D.3 RUNWAY LENGTH ANALYSIS

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APPENDIX D.3
AIRFIELD GEOMETRIC REQUIREMENTS

This information provided in this appendix outlines the airfield geometric requirements for the proposed airfield development at FLL. In addition to runway length and width requirements, it also identifies the taxiway width and centerline separations necessary to accommodate the FLL projected aircraft fleet mix through 2020. These requirements serve as the basis for the development of runway alternatives formulated for screening and evaluation in this Draft EIS analysis.

D.3.1 OVERVIEW

To evaluate a specific airfield configuration, the overall configuration and usable length of the available runways and associated taxiways must be considered. Without adequate runway length, width, and taxiway infrastructure configured to serve the anticipated aircraft fleet mix, the capacity of the overall airfield may be compromised. Therefore, for the intention of developing the purpose and need, it is prudent to establish the airfield design standards that would be necessary to accommodate the current and projected aircraft fleet mix at the Fort Lauderdale-Hollywood International Airport (FLL).

The ability to operate a particular aircraft on a runway can be limited by either the available departure/landing distance of the runway, or its overall width. The ability to accommodate an aircraft on a runway is also predicated on the configurations of the taxiways that serve it. This assessment evaluates the current and projected aircraft fleet mix at FLL to establish the runway length and width characteristics necessary to satisfy the purpose and need for the sponsor's proposed project. It also establishes the taxiway geometry requirements for consideration during the development and evaluation of airfield development alternatives. This includes establishing recommended taxiway width and lateral separation from the runway(s) that they serve.

The results of this analysis are intended to serve as a benchmark for developing and evaluating the airfield development alternatives considered during the EIS. The runway lengths prescribed herein are established in accordance to the take-off and landing runway length requirements for the most demanding aircraft types contained in the fleet mix projected for 2012. Consistent with FAA airfield design standards, the runway width and taxiway geometry requirements are predicated on the Airplane Design Group (ADG), which is based on aircraft wingspan.

D.3.2 CURRENT AIRFIELD OPERATIONAL CONSTRAINTS

The affects of runway length/width is of particular concern at airports comprised of multiple runways with variable operational lengths and widths, such as FLL. Inadequate runway length/width provided by shorter/narrower secondary runway(s) may require more demanding aircraft types to utilize the longer/wider primary runway(s) at the Airport. This induces demand on the primary runway(s) that can create an unbalanced distribution of demand among the various runways.

As a result, the smaller runways become underutilized, thereby compromising the overall throughput capacity of the airfield. In addition, increased demand imposed on the primary runway during peak periods can accelerate the occurrence and increase the duration of aircraft operational delays.

The current airfield configuration at FLL produces considerable variances among available runway length. Runway 9L-27R is currently the longest runway with an overall length of 9,000 feet; making it the primary runway for most air carrier aircraft operations. In comparison, Runways 13-31 and 9R-27L currently have an overall length of 6,928 feet and 5,276 feet, respectively. Therefore, an aircraft that requires a runway length that exceeds the available length for these two runways would be required to operate from Runway 9L-27R. As a result, the overall capacity of FLL is currently constrained by the limited lengths of these two secondary runways.

In addition to the variable runway lengths at FLL, Runway 9R-27L currently has an overall width of 100 feet, thereby restricting its use to aircraft with a wingspan up to, but not including 118 feet (see ADG description under Runway Width section). This precludes many air carrier aircraft types, such as the new generation B737s, B757, B767, and Airbus A320 aircraft from utilizing Runway 9R-27L. In comparison, both Runways 9L-27R and 13-31 at FLL have a width of 150 feet, which is adequate to serve air carrier and general aviation aircraft that currently operate at FLL.

The overall width and lateral separation of the two parallel Taxiways G and H that currently serve Runway 9R-27L further restrict utilization of this runway. These two taxiways currently have a width of 50 feet and a lateral separation of 250 feet from the runway. Both of these dimensions are adequate to serve ADG II aircraft (wingspan up to, but not including 79 feet) only. This restriction precludes most air carrier and more demanding general aviation jets from utilizing Runway 9R-27L. In comparison, Runways 9L-27R and 13-31 currently comply with the standard taxiway width and lateral separation from the runway of 75 feet and 400 feet, respectively. This geometry allows most air carrier and general aviation jet aircraft to utilize these two runways.

D.3.3 RUNWAY WIDTH REQUIREMENTS

For the purposes of establishing airfield design standards, the FAA classifies aircraft by wingspan. There are six aircraft wingspan classifications, which are referred to as Airplane Design Groups (ADG) I through VI. The design aircraft for the future fleet mix at FLL is the B767-400. With an overall wingspan of 170.3 feet, this aircraft is classified within ADG IV, which includes aircraft with a wingspan of up to, but not including 171 feet. The minimum runway width for ADG IV aircraft is 150 feet, and therefore, is established as the preferential runway width for all runway development alternatives considered under the EIS. It is also noted that this runway width is adequate to accommodate ADG V aircraft which includes the larger B747 and A340 aircraft types.

D.3.4 RUNWAY LENGTH REQUIREMENTS

The runway length requirements for aircraft departures typically exceed the requirements for aircraft landings. Therefore, the ability to operate a particular aircraft type at an airport is typically limited by the available departure length of its runways. However, some runways have a displaced landing threshold to mitigate obstructions or comply with runway safety area, object free area, or runway protection zone criteria. By displacing the runway threshold, the available landing distance on the runway is reduced accordingly. Therefore, it is prudent to evaluate both landing and departure distances to assess the preferential runway length requirements.

This analysis considers both departure and landing length requirements since a proposed runway alternative could result in differing operational lengths. When calculating the runway length requirement for a secondary runway, it is also important to note that the role of the runway is to help alleviate congestion from the primary runway, and as such, is not required to support the entire fleet that is projected to use the airport. On that basis, this analysis identifies a runway length requirement that would accommodate at least 80 percent of the aircraft fleet as projected in the primary and derivative forecasts that were developed earlier in the EIS process.

The runway length requirements presented herein are defined in accordance with the Aircraft Characteristics for Airport Planning Manuals distributed by the corresponding aircraft manufacturers. These manuals provide consideration for most factors that influence the runway length required for aircraft operations. Other sources, such as FAA advisory circulars, were utilized for those factors not covered by the manuals. The planning factors that went into the runway length determination include, but not limited to:

- **Aircraft Type:** The runway length analysis is predicated on the aircraft fleet mix identified in the design day flight schedules that resulted from the derivative forecast. It provides consideration for the runway length requirements for the most demanding aircraft types that are anticipated to operate during peak periods at FLL. These aircraft types represent over 40 percent of the overall aircraft fleet contained in the 2012 design day flight schedule. The runway length requirements for the remaining 60 percent is much less demanding and therefore, could be accommodated by the resulting runway length requirements prescribed herein.
- **Aircraft Weight:** Aircraft weight is the single most important factor when conducting a runway length analysis. As the weight of a particular model of aircraft increases, so does the runway length requirement for a given condition. For each aircraft type, the weight of an aircraft can vary considerably depending on payload (passengers, baggage, and cargo) and the amount of fuel on board to fly a defined stage length.
- **Engine Model:** JP Airline-Fleets International provides current information pertaining to aircraft equipment and engine types for each airline. The most demanding engine types, in terms of runway length requirements, of the airlines that operate at FLL are considered.

- **Runway Gradient:** The Aircraft Characteristics for Airport Planning Manuals distributed by the various aircraft manufacturers provide runway requirements that are predicated upon a runway with no change in runway elevation (effective gradient of 0.0 percent). These manuals do not provide the ability to adjust runway length requirements based on runway with an effective gradient. However, the FAA does provide an adjustment for runway grade in Advisory Circular (AC) 150/5325-4A, Runway Length Requirements for Airport Design. This AC states that the runway length requirements are to be increased at a rate of ten feet for each foot of elevation difference between the high and low points of the runway centerline.
- **Weather (temperature, prevailing winds, etc.):** This assessment provides consideration for performance characteristics that are typical of the most demanding weather conditions that typically occur at FLL. The runway length requirements contained herein reflect the aircraft performance characteristics during the manufacturer defined "hot day" (86°F – 91°F), and zero wind conditions. Due to the potential for strong upper level headwinds associated with the jet stream during the peak month, aircraft range capabilities to destinations to the west may be reduced. On that basis, a 25% reduction in aircraft range capability is assumed for these markets.
- **Flap Settings:** Most aircraft provide a variety of flap settings that affect runway length requirements. The optimal aircraft flap settings for landing and take-off performance were utilized during the analyses.
- **Airport Elevation:** Aircraft performance is also affected by the elevation of the airfield. Since the airfield elevation at FLL is seven feet above Mean Sea Level (MSL), the runway length requirements are reflective of the aircraft performance characteristics at sea level.
- **Runway Surface Conditions:** AC 150/5325-4B, *Runway Length Requirements for Airport Design*, addresses the implications of wet, slippery pavement conditions. In accordance with this document, the landing runway length requirements are to be increased to provide considerations for wet pavement conditions while assessing turbojet powered aircraft. When data pertaining to landing distances on wet runways is unavailable, a net increase of 15 percent is recommended. Take-off runway length requirements prescribed by the aircraft manufacturers do not require adjustments to account for wet pavement conditions.
- **Aircraft Fleet Mix:** Due to the variety of aircraft performance characteristics, the establishment of a preferred runway length does not require the evaluation of every aircraft type. Only the most demanding aircraft types, in terms of runway length and width need to be evaluated. For the purposes of this analysis, the aircraft fleet mix contained in the design day flight schedule for 2012 was sorted to identify a representative list of aircraft types for evaluation. Aircraft performance characteristics and operational frequency were the primary factors considered to determine the most demanding aircraft types.

These factors will be utilized during the take-off and landing runway length requirement analysis presented in the following sections.

D.3.4-1 Take-Off Runway Length

AC 150/5325-4B states, "For federally funded projects, the airport designer must take into account the length of haul (range) that is flown by airplanes on a substantial use basis."[1] This is predicated on the fact that aircraft takeoff weights are influenced by the amount of fuel payload that are required to travel to the destination, including minimum fuel reserves prescribed by the FAA. Therefore, the determination of runway length requirements necessary to serve aircraft departures must consider the non-stop markets that are projected to be served by the Airport. To facilitate this analysis, the design day schedules contained in the derivative forecasts for FLL serve the basis for establishing the minimum runway length requirements.

It should be noted that the aircraft fleet mix and air service markets contained in the design day schedules are speculative, thereby possessing a level of uncertainty. The dynamic airline industry, socioeconomic and demographic patterns, and technological advances are a few examples of the factors that contribute to these uncertainties. Therefore, it is prudent to conduct additional analyses to determine the operational implications of serving long range markets and/or serving existing markets with more demanding aircraft. This serves to identify a maximum runway length requirement that would ensure the greatest ability to accommodate aircraft departures.

In order to comply with the criteria prescribed by FAA and enhance the Airport's ability to serve the aviation industry, two methodologies were conducted to determine the proper runway length requirement to meet the operational needs of the aircraft that are projected to operate in 2012, and include:

- **Derivative Stage Length Analysis (DSLA):** This analysis serves to identify the departure runway length necessary to accommodate 80 percent of aircraft departures during the peak hour. These values are indicative of the takeoff weights associated with the fuel payloads that are necessary to reach the destinations contained in the design day schedules for 2012. The runway length identified under this approach is considered the minimum runway length to be considered for identifying airfield development alternatives.
- **90/90 Rule:** This approach serves to identify the maximum runway length to be considered during the identification and evaluation of airfield development alternatives. It serves to evaluate the entire aircraft fleet during peak demand periods to ensure the ability to serve FLL's potential long-range markets with the aircraft fleet mix projected under the derivative forecasts. The take-off runway length requirements prescribed herein are

[1] FAA Advisory Circular 150/5325-4B, *Runway Length Requirements for Airport Design*, July 1, 2005.

predicated on the ability to accommodate 90 percent of aircraft departures from FLL at 90 percent of the aircraft's usable payload, regardless of destination.

The identification of airfield development alternatives will consider the ability to exceed the minimum runway length prescribed by the DSLA methodology in an attempt to achieve the maximum runway length identified with the aforementioned 90/90 rule. These two methodologies are detailed in the following sections.

Derivative Stage Length Analysis (DSLA)

The DSLA methodology utilizes the peak periods of the design day schedule, a derivative forecast presented in the forecast section of this report. This methodology suggests that a secondary runway should be capable of supporting 80 percent of the aircraft departures during peak demand periods. The methodology was conducted in the following steps:

1) Using the 2012 design day schedule, identify the departure aircraft and their destinations that are forecast to operate during peak demand periods.
2) Based on the following assumptions, calculate the departure runway length requirement for each aircraft identified in the previous step:
   a) Each aircraft will depart with a passenger load factor of 100 percent
   b) With regards to aircraft weight, an average per passenger weight of 225 pounds to include baggage and cargo was utilized during the analysis (per aircraft manufacturer recommendations)
   c) Fuel requirements to coincide with stage lengths identified in the 2012 design day schedule
   d) Fuel reserves as per FAA regulations
3) Determine operational length to support 80 percent of the airport's fleet.

Using the manufacturer supplied aircraft performance manuals, and the assumptions stated above, the percent of time a design runway length would support the projected peak hour design day schedule was calculated (see **Table D.4-1).** As shown, it was determined that at 6,000 feet of runway length, approximately 80 percent, respectively, of all 2012 design day peak hour fleet are capable of operating. Once the runway length falls below 6,000 feet, the requirement of supporting 80 percent of the peak hour fleet is not met. Therefore, utilizing the derivative stage length analysis method, the runway length requirement for a secondary runway at FLL is 6,000 feet.

The 90/90 Rule

The 90/90 rule prescribes a runway length capable of supporting 90 percent of the airport's aircraft departures at 90 percent of the aircraft's stated maximum payload (fuel, passengers, cargo and baggage) for the design year. Another way of stating

this methodology is that a secondary runway is not required to support the most demanding 10 percent of the projected aircraft fleet while operating at 90 percent payload. The following assumptions were utilized during this approach:

- Aircraft payload was set at 90 percent of maximum per each aircraft model
- Standard FAA fuel reserves

Utilizing the forecasts presented earlier, it was determined that the following aircraft represent the most demanding aircraft that are projected to utilize the airfield in 2012.

- Airbus 319 (A319-100)
- Airbus 320 (A320-200)
- Airbus 321 (A321-200)
- Boeing 737-200 (B737-200)
- Boeing 737-300 (B737-300)
- Boeing 737-400 (B737-400)
- Boeing 737-500 (B737-500)
- Boeing 737-700 (B737-700)
- Boeing 737-900 (B737-900)
- Boeing 767-300 (B767-300)

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Table D.4-1
Runway Length Requirements - Peak Hour Aircraft (Derived from 2012 Schedule)

			Share of Peak Hour Fleet Accommodated at Specified Runway Length								
	2012 Operations		7,000 Feet			6,500 Feet			6,000 Feet		
Aircraft	Scheduled	Fleet Mix Percentage	Number of Aircraft	Model Percentage	Fleet Mix Percentage	Number of Aircraft	Model Percentage	Fleet Mix Percentage	Number of Aircraft	Model Percentage	Fleet Mix Percentage
A319-100	7	7.9%	6	85.7%	6.7%	6	85.7%	6.7%	5	71.4%	5.6%
A320-200	9	10.1%	9	100.0%	10.1%	9	100.0%	10.1%	5	55.6%	5.6%
A321-200	2	2.2%	1	50.0%	1.1%	1	50.0%	1.1%	0	0.0%	0.0%
B717-200	1	1.1%	1	100.0%	1.1%	1	100.0%	1.1%	1	100.0%	1.1%
B737-300	1	1.1%	1	100.0%	1.1%	1	100.0%	1.1%	1	100.0%	1.1%
B737-800	4	4.5%	4	100.0%	4.5%	4	100.0%	4.5%	0	0.0%	0.0%
B757-200	8	9.0%	8	100.0%	9.0%	8	100.0%	9.0%	8	100.0%	9.0%
B767-300	4	4.5%	4	100.0%	4.5%	4	100.0%	4.5%	1	25.0%	1.1%
B737-700	4	4.5%	4	100.0%	4.5%	4	100.0%	4.5%	4	100.0%	4.5%
ATR72-212	1	1.1%	1	100.0%	1.1%	1	100.0%	1.1%	1	100.0%	1.1%
ERJ-170LR	2	2.2%	2	100.0%	2.2%	2	100.0%	2.2%	2	100.0%	2.2%
ERJ-190AR	1	1.1%	1	100.0%	1.1%	1	100.0%	1.1%	1	100.0%	1.1%
MD82	3	3.4%	3	100.0%	3.4%	2	66.7%	2.2%	2	66.7%	2.2%
Subtotal Air Carrier	**47**	**52.8%**	**45**	95.7%	**50.6%**	**44**	93.6%	**49.4%**	**31**	66.0%	**34.8%**
Air Taxi	8	9.0%	8	100.0%	9.0%	8	100.0%	9.0%	8	100.0%	9.0%
Cargo	1	1.1%	0	0.0%	0.0%	0	0.0%	0.0%	0	0.0%	0.0%
Commuter	19	21.3%	19	100.0%	21.3%	19	100.0%	21.3%	19	100.0%	21.3%
General Aviation	14	15.7%	14	100.0%	15.7%	14	100.0%	15.7%	14	100.0%	15.7%
Subtotal	**42**	**47.2%**	**41**	97.6%	**46.1%**	**41**	97.6%	**46.1%**	**41**	97.6%	**46.1%**
All Aircraft	**89**	**100.0%**	**86**	96.6%	**96.6%**	**85**	95.5%	**95.5%**	**72**	80.9%	**80.9%**

Notes:
The temperature was assumed to be the average maximum daily tempature during spring season (87 degres Fahrenheit)
The runway gradient was assumed to be zero (flat runway)
The runway elevation was assumed to be at mean sea level

Source: FLL 2012 Schedule, Landrum & Brown, January 2007
Prepared by: The Corradino Group, February 2007

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Table D.4-2 presents a comparison of the departure runway length requirements for the ten representative aircraft types at 90 percent of the maximum allowable payload. The most demanding aircraft, relative to runway length requirements of the FLL fleet, include the B737-500, B737-200, A321-200, B767-300, and B737-300.

Table D.4-2
90/90 RULE (DERIVED FROM 2012 SCHEDULE)
Fort Lauderdale-Hollywood International Airport

Aircraft Type	Fleet Mix Percentage		Departure Length Required Percent of Maximum Payload
	Individual	Cumulative	90% Payload
B737-500	0.2%	0.2%	8,700
B737-200	0.4%	0.6%	8,500
A321-200	3.7%	4.3%	8,050
B767-300	2.2%	6.5%	8,000
B737-300	**2.8%**	**9.3%**	**8,000**
B737-700	9.7%	19.0%	7,850
B737-900	1.5%	20.5%	7,500
B737-400	0.4%	20.9%	7,000
A320-200	12.1%	33.1%	5,600
A319-100	6.9%	40.0%	4,600

Source: FLL 2012 Schedule, Landrum & Brown, January 2007
Prepared by: The Corradino Group, February 2007

As shown in the table above, an 8,000 foot runway is necessary for the B737-300 aircraft to depart at 90 percent maximum payload. This aircraft represents the breakpoint at which 90 percent of the fleet would be able to depart from the proposed runway at FLL at 90 percent maximum payload. As the runway length available for departures is reduced, fewer and fewer aircraft in the FLL fleet would be able to use the proposed runway for departures.

D.3.4-2 Recommended Runway Length

The analysis presented earlier in *Derivative Stage Length Analysis (DSLA),* indicates that a runway length of 6,000 feet is the absolute minimum length considered at FLL to be usable by 80 percent of the projected peak hour fleet for departures. A maximum runway length of 8,000 feet will accommodate at least 90 percent of the design day aircraft departures at 90 percent maximum payload. A secondary runway at FLL should be as close to 8,000 feet in length, plus grade adjustments, as practicable, but not less than 6,000 feet.

D.3.5 TAXIWAY GEOMETRY REQUIREMENTS

In addition to the runway length and width requirements prescribed above, the taxiway infrastructure that serves new runway development at FLL should be configured in accordance to ARC D-IV standards. This includes providing a minimum lateral separation of 400 feet between the runway and parallel taxiway centerlines. Similarly, parallel taxiways should have a minimum separation of

129.5 feet and an overall pavement width of 75 feet. Pavement shoulders of 25 feet are also necessary to ensure jet blast protection associated with taxiing aircraft.

The identification, evaluation, and refinement of the airfield development alternatives were subject to a variety of planning, engineering, and constructability reviews. These preliminary analyses were conducted following both advisory and regulatory requirements as prescribed by Federal, State, county and local agencies. The documentation of these analyses is intended to convey a general understanding of the various factors that are required to be assessed during the conduct of an environmental impact statement; these include but are not limited to

- Determination of airfield geometric requirements, NAVAID siting requirements and airspace criteria to facilitate a general understanding of direct facility and environmental impacts associated with proposed development
- Evaluate the operational efficiency of airport facilities during both construction and upon project completion and quantify preliminary estimates of materials and implementation costs necessary for conducting a Net Benefits Analysis
- Assess construction sequencing, duration, and logistics to facilitate air quality analyses, identify potential temporary construction impacts, and estimate construction completion dates
- Quantification of preliminary drainage infrastructure requirements and water quality impacts
- Assess direct and indirect facility impacts to determine the need to exercise tenant leasehold buyout options and/or acquire additional property to accommodate displaced tenants.