Chapter 6

Airborne Navigation Databases

Introduction

Area Navigation (RNAV) systems, aeronautical applications, and functions that depend on databases are widespread. [Figure 6-1] Since the 1970s, installed flight systems have relied on airborne navigation databases to support their intended functions, such as navigation data used to facilitate the presentation of flight information to the flight crew and understanding and better visualization of the governing aeronautical flight charts. With the overwhelming upgrades to navigation systems and fully integrated flight management systems (FMS) that are now installed in almost all corporate and commercial aircraft, the need for reliable and consistent airborne navigation databases is more important than ever.

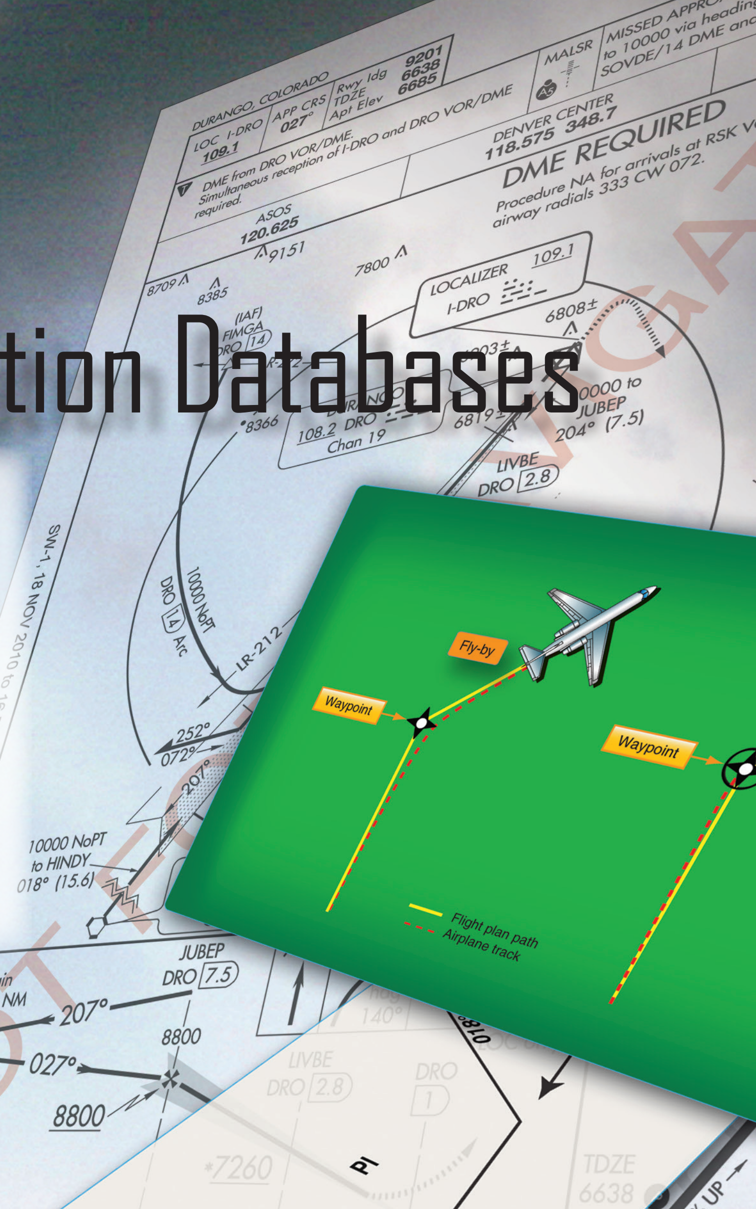

Figure 6-1. Area navigation (RNAV) receivers.

The capabilities of airborne navigation databases depend largely on the way they are implemented by the avionics manufacturers. They can provide data about a large variety of locations, routes, and airspace segments for use by many different types of RNAV equipment. Databases can provide pilots with information regarding airports, air traffic control (ATC) frequencies, runways, and special use airspace. Without airborne navigation databases, RNAV would be extremely limited. In order to understand the capabilities and limitations of airborne navigation databases, pilots must understand the way databases are compiled and revised by the database provider and processed by the avionics manufacturer. Vital to this discussion is understanding of the regulations guiding database maintenance and use.

There are many different types of RNAV systems certified for instrument flight rules (IFR) use in the National Airspace System (NAS). The two most prevalent types are GPS and the multisensory FMS. [Figure 6-2] A modern GPS unit accurately provides the pilot with the aircraft's present position; however, it must use an airborne navigation database to determine its direction or distance from another location. The database provides the GPS with

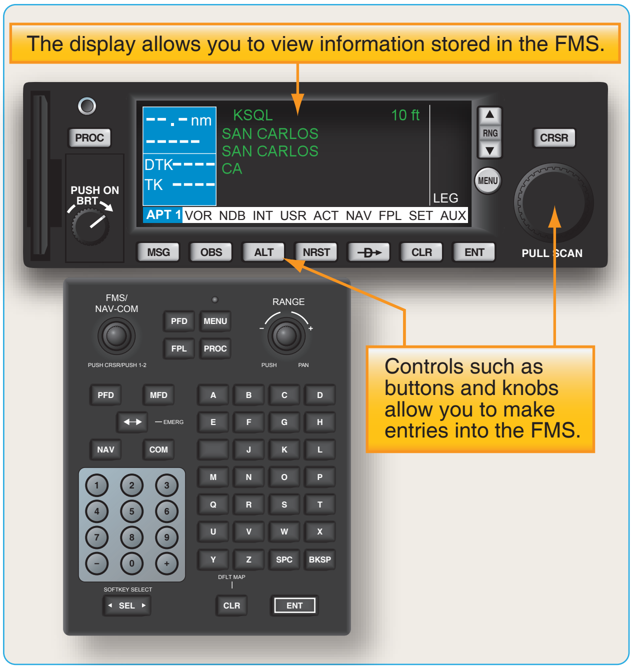

Figure 6-2. GPS with a flight route on display.

position information for navigation fixes so it may perform the required geodetic calculations to determine the appropriate tracks, headings, and distances to be flown. [Figure 6-3]

Modern FMS are capable of a large number of functions including basic en route navigation, complex departure and arrival navigation, fuel planning, and precise vertical navigation. Unlike stand-alone navigation systems, most FMS use several navigation inputs. Typically, they formulate the aircraft's current position using a combination of conventional distance measuring equipment (DME) signals, inertial navigation systems (INS), GPS receivers, or other RNAV devices. Like stand-alone navigation avionics, they rely heavily on airborne navigation databases to provide the information needed to perform their numerous functions.

Airborne Navigation Database Standardization

Beginning in the 1970s, the requirement for airborne navigation databases became more critical. In 1973,

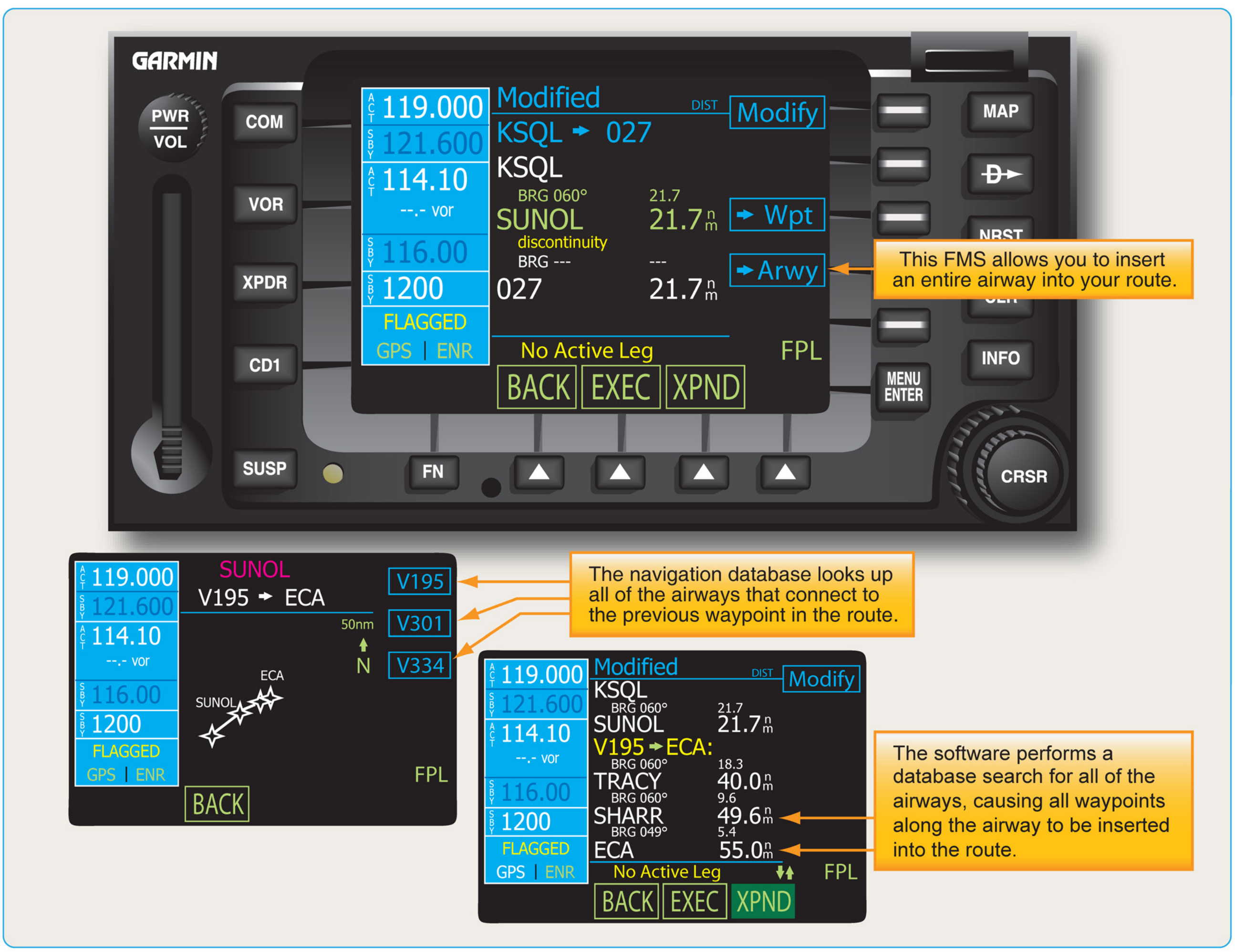

Figure 6-3. FMS display.

National Airlines installed the Collins ANS-70 and AINS-70 RNAV systems in their DC-10 fleet, which marked the first commercial use of avionics that required navigation databases. A short time later, Delta Air Lines implemented the use of an ARMA Corporation RNAV system that also used a navigation database. Although the type of data stored in the two systems was basically identical, the designers created the databases to solve the individual problems of each system, which meant that they were not interchangeable. As the implementation of RNAV systems expanded, a world standard for airborne navigation databases was needed.

In 1973, Aeronautical Radio, Inc. (ARINC) sponsored the formation of a committee to standardize aeronautical databases. In 1975, the committee published the first standard, ARINC Specification 424, which has remained the worldwide accepted format for transmission of navigation databases.

ARINC 424

ARINC 424 is the air transport industry's recommended standard for the preparation and transmission of data for the assembly of airborne system navigation databases. The data is intended for merging with the aircraft navigation system software to provide a source of navigation reference. Each subsequent version of ARINC 424 Specification provides additional capability for navigation systems to utilize. Merging of ARINC 424 data with each manufacturer's system software is unique and ARINC 424 leg types provide vertical guidance and ground track for a specific flight procedure. These leg types must provide repeatable flight tracks for the procedure design. The navigation database leg type is the path and terminator concept.

ARINC 424 Specification describes 23 leg types by their path and terminator. The path describes how the aircraft gets to the terminator by flying direct (a heading, a track, a course, etc.). The terminator is the event or condition that causes the navigation computer system to switch to the next leg (a fix, an altitude, an intercept, etc.). When a flight procedure instructs the pilot to fly runway heading to 2000 feet then direct to a fix, this is the path and terminator concept. The path is the heading and the terminator is 2000 feet. The next leg is then automatically sequenced. A series of leg types are coded into a navigation database to make a flight procedure. The navigation database allows an FMS or GPS navigator to create a continuous display of navigational data, thus enabling an aircraft to be flown along a specific route. Vertical navigation can also be coded.

The data included in an airborne navigation database is organized into ARINC 424 records. These records are strings of characters that make up complex descriptions of each navigation entity. ARINC records can be sorted into four general groups: fix records, simple route records, complex route records, and miscellaneous records. Although it is not important for pilots to have in-depth knowledge of all the fields contained in the ARINC 424 records, pilots should be aware of the types of records contained in the navigation database and their general content.

Fix Records

Database records that describe specific locations on the face of the earth can be considered fix records. Navigational aids (NAVAIDs), waypoints, intersections, and airports are all examples of this type of record. These records can be used directly by avionics systems and can be included as parts of more complex records like airways or approaches.

Another concept pilots should understand relates to how aircraft make turns over navigation fixes. Fixes can be designated as fly-over or fly-by, depending on how they are used in a specific route. [Figure 6-4] Under certain circumstances, a navigation fix is designated as fly-over. This simply means that the aircraft must actually pass directly over the fix before initiating a turn to a new course. Conversely, a fix may be designated fly-by, allowing an aircraft's navigation system to use its turn anticipation feature, which ensures that the proper radius of turn is commanded to avoid overshooting the new course. Some RNAV systems are not programmed to fully use this feature. It is important to remember a fix can be coded as fly-over and fly-by in the same procedure, depending on how the fix is used (i.e., holding at an initial approach fix). RNAV or GPS stand-alone IAPs are flown using data pertaining to the particular IAP obtained from an onboard database to include the sequence of all waypoints used for the approach and missed approach, except that step down waypoints may not be included in some TSO-C129 receiver databases. Included in the database, in most receivers, is coding that informs the navigation system of which WPs are fly-over or fly-by. The navigation system may provide guidance appropriately to include leading the turn prior to a fly-by waypoint; or causing over flight of a fly-over waypoint. Where the navigation system does not provide such guidance, the pilot must accomplish the turn lead or waypoint over flight manually. Chart symbology for the fly-by waypoint provides pilot awareness of expected actions.

Simple Route Records

Route records are those that describe a flightpath instead of a fixed position. Simple route records contain

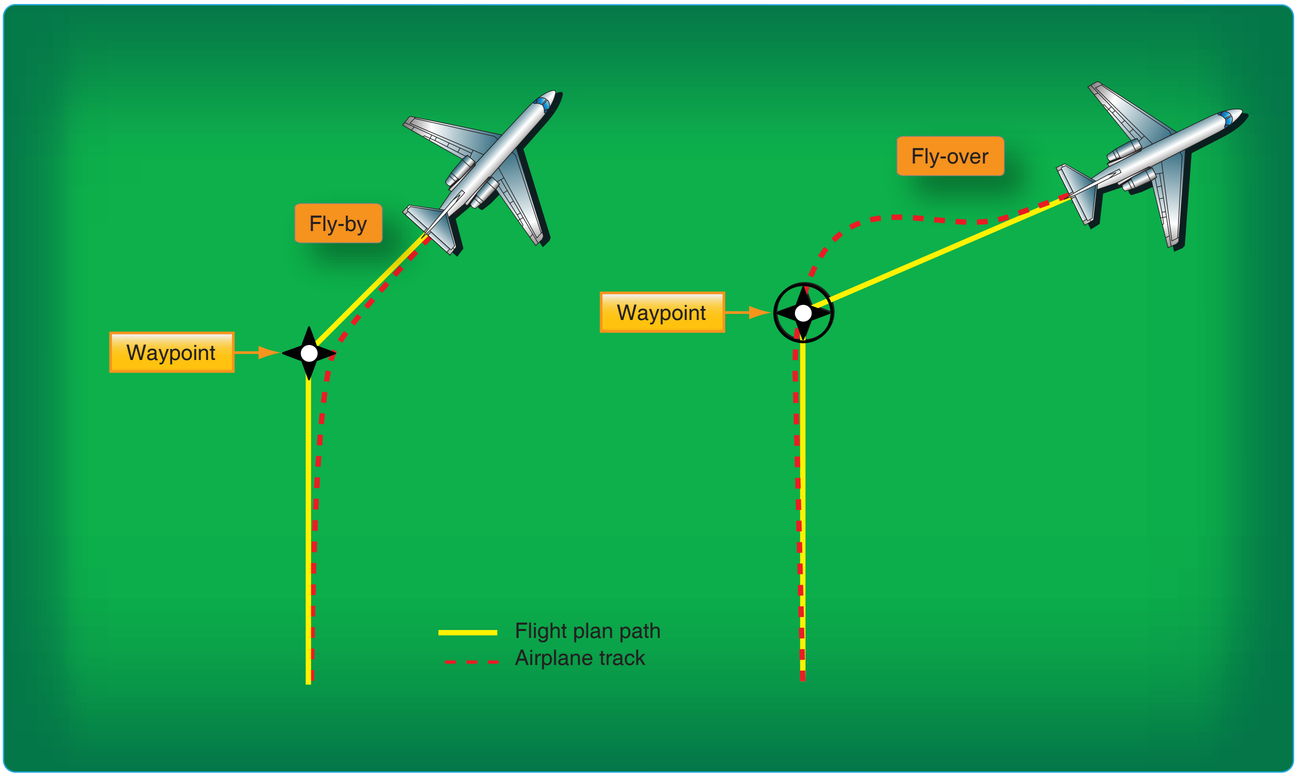

Figure 6-4. Fly-by-waypoints and fly-over-waypoints.

strings of fix records and information pertaining to how the fixes should be used by the navigation avionics.

A Victor Airway, for example, is described in the database by a series of en route airway records that contain the names of fixes in the airway and information about how those fixes make up the airway.

Complex Route Records

Complex route records include those strings of fixes that describe complex flightpaths like standard instrument departures (SIDs), standard terminal arrival routes (STARs), and instrument approach procedures (IAPs). Like simple routes, these records contain the names of fixes to be used in the route, as well as instructions on how the route is flown.

Miscellaneous Records

There are several other types of information that is coded into airborne navigation databases, most of which deal with airspace or communications. The receiver may contain additional information, such as restricted airspace, airport minimum safe altitudes, and grid minimum off route altitudes (MORAs).

Path and Terminator Concept

The path and terminator concept is a means to permit coding of terminal area procedures, SIDs, STARs, and approach procedures. Simply put, a textual description of a route or a terminal procedure is translated into a format that is useable in RNAV systems. One of the most important concepts for pilots to learn regarding the limitations of RNAV equipment has to do with the way these systems deal with the path and terminator field included in complex route records.

The first RNAV systems were capable of only one type of navigation; they could fly directly to a fix. This was not a problem when operating in the en route environment in which airways are mostly made up of direct routes between fixes. The early approaches for RNAV did not present problems for these systems and the databases they used because they consisted mainly of DME/DME overlay approaches flown only direct point-to-point navigation. The desire for RNAV equipment to have the ability to follow more complicated flightpaths necessitated the development of the path and terminator field that is included in complex route records.

Path and Terminator Legs

There are currently 23 different leg types, or path and terminators that have been created in the ARINC 424 standard that enable RNAV systems to follow the complex paths that make up instrument departures, arrivals, and approaches. They describe to navigation avionics a path to be followed and the criteria that must be met before the path concludes and the next path begins. Although there are 23 leg types available, none of the manufactured database equipment is capable of using all of the leg types. Pilots must continue to monitor procedures for accuracy and not rely solely on the information that the database is showing. If the RNAV system does not have the leg type

Figure 6-5. Initial fix.

demanded by procedures, data packers have to select one or a combination of available lleg types to give the best approximation, which can result in an incorrect execution of the procedure. Below is a list of the 23 leg types and their uses that may or may not be used by all databases.

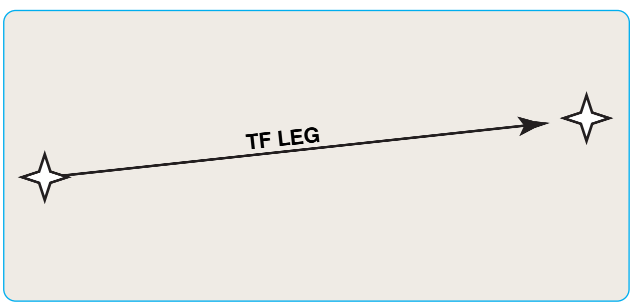

Figure 6-6. Track to a fix leg type.

- Initial fix or IF leg—defines a database fix as a point in space and is only required to define the beginning of a route or procedure. [Figure 6-5]
- Track to a fix or TF leg—defines a great circle track over the ground between two known database fixes and the preferred method for specification of straight legs (course or heading can be mentioned on charts but designer should ensure TF leg is used for coding). [Figure 6-6]
- Constant radius arc or RF leg—defines a constant radius turn between two databases fixes, lines tangent to the arc, and a center fix. [Figure 6-7]
- Course to a fix or CF leg—defines a specified course to a specific database fix. Whenever possible, TF legs

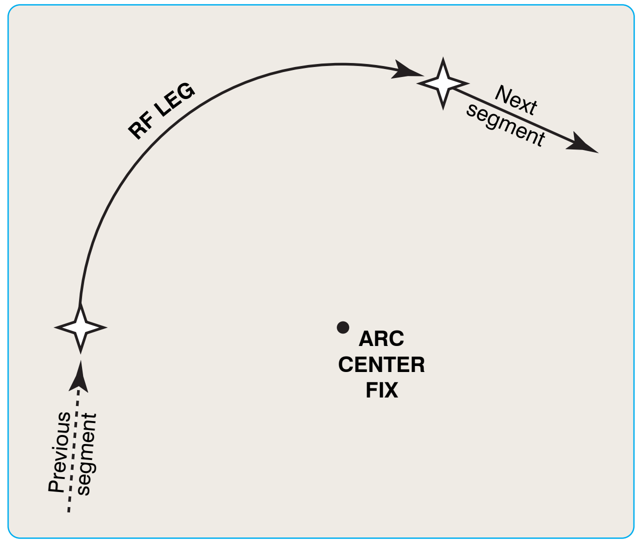

Figure 6-7. Constant radius arc or RF leg.

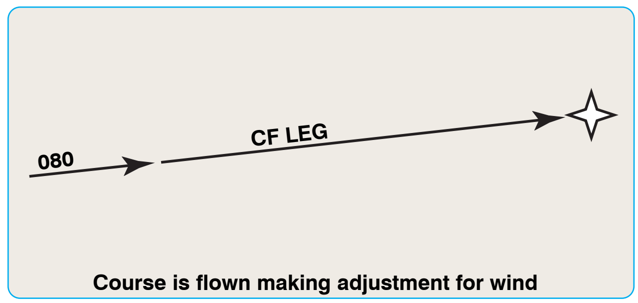

Figure 6-8. Course to a fix or CF leg.

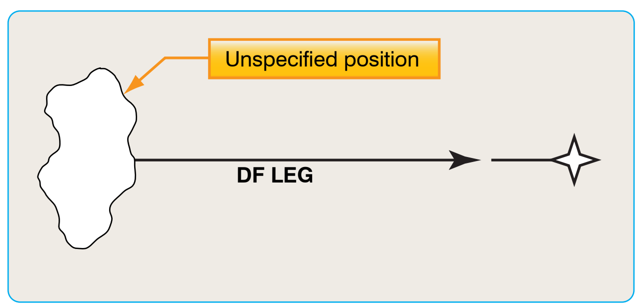

Figure 6-9. Direct to a fix or DF leg.

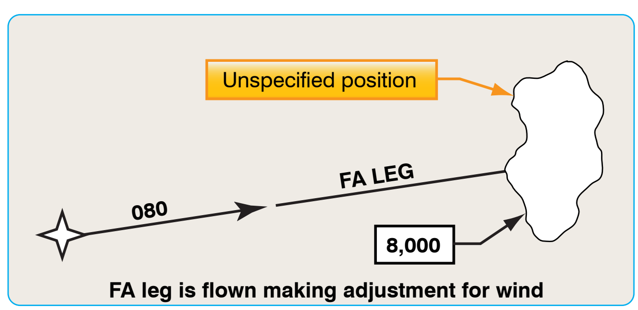

Figure 6-10. Fix to an altitude or FA leg.

should be used instead of CF legs to avoid magnetic variation issues. [Figure 6-8]

- Direct to a fix or DF leg—defines an unspecified track starting from an undefined position to a specified

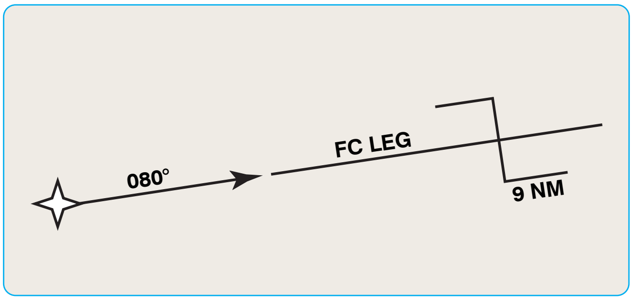

Figure 6-11. Track from a fix from a distance or FC leg.

fix. [Figure 6-9]

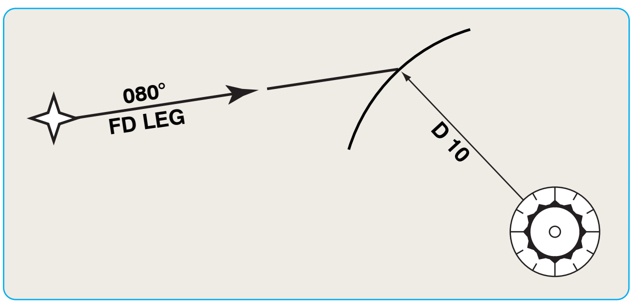

Figure 6-12. Track from a fix to a DME distance or FD leg.

- Fix to an altitude or FA leg—defines a specified track over the ground from a database fix to a specified altitude at an unspecified position. [Figure 6-10]

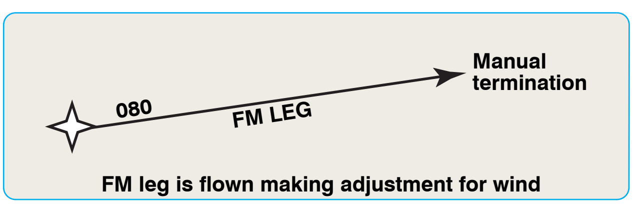

Figure 6-13. From a fix to a manual termination or FM leg.

- Track from a fix from a distance or FC leg—defines a specified track over the ground from a database fix for a specific distance. [Figure 6-11]
- Track from a fix to a distance measuring equipment (DME) distance or FD leg—defines a specified track over the ground from a database fix to a specific DME distance that is from a specific database DME NAVAID. [Figure 6-12]

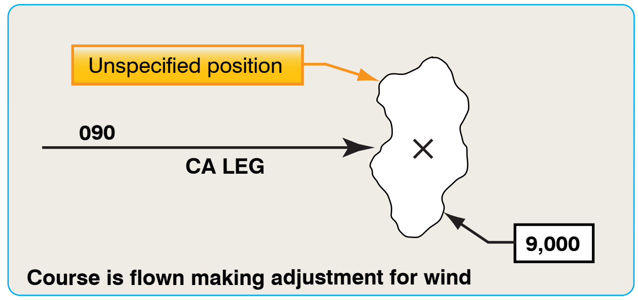

Figure 6-14. Course to an altitude or CA leg.

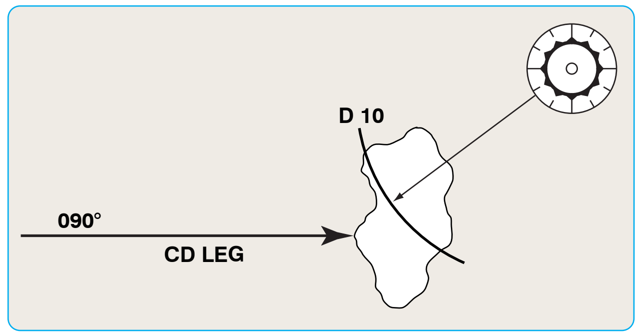

Figure 6-15. Course to a DME distance of CD leg.

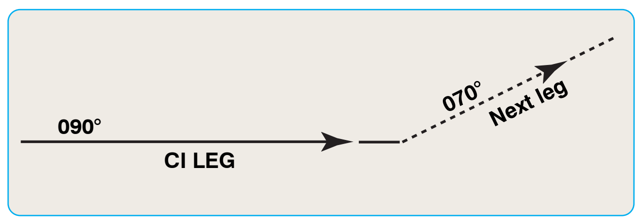

Figure 6-16. Course to an intercept or CI leg.

- From a fix to a manual termination or FM leg—defines a specified track over the ground from a database fix until manual termination of the leg. [Figure 6-13]

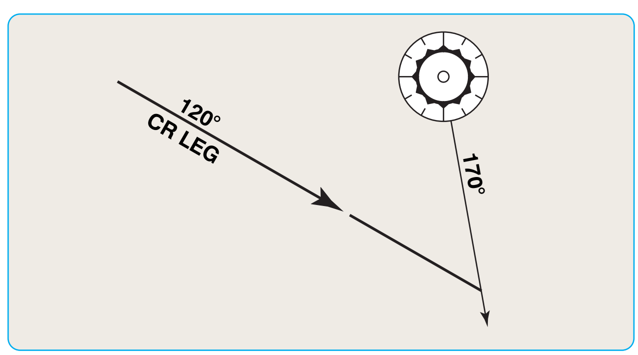

Figure 6-17. Course to a radial termination or CR leg.

- Course to an altitude or CA leg—defines a specified course to a specific altitude at an unspecified position. [Figure 6-14]

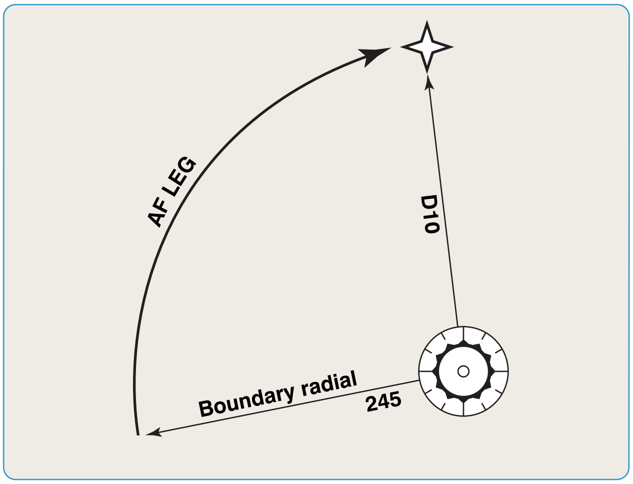

Figure 6-18. Arc to a fix or AF leg.

- Course to a DME distance or CD leg—defines a specified course to a specific DME distance that is from a specific database DME NAVAID. [Figure 6-15]

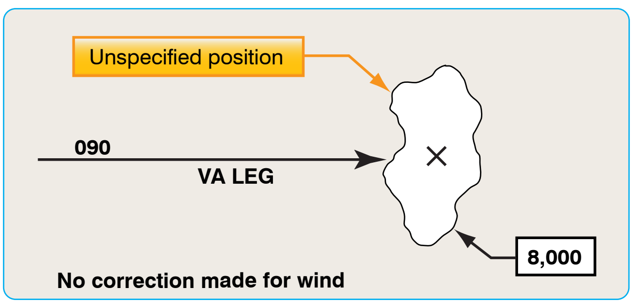

Figure 6-19. Heading to an altitude termination or VA leg.

- Course to an intercept or CI leg—defines a specified course to intercept a subsequent leg. [Figure 6-16]
- Course to a radial termination or CR leg—defines a course to a specified radial from a specific database VOR NAVAID. [Figure 6-17]

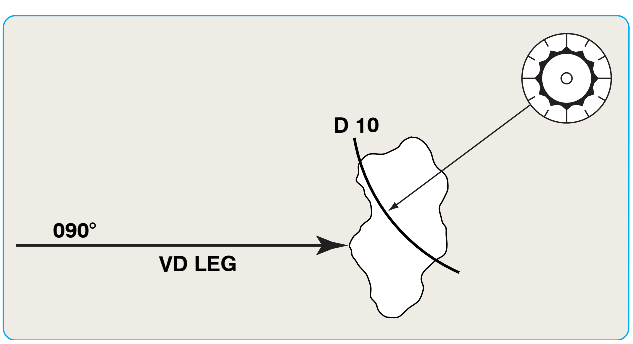

Figure 6-20. Heading to a DME distance termination or VD leg.

- Arc to a fix or AF leg—defines a track over the ground at a specified constant distance from a database DME NAVAID. [Figure 6-18]

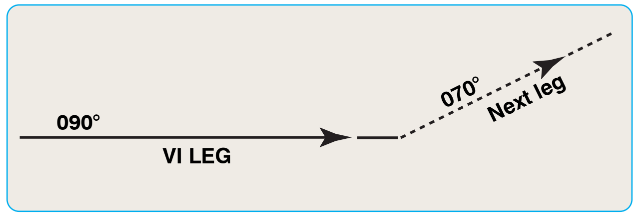

Figure 6-21. Heading to an intercept or VI leg.

- Heading to an altitude termination or VA leg—defines a specified heading to a specific altitude termination at an unspecified position. [Figure 6-19]

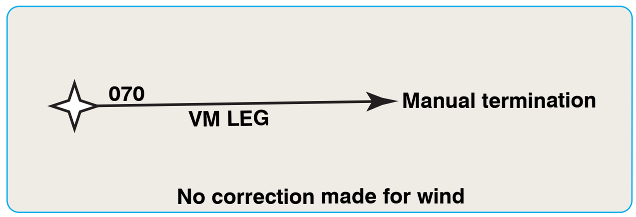

Figure 6-22. Heading to a manual termination or VM leg.

- Heading to a DME distance termination or VD leg—defines a specified heading terminating at a specified DME distance from a specific database DME NAVAID. [Figure 6-20]

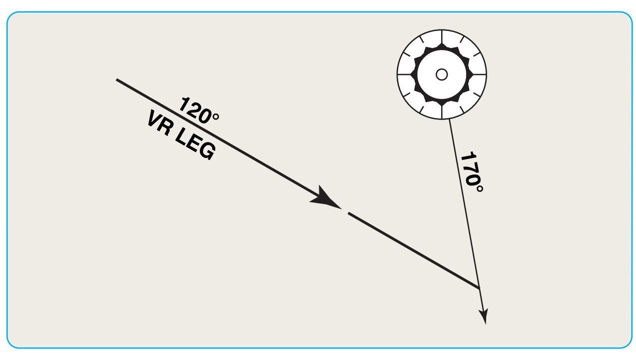

Figure 6-23. Heading to a radial termination or VR leg.

- Heading to an intercept or VI leg—defines a specified heading to intercept the subsequent leg at an unspecified position. [Figure 6-21]

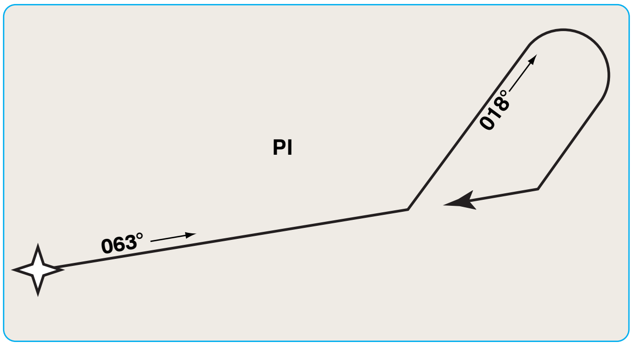

Figure 6-24. Procedure turn or PI leg.

- Heading to a manual termination or VM leg—defines a specified heading until a manual termination. [Figure 6-22]

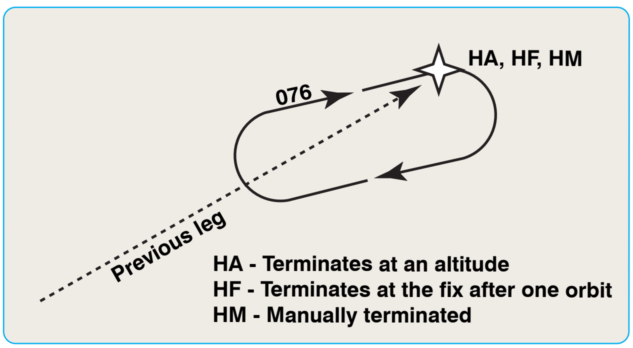

Figure 6-25. Racetrack course reversal or HA, HF, and HM leg.

- Heading to a radial termination or VR leg—defines a specified heading to a specified radial from a specific database VOR NAVAID. [Figure 6-23]
- Procedure turn or PI leg—defines a course reversal starting at a specific database fix and includes outbound leg followed by a left or right turn and 180° course reversal to intercept the next leg. [Figure 6-24]
- Racetrack course reversal or altitude termination (HA), single circuit terminating at the fix (base turn) (HF), or manual termination (HM) leg types—define racetrack pattern or course reversals at a specified database fix. [Figure 6-25]

The GRAND JUNCTION FIVE DEPARTURE for Grand Junction Regional in Grand Junction, Colorado, provides a good example of different types of path and terminator legs used. [Figure 6-26] When this procedure is coded into the navigation database, the person entering the data into the records must identify the individual legs of the flightpath and then determine which type of terminator should be used.

The first leg of the departure for Runway 11 is a climb via runway heading to 6,000 feet mean sea level (MSL) and then a climbing right turn direct to a fix. When this is entered into the database, a heading to an altitude (VA) value must be entered into the record's path and terminator field for the first leg of the departure route. This path and terminator tells the avionics to provide course guidance based on heading, until the aircraft reaches 6,000 feet, and then the system begins providing course guidance for the next leg. After reaching 6,000 feet, the procedure calls for a right turn direct to the Grand Junction (JNC) VORTAC. This leg is coded into the database using the path and terminator direct to a fix (DF) value, which defines an unspecified track starting from an undefined position to a specific database fix.

Another commonly used path and terminator value is heading to a radial (VR) which is shown in Figure 6-27 using the CHANNEL ONE DEPARTURE procedure for Santa Ana, California. The first leg of the runway 19L/R procedure requires a climb on runway heading until crossing the I-SNA 1 DME fix or the SLI R-118, this leg must be coded into the database using the VR value in the Path and Terminator field. After crossing the I-SNA 1 DME fix or the SLI R-118, the avionics should cycle to the next leg of the procedure that in this case, is a climb on a heading of 175° until crossing SLI R-132. This leg is also coded with a VR Path and Terminator. The next leg of the procedure consists of a heading of 200° until intercepting the SXC R-084. In order for the avionics to correctly process this leg, the database record must include the heading to an intercept (VI) value in the Path and Terminator field. This value directs the avionics to follow a specified heading to intercept the subsequent leg at an unspecified position.

The path and terminator concept is a very important part of airborne navigation database coding. In general, it is not necessary for pilots to have an in-depth knowledge of the ARINC coding standards; however, pilots should be familiar with the concepts related to coding in order to understand the limitations of specific RNAV systems that use databases.

Path and Terminator Limitations

How a specific RNAV system deals with Path and Terminators is of great importance to pilots operating with airborne navigation databases. Some early RNAV systems may ignore this field completely. The ILS or LOC/DME RWY 3 approach at Durango, Colorado, provides an example of problems that may arise from the lack of path and terminator capability in RNAV systems. Although approaches of this type are authorized only for sufficiently equipped RNAV systems, it is possible that a pilot may elect to fly the approach with conventional navigation, and then

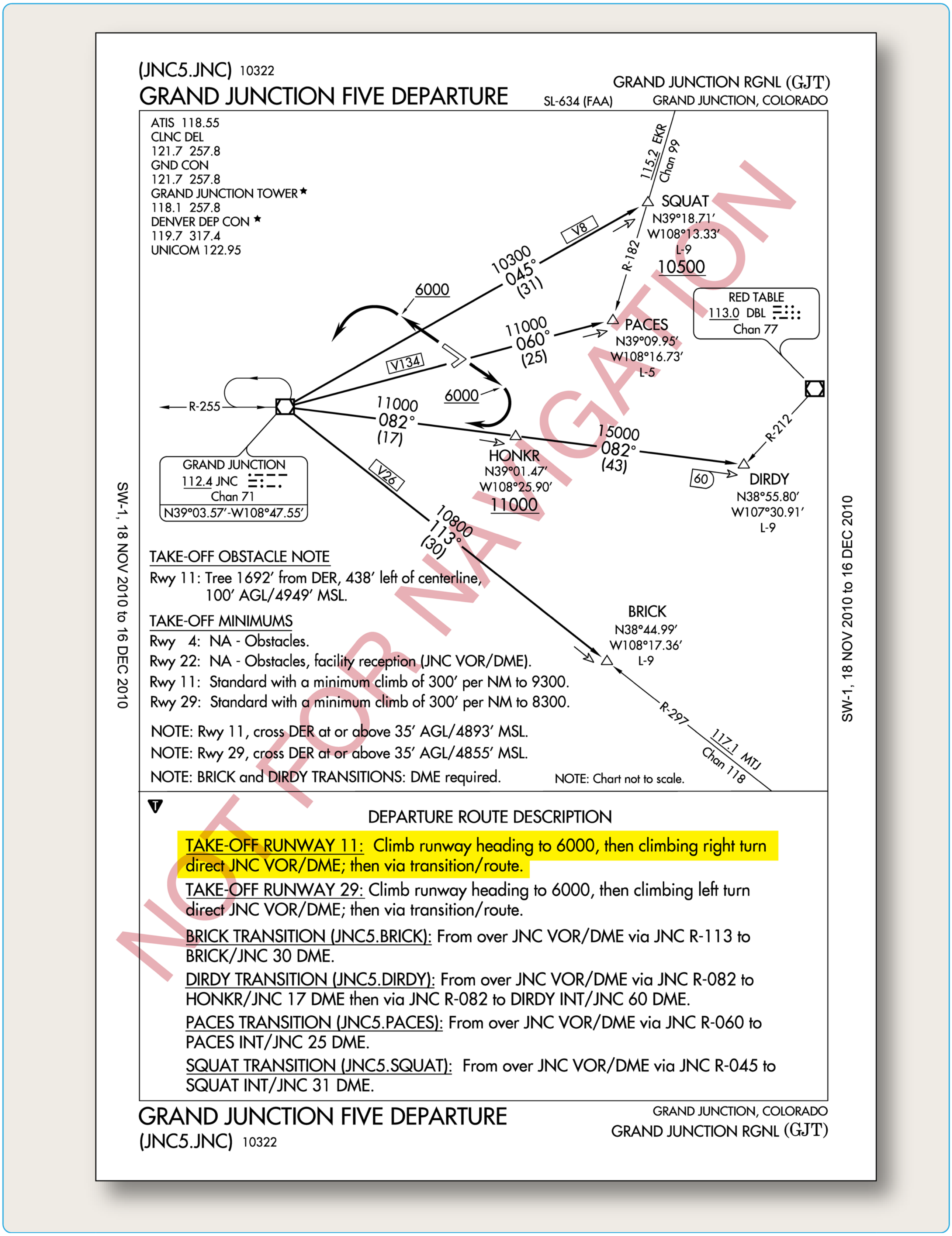

Figure 6-26. Grand Junction Five Departure.

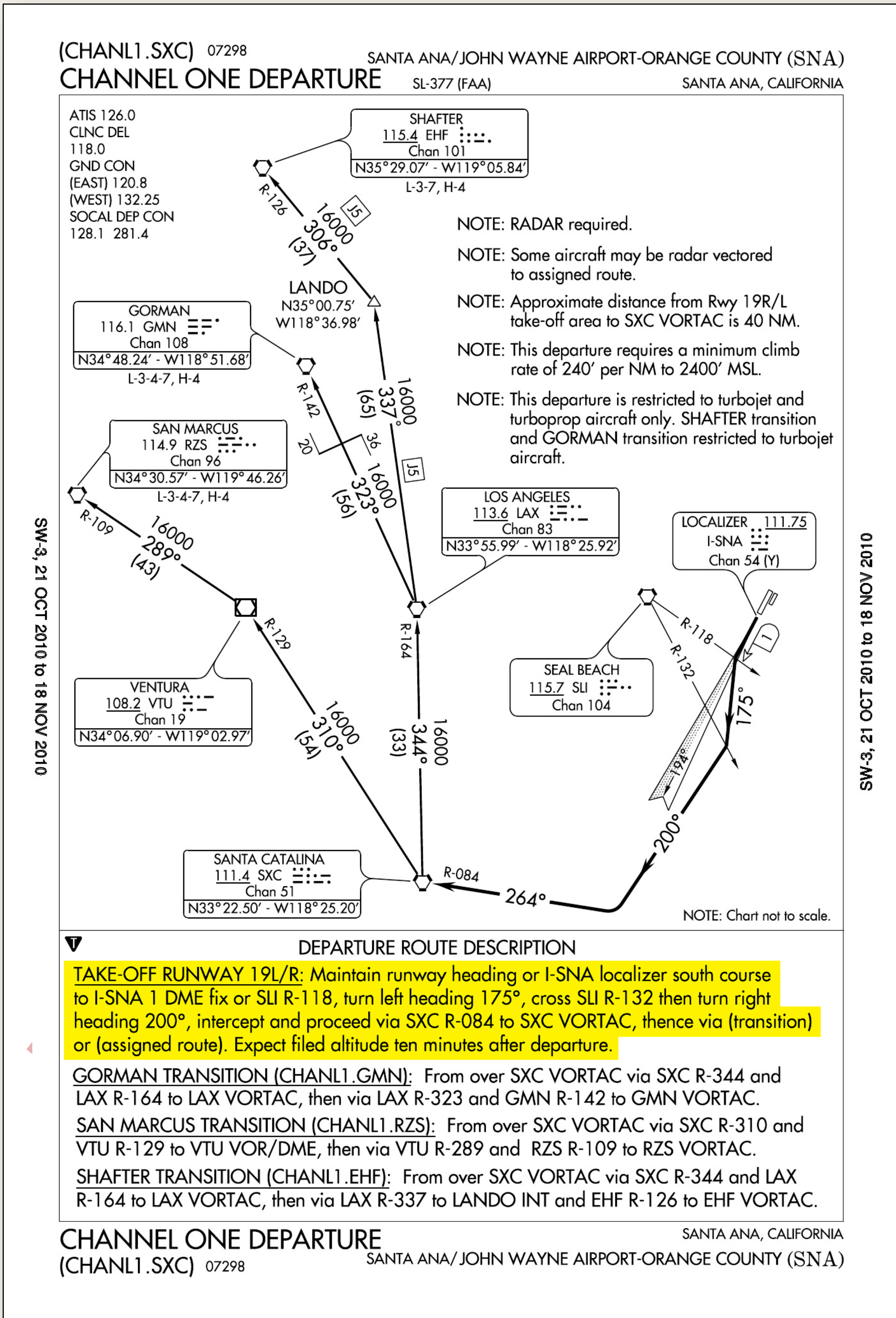

Figure 6-27. Channel One Departure.

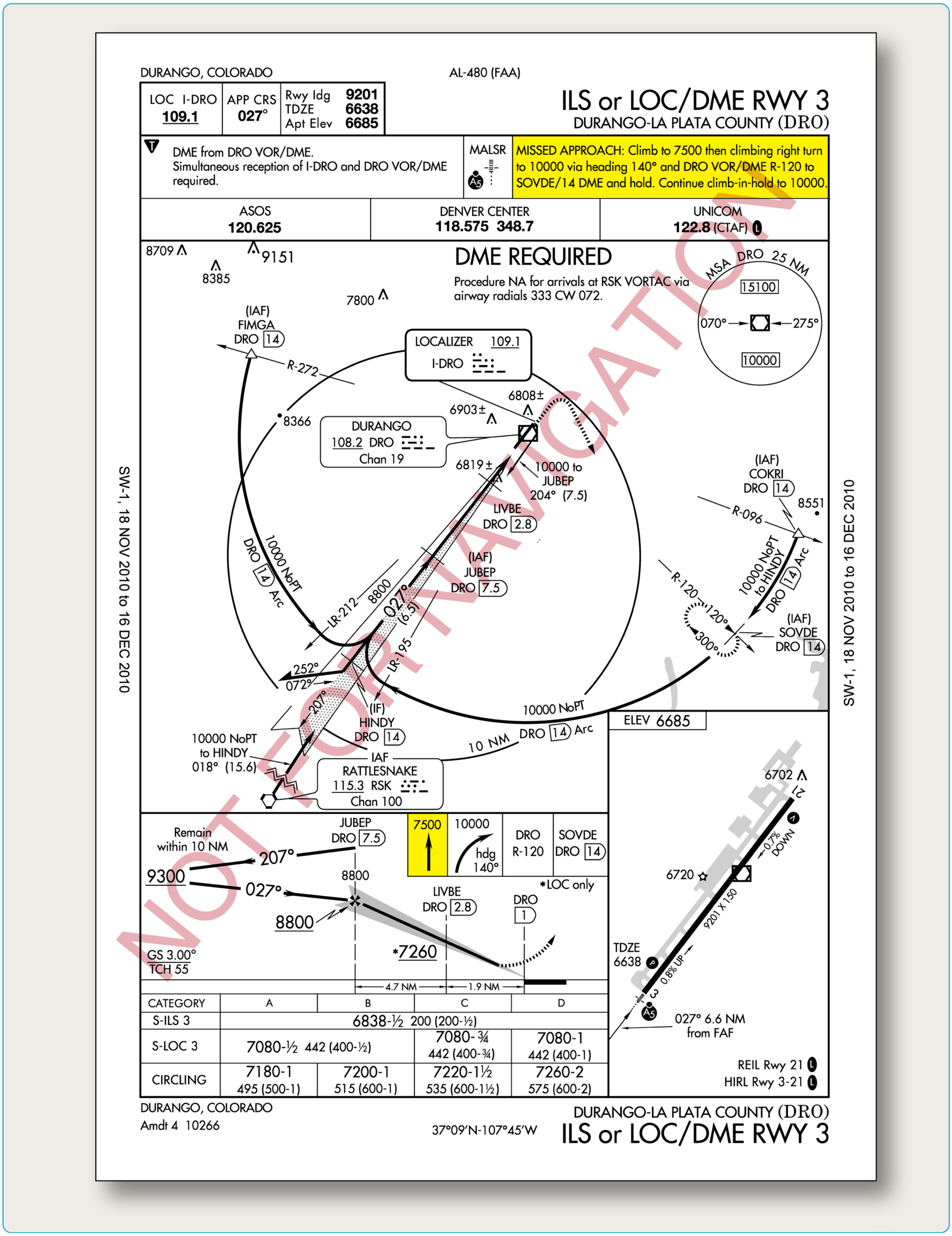

Figure 6-28. ILS or LOC/DME RWY 3 in Durango, Colorado.

reengage RNAV during a missed approach. If this missed approach is flown using an RNAV system that does not use Path and terminator values or the wrong leg types, then the system will most likely ignore the first two legs of the procedure. This will cause the RNAV equipment to direct the pilot to make an immediate turn toward the Durango VOR instead of flying the series of headings that terminate at specific altitudes as dictated by the approach procedure. [Figure 6-28] Pilots must be aware of their individual systems Path and Terminator handling characteristics and always review the manufacturer's documentation to familiarize themselves with the capabilities of the RNAV equipment they are operating. Pilots should be aware that some RNAV equipment was designed without the fly-over capability which can cause problems for pilots attempting to use this equipment to fly complex flightpaths in the departure, arrival, or approach environments.

Role of the Database Provider

Compiling and maintaining a worldwide airborne navigation database is a large and complex job. Within the United States, the FAA sources give the database providers information, in many different formats, which must be analyzed, edited, and processed before it can be coded into the database. In some cases, data from outside the United States must be translated into English so it may be analyzed and entered into the database. Once the data is coded, it must be continually updated and maintained.

Once the FAA notifies the database provider that a change is necessary, the update process begins. The change is incorporated into a 28-day airborne database revision cycle based on its assigned priority. If the information does not reach the coding phase prior to its cutoff date (the date that new aeronautical information can no longer be included in the next update), it is held out of revision until the next cycle. The cutoff date for aeronautical databases is typically 21 days prior to the effective date of the revision.

The integrity of the data is ensured through a process called cyclic redundancy check (CRC). A CRC is an error detection algorithm capable of detecting small bit-level changes in a block of data. The CRC algorithm treats a data block as a single, large binary value. The data block is divided by a fixed binary number called a generator polynomial whose form and magnitude is determined based on the level of integrity desired. The remainder of the division is the CRC value for the data block. This value is stored and transmitted with the corresponding data block. The integrity of the data is checked by reapplying the CRC algorithm prior to distribution.

Role of the Avionics Manufacturer

When avionics manufacturers develop a piece of equipment that requires an airborne navigation database, they typically form an agreement with a database provider to supply the database for that new avionics platform. It is up to the manufacturer to determine what information to include in the database for their system. In some cases, the navigation data provider has to significantly reduce the number of records in the database to accommodate the storage capacity of the manufacturer's new product, which means that the database may not contain all procedures.

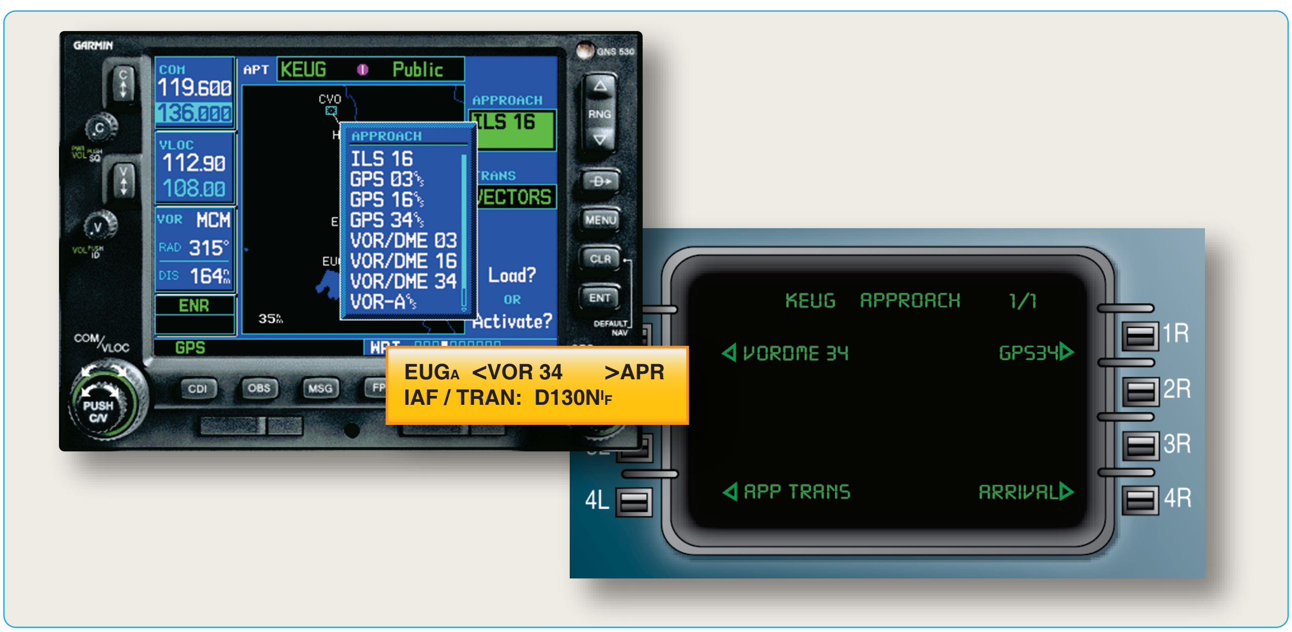

Figure 6-29. Naming conventions of three different systems for the VOR 34 Approach.

Another important fact to remember is that although there are standard naming conventions included in the ARINC 424 specification, each manufacturer determines how the names of fixes and procedures are displayed to the pilot. This means that although the database may specify the approach identifier field for the VOR/DME Runway 34 approach at Eugene Mahlon Sweet Airport (KEUG) in Eugene, Oregon, as "V34," different avionics platforms may display the identifier in any way the manufacturer deems appropriate. For example, a GPS produced by one manufacturer might display the approach as "VOR 34," whereas another might refer to the approach as "VOR/DME 34," and an FMS produced by another manufacturer may refer to it as "VOR34." [Figure 6-29]

These differences can cause visual inconsistencies between chart and GPS displays, as well as confusion with approach clearances and other ATC instructions for pilots unfamiliar with specific manufacturer's naming conventions. The manufacturer determines the capabilities and limitations of an RNAV system based on the decisions that it makes regarding that system's processing of the airborne navigation database.

Users Role

Like paper charts, airborne navigation databases are subject to revision. According to Title 14 of the Code of Federal Regulations (14 CFR) Part 91, section 91.503, the end user (operator) is ultimately responsible for ensuring that data meets the quality requirements for its intended application. Updating data in an aeronautical database is considered to be maintenance and all Part 91 operators may update databases in accordance with 14 CFR Part 91, section 43.3(g). Parts 121, 125, and 135 operators must update databases in accordance with their approved maintenance program. For Part 135 helicopter operators, this includes maintenance by the pilot in accordance with 14 CFR Part 43, section 43.3(h).

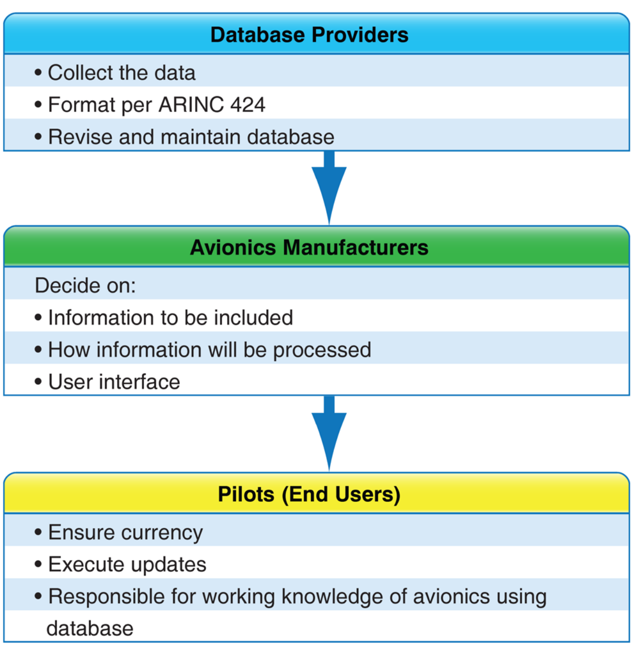

Figure 6-30. Database rolls.

Pilots using the databases are ultimately responsible for ensuring that the database they are operating with is current. This includes checking Notices to Airmen (NOTAM)-type information concerning errors that may be supplied by the avionics manufacturer or the database supplier. The database user is responsible for learning how the specific navigation equipment handles the navigation database. The manufacturer's documentation is the pilot's best source of information regarding the capabilities and limitations of a specific database. [Figure 6-30]

Operational Limitations of Airborne Navigation Databases

Understanding the capabilities and limitations of the navigation systems installed in an aircraft is one of the pilot's biggest concerns for IFR flight. Considering the vast number of RNAV systems and pilot interfaces available today, it is critical that pilots and flight crews be familiar with the manufacturer's operating manual for each RNAV system they operate and achieve and retain proficiency operating those systems in the IFR environment.

Most professional and general aviation pilots are familiar with the possible human factors issues related to flightdeck automation. It is particularly important to consider those issues when using airborne navigation databases. Although modern avionics can provide precise guidance throughout all phases of flight, including complex departures and arrivals, not all systems have the same capabilities.

RNAV equipment installed in some aircraft is limited to direct route point-to-point navigation. Therefore, it is very important for pilots to familiarize themselves with the capabilities of their systems through review of the manufacturer documentation. Most modern RNAV systems are contained within an integrated avionics system that receives input from several different navigation and aircraft system sensors. These integrated systems provide so much information that pilots may sometimes fail to recognize errors in navigation caused by database discrepancies or misuse. Pilots must constantly ensure that the data they enter into their avionics is accurate and current. Once the transition to RNAV is made during a flight, pilots and flight crews must always be capable and ready to revert to conventional means of navigation if problems arise.

Closed Indefinitely Airports

Some U.S. airports have been closed for up to several years, with little or no chance that they will ever reopen; yet their "indefinite" closure status – as opposed to permanent or UFN closure, or abandonment – causes them to continue to appear on both VFR and IFR charts and in airborne navigation databases; and their instrument approach procedures, if any, continue to be included – and still appear to be valid – in the paper and electronic versions of the United States Terminal Procedures Publication (TPP) charts. Airpark South, 2K2, at Ozark, Missouri, is a case in point.

Even though this airport has been closed going on two years and, due to industrial and residential development surrounding it, likely will never be reopened, the airport is nonetheless still charted in a way that could easily lead a pilot to believe that it is still open and operating. Even the current U.S. Low Altitude En route chart displays a blue symbol for this airport, indicating that it still has a Department of Defense (DOD) approved instrument approach procedure available for use.

Aircrews need to use caution when selecting an airport in a cautionary or emergency situation, especially if the airport was not previously analyzed suitable for diversion during preflight. Aircrews could assume, based on charts and their FMS database, the airport is suitable and perhaps the only available diversionary or emergency option. The airport however, could be closed and hazardous even for emergency use. In these situations, Air Traffic Control may be queried for the airport's status.

Storage Limitations

As the data in a worldwide database grows, the required data storage space increases. Over the years that panel-mounted GPS and FMSs have developed, the size of the commercially available airborne navigation databases has grown exponentially.

Some manufacturer's systems have kept up with this growth and some have not. Many of the limitations of older RNAV systems are a direct result of limited data storage capacity. For this reason, avionics manufacturers must make decisions regarding which types of procedures will be included with their system. For instance, older GPS units rarely include all of the waypoints that are coded into master databases. Even some modern FMS equipment, which typically have much larger storage capacity, do not include all of the data that is available from the database producers. The manufacturers often choose not to include certain types of data that they think is of low importance to the usability of the unit. For example, manufacturers of FMS used in large airplanes may elect not to include airports where the longest runway is less than 3,000 feet or to include all the procedures for an airport.

Manufacturers of RNAV equipment can reduce the size of the data storage required in their avionics by limiting the geographic area the database covers. Like paper charts, the amount of data that needs to be carried with the aircraft is directly related to the size of the coverage area. Depending on the data storage that is available, this means that the larger the required coverage area, the less detailed the database can be.

Again, due to the wide range of possible storage capacities, and the number of different manufacturers and product lines, the manufacturer's documentation is the pilot's best source of information regarding limitations caused by storage capacity of RNAV avionics.

Charting/Database Inconsistencies

It is important for pilots to remember that many inconsistencies may exist between aeronautical charts and airborne navigation databases. Since there are so many sources of information included in the production of these materials, and the data is manipulated by several different organizations before it is eventually displayed on RNAV equipment, the possibility is high that there will be noticeable differences between the charts and the databases. Because of this, pilots must be familiar with the capabilities of the database and have updated aeronautical charts while flying to ensure the proper course is being flown.

Naming Conventions

Obvious differences exist between the names of procedures shown on charts and those that appear on the displays of many RNAV systems. Most of these differences can be accounted for simply by the way the avionics manufacturers elect to display the information to the pilot. It is the avionics manufacturer that creates the interface between the pilot and the database. For example, the VOR 12R approach in San Jose, California, might be displayed several different ways depending on how the manufacturer designs the pilot interface. Some systems display procedure names exactly as they are charted, but many do not.

The naming of multiple approaches of the same type to the same runway is also changing. Multiple approaches with the same guidance will be annotated with an alphabetical suffix beginning at the end of the alphabet and working backwards for subsequent procedures (e.g., ILS Z RWY 28, ILS Y RWY 28, etc.). The existing annotations, such as

ILS 2 RWY 28 or Silver ILS RWY 28, will be phased out and replaced with the new designation.

NAVAIDs are also subject to naming discrepancies as well. This problem is complicated by the fact that multiple NAVAIDs can be designated with the same identifier. VOR XYZ may occur several times in a provider's database, so the avionics manufacturer must design a way to identify these fixes by a more specific means than the three-letter identifier. Selection of geographic region is used in most instances to narrow the pilot's selection of NAVAIDs with like identifiers.

Non-directional beacons (NDBs) and locator outer markers (LOMs) can be displayed differently than they are charted. When the first airborne navigation databases were being implemented, NDBs were included in the database as waypoints instead of NAVAIDs. This necessitated the use of five character identifiers for NDBs. Eventually, the NDBs were coded into the database as NAVAIDs, but many of the RNAV systems in use today continue to use the five-character identifier. These systems display the characters "NB" after the charted NDB identifier. Therefore, NDB ABC would be displayed as "ABCNB."

Other systems refer to NDB NAVAIDs using either the NDB's charted name if it is five or fewer letters, or the one to three character identifier. PENDY NDB located in North Carolina, for instance, is displayed on some systems as "PENDY," while other systems might only display the NDBs identifier "ACZ." [Figure 6-31]

Using the VOR/DME Runway 34 approach at Eugene Mahlon Sweet Airport (KEUG) in Eugene, Oregon, as another example, which is named V34, may be displayed differently by another avionics platform. For example, a GPS produced by one manufacturer might display the approach as VOR 34, whereas another might refer to the approach as VOR/DME 34, and an FMS produced by another manufacturer may refer to it as VOR34. These differences can cause visual inconsistencies between chart and GPS displays, as well as confusion with approach clearances and other ATC instructions for pilots unfamiliar with specific manufacturer's naming conventions.

For detailed operational guidance, refer to Advisory Circular (AC) 90-100, U.S. Terminal and En Route Area Navigation (RNAV) Operations; AC 90-101, Approval Guidance for RNP Procedures with Special Aircraft and Aircrew Authorization Required (SAAAR); AC 90-105, Approval Guidance for RNP Operations and Barometric Vertical Navigation in the U.S. National Airspace System; and AC 90-107, Guidance for Localizer Performance with Vertical Guidance and Localizer Performance without Vertical Guidance Approach Operations in the U.S. National Airspace System.

Issues Related To Magnetic Variation

Magnetic variations for locations coded into airborne navigation databases can be acquired in several ways. In many cases they are supplied by government agencies in the epoch year variation format. Theoretically, this value is determined by government sources and published for public use every five years. Providers of airborne navigation databases do not use annual drift values; instead the database uses the epoch year variation until it is updated by the appropriate source provider. In the United States, this is the National Oceanic and Atmospheric Administration (NOAA). In some cases the variation for a given location is a value that has been calculated by the avionics system. These dynamic magnetic variation values can be different than those used for locations during aeronautical charting and must not be used for conventional NAVAIDs or airports.

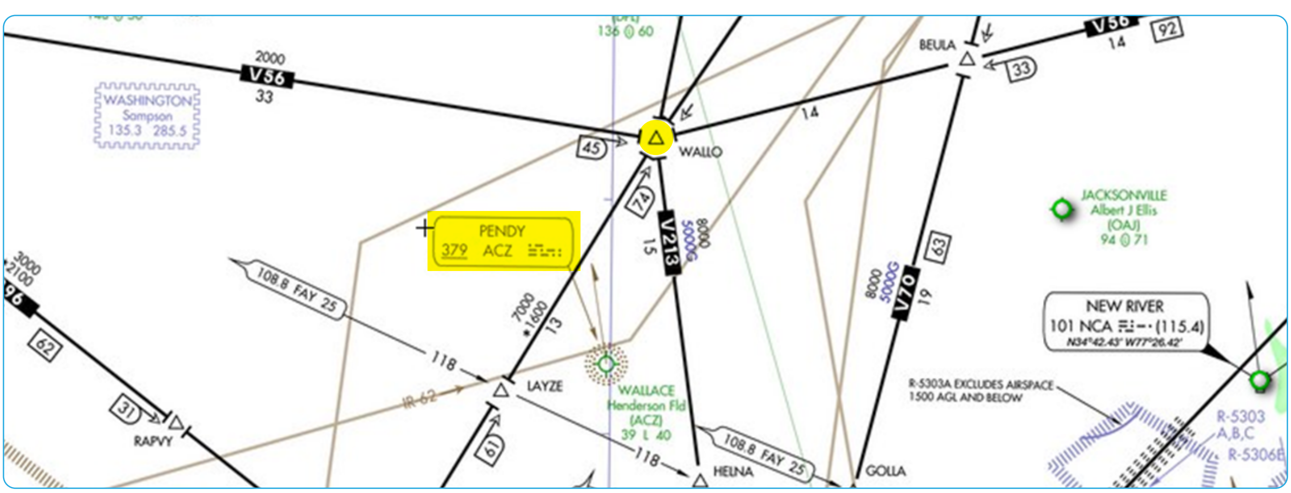

Figure 6-31. Manufacturer's naming conventions.

Discrepancies can occur for many reasons. Even when the variation values from the database are used, the resulting calculated course might be different from the course depicted on the charts. Using the magnetic variation for the region instead of the actual station declination can result in differences between charted and calculated courses and incorrect ground track. Station declination is only updated when a NAVAID is site checked by the governing authority that controls it, so it is often different than the current magnetic variation for that location. Using an onboard means of determining variation usually entails coding some sort of earth model into the avionics memory. Since magnetic variation for a given location changes predictably over time, this model may only be correct for one time in the lifecycle of the avionics. This means that if the intended lifecycle of a GPS unit were 20 years, the point at which the variation model might be correct would be when the GPS unit was 10 years old. The discrepancy would be greatest when the unit was new, and again near the end of its life span.

Another issue that can cause slight differences between charted course values and those in the database occurs when a terminal procedure is coded using magnetic variation of record. When approaches or other procedures are designed, the designers use specific rules to apply variation to a given procedure. Some controlling government agencies may elect to use the epoch year variation of an airport to define entire procedures at that airport. This may result in course discrepancies between the charted value and the value calculated using the actual variations from the database.

Issues Related To Revision Cycle

Pilots should be aware that the length of the airborne navigation database revision cycle could cause discrepancies between aeronautical charts and information derived from the database. One important difference between aeronautical charts and databases is the length of cutoff time. Cutoff refers to the length of time between the last day that changes can be made in the revision, and the date the information becomes effective. Aeronautical charts typically have a cutoff date of 10 days prior to the effective date of the charts.