAV (GPS) RWY 6	1100 | 3	-	-	PBN Only
W24	Falwell	RNAV (GPS) RWY 28	600 | 1	-	-	PBN Only
W31	Lunenburg County	RNAV (GPS)-A	500 | 1	-	-	PBN Only
W63	Lake Country Regional	RNAV (GPS) RWY 4	400 | 1	-	-	PBN Only
W75	Hummel Field	RNAV (GPS) RWY 1	1100 | 3	-	-	PBN Only
W81	Crewe Municipal	RNAV (GPS)-A	1000 | 3	-	-	PBN Only
W90	New London	RNAV (GPS) RWY 18	1100 | 3	-	-	PBN Only
W91	Smith Mountain Lake	RNAV (GPS) RWY 23	1100 | 3	-	-	PBN Only
XSA	Tappahannock-Essex County	RNAV (GPS) RWY 28	300 | 1	-	-	PBN Only

Source: FAA

As the next step in the gap analysis, airports were separated into three distinct groupings based on approach type availability and NAVAID ownership (see ***Figure 15***). Dulles and Reagan National are not included.

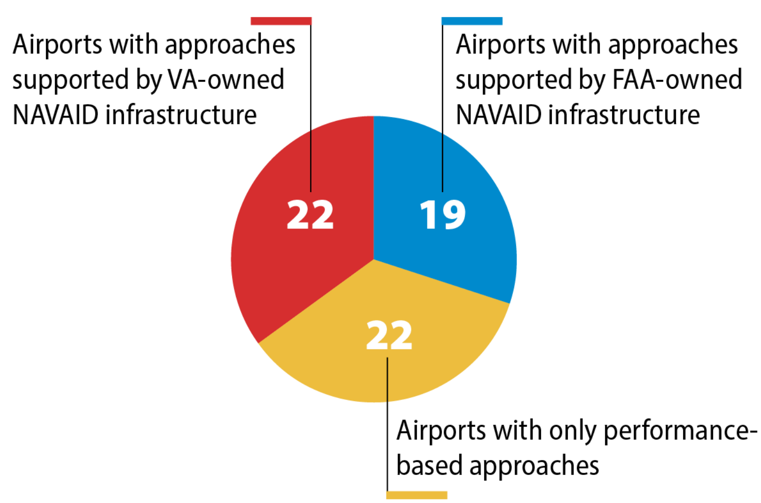


Figure 15: Approach-type availability and NAVAID ownership.

3.4.1 Airports with Approaches Supported by FAA-Owned NAVAID Infrastructure

Nineteen of the study airports have ground-based approaches supported by FAA equipment; thus, DOAV is limited in influencing the future of these approach procedures. The VOR and VOR/DME approaches are supported by NAVAIDs anticipated to remain part of the FAA MON, except for the VOR/DME-B approach at Luray, which uses the LDN VORTAC.

Table 18: Airports with an approach supported by FAA-owned NAVAID infrastructure.

ID	Airport	PBN	Minimums	GBN	Minimums	Gap
CHO	Charlottesville-Albemarle	RNAV (GPS) RWY 3	200 | ½	ILS or LOC RWY 3	200 | ½	No
DAN	Danville Regional	RNAV (GPS) RWY 2	200 | ½	ILS or LOC RWY 2	200 | ½	No
HSP	Ingalls Field	RNAV (GPS) RWY 25	400 | 1 ¼	ILS or LOC RWY 25	300 | ⅞	Yes
JYO	Leesburg Executive	RNAV (GPS) RWY 17	300 | ¾	ILS or LOC RWY 17	300 | ¾	No
LYH	Lynchburg Regional	RNAV (GPS) RWY 4	300 | ½	ILS or LOC RWY 4	200 | ½	Yes
HEF*	Manassas Regional	RNAV (GPS) RWY 16L	300 | ½	ILS or LOC RWY 16L	200 | ½	Yes
PSK	New River Valley	RNAV (GPS) RWY 6	200 | 1	ILS or LOC Z RWY 6	200 | 1	No
PHF	Newport News-Williamsburg	RNAV (GPS) RWY 7	300 | ½	ILS or LOC RWY 7	200 | ½	Yes
ORF	Norfolk International	RNAV (GPS) Z RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	No
RIC	Richmond International	RNAV (GPS) Z RWY 16	200 | ½	ILS or LOC RWY 16	200 | ½	No
ROA	Roanoke-Blacksburg Regional	RNAV (RNP) Z RWY 6	300 | ½	LDA Z RWY 6	300 | ½	No
SHD	Shenandoah Valley Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	No
LNP	Lonesome Pine	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	No
BKT	Allan C. Perkinson Municipal	RNAV (GPS) RWY 4	300 | 1	NDB-A	700 | 2 ¼	No
LUA	Luray Caverns	RNAV (GPS) RWY 22	600 | 1	VOR/DME-B	1300 | 1 ¼	No
W96	New Kent County	RNAV (GPS) RWY 11	500 | 1	VOR-A	600 | 1	No
OMH	Orange County	RNAV (GPS) RWY 8	600 | 1	VOR/DME-A	1600 | 1 ¼	No
W78	William M. Tuck	RNAV (GPS) RWY 1	300 | 1	VOR-A	600 | 1	No
JGG	Waltrip Williamsburg Executive	RNAV (GPS)-C	1100 | 3	VOR-B	1100 | 3	No

Source: FAA

EVALUATION SUMMARY:

- Four of the nineteen airports in this grouping have RNAV (GPS) approaches with minimums higher than those of the comparable ground-based approaches: Ingalls Field (HSP), Lynchburg Regional (LYH), Manassas Regional (HEF), and Newport News (PHF).
- Eight of the eleven airports with ILS or LOC approaches already achieve reasonable minimums of 200 and ½ mile with current equipment. The three airports that do not meet that standard include Ingalls Field (HSP), Leesburg Executive (JYO), and New River Valley (PSK).
- Six airports with circling approaches supported by FAA NAVAIDs each have at least one RNAV (GPS) approach with equal or better minimums than those offered in the ground-based circling approaches. Those airports are Allan C. Perkinson Municipal (BKT), Luray Caverns (LUA), William M. Tuck (W78), New Kent County (W96), Orange County (OMH), and Waltrip Williamsburg Executive (JGG).
- The LOC approach to Runway 24 at Lonesome Pine is supplemented by an RNAV (GPS) approach with LPV minimums of 300 and 1. This represents a slightly better performance than the LOC approach and offers vertical guidance.

As this grouping of airports and the associated procedures relies on equipment owned and maintained by the FAA, they are not prioritized in the approach procedure gap analysis.

3.4.2 Airports with Performance-Based Approaches Only

Twenty-two of the study airports are supported solely by PBN approaches, meaning they do not ultimately rely on ground-based equipment for use. These airports are predominantly lower traffic facilities in the Virginia General Aviation-Community or Local Service roles and are typically considered GA Basic in the NPIAS or not included. For those airports not included in the NPIAS, funding for ground-based procedures from the FAA is unavailable. There is limited justification for the airports in this grouping to require a ground-based procedure.

Table 19 lists those airports with performance-based approaches only.

Table 19: Airports with performance-based approaches only.

ID	Airport	Best approach	Minimums
0V4	Brookneal-Campbell County	RNAV (GPS) RWY 6	300 | 1
0VG	Lee County	RNAV (GPS) RWY 7	300 | 1
7W4	Lake Anna	RNAV (GPS) RWY 8	1100 | 3
8W2	New Market	RNAV (GPS)-A	1100 | 3
CXE	Chase City Municipal	RNAV (GPS) RWY 18	1100 | 3
FKN	Franklin Municipal	RNAV (GPS) RWY 9	300 | 1
FRR	Front Royal-Warren County	RNAV (GPS)-A	1200 | 1 ¼
FVX	Farmville Regional	RNAV (GPS) RWY 21	300 | 1
GVE	Gordonsville Municipal	RNAV (GPS)-A	1100 | 3
HLX	Twin County	RNAV (GPS) RWY 1	300 | 1

ID	Airport	Best approach	Minimums
LVL	Brunswick County	RNAV (GPS)-A	1100 | 3
TGI	Tangier Island	RNAV (GPS)-B	600 | 1
VBW	Bridgewater Air Park	RNAV (GPS) RWY 33	700 | 1
W13	Eagle's Nest	RNAV (GPS) RWY 6	1100 | 3
W24	Falwell	RNAV (GPS) RWY 28	600 | 1
W31	Lunenburg County	RNAV (GPS)-A	500 | 1
W63	Lake Country Regional	RNAV (GPS) RWY 4	400 | 1
W75	Hummel Field	RNAV (GPS) RWY 1	1100 | 3
W81	Crewe Municipal	RNAV (GPS)-A	1000 | 3
W90	New London	RNAV (GPS) RWY 18	1100 | 3
W91	Smith Mountain Lake	RNAV (GPS) RWY 23	1100 | 3
XSA	Tappahannock-Essex County	RNAV (GPS) RWY 28	300 | 1

Source: FAA

EVALUATION SUMMARY:

- Seven airports offer circling-only approaches (8W2, FRR, GVE, LVL, TGI, W31, W81).
- Nine airports have minimums of 1100 and 3 and offer potential opportunities for improvement.

3.4.3 Airports with Approaches Supported by VA DOAV NAVAID Infrastructure

Twenty-two airports have approaches supported by NAVIADs owned by the Commonwealth. In most instances, this equipment is located within an airport's fence line, but there are several instances where an NDB is located on leased property off the airport.

Table 20 compares approach procedure capabilities to assess if there is any potential gap where ground-based procedure capabilities are not matched or exceeded by a similar performance-based approach.

Table 20: Airports with approaches relying on Commonwealth-owned equipment.

ID	Airport	PBN	Minimums	GBN	Minimums	Gap
AKQ	Wakefield Municipal	RNAV (GPS) RWY 20	1100 | 3	NDB RWY 20	1100 | 3	No
AVC	Mecklenburg-Brunswick Regional	RNAV (GPS) RWY 1	300 | 1	LOC RWY 1	400 | 1	No
BCB	Virginia Tech-Montgomery Executive	RNAV (GPS) RWY 31	300 | ⅞	LOC RWY 13	400 | 1	No
CJR	Culpeper Regional	RNAV (GPS) RWY 4	300 | 1	LOC RWY 4	400 | 1	No
CPK	Chesapeake Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	No
EMV	Emporia-Greensville Regional	RNAV (GPS) RWY 34	300 | 1	LOC RWY 34	400 | 1	No
EZF	Shannon	RNAV (GPS) RWY 24	1100 | 3	NDB RWY 24	1100 | 3	No

ID	Airport	PBN	Minimums	GBN	Minimums	Gap
FCI	Richmond Executive-Chesterfield County	RNAV (GPS) RWY 33	300 |½	ILS or LOC RWY 33	200 | ½	Yes
FYJ	Middle Peninsula Regional	RNAV (GPS) RWY 10	300 | 1	LOC RWY 10	700 | 1	No
HWY	Warrenton-Fauquier	RNAV (GPS) RWY 15	200 | ¾	LOC/DME RWY 15	500 | 1	No
JFZ	Tazewell County	RNAV (GPS) RWY 7	500 | 1	LOC/DME RWY 25	600 | 1	No
LKU	Louisa County	RNAV (GPS) RWY 27	300 | ¾	LOC RWY 27	400 | 1	No
MFV	Accomack County	RNAV (GPS) RWY 3	300 | 1	LOC RWY 3	500 | 1	No
MKJ	Mountain Empire	RNAV (GPS) RWY 26	600 | 1	LOC RWY 26	700 | 1	No
MTV	Blue Ridge	RNAV (GPS) RWY 31	300 | ¾	LOC RWY 31	500 | 1	No
OFP	Hanover County Municipal	RNAV (GPS) RWY 34	300 | 1	LOC RWY 16	500 | 1	No
OKV	Winchester Regional	RNAV (GPS) RWY 32	200 | ¾	ILS or LOC RWY 32	200 | ½	Yes
PTB	Dinwiddie County	RNAV (GPS) RWY 23	400 | 1	LOC RWY 5	500 | 1	No
PVG	Hampton Roads Executive	RNAV (GPS) RWY 10	200 | ¾	ILS or LOC RWY 10	200 | ¾	No
RMN	Stafford Regional	RNAV (GPS) RWY 33	300 | ¾	ILS or LOC RWY 33	200 | ¾	Yes
SFQ	Suffolk Executive	RNAV (GPS) RWY 4	300 | ⅞	LOC RWY 4	600 | 1	No
VJI	Virginia Highlands	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	No

Source: FAA

EVALUATION SUMMARY:

- In nearly all instances, these airports' RNAV (GPS) approaches offer comparable or improved minimums. Performance-based approaches adequately cover these airports and offer complementary ground-based approaches.
- Three airports, Chesterfield (FCI), Stafford (RMN), and Winchester (OKV), maintain ILS or LOC approaches with slightly better minimums than those available on comparable RNAV (GPS) approaches and represent potential opportunities for improvement to the performance-based approaches.

3.5 Gap Analysis Conclusions

Overall, Virginia maintains a highly accessible and capable system of airports, supported by its availability of instrument approach procedures. From airports with commercial airline services to those with recreational general aviation activity, each airport maintains at least one procedure, with nearly two-thirds of the system maintaining both performance- and ground-based approaches.

The gap analysis centered on opportunities where performance-based approaches lagged in capability behind a comparable ground-based approach. Closing this gap assists Virginia airports in the ongoing NAS transition from ground-based navigation to satellite and space-based navigation.

This analysis also highlights where there are redundancies in the system. Redundancy can be approached from a perspective of resiliency, where a system of ground-based procedures should be maintained in the event of a satellite failure, but also from a perspective of excess capability, where funds supporting ground-based NAVAIDs could be reallocated to alternative projects that improve the Virginia air transportation system.

Conclusions highlight airports with existing procedures that could be improved, airports that could benefit from new procedures, and those airports where existing redundancies in ground-based and performance-based approaches will influence the essential Non-Federal NAVAID network.

3.5.1 Potential Procedure Improvements

Nine airports were identified for potential improvements to existing minimums. Three airports, Richmond Executive (FCI), Stafford Regional (RMN), and Winchester Regional (OKV), maintain precision approaches supported by NAVAID equipment owned and maintained by DOAV. Each runway end has a corresponding RNAV (GPS) approach with slightly higher ceiling or visibility minimums that could potentially be improved to match those published in the ILS or LOC approaches. Another three airports, Newport News-Williamsburg (PHF), Lynchburg Regional (LYH), and Manassas Regional (HEF), maintain ILS or LOC approaches with 200 and ½ minimums, but with RNAV (GPS) approaches to the same runways with higher minimums. These performance-based approaches could be evaluated for further improvement to match the capability provided in the precision approaches. Finally, three airports – Ingalls Field (HSP), Leesburg Executive (JYO), and New River Valley (PSK) – with ILS or LOC approaches supported by FAA equipment do not meet the 200 and ½ minimums and can be evaluated for improvement.

Table 21: Approach procedures identified for potential improvements from gap analysis.

ID	Airport	Existing procedure	Proposed action
FCI	Richmond Executive-Chesterfield County	RNAV (GPS) RWY 33	Evaluate the feasibility of reducing the 300' ceiling minimum to match the existing 200' ceiling on the ILS or LOC approach.
RMN	Stafford Regional	RNAV (GPS) RWY 33	Evaluate the feasibility of reducing the 300' ceiling minimum to match the existing 200' ceiling on the ILS or LOC approach.
OKV	Winchester Regional	RNAV (GPS) RWY 32	Evaluate the feasibility of reducing the ¾ mile visibility minimum to match the existing ½ mile visibility on the ILS or LOC approach.
HSP	Ingalls Field	RNAV (GPS) RWY 25	Evaluate the feasibility of reducing the minimums on both the RNAV (GPS) and ILS or LOC approach to 200 and ½, or improve the RNAV (GPS) to match the current minimums on the ILS or LOC.

ID	Airport	Existing procedure	Proposed action
LYH	Lynchburg Regional	RNAV (GPS) RWY 4	Evaluate the feasibility of reducing the minimums on the RNAV (GPS) approach to match the 200 and ½ on the ILS or LOC approach.
HEF	Manassas Regional	RNAV (GPS) RWY 16L	Evaluate feasibility of reducing the minimums on the RNAV (GPS) approach to match the 200 and ½ on the ILS or LOC approach.
PHF	Newport News-Williamsburg	RNAV (GPS) RWY 7	Evaluate feasibility of reducing the minimums on the RNAV (GPS) approach to match the 200 and ½ on the ILS or LOC approach.
JYO	Leesburg Executive	ILS or LOC RWY 17	Evaluate feasibility of reducing the ILS or LOC minimums to 200 and ½.
PSK	New River Valley	ILS or LOC Z RWY 6	Evaluate feasibility of reducing the ILS or LOC minimums to 200 and ½.

Source: Woolpert

3.5.2 Opportunities for New Procedures

Eight airports maintain approaches that are available only through circling. Airports with -A and -B approach types effectively have approaches to each runway end, but are only accessible once reaching a certain altitude and circling. There are also nine airports, aside from those with circling-only approaches, that do not maintain a straight-in approach to one of the primary runway ends.

Table 22: Airports with opportunity for new procedures.

ID	Airport	Existing procedures	Proposed action
8W2	New Market	RNAV (GPS)-A RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.
FRR	Front Royal-Warren County	RNAV (GPS)-A	Evaluate the feasibility and value of adding straight-in approaches.
GVE	Gordonsville Municipal	RNAV (GPS)-A RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.
JGG	Waltrip Williamsburg Executive	RNAV (GPS)-C VOR-B	Evaluate the feasibility and value of adding straight-in approaches.
LVL	Brunswick County	RNAV (GPS)-A RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.
TGI	Tangier Island	RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.
W31	Lunenburg County	RNAV (GPS)-A RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.
W63	Lake Country Regional	RNAV (GPS) RWY 4	No approach to Runway 22; evaluate the feasibility of a new approach.
W81	Crewe Municipal	RNAV (GPS)-A RNAV (GPS)-B	Evaluate the feasibility and value of adding straight-in approaches.

ID	Airport	Existing procedures	Proposed action
AKQ	Wakefield Municipal	RNAV (GPS) RWY 20 NDB RWY 20	No approach to Runway 2; evaluate the feasibility of a new approach.
EZF	Shannon	RNAV (GPS) RWY 24 NDB RWY 24	No approach to Runway 6; evaluate the feasibility of a new approach.
FYJ	Middle Peninsula Regional	RNAV (GPS) RWY 10 RNAV (GPS)-B LOC RWY 10 VOR-A	No approach to Runway 28; evaluate the feasibility of a new approach.
MKJ	Mountain Empire	RNAV (GPS) RWY 26 LOC RWY 26	No approach to Runway 8; evaluate the feasibility of a new approach.
RMN	Stafford Regional	ILS or LOC RWY 33 RNAV (GPS) RWY 33 VOR RWY 33	No approach to Runway 15; evaluate the feasibility of a new approach.
W24	Falwell	RNAV (GPS) RWY 28	No approach to Runway 10; evaluate the feasibility of a new approach.
W78	William M. Tuck	RNAV (GPS) RWY 1 VOR-A	No approach to Runway 19; evaluate the feasibility of a new approach.
W91	Smith Mountain Lake	RNAV (GPS) RWY 23	No approach to Runway 5; evaluate the feasibility of a new approach.

Source: Woolpert

3.5.3 Approach Procedure Redundancies

As previously established in Chapter 2, the FAA has already established its VOR MON, which identifies critical ground-based navigation aids as well as airports that can be used in the event of a GPS outage. Considered at a broad level, this theoretically means any ground-based approach procedure not included in the MON plan is redundant from a critical safety perspective. However, ground-based navigation has a certain acceptable level of redundancy due to its familiarity and reliability.

Table 23: Redundant ground-based approaches with FAA-owned equipment.

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
DAN	Danville Regional	RNAV (GPS) RWY 2	200 | ½	ILS or LOC RWY 2	200 | ½	Equal
CHO	Charlottesville-Albemarle	RNAV (GPS) RWY 3	200 | ½	ILS or LOC RWY 3	200 | ½	Equal
LYH	Lynchburg Regional	RNAV (GPS) RWY 4	300 | ½	ILS or LOC RWY 4	200 | ½	GBN
ORF	Norfolk International	RNAV (GPS) Z RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
SHD	Shenandoah Valley Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
PHF	Newport News-Williamsburg	RNAV (GPS) RWY 7	300 | ½	ILS or LOC RWY 7	200 | ½	GBN

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
RIC	Richmond International	RNAV (GPS) Z RWY 16	200 | ½	ILS or LOC RWY 16	200 | ½	Equal
HEF	Manassas Regional	RNAV (GPS) RWY 16L	300 | ½	ILS or LOC RWY 16L	200 | ½	GBN
JYO	Leesburg Executive	RNAV (GPS) RWY 17	300 | ¾	ILS or LOC RWY 17	300 | ¾	Equal
HSP	Ingalls Field	RNAV (GPS) RWY 25	400 | 1 ¼	ILS or LOC RWY 25	300 | ⅞	GBN
PSK	New River Valley	RNAV (GPS) RWY 6	200 | 1	ILS or LOC Z RWY 6	200 | 1	Equal
ROA	Roanoke-Blacksburg Regional	RNAV (RNP) Z RWY 6	300 | ½	LDA Z RWY 6	300 | ¾	PBN
LNP	Lonesome Pine	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	PBN
BKT	Allan C. Perkinson Municipal	RNAV (GPS) RWY 4	1100 | 3	NDB-A	700 | 2 ¼	GBN
OMH	Orange County	RNAV (GPS) RWY 8	600 | 1	VOR/DME-A	1600 | 1 ¼	PBN
LUA	Luray Caverns	RNAV (GPS) RWY 22	600 | 1	VOR/DME-B	1300 | 1 ¼	PBN
W78	William M. Tuck	RNAV (GPS) RWY 1	300 | 1	VOR-A	600 | 1	PBN
W96	New Kent County	RNAV (GPS) RWY 11	500 | 1	VOR-A	600 | 1	PBN
JGG	Waltrip Williamsburg Executive	RNAV (GPS)-C	1100 | 3	VOR-B	1100 | 3	Equal

Source: FAA

Nineteen airports maintain ground-based approaches that are redundant with performance-based approaches that offer better minimums. The ILS or LOC approaches and the LDA approach at Roanoke (ROA) offer high performance and significant benefits to the Virginia airport system. As these approaches are supported by FAA equipment and are located at Commercial Service and Reliever airports, they will likely continue to be maintained well into the future.

On the other hand, some airports with capable performance-based approaches are also supported by procedures that rely on antiquated FAA-owned technology. These approaches may continue as needed, but they may not likely be a priority for the FAA or pilots using these airports.

Table 24: Redundant ground-based approaches with VA-owned equipment.

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
CPK	Chesapeake Regional	RNAV (GPS) RWY 5	200 | ½	ILS or LOC RWY 5	200 | ½	Equal
PVG	Hampton Roads Executive	RNAV (GPS) RWY 10	200 | ¾	ILS or LOC RWY 10	200 | ¾	Equal
OKV	Winchester Regional	RNAV (GPS) RWY 32	200 | ¾	ILS or LOC RWY 32	200 | ½	GBN
FCI	Richmond Executive-Chesterfield County	RNAV (GPS) RWY 33	300 | ½	ILS or LOC RWY 33	200 | ½	GBN
RMN	Stafford Regional	RNAV (GPS) RWY 33	300 | ¾	ILS or LOC RWY 33	200 | ¾	GBN
AVC	Mecklenburg-Brunswick Regional	RNAV (GPS) RWY 1	300 | 1	LOC RWY 1	400 | 1	PBN
CJR	Culpeper Regional	RNAV (GPS) RWY 4	300 | 1	LOC RWY 4	400 | 1	PBN
SFQ	Suffolk Executive	RNAV (GPS) RWY 04	300 | ⅞	LOC RWY 4	600 | 1	PBN
PTB	Dinwiddie County	RNAV (GPS) RWY 23	300 | 1	LOC RWY 5	500 | 1	PBN
FYJ	Middle Peninsula Regional	RNAV (GPS) RWY 10	300 | 1	LOC RWY 10	400 | 1	PBN
BCB	Virginia Tech-Montgomery Executive	RNAV (GPS) RWY 31	300 | ⅞	LOC RWY 13	400 | 1	PBN
OFP	Hanover County Municipal	RNAV (GPS) RWY 34	300 | 1	LOC RWY 16	500 | 1	PBN
VJI	Virginia Highlands	RNAV (GPS) RWY 24	300 | 1	LOC RWY 24	500 | 1	PBN
MFV	Accomack County	RNAV (GPS) RWY 03	300 | 1	LOC RWY 3	500 | 1	PBN
MKJ	Mountain Empire	RNAV (GPS) RWY 26	600 | 1	LOC RWY 26	700 | 1	PBN
LKU	Louisa County	RNAV (GPS) RWY 27	300 | ¾	LOC RWY 27	400 | 1	PBN
MTV	Blue Ridge	RNAV (GPS) RWY 31	300 | ¾	LOC RWY 31	500 | 1	PBN
EMV	Emporia-Greensville Regional	RNAV (GPS) RWY 34	300 | 1	LOC RWY 34	400 | 1	PBN
HWY	Warrenton-Fauquier	RNAV (GPS) RWY 15	200 | ¾	LOC/DME RWY 15	500 | 1	PBN
JFZ	Tazewell County	RNAV (GPS) RWY 7	500 | 1	LOC/DME RWY 25	600 | 1	PBN

ID	Airport	PBN	Minimums	GBN	Minimums	Comp.
AKQ	Wakefield Municipal	RNAV (GPS) RWY 20	1100 | 3	NDB RWY 20	1100 | 3	Equal
EZF	Shannon	RNAV (GPS) RWY 24	1100 | 3	NDB RWY 24	1100 | 3	Equal

Source: FAA

These twenty-two airports represent the focus of the subsequent NAVAID development scenarios summarized in Chapter 4.

4 FACILITY AND EQUIPMENT CONSIDERATIONS

Several scenarios were developed to illustrate the potential avenues the Commonwealth may follow for maintaining its NAVAID system. These scenarios consist of an end-state network of NAVAIDs that varies depending on the intended outcomes discussed in each alternative. Ultimately, one of these scenarios will be selected through the NAVAID study and will inform Virginia's decision-making process for maintaining or decommissioning its equipment.

4.1 FAA VOR Minimum Operational Network

The FAA's VOR MON plan was developed as a method to optimize the VOR network throughout the Lower 48 states in case of a GPS network outage. The root of the plan ensures VOR signal coverage starting at 5,000 feet AGL, which would permit aircraft to navigate from VOR to VOR or proceed to an airport within the MON to conduct a VOR, LOC, or ILS approach during the outage.[2]

At the beginning of the VOR MON implementation in 2015, there were 896 VORs in the contiguous United States, with an end-state MON of 590 retained VORs and 306 discontinued VORs. Within the original system, certain VORs were nearing replacement or providing significant overlapping coverage. In the previous era of air navigation, this redundancy was important when VORs would fall out of service due to maintenance or repair. The FAA, acknowledging a general shift from ground-based to space-based navigation, realized an opportunity to systematically reduce its VOR network while maintaining a sufficient base for emergencies.

4.1.1 VOR Decommissioning

The FAA used a set of criteria to determine which VORs would be retained as part of the MON. Those requirements listed in **Bold** below include criteria specific to VORs in Virginia:

- **Retain VORs to perform ILS, LOC, or VOR approaches supporting MON airports at suitable destinations within 100 NM of any location within the CONUS. Selected approaches would not require ADF, DME, radar, or GPS.**
- Retain VORs to support international oceanic arrival routes.
- **Retain VORs to provide coverage at and above 5,000-foot AGL.**
- Retain most VORs in the Western U.S. Mountainous Area (WUSMA), specifically those anchoring Victor airways through high-elevation terrain.
- Retain VORs required for military use.

The VOR MON is already taking effect in Virginia, where three VORs have already been decommissioned. ***Table 25*** summarizes the FAA's plan for VOR facilities in Virginia, the anticipated closure date, and the relation of the VOR to published instrument approach procedures.

[2] https://www.faa.gov/air_traffic/flight_info/aeronav/acf/media/Presentations/23-01-VOR-MON-Program.pdf

Table 25: VOR facilities in Virginia.

ID	Name	Type	MON plan	Closure date	Appearance on IAP
BRV	Brooke	L-VORTAC	Retain	-	4 (1 as Primary)
FAK	Flat Rock	H-VORTAC	Retain	-	3 (0 as Primary)
GVE	Gordonsville	H-VORTAC	Retain	-	8 (1 as Primary)
GZG	Glade Spring	L-VOR/DME	Retain	-	1 (0 as Primary)
HCM	Harcum	L-VORTAC	Retain	-	10 (2 as Primary)
HPW	Hopewell	L-VORTAC	Retain	-	8 (2 as Primary)
MOL	Montebello	L-VOR/DME	Retain	-	2 (0 as Primary)
ORF	Norfolk	H-VORTAC	Retain	-	7 (3 as Primary)
RIC	Richmond	H-VORTAC	Retain	-	11 (5 as Primary)
SBV	South Boston	L-VORTAC	Retain	-	6 (1 a Primary)
DCA	Washington	L-VORW/DME	Retain	-	
DAN	Danville	L-VOR	Removed	9/5/2024	1 (1 as Primary)
FKN	Franklin	L-VORTAC	Removed	9/5/2024	1 (0 a Primary)
LVL	Lawrenceville	L-VORTAC	Removed	9/5/2024	0
ODR	Woodrum	T-VORW	Removed	6/12/2025	1 (1 as Primary)
PSK	Pulaski	H-VORTAC	Candidate	3/19/2026	7 (3 as Primary)
CCV	Cape Charles	L-VORTAC	Candidate	2/15/2029	5 (1 as Primary)
LYH	Lynchburg	L-VORW/DME	Candidate	6/7/2029	6 (2 as Primary)
ROA	Roanoke	L-VORW/DME	Candidate	6/7/2029	2 (1 as Primary)
AML	Armel	L-VORW/DME	Candidate	3/14/2030	1 (1 as Primary)
CSN	Casanova	H-VORTAC	Candidate	3/14/2030	13 (2 as Primary)
LDN	Linden	L-VORTAC	Candidate	5/9/2030	5 (1 as Primary)

Source: FAA

Figure 16 displays the VORs in Virginia proposed for retention in the MON plan.

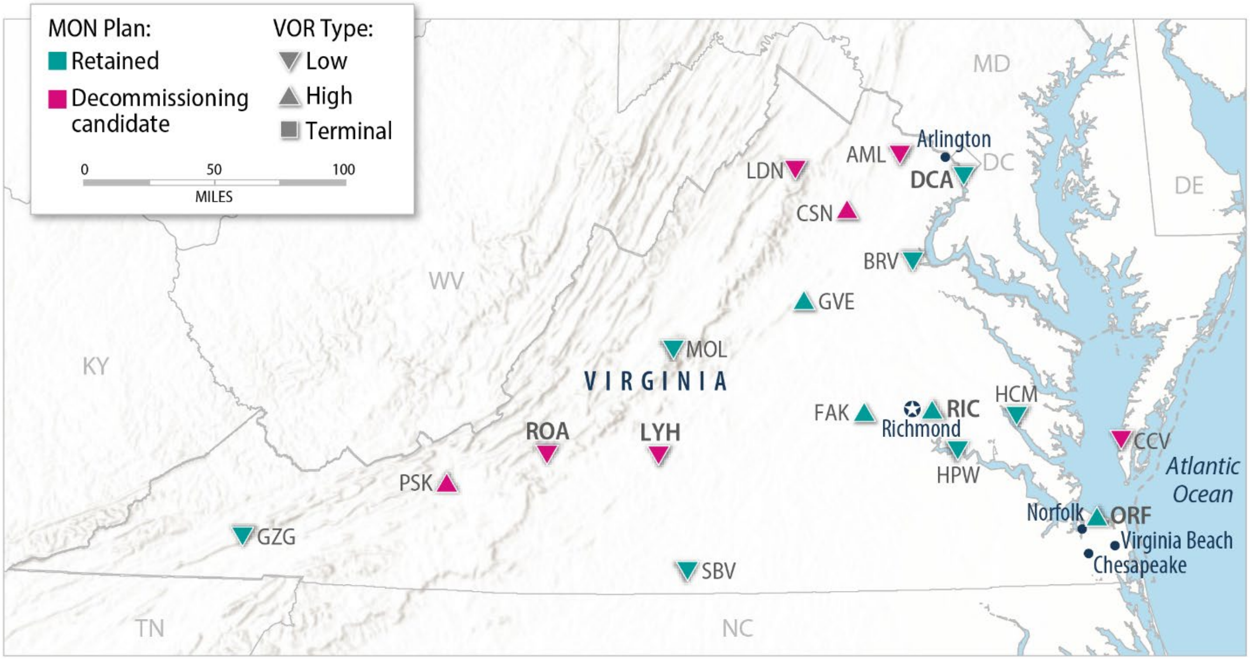


Figure 16: Future Virginia VOR network.

With its MON network established, the FAA is actively decommissioning VORs that are no longer needed. In Virginia, the FAA has designated two VOR MON airports on IFR En route Low Altitude Charts: Charlottesville-Albemarle Airport (CHO) and Richmond International Airport (RIC). An example from an IFR En route Low Altitude Chart is shown in ***Figure 17.*** The intent of identifying specific MON airports is to provide an approach that can be used by aircraft without ADF or DME when radar may not be available.

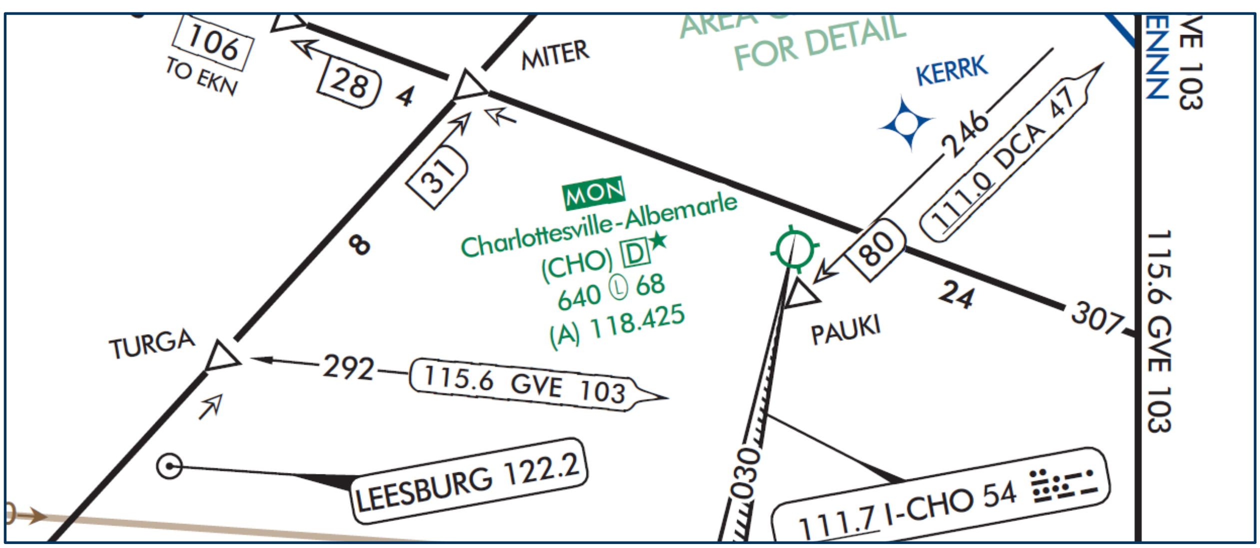


Figure 17: FAA MON network airport on IFR En route Low Altitude Chart.

At CHO, the ILS or LOC approach to Runway 03 serves as the critical ground-based approach within the MON, while at RIC, there are ILS, ILS or LOC, or VOR approaches available to all four runway ends.

Other MON airports located outside the Commonwealth provide coverage to Virginia airports and include:

- West Virginia International Airport (CRW)
- London-Corbin Airport-Magee Field (LOZ)
- Piedmont Triad International Airport (GSO)
- Hickory Regional Airport (HKY)

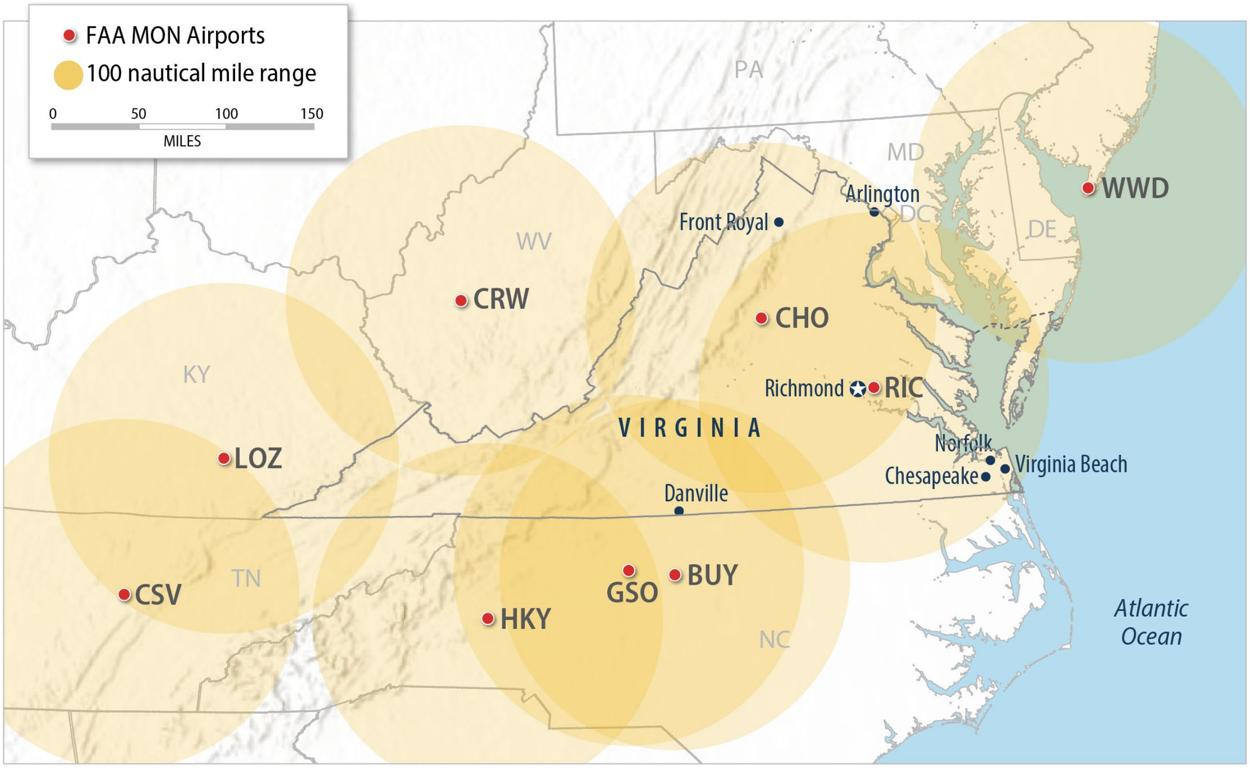


Figure 18: FAA MON airport coverage of Virginia.

The FAA is implementing the VOR MON plan through two separate phases, one of which has already been completed, and another is currently underway. In the first phase, from 2016 to 2020, eighty-two VORs were decommissioned due to redundancies within the existing network of NAVAIDs. The second phase spans from 2021 to 2030 with the intent to decommission an additional 224 VORs. Through the end of 2024, 190 VORs of the 306 identified for decommissioning have been removed from use. Ten of the eighteen VORs in Virginia are anticipated to remain in use as part of the VOR MON plan.

4.1.2 NAVAID Network Resiliency

The VOR MON plan further emphasizes the need for Virginia to maintain an adequate, efficient, and lean network of NAVAIDs to help support the FAA-owned network incorporated into the MON. While GPS navigation offers comparable minimums to IAPs reliant on ground-based navigation aids, it is critical that Virginia continue to support certain facilities that benefit from the ground-based NAVAID functionality.

The FAA also considers resiliency in the NAVAIDs it owns and maintains, with a goal to “ensure resiliency in all phases of flight for all aviation users by sustaining legacy Ground-Based NAVAIDs and Visual

Guidance Lighting Systems for the near future while rationalizing systems to right-size the existing infrastructure and avoid unnecessary costs."

Resiliency in NAVAIDs is crucial for ensuring aviation safety and efficiency in the Commonwealth, especially in a space-based navigation outage. It is paramount that the necessary ground-based navigation aids remain available and offer a reliable option for pilots operating in the airspace.

This component of resiliency must also be considered in the context of the FAA's VOR MON plan. Elements of resiliency that affect Commonwealth-owned NAVAIDs include environmental factors, equipment age, and condition, which will directly impact whether the necessary equipment will be functional when it is ultimately most relied upon.

Virginia can help ensure resiliency in its NAVAID system by incorporating regular maintenance, timely upgrades, and strategic planning to address potential vulnerabilities. Within the NAVAID F&E study, recommendations and scenario evaluations will consider decommissioning excess or outdated equipment, ensuring adequate alternative ground-based NAVAIDs, or replacing the equipment with newer and more reliable systems. This proactive approach ensures that NAVAIDs can withstand adverse conditions and continue to provide pilots with accurate navigation information.

A resilient NAVAID network is essential for maintaining aviation safety, supporting efficient flight operations, and ensuring that pilots always have access to reliable navigation information. The assessment of the non-federal navigational aid network and the gap analysis of current approach procedures provide Virginia with a baseline for a resilient network of ground-based navigation aids.

4.1.3 Commonwealth Airport Impact

VOR decommissioning as part of the MON plan will impact existing instrument approach procedures at Virginia airports. As a result, DOAV needs to remain informed as to which IAPs will require amendments or be decommissioned entirely. The IAP gap analysis provides additional information as to which specific procedures serving Virginia airports may require amendments to reflect changes to the NAVAID network as the FAA implements the MON plan.

Most importantly, the MON provides Virginia pilots with a safe and reliable network of airports with ground-based procedures and VORs for navigation in the event of a GPS outage. With this federal network in place, the need for ground-based approaches at other Virginia airports is diminished. The Department of Aviation's role in sustaining ground-based navigational aids is assessed in further detail through a series of scenarios that contemplate the benefits and costs associated with continuing support, or eventual decommissioning, of NAVAID equipment at certain Virginia airports.

4.2 Navigational Aid Equipment Scenarios

Several scenarios were developed to better evaluate the benefits and costs of maintaining NAVAID equipment supporting ILS and LOC approaches.

The Department of Aviation maintains an equipment purchase and maintenance contract with Selex. This contract runs for two years and was initially issued in 2024; the contract includes a one-year extension option, meaning that the contract will either go to bid in 2026 or 2027. The outcome of the subsequent contract bid process will likely impact the cost assumptions outlined in the following scenarios. It is recommended that replacement equipment costs and those associated with maintenance be reviewed and issued for bid regularly to ensure the DOAV receives competitive pricing for managing its facilities and equipment.

Table 26 includes the current costs of replacing equipment and the ranges for ongoing maintenance. Costs referenced in the scenarios and implementation plan include an assumed 2.83% inflation estimate based on consumer price index data from the Federal Reserve Bank of St. Louis (FRED).

Table 26: NAVAID equipment unit and maintenance costs.

Equipment	Full replacement	Annual maintenance
Localizer	$159,120 - $204,172	$9,645 - $16,450
Glideslope	$146,183	$9,795 - $10,730
DME	$125,058	$1,525 - $2,660
ALS*	-	$7,500
AWOS*	$200,000	$3,500

Source: DOAV & Selex

Figure 19 illustrates the fifteen airports in Virginia with NAVAIDs owned and maintained by the FAA, and the other twenty with ground-based NAVAIDs owned and maintained by the DOAV.

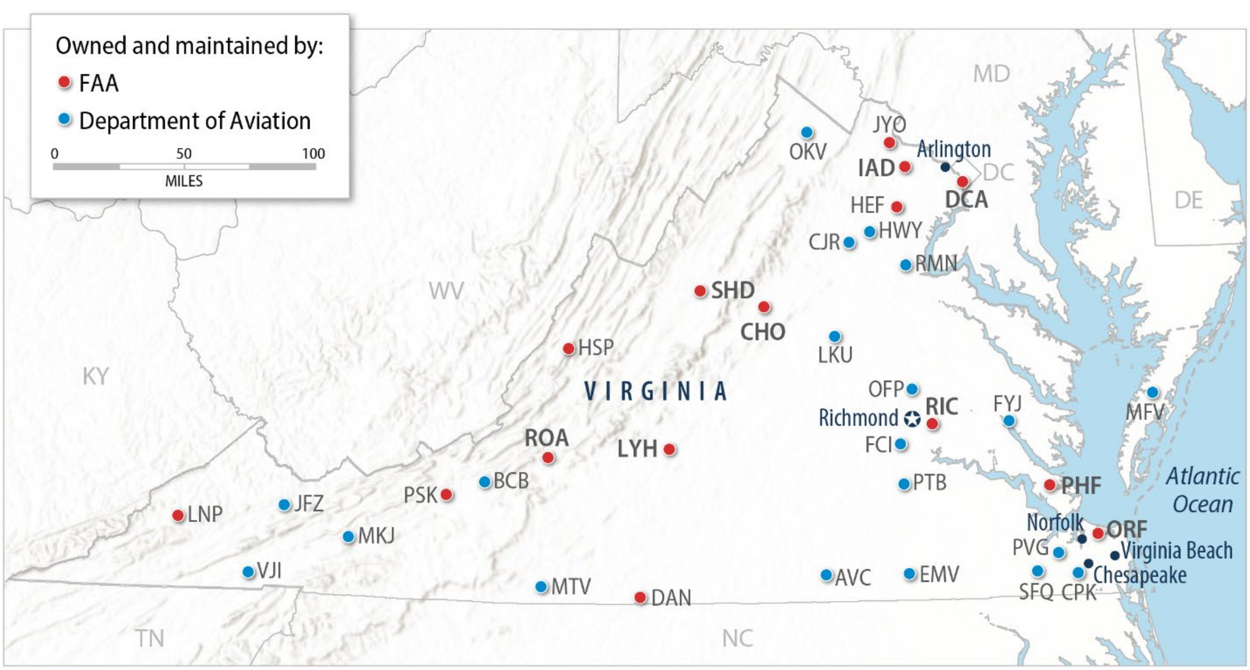


Figure 19: Airports with ILS or localizer approaches in Virginia.

The following sections summarize end-state scenarios based on different approaches the DOAV can take to manage its ground-based NAVAIDs network. Localizers are used as the core NAVAID in review, as DME is typically only present with an accompanying localizer, and glideslopes and approach lighting systems for instrument landing systems. It is generally assumed that if a localizer is set for decommissioning, then other related equipment will also be decommissioned. Due to the nature of some localizer approaches, DME may or may not be required and thus could be decommissioned without affecting the published localizer approach. For simplicity in the development scenarios, it is assumed that DME will continue to function with the localizer until decommissioning unless specified in the scenario. Ultimately, following the summary of each scenario, a preferred scenario is recommended and incorporated into the study's implementation plan.

Due to the uncertainty of when equipment would require full replacement, these scenarios focus solely on predicted maintenance expenditures. As the FAA's MON plan provides adequate ground-based navigation coverage in the event of a satellite outage, it is generally recommended that if equipment does fail, the department should not seek to replace the equipment immediately.

4.2.1 Maintain and Replace

The 2010 study proposed that all VATSP Commercial Service, Reliever, General Aviation–Regional, and General Aviation–Community airports maintain a ground-based instrument approach procedure to at least one runway end. Using this benchmark, airports in the Commercial Service and Reliever roles all meet this criterion, while most airports in the GA-Regional role also meet it. About half of Virginia airports in the GA-Community role would meet the criterion of maintaining a ground-based approach to one runway end, and none of the Local Service airports would meet the criterion.

As the system nearly meets that benchmark in its current state, this scenario considers the twenty-year implications of continuing to maintain the ground-based NAVAID network as-is to continue providing a high level of accessibility via ground-based approaches. If continuing to fix existing systems and replace parts as necessary, DOAV could anticipate its maintenance costs to increase from about $350,000 to nearly $650,000 annually over twenty years. Ultimately, this scenario represents an outdated approach to air navigation, especially within the context of the FAA's VOR MON plan.

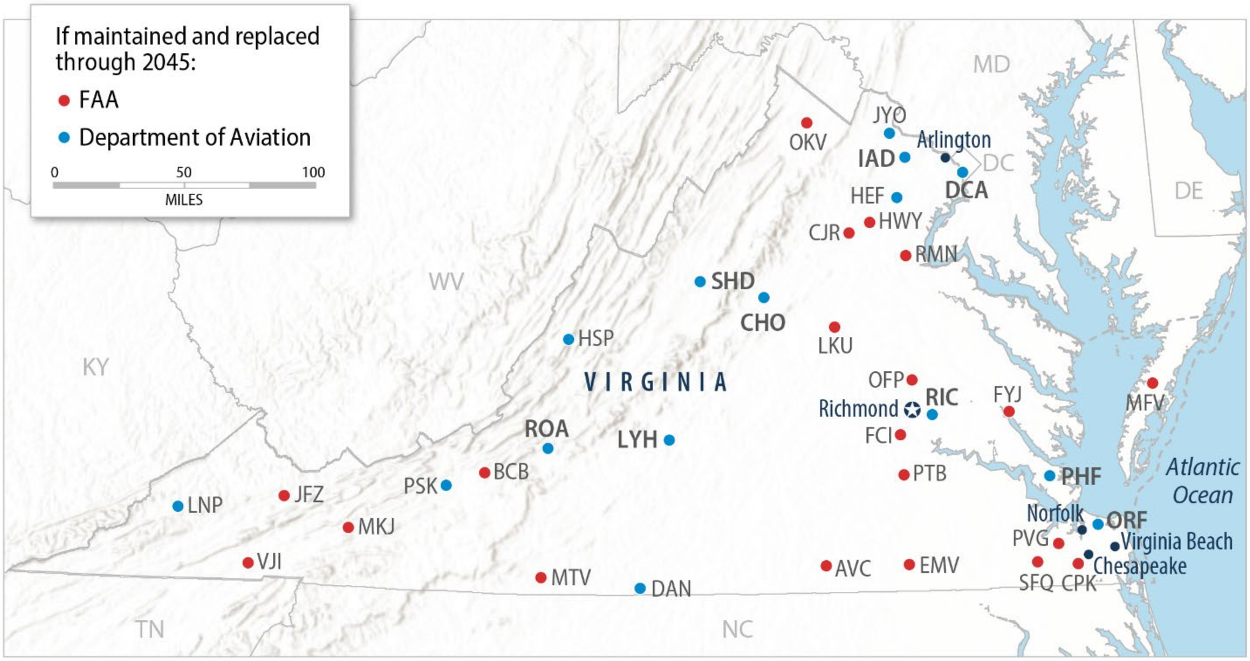


Figure 20: Airports with localizer approaches if maintained and replaced through 2045.

The maintain-and-replace scenario results in DOAV maintaining ownership and responsibility of equipment at all twenty airports with localizer equipment, including five airports with ILS approaches. Each localizer is also paired with DME, which would remain in service over the study timeframe. ***Figure 21*** summarizes the costs of the maintain-and-replace scenario compared to existing maintenance costs.

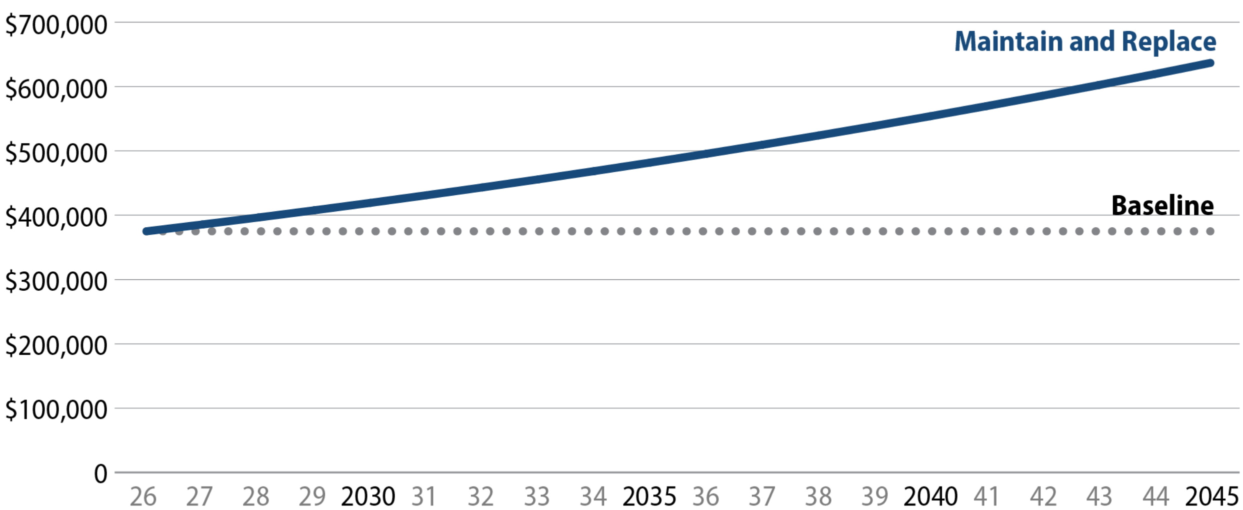


Figure 21: Comparison of baseline costs with maintain-and-replace scenario.

4.2.2 Decommission DOAV NAVAIDs

This scenario would result in the decommissioning of all ground-based, Commonwealth-owned NAVAID assets, aside from the weather reporting systems. The decommissioning would include the removal of two NDBs, twenty DMEs, five glideslopes, twenty localizers, and four approaching lighting systems.

As part of this scenario, Commonwealth-owned NAVAIDs are decommissioned within the first five years following the study. Near-immediate decommissioning would result in annual cost savings of approximately $350,000 to $400,000 due to the reduction in maintenance costs. Ultimately, the realized cost savings are likely greater as replacement parts and the wholesale replacement of systems are not factored into the annual maintenance costs. There would be one-time costs for removing and repurposing equipment, but these could be defrayed by selling systems to other airports or recycling metal and other parts.

Through a gradual reduction of NAVAIDs in the first five years following this study, based on the vintage of localizers, DOAV could expect its maintenance costs to drop to around $200,000 per year with immediate decommissioning of systems past their useful life and then elimination of all maintenance expenses following the decommissioning of remaining NAVAIDs after 2030.

While the actions in this scenario result in near-immediate cost savings, they are primarily included for comparison purposes. Decommissioning NAVAIDs involves complex interactions with sponsors, and most of the equipment is still well within its useful life, with most localizer installations occurring in the last ten years.

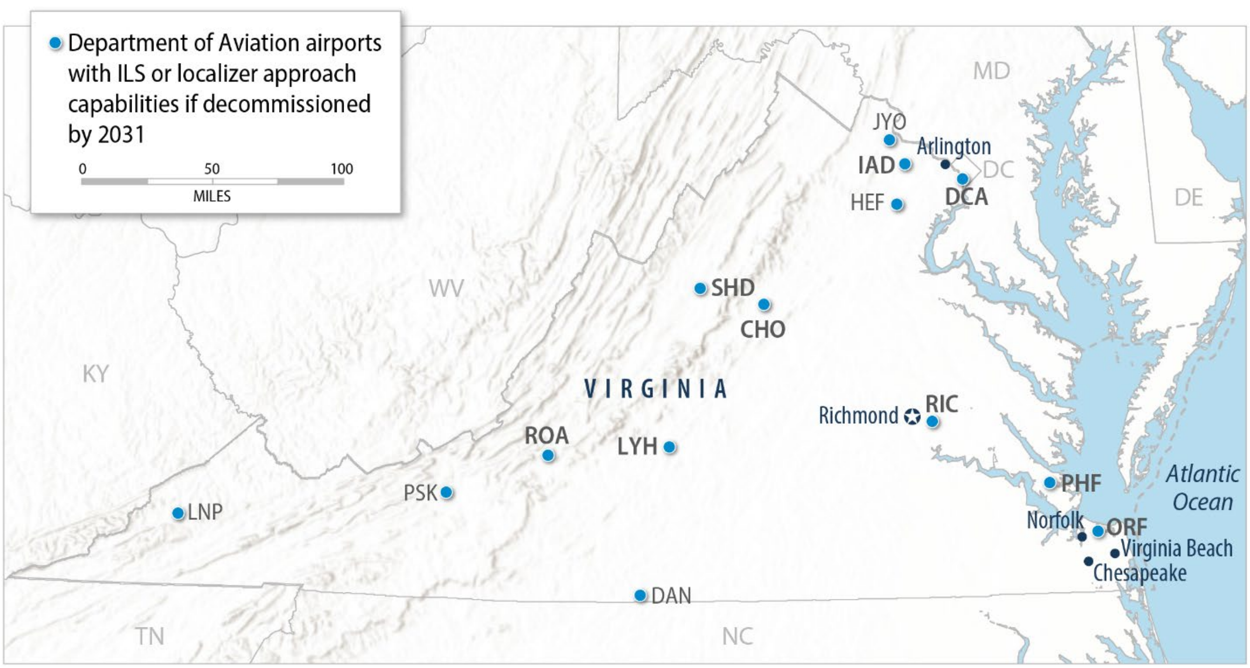


Figure 22: Airports in Virginia with ILS or localizer approach capabilities if decommissioned by 2031.

In this scenario, costs would decrease in the first five years as older equipment is decommissioned, then drop to zero afterward as all equipment is removed from service. This scenario presents a drastic approach to the Commonwealth's NAVAID inventory and would leave only FAA-owned equipment in service to support ILS, LOC, and LOC/DME approaches. ***Figure 23*** illustrates the cost savings offered in the immediate decommissioning scenario.

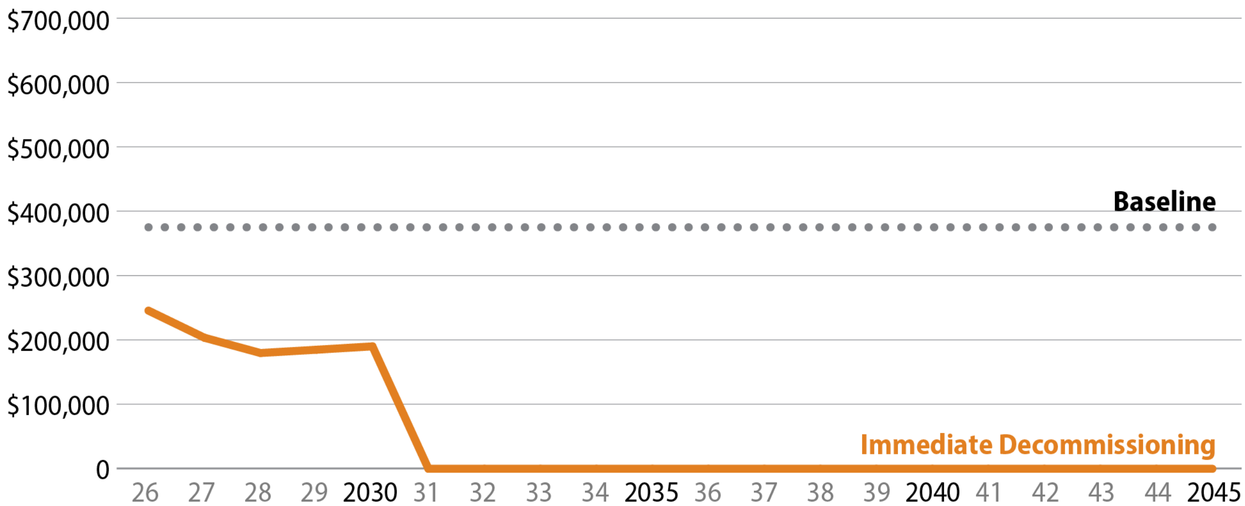


Figure 23: Comparison of baseline costs with the immediate decommissioning scenario.

4.2.3 Maintain Until Failure

In the third scenario, the DOAV's approach would consist of ongoing maintenance until a piece of equipment fails. As the results within this scenario are largely unpredictable due to future weather events, equipment degradation rates, and the availability of maintenance parts, it is assumed that equipment will generally fail approximately twenty-five years following installation. Within the twenty-year study period, it is assumed that thirteen localizer and DME pairs would be removed from service, including two ILS approaches at Chesapeake Regional (CPK) and Winchester Regional (OKV). ***Figure 24*** presents the presumed end-state in 2045 based on a maintain-until-failure approach.

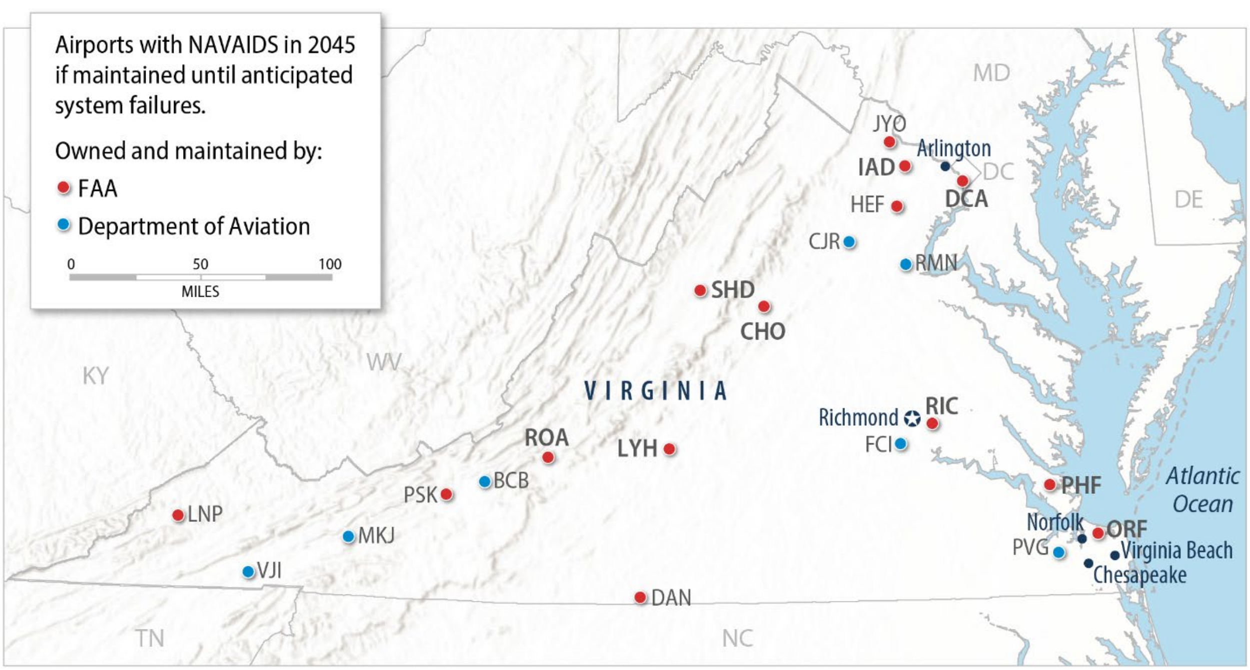


Figure 24: Airports with Virginia NAVAIDs in 2045 if maintained until anticipated system failure.

Over the twenty-year period, it is assumed that costs will remain around the current spending level, with a decline in maintenance expenses in later years as equipment surpasses twenty-five years of use. ***Figure 25*** illustrates expected maintenance costs compared to the existing maintenance expenditures on NAVAIDs.

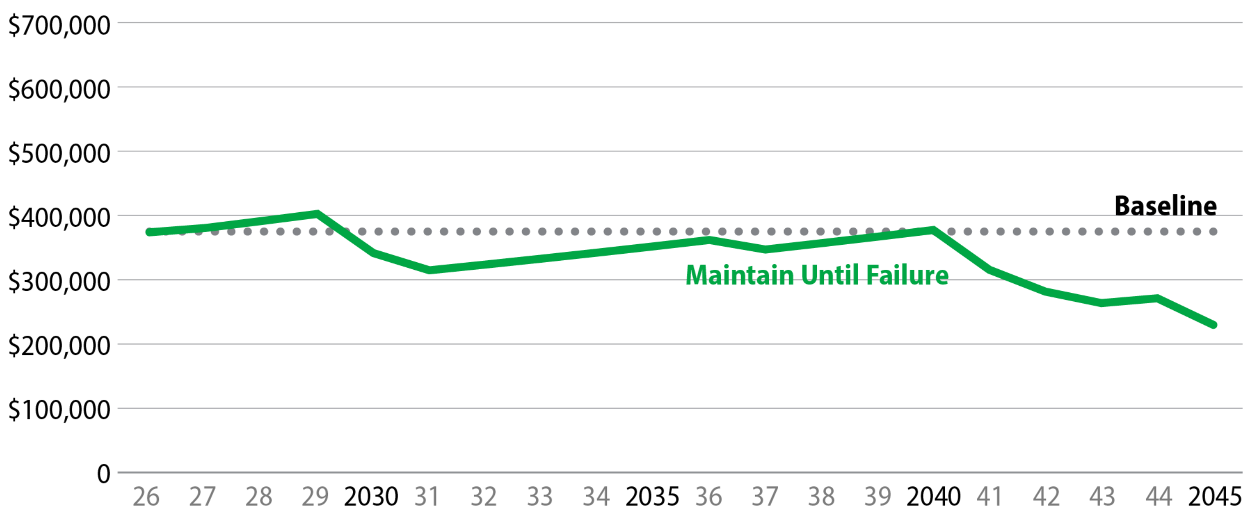


Figure 25: Comparison of baseline costs with maintain-until-failure scenario.

This scenario assumes that some NAVAID systems will fall out of commission due to age or damage. Assumptions built into this model pertain primarily to the age of equipment and the likelihood that, over a significant period from installation, the equipment will cease to function or become functionally obsolete as parts become unavailable. At such time, it is assumed that the system will be removed from service and not replaced.

4.2.4 Optimization and Gradual Decommissioning

This tailored approach to Commonwealth-owned NAVAIDs considers each piece of equipment's role within an individual airport's operational profile, as well as the airport's relative geographic position and role within the Virginia air transportation system. Age, condition, technology vintage, and usage were also critical factors used to determine recommendations for equipment in this scenario. The optimization component ensures that the DOAV takes a balanced approach to reducing its management of NAVAIDs while providing adequate redundancy and resiliency throughout its system. In this scenario, it is ensured that there are available ground-based approaches near major population centers, including Hampton Roads, Richmond, and the Northern Virginia metro, as well as more rural and mountainous areas such as Blacksburg and other communities along Interstate 81.

Figure 26 shows the projected end-state of airports with DOAV-owned NAVAIDs in 2045. This scenario results in the decommissioning of approximately half of the Commonwealth's NAVAIDs. Nine airports would maintain localizers and DME, with three of those airports maintaining full ILS capabilities. Ultimately, the gradual decommissioning of approximately half of the DOAV-owned NAVAIDs is recommended, as this provides the department with a balance of cost-saving measures while still promoting system accessibility and resiliency. This scenario is explored in more depth in Chapter 5, Implementation Plan.

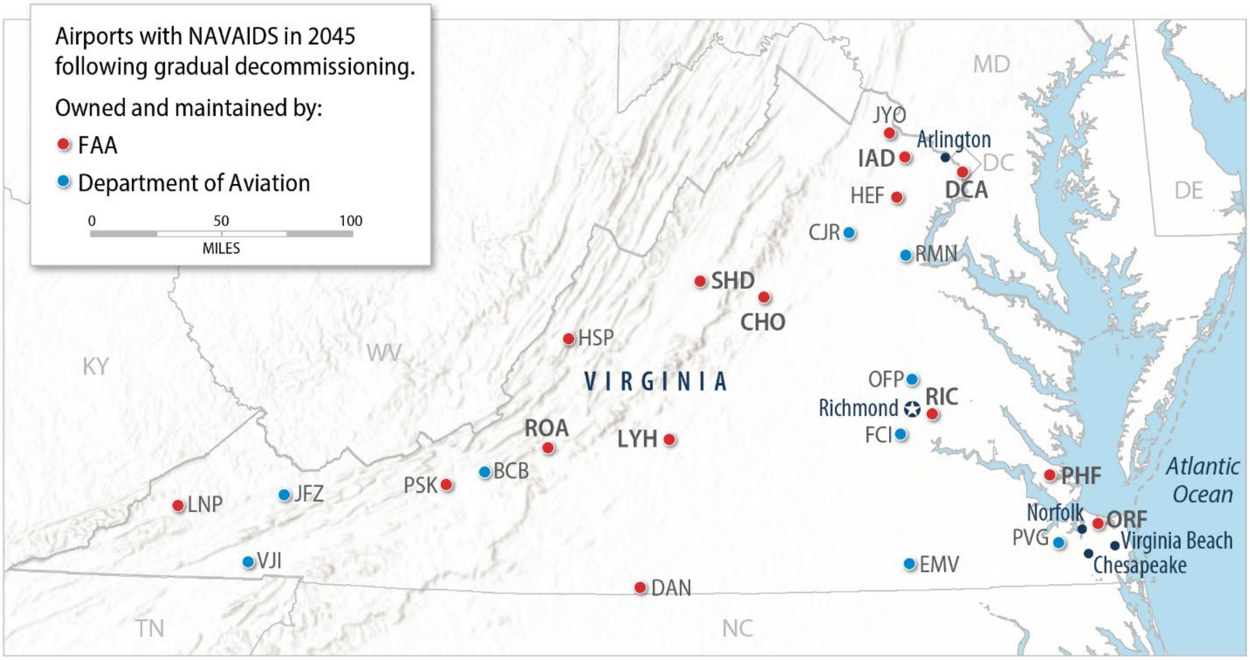


Figure 26: Virginia NAVAIDs in 2045 following gradual decommissioning.

While the costs in this scenario, displayed in ***Figure 27***, nearly mirror the maintain-until-failure approach, this end-state provides additional ground-based NAVAID coverage for comparable costs.

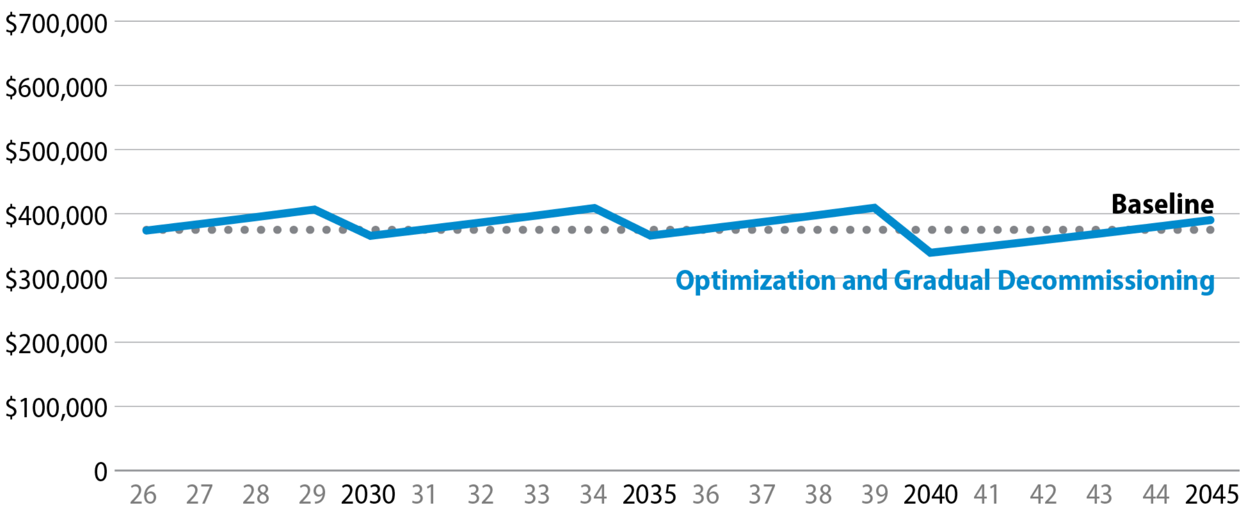


Figure 27: Comparison of baseline costs with optimization and gradual decommissioning.

4.3 Weather Reporting Systems

The AWOS maintained by DOAV are critical to ongoing aviation operations and, as such, are recommended to remain in place over the twenty-year planning period.

Weather reporting alternatives, such as backup AWOS or weather cameras, may be useful additions to the systems, especially in equipment outages. These systems and their potential impact on the Commonwealth are examined in further detail in Chapter 6.

Following a review of the past three years of costs incurred to maintain the AWOS network and the installation patterns over the past thirty-five years, Virginia is recommended to begin planning for routine replacements of systems at Reliever and GA-Regional airports. Since the last major installation period in 2013 and 2014 took place primarily at GA-Community and Local Service airports, these systems are in a better position to maintain usability over the twenty-year planning period. The airports with older systems, while maintained at a high level through the Facility & Equipment Program, are likely due for a refresh within the first ten years of the study period.

Planning for these replacement costs now, especially within each airport's six-year ACIP, is an important first step and will help DOAV's budgeting processes moving forward. This scenario shifts the focus from simply maintaining and fixing broken AWOS pieces to proactive planning for upgrades and replacements.

4.4 Essential Commonwealth NAVAID Network

The essential Commonwealth NAVAID network considers the needs of the Virginia air transportation system, the usage of equipment at each airport, and the relative costs of maintaining and replacing systems as they age. Due to the extreme circumstances considered in the **Maintain and Replace** and **Immediate Decommissioning** scenarios, they were not considered for implementation. The remaining scenarios, **Maintain Until Failure** and **Optimization and Gradual Decommissioning**, ultimately result in similar estimated maintenance expenditures over the twenty-year planning period but lead to different end-states regarding NAVAID availability. Within the **Maintain-Until-Failure** scenario, it is estimated that only seven airports with DOAV-owned localizers would remain in the system compared to nine airports in the **Optimization and Gradual Decommissioning** scenario. Compared to the estimated maintenance expenditures, the benefits resulting from the Optimization scenario, including reasonable geographic coverage and operational capacity, make it the preferred scenario for DOAV to implement. More details pertaining to the implementation plan are summarized in the subsequent chapter.

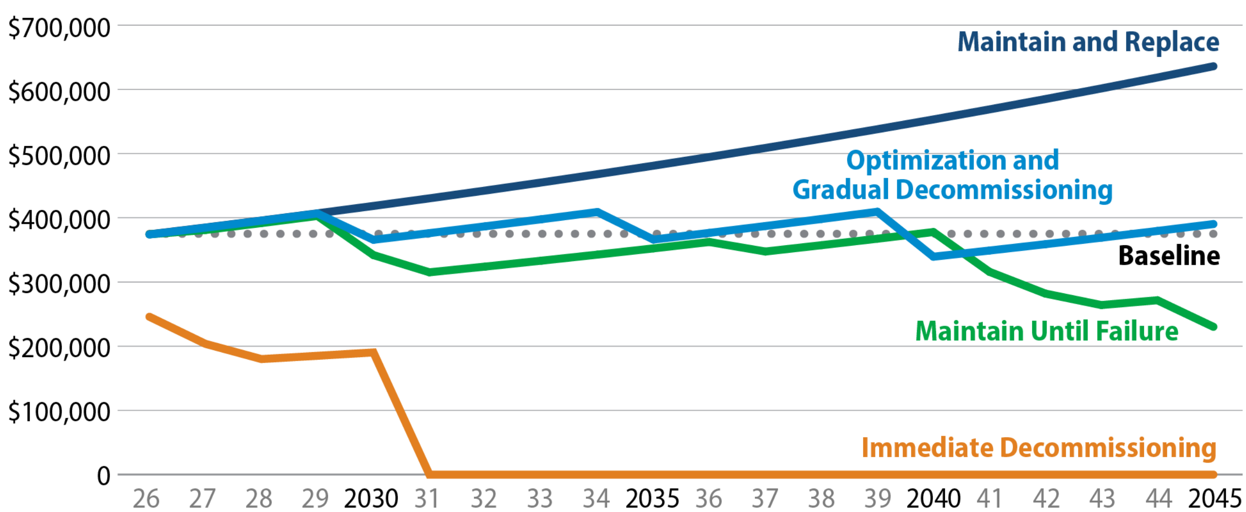


Figure 28: Comparison of baseline costs with all scenarios.

5 IMPLEMENTATION PLAN

The NAVAID Study Implementation Plan considers the context of FAA decision-making, DOAV program guidance, recent NAVAID investment, and anticipated changes in the aviation industry.

5.1 FAA Considerations

While this study focuses on the NAVAIDs owned and maintained by the DOAV, FAA guidance and planning documents will influence future developments and best practices for managing facilities and equipment for air navigation.

5.1.1 Airport Improvement Program Handbook

The FAA's AIP Handbook sets the useful life of NAVAIDs and weather reporting equipment at fifteen years. While the fifteen-year useful life established by the FAA does not necessarily pertain to DOAV-owned NAVAIDs, it is incorporated into the implementation plan as a reference milestone for potential replacement. Most NAVAIDs in the Virginia system exceed their listed useful life and continue to operate for years after. Taking note of the expected useful life in use by the FAA ensures that DOAV is aligned with best practices.

5.1.2 National Airspace System Capital Investment Plan

The Federal Aviation Administration (FAA) National Airspace System (NAS) Capital Investment Plan (CIP) outlines the necessary investments over a five-year period to maintain and modernize the NAS infrastructure, systems, and services. The FY 2025-2029 CIP Overview provides information on NAS programs and services, including the NAS Enterprise Architecture (EA) Roadmaps, offering a fifteen-year perspective on NAS modernization. Additionally, the CIP describes the Next Generation Air Transportation System (NextGen) portfolios and identifies aviation safety, facilities, and mission support programs. The CIP is a crucial component of the FAA's planning and budgeting process, developed annually with inputs from various sources to ensure alignment with the President's Budget request and approved funding. Two of the NAS EA Roadmaps apply to the scope of this study: Navigation and Weather.

Figure 29: FAA NAS CIP, FY25-FY29.

The Navigation Roadmap indicates that most NAVAID programs will continue to be funded through the roadmap's fifteen-year planning period. Some programs, however, will see changes. The VASI program is in draw-down mode, with funding going towards replacing these systems with precision approach path indicators (PAPIs). NDB funding is also indicated as being in drawdown mode. VOR, VORTAC, and TACAN individual program funding is set to sunset in 2030 when their MON programs are to be completed. Once the MON is in place, the DME/VOR/TACAN (DVT) Sustainment Program will support the remaining DMEs, VORs, and TACANs through the end of the planning horizon. Funding through the NextGen program will expand the DME network to support PBN strategies until complete in 2035. All federal AWOS and ASOS, as well as non-federal AWOS, will continue to be sustained through the end of the planning horizon.

5.2 Department of Aviation Program Guidance and Funding

The Virginia Department of Aviation outlines the Facilities and Equipment Program in Chapter 6 of its Airport Program Manual. This chapter includes DOAV's responsibilities regarding funding, maintenance, and ownership of electronic communication, navigation, and information systems that support the Virginia air transportation system.

Eligible projects include DOAV-owned or sponsor-owned systems and must be identified as a recommended action within the Facilities and Equipment Plan (this document). This document also outlines which equipment is eligible for DOAV ownership versus sponsor ownership. As previously established in this document, the DOAV owns localizers, glideslopes, DME, NDBs, and MALSRs, while sponsors own the AWOS, with maintenance support funded by DOAV.

The Department primarily funds the installation and maintenance of NAVAIDs through an allocation for the Facilities and Equipment Program and through the Commonwealth Aviation Fund when those funds are unavailable. Funding sources for airport improvements are typically constrained and subject to change based on directives from the Commonwealth's General Assembly or a change in priorities within the department. In the event funding availability for the Facilities and Equipment Program decreases, alternative funding sources will be required, or airports risk deferred maintenance on equipment.

A potential solution to changes in funding within the program is to shift ownership of any NAVAID equipment slated for decommissioning to the sponsor. This would require extensive prior coordination and a willingness from the sponsor to cooperate, but it could prove beneficial to both parties in that the sponsor would be able to continue using the equipment, and the department would no longer be obligated for annual maintenance or replacement.

5.3 NAVAID Recommendations from Preferred Scenario

While this study evaluates the necessity and viability of NAVAIDs over a twenty-year period, it is a snapshot in time. It will require iterative updates as specific NAVAIDs are replaced or decommissioned and as IAPs are amended or removed. The recommended implementation plan incorporates a phased approach to maintaining the NAVAID system in Virginia.

5.3.1 Localizer, DME, Glideslope, and ALS Equipment

The DOAV manages fifty-one localizers, DMEs, glideslopes, and approach lighting systems at twenty of its system airports. Each localizer is paired with DME, while four of the airports are equipped with NAVAIDs that support ILS approaches (localizer, glideslope, DME, and approach lighting). A fifth airport with ILS equipment owned by DOAV, Hampton Roads Executive (PVG), maintains airport-owned approach lighting.

Six of the localizers exceed the fifteen-year useful life standard and are candidates for decommissioning or replacement in the coming years. It is recommended that DOAV monitor the investment made at these airports.

5.3.2 Non-Directional Beacons

The two remaining non-directional beacons at Wakefield (AKQ) and Shannon (EZF) play a minimal role within the system, as this equipment is outdated and redundant with existing RNAV (GPS) approaches to the same runway end. With relatively low maintenance costs, it is recommended that DOAV continue maintaining each NDB until failure and, in the interim, evaluate the feasibility of lowering existing PBN minimums and potentially adding new PBN approaches to the runway ends at each airport that lack an RNAV (GPS) approach. Over the twenty-year study period, it is anticipated that ongoing maintenance of the systems will remain under $100,000, a relatively minimal cost to maintain the existing equipment. The complete replacement of a system would cost approximately $100,000, an expense unlikely to be justifiable for a one-time purchase and installation of outdated equipment. Once the two remaining NDB systems fail, it is reasonable for DOAV to proceed with decommissioning.

5.4 Phased Implementation Plan and Next Steps

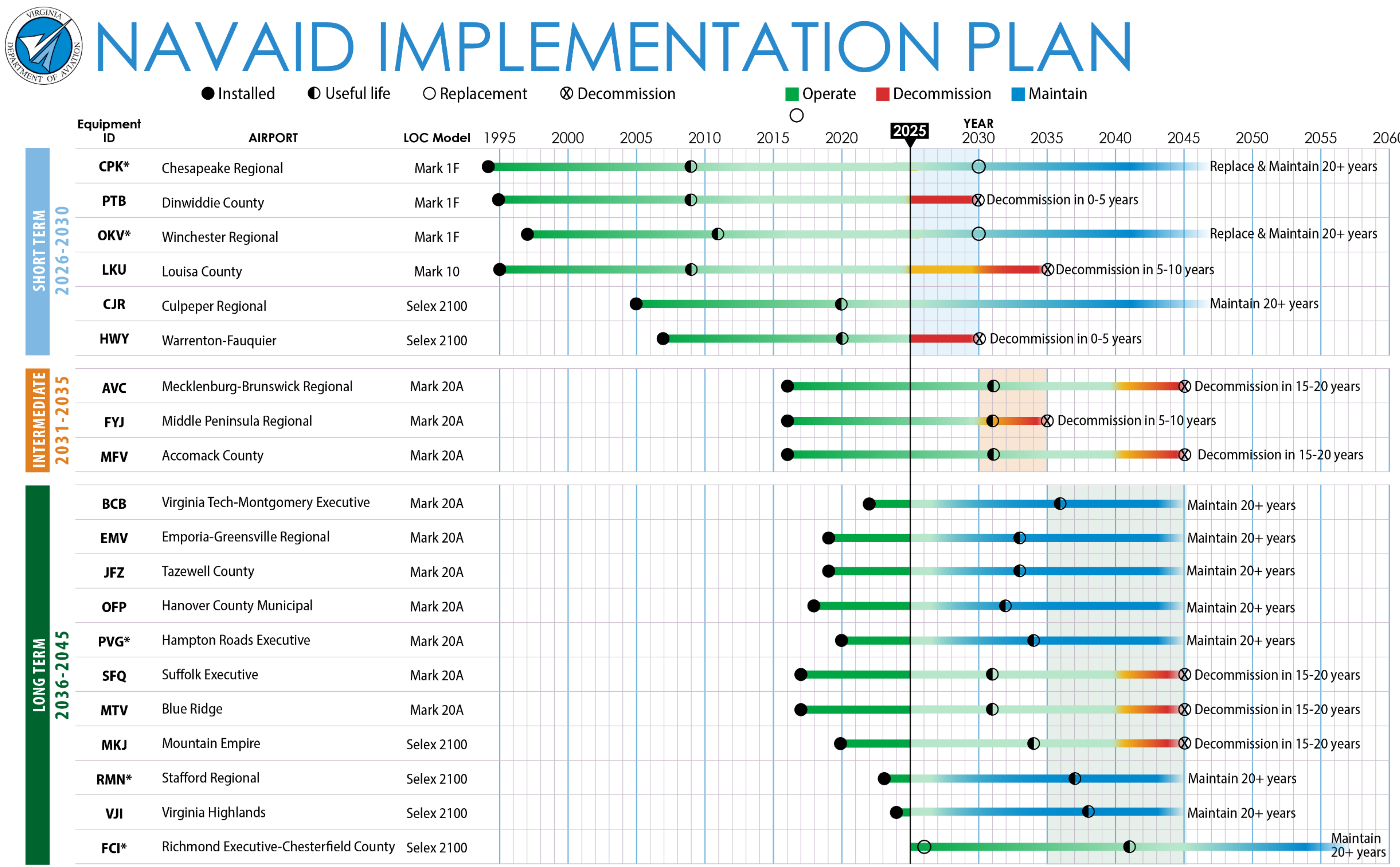
The phased implementation plan is the culmination of the analysis conducted as part of the study. The estimated costs in the implementation plan represent those necessary to maintain a NAVAID network for the Virginia Air Transportation System.

Recommendations pertaining to each phase include comparing estimated maintenance costs for each unit with actual costs realized over the same period. A review of the F&E Study should occur every five years to benchmark progress and reevaluate recommendations to ensure alignment with the DOAV mission and ongoing efforts.

It is generally recommended that the Commonwealth continue ongoing maintenance of specific NAVAIDs while limiting purchases of new equipment due to the increasing reliance on space-based navigation. As evidenced in earlier analysis, there is adequate ground-based coverage through the FAA's VOR MON plan and through systems owned by DOAV that are recommended for continuance.

Figure 30 presents the phased implementation plan for NAVAIDs owned and managed by DOAV.

Figure 30: 2025-2045 Virginia NAVAID Study Implementation Plan.



* Equipped with glide slope

5.4.1 Short Term (2026-2030)

The short-term implementation plan focuses on older localizer systems under DOAV's management. As these systems approach nearly thirty years in service, it is reasonable for DOAV to begin preparations for eventual decommissioning or replacement. Over the next five years, it is recommended that equipment at three airports, Dinwiddie County (PTB), Louisa County (LKU), and Warrenton-Fauquier (HWY), be decommissioned.

Decommissioning equipment at these airports would eliminate the LOC/DME approach at HWY, and two LOC approaches at LKU and PTB. Each ground-based procedure is redundant with a published RNAV (GPS) approach.

One airport with an older localizer model, Culpeper (CJR), received a new DME unit in 2025. With the installation of this new DME, it is reasonable to maximize its usefulness and lifecycle by pairing it with a replacement localizer. Based on age, it is assumed that the Culpeper (CJR) localizer can remain in service within the short-term planning period. Still, it would be reasonable for DOAV to plan for its eventual replacement within the next five years.

Summary: Decommission three localizers, three DMEs, and two NDBs. The localizer at CJR should be replaced once it is no longer supported, to ensure alignment with the newly installed DME. Following this phase, forty-three pieces of equipment would remain under DOAV's ownership in the Facilities and Equipment Program.

5.4.2 Intermediate Term (2031-2035)

Depending on the steps taken during the initial five years following the study, as well as the status of equipment, it is recommended that the NAVAID equipment at Middle Peninsula Regional (FYJ) be decommissioned in this timeframe.

As DOAV approaches this intermediate term, it would be reasonable to amend the plan to continue to maintain or fully replace the system at Accomack County (MFV) due to its relative location to other localizer-equipped airports. Due to the more remote location of Accomack County (MFV) compared to other Virginia airports and the availability of equipment at other airports near Richmond, it is likely that the equipment serving this airport would generate the most favorable benefit-cost to DOAV.

Summary: If both sets of equipment are decommissioned, two LOC approaches would be removed from service. The accompanying RNAV (GPS) procedures to each of the runway ends with localizer equipment maintain lower ceiling minimums and comparable visibility minimums, resulting in limited loss in system performance capabilities. Following this phase, there would be forty-one pieces of equipment remaining under DOAV ownership in the Facilities and Equipment Program.

5.4.3 Long Term (2036-2045)

In the long-term phase of the implementation plan, four airports are recommended for eventual decommissioning of localizer and DME equipment: Mecklenburg-Brunswick Regional (AVC), Suffolk Executive (SFQ), Blue Ridge (MTV), and Mountain Empire (MKJ). Decommissioning these systems results in the loss of four LOC approaches. As with the two previous phases, each LOC approach is complemented by an RNAV (GPS) approach with comparable minimums. It is recommended that the

RNAV (GPS) approach at MKJ visibility minimums be reduced to match those on the current LOC approach to ensure no loss in capability if decommissioned.

Ultimately, twelve airports with DOAV-owned equipment are recommended to represent an essential network of ground-based NAVAIDs. This network of equipment would provide an additional layer of ground-based navigation backup to an already existing FAA minimum operational network. The remaining ground-based, DOAV-owned NAVIAD network would consist of geographically diverse airports with relatively recent equipment installations.

Summary: In twenty years, if implemented, the status of equipment owned and maintained by DOAV will be drastically different than where the program stands in 2025. Nearly half of the available localizers and associated equipment in the Commonwealth's program could be decommissioned in the next twenty years. While that represents a significant change, the air transportation system would still maintain reasonable and resilient access to its airport system through the twelve remaining localizer and ILS systems under DOAV management, not to mention those ground-based systems managed by the FAA at fifteen other system airports. This end-state would leave thirty-three pieces of equipment for management by DOAV in the Facilities and Equipment Program.

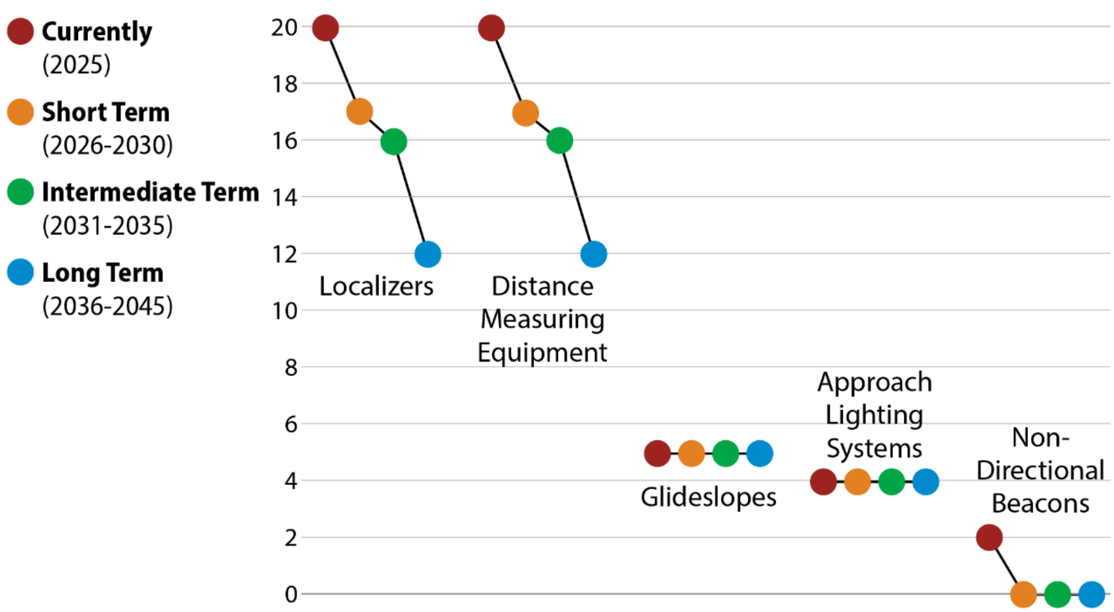


Figure 31: Change in DOAV-owned equipment over twenty years.

5.4.4 Weather Reporting Systems

The DOAV assists airports in maintaining robust weather reporting coverage across the Commonwealth. On-site weather reporting permits lower minimums on approaches and provides pilots with the best available weather information at specific sites. The following section will evaluate the recommendations associated with weather reporting systems across Virginia over the twenty-year planning period.

The AWOS funded and maintained by Virginia DOAV are critical to ongoing aviation operations and, as such, are recommended to remain in place over the twenty-year planning period. There is potential for expansion as new weather reporting alternatives, such as backup AWOS and weather cameras, become more prevalent.

AUTOMATED SURFACE WEATHER OBSERVING SYSTEMS (ASOS)

Eleven ASOS sites in Virginia will continue to operate through the joint efforts of the FAA, NWS, and DoD. If program funding is ever altered, DOAV may be required to assist airports with its system equipped with ASOS. It is most likely that DOAV would be required to assist these airports in replacing the ASOS with AWOS, as is typical practice at other Virginia Air Transportation System facilities. The ASOS are generally over twenty years old and may require replacement over the study period.

AUTOMATED WEATHER OBSERVATION SYSTEMS (AWOS)

Thirty-two of the fifty-one AWOS maintained by DOAV exceed the fifteen-year useful life criterion and are technically eligible for replacement. Another seventeen systems, primarily those installed at airports in the Local Service airport role in 2013 and 2014, will be eligible for replacement in the next five years. Two systems, those at JGG and VJI, have been replaced in the last two years.

Summary: The DOAV can expect to continue investing in AWOS replacement parts, maintenance, and inspections over the next twenty years, as weather reporting availability at these sites remains a critical facet of aviation safety throughout the Commonwealth.

5.4.5 Summary and Next Steps

As stipulated in the DOAV's Airport Program Manual, a NAVAID must be included in the Commonwealth's Facilities and Equipment NAVAID Study to be eligible. It is recommended that equipment recommended for decommissioning remain eligible for maintenance expenditures until the department finalizes decommissioning plans with the sponsor. If equipment is recommended to be maintained through the study period, those systems are recommended to remain eligible for full replacement in future years. All weather systems should remain eligible for maintenance, inspection, and replacement parts as deemed necessary by the Facilities and Equipment Program Manager. ***Table 27*** provides a complete summary of recommendations pertaining to DOAV-owned NAVAIDs.

Table 27: Summary of recommendations and eligible systems for maintenance and replacement.

ID	Airport	Recommendation
AKQ	Wakefield Municipal	Decommission NDB in one to five years.
AVC	Mecklenburg-Brunswick Regional	Decommission localizer and DME in fifteen to twenty years.
BCB	Virginia Tech-Montgomery Executive	Maintain localizer and DME for twenty-year study period.
CJR	Culpeper Regional	Replace and maintain localizer and maintain DME for next twenty years.
CPK	Chesapeake Regional	Maintain and/or replace localizer, glideslope, and DME for twenty-year study period. Maintain support for approach lighting system.
EMV	Emporia-Greensville Regional	Maintain localizer and DME for next twenty years.
EZF	Shannon	Decommission NDB in one to five years.

ID	Airport	Recommendation
FCI	Richmond Executive-Chesterfield County	Replace localizer and glideslope with anticipated runway extension in 2026-2027. Maintain localizer and DME for next twenty years.
FYJ	Middle Peninsula Regional	Decommission localizer and DME in five to ten years.
HWY	Warrenton-Fauquier	Decommission localizer and DME in one to five years.
JFZ	Tazewell County	Maintain localizer and DME for twenty-year study period.
LKU	Louisa County	Decommission localizer and DME in five to ten years.
MFV	Accomack County	Decommission localizer and DME in fifteen to twenty years.
MKJ	Mountain Empire	Decommission localizer and DME in fifteen to twenty years.
MTV	Blue Ridge	Decommission localizer and DME in fifteen to twenty years.
OFP	Hanover County Municipal	Maintain localizer and DME for twenty-year study period.
OKV	Winchester Regional	Maintain and/or replace localizer, glideslope, and DME for twenty-year study period. Maintain support for approach lighting system.
PTB	Dinwiddie County	Decommission localizer and DME in one to five years.
PVG	Hampton Roads Executive	Maintain localizer, glideslope, and DME for twenty-year study period.
RMN	Stafford Regional	Maintain localizer, glideslope, DME, and approach lighting for twenty-year study period.
SFQ	Suffolk Executive	Decommission localizer and DME in fifteen to twenty years.
VJI	Virginia Highlands	Maintain localizer and DME for twenty-year study period.

Source: Woolpert

Emerging technologies that are either certified, in testing, or not yet created may offer opportunities that change the direction of the implementation plan. The following chapter summarizes considerations related to Advanced Air Mobility (AAM) and uncrewed aircraft systems and how the emergence of these technologies may impact the Virginia air transportation system and the management of DOAV's Facilities and Equipment Program.

6 AAM CONSIDERATIONS

*Advanced Air Mobility encompasses emerging aviation technology, including **eVTOLs, UAS, electric conventional aircraft, and hydrogen-powered aircraft.***

Advanced Air Mobility (AAM) is a rapidly growing sector of the aerospace industry. AAM is focused on developing innovative, cost-effective aircraft with a low environmental impact. A key aspect of AAM is its ability to transport people and goods in areas that are either unserved or underserved by traditional aviation. The National Aeronautics and Space Administration (NASA) and other advocates have championed vehicle designs that are "enabled by electrification and scaled through automation." AAM is primarily associated with electric vertical takeoff and landing vehicles (eVTOLs); however, it also encompasses electric conventional takeoff and landing vehicles (eCTOL) and unmanned aircraft systems (UAS). In addition to lower carbon outputs, AAM aircraft aim to revolutionize aircraft design through automation by transitioning from manual flight towards simplified vehicle operation (SVO). The new cockpits are intended to reduce pilot workload by automating some or all elements of aircraft control. Most eVTOL aircraft will initially be certified with a pilot on board, while others seek to enter the market as autonomous aircraft. AAM is in its formative years, with technology and regulation actively evolving as it progresses towards maturation. This section is intended to provide the DOAV with insight to support preparations as AAM aircraft enter service.

6.1 Progress in Virginia

Virginia has made significant strides in advancing its aviation infrastructure and capabilities. The DOAV has been actively working on various initiatives to enhance the efficiency, safety, and accessibility of air transportation. This section provides an overview of the progress made in Virginia, highlighting key projects and developments that demonstrate the Commonwealth's commitment to improving its aviation systems.

6.1.1 Virginia AAM Strategy

The Virginia AAM strategy is a forward-thinking initiative designed to enhance transportation and connectivity across the Commonwealth. By leveraging emerging aviation technologies, the strategy aims to develop new, affordable, and flexible transportation platforms that improve safety and reduce environmental impacts. The Commonwealth has positioned itself as a leader in this field through years of collaboration among various stakeholders, including public and private entities. This collaborative approach has resulted in substantial groundwork, such as securing one of the seven FAA-awarded UAS test sites and forming various alliances and public-private partnerships.

A key aspect of Virginia's AAM strategy is its community-led model, which empowers local communities to identify their specific needs and invest in infrastructure development within an established framework. By involving community leadership at Virginia's airports and partnering with industry, the strategy fosters a sense of ownership and ensures that the infrastructure developed is both practical and beneficial. This model has proven successful in traditional aviation systems and is expected to yield similar results for AAM, creating a network that is interoperable within Virginia and aligned with other states.

The strategy also emphasizes economic viability and financial sustainability, aiming to ensure that investments lead to long-term benefits for all stakeholders. The strategy aims to support commercially viable operations that enhance aviation safety and services by focusing on community-identified needs and industry requirements. The phased, incremental infrastructure rollout allows for careful planning, testing, and refinement, reducing risks and costs.

This smart approach supports immediate needs and lays the groundwork for future advancements in aviation technology, making Virginia an attractive destination for aviation industry participants and fostering economic growth across the Commonwealth. Since the publication of this strategic plan, the DOAV has initiated steps to advance its objectives. Two of these initiatives are discussed in the following sections.

6.1.2 Virginia Innovation Partnership Corporation

Virginia Innovation Partnership Corporation (VIPC), which originated as the Center for Innovative Technology (CIT) in 1985, is a non-profit organization that creates technology-based economic development strategies to accelerate innovation and foster the next generation of technology and technology companies. VIPC was formed to support the Commonwealth's vision for expanding innovation, opportunity, and job creation in Virginia. VIPC can be categorized as a form of venture capital or angel investor for Virginia-based tech companies, providing seed funding and support for early-stage technology companies to commercialize their innovations, grow their businesses, and ultimately bring high-paying jobs to Virginia. VIPC is the operating non-profit of the Virginia Innovation Partnership Authority (VIPA), which was created by the Virginia General Assembly in HB 1017.

VIRGINIA'S ADVANCED AIR MOBILITY FUTURE

The Virginia Advanced Air Mobility Future report, published in 2023 by VIPC, is an economic impact study aimed at educating the general public about the potential benefits of AAM in Virginia. The report covers the business cases for AAM and its elements, job creation impacts, workforce development needs, and recommendations for the Commonwealth to support the growth of this emerging industry. The report highlights the transformative potential of AAM in Virginia, emphasizing its societal and economic benefits. It explores how AAM can bridge the rural-urban divide, enhance tourism, and improve healthcare outcomes by providing efficient transportation options. The study estimates that by 2045, AAM will generate $16 billion in new business activity, create over 17,000 full-time jobs, and produce $2.8 billion in local, state, and federal tax revenues. Additionally, the report forecasts that by 2045, approximately 66 million passengers will have traveled using new eVTOL services, with about 7.7 million passengers per year during the 2041-2045 period. The study concludes by offering recommendations to the Commonwealth to continue to support AAM growth in the state. The recommendations are:

- Appoint an executive AAM leader for the Commonwealth.
- Invest in USA traffic management (UTM) infrastructure (low and mid altitude).

- Create additional AAM development/flight testing areas in Virginia.
- Offer a compelling incentive program to attract AAM OEMs to the Commonwealth.
- Prepare Virginia public use airports for AAM by:
  - Developing passenger handling facilities.
  - Working to implement scheduled and on-demand AAM services.
  - Building charging networks.
- Expand science, technology, engineering, and mathematics (STEM) programs to enhance the AAM workforce development.
- Incorporate Washington, DC, into Virginia AAM plans.
- Introduce digital twinning and immersive technologies to create a laboratory for accelerating the AAM community integration.

HAMPTON ROADS AIRSPACE ANALYSIS

The Hampton Roads Airspace Analysis, published in 2023 under the VIPC umbrella, evaluates a proposed drone delivery route from Riverside Hospital in Onancock, Virginia, to Tangier Island in Chesapeake Bay. Following the FAA's Safety Risk Management guidelines, the analysis considers factors such as airspace, airports, and historical air traffic to assess operational risk. The report also provides a comprehensive overview of factors affecting UAS delivery within Virginia, including existing operations, infrastructure, economic factors, and climate implications.

The findings indicate that Virginia is an exceptionally favorable environment for UAS delivery services, with strong organizational support, a robust economy, and successful drone delivery projects. The Commonwealth’s topography, climate, and existing transportation infrastructure further enhance its suitability. Despite some challenges with special-use airspace, the overall conclusion is that Virginia offers a highly favorable landscape for UAS delivery enterprises. The proposed delivery operation was successfully tested in real-life scenarios in February 2024, demonstrating the practical viability of the report's recommendations.

6.1.3 Virginia Tech Mid-Atlantic Aviation Partnership (MAAP)

The Mid-Atlantic Aviation Partnership (MAAP) is an FAA-selected UAS test site formed in 2013 as a collaboration among Virginia, Maryland, and New Jersey, led by Virginia Tech. MAAP undertakes research to address pressing technical and operational challenges in UAS integration. Leading Virginia’s BEYOND team and other major federal UAS-integration efforts, MAAP's work has consistently resulted in landmark permissions and operations that have advanced the industry. MAAP is actively engaged in developing industry standards, utilizing data and insights from its work to shape the framework that will support the evolution of UAS technology towards its full potential. DOAV has utilized the MAAP to advance its AAM Strategic Plan initiatives, with the most recent example being the publication of the Virginia AAM Minimum Viable Infrastructure report.

6.1.4 Stafford-Warrenton-Winchester Corridor

The Stafford-Warrenton-Winchester corridor connects three communities and airports outside the D.C. airspace to further develop AAM use cases. These use cases include drone as a first responder (DFR), middle-mile connections, emergency air medical transport, and survey and inspection capabilities.

6.1.5 Business Activity

Several leading companies in the AAM space are developing cutting-edge technologies within the Commonwealth. These developments enable local communities to engage with advanced technology while positioning the Commonwealth as a leader in UAS operations.

The Commonwealth is well-positioned to continue at the forefront of technological advancements and economic growth in this sector. These companies drive innovation and provide local communities with the opportunity to engage with cutting-edge technology, making Virginia a leader in UAS and AAM operations.

DRONEUP

DroneUp is a leading small Unmanned Aircraft System (sUAS) package delivery company founded in 2016 and based in Virginia Beach. The company focuses on the last-mile delivery of parcels under ten pounds. DroneUp's flagship partnership is with Walmart, where they deliver grocery products from Walmart parking lots in multiple states. DroneUp is working towards completing Part 135 certification while testing its limited beyond visual line-of-sight (BVLOS) operations to eventually implement operations at scale. With the unveiling of the DroneUp ecosystem, the company is well-positioned to be a major player in the sUAS delivery market after the FAA completes its Part 108 rulemaking process.

TRUWEATHER

TruWeather Solutions is a weather-centered solution for the AAM industry aimed at "reducing the weather tax" on communities and commerce. TruWeather offers a variety of advanced weather sensors designed to capture micro-weather data at AAM flight altitudes. The company offers an accompanying meteorological subscription where they help provide go or no-go decisions for flight missions. The company was heavily involved in creating the American Society for Testing and Materials' (ASTM) F3673-23 Standard Specification for Performance for Weather Information Reports, Data Interfaces, and Weather Information Providers (WIPs). TruWeather is a leader in AAM weather technologies and could play an important role in addressing BVLOS issues for AAM operations.

AURA NETWORK SYSTEMS

Advanced Ultra Reliable Aviation (AURA) Network Systems is an AAM-centric command and control (C2) network. AURA operates secure, reliable, mission-critical communications services via its licensed spectrum, providing nationwide coverage for autonomous flight operations. The company worked on AAM flight testing with NASA in 2022. In October 2024, they announced the publication of RTCA DO-406, establishing UHF radio performance standards for UAS command and control. Reliable and secure C2 links are vital to the success of uncrewed operations, and AURA believes they have the technology to be the spectrum AAM relies on.

ANRA TECHNOLOGIES

ANRA Technologies is an airspace and mission management software for the AAM sector. ANRA's UTM ecosystem claims to deliver dynamic routing, real-time aircraft tracking, and deconfliction services. The company is a leader in the Unmanned Aircraft System Traffic Management (UTM) space as a key participant in the Dallas-Fort Worth key site project completed by the FAA and NASA. ANRA provided services for the first commercially shared airspace flight in the United States on June 21, 2024. The project used production-grade software to deconflict uncrewed aircraft operations between aircraft operated for Wing Drone Delivery and Manna Air Delivery.

ELECTRA AERO

Electra Aero is an aircraft OEM working towards bringing its hybrid electric short takeoff and landing (eSTOL) aircraft into service by 2028. eSTOL has the benefit of a compact takeoff and landing area while maintaining the safety and economics of a conventional fixed-wing aircraft. The company plans for the aircraft to have a 500-mile range (plus a 45-minute reserve), to carry nine passengers (or 2,500 lbs. of cargo), and to have a landing footprint comparable to a soccer field at 300 x 100 feet. Electra has been testing their demonstrator since 2023 and has secured 2,000 pre-orders. Electra's unique concept and promising progress should make them a force in the regional air mobility market.

UNITED THERAPEUTICS

United Therapeutics, under its acquisition Revivicor, develops organs from gene-edited pigs that are ready for transplant into humans. Headquartered in Silver Spring, Maryland, United Therapeutics maintains a lab development facility in Blacksburg, where organs are developed and eventually transported to the Washington, D.C., and Maryland area. To assist in transporting these organs in an environmentally friendly and sustainable manner, United Therapeutics has partnered with Beta Technologies to test and facilitate route development between the two United Therapeutics sites. This partnership represents a significant step forward for both realizing an AAM use case and furthering the use of electric aircraft.

6.2 Application to Virginia NAVAID Network

6.2.1 Weather Systems

Weather reporting systems at Virginia airports provide viable insight into conditions at those locations, but as AAM further develops and off-airport vertiports are integrated into the Virginia Air Transportation System, DOAV may see value in deploying weather systems at these sites.

Traditional weather reporting systems were built to support legacy airport operations and higher-altitude airways and lacked an emphasis on products that provide low-altitude information. As aviation technology advances, expanded low-altitude capabilities will be required in order to accommodate AAM activity at airports, and even at vertiports and droneports.

AAM will likely use surface infrastructure locations both on- and off-airport, requiring weather reporting systems at new locations with higher data fidelity and integrity. Temperature and wind at small-scale facilities, especially in urban environments, can change rapidly due to the materials used on surfaces and structures. New weather reporting systems, calibrated and standardized to the needs of AAM takeoff/landing areas and low-altitude routes, are expected to offer an alternative means to traditional AWOS, which may represent a more significant investment than required at certain locations.

Alternative weather infrastructure companies have emerged to fill this niche and continue building momentum toward adoption. The FAA's EB-105A update noted that new entrant weather systems are being evaluated as potential options for vertiports, with additional details to be included in future guidance. Inclusion and consideration in EB-105A indicate the FAA's recognition that new systems with more localized weather data will be required for AAM activity.

ASTM International, the global industry standards organization, developed F3673-23, Standard Specification for Performance for Weather Information Reports, Data Interfaces, and Weather Information Providers (WIPs), to ensure that new weather reporting products meet specific performance criteria. This standardization enhances the legitimacy of new weather systems by establishing consistent quality and reliability benchmarks. The involvement of ASTM International's publication and guidance lends credibility to the need for additional system types, as well as for a standard that facilitates interoperability between different weather systems. Establishing weather system standards through ASTM International is an important initial step, but testing and adoption by the FAA will be a critical follow-on task to permit the funding and installation of new, non-federal weather systems as a source for hyper-local weather reporting at vertiports.

Another consideration pertaining to weather reporting is the emergence of third-party AWOS providers and backup AWOS. While not yet approved by the FAA as part of the non-federal NAVAID program, having these systems in place either at high-traffic airports that may be the first to experience AAM traffic or at standalone vertiports, deciding how DOAV will go about supporting or implementing these systems will be an important next step for AAM in the Commonwealth.

6.2.2 Ground-Based NAVAIDs

The slower approach speeds of AAM aircraft will influence the feasibility and utilization of straight-in approaches reliant on ground-based NAVAIDs. It is most likely that specific RNAV (GPS) procedures will need to be developed to accommodate these emerging aircraft types.

Ground-based approaches can still serve as a backup option for these aircraft and add to the resiliency of the Virginia airport network, especially in the Stafford-Warrenton-Winchester and Blackstone-Blacksburg-Roanoke corridors that have been developed specifically with AAM in mind. Ultimately, decisions related to the ground-based NAVAID network should not be delayed in an effort to integrate these systems with AAM aircraft activity. Instead, it is recommended that DOAV be proactive in adapting its airspace and approach network to accommodate satellite-based navigation to and from existing airports and any other new aviation facilities.

6.2.3 Summary

AAM has an opportunity to add economic benefits to Virginia communities by introducing a new mode of regional connectivity. When considering the Commonwealth's air transportation system accessibility and the fact that nearly ninety-five percent of Virginia's population lives within a thirty-minute drive of an airport, many low-volume general aviation airports located in small communities may prove to be ideal locations to host eVTOL operations.

Airports provide existing infrastructure, including approach and departure protections, land use compatibility, and takeoff and landing surfaces, which make them an ideal option for initial eVTOL applications. General aviation airports, including those in Virginia, have been developed to meet federal design standards that address important safety elements. To ensure airports remain viable for AAM, Airport Layout Plans and Airport Master Plans should incorporate planning practices that provide flexibility in operations and infrastructure utility. Most importantly, airports offer an immediate solution, as opposed to vertiports that will require new authorizations and adaptations to land use codes.

Two other important operational considerations when assessing a general aviation airport's ability to support AAM activity are integrating slower eVTOL aircraft with typical manned/fixed-wing aircraft and electrical charging readiness.

Some eVTOLs will be capable of flying at speeds similar to smaller general aviation propeller aircraft, while others will fly at significantly slower airspeeds. At a busy general aviation airport, if eVTOLs fly at slow speeds, this could create problems with general aviation aircraft with faster approach speeds attempting to land at the same airport. Depending on how slow the eVTOLs fly in the traffic pattern or on final approach, it may be necessary to establish an alternate traffic pattern for the eVTOL that leads to the landing surface. Establishing alternate traffic patterns to separate aircraft with different approach speeds could be complex at some airports. While some manufacturers highlight their developmental concepts as having vertical capabilities, it is important to note that the vertical nature of these vehicles is not yet fully understood by the industry. Some OEMs have suggested that operationally, it may be more efficient for certain eVTOLs to operate more like short takeoff and landing (STOL) aircraft rather than purely vertical vehicles, due to considerations of vehicle stability, battery power consumption, and contingency plans.

Airports with the electrical capacity necessary for eVTOL charging will likely be initial candidates for AAM activity. As evidenced by Beta's activity at the Virginia Tech-Montgomery Executive Airport, a reliable and powerful charging station will be required for operators. Stable three-phase power, capable of simultaneously meeting the peak power needs of multiple aircraft, will be required. In March 2024, DOAV introduced a $200,000 grant for airports interested in upgrading their electric infrastructure to three-phase power and enhancing broadband connectivity. These grants represent Virginia's interest in leveraging existing airports as sites for AAM activity.

As DOAV refines its Facilities and Equipment Program, it will be critical to incorporate AAM into Airport Master Plans and Airport Layout Plans. Identifying infrastructure and preserving space for these types of operations will help ensure projects are eligible for FAA funding as programs evolve and develop. With AAM integrated into the planning process, DOAV can help ensure its airports are taking a safe and efficient first step into an ever-evolving operating environment.

7 SUPPLEMENTAL DOCUMENTATION

7.1 NAVAID and IAP Database

An Excel spreadsheet database was compiled during the study and has been supplied to DOAV.

7.2 Supporting an Essential Training Network with Virginia NAVAIDs

7.2.1 Introduction

The objective of the 2025 Commonwealth of Virginia (VA) Department of Aviation (DOAV) Facility and Equipment (F&E) Navigational Aid (NAVAID) Study is to provide recommendations to the DOAV that help ensure continued safe operations and adequate service levels within the Commonwealth. In many ways, Virginia is a national leader in advancing the future of aviation and air transportation by including the advances in unmanned aircraft systems and advanced air mobility at NASA Langley Research Center and universities such as Virginia Tech.

Additionally, Virginia maintains a robust network of pilot training centers and resources that feed the air transportation system. A vital aspect of pilot training is qualifying pilots to fly and navigate under conditions where instrument flight rules apply. Global Positioning Systems (GPS) are now the dominant means by which pilots determine their position and navigate to their destinations. The technologies that provide pilots with GPS information have advanced to the point where some aircraft manufacturers do not include the necessary systems to receive information from legacy NAVAIDS in their new models. However, the real possibility still exists that a pilot may be denied GPS information. Thus, the pilot certification requirements set by the FAA still require flight schools and certified flight instrument instructors to ensure their students demonstrate proficiency in executing approaches, departures, and en-route navigation utilizing ground-based NAVAIDS.

To support the network of FAA-certificated flight schools in Virginia that provide pilots with exceptional training in instrument flying, the DOAV relies on a complementary and overlapping network of ground-based NAVAIDS, as well as those supported by the FAA. This network provides a reliable and economical means of delivering the required instrument training for student pilots and currency for certificated pilots and instructors. The maintenance of this essential flight training network of ground-based NAVAIDS should be taken into consideration when exploring the future maintenance and replacement of Virginia-owned assets.

7.2.2 Determining the Parameters of an Essential Flight Training Network

To provide sound recommendations to the DOAV, Futron Aviation Corporation relied on the collective experience of seasoned, instrument-rated pilots and certificated flight instructors with extensive recent experience in training for an instrument rating in light aircraft to establish the initial parameters upon which to base the DOAV recommendations. With the initial parameters set, the researchers validated the assumptions and conclusions by interviewing a number of Virginia flight schools certified to provide instrument flight training under Part 141 of FAA regulations, as well as other instrument flight instructors certified under Part 61. These two parts of the federal code allow for subtle differences in how the training is delivered. The main difference is that Part 61 instructors are provided with the latitude to include instrument approaches at different points of student training, whereas Part 141 schools (which typically operate from a base airport) are required by the FAA to follow an approved syllabus where certain skills are demonstrated during specified flights.

7.2.3 The Drivers for Ground-Based NAVAID Instrument Flight Training

In examining the need to provide effective instrument training in Virginia, Futron Aviation determined several drivers:

- **Training Syllabus Requirements:** For Part 141 certificated schools, student pilots are required to demonstrate proficiency in flying ILS approaches on a minimum of three or four different syllabus flights. In practice, instrument instructors stated that a student pilot will typically fly over 50 ILS approaches during the course of training.
- **Order of Syllabus Flights:** Again, for Part 141 flight schools, the instrument training syllabus flights must be completed in order. Thus, unlike a student learning with a Part 61 certificate instructor, the required ILS approaches cannot be completed on a cross-country flight.
- **Simulator Usage:** Although a number of simulated instrument approaches can be completed in a flight simulator, the frequency of simulator use in Virginia is unknown but likely contributes a small percentage of approach requirements at present based upon interviews with instrument instructors.
- **Cross-Country Flight Definition:** For flight training purposes, a cross-country flight is one that is over fifty miles in length. Thus, for Part 141 flight school, all dedicated instrument approaches must be completed at a facility within fifty miles of the base airport.
- **Flight School Business Requirements:** For flight schools to maintain a viable business, there are considerations that are pivotal and also impacted by the need to train student pilots to instrument approaches:
  - Flight schools strive to minimize the costs to both the flight school and to the student.
  - Flight schools strive to maximize their student throughput as well as the days between maintenance and phased inspections on their aircraft.

In order to develop sound recommendations to the DOAV regarding the maintenance of an essential training network in Virginia, Futron needed to answer a number of key questions. First and foremost, were the following:

Which ground-based NAVAIDs owned by the Commonwealth are necessary to support the training network?

After examining the list of DOAV-owned NAVAIDS and understanding that all VORs in Virginia are operated by the FAA, the only equipment critical for instrument training requirement support is the infrastructure that supports ILS approaches.

7.2.4 The Variables Impacting an Essential Flight Training Network in Virginia

Given this single constant and the identified drivers, Futron sought to solve the problem for the following variables:

1. Where are the Virginia-owned ILS approaches/equipment?
2. Where are the FAA-owned ILS approaches/equipment?
3. Where are the Part 141 flight schools?
4. Where are the Part 61 flight schools?

5. What is the maximum desired range to an ILS-equipped airport available for practice approaches?
6. What is the likelihood that the FAA will continue to support the ILS equipment they own in Virginia?
7. What is the likelihood that the FAA will change the instruction requirements for ILS approach experience/satisfactory demonstration?

The answers for the first two variables are depicted in ***Figure 32***. Within the Virginia air transportation system and the thirty-five airports that support ground-based instrument approaches, nineteen of those airports have ILS approaches.

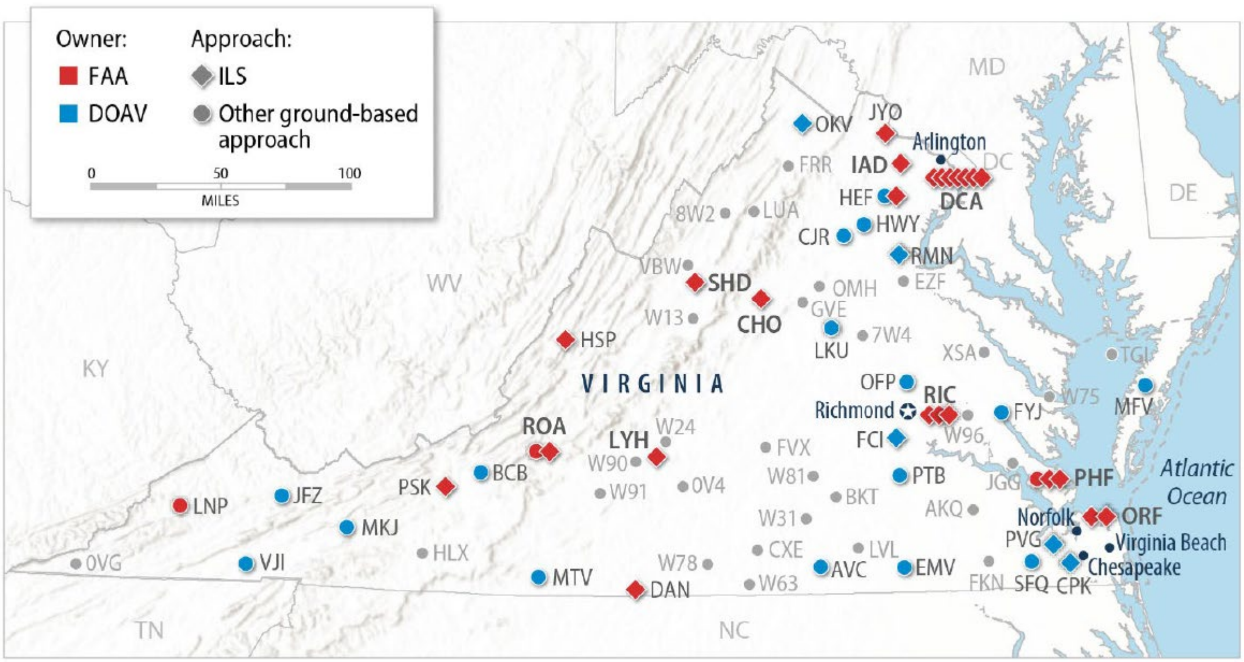


Figure 32: Location of ILS approaches in Virginia.

The answers for Variables 3 and 4 are depicted in ***Figure 33.*** The figure only depicts a select number of Part 61 certificated flight schools, given that Part 61 instructors are not required to operate from a specific base airport.

The fifth variable includes a range of values based upon interviews with instrument instructors and flight schools. Futron determined that instructors are generally willing to fly to an airfield within thirty miles of the flight school's home airport to conduct syllabus ILS approaches. This accepted range led to determining the answers for Variable 5. In ***Figure 34***, a twenty-five-mile radius around each of the airports supporting a Part 141 flight school is plotted. Based on this plot, Futron was able to determine if the current Virginia-based Part 141 instrument flight schools were within twenty-five miles (five miles less than the agreed-upon maximum accepted range of thirty miles) from a Virginia-owned or an FAA-owned ILS.

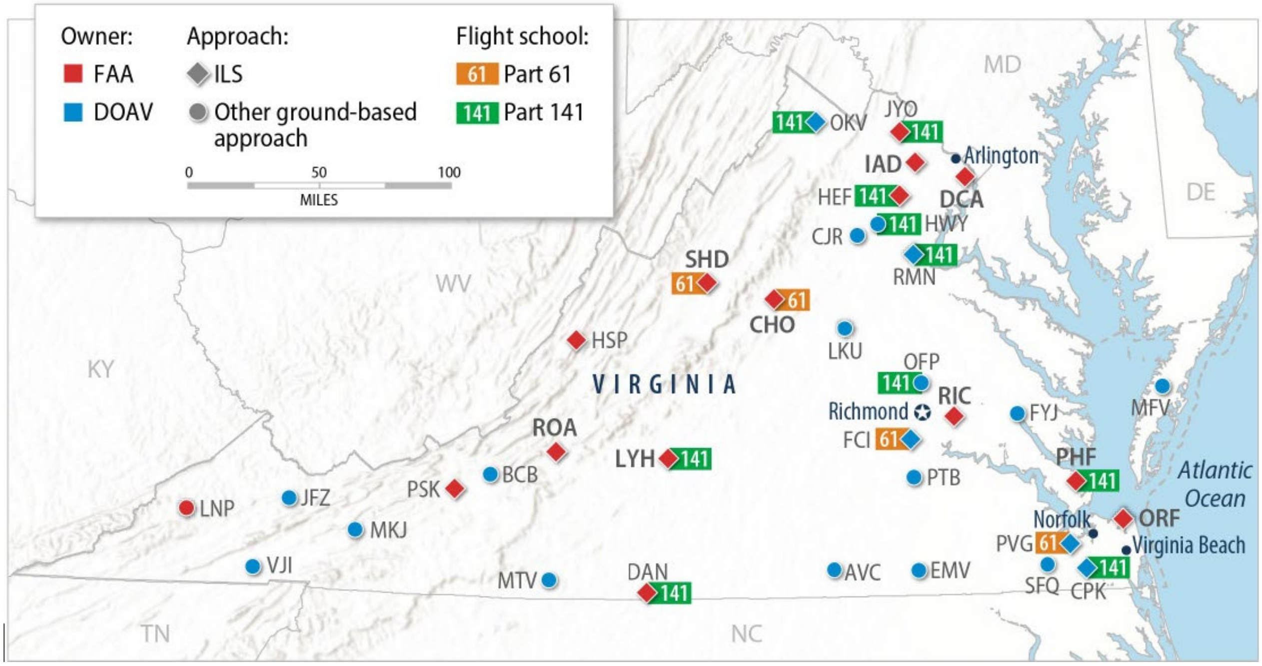


Figure 33: Location of Virginia instrument flight schools.

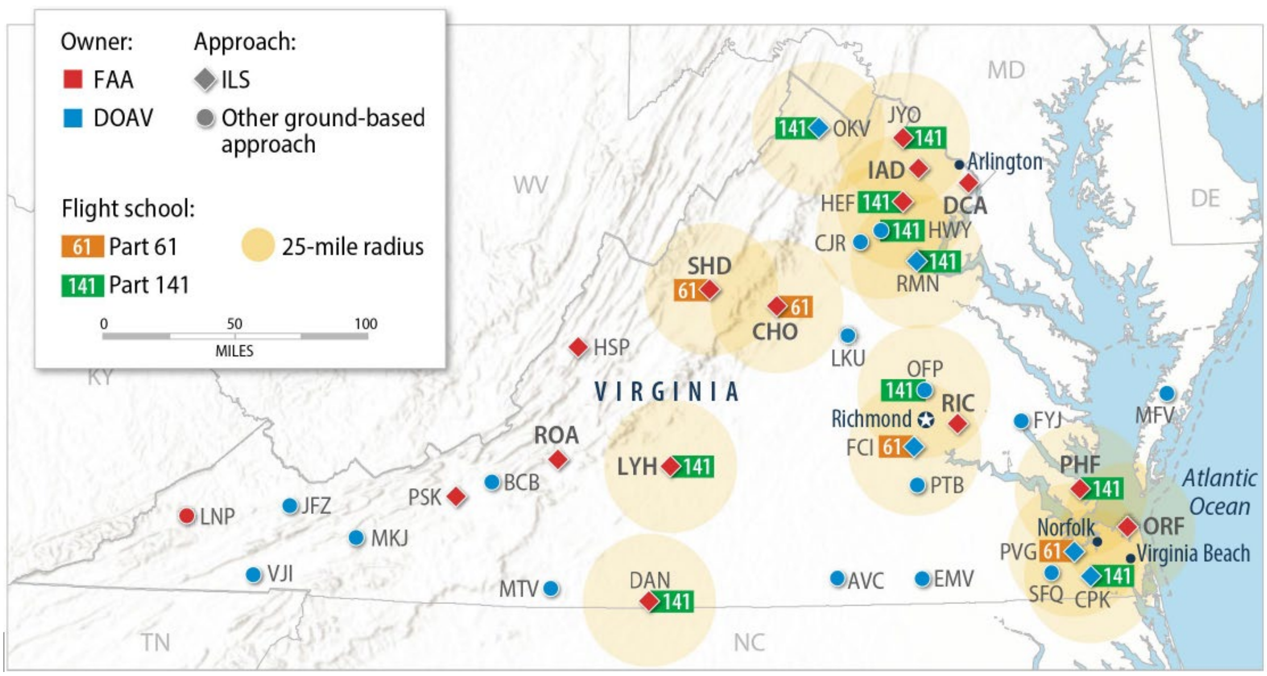


Figure 34: Ranges to ILS approaches from Part 141 flight schools.

Futron did not contact the FAA to determine the answer for Variable 6, but based upon discussions with the DOAV, it is highly unlikely that the FAA will discontinue supporting any of the ILS approaches at Virginia airports.

Regarding Variable 7, this is yet to be determined. Given the movement to reliance upon satellite-based navigation amongst certified pilots, it seems likely that FAA training requirements may change in the future, especially given that some aircraft manufacturers are beginning to exclude ground-based avionics from their standard navigation suites. For the foreseeable future, requirements to achieve an instrument rating will require pilots to master flying an ILS approach.

7.2.5 Analysis and Conclusions Regarding the Virginia Essential Flight Training Network

The analysis of the current state of support for instrument flight training requirements in Virginia revealed the following results:

- All Virginia Part 141 certified flight schools are either collocated or within twenty-five miles of an ILS.
- The Virginia-owned ILS are located at the following facilities:
  - Chesapeake Regional Airport (CPK)
  - Winchester Regional Airport (OKV)
  - Stafford Regional Airport (RMN)

  None of these airports is designated as a reliever airport by the FAA.
- All airports with flight schools and Virginia-owned ILS are within twenty-five miles of an FAA-owned ILS with the exception of OKV.
- The closest FAA-owned ILS to the Virginia-owned ILS at RMN is within Washington, D.C., airspace, making flight training at those facilities problematic.

Currently, the existing ILS facilities and approaches support instrument flight training in Virginia exceptionally well. It is recommended that the DOAV continue to support the ILS infrastructure at the three airports with Commonwealth-owned equipment. Given that two of the three airports supported by Virginia-owned ILS have unique situations, namely OKV and RMN, it would follow that these airports' priority rating should support consideration of a change in the future.

7.3 Public Outreach Summary

7.3.1 Futron Aviation Corporation: Virginia Department of Aviation Navigation Aid Airport Survey: August 9, 2024

SECTION 1: SUMMARY

The Virginia Department of Aviation (DOAV) commissioned a study of Commonwealth-owned facilities and equipment. This study focuses on Navigational Aids (NAVAIDs) located at Virginia Airports to provide information and recommendations regarding the current and future utility of the equipment in the coming years. Futron Aviation Corporation served as a subcontractor to Woolpert, providing pilot expertise and knowledge of airports in Virginia, as well as conducting onsite interviews with air navigation stakeholders at various airports throughout the state.

To support the study, Futron Aviation consultants visited six airports, each having specific characteristics that allow for a varied and informed view into the preferences and general use of NAVAIDs by pilots and airport managers. The six airports visited were (in order of visit):

- Virginia Tech Montgomery Executive Airport (BCB) – June 5, 2024
- Roanoke-Blacksburg Regional Airport (ROA) – June 5, 2024
- Lynchburg Regional Airport (LYH) – June 11, 2024
- Winchester Regional Airport (OKV) – June 12, 2024
- Culpeper Regional Airport (CJR) – July 10, 2024
- Shannon Airport (EZF) – July 10, 2024

During the visits, Futron consultants facilitated group discussions with representative samples of local pilots (commercial, corporate, and general aviation), flight instructors, and other airport stakeholders to understand which navigation aids and approach methods are commonly employed.

Key findings from the visits common to all six airports include:

- **GPS navigation and approaches are the most used.** As expected, GPS navigation is preferred and relied upon for air navigation.
- **Pilots rely on other approach methods for a variety of reasons.** Pilots indicated that ILS and localizer approaches are used when the approach minimums are lower, topography is preferable, and for currency.
- **NDBs are not utilized for navigation.** NDBs are no longer used for navigation, and most aircraft are not equipped to pick up the broadcasts.
- **Pilots are wary that backup modes of navigation will be available if GPS is denied or aircraft avionics fail.** While pilots acknowledged that the reliability of GPS signals and the aircraft's GPS avionics are quite sound, there was a perception that the GPS system had been compromised at each airport, and that it may have been compromised in other areas, with the possibility that malicious actors could do the same locally or regionally.
- **Stakeholders appreciated the opportunity to participate in this study and possibly influence the future** of the DOAV system. From the national level, pilots believe the needs of general aviation

are not being prioritized when considering the decommissioning of key FAA-owned VORs in Virginia.

- **Pilots are generally satisfied with the meteorological services available to them in Virginia.** The use of streaming weather video at airports was interesting, but most pilots interviewed felt it was unnecessary to have video cameras located at the airport. An alternative benefit might come from placing video cameras on key terrain around the airport or in training areas to address visibility concerns and enhance situational awareness.

Pilots discussed the different needs at each airport based upon the varying topography in the state and the complex airspace system in Northern Virginia. Additionally, the location and availability of certain NAVAIDs are affecting how pilots are trained during flight instruction and checkrides. Detailed discussions of these and other findings are provided in the remainder of the report.

SECTION 2: METHODOLOGY

Approach to Selecting Airports

Six airports were selected for visitation during this phase of the study. DOAV and Woolpert led the selection process based on the initial research and analysis performed during the study. Futron recommended that airports with robust flight schools or aviation education programs be visited, along with a mix of commercial service and general aviation-only airports. The premise is that utilizing the direct interviewing approach, with a wide variety of pilot experience and expertise, would provide a greater understanding of pilot navigation needs and usage.

The airports selected for visitation are depicted in ***Figure 35***.

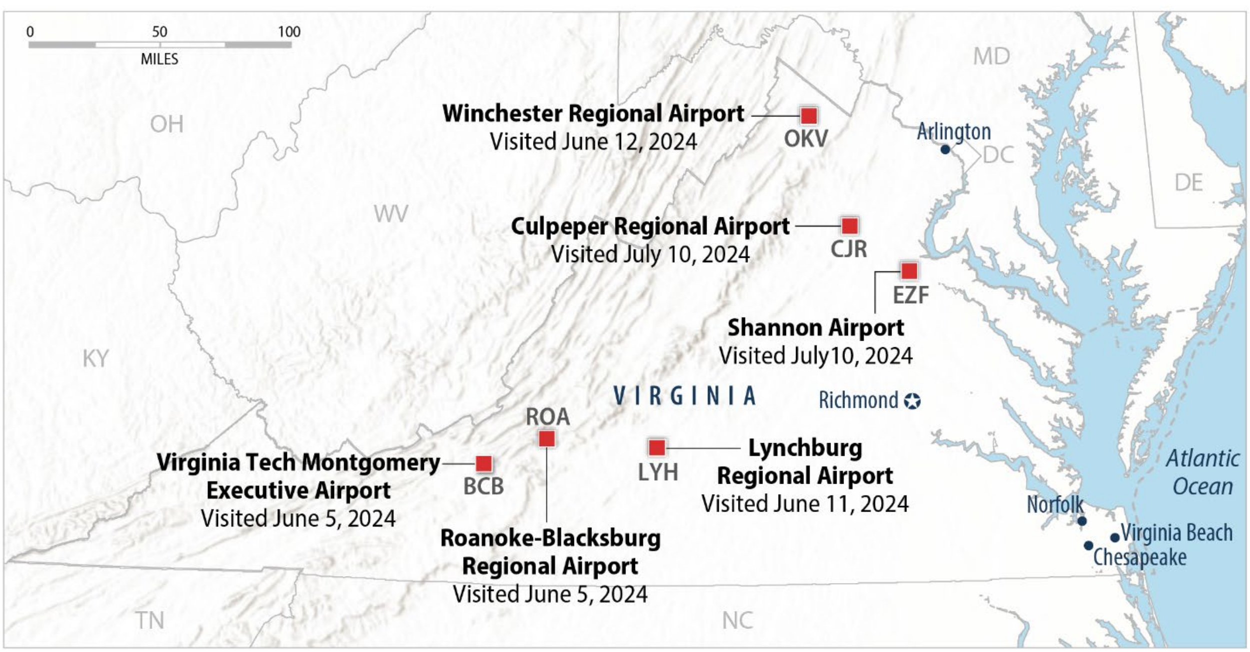


Figure 35: Virginia Airports Visited for the DOAV NAVAID Survey.

Selecting airports with active flight schools proved to be the most beneficial. The decision was based on the belief (which was confirmed in the process of conducting the interviews) that flight instructors and students are thinking most actively about how they will use the available NAVAIDS to meet the instrument flight training requirements set out by the FAA.

While the surveys also included useful input from established pilots and airport executives, it proved invaluable to have flight instructors, flight examiners, and new pilots in the room.

Airports were also evaluated for terrain and weather considerations. Some airports, such as Culpeper Regional Airport, enjoy largely flat terrain and relatively predictable weather patterns. Others, such as Roanoke-Blacksburg Regional Airport, must contend with a mountainous terrain that not only makes approach paths more challenging but also introduces hard-to-predict microclimates around mountain peaks.

The selected airports ensured that the concerns of stakeholders in general aviation, operating in a variety of challenging flying situations, would be taken into consideration alongside the needs of the larger commercial service airports throughout the state.

Approach to Information Gathering

In-Person Discussions

During initial discussions with the participating airports, Futron planned to conduct individual interviews around the airport or facilitated group discussions with pilots and airport staff available during a specific day and time window. The formats for the first two visits to BCB and ROA were facilitated group discussions based on the recommendations of the airport directors, and it was apparent that this format would be the most efficient and the most effective. All subsequent airport interviews were conducted in a group interview format with a Futron facilitator guiding the discussion. This format allowed participants to speak freely. The success of this format was also the result of the investigation team's previous experience conducting facilitated group interviews. A discussion space – typically a conference room – was set up in each airport's executive building, and stakeholders were invited to attend by the point of contact at each airport.

Futron and Woolpert developed a question bank to guide the airport discussions, with the finalized list being approved by DOAV. The questions or discussion guidelines are included as Appendix A. The list of questions was used as a discussion guide rather than as a script. The investigation team's experience facilitated a guided conversation, allowing interviewees to feel at ease and enabling them to discuss their responses in-depth with each other and the interviewers. The added context provided a richer picture of the experience of being a pilot at each airport and elicited responses that the interviewees would otherwise have neglected to mention if restricted to answering specific questions in order. At the end of each airport session, the Futron facilitator checked the question guide to ensure all topics were addressed and then asked the participants for any additional comments or thoughts.

Additional members of the Futron team took detailed notes of the responses and stories as they were supplied by the interviewees. In case the team needed further clarification or elaboration on an interviewee's responses, a sign-in sheet was made available, requesting each participant to provide their name and contact information. The list of attendees at each airport is provided in Appendix B.

Online Surveys

While an in-person free discussion format was optimal, the team also provided airports with an online survey containing the main research questions for stakeholders unable to attend the main meeting. Respondents were presented with the same thirteen questions listed in Appendix A and provided with the opportunity to explain their reasoning for each question. Responses were collected and compiled digitally. Responses were received from pilots at BSB and ROA only. Those responses are incorporated into the content of Appendix C.

Interview Guidelines

The questions listed in Appendix A served as guidelines for discussion, not as a rigid script. Since this list was developed before the start of the investigation, it was necessary to include a wide range of topics to identify the issues and navigation technologies most relevant to stakeholders. As the investigation progressed, it quickly became clear that certain topics were of more interest than others – for example, the question of selecting an approach was based on factors other than minimums, which varied depending on the airport.

Analysis and Presentation Approach

Individual airport responses were organized using an Excel spreadsheet according to the questions in the discussion guide. This tabulation enabled the team to identify trends in the responses and provide evidence for those trends, organized by individual airport.

During the free-flowing discussions, it was noted that stakeholders often provided interesting feedback regarding their use of NAVAIDs, as well as the safety of flight, that did not fit neatly into the prepared discussion guide. Furthermore, not all stakeholders agreed on certain points. For example, while most pilots primarily fly RNAV approaches, a handful of pilots still prefer to navigate by VOR. In addition, stakeholders at airports with challenging terrain used ground-based NAVAIDs more frequently than those in less challenging terrain areas, due to gaps in GPS signal coverage, as well as the approach minimums being more favorable for certain runways. Unique airport issues are represented in individual spreadsheets in Appendix C.

SECTION 3: FINDINGS

Consistent Responses

Use of Non-Directional Beacons (NDBs)

A consensus was reached across all airports visited that NDBs are not commonly used by pilots in everyday operations. In fact, very few aircraft at the surveyed airports are equipped with an Automatic Direction Finding (ADF) receiver. NDBs are a legacy system; several newer pilots had used them only in simulation or learned about the equipment in ground school academic materials, while some pilots with many years of experience recalled fond (and often painful) memories of shooting harrowing NDB approaches.

Table 28: Responses regarding NDB usage by airport.

BCB	ROA	LYH	OKV	CJR	EZF
No one uses the NDB; most aircraft are not even equipped with ADF.	No aircraft are equipped with ADF anymore.	None of Liberty's, nor Freedom Aviation's, aircraft are equipped with ADF.	Most aircraft are not ADF equipped. If needed for instruction, they'll use the simulator.	No one at the meeting had an aircraft equipped to receive NDB signals.	Very few aircraft are equipped with ADF, and few pilots would know how to use it.

Notable responses include the following:

- "We don't do it. We don't have it. We don't want it."
- "Few aircraft are equipped, and if they have the receiver, it is used to listen to radio broadcasts."

However, it was also agreed at airports with NDBs that maintenance of NDBs was very simple. Outages are rare and unimportant enough that they could go unreported for weeks.

Pilots had one main concern regarding the potential loss of support for NDBs: anxiety over the reliability of GPS systems. If GPS were to go down or be spoofed, pilots saw airport-located NDBs as perhaps the only ground-based alternative in some areas, particularly when the FAA begins to retire VORs per the FAA's VOR Minimum Operational Network Plan.

Use of Area Navigation (RNAV) using Satellite Navigation

The majority of the pilots interviewed reported that they fly primarily using RNAV. This was true even for flight schools. While training on VORs is becoming less popular, most training is now concentrated on how to fly by RNAV and execute RNAV approaches.

Table 29: Responses regarding RNAV approach usage by airport.

BCB	ROA	LYH	OKV	CJR	EZF
Around 90% of flights at BCB use GPS/RNAV.	For approaches, pilots must use a variety of localizers [not just RNAV], depending on the active runway and weather conditions for terrain considerations.	Most training at Lynchburg is now RNAV, particularly with the local VOR being unavailable recently.	Pilots utilize the ILS and GPS approaches. Corporate pilots fly RNAV LPV approaches 95% of the time due to available glideslope information.	RNAV is the most popular. It has the lowest minimums, and LPV glideslope is available.	The field is primarily VFR for landings, but they train almost entirely using RNAV approaches.

At ROA, VORs (particularly Pulaski) are popular and viewed as necessary for aiding navigation in and around mountains. There were concerns about the impact the PSK VOR retirement will have on general aviation operations in the region. One pilot noted that due to mountainous terrain, the minimum vectoring altitudes are higher than in flat terrain; therefore, multiple NAVAIDs and instrument approaches are required more often than at other airports.

Pilots rely on ground-based localizers to navigate the more challenging terrain. One pilot based in BCB commented, “Being in Appalachia, we are sometimes in the red zone for GPS reception, and the LOC and local VORs are critical for navigation.”

At EZF, the minimums for an RNAV approach are currently very high, so pilots tend to prefer VFR approaches. The approach design at EZF was expressly discussed as an issue.

Terrain Impact on Use of Ground-Based NAVAIDs

It was found that airports surrounded by flat terrain (or at least less mountainous) were less likely to rely on ground-based NAVAIDs for instrument approaches. The primary value for ground-based NAVAIDs and approaches for these Northern Virginia airports was to properly navigate around the challenging airspace that restricts operations around the Washington, D.C., airports and the Quantico Marine Corps base.

Table 30: Responses regarding approaches for non-terrain airports.

LYH	CJR	EZF
If you've got an ILS, you can shoot that as a localizer approach. The GPS is more accurate than the VOR at Lynchburg.	RNAV is the most popular. It has the lowest minimums, and it has a glide slope.	VOR/ILS is the alternative for GPS, but the minimums are very high. They rely almost entirely on RNAV for training now.

On the other hand, airports surrounded by more mountainous terrain were more likely to rely on ground-based NAVAIDs. At BCB, the LOC approach is often preferable for many pilots due to the minimums and the surrounding terrain.

Table 31: Responses regarding approaches for mountainous-terrain airports.

BCB	ROA	OKV
"Would rather use the LOC [rather than RNAV] if available." "Weather near BCB can be quite sketchy in the mountains. Having the lowest possible option (not necessarily RNAV) would be best."	For instrument conditions, pilots must use a variety of approaches, depending on the active runway and weather conditions.	Use all three: ILS, VOR, and GPS. ILS is generally preferred over the RNAV approaches to RWY 32.

Use of Very High Frequency Omni-Directional Range (VOR)

While not DOAV-owned and -operated, the subject of the FAA plan to decommission many VORs came up often and with intensity. Certain Virginia VORs were high-priority items to nearby regional airports. At BCB, continued support for the FAA-owned Pulaski (PSK) VOR was unanimously agreed to be of critical importance. At ROA, PSK, and Lynchburg (LYH) VOR, the descriptions were similar. At CJR, the

Casanova (CSN) VOR was described similarly, particularly from the standpoint of having one of the only flight examiners in Northern Virginia operating out of CJR.

Pilots, and especially flight schools, were very concerned that losing these VORs would negatively impact the effectiveness of their flight schools. Without a VOR nearby, instructors will be required to fly additional distances to perform VOR navigation and approaches or rely solely on simulation for their students. All airport participants expressed their desire for DOAV to remain engaged with the FAA and advocate for Virginia's general aviation pilots.

Table 32: Responses regarding the importance of VORs.

BCB	ROA	LYH	OKV	CJR
No. 1 NAVAID concern is the PSK VOR remaining in operation.	"Out of ROA, just about everyone--even the commercial pilots--navigates using the Lynchburg VOR." "The VORs nearby help navigate around the mountainous terrain"	No longer rely upon the LYH VOR. Having it down for so long has made training a lot harder, requiring them to send students to South Boston or Roanoke.	“Martinsburg VOR is used, but there are issues (perhaps with terrain), so you can't read radials.”	No. 1 NAVAID concern is the Casanova VOR remaining in operation.

Notable responses include the following:

- "We're screwed at Culpeper for training if they take that out (CSN VOR)."
- "Out of ROA, just about everyone--even the commercial pilots--navigates using the Lynchburg VOR."

Unique Airport Issues

Additional topics came up in discussions at each airport. The reliability of Commonwealth-owned Automated Weather Observing Systems (AWOS), along with the feasibility and desire for airports to introduce weather cameras at Virginia airports, were key topics explored.

BCB

Pilots at the Virginia Tech Montgomery Executive Airport were the only ones who discussed choosing to fly a certain approach that may have higher minimums but followed more forgiving terrain. The location in the mountains and the knowledge of the terrain local pilots possess are drivers for such decisions. Pilots from outside the area would not have such knowledge and would therefore rely on other considerations when planning for their arrivals.

ROA

At Roanoke-Blacksburg Regional Airport (in addition to their VOR concerns), interviewees expressed that live weather cameras could be helpful to address issues with predicting microclimates around the airport. They were not interested in the idea of cameras watching the sky directly above the airfield, but rather specified that a properly positioned camera on peaks like Mill Mountain, overlooking an entire working area, would be helpful to determine what the weather conditions were like in frequently used training areas where accurate weather services are not readily available.

LYH

At Lynchburg Regional Airport (in addition to their VOR concerns), the pilots were interested in an ILS installed for Runway 22, in order that they might have a precision approach to both runways.

OKV

At Winchester Regional Airport, pilots expressed that while weather cameras would be helpful, their main concern is building a control tower. The airport is experiencing approximately 56,000 operations annually, and it would be helpful to have Air Traffic Control to manage the volume of traffic.

CJR

At Culpeper Regional Airport (in addition to their VOR concerns), pilots expressed that an ILS would be helpful, since they do not yet have a precision approach.

EZF

At Shannon Airport, stakeholders were interested in simpler NAVAIDs for VFR approach aids, such as Pulse Light Approach Slope Indicators (PLASI). Given the nature of the flight activity at the airport and the fact that they continue to request redesign of their approaches with the FAA for their LOC, the airport is effectively a VFR airport. Their main issue where DOAV support might be of benefit was having the instrument approach minimums lowered to reflect the efforts made to clear obstructions from the approach paths.

Understanding that the Commonwealth is seeking ways to optimize support for safe air navigation, stakeholders at EZF suggested to the DOAV that investing in PLASI across the state would be an effective and cost-effective tool to enhance landing performance and safety for general aviation pilots. They suggested that procuring the equipment through the State would make the process more expensive than if acquired privately; still, this addition to the future navigation and flight safety investment plan should be considered.

SECTION 4: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In summary, the following conclusions were made by the Futron team after meeting with pilots and airport staff at the six selected Virginia airports:

- **NAVAID vs. RNAV Usage:** Navigation using RNAV is by far the most commonly used mode by instrument pilots. As technology advances, high levels of system reliability and aircraft equipage by the manufacturer, in some cases (such as Cirrus-built airplanes), are driving the shift. Flight training methods, techniques, and FAA requirements are also shifting to accommodate this change.
- **Approach Selection Criteria:** Pilots generally select approaches with which they are familiar; thus, RNAV approaches are the most common. When weather conditions dictate, pilots will choose the approach with the lowest minimums, and in special cases (such as at BCB in mountainous terrain),

they may select the approach with the most favorable ground track. Some pilots indicated that they would choose to fly a localizer approach if the approach track provided a shorter route to landing or allowed them to most effectively avoid Class B airspace or Special Flight Rules Areas (SFRA).

- **NAVAID Backup considerations:** Pilots interviewed are satisfied with the reliability of the available DOAV NAVAIDs. The concerns voiced were directed at the reliability of VORs and the decommissioning plans for Virginia VORs used by all.
- **Weather Services:** Pilots were satisfied with the weather services available in the Commonwealth and with the reliability of AWOS. Other online weather reporting services are also used. Pilots did not feel that weather cameras at Virginia airports would be of great value. They hold that there are multiple AWOSs they can rely on to ensure they receive accurate observations and forecasts.

Recommendations

After guided discussions at six airports, the Futron team can make the following recommendations for future NAVAID decisions:

- **Eliminate support of NDBs.** Lack of use and aircraft equipage make maintaining support for DOAV-owned NDBs unnecessary for ensuring flight safety.
- **Consider applying funds to equipping airports with PLASI.** Based solely on the discussions at Shannon Airport, implementing this improvement should be examined as a means to enhance flight safety effectively and cost-effectively.
- **Continued engagement on VORs.** Those interviewed requested that the DOAV pass on their concerns to the FAA regarding the decommissioning plan for VORs located in Virginia.
- **Degraded GPS training.** Pilots expressed a desire to learn more/have procedures for potential GPS outages. Although the role the DOAV might play was unclear, some interviewees believed it was an issue worth studying.
- **Continued engagement with pilots and airports across Virginia.** The pilots and airport staff interviewed were appreciative of the opportunity to have a voice in the decision-making process. The DOAV should continue to organize and conduct forums such as those used to support this project to interact with and capture the thoughts and ideas of the Virginia flying community.

APPENDIX A. AIRPORT SITE VISIT DISCUSSION GUIDELINES

The instructions and questions used to guide the airport visit discussions are provided on the following page.

VA DOAV NAVAID Study

Airport Site Visit Discussion Guidelines

The questions listed below were developed to guide discussions with pilots and air navigation stakeholders during Futron Aviation's scheduled visits to select Virginia airports. A survey was distributed via SurveyMonkey for those unable to attend the meetings.

Introduction

We are supporting the Virginia Department of Aviation on a project to study the utilization of ground-based NAVAIDs and the trends among pilots as they incorporate new technologies/applications into their navigation practices. The relative utilization of procedures as pilots decide to use legacy systems such as VORs, localizers, and NDBs versus RNAV-GPS is of special interest. The report based on the results of this study will assist the Department of Aviation in considering future priorities, such as investments in navigation versus weather reporting versus 360-degree weather cameras.

Guiding Questions for Airport Discussions

- Was a NAVAID or RNAV used during the majority of (today's, this week's) arriving/departing flights?
- Is it critical for the NAVAIDs to be supported due to the location and type of flight operations? If so, please explain why. For example, is this airport the only one in a given radius with this system, or is the NAVAID crucial for a flight school?
- Are pilots choosing the approach procedure with the best minimums?
- Do or would pilots ever choose an RNAV approach even if a different approach had better minimums?
- Do or would pilots ever choose a Localizer approach even if a different approach had better minimums?
- When a pilot chooses to execute an instrument approach, how often is the decision based on factors other than minimums?
- Do pilots select an approach based upon a preferred ground track?
- Are there other considerations that could impact the use and utility of a specific NAVAID, such as whether there is a generator backup for the systems, thus providing navigation service during power outages?
- Are NAVAID outages, whether local or in the area/region, common or rare for those used by pilots at your airport?
- How do pilots receive weather information for your airport? What weather observation or forecast resources/technologies might aid pilots operating from your airport?

APPENDIX B. AIRPORT DISCUSSION PARTICIPANTS

Stakeholders who attended the discussions were asked to provide their name, organization, flight experience, and contact information in case additional questions arose as the study is finalized.

Table 33: Virginia Tech Montgomery Executive Airport (BCB) visit June 5, 2024.

Name	Organization	Aviation Experience	Email
Denny Carlyle	AvitekLLC	CFI	dccarlyle@gmail.com
Mark Cline		Private Pilot	macline2@vt.edu
Arthur Lucia	EAA 906		artlucia73@gmail.com
Richard Humphreys	Virginia Tech	Command Pilot	vttech@vt.edu
Scott Standfield	BCB Airport	Operations Director/Private Pilot	do@vtbcb.com

Table 34: Roanoke-Blacksburg Regional Airport (ROA) visit June 5, 2024.

Name	Organization	Aviation Experience	Email
David Tickner	RRAC	Airport Planning	david.tickner@flyroa.com
Bill Eschenfelder	Delta Airport	Project Manager	beschenfelder@deltaairport.com
Kyle Kotchou	RRAC	Director of Planning & Engineering	kyle.kotchou@flyroa.com
B.J. Nipper	RRAC	Operations Manager	billiejo.nipper@flyroa.com
Garrett Leffue	RRAC	Operations Officer	garrett.leffue@flyroa.com
Nate Stevens	Mozart Investments	Chief Pilot - G550, Flight Instructor	widgeon3@aol.com
Jon Beard	Star Flight Training	Operations Manager, 191/135/165	jon@starflighttraining.com
Randy Lambert		Local Pilot/CFI (7 years)	premin-paintbody@yahoo.com
Andrew Phillips	Civil Air Patrol	CFI/II	andrew.phillips@vawg.cap.gov
Leah Sanders		Commercial Pilot (6-7 years)	

Table 35: Lynchburg Regional Airport (LYH) visit June 11, 2024.

Name	Organization	Aviation Experience	Email
Andrew Wallace	Freedom Aviation	President	jwallace@flyfreedom.com
Kasey Boyer	Freedom Aviation	Coordinator	
Bailey Dorrier	Freedom Aviation	Coordinator	bdorrier@flyfreedom.com
Cedric Simon	LYH	Airport Operator	cedricsimon@lynchburgva.gov

Table 36: Winchester Regional Airport (OKV) visit June 12, 2024.

Name	Organization	Aviation Experience	Email
Brendy Garcia	Aviation Adventures	CFII	brendygarcia@outlook.com
Logan Campbell	Aviation Adventures	CFII	Logan2212@outlook.com
Nathan Welch			welch88@yahoo.com
Nick Sabo	OKV	Airport Manager	nsabo@flyokv.com
Christian Borel	Aviation Adventures	CFI	N4472K@gmail.com
Leslie Melanson	Aviation Adventures	CFII/MEI	ICE317537@yahoo.com
Andrew Melanson		Student	deadlyechomew@gmail.com
Stoney Jarvis	Aero Elite	Operations Manager/CFI	stoney.jarvis@aeflight.com

Table 37: Culpeper Regional Airport (CJR) visit July 10, 2024.

Name	Organization	Aviation Experience	Email
TR Proven	CAF	Military Aviator, airplane historian	trprovenii@gmail.com
Kirk Crawford	PHI	Dual-rated CFI, medical heli pilot, VFR	zcrawford@phiairmedical.com
Barbara Koehler		GA, Light IFR, CFII, taught at Manassas	barbara_us@yahoo.com
Allan Badrow		47k hours instructing	CaptBadrow@verizon.net
Carter Bunch	Culpeper Airport	Operations Manager, 6500 hours, instrument-rated	cbunch@culpepercounty.gov
Chris Godart	Culpeper Airport	Operations, VFR	cgodart@culpepercounty.gov
Steve Nixon	Airport Com	1200 hours, heli, 135s	senixon2016@gmail.com
Tanya Woodward	Culpeper Airport	Airport Director	twoodward@culpepercounty.gov

Table 38: Shannon Airport (EZF) Airport visit July 10, 2024.

Name	Organization	Aviation Experience	Email
Will Trivett		Full-time Flight Instructor	wdtrivett@gmail.com
Kristen Barnum	Shannon Airport	-	kcurtas@shannonezf.com
Luke Curtas	Shannon Airport	EZF President	lkurtas@shannonezf.com
Jerry Knouff	Shannon Airport	Long-time Pilot Examiner & SME	wa3cub@yahoo.com

7.3.2 Presentations

A webinar was held on 5/29/2025 and a final presentation was made to the Virginia Aviation Board on 8/15/2025. To view the presentation material, please reach out directly to the Department.

Figure 36: Opening slide of presentation to Virginia Aviation Board.

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