

## **APPENDIX B**

# **AIRSPACE AND AIR TRAFFIC CONTROL**

The National Airspace System (NAS) is a complex network of air navigation facilities, air traffic control facilities, airports, technology, and appropriate rules and regulations. ATC uses highly technical, intricate procedures to direct aircraft. This appendix only details areas of the NAS that impact operations in the immediate vicinity of MSP (up to and including 3000 feet of altitude). Detailed operational procedures unique to MSP are discussed in Chapters Four and Seven.

## **BACKGROUND**

The Federal Aviation Act of 1958 established the FAA and made it responsible for the control and use of navigable airspace within the United States. The FAA created the National Airspace System (NAS) to protect persons and property on the ground, and to establish a safe and efficient airspace environment for civil, commercial, and military aviation. The NAS is made up of a network of air navigation facilities, air traffic control facilities, airports, technology, and appropriate rules and regulations that are needed to operate the system. This appendix details the various components of the NAS, and then describes how these components interact to ensure safe and efficient air travel.

## **AIRSPACE**

Aircraft flying in the United States are subject to varying degrees of control depending on their operating rules, airspace type, and meteorological conditions. The airspace that aircraft operate within is divided into many different blocks of airspace segregated by geography, altitudes, and location. The control of aircraft operating in the airspace is exercised from a network of air traffic control (ATC) facilities. The ATC system operates within a framework of laws and regulations to provide for the safe operation of aircraft. Accuracy of communication and air navigation is required to maintain the air traffic control system and use of Federal airways and routes.

Section 4.2.3 discusses flight rules and weather conditions.

Airspace is broadly classified as either controlled or uncontrolled. Controlled airspace is intended to ensure separation of IFR traffic from other aircraft, both IFR and VFR. It is supported by ground-to-air communications, navigation aids, and air traffic services. Aircraft operating within controlled airspace are subject to varying requirements for positive air traffic control.

## **NAVIGATION SYSTEM**

ATC is in contact with and navigational service is available to aircraft in all phases of flight – departure, en route, and arrival. Several navigational systems are available, all comprising of ground-based transmission facilities and receiving instruments on aircraft. Navigational aids (NAVAIDS) often provide navigation to a broad area of airspace.

A non-directional beacon (NDB) is a general purpose, low-frequency radio beacon that transmits a non-directional signal. An aircraft equipped with direction finding equipment can determine a bearing to or from the radio beacon, and use this to navigate.

The most common and important NAVAID is the VHF omni-directional radio range (VOR) station. The VOR is a ground-based NAVAID which transmits high frequency radio signals (known as radials) 360 degrees in azimuth from the station. A pilot can select a specific radial from a VOR, and use this to fly to or from another point. Two VORs can be used to triangulate an aircraft's position. A pilot can also use distance measuring equipment (DME) to measure an aircraft's distance from a properly-equipped VOR. Some VORs are also co-located with TACAN (tactical air navigation equipment), which is used by the military. These installations are known as VORTAC, and operate in the same way as a VOR station. VOR radials are often used to define both low altitude (Victor) and high altitude (Jet) federal airways. They are also sometimes used to direct aircraft into and out of airports.

Aircraft also use "fixes" for navigational purposes. A fix is a defined geographic point, with a single five-letter name. It is known to both air traffic controllers and pilots, and is identified on air navigation charts. Latitude/longitude designations and radials are used to define fixes. The intersection of specific radials from two VORs, or a specific radial and a distance from DME equipment are the two most common methods used to identify a fix location.

Satellite navigation, using the Global Positioning System (GPS), is intended to replace ground-based NAVAIDS. GPS will become the primary NAVAID used by pilots and ATC. The GPS equipment uses a database of fix locations. GPS determines the aircraft's position, in latitude and longitude, and computes a course between the aircraft's position and a selected fix. Additional information on GPS is contained in Appendix G.

NAVAIDS are also used to guide an aircraft for landing at an airport during the arrival portion of flight. The procedures used with these NAVAIDS are known as Instrument Approach Procedures, and are used to guide aircraft to a specific runway for landing in IMC. An instrument approach procedure that uses VORs and NDBs as the primary NAVAID are known as non-precision approaches, because they only provide horizontal (position) guidance and do not provide exact altitude guidance. An Instrument Landing System (ILS) is known as a precision approach, because it provides precision altitude guidance for an aircraft as it is guided to the runway. It also has more precise horizontal (position) guidance than a VOR or NDB system.

## **AIR TRAFFIC CONTROL FACILITIES**

The FAA provides air traffic control service through a number of facilities and assigned areas of air traffic control responsibility. The following provides a brief description of the different types of air traffic control facilities.

### ***Air Route Traffic Control Centers (ARTCC)***

The FAA has established Air Route Traffic Control Centers (ARTCC), known as Centers, in the continental United States to control aircraft operating under instrument flight rules (IFR) within controlled airspace and while in the en route phase of flight. ARTCCs also provide limited air traffic service to VFR aircraft operating in controlled airspace. An ARTCC assigns specific routes and altitudes along federal airways to maintain separation and orderly air traffic flow. The

ARTCC uses radio communication and long range radar with automatic tracking capability to provide en route air traffic services. An ARTCC splits its airspace into sectors and assigns a controller or team of controllers to each sector. As an aircraft travels through the ARTCC, one sector hands off control to another. Each sector guides the aircraft using discrete radio frequencies.

### ***Terminal Radar Approach Control (TRACON)***

The ARTCC delegates certain airspace to local terminal facilities, which assume responsibility for the orderly flow of air traffic arriving and departing from major airports, such as MSP. These facilities provide radar vectoring, sequencing, and separation of IFR aircraft. They also provide air traffic service to aircraft operating from smaller airports within the TRACON's boundaries, and traffic advisories for VFR aircraft operating in the area.

TRACONs can be located at an ATCT or in close proximity to the airport. TRACON's use radar to guide aircraft, and therefore they do not have to be located at an airport facility. Like ARTCCs, a TRACON's airspace may also be divided into a number of different sectors to make the workloads of air traffic controllers manageable.

### ***Airport Traffic Control Tower (ATCT)***

Traffic at busy airports is controlled by an ATCT. ATCTs are located at the airport and provide local air traffic control, usually within five nautical miles of the airport. Air traffic controllers in towers primarily use sight to track and control aircraft.

Large commercial airports, such as MSP, typically have several runways that can be used simultaneously. As a result, these airports operate in a safe, systematic departure and arrival configuration (or flow) that is based on the prevailing winds and the physical layout of the runways. MSP typically operates in an east or west flow. If airports are in close proximity to each other (such as MSP and St. Paul Downtown Airport, or Flying Cloud Airport), operations at the airports must be able to smoothly interact. This requires extensive planning and coordination between the air traffic control facilities, including ATCTs, TRACONs, and ARTCCs that operate within an area.

## **PHASES OF FLIGHT**

All of the components of the National Airspace System, including airports, navigational aids, air traffic control, and aircraft must be able to interact so that aircraft can safely and efficiently travel from one place to another. This appendix has, thus far, discussed the various components of the NAS, but will now detail how these systems interact. An aircraft traveling from one place to another goes through three phases of flight: departure (takeoff), en route (cruise), and arrival (landing); during each of these phases, different components of the NAS are used. Noise abatement procedures are also used at some airports, and are integrated with the ATC system and routes assigned to aircraft.

### ***Departure Phase***

An aircraft operating on an IFR flight plan will receive an ATC clearance, specifying the air routes and initial altitudes that are to be used on the flight. The clearance may come in the form of a departure procedure (DP). A DP is a standardized ATC departure procedure, containing a group of procedures that would otherwise be transmitted piece by piece, used at certain airports to simplify clearance delivery procedures. As discussed earlier, many busy airports have a systematic and coordinated arrival and departure flow. As a result, many aircraft may receive the same clearance to depart from the airport and transition to the en route portion of their flight; a DP permits the controller to relay this clearance simply and quickly without having to repeat the information for every flight. The ATCT will transmit this clearance to the pilot, and will also give clearance for the aircraft to taxi to the runway. The ATCT will also give clearance for the aircraft to takeoff.

Shortly after takeoff, the aircraft is handed off to the TRACON. The TRACON acquires the aircraft on radar, and the pilot switches radio frequencies. The TRACON controller will vector the aircraft to follow a specific course or to avoid other air traffic, and will give it instructions to climb to certain altitudes. The TRACON directs the aircraft to a specific departure gate, which is a designated area of airspace where the aircraft is handed off to the ARTCC.

### ***En Route Phase***

By definition, the en route system of air traffic control is that part of the system devoted to controlling IFR aircraft between the terminal area of origination and the terminal area of destination. For this study, the term “en route system” includes all routes and procedures 3,000 feet and higher. This definition is consistent with the definition of airport traffic areas and environmental review procedures. The “roof” of the airport traffic area is 3,000 feet above ground level (AGL). FAA Order 1050.1D establishes 3,000 feet AGL as the altitude above which changes in en route procedures, airport approach procedures and airport departure procedures are normally categorically excluded from the requirement for an environmental assessment (EA) or environmental impact statement (EIS).

The pilot of the aircraft will initially contact the ARTCC by switching to another discrete radio frequency, and the ARTCC will detect the aircraft on its long-range radar. ARTCC will vector and direct aircraft so that it is adequately separated from other air traffic, and will direct the aircraft along its assigned route. The route will consist of a combination of VORs, airways, fixes, and radar vectors. The ARTCC will also direct the aircraft to climb to its cruise altitude. The aircraft will be handed off to different sectors and ARTCCs as it traverses along the route towards its destination.

### ***Arrival Phase***

When the aircraft comes within a couple hundred miles of its destination, the ARTCC will direct it to begin a descent to a specified lower altitude. The aircraft may be routed using a standard terminal arrival route (STAR). A STAR is very similar to a DP; it contains a group of

procedures, including routes and fixes, to be used by the aircraft as it approaches the airport. Like a DP, a STAR is intended to simplify clearance delivery procedures.

The ARTCC will direct the aircraft along a route (and to an arrival gate) used to funnel traffic into a specific airport when using a given north, south, east, or west flow. The controllers at the ARTCC merge aircraft along these routes, and provide sequencing and adequate separation from other air traffic. They will then transfer control of the aircraft to the appropriate TRACON at the arrival gate. This transfer is usually completed within approximately 20 nautical miles of the destination airport.

After the TRACON controllers establish communication with the aircraft, they provide approach control services by instructing the pilot to fly along specific routes, using fixes, NAVAIDS, and vectors. During IMC conditions, the TRACON will also direct the aircraft to an instrument approach for landing at the destination airport.

The TRACON will often route the aircraft to the airport using a local traffic pattern. The pattern is used by aircraft operating to and from an airport, to ensure that all aircraft use similar procedures and follow similar routes to and from the runways. If at all possible, aircraft should land and takeoff into the prevailing wind. This reduces takeoff and landing distance, and also helps to create an orderly traffic flow. The terminology used to describe the different legs of the traffic pattern are based upon the leg position relative to the direction of the prevailing wind and the runway. An aircraft taking off is flying into the wind, and hence the leg is known as the “upwind” leg. An aircraft that is flying perpendicular to the wind, on the departure side of the runway, is on the “crosswind” leg of the pattern. An aircraft flying parallel and towards the arrival end of the runway is on the “downwind” leg. The “base” leg is also perpendicular to the prevailing wind, and is intended as a “base” as the aircraft begins its approach for landing on the runway. The last leg, when the aircraft is aligned with the runway for landing, is known as “final.” For jet airline traffic, the traffic pattern is usually fairly “wide,” meaning it is flown several miles away from the airport. During IMC conditions, the pattern flown may be very wide, and pattern legs are used mainly to describe the aircraft’s relative position to the airport.

The TRACON hands the aircraft off to the airport’s ATCT when it is within approximately five to 10 nautical miles of the airport, or when the ATCT has visual contact with the aircraft. The ATCT gives the aircraft final clearance to land, and the aircraft safely completes its flights using the various components of the NAS.