Terminal Control Center

The inside of the Potomac TRACON.

A **Terminal Control Center** (also known as **Terminal Radar Approach CONtrol** or **TRACON** in the United States) is an Air Traffic Control Center usually located within the vicinity of a large airport. Typically, the Terminal Control Center controls aircraft within a 30-50 nautical mile (56 to 93 km) radius of the airport between the surface and 10,000 feet. A Terminal Control Center is sometimes also known as an **Approach Control** or **Departure Control**.

Terminal Control Center radar facilities

Terminal Control Centers normally have their own radar system that allow air traffic controllers to track aircraft. This is typically based on one or more Airport Surveillance Radar(s) (ASR), sweeping once every 6 seconds. These frequent updates help controllers see the result of direction changes quickly. U.S. TRACONs also have the capability to make use of CENRAP (CENter RAdar Presentation) as a backup if their primary system fails. This makes use of en-route surveillance radar used by Air Route Traffic Control Centers (ARTCCs). Expanded separation minimums are normally required when in this mode.

Terminal Control Center Control positions

Terminal Control Center control positions usually include a radar controller and a coordinator who generally stands behind the radar position.

Radar controller

The radar controller is responsible for ensuring appropriate separation, and issuing traffic and other local aviation information for aircraft under its control. Additionally, the radar controller is responsible for ensuring all required coordination with other controllers in the tower, Terminal Control Center, or en-route center is completed, making computer required computer entries, and updating the flight progress strips.

Coordinator

The coordinator provides coordination support for the radar controller. He/she will provide inter/intra faciity coordination when required for the radar controller and make computer entries.

"Hands-off" controller

Some Terminal Control Centers have the ability to staff a second position at the radar console, referred to as a "hands-off" controller. This position is responsible for providing direct support by coordinating for the radar controller, managing flight progress strips, and making computer entries. When this position is staffed, the coordinator duties are greatly reduced, allowing him/her to provide support for a number of positions.

Terminal Control Center traffic responsibilities

Terminal Control Centers are responsible for providing all ATC services within their airspace. Generally, there are four types of traffic flows controlled by Terminal Control Center controllers. These are departures, arrivals, overflights, and aircraft operating under Visual Flight Rules (VFR).

Departure aircraft

Departure aircraft are received from the tower and are generally 1,000 feet to 2,000 feet high, climbing to a pre-determined altitude. The Terminal Control Center controller working this traffic is responsible for clearing all other Terminal Control Center traffic and, based on the route of flight, placing the departing aircraft on a track and in a geographical location (sometimes referred to as a "gate") that is pre-determined through agreements for the en-route center controller. This positioning is designed to allow the en-route center to integrate the aircraft into its traffic flow easily.

Arrival aircraft

Arrival aircraft are received from the en-route center in compliance with pre-determined agreements on routing, altitude, speed, spacing, etc. The Terminal Control Center controller working this traffic will take control of the aircraft and blend it with other aircraft entering the center airspace from other areas or "gates" into a single, parallel or perpendicular final for the runway. The spacing is critical to ensure the aircraft can land and clear the runway prior to the next aircraft touching down on the runway. The tower may also request expanded spacing between aircraft to allow aircraft to depart or to cross the runway in use.

Overflight aircraft

Overflight aircraft are aircraft that enter the Terminal Control Center airspace at one point and exit the airspace at another without landing at an airport. They must be controlled in a manner that ensures they remain separated from the climbing and descending traffic that is moving in and out of the airport. Their route may be altered to ensure this is possible. When they are returned to the en-route center, they must be on the original routing unless a change has been coordinated.

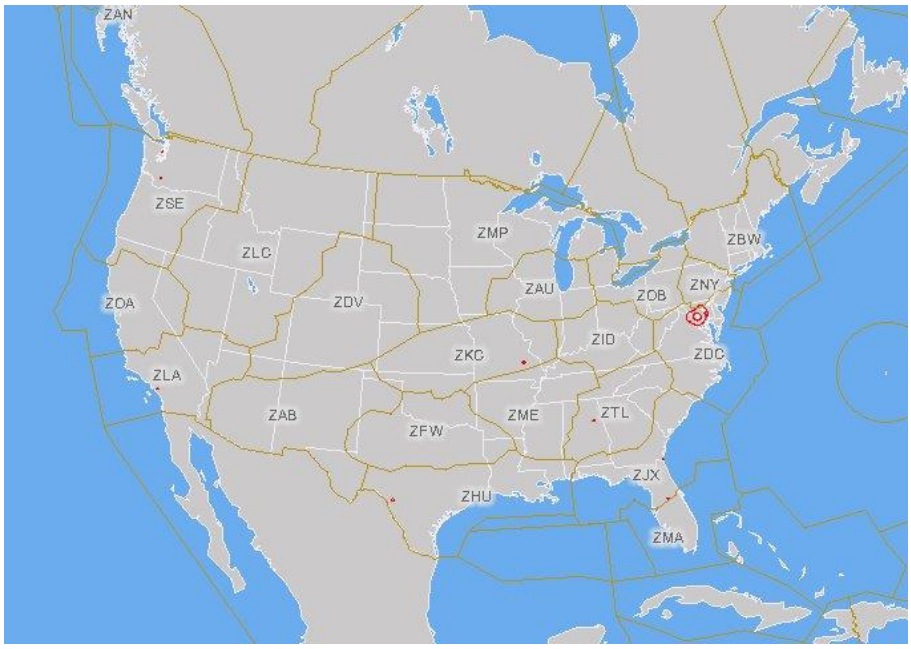
VFR aircraft

VFR aircraft are handled as traffic permits outside Positive Control Areas. Controllers will provide traffic calls and traffic alerts to ensure safety with other aircraft. Controllers lack the level of control over these aircraft that he/she has over aircraft on instrument flight plans in non-positive control airpace. Controllers usually provide information for the pilot about traffic in the immediate vicinity and weather reports if applicable. In positive control areas, the aircraft are required to conform to all control instructions until the exit. This ensures separation from Instrument Flight Plan (IFR) aircraft is maintained in the critical flight areas around the airports.

Terminal Control Center availability

Not all airports have a Terminal Control Center available. In this case, the en-route center will coordinate directly with the tower and provide this type of service where radar coverage permits. Generally, however, the separation minimums are greatly increased.

Area Control Center



This temporary flight restriction map from the Federal Aviation Administration shows the boundaries of the regions controlled by the Area Control Centers within and adjoining the continental United States, as well as the IATA airport code of each such Center operated by the United States.

In air traffic control, an **Area Control Center** (**ACC**), also known as a **Center**, is a facility responsible for controlling instrument flight rules aircraft en route in a particular volume of airspace (a Flight Information Region) at high altitudes between airport approaches and departures. In the United States, such a Center is referred to as an **Air Route Traffic Control Center** (**ARTCC**).

A Center typically accepts traffic from, and ultimately passes traffic to, the control of a TRACON or of another Center. Most Centers are operated by the national governments of the countries in which they are located. The general operations of Centers world-wide, and the boundaries of the airspace each Center controls, are governed by the International Civil Aviation Organization.

In some cases, the function of an Area Control Center and a TRACON are combined in a single facility such as a CERAP.

FAA definition

The United States Federal Aviation Administration defines an ARTCC as

> [a] facility established to provide air traffic control service to aircraft operating on IFR flight plans within controlled airspace, principally during the en route phase of flight. When equipment capabilities and controller workload permit, certain advisory/assistance services may be provided to VFR aircraft. An ARTCC is the U.S. equivalent of an Area Control Center (ACC).

Subdivision of airspace into sectors

The Flight Information Region controlled by a Center may be further administratively subdivided into sectors; each sector may use a distinct set of communications frequencies and personnel. An aircraft passing from one sector to another may be handed off and requested to change frequencies to contact the next sector controller. Sector boundaries are specified by an aeronautical chart.

Center operations

Controllers at work at the Washington Air Route Traffic Control Center.

Air traffic controllers working within a Center communicate via radio with pilots of instrument flight rules aircraft passing through the Center's airspace. A Center's communication frequencies (typically in the very high frequency amplitude modulation aviation bands, 118 MHz to 137 MHz, for overland control) are published in aeronautical charts and manuals, and will also be announced to a pilot by the previous controller during a hand-off.

In addition to radios to communicate with aircraft, Center controllers have access to communication links with other Centers and TRACONs. In the United States, Centers are electronically linked through the National Airspace System, which allows nationwide coordination of traffic flow to manage congestion. Centers in the United States also have electronic access to nationwide radar data.

Controllers use radar to monitor the progress of flights and instruct aircraft to perform course adjustments as needed to maintain separation from other aircraft. Aircraft with which a Center has made radar contact can be readily distinguished by their transponders. Pilots may also request altitude adjustments or course changes to avoid turbulence or adverse weather conditions.

Controllers can assign routing relative to location fixes derived from latitude and longitude, or from radionavigation beacons such as VORs. See also Airway; VORs and aerial highways.

Typically, Centers have advance notice of a plane's arrival and intentions from its prefiled flight plan.

Oceanic air traffic control

Some Centers have ICAO-designated responsibility for airspace located over an ocean, the majority of which is international airspace. Because substantial volumes of oceanic airspace lie beyond the range of ground-based radars, oceanic airspace controllers have to estimate the position of an airplane from pilot reports and computer models (procedural control), rather than observing the position directly (positive control). Pilots flying over an ocean can determine their own positions accurately using the Global Positioning System and can supply periodic updates to a Center. See also Air traffic control: Radar Coverage.

A Center's control service for an oceanic FIR may be operationally distinct from its service for a domestic overland FIR over land, employing different communications frequencies, controllers, and a different ICAO code.

Pilots typically use high frequency radio instead of very high frequency radio to communicate with a Center when flying over the ocean, because of HF's relatively greater propagation over long distances.

ARTCCs in the United States

The continental United States has twenty Centers, which are operated by the Federal Aviation Administration. The Centers are named after major cities, although several are physically located outside the cities for which they are named. Each Center is identified by a three-letter IATA airport code as well as a four-letter ICAO airport code, which is the same as the IATA code prefixed by the United States country code "K".

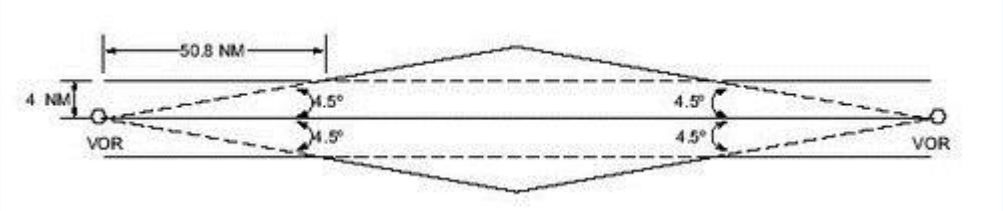
- Albuquerque Air Route Traffic Control Center, Albuquerque, New Mexico (KZAB)
- Atlanta Air Route Traffic Control Center, Hampton, Georgia (KZTL)
- Boston Air Route Traffic Control Center, Nashua, New Hampshire (KZBW)
- Chicago Air Route Traffic Control Center, Aurora, Illinois (KZAU)
- Cleveland Air Route Traffic Control Center, Oberlin, Ohio (KZOB)
- Denver Air Route Traffic Control Center, Longmont, Colorado (KZDV)
- Fort Worth Air Route Traffic Control Center, Euless, Texas (KZFW)
- Houston Air Route Traffic Control Center, Houston, Texas (KZHU)
- Indianapolis Air Route Traffic Control Center, Indianapolis, Indiana (KZID)
- Jacksonville Air Route Traffic Control Center, Hilliard, Florida (KZJX)
- Kansas City Air Route Traffic Control Center, Olathe, Kansas (KZKC)
- Los Angeles Air Route Traffic Control Center, Palmdale, California (KZLA)
- Memphis Air Route Traffic Control Center, Memphis, Tennessee (KZME)
- Miami Air Route Traffic Control Center, Miami, Florida (KZMA)
- Minneapolis Air Route Traffic Control Center, Farmington, Minnesota (KZMP)
- New York Air Route Traffic Control Center, Ronkonkoma, New York (KZNY)
- Oakland Air Route Traffic Control Center, Fremont, California (KZOA)
- Salt Lake City Air Route Traffic Control Center, Salt Lake City, Utah (KZLC)
- Seattle Air Route Traffic Control Center, Auburn, Washington (KZSE)
- Washington Air Route Traffic Control Center, Leesburg, Virginia (KZDC)

The United States also operates Centers outside the continental United States:

- Anchorage Air Route Traffic Control Center, Anchorage, Alaska (KZAN)
- Honolulu CERAP, Honolulu, Hawaii (KZHN)
- San Juan CERAP, San Juan, Puerto Rico (TJZS/ZSU)
- Guam CERAP, Agana, Guam (PGZU/ZUA)

Airway (aviation)

In aviation, an **airway** is a designated route in the air. Airways are laid-out between navigation aids such as VORs and NDB's (NDB-based airways are rare in the United States, but are more common in much of the rest of the world).



Airway diagram. Controlled airspace is between the solid lines.

In the United States low altitude airways (below 18,000 feet MSL) appear on sectional and world aeronatical charts and are designated by the letter "V" (pronounced *Victor*, hence *Victor airways*). High alititude airways (above 18,000 MSL), called jetways, appear on high altitude charts (that usually don't show topography as the low altitude charts do) and are designated by the letter "J".

In the UK, Airways are corridors 10 nautical miles wide of class A controlled airspace with a defined lower base, extending to FL245. They link the major airports giving protection to IFR flights during the climb and descent phases, and often for non-jet aircraft, cruise phases of flight. Historically they were laid out between VORs, however advances in navigational technology mean that nowadays this is not always the case. Like roads, each airway has a designator containing one letter and one to three numbers. All airspace above FL245 is class B controlled airspace, the equivalent to airways being called Upper Air Routes and have designators prefixed with a U. If an upper air route follows the same track as an airway its designator will be indentical to the airway, prefixed with a U.

Flight plan

Flight plans are plans filed by pilots with the local Aviation Authority (e.g. FAA in the USA) prior to flying. They generally include basic information such as departure and arrival points, estimated time, alternate airports in case of bad weather, type of flight whether instrument flight rules or visual flight rules, pilot's name and number of passengers. Flight plans are required for flights under IFR. Under VFR, they provide a way of alerting rescuers if the flight is overdue.

Routing Types

Aircraft routing types used in flight planning are: Airway, Navaid and Direct. A route may be composed of segments of different routing type. For example, a route from Chicago to Rome may include Airway routing over the U.S. and Europe, but Direct routing over the Atlantic Ocean.

Airway routing occurs along pre-defined pathways called Airways. Airways can be thought of as three-dimensional highways for aircraft. In most land areas of the world, aircraft are required to fly airways between the departure and destination airports. The rules governing airway routing cover altitude, airspeed, and requirements for entering and leaving the airway (see #SIDs and STARs). Most airways are eight nautical miles (14 kilometers) wide, and the airway flight levels keep aircraft separated by at least 1000 vertical feet from aircraft on the flight level above and below. Airways usually intersect at Navaids, which designate the allowed points for changing from one airway to another. Airways have names consisting of one or more letters followed by one or more digits (e.g., V484 or UA419).

The airway structure is divided into high and low altitudes. The low altitude airways in the U.S. all have names that start with the letter V, and are therefore called Victor Airways. They cover altitudes from approximately 700 feet (213 meters) above ground level (AGL) to 18,000 feet (5,486 meters) above mean sea level (MSL). The high altitude airways in the U.S. all have names that start with the letter J, and are called Jet Routes. These run from 18,000 feet to 35,000 feet (5,486 meters to 10,668 meters). The altitude separating the low and high airway structures varies from country to country. For example, it is 19,500 feet in Switzerland, and 25,500 feet in Egypt.

Navaid routing occurs between Navaids (short for Navigational Aids, see VOR) which are not always connected by airways. Navaid routing is typically only allowed in the continental U.S. If a flight plan specifies Navaid routing between two Navaids which are connected via an airway, the rules for that particular airway must be followed as if the aircraft was flying Airway routing between those two Navaids. Allowable altitudes are covered in Flight Levels.

Direct routing occurs when one or both of the route segment endpoints are at a latitude/longitude which is not located at a Navaid. Some flight planning organizations specify that checkpoints generated for a Direct route be a limited distance apart, or limited by time to fly between the checkpoints (i.e., Direct checkpoints could be farther apart for a fast aircraft than for a slow one).

SIDs and STARs

SIDs and STARs are procedures and checkpoints used to enter and leave the airway system. There is a defined transition point at which an airway and a SID or STAR intersects.

A SID, or Standard Instrument Departure, defines a pathway out of an airport and onto the airway structure. A SID is sometimes called a Departure Procedure (DP). SIDs are unique to the associated airport.

A STAR, or Standard Terminal Arrival Route, defines a pathway into an airport from the airway structure. STARs can be associated with more than one arrival airport, which can occur when two or more airports are in close proximity (e.g., San Francisco and San Jose).

Special Use Airspace

In general, flight planners are expected to avoid areas called Special Use Airspace (SUA) when planning a flight. There are several types of SUA, including Restricted, Warning, Prohibited, Alert, and Miliary Operation Area. Examples of Special Use Airspace include a region around the White House in Washington, D.C., and the country of Cuba. Government and military aircraft may have different requirements for particular SUA areas, or may be able to acquire special clearances to traverse through these areas.

Flight Levels

Flight Levels are used to specify aircraft cruising altitude and are abbreviated in 100s of feet above mean sea level. For example, 29000 feet is FL290 and 25500 feet is FL255. Flight levels are an important part of flight planning, assuring a safe vertical separation of aircraft.

Airways have a set of associated standardized flight levels (sometimes called the “flight model”) which must be used when on the airway. On a bi-directional airway, each direction has its own set of flight levels. A valid flight plan must include a legal flight level at which the aircraft will traverse the airway. Due to differences in flight levels on different airways, a change in airway may include a required altitude change to stay at an acceptable flight level.

In the U.S., eastbound (heading 0-179 degrees) IFR flights must use “odd” flight levels in 2000 foot increments starting at FL190 (i.e., FL190, FL210, FL230, etc.); Westbound (heading 180-359 degrees) flights must use “even” flight levels in 2000 foot increments starting at FL180 (i.e., FL180, FL200, FL220, etc.).

Large aircraft flying a long distance may plan on altitude changes to a higher flight level, primarily to save fuel. For example, due to a heavy fuel load, an aircraft may be able to reach FL350 early in a flight, but move to FL370 later in the route after weight has decreased due to fuel burn off.

Alternate Airports

Part of flight planning often involves the identification of one or more airports which can be flown to in case of unexpected conditions (such as weather) at the destination airport. The planning process must be careful to include only alternate airports which can be reached with the anticipated fuel load and total aircraft weight and the have capabilities necessary to handle the type of aircraft being flown.

Fuel

Aircraft manufacturers are responsible for generating flight performance data which flight planners use to estimate fuel needs for a particular flight. The fuel burn rate is based on specific throttle settings for climbing and cruising. The planner uses the projected weather and aircraft weight as inputs to the flight performance data to estimate the necessary fuel to reach the destination. The fuel burn is usually given in pounds of fuel instead of volume (such as gallons) because aircraft weight is critical.

In addition to standard fuel needs, some organizations require that a flight plan include reserve fuel if certain conditions are met. For example, an over-water flight of longer than a specific duration may require the flight plan to include reserve fuel. The reserve fuel may be planned as extra which is left over on the aircraft at the destination, or it may be assumed to be burned during flight (perhaps due to unaccounted for differences between the actual aircraft and the flight performance data).

Other Flight Planning Considerations

Holding over the destination or alternate airports is a required part of some flight plans. Holding (circling in a pattern designated by the airport control tower) may be necessary if unexpected weather or congestion occurs at the airport. If the flight plan calls for hold planning, the additional fuel and hold time should appear on the flight plan.

Organized Tracks are a series of paths similar to airways which cross ocean areas. Some organized track systems are fixed and appear on navigational charts (e.g., the NOPAC tracks over the Northern Pacific Ocean). Others change on a daily basis depending on weather and other factors and therefore cannot appear on printed charts (e.g., the NAT tracks over the North Atlantic Ocean).

Some Terms and Acronyms Used in Flight Planning

Above Ground Level (AGL)
: A measurement of altitude above a specific land mass (also see MSL).

International Civil Aviation Organization (ICAO)
: The ICAO is the specialized agency of the United Nations with a mandate “to ensure the safe, efficient and orderly evolution of international civil aviation.” The standards which become accepted by the ICAO member nations “cover all technical and operational aspects of international civil aviation, such as safety, personnel licensing, operation of aircraft, aerodromes, air traffic services, accident investigation and the environment.” A simple example of ICAO responsibilities is the unique worldwide names used to identify Navaids, Airways, airports and countries.

Knot (Kt)
: A unit of speed used in aviation equal to one nautical mile per hour.

Mean Sea Level (MSL)
: The average height of the surface of the sea for all stages of tide; used as a reference for elevations (also see AGL).

Nautical Mile (NM)
: A unit of distance used in aviation equal to approximately 1.15 statute mile. It is equal to one minute of latitudinal arc at the equator.

Controlled airspace

Controlled airspace exists in areas where air traffic control is capable of providing traffic separation. These would often be areas where radar coverage is available, or at high altitudes where flight under visual flight rules (VFR) is prohibited. This does not mean that air traffic control actually provides services to all flights in the airspace, only that such service is possible.

In the United States, most airspace that is more than 1,200 feet above ground level (AGL) is controlled airspace. Exceptions include remote and mountainous areas where radar coverage and radio communications may not be available except at higher altitudes. Airspace designations are standardized by the International Civil Aviation Organization (ICAO) and break down into seven classes:

- In the United States, 'Class A' airspace exists only at high altitudes (18,000 feet above **M**ean **S**ea **L**evel and above). In some countries, 'class A' airspace also exists around very busy airports (for example, London Heathrow). Only flight under instrument flight rules (IFR) is permitted in 'class A' airspace. All other classes of controlled airspace permit both IFR and VFR flight. There is no speed limit in class A airspace (except the sound barrier over land).

- 'Class B' airspace exists around the very busiest airports in the world — generally major air carrier hubs (for example, Los Angeles International). All aircraft must have a clearance to enter the airspace and an altitude-encoding (Mode-C) transponder that automatically reports the aircraft altitude to air traffic control is mandatory. Canada has classified all airspace from 12,500' to 18,000' as Class B as well. This may be an added safety measure as flight above this altitude requires either a pressurized plane or an oxygen breathing system. (See also Class B Airports)

- 'Class C' airspace exists around moderately busy airports — generally the primary airports for major cities though not major hubs (for example, San Jose, California). An altitude-encoding transponder is mandatory. All aircraft must be in two-way communication with air traffic control. A clearance is not needed to enter the airspace. (See also Class C Airports)

- 'Class D' airspace exists around airports with an operational control tower and that are not busy enough to warrant a 'class B' or 'class C' airspace designation. Radar coverage may exist but is not mandatory (pilot position reports and tower binoculars are usually sufficient). The tower is responsible for sequencing takeoffs and landings.

- 'Class E' airspace exists almost everywhere else (in the United States) except close to the ground. Both VFR and IFR flight is permitted and communication with air traffic control is not required for VFR flight.

- 'Class F' is Advisory Airspace. This exists when some form of positive separation is offered between certain flights, but where the traffic environment is not fully known to Air Traffic Control. It is therefore uncontrolled airspace. Many countries use Class F airspace on low-

traffic routes, around low-traffic airports and for military and other special-use airspace. Class F airspace is not used in the United States.

- 'Class G' uncontrolled airspace is all airspace that has not been designated in one of the previous categories. Both VFR and IFR flight is permitted and communication with air traffic control is not required. VFR flight in class G can be conducted in lower visibilities then Class E. In the Unitd States, radar separation of traffic is not available in Class G.

This internationally standardized system of controlled airspaces has replaced most countries' own systems, however the narrative here describes how this is applied to airports in the United States; other countries apply these airspace classifications differently.