Chapter 3
En Route Operations

The en route phase of flight has seen some of the most dramatic improvements in the way pilots navigate from departure to destination. Developments in technology have played a significant role in most of these improvements. Computerized avionics and advanced navigation systems are commonplace in both general and commercial aviation.

The procedures employed in the en route phase of flight are governed by a set of specific flight standards established by Title 14 of the Code of Federal Regulations (14 CFR), Federal Aviation Administration (FAA) Order 8260.3, *United States Standard for Terminal Instrument Procedures* (TERPS), and related publications. These standards establish courses to be flown, obstacle clearance criteria, minimum altitudes, navigation performance, and communications requirements. For the purposes of this discussion, the en route phase of flight is defined as that segment of flight from the termination point of a departure procedure to the origination point of an arrival procedure.

EN ROUTE NAVIGATION

Part 91.181 is the basis for the course to be flown. To operate an aircraft within controlled airspace under instrument flight rules (IFR), pilots must either fly along the centerline when on a Federal airway or, on routes other than Federal airways, along the direct course between navigational aids or fixes defining the route. The regulation allows maneuvering to pass well clear of other air traffic or, if in visual flight rules (VFR) conditions, to clear the flight path both before and during climb or descent.

En route IFR navigation is evolving from the ground based navigational aid (NAVAID) airway system to a sophisticated satellite and computer-based system that can generate courses to suit the operational requirements of almost any flight. Although the promise of the new navigation systems is immense, the present system of navigation serves a valuable function and is expected to remain for a number of years.

The procedures pilots employ in the en route phase of flight take place in the structure of the National Airspace System (NAS) consisting of three strata. The first, or lower stratum is an airway structure that extends from the base of controlled airspace up to but not including 18,000 feet mean sea level (MSL). The second stratum is an area containing identifiable jet routes as opposed to designated airways, and extends from 18,000 feet MSL to Flight Level (FL) 450. The third stratum, above FL 450 is intended for random, point-to-point navigation.

AIR ROUTE TRAFFIC CONTROL CENTERS

The **Air Route Traffic Control Center (ARTCC)** encompasses the en route air traffic control system air/ground radio communications, that provides safe and expeditious movement of aircraft operating on IFR within the controlled airspace of the Center. ARTCCs provide the central authority for issuing IFR clearances and nationwide monitoring of each IFR flight. This applies primarily to the en route phase of flight, and includes weather information and other inflight services. There are 20 ARTCCs in the conterminous United States (U.S.), and each Center contains between 20 to 80 sectors, with their size, shape, and altitudes determined by traffic flow, airway structure, and workload. Appropriate radar and communication sites are connected to the Centers by microwave links and telephone lines. [Figure 3-1 on page 3-2]

The CFRs require the pilot in command under IFR in controlled airspace to continuously monitor an appropriate Center or control frequency. When climbing after takeoff, an IFR flight is either in contact with a radar-equipped local departure control or, in some areas, an ARTCC facility. As a flight transitions to the en route phase, pilots typically expect a handoff from departure control to a Center frequency if not already in contact with the Center. The FAA National Aeronautical Charting Office (NACO) publishes en route charts depicting Centers and sector frequencies, as shown in Figure 3-2 on page 3-2. During handoff from one Center to another, the previous controller assigns a new frequency. In cases where flights may be still out of range, the Center frequencies on the face of the chart are very helpful. In Figure 3-2 on page 3-2, notice the boundary between Memphis and Atlanta Centers, and the remoted sites with discrete very high frequency (VHF) and ultra high frequency (UHF) for communicating with the appropriate ARTCC. These Center frequency boxes can be used for finding the nearest frequency within the aircraft range. They also can be used

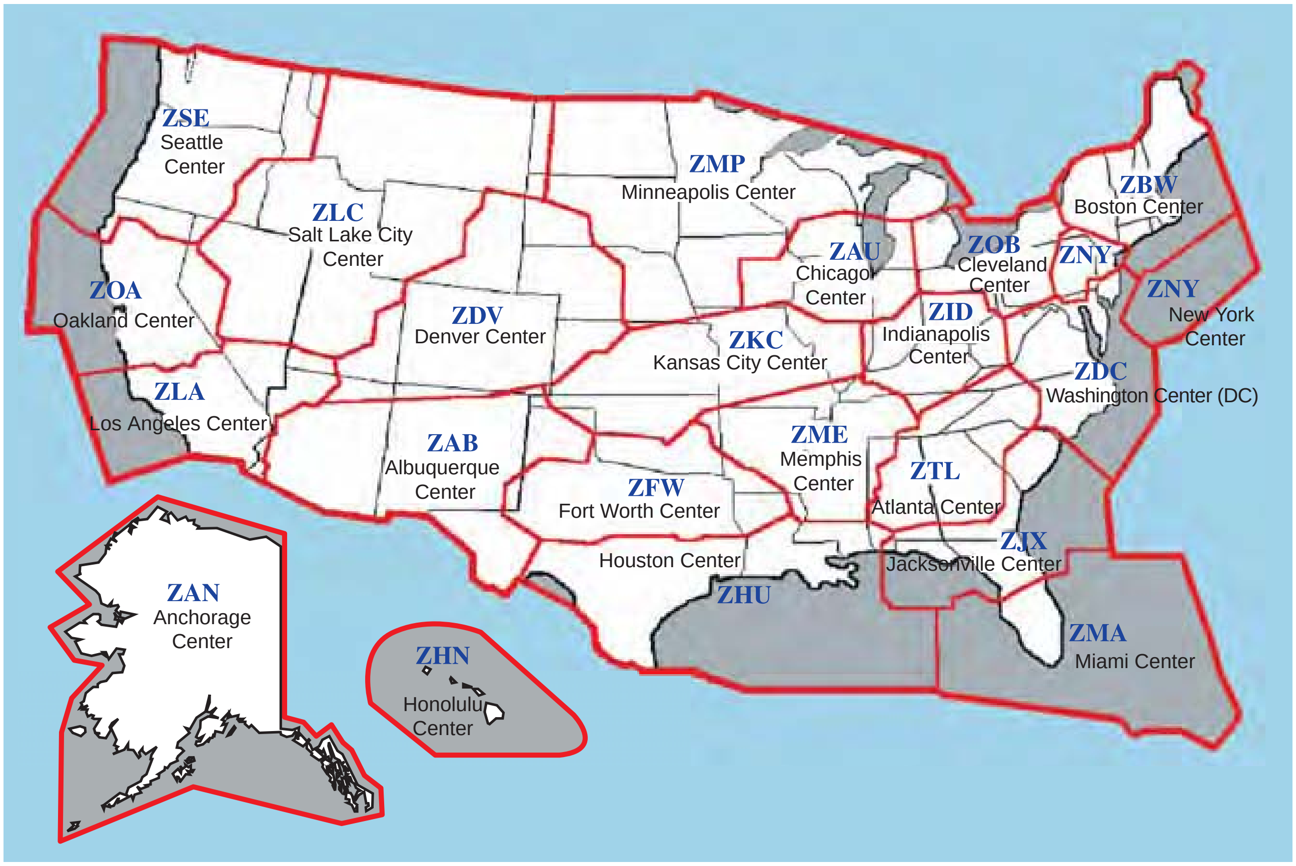

Figure 3-1. Air Route Traffic Control Centers.

for making initial contact with the Center for clearances. The exact location for the Center transmitter is not shown, although the frequency box is placed as close as possible to the known location.

During the en route phase, as a flight transitions from one Center facility to the next, a handoff or transfer of control is required as previously described. The handoff procedure is similar to the handoff between other

Figure 3-2. ARTCC Centers and Sector Frequencies.

radar facilities, such as departure or approach control. During the handoff, the controller whose airspace is being vacated issues instructions that include the name of the facility to contact, appropriate frequency, and other pertinent remarks.

Accepting radar vectors from controllers does not relieve pilots of their responsibility for safety of flight. Pilots must maintain a safe altitude and keep track of their position, and it is their obligation to question controllers, request an amended clearance, or, in an emergency, deviate from their instructions if they believe that the safety of flight is in doubt. Keeping track of altitude and position when climbing, and during all other phases of flight, are basic elements of situational awareness. Aircraft equipped with an enhanced ground proximity warning system (EGPWS) or terrain awareness and warning system (TAWS) and traffic alert and collision avoidance system (TCAS) help pilots detect and correct unsafe altitudes and traffic conflicts. Regardless of equipment, pilots must always maintain situational awareness regarding their location and the location of traffic in their vicinity.

PREFERRED IFR ROUTES

A system of **preferred IFR routes** helps pilots, flight crews, and dispatchers plan a route of flight to minimize route changes, and to aid in the efficient, orderly management of air traffic using Federal airways. Preferred IFR routes are designed to serve the needs of airspace users and to provide for a systematic flow of air traffic in the major terminal and en route flight environments. Cooperation by all pilots in filing preferred routes results in fewer air traffic delays and better efficiency for departure, en route, and arrival air traffic service. [Figure 3-3]

Preferred IFR routes are published in the *Airport/Facility Directory* for the low and high altitude stratum. If they begin or end with an airway number, it indicates that the airway essentially overlies the airport and flights normally are cleared directly on the airway. Preferred IFR routes beginning or ending with a fix indicate that pilots may be routed to or from these fixes via a standard instrument departure (SID) route, radar vectors, or a standard terminal arrival route (STAR). Routes for major terminals are listed alphabetically under the name of the departure airport. Where several airports are in proximity they are listed under the principal airport and categorized as a metropolitan area; e.g., New York Metro Area. One way preferred IFR routes are listed numerically showing the segment fixes and the direction and times effective. Where more than one route is listed, the routes have equal priority for use. Official location identifiers are used in the route description for very high frequency omnidirectional ranges (VORs) and very high frequency omnidirectional ranges/tactical air navigation (VORTACs), and intersection names are spelled out. The route is direct where two NAVAIDs, an intersection and a NAVAID, a NAVAID and a NAVAID radial and distance point, or any navigable combination of these route descriptions follow in succession.

SUBSTITUTE EN ROUTE FLIGHT PROCEDURES

Air route traffic control centers are responsible for specifying essential substitute airway and route segments and fixes for use during VOR/VORTAC shutdowns. Scheduled shutdowns of navigational facilities require planning and coordination to ensure an uninterrupted flow of air traffic. A schedule of proposed facility shutdowns within the region is maintained and forwarded as far in advance as possible to enable the substitute routes to be published. Substitute routes are normally based on VOR/VORTAC facilities established and published for use in the appropriate altitude strata. In the case of substitute routes in the upper airspace stratum, it may be necessary to establish routes by reference to VOR/VORTAC facilities used in the low altitude system. Nondirectional radio beacon (NDB) facilities may only be used where VOR/VORTAC coverage is inadequate and ATC requirements necessitate use of such NAVAIDs. Where operational necessity dictates, navigational aids may be used beyond their **standard service volume (SSV)** limits, provided that the routes can be given adequate frequency protection.

SPECIAL LOW ALTITUDE DIRECTIONAL ROUTES

Terminals	Route	Effective Times (UTC)
Low Altitude IFR routes for traffic overflying the Charlotte Metro Area:		
	PSK V37 CAE (90 and 100 only)	1100–0300
	SPA V54 LOCAS (90 and 100 only)	1100–0300
	GRD V66 SDZ (30–100 only)	1100–0300
Low Altitude IFR single-direction routes for traffic overflying Atlanta Metro Area:		
Southbound	RMG V154 MCN (70 MSL)	1100–0300
Northbound	MCN LOGEN NELLO (70 MSL, RNAV)	1100–0300
	HIGH ALTITUDE	
ATLANTA		
Austin	WEONE J239 MEI AEX LFK	1100–0300
Baltimore	EAONE SPA J14 RIC OTT–STAR	1100–0300
Boston	EATWO GRD J209 RDU J207 FKN J79 JFK ORW–STAR	1100–0300
Bradley	EATWO GRD J209 RDU J207 FKN J79 JFK DPK DPK–STAR	1100–0300
Chicago Midway	NOONE J89 BVT BVT–STAR	1100–0300
Chicago O'Hare	NOONE J89 KURTZ VHP OKK OKK–STAR	1100–0300

Figure 3-3. Preferred IFR Routes.

The centerline of substitute routes must be contained within controlled airspace, although substitute routes for off-airway routes may not be in controlled airspace. Substitute routes are flight inspected to verify clearance of controlling obstacles and to check for satisfactory facility performance. To provide pilots with necessary lead time, the substitute routes are submitted in advance of the en route chart effective date. If the lead time cannot be provided, the shutdown may be delayed or a special graphic NOTAM may be considered. Normally, shutdown of facilities scheduled for 28 days (half the life of the en route chart) or less will not be charted. The format for describing substitute routes is from navigational fix to navigational fix. A minimum en route altitude (MEA) and a maximum authorized altitude (MAA) is provided for each route segment. Temporary reporting points may be substituted for the out-of-service facility and only those other reporting points that are essential for air traffic control. Normally, temporary reporting points over intersections are not necessary where Center radar coverage exists. A minimum reception altitude (MRA) is established for each temporary reporting point.

TOWER EN ROUTE CONTROL

Within the NAS it is possible to fly an IFR flight without leaving approach control airspace, using **tower en route control (TEC)** service. This helps expedite air traffic and reduces air traffic control and pilot communication requirements. TEC is referred to as "tower en route," or "tower-to-tower," and allows flight beneath the en route structure. Tower en route control reallocates airspace both vertically and geographically to allow flight planning between city pairs while remaining with approach control airspace. All users are encouraged to use the TEC route descriptions in the *Airport/Facility Directory* when filing flight plans. All published TEC routes are designed to avoid en route airspace, and the majority are within radar coverage. [Figure 3-4]

The graphic depiction of TEC routes is not to be used for navigation or for detailed flight planning. Not all city pairs are depicted. It is intended to show geographic areas connected by tower en route control. Pilots should refer to route descriptions for specific flight planning. The word "DIRECT" appears as the route when radar vectors are used or no airway exists. Also, this indicates that a SID or STAR may be assigned by ATC. When a NAVAID or intersection identifier appears with no airway immediately preceding or following the identifier, the routing is understood to be direct to or from that point unless otherwise cleared by ATC. Routes beginning and ending with an airway indicate that the airway essentially overflies the airport, or radar vectors will be issued. Where more than one route is listed to the same destination, ensure that the correct route for the type of aircraft classification has been filed. These are denoted after the route in the altitude column using J (jet powered), M (turbo props/special, cruise speed 190 knots or greater), P (non-jet, cruise speed 190 knots or greater), or Q (non-jet, cruise speed 189 knots or less). Although all airports are not listed under the destination column, IFR flights may be planned to satellite airports in the proximity of major airports via the same routing. When filing flight plans, the coded route identifier, i.e., BURL1, VTUL4, or POML3, may be used in lieu of the route of flight.

AIRWAY AND ROUTE SYSTEM

The present en route system is based on the VHF airway/route navigation system. Low frequency (LF) and integrated LF/VHF airways and routes have gradually been phased out in the conterminous U.S., with some remaining in Alaska.

MONITORING OF NAVIGATION FACILITIES

VOR, VORTAC, and instrument landing system (ILS) facilities, as well as most nondirectional radio beacons (NDBs) and marker beacons installed by the FAA, are provided with an internal monitoring feature. Internal monitoring is provided at the facility through the use of equipment that causes a facility shutdown if performance deteriorates below established tolerances. A remote status indicator also may be provided through the use of a signal-sampling receiver, microwave link, or telephone circuit. Older FAA NDBs and some non-Federal NDBs do not have the internal feature and monitoring is accomplished by manually checking the operation at least once each hour. FAA facilities such as automated flight service stations (AFSSs) and ARTCCs/sectors are usually the control point for NAVAID facility status. Pilots can query the appropriate FAA facility if they have questions in flight regarding NAVAID status, in addition to checking notices to airmen (NOTAMs) prior to flight, since NAVAIDs and associated monitoring equipment are continuously changing.

LF AIRWAYS/ROUTES

Numerous low frequency airways still exist in Alaska, as depicted in this NACO en route low altitude chart excerpt near Nome, Alaska. [Figure 3-5] Colored LF east and west airways G7, G212 (green), and R35 (red), are shown, along with north and south airways B2, B27 (blue), and A1 (amber), all based upon the Fort Davis NDB en route NAVAID. The nearby Nome VORTAC VHF en route NAVAID is used with victor airways V452, V333, V507, V506, and V440.

Figure 3-4. Tower En Route Control.

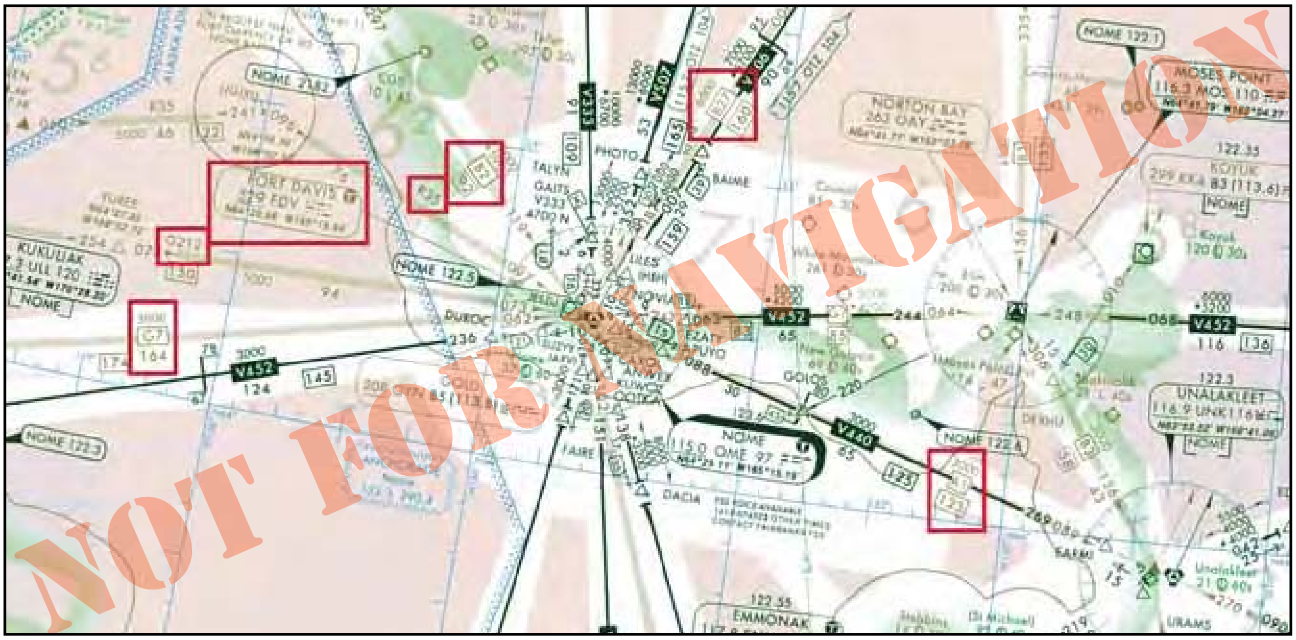

Figure 3-5. LF and VHF Airways — Alaska.