U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
Air Traffic Organization Policy

ORDER JO 7470.1A

Effective Date:
April 30, 2007

SUBJ: Distance Measuring Equipment (DME)/DME Infrastructure Evaluation for Area Navigation (RNAV) Routes and Procedures

1. Purpose. This order provides guidance and standardization for DME/DME infrastructure evaluation in support of RNAV route and procedures development.

2. Distribution. This order is distributed in Washington headquarters at the division level of Flight Standards; director level of Air Traffic, the offices of Airport Safety and Standards and Communications, Navigation, and Surveillance Systems, the National Flight Procedures Group; the Regulatory Standards Division at the Mike Monroney Aeronautical Center; regional Flight Standards offices, Air Traffic Organization (ATO) service centers, all air traffic field offices and facilities, and special military and public addresses.

3. Cancellation. This order cancels Federal Aviation Administration Order 7470.1, Distance Measuring Equipment (DME)/DME Infrastructure Evaluation for Area Navigation (RNAV) Routes and Procedures, dated November 1, 2004.

4. Explanation of Changes. This order is revised to reflect updated FAA branding. Minor administrative changes to processes and office identification have been incorporated throughout.

5. Background. Many RNAV aircraft systems use information from multiple DMEs to determine the aircraft's position. Procedures and routes relying on this capability require evaluation to determine if the DME/DME coverage provides adequate support.

a. The FAA is responsible for evaluating DME/DME coverage against a minimum standard (baseline) DME/DME RNAV system for each route and procedure authorized to use DME/DME RNAV. The FAA will assess if adequate DME/DME coverage is available on the routes and procedures using a combination of a computer tool (assessing if the available DME/DME performance is adequate) and flight inspection (to validate the reception and performance of individual DME facilities). This document establishes the procedures for the DME/DME infrastructure evaluation and its operational implementation.

b. The assessment of DME/DME coverage will also determine if an expanded service volume (ESV) is necessary for select DME facilities. The implementation of DME/DME will also impact the long-term sustainment and implementation of DME facilities to support these operations.

c. All DME facilities maintained by the FAA and used to define the availability of these RNAV routes or procedures comply with applicable International Civil Aviation

Organization (ICAO) facility maintenance and performance standards and several added requirements necessary to support RNAV operations. It is recognized the FAA cannot ensure that foreign DMEs (e.g., Canadian and Mexican DME facilities) meet ICAO standards for use on these domestic RNAV routes and procedures. In circumstances where alternatives are not viable (i.e., Global Positioning System required), and the National Airspace Procedures Team (NAPT) concurs with continued procedure development, the FAA may coordinate with foreign authorities to ensure DME performance.

6. Definitions. Definitions are contained in appendix A.

7. Related Publications.

a. Order 7100.9, Standard Terminal Arrival Program and Procedures

b. Order 7400.2, Procedures for Handling Airspace Matters

c. Order 7930.2, Notices to Airmen (NOTAM)

d. Order 8260.3, United States Standard for Terminal Instrument Procedures (TERPS)

e. Order 8260.19, Flight Procedures and Airspace

f. Order 8260.40, Flight Management System (FMS) Instrument Procedures Development

g. Order 8260.43, Flight Procedures Management Program

h. Order 8260.44, Civil Utilization of Area Navigation (RNAV) Departure Procedures

i. Order 8260.46, Instrument Departure Procedure (DP) Program

j. Order 8260.53, Standard Instrument Departures That Use Radar Vectors to Join RNAV Routes

k. Advisory Circular 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations

l. FAA No. 405, Standards for Aeronautical Surveys and Related Products

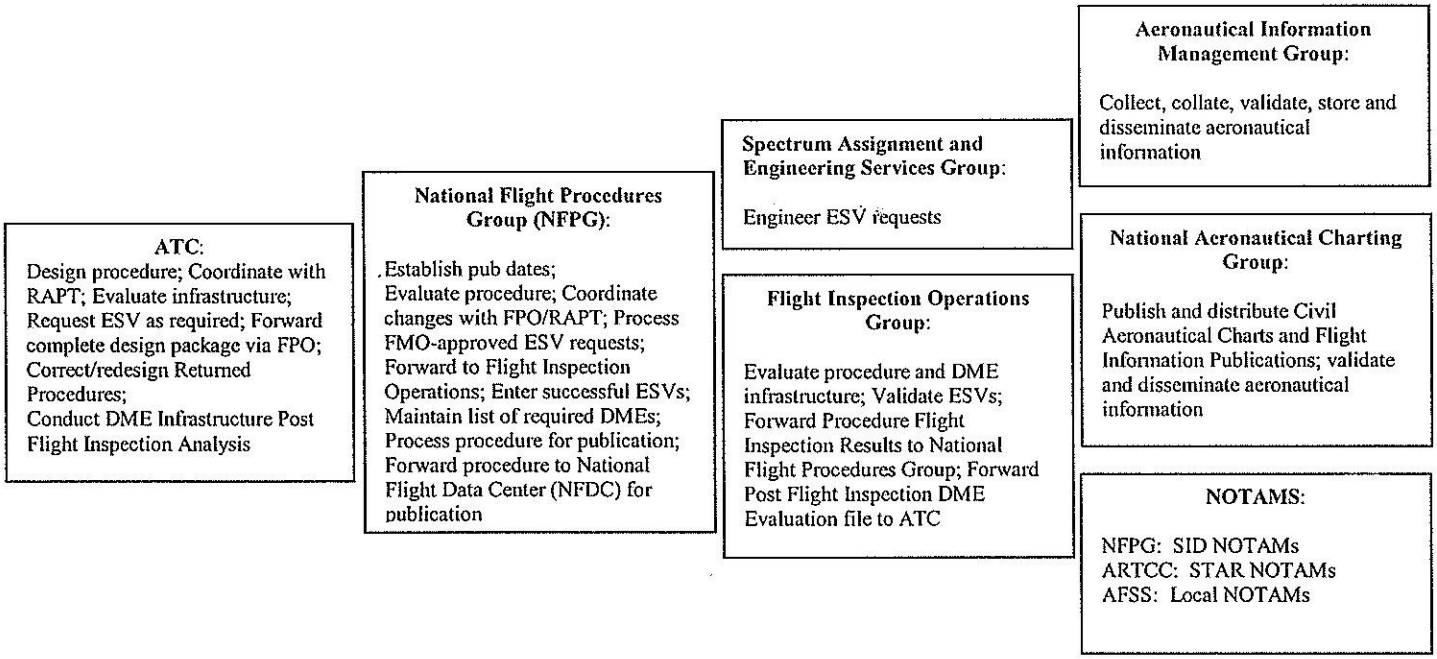
8. Forms. Appendix 2 is the format for Required Data for RNAV-Pro Evaluation.

9. DME/DME Infrastructure Evaluation Process.

a. General. The following guidance outlines procedures for conducting DME/DME infrastructure evaluation in support of RNAV procedure development. Procedure development normally begins within FAA service areas, with air traffic facilities or industry

proponents, and tracks through the development process to approval at the national level. Figure 1 depicts the design and DME evaluation process.

Figure 1
Procedure Design and DME/DME Evaluation Process



(1) The Flight Operations Simulation and Analysis Branch (AFS-440) has developed RNAV-Pro, the FAA-approved DME/DME evaluation tool. This tool is available via the Internet and shall be used to perform the computer assessment of the DME infrastructure supporting a specific route or procedure.

(2) The Terminal Area Route Generation, Evaluation, and Simulation (TARGETS) tool is an FAA-approved software tool for RNAV standard terminal arrival (STAR) and standard instrument departure (SID) development. Embedded within TARGETS is a file-export function to provide input files for the DME/DME infrastructure evaluation tool.

(3) Regional Coordination. Regional Airspace Procedures Teams (RAPT), chaired by the regional Flight Procedures offices (FPO), are established within each FAA region for the purpose of coordinating, prioritizing, evaluating, approving, and/or denying requests for establishment, amendment, and cancellation of instrument flight procedures. In its facilitative role, the RAPT is responsible for tracking regional procedures from inception to operational implementation in accordance with applicable FAA instructions. This includes ensuring completion of DME/DME infrastructure evaluation and requesting ESV for DMEs as needed.

(4) National Coordination. The NAPT ensures consistent application of FAA policy during the development of procedures and, when necessary, resolves problems with the

development process. The NAPT will clarify policies and procedures for the RAPT and, when necessary, establish national priorities.

b. DME Infrastructure Assessment. The DME/DME evaluation tool provides assessment results that include:

(1) Identification of critical facilities. RNAV SIDs and STARs may be published with only two DMEs providing a navigation solution at any given point, each of which would be a "critical DME" facility. Loss of one of the critical DMEs results in procedure nonavailability for DME/DME-only navigation. Where more than two facilities are available and the loss of a particular facility results in loss of a navigation solution, that facility is a critical DME facility. En route procedures may not be published with critical facilities. If during an evaluation critical facilities are indicated for an RNAV route, these must be resolved through the use of ESVs, DME/DME/Inertial Reference Unit (IRU), or a requirement for the global navigation satellite system (see paragraph 9b(5)(b) below).

(2) A list of available DMEs and transition points for flight inspection assessment. The list will identify each DME facility as critical or available. If the DME/DME evaluation tool determines insufficient DMEs are available, the tool will identify gaps in reception and can propose facility ESVs to mitigate the gaps.

(3) A list of other available DMEs and applicable route/procedure segments. This includes facilities which are expected to be available along the route, but which are not required to support the publication of the route.

(4) Identify very high frequency omnidirectional radio range (VOR) facilities within 40 nautical miles of the route within a DME coverage gap. Identify VOR along track and cross track distance at the beginning and end of DME coverage.

(5) Expanded service volume requirements. Where the DME infrastructure assessment indicates insufficient DME coverage or critical facilities, the tool can identify proposed ESVs for a subset of DME facilities that should ensure an acceptable navigational solution. The user also can manually input proposed ESVs for evaluation. ESVs are requested through the Expanded Service Volume Management System (ESVMS), which is Internet-accessible and managed by the Technical Operations ATC Spectrum Engineering Services Office, Spectrum Assignment and Engineering Services Group. Figure 2 details the ESVMS process.

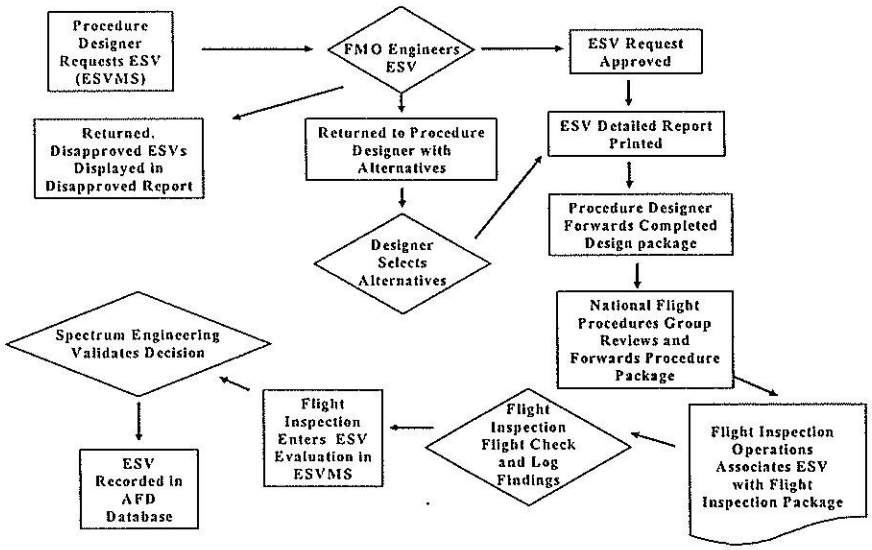
(6) Use of DME/DME and DME/DME/IRU. The tool is capable of screening procedures emulating aircraft DME/DME and DME/DME/IRU operation.

(a) Screening is accomplished using the user-selectable, baseline simulation profiles for SIDs, STARs, and en route procedures. A user-defined option is also available.

(b) When operationally advantageous or if unable to obtain satisfactory results with DME/DME or DME/DME/IRU, screen the route using a proposed set of ESVs to mitigate

navigation gaps. A combination of ESVs and/or procedure redesign may be required to obtain satisfactory results.

Figure 2
ESVMS Process



c. NOTAM Requirements. A national NOTAM system has been established to provide airmen with the current status of the National Airspace System (NAS). Management/operational guidance is contained in Order 7930.2. NOTAMs provide timely knowledge, to airmen and other aviation interests, of information or conditions that are essential to safety of flight.

(1) A navigational aid (NAVAID) NOTAM (D) regarding en route navigation aids, civil public-use airports listed in the Airport/Facility Directory (A/FD), facilities, services, and STARs/SIDs is issued under the Flight Service Station Accountability System and receives the same dissemination as the surface weather report for the originating station.

(a) When a NAVAID monitored at other than a flight service station fails, the monitoring facility shall be responsible for notifying all affected facilities, including air traffic control (ATC) controlling facilities, and coordinating issuance of a NOTAM.

(b) Changes to STARs requiring NOTAM action are promulgated as a NOTAM D. The appropriate air route traffic control center (ARTCC) retains the responsibility for initiating, tracking, and canceling STAR NOTAMs.

(c) Changes to graphic obstacle departure procedures (ODP) and SIDs are promulgated as NOTAM Ds. These NOTAMs are developed by the ATO Technical Operations Services, National Flight Procedures Group and are issued by the U.S. NOTAM Office (USNOF).

(2) NOTAMs regarding the accuracy and currency of charted terminal and en route flight procedures are issued as FDC NOTAMs by the USNOF. The National Flight Procedures Group is responsible for formulating procedural and airway FDC NOTAMs and forwarding them for transmittal. ARTCCs are responsible for forwarding FDC NOTAM information to affected terminal facilities.

10. Roles and Responsibilities.

a. Flight Operations Simulation and Analysis Branch (AFS-440). Develops and supports the DME/DME evaluation tool in conformance with the Requirements Document for the FAA DME/DME/IRU Evaluation Tool. The tool performs assessment of individual routes and procedures, or area assessment of user-defined parameters per baseline avionics in AC 90-100.

b. Service Center. Through the RAPT, the service center manages the RNAV procedures development process. The RAPT coordinates the activities of the RNAV Implementation Working Group established for development of a particular procedure. The RAPT:

(1) Ensures availability of the TARGETS operator for RNAV STAR/SID development. Where training or assistance is needed in the use of TARGETS, coordinates with the System Operations Airspace and Aeronautical Information Management (AIM) Office, RNAV/Required Navigation Performance (RNP) Group.

(2) Uses the DME screening tool to perform the DME/DME infrastructure assessment. Air traffic procedure designers assigned to the RNAV Implementation Working Group will perform the assessment normally using the input files generated by TARGETS. The DME screening must be accomplished before the procedure is submitted to the FPO. Ensures a copy of the screening is included with the procedure submission package.

(a) The RNAV/RNP Group will assist the RNAV Implementation Working Group in accomplishing DME infrastructure assessment in circumstances where onsite screening cannot be accomplished. When unable to access the screening tool or where screening output is inadequate for submission, electronically forwards the TARGETS file to the RNAV/RNP Group for assistance. When TARGETS is not available, forwards a flight plan profile using the format in appendix 2.

(b) Air traffic procedure designers must ensure the altitudes used by air traffic are reflected for waypoints or route segments when conducting DME/DME infrastructure assessment. These altitudes impact assessment tool performance and the output provided for flight inspection operations.

(i) For STAR and en route procedures, input an altitude for each waypoint, route, or route segment. Use the lowest realistic operational ATC altitude. The altitude evaluated at a waypoint will be charted as the minimum en route altitude (MEA) for the segment immediately preceding the waypoint, and is entered as the MEA on the FAA Form 7400-4, STAR-Standard Terminal Arrival.

(ii) For SID procedures, no altitude input is required except:

(aa) ATC crossing restriction altitudes.

(bb) The normal (lowest) operational en route altitude when reached before the end of the procedure. This should be the handoff altitude and must be input for all waypoints after it is reached. This is to preclude screening at unrealistically high altitudes.

(c) When advised by the Technical Operations Aviation System Standards Office, Flight Inspection Operations Group of unsatisfactory flight inspection results, coordinates potential mitigations with the National Flight Procedures Group, the Flight Inspection Operations Group, and the RNAV/RNP Group. When requested, the RNAV/RNP Group will assist with use of the DME tool to resolve deficiencies. When complete, reevaluates the procedure or route.

(d) If satisfactory results are then obtained from the tool, follows the ESV request procedure, if required, and coordinates changes with the National Flight Procedures Group and the Flight Inspection Operations Group. Additional flight inspection may not be required.

(e) When unable to obtain satisfactory results, proceeds as in paragraph 10b(4)(c) below.

(3) Notifies the RNAV/RNP Group when unsatisfactory results are obtained but the DME screening tool output indicates foreign facilities within radio reception of a proposed route or procedure. The RNAV/RNP Group will assist in evaluating use of any foreign facilities.

(4) Where DME coverage is insufficient for baseline avionics (AC 90-100), DME/DME/IRU performance is inadequate, or when operationally advantageous, ESVs may be requested as follows:

(a) Submit an ESV request using the ESVMS. When approved, the ESV detailed report is available to the requester and shall be included in the procedure/route submission package.

(b) When restricted, ESVs are returned to the requester with alternatives. The alternatives shall be screened in the DME evaluation tool through use of the User Data function to input ESV sector and range limitations. If acceptable for the procedure, complete the ESVMS process using the alternative, and forward the ESV detailed report with the procedure/route submission package.

(c) Where ESVs are not approved and DME/DME/IRU is not an alternative:

(i) Redesign the procedure to obtain the required coverage or

(ii) Limit the procedure to GNSS-equipped aircraft.

(5) Completes procedure design following successful DME infrastructure assessment.

(a) Forwards the assessment results output with the procedure submission package to the National Flight Procedures Group through the service center and regional FPO.

(b) Requests for Q-routes are forwarded to the System Operations Airspace and AIM, Airspace and Rules Group, for initiation of a Notice of Proposed Rulemaking (NPRM) action. No DME screening is required with this submission. Concurrent with submission to the Airspace and Rules Group, the service center forwards the route submission package, including the DME screening output, to the Aviation System Standards Office, National Aeronautical Charting Group, Airspace Section via the FPO. This facilitates route validation and review before rulemaking action is initiated.

c. Technical Operations ATC Spectrum Engineering Services Office, Spectrum Assignment and Engineering Services Group. Processes requests for ESVs. Enters approved, disapproved, or restricted results in the ESVMS.

d. Technical Operations Aviation System Standards Office, National Flight Procedures Group. Reviews STARs/SIDs for conformance with established criteria. Performs obstruction evaluation of STARs/SIDs and will return any nonconforming STAR/SID to the originating service center through the FPO.

(1) When necessary, advises and assists the submitting service center with revisions needed to ensure conformance with criteria.

(2) Forwards the procedure to the Flight Inspection Operations Group for completion of the procedure flight inspection.

(3) Reviews unsatisfactory flight inspection results and coordinates with the submitting service center, through the regional FPO, potential mitigations for resolution. If mitigations are not possible, returns the unsatisfactory STAR or SID to the submitting service center through the regional FPO.

(4) Following successful completion of the flight inspection, prepares the final STAR/SID procedure package for publication. Forwards the final copy to the System Operations Airspace and AIM, Aeronautical Information Management Group for further processing, and forwards a copy to the originating service center through the regional FPO. When ESVs have been requested, forwards ESV evaluation results to the Spectrum Assignment and Engineering Services Group.

(5) Prepares FDC NOTAMs as required by Order 8260.19.

e. Technical Operations Aviation System Standards Office, Flight Inspection Operations Group. Schedules and performs the flight inspection. Forwards flight inspection results to the National Flight Procedures Group. Flight inspection results will:

(1) Measure DME signal coverage and log findings, including any DME proposed for ESV.

(2) Evaluate the route or area with available DMEs and identify facilities not meeting stated accuracy requirements.

(3) Provide documentation of DMEs identified to provide the navigation solution.

(4) Advise if VOR accuracy in DME gaps is not suitable for RNAV performance based on modeling results.

f. System Operations Airspace and AIM Office, Aeronautical Information Management Group:

(1) Conducts a prepublication review of submitted forms to ensure compliance with applicable directives and resolves data conflicts, form discrepancies, etc., with the National Flight Procedures Group and submitting service center.

(2) Assigns an effective date authorizing charting agencies to publish the route, STAR, or SID.

(3) Files and maintains the original signed copy of procedure forms.

g. Technical Operations Aviation System Standards Office, National Aeronautical Charting Group:

(1) Advises the RAPT and service center of any charting issues or publication delays.

(2) Conducts Q-route validation and review before submission of the NPRM.

(3) Publishes the STAR, SID, or route as required on the assigned effective date. For Q-routes, publishes a listing of DME facilities evaluated in the appropriate A/FD. For RNAV STAR and SID procedures, critical DME facilities are published in the procedure notes.

11. Operational Implementation.

a. Avionics Systems Branch, AIR-130. Develops and publishes aircraft/avionics qualification criteria for DME/DME RNAV systems.

(1) Incorporates characteristics of baseline system as minimum requirements.

(2) Establishes ground-based navigational facility requirements to support RNAV DME/ DME STARs, SIDs, and routes in the NAS. Include requirements for tactical air navigational aid, instrument landing system/DME and the use of foreign facilities.

(3) Develops criteria for minimum DME/DME/IRU RNAV system.

(4) Updates provisions for use of the DME figure of merit.

b. Flight Operations Branch, AFS-410. Publishes operational guidance for operations on RNAV routes and procedures.

(1) Defines and documents operational and performance requirements.

(2) Ensures criteria are compatible with baseline criteria developed for the aircraft.

(3) Develops guidance for flight planning and operations to ensure pilots understand the impact of critical DME facility outage.

c. System Operations Airspace and AIM Office, RNAV/RNP Group.

(1) Coordinates national DME infrastructure evaluation requirements.

(2) Provides DME infrastructure evaluation training for air traffic procedure specialists.

(3) Assists the RNAV Implementation Working Group in accomplishing DME/DME infrastructure assessment.

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APPENDIX A. Acronyms, Terms, and Definitions

Acronym/Term	Definition
Available DME	A distance measuring equipment (DME) facility whose operational service volume (OSV) covers all, or a portion, of a route or procedure.
Critical DME	A DME facility that, when unavailable, results in inadequate DME/DME area navigation (RNAV) system performance to sustain operations along a specific route or procedure. The required performance assumes an aircraft's RNAV system meets, but does not exceed, the minimum standard (baseline) for DME/DME RNAV systems found in Advisory Circular 90-100.
DME	Distance Measuring Equipment. The term "DME" is a generic term for any ground-based navigational aid (NAVAID) facility that responds to DME interrogations, including different types and/or combinations of collocated DME and tactical air navigational aid (TACAN) facilities (e.g., nondirectional radio beacon (NDB)/DME, very high frequency omnidirectional radio range (VOR)/DME, VOR and TACAN collocated (VORTAC), TACAN, instrument landing system (ILS)/DME).
DME/DME Coverage	DME/DME coverage exists where the availability of DME facilities permits the minimum standard RNAV system performance defined in FAA Advisory Circular 90-100. DME/DME coverage requires at least two DME facilities operating within their OSV.
ESV	Expanded Service Volume. ESVs are used to designate a service volume larger than the standard service volume (SSV). If a DME facility requires an ESV to serve as an available DME for an RNAV route or procedure, the request is submitted via the Expanded Service Volume Management System.
Flight Plan	The term "flight plan," as used in this document, refers to an input file consisting of a series of route/procedure-related fields. The input file fields include waypoint name, waypoint latitude and longitude, aircraft altitude at waypoint, climb logic (i.e., step or vertical navigation), airspeed, waypoint type (i.e., flyover or flyby), and RNAV leg type.
Flight Track	The term "flight track" refers to an input file consisting of a series of sequential latitudes, longitudes, and altitudes that defines the exact position of the aircraft as it flies the route or procedure.
OSV	Operational Service Volume – Includes the SSV (minus any restricted areas) and any approved ESVs. The OSV shall not extend beyond the frequency-protected service volume on any radial from the facility, at any distance from the facility, or at any altitude beyond the altitude spectrum defining the facility's service.

Required DME	A DME facility that if it fails flight inspection or does not receive approval for a proposed ESV, then DME/DME coverage is not available, and the proposed route or procedure requires reevaluation or redesign.
(Route) Segment	A portion of a route along which DME coverage is provided by up to five facilities. Segments vary in length and are predicated on tool-determined changeover points between facility subsets.
SSV	Standard Service Volume – The three-dimensional volume of airspace within which NAVAID performance meets specified performance criteria and is free of interference and co-channeling. The DME evaluation tool assumes the following SSV for each class of DME facility: ▪ Terminal DME Facility: 25 nautical miles from the facility (from 12,000 feet down to 1,000 feet above the facility). Below 1,000 feet, coverage area takes the shape of a parabolic cone. ▪ Low-altitude DME Facility: 40 nautical miles from the facility (from 18,000 feet down to 1,000 feet above the facility). Below 1,000 feet, coverage area takes the shape of a parabolic cone. ▪ High-altitude DME Facility: 100 nautical miles from the facility (from 60,000 feet down to 45,000 feet above the facility); 130 nautical miles from the facility (below 45,000 feet down to 18,000 feet above the facility); 100 nautical miles from the facility (below 18,000 feet down to 14,500 feet above the facility); 40 nautical miles from the facility (below 14,500 feet down to 1,000 feet above the facility). Below 1,000 feet, coverage area takes the shape of a parabolic cone.

Appendix B. Required Data for RNAV-Pro Evaluation

WP Name	WP Type	Latitude	Longitude	Altitude	VNAV Mode	IAS	Turn Type	Turn Direction	Leg Type	CF Radial
SKILS	WP	N 393014.00	W 0763752.32	14000	STEP	300	FLY_BY	DECIDE	TF	
BAL	WP	N 391015.83	W 0763940.52	12000	STEP	300	FLY_BY	DECIDE	TF	
BRUNC	WP	N 385550.89	W 0765624.24	10000	STEP	250	FLY_BY	DECIDE	TF	
FLETY	WP	N 384646.15	W 0765640.79	8000	STEP	250	FLY_BY	DECIDE	TF	
HITEK	WP	N 384119.00	W 0765609.00	6000	STEP	250	FLY_BY	DECIDE	TF	
CAVDI	WP	N 382533.43	W 0765443.49	4000	STEP	250	FLY_BY	DECIDE	TF	

Appendix C. Airway Facility Assumptions

1. Background. Before procedure design and operational implementation, airway facility performance standards must be documented.

2. Collocation. The geographic coordinates of the very high frequency omnidirectional radio range (VOR) component are reported as the facility position in the Airport/Facility Directory. AC 00-31A, "*United States (U.S.) National Aviation Standard for the Very High Frequency Omnidirectional Radio Range (VOR)/Distance Measuring Equipment (DME)/Tactical Air Navigation (TACAN) Systems*," defines offset collocation as follows:

a. For those facilities used in terminal areas for approach purposes or other procedures where the highest position fixing accuracy of system capability is required, the separation of the VOR and DME or tactical air navigational aid (TACAN) antennas will not exceed 100 feet (30 meters).

b. At Doppler VOR sites, the antennas may be separated by not more than 260 feet (80 meters).

c. For purposes other than those indicated in paragraph 2a, the separation of the VOR and either the DME or TACAN antennas will not exceed 2,000 feet (610 meters).

3. Tech Ops Performance Assumptions.

a. DME/TACAN facilities classified as "collocated" but not within 30 meters of the same VOR vertical axis should be published with separate geographic coordinates in the Airport/Facility Directory.

b. Ensure VOR and TACAN collocated (VORTAC) or DME facility movement remains within 30 meters of published coordinates. DME facilities not meeting facility survey and notification requirements and/or Department of Defense TACANs should not be used for DME/DME RNAV.

4. Survey Accuracy and Publication Resolution.

a. FAA Specification 405 states horizontal survey accuracy of 20 feet when located on public-use airports and military fields, and 50 feet horizontal accuracy elsewhere.

b. The National Flight Data Center (NFDC) publishes navigation aid position data in degrees, minutes, seconds, and ten-thousandths of a second resolution (for example, N35 35 04.5435 W97 23 05.0234). These data are contained in the National Airspace System Resource Aeronautical Data files.

c. The publication resolution of all en route DME/VORTAC facilities is to the nearest one-hundredth of a minute when published in the Airport/Facility Directory.

d. The navigation aid resolution in ARINC 424 specifications can accommodate survey measurements reported to one one-hundredth of a second (1 foot) for electronic database use.