# Appendix C

## Airfield Demand/Capacity Analysis

# C. Airfield Demand/Capacity Analysis

This appendix describes the demand/capacity analysis conducted for the Airport. The purpose of the airfield demand/capacity analysis is to assess the capability of the airfield facilities to accommodate existing and forecast aircraft operations. In conducting this analysis, airfield capacity and aircraft delay were calculated using the methodologies outlined in AC 150/5060-5, *Airport Capacity and Delay*.

Airfield capacity, sometimes referred to as throughput, is defined in AC 150/5060-5 as the maximum number of aircraft operations that an airfield can accommodate during a specific period of time without incurring an unacceptable level of delay. Aircraft delays increase exponentially as the number of aircraft operations (aircraft demand) nears or exceeds airfield capacity under specific operating conditions. The following terms, as defined by the FAA, were used in this analysis:

- **Peak-hour capacity** – Peak-hour capacity is defined as the maximum number of aircraft operations that can occur in one hour under specific operating conditions. Peak-hour capacity can only be estimated, as many factors that affect capacity are not constant. For instance, aircraft demand is not usually constant throughout the peak period. Therefore, changes in peaking characteristics cause hourly capacity to fluctuate.
- **Annual service volume (ASV)** – AC 150/5060-5 defines ASV as “a reasonable estimate of an airport’s annual capacity.” Annual service volume accounts for the hourly, daily, and seasonal variations in aircraft demand associated with the airfield and the occurrence of low visibility conditions during which air traffic control (ATC) procedures for the Airport are modified to maintain operational safety.

## C.1 Factors Affecting Airfield Capacity

The capacity of an airfield system, including the runways and associated exit taxiways, is not constant over time. A variety of factors can affect airfield capacity, each of which is discussed below. These include:

- Meteorological conditions
- Airfield geometry and operating configurations
- Frequency of touch-and-go operations
- Aircraft fleet mix

### C.1.1 METEOROLOGICAL CONDITIONS

Airfield capacity can vary significantly based on meteorological conditions at an airport. Prevailing winds (direction and speed) dictate which runways can be used for aircraft arrivals and departures. Aircraft typically land and take off into the wind, and can withstand limited crosswind and tailwind conditions. If the maximum crosswind or tailwind is exceeded, the aircraft may not be able to operate safely on a particular runway. Therefore, wind conditions may prevent the use of a higher capacity airfield operating configuration, thus increasing aircraft delays.

Other meteorological conditions affecting airfield capacity include cloud ceiling height and visibility. Low cloud ceilings and low visibility conditions result in increased spacing between aircraft in the airspace surrounding the airport. These conditions may also restrict which runways can be used, because arrivals in these conditions may require precision approach instrumentation.

Visual flight rules (VFR) govern the procedures used to conduct flight operations under visual meteorological conditions (VMC). Similarly, instrument flight rules (IFR) govern the procedures used to conduct flight operations under instrument meteorological conditions (IMC). AC 150/5060-5 defines VMC as a cloud ceiling height of at least 1,000 feet above ground level (AGL) and visibility greater than three statute miles. IMC is defined as a ceiling height less than 1,000 feet AGL and/or visibility less than three statute miles.

During IFR conditions (i.e., IMC), only Runway 7-25 has the necessary instrumentation and published procedures to support aircraft operations. However, aircraft operational demand is also reduced during IMC, as many private pilots are prohibited from flying during these conditions unless they possess an instrument rating and the aircraft are properly equipped for operating under IFR.

Based on an analysis of hourly wind and weather observations at the Airport, as described in Section 2, VMC prevail at the Airport approximately 97 percent of the time, while IMC occur approximately 3 percent of the time.

### C.1.2 AIRFIELD GEOMETRY AND OPERATING CONFIGURATIONS

The Airport has one primary air carrier runway (Runway 7-25) that serves most aircraft operations. When conditions allow, an intersecting crosswind runway (Runway 12-30) is used by crop dusters (agricultural spraying), small single-engine general aviation aircraft, and helicopters.

The geometry of the runways can result in a variety of airfield operating configurations. Weather, aircraft types, runway design and instrumentation, and air traffic controller preference are some of the factors in determining which runway or operating configuration is used. Based on conversations with ATC personnel, approximately 95 percent of aircraft operations during VFR conditions occur on Runway 7-25, with approximately 5 percent occurring on Runway 12-30. During IFR conditions, Runway 7-25 is used 100 percent of the time due to the lack of instrumentation on and published instrument procedures for Runway 12-30.

### C.1.3 FREQUENCY OF TOUCH-AND-GO OPERATIONS

Touch-and-go operations are defined as operations by a single aircraft landing and departing on a runway without stopping or exiting the runway. Pilots conducting touch-and-go operations usually stay in an airport's traffic pattern, as they are generally performing training exercises. Airport capacity can be impacted by touch-and-go operations because aircraft in the pattern are continually making approaches. Touch-and-go operations may also reduce the availability of a runway for other types of operations. For purposes of the airfield capacity analysis, it was assumed that touch-and-go operations account for up to 40 percent of total peak hour operations at the Airport.

### C.1.4 AIRCRAFT FLEET MIX

Aircraft operational fleet mix is an important factor in determining an airport's operational capacity. For the purpose of calculating capacity, aircraft are categorized according to their approach speed and weight. Operational capacity decreases as the diversity of approach speeds and aircraft weights increase. This is because aircraft following each other, either on take-off or departure, are spaced according to the difference in their air speeds and weights. Heavy aircraft create wake vortices that require greater spacing between large and small aircraft. The greater the difference in size and speed of the aircraft in the fleet, the greater the space required between aircraft and, therefore, the lower the operational capacity.

To capture the effects of aircraft weight and speed on airfield capacity, AC 150/5060-5 groups aircraft into four classes, as shown in **Table C-1**, based on the maximum takeoff weight and estimated approach speed of the aircraft.

**Table C-1 Aircraft Classification for Airfield Capacity**

| AIRCRAFT CLASSIFICATION | TAKEOFF WEIGHT (POUNDS) | TYPES OF AIRCRAFT | ESTIMATED APPROACH SPEED (KNOTS) |
|---|---|---|---|
| A | 12,500 or less | Small single-engine aircraft (such as Piper PA-28, Cessna 152, and Cessna 210) | 95 |
| B | 12,500 or less | Small twin-engine aircraft (such as Beechcraft Duchess, Cessna Citation II, and Learjet 35) | 120 |
| C | 12,500 to 300,000 | Large aircraft (such as Boeing 737 and MD-80) | 130 |
| D | 300,000 or more | Heavy Aircraft (such as Airbus A300, Boeing 767, and Boeing 777) | 140 |

SOURCE: Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay*.
PREPARED BY: Ricondo & Associates, Inc., November 2011.

Based on the aircraft weight classifications shown in Table C-1 and the aircraft fleet mix presented in Section 3, **Table C-2** depicts how the Airport's historical and projected aircraft fleet mix was grouped into the aircraft classifications described in AC 150/5060-5. Also shown is the mix index, which is a mathematical expression equal to the percent of Class C aircraft plus 3 times the percent of Class D aircraft.

**Table C-2 Aircraft Fleet Mix for Airfield Capacity**

| | | FORECAST | | | |
|---|---|---|---|---|---|
| AIRCRAFT CLASSIFICATION | 2009 | 2014 | 2019 | 2024 | 2029 |
| A&B | 50% | 57% | 56% | 56% | 55% |
| C | 50% | 43% | 44% | 44% | 45% |
| D | 0% | 0% | 0% | 0% | 0% |
| Total | 100% | 100% | 100% | 100% | 100% |
| Mix index 1/ | 50 | 43 | 44 | 44 | 45 |

Note:

1/ The mix index is equal to the percentage of Class C + 3 * (percentage of Class D).

SOURCES: Ricondo & Associates, Inc., January 2011, based on Federal Aviation Administration, Advisory Circular 150/5060-5, *Airport Capacity and Delay* and aviation activity forecasts presented in Section 3.

PREPARED BY: Ricondo & Associates, Inc., November 2011.

The mix index for TWF reflects a fleet composition that is dominated by Class A, B, and C aircraft. No aircraft over 300,000 pounds maximum takeoff weight (Class D) are projected to conduct scheduled operations at the Airport during the planning period. Therefore, critical to the mix index calculation is the number of Class C aircraft operating or projected to operate at the Airport. Because a projected breakout of specific aircraft types was not developed, the following assumptions were used to determine the percentage of Class C aircraft projected to operate at the Airport:

- 2/3 of jet/turboprop general aviation aircraft
- 50 percent of air taxi aircraft
- 10 percent of all-cargo aircraft
- 50 percent of military aircraft
- 100 percent of regional/commuter and air carrier aircraft

## C.2 Airfield Capacity

Based on the factors affecting airfield capacity at the Airport, a methodology contained in AC 150/5060-5 was used to determine the peak hour and annual capacity of the Airport. Peak hour capacity is typically derived independently for VFR and IFR operations and is a measure of the maximum number of aircraft operations which can be accommodated on the airport in an hour. Annual Service Volume (ASV) is a reasonable estimate of an airport's annual capacity, which accounts for differences in the previously-described factors affecting airfield capacity that would be encountered over the course of a year. ASV can be used as a reference point for the general planning of capacity-related improvements.

The methodology to determine peak hour and annual capacity involves selecting one of 19 runway configurations illustrated in AC 150/5060-5 that best represents the runway configuration of the Airport. For the selected configuration, the peak hour capacity and ASV corresponding to the calculated mix index is obtained from AC 150/5060-5. Use of the published illustrations and corresponding capacity values is contingent upon the following assumptions being true:

- The number of arrivals is equal to the number of departures.
- The percent of touch-and-go operations is within prescribed ranges, based on the calculated mix index (up to 40 percent for a mix index between 21 and 50).
- There is a full-length parallel taxiway, ample runway entrance/exist taxiways, and no taxiway crossing problems.
- There are no airspace limitations which would adversely impact flight operations or otherwise restrict aircraft which could operate at the airport. Missed approach protection is assured for all converging operations in IFR weather conditions.
- The airport has at least one runway equipped with an Instrument Landing System (ILS).
- IFR weather conditions occur roughly 10 percent of the time.
- Roughly 80 percent of the time the airport is operated in the runway configuration which produces the greatest hourly capacity.

Using the methodology described above, a mix index of 21 to 50 for the most representative runway configuration illustrated in AC 150/5060-5 equates to an estimated ASV of 200,000 operations per year. The resulting hourly capacity is 77 operations per hour under VFR conditions and 57 operations per hour under IFR conditions. As shown in Table C-2, the mix index is not forecast to surpass 50 during the planning period. Therefore, ASV for the Airport is estimated to be 200,000 operations per year throughout the planning period.

## C.3 Aircraft Delay

Annual aircraft delay, expressed in minutes per aircraft operation, is also an important measure of an airport's ability to accommodate projected aircraft operations. The relationship between the ratio of annual demand to ASV and the average annual aircraft delay is shown in **Table C-3**.

These relationships were derived from AC 150/5060-5, based on traffic records for a number of high-capacity airports in the United States and a range of assumptions on likely operating conditions. As shown in Table IV-5, when annual aircraft operations equal the ASV (ratio of 1.0), the average annual aircraft delay is 2.6 minutes per aircraft. The actual delay at any given time for an individual aircraft depends on several conditions that can vary the average delay by a factor of 5 to 10 times. For example, when an airport's demand/capacity reaches 1.0, any individual aircraft may not be delayed at all or could be delayed as much as 13 to 26 minutes, depending upon the time of day the operation occurs.

**Table C-3 Relationship Between Average Service Volume and Annual Aircraft Delay**

| RATIO OF ANNUAL DEMAND TO ANNUAL SERVICE VOLUME | ESTIMATED AVERAGE ANNUAL AIRCRAFT DELAY (MINUTES PER OPERATION) |
|---|---|
| 0.1 | - |
| 0.2 | 0.1 |
| 0.3 | 0.2 |
| 0.4 | 0.3 |
| 0.5 | 0.4 |
| 0.6 | 0.5 |
| 0.7 | 0.7 |
| 0.8 | 0.9 |
| 0.9 | 1.4 |
| 1.0 | 2.6 |

SOURCE: Ricondo & Associates, Inc., January 2011, based on Federal Aviation Administration Advisory Circular 150/5060-5, *Airport Capacity and Delay*.
PREPARED BY: Ricondo & Associates, Inc., November 2011.

The relationships between the ratio of annual demand to ASV and the average annual aircraft delays for the Airport over the planning period are shown in **Table C-4**.

**Table C-4 Annual Demand, Annual Service Volume, and Average Annual Aircraft Delay**

| YEAR | ANNUAL SERVICE VOLUME | ANNUAL DEMAND | RATIO OF DEMAND TO ASV | ESTIMATED AVERAGE DELAY (MINUTES PER OPERATION) | ESTIMATED TOTAL ANNUAL DELAY (HOURS) |
|---|---|---|---|---|---|
| **Historical** | | | | | |
| 2009 | 200,000 | 33,424 | 0.17 | - | - |
| **Forecast** | | | | | |
| 2014 | 200,000 | 40,478 | 0.20 | 0.1 | 67 |
| 2019 | 200,000 | 42,308 | 0.21 | 0.1 | 71 |
| 2024 | 200,000 | 44,372 | 0.22 | 0.1 | 74 |
| 2029 | 200,000 | 46,512 | 0.23 | 0.1 | 78 |

Note: ASV = annual service volume.

SOURCE: Ricondo & Associates, Inc., January 2011, based on Federal Aviation Administration Advisory Circular 150/5060-5, *Airport Capacity and Delay*.
PREPARED BY: Ricondo & Associates, Inc., November 2011.

# C.4 Demand/Capacity Summary

Typically, when an airport's annual operations total exceeds 60 percent of its airfield capacity (ASV), some aircraft delay occurs. Therefore, when the airfield is operating at 60 percent of capacity (120,000 operations), planning for new airfield facilities should be initiated. When airport activity reaches 80 percent of capacity (160,000 operations), new airfield facilities should be constructed or demand management strategies should be implemented. As shown on Table C-4, based on the aviation activity forecasts presented in Section 3, the Airport's annual demand is projected to reach approximately 23 percent of the Airport's ASV by the end of the planning period.

The results of the demand/capacity analysis indicate that the Airport has adequate capacity to efficiently accommodate projected demand throughout the planning period. As a result, no additional runway facilities will be required for purposes of increasing capacity during the planning period. However, if the number of annual operations or the fleet mix serving the Airport should change dramatically from the forecasts, capacity may need to be reassessed.