La Crosse Regional
AIRPORT

Appendix G: Airfield Capacity Analysis

A. Runway Capacity Factors

There are several factors that can affect hourly airfield capacity. These factors are described in the following sections:

- Ceiling and Visibility
- Runway Use Configuration
- Aircraft Mix Index
- Percent Arrivals
- Percent Touch-and-Go Operations
- Exit Taxiway Locations

1. Ceiling and Visibility

Adverse weather conditions can impact an airport's capacity by forcing additional distance between aircraft on arrival. Aircraft operate under two primary weather categories: Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). VFR conditions exist when the cloud ceiling is 1,000 feet or greater above ground level (AGL) and visibility is at least three statute miles. IFR weather conditions prevail when the cloud ceiling is 500 feet AGL, or greater, but less than 1,000 feet and visibility is less than three statute miles. In general, any weather conditions below VFR minimums are considered IFR weather conditions. The ability of aircraft to operate during IFR conditions is often solely dependent on the lowest available instrument approach minimums at the airport. The lowest minimums at LSE are a 200-foot cloud ceiling and 1/2-mile visibility that correspond to the Instrument Landing System (ILS) and Localizer (LOC) approaches to Runway 18. During VFR and IFR conditions, the required separation distances between aircraft vary. In general, greater separation is required under IFR than VFR.

LSE has an Automated Surface Observing System (ASOS) located on the field. The ASOS observed the following for VFR and IFR conditions from 2008 to 2017:

- 83.7 percent of reported weather conditions were VFR.
- 16.3 percent of reported weather conditions were IFR.

2. Runway Use Configuration

Runway use configuration refers to the number, location, and orientation of the active runways. It also refers to the type and direction of operations as well as the flight rules in effect at any given time. AC 150/5060-5 includes a variety of diagrams for various runway use configurations. When considering a runway use configuration, the AC advises selecting one that best represents airport use during the specified hour. LSE has three intersecting runways. **Table 1** below shows each distance between each runway's landing threshold and the first runway intersection encountered on landing, rounded to the nearest 10 feet.

Table 1: LSE Runway Intersection Distances		
Runway	**Intersecting Runway**	**Distance (feet)**
Runway 18	Runway 13/31	4,430
Runway 22	Runway 13/31	2,170
Runway 31	Runway 04/22	1,060
Runway 36	Runway 13/31	3,180
Runway 04	Runway 18/36	450
Runway 13	Runway 18/36	2,070

Based on this layout, the appropriate runway use configuration diagram from the AC is Runway Use Configuration Number 44. While this diagram only shows two intersecting runways, it best represents the runway use configuration at LSE since Runway 04/22 is closed during the winter months; therefore, most operations occur on Runway 18/36 and Runway 13/31. This chapter specifically focuses on analyzing Runway 18/36 and Runway 13/31 separate from Runway 04/22 to determine if Runway 04/22 affects airfield capacity at LSE positively or negatively, and whether Runway 04/22 is a necessary facility.

3. Aircraft Mix Index

The aircraft mix index is based on the percentage of operations conducted by four different categories of aircraft (A, B, C, and D). Aircraft class definitions used to calculate the mix index are based on a combination of maximum certified takeoff weight, number of engines, and wake turbulence classification. The mix index can significantly impact airfield capacity. Depending on the approach speeds as well as the aircraft weights, airfield capacity can increase or decrease based on the mix index.

Aircraft create wake vortices in which air turbulence trails behind aircraft as a result of their movement through the air. The heavier the aircraft, the more significant the wake vortices are. Wake vortices are more prevalent during arrival; however, they are hazardous during any operation. To mitigate the hazards of wake vortices, aircraft are spaced according to differences in approach airspeed as well as weight. In general, aircraft departures are spaced two minutes apart for large aircraft wake vortices and at least three minutes for super aircraft (AC 90-23G, *Aircraft Wake Turbulence)*. Large aircraft are those that weigh more than 41,000 pounds maximum takeoff weight up to, but not including, 300,000 pounds. This final aircraft category identifies aircraft that are above the large category (300,000 pounds or greater), such as the Airbus A380 and the Antonov AN225. Separation between aircraft to account for wake turbulence creates delay which affects airfield capacity.

To better understand the effect aircraft mix has on runway configuration and capacity, FAA AC 150/5060-5 uses different aircraft classifications than FAA AC 150/5300-13A, *Airport Design.* When referring to the aircraft mix index categories, the categories laid out in **Table 2** coincide with the criteria used in AC 150/5060-5.

Table 2: Aircraft Mix Index Categories			
Class	**Maximum Takeoff Weight (pounds)**	**Aircraft Type**	**Wake Turbulence Factor**
A	12,500 or less	Small Single-Engine	Small
B	12,500 or less	Small Multi-Engine	Small
C	12,500 - 300,000	Large	Large
D	300,000 or more	Heavy	Heavy

Source: FAA Advisory Circular 150/5060-5, Airport Capacity and Delay

The aircraft fleet mix for LSE was determined based on FAA operations data from the Traffic Flow Management System Counts (TFMSC) database for the year 2017. TFMSC collects information for aircraft flying under Instrument Flight Rules (IFR) flight plans and captured by FAA enroute computers. Although LSE has an Air Traffic Control Tower (ATCT) on the field, it does not record aircraft type and weight which is why TFMSC data was used. Baseline 2017 operations data from Chapter 2 is used in the airfield capacity calculations.

AC 150/5060-5 defines the aircraft mix index as the percent of Class C aircraft plus 3 times the percent of Class D aircraft, or %(C+3D). There are no Class D aircraft expected at LSE during the 20-year planning period and therefore they will not affect the aircraft mix index. A review of the TFMSC database for 2017 operations shows 6,396 operations by Class C aircraft and no D aircraft. As the total number of operations for 2017 is 18,034 this means that the mix index is 35 percent. For the purposes of this analysis, the aircraft mix index is expected to remain consistent in both VFR and IFR conditions throughout the next 20 years.

4. Percent Arrivals

Percent arrivals is the ratio of arrivals to total operations. In general, aircraft on final approach are given priority over departures, which increases percentage of arrivals during peak periods, thus reducing the ASV. Percent arrivals are computed as follows:

$$Percent\ Arrivals = \frac{A + 0.5(T)}{A + D + T}\ x\ 100$$

A = Number of arriving aircraft in the hour
D = Number of departing aircraft in the hour
T = Number of touch-and-go operations in the hour

In Chapter 2, the peak aircraft operations analysis found there were 58 operations during the peak month average day at LSE in 2017. The TFMSC database does not track touch-and-go operations. The percent arrivals calculation assumes a conservative touch-and-go percentage of 10 percent. For these 58 operations, it is estimated that 26 were arriving aircraft, 26 departing aircraft and 6 aircraft were conducting touch and go operations. Arriving and departing aircraft were determined based on the assumption that for every arriving aircraft, there was also a departing aircraft. Based on the formula above as well as touch-and-go estimates, the percent arrivals during the peak hour is 50 percent.

5. Percent Touch-and-Go Operations

To maintain license currency under FAA regulations, pilots are required to conduct touch-and-go operations. Percent touch-and-go operations include operations by aircraft that land on and take off from the runway without stopping or exiting. This type of operation generally occurs during flight training. Some flight instruction occurs on the field at the local Fixed Base Operator (FBO) in addition to operations that can be expected from local based aircraft for currency. As the TFMSC database does not track this specific type of operation, the percentage of touch-and-go operations was estimated at 10 percent.

6. Exit Taxiway Locations

In some cases, exit taxiway locations can limit capacity if they do not provide adequate access to the parallel taxiway for arriving aircraft. **Table 3** lists the taxiway intersection distances from each runway end that were used for the peak hour airfield capacity analysis. Intersection distances listed in the table are rounded down to the nearest 50 feet. This mirrors air traffic procedures to provide a safety margin when pilots query intersection distances from air traffic control.

Table 3: Runway Exit Intersection Distances from Runway End

Runway 18/36	**Taxiway Intersection Distance from Runway End (feet)**					
	C	**C5**	**B**	**C4**	**C3**	**C2**
18	0	1,600	5,150	6,200	6,800	7,700
36	8,650	7,100	3,550	2,500	1,900	1,000
Runway 13/31	**B2**	**C**	**A**	**B1**		
13	750	1,500	4,750	6,000		
31	5,250	4,550	1,250	0		
Runway 04/22	**A2**	**A3**	**B**	**A4**		
4	950	1,950	2,500	5,150		
22	4,200	3,200	2,650	0		

Source: Mead & Hunt, Inc.

7. Peak Hour Airfield Capacity

Peak hour airfield capacity is calculated using the guidelines in AC 150/5060-5 under both VFR and IFR conditions. It is calculated as follows:

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

C = Hourly capacity base*
T = Touch-and-go factor
E = Exit factor

The hourly capacity base (C*) is based on performance curves developed for the specific runway use configuration. As shown in **Figure 1** and **Figure 2** below, C* is calculated by identifying aircraft mix index and percent arrivals, which are 35 percent and 50 percent respectively. Using these inputs, C* is 99 operations per hour in VFR conditions and 57 operations per hour in IFR conditions.

Figure 1: VFR Hourly Capacity Base

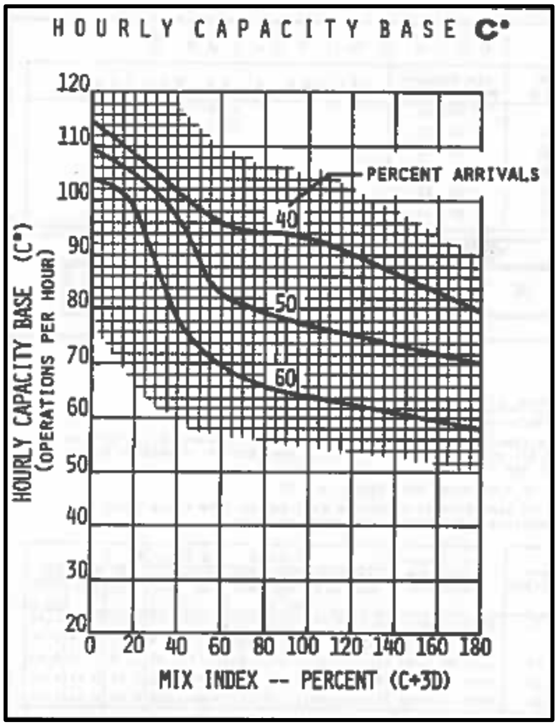
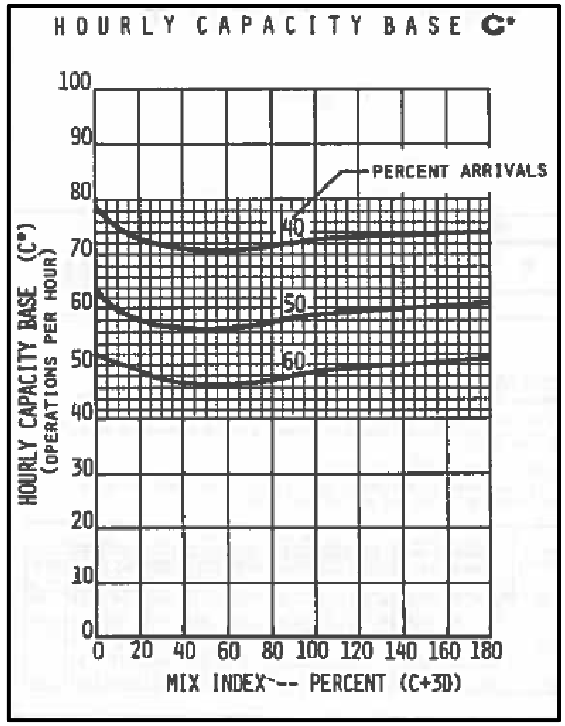


Figure 2: IFR Hourly Capacity Base



Source: AC 150/5060-5, Airport Capacity and Delay, Figure 3-27 and Figure 3-59

The touch-and-go factor (T) is determined based on the aircraft mix index and percent touch-and-go, which is 35 percent and 10 percent, respectively. A table in the AC specific to the runway use configuration identifies T based on pairing these two factors. At LSE with the current runway use configuration, T equals 1.03 in VFR and 1.00 in IFR conditions.

The exit factor (E) is determined by several factors including aircraft mix index, percent arrivals, and the average number of exits located in the appropriate exit range separated by at least 750 feet. As indicated by taxiway the intersection distances in **Table 3,** the average number of exits (N) for Runway 18/36, Runway 13/31, and Runway 04/22 is 4.67. Based on these numbers, E is 1.03 for VFR and 1.00 for IFR conditions.

Lastly, using the hourly capacity bases (C*), touch-and-go factors (T), and exit factors (E) described above, the hourly capacities of the airport at LSE are as follows:

$$VFR\ Hourly\ Capacity = C^*\ x\ T\ x\ E = 99\ x\ 1.03\ x\ 1.00 = 102.0\ operations$$

$$IFR\ Hourly\ Capacity = C^*\ x\ T\ x\ E = 57\ x\ 1.00\ x\ 1.00 = 57.0\ operations$$

i. Annual Service Volume Calculation

When calculating the Annual Service Volume (ASV), three variables are considered: weighted hourly capacity (C_w), the ratio of annual demand to average daily demand during the peak month (D), and the ratio of average daily demand to average peak hour demand during the peak month (H).

Using the weighted hourly capacity formula found in AC 150/5060-5, the weighted hourly capacity (C_W) of the airfield at LSE is 97.7 operations.

The Daily Demand Ratio (D) is the ratio of annual demand to average daily demand during the peak month. Using 2017 operational levels identified in Chapter 2, this ratio is calculated as follows:

$$D = Annual\ Demand/Peak\ Month\ Average\ Daily\ Demand$$

$$D = 18{,}034/64.2$$

$$D = 280.90$$

The Hourly Demand Ratio (H) is the ratio of the average daily demand to average peak hour demand during the peak month. This ratio is calculated using 2017 operational levels as shown below:

$$H = Peak\ Month\ Average\ Daily\ Demand/Peak\ Hour\ Demand$$

$$H = 64.2/11.7$$

$$H = 5.49$$

Lastly, the Annual Service Volume (ASV) is calculated below and rounded to the nearest whole number:

$$ASV = C_W\ x\ D\ x\ H$$

$$ASV = 97.7\ x\ 280.90\ x\ 5.49$$

$$ASV = 150{,}651\ operations$$

Overall, the AC does not provide guidance for estimating change in ASV over time. Therefore, a typical airfield capacity analysis stays fixed at a given number (such as 150,651 operations) throughout the planning period, instead of flexing with operational demand. Aircraft operations forecasts are then compared to a static ASV to determine if and when the LSE will need additional airfield capacity, as shown in **Table 4**.

Table 4: Forecasted Operations as a Percentage of ASV

Year	Forecasted Annual Operations	% of ASV
2017	18,034	12.0%
2022	18,634	12.4%
2027	18,894	12.5%
2032	19,164	12.7%
2037	19,440	12.9%

Source: Mead & Hunt, Inc.

ii. Conclusion

Current guidelines from the FAA National Plan of Integrated Airport Systems (NPIAS) direct airport sponsors to consider airfield capacity improvements when activity reaches 60 percent to 75 percent of the airport's ASV. This guidance is conservative in nature and allows adequate lead time for environmental reviews, land purchases, and other necessary actions that can take up to 10 or more years to complete and could theoretically place activity at 80 percent of the ASV by the time improvements are implemented.

As shown in **Table 4**, the preferred forecasts presented in Chapter 2 result in 12.9 percent of ASV being reached by the end of the planning period. Therefore, no airfield capacity improvements are expected to be needed during the 20-year planning period.

As the planning period extends out, recommended actions and level of certainty tend to decrease. In general, facility requirements that are forecasted to occur within one to five years should result in immediate action. For facility requirements forecasted between five and ten years in the future, such improvements should be seriously considered and integrated with initial designs. Finally, for requirements forecasted between 10 and 20 years in the future, there should be an integration of needs into the general planning framework. Planning beyond 20 years makes valid conclusions difficult when considering capacity-related needs.

The airfield is expected to provide adequate capacity because aircraft operations are not forecasted to reach 60 percent of ASV by the end of the planning period. Therefore, planning for additional airfield capacity is not necessary. Furthermore, the results of this analysis indicate that Runway 04/22 is not a necessary runway from an airfield capacity standpoint.