Chapter 4 – Airfield Demand/Capacity Analysis

INTRODUCTION

The purpose of this analysis is to examine the capability of Space Coast Regional (TIX) to meet the needs of its users. In doing so, this task provides an analysis of the ability for the existing airfield to satisfy the forecasted operational demands. This assessment will be expressed in terms of the hourly capacity and annual service volume of the airfield, along with the total estimated annual delay. The Facility Requirements – Chapter 5, provides specific recommendations intended to address any deficiencies identified in Airport facilities.

AIRFIELD CHARACTERISTICS

Methods for determining airport capacity and delay can be found in Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5060-5 Change 2, entitled "Airport Capacity and Delay." For this Master Plan Update, the FAA's methodology was used applying the elements listed below:

- Runway Configuration
- Aircraft Mix Index
- Taxiway Configuration
- Airfield Operational Characteristics
- Meteorological Conditions

When analyzed collectively, the above elements provide the basis for establishing the operational capacity of an airport. The following sections will evaluate each of these capacity related characteristics with respect to TIX.

Runway Configuration

The airfield configuration for TIX includes two paved runways. The primary runway, Runway 18-36, has a north to south orientation, while the secondary or crosswind runway, Runway 9-27, has an east to west alignment. The eastern end of Runway 9-27 intersects the approximate midpoint of Runway 18-36. This configuration helped the Air Traffic Control Tower (ATCT) staff gain approval to allow Land And Hold Short Operations (LAHSO) at TIX, thus providing for simultaneous operations to occur.

The characteristics of the area's prevailing winds require that both runways be maintained at TIX. Since aircraft takeoff and land into the wind, the FAA recommends that sufficient runways be provided to achieve 95 percent wind coverage. This is calculated by using a 10.5-knot crosswind component for the smaller and lighter aircraft, while 13-knot and 16-knot crosswind components are utilized for the larger, heavier, aircraft. FAA AC 150/5300-13, Change 8, "Airport Design" requires that weather for a period of at least ten years be used to determine the wind coverage of an airport. The Inventory, Chapter 2 of this study, evaluated the wind coverage for the Airport based on data collected between 1992 and 2001. This analysis showed that neither Runway 18-36 nor Runway 9-27 could independently provide 95 percent wind coverage in the 10.5-knot category. Therefore, both runways are required to provide the appropriate wind coverage for the smaller and lighter aircraft that predominately use the airfield.

Aircraft Mix Index

Knowing the operational fleet mix, it is possible to establish the mix index required to compute the airfield's capacity. The aircraft mix index is calculated based on the type or class of aircraft expected to serve an airfield. **Exhibit 4-1** provides examples of typical aircraft for each of the FAA's four capacity classifications. The formula for finding the mix index is %(C + 3D), where C is the percentage of aircraft over 12,500 pounds, but less than 300,000 pounds, and D is the percentage of aircraft over 300,000 pounds. Since there was no recorded historical operational mix data available for TIX, the operational fleet mix was generated from ATCT records and interviews with airport tenants. The result of this analysis was included in the Forecast chapter and reflects that a majority of the current operations at TIX is conducted by Category A and B aircraft including rotorcraft.

The Category C aircraft expected to operate at the Airport will consist of the business and corporate jet aircraft, as well as some of the larger jet aircraft within this classification, conducting charter or cargo type operations. It is assumed that all of the current and future jet aircraft in the operational fleet mix will be conducted by Category C aircraft. While the occasional Category D aircraft may operate at TIX, there are not enough now or expected later to impact the mix index calculation. Using the FAA formula, the aircraft mix index will simply increase to 13 by the year 2022 from the airport's current index of nine. As the mix index rises, the overall airfield capacity diminishes. However, due to the level of Category C aircraft, the decrease in the overall capacity at TIX will only be slight.

Taxiway Configuration

As mentioned in the Inventory – Chapter 2, there are six taxiways serving both Runway 18-36 and 9-27. Based on the FAA's criteria, the exit factor is maximized when a runway has four exit taxiways within a range determined by the operations using that runway. At TIX, this range is 2,000 feet to 4,000 feet from the landing threshold and each exit must be separated by at least 750 feet. Using this criterion, Runway 18-36 has four exits and Runway 9-27 one exit. Using the FAA methodology, the exit factor is maximized for the primary runway, but not for the crosswind runway.

Airfield Operational Characteristics

Significant operational characteristics that can affect an airfield's overall capacity include the percentage of aircraft arrivals, the sequencing of aircraft departures, and the percentage of touch-and-go operations.

Percentage of Aircraft Arrivals

The percentage of aircraft arrivals is the ratio of landing operations to the total operations of the airport. This percentage is considered due to the fact that aircraft approaching an airport for landing require more runway occupancy time than an aircraft departing the airfield. The FAA methodology used herein provides for computing airfield capacity with a 40, 50, or 60 percent of arrivals figure.

The 40 and 60 percent figures result in an average annual service volume variance of ±11 percent when compared to the 50 percent level, with the lower percentage (40) having the highest capacity. For general planning purposes, the 50 percent of arrivals value was utilized as an average or neutral effect to determine the overall capacity at TIX. It is not typical for most general aviation airports to have any regular periods where aircraft arrivals outweigh aircraft departures and vice versa. This tends to only be a trait of commercial service airports with regularly scheduled passenger service.

Insert Exhibit 4-1 (Aircraft Classifications)

Percentage of Touch-and-Go Operations

The percentage of touch-and-go operations plays a critical role in the determination of airport capacity. Touch-and-go operations are counted as one landing and one takeoff (i.e., two operations) and are normally associated with flight-training activities. Based on interviews with ATCT staff, airport management, and airport tenants, the level of touch-and-go operations at TIX is significant. Unfortunately, no official counts are made. Therefore, a set of assumptions has been made based on the input received during interviews. The first assumption was that jet aircraft did not conduct touch-and-go operations at TIX. Next, the numerous rotorcraft operations were excluded, for the most part, as they typically do not conduct their training activity to and from the active runway, but rather to pre-designated locations on the airfield depending on traffic flow. However, due to the potential for up to six independent flows (one to the active runway and five to various helispots on the airport) rotorcraft operations were given some consideration, as at times they can limit the percentage of fixed wing touch-and-go operations. The final assumption was related to the remaining single-engine and multi-engine activity, and it assumed that nearly all of the local operations were considered to be in the pattern, conducting touch-and-go type operations. As a result, it is estimated that the current touch-and-go operation represents approximately 38 percent of the annual operations. Using the same assumptions, touch-and-go's will represent approximately 36 percent by the end of the planning period. As such, the 31 to 40 percent range in the FAA capacity calculations was applied to all years when determining the touch-and-go factor for visual weather conditions (VFR) capacity. The percentage of touch-and-go operations is not a factor when calculating capacity under instrument meteorological conditions (IFR).

Meteorological Conditions

Meteorological conditions can adversely affect the decision as to which runway end is active at an airport. Thus, these conditions have an affect on the overall capacity for the airfield. Runway utilization is normally determined by wind conditions, while the cloud ceiling and visibility dictates spacing requirements. Using the information provided by ATCT staff and the breakdown of the area's wind characteristics from the Inventory – Chapter 2, the percent of use for each runway end was calculated. Based on these wind observations, Runway 18-36 is favored 60 percent of the time while Runway 9-27 is utilized 40 percent. **Table 4-1** provides the breakdown for each runway end.

TABLE 4-1
RUNWAY END UTILIZATION

Runway End	Runway Use	Runway End Utilization
18	60 % of total	30 %
36		70 %
9	40% of total	65 %
27		35 %

Source: Titusville Station, National Climatic Data Center, 1992-2001.

There are three measures of cloud ceiling and visibility conditions recognized by the FAA in calculating the capacity of an airport. These include:

- Visual Flight Rules (VFR) – Cloud ceiling is greater than 1,000 feet above ground level (AGL) and the visibility is at least three statute miles.

- Instrument Flight Rules (IFR) – Cloud ceiling is at least 500 feet AGL but less than 1,000 feet AGL and/or the visibility is at least one statute mile but less than three statute miles.

- Poor Visibility and Ceiling (PVC) – Cloud ceiling is less than 500 feet AGL and/or the visibility is less than one statute mile.

TIX experiences VFR conditions 95 percent of the time, IFR conditions 4.3 percent of the time, and PVC conditions 0.7 percent of the time. These percentages are based on data collected by the National Climatic Data Center from the Titusville Station between 1992 and 2001.

AIRFIELD CAPACITY ANALYSIS USING FAA METHODOLOGY

The preceding characteristics of the airfield's capacity were used in conjunction with the methodology developed by the FAA to determine airfield capacity. As mentioned previously, this FAA methodology generates three different values for measuring airfield capacity. These include the hourly capacity of runways, annual service volume, and annual aircraft delay.

Hourly Capacity of Runways

Hourly capacity of the runways measures the maximum number of aircraft operations that can be accommodated by the airport's runway configuration in one hour. Based on the FAA methodology, hourly capacity for runways is calculated by analyzing the appropriate VFR and IFR figures for the airport's runway configuration. From these figures, the aircraft mix index and percent of aircraft arrivals are utilized to calculate the hourly capacity base. The touch-and-go factor is also applied in combination with the aircraft mix index. The calculation considers the taxiway exit factor, which is determined by the aircraft mix index, percent of aircraft arrivals, and number of exit taxiways within the specified exit range.

For both VFR and IFR conditions, the hourly capacity for runways is calculated by multiplying the hourly capacity base, touch-and-go factor, and exit factor. This equation is:

$$\text{Hourly Capacity} = C^* \times T \times E$$

Where: C^* = hourly capacity base
T = touch-and-go factor
E = exit factor

An airport's mix index can substantially change the value of the hourly capacity base in the FAA capacity tables. Since the mix index only varies slightly over the course of the planning period, this resulted in very little change in the VFR hourly capacities for the Airport. For IFR calculations, the hourly capacity remains constant throughout the same period. A weighted hourly capacity for the airport is calculated by taking the VFR and IFR calculations and pro-rating them based on the percent that these conditions have been observed at the airport. These hourly capacity values were calculated and are summarized in **Table 4-2**.

TABLE 4-2 HOURLY CAPACITY OF RUNWAYS			
Year	VFR Operation/Hour	IFR Operation/Hour	Weighted Hourly Capacity (Cw)
Base Year			
2001	125	59	121
Forecast			
2007	123	59	119
2012	120	59	117
2022	118	59	115

Source: THE LPA GROUP INCORPORATED, 2003.

Annual Service Volume

The most important value that must be computed in order to understand the estimated capacity at an airport is the annual service volume (ASV). ASV represents a measure of the approximate number of total operations that the airport can support annually. In other words, the ASV represents the theoretical limit of operations that the airport can safely accommodate. Using the FAA's methodology to estimate ASV, first the ratio of annual operations to average daily operations, during the peak month, is calculated along with the ratio of average daily operations to average peak hour operations, during the peak month. These values are then multiplied together and the resulting product is multiplied by the weighted hourly capacity. This equation is:

Annual Service Volume = Cw x D x H

where: Cw = weighted hourly capacity
D = ratio of annual operations to average daily operations during the peak month
H = ratio of daily operations to average peak hour operations during the peak month

The calculated ASV accounts for differences in forecasted activity levels, runway use, aircraft mix, weather conditions, and other factors that occur over a single year. For TIX, the current and projected ASV will vary slightly over the planning period. This is partially due to the fact that two of three elements in the equation are similar. When the average day of the peak month and peak hour operations were calculated in the Aviation Activity Forecasts – Chapter 3, the same methodology was applied for each planning year. Thus, the ratios for D and H are the same. Therefore, the anticipated ASV for the Airport was only reduced slightly for the entire planning period due to the slight change in weighted hourly capacity. These results are reflected in **Table 4-3**.

Since ASV is the approximate measure of an airport's capability in terms of annual throughput capacity, a demand that exceeds the ASV will typically result in significant delays on the airfield. However, no matter how substantial an airport's capacity may appear, it should be realized that delays can occur even before an airport reaches its stated capacity. In fact, a number of projects that would increase the capacity at an airport are eligible for funding from the FAA. According to FAA Order 5090.3B, "Field Formulation of the National Plan of Integrated Airport Systems (NPIAS)," this eligibility is achieved once the airfield has reached 60 percent of its current capacity. This allows improvements to be made before demand levels exceed the capacity of the facility in order to avoid lengthy delays. Future capacity levels for the airport have been calculated based on the forecasted annual operations and the ASV for the Airport. These levels are depicted in **Table 4-3** and are shown graphically in **Exhibit 4-2**.

TABLE 4-3 AIRFIELD CAPACITY LEVELS			
Year	**Annual Operations**	**Annual Service Volume**	**Capacity Level**
Base Year			
2001	214,446	365,464	59%
Forecast			
2007	270,960	358,269	76%
2012	295,798	353,147	84%
2022	352,248	346,227	102%

Source: THE LPA GROUP INCORPORATED, 2003.

Table 4-3 and **Exhibit 4-2** both show that the current airfield capacity is considered sufficient to accommodate the aircraft operations forecasted for the first half of the planning period. However, as conditions change over the years, the capacity of the airfield will exceed the 60 percent ASV threshold during the short term, according to FAA guidance, triggers the need to plan for improvement projects to enhance the overall capacity of the airfield.

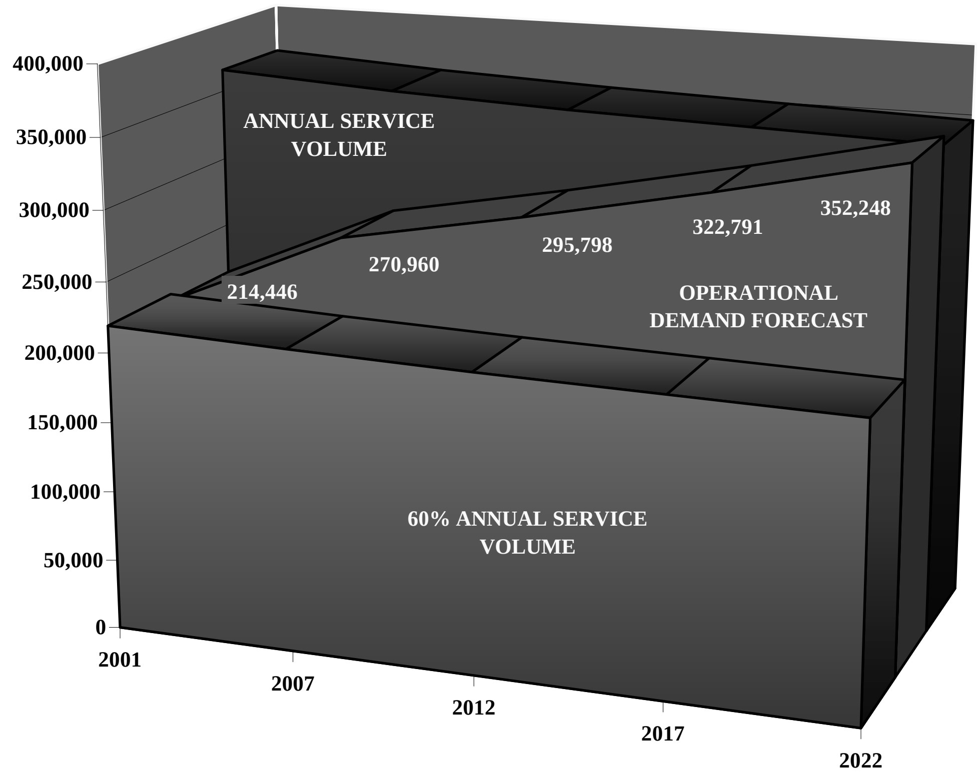
Annual Aircraft Delay

As an airport's level of annual operations increase, so do the times when the airfield experiences periods of delay. Annual aircraft delay allows a total to be estimated for all of the delay incurred by aircraft on the airfield during a given year. The estimate of annual delay includes arriving and departing aircraft operations under both VFR and IFR conditions. FAA AC 5060-5 Change 2, provides a method by which the annual delay can be quantified. Essentially the ratio of annual demand to ASV is utilized in FAA charts to determine the average delay per aircraft. This value is then applied back to the annual operations to estimate the total amount of annual aircraft delay. The results of these calculations are included in **Table 4-4**.

TABLE 4-4 ANNUAL AIRCRAFT DELAY				
Year	**Average Delay per Aircraft (minutes)**		**Total Annual Operational Delay (hours)**	
	Low	**High**	**Low**	**High**
Base Year				
2001	0.2	0.7	733	2,567
Forecast				
2007	0.4	1.2	1,800	5,417
2012	0.5	1.7	1,817	6,183
2022	1.2	4.0	4,700	15,667

Source: THE LPA GROUP INCORPORATED, 2003.

EXHIBIT 4-2
AIRFIELD VS. CAPACITY



ADJUSTED AIRFIELD CAPACITY

In the previous sections, the FAA methodology for assessing airfield capacity was conducted. Unfortunately, the results reflected in **Tables 4-3** and **4-4** are not considered representative of the actual conditions at TIX. This is due to the fact that total annual operations used in the previous sections included the heavy rotorcraft activity. At TIX, rotorcraft activity accounts for approximately 31 percent of the current annual operations. This percentage is forecasted to increase to 37 percent of the total operations by 2022. Since nearly all of the rotorcraft operations at TIX are training related, the airport has designated different locations for rotorcraft operations to avoid interfering with fixed wing runway operations. In essence, this allows the airport to conduct many simultaneous operations, as if the airport had a parallel runway configuration. Since the FAA methodology does not provide a method to model this situation, the runway capacity analysis has been reevaluated by removing rotorcraft operations from the calculations, which is represented in the following sections.

Adjusted Annual Service Volume

Future capacity levels for the airport have been calculated by subtracting the rotorcraft operations from the total operations. Then, the ASV values from the previous sections were applied to define the adjusted runway capacity and aircraft delay figures for TIX. These levels are depicted in **Table 4-5** and are shown graphically in **Exhibit 4-3**.

Based on the adjusted airfield capacity analysis, the current airfield system will accommodate all of the aircraft operations forecasted through 2022. As shown, the airfield will reach the 60 percent capacity threshold towards the second half of the planning period. Therefore, based on the adjustments, the airport will not need to explore plans to enhance the capacity of the airfield until sometime during the later stage of the long-term planning period.

TABLE 4-5
ADJUSTED AIRFIELD CAPACITY LEVELS

Year	Adjusted Annual Operations	Annual Service Volume	Capacity Level
Base Year			
2001	137,245	365,464	38%
Forecast			
2007	170,705	358,464	48%
2012	192,269	353,147	54%
2022	243,051	346,227	70%

Source: THE LPA GROUP INCORPORATED, 2003.

Adjusted Annual Aircraft Delay

Table 4-6 summarizes the annual aircraft delay based on the adjusted annual operations and ASV for TIX.

TABLE 4-6
ANNUAL AIRCRAFT DELAY

Year	Average Delay per Aircraft (minutes)		Total Annual Operation Delay (hours)	
	Low	High	Low	High
Base Year				
2001	0.1	0.3	450	1,350
Forecast				
2007	0.2	0.5	567	1,433
2012	0.2	0.6	633	1,917
2022	0.3	1.0	1,350	4,517

Source: THE LPA GROUP INCORPORATED, 2003.

CONCLUSION

Table 4-5 and **Exhibit 4-3** both show that TIX should not experience any significant capacity related problems during the planning period. Essentially this analysis indicates that no immediate improvements are required to be made to the airfield based on capacity alone. However, as conditions change over the years, and certainly once the actual capacity of the airfield exceeds 60 percent of the ASV, improvement projects will need to be planned to enhance the overall capacity. Finally, while difficult to quantify, the analysis did reveal that some improvements can be made to enhance the capacity, but more importantly the safety of operations at TIX. These include the exit factor for the crosswind runway and the helispots used for rotorcraft operations. Additional exits off of Runway 9-27 would enhance the flow and allow less runway occupancy time, while additional helispots have the potential to improve traffic flows during peak times. Both of these issues will be addressed in the Facility Requirements – Chapter 5 that follows.

EXHIBIT 4-3
AIRFIELD DEMAND VS. CAPACITY