APPENDIX H - AIRFIELD DESIGN REQUIREMENTS

Introduction

This Appendix discusses runway and taxiway design standards and runway length requirements.

FAA Design Guidelines

Guidance on airport design standards is found in FAA Advisory Circular 150/5300-13A, *Airport Design*. Airport design standards provide basic guidelines for a safe, efficient, and economic airport system. Careful selection of basic aircraft characteristics for which the airport will be designed is important. Airport designs based only on existing aircraft can severely limit the ability to expand the airport to meet future requirements for larger, more demanding aircraft. Airport designs that are based on large aircraft unlikely to operate at the airport are not economical.

Critical Aircraft

Planning a new airport or improvements to an existing airport requires the selection of one or more "critical aircraft." FAA design standards for an airport are determined by a coding system that relates the physical and operational characteristics of an aircraft to the design and safety separation distances of the airfield facility. The design aircraft is the most demanding aircraft operating or forecast to operate at the airport on a regular basis, which is typically considered 500 annual takeoff and landing operations. The design aircraft may be a single aircraft, or a grouping of aircraft. As of the time of this study, additional guidance is found in FAA Advisory Circular 150/5000-XX, *Critical Aircraft and Regular Use Determination (DRAFT)*.

The first consideration should be the safe operation of aircraft that regularly use the airport. According to FAA AC 150/5300-13A, any operation of an aircraft that exceeds design criteria of the airport may result in either an unsafe operation or a lesser safety margin unless air traffic control (ATC) Standard Operating Procedures (SOPs) are in place for those operations. However, the AC also states that it is not the usual practice to base the airport design on an aircraft that uses the airport infrequently, and it is appropriate and necessary to develop ATC SOPs to accommodate faster and/or larger aircraft that use the airport occasionally.[1] The FAA typically only provides funding for design standards required by the existing and approved forecasted critical aircraft that are expected to exceed 500 annual operations.

Airport and Runway Classifications

The FAA has established aircraft classification systems that group aircraft types based on their performance and geometric characteristics. These classification systems, described below and illustrated in **Table H-1** and **Exhibit H-1**, are used to determine the appropriate airport design standards for specific runway, taxiway, apron, or other facilities, as described in FAA AC 150/5300-13A *Airport Design*.

- **Aircraft Approach Category (AAC)**: a grouping of aircraft based on approach speed.
- **Airplane Design Group (ADG)**: a classification of aircraft based on wingspan and tail height. When the aircraft wingspan and tail height fall in different groups, the higher group is used.
- **Approach Visibility Minimums**: relates to the visibility minimums expressed by Runway Visual Range (RVR) values in feet of 1200, 1600, 2400, 4000, and 5000 (corresponding to lower than 1/4 mile, lower than 1/2 mile but not lower than 1/4 mile, lower than 3/4 mile but not lower

[1] FAA Advisory Circular 150/5300-13A, *Airport Design*

than 1/2 mile, lower than 1 mile but not lower than 3/4 mile, and not lower than 1 mile, respectively).

- **Taxiway Design Group (TDG):** A classification of airplanes based on outer to outer Main Gear Width (MGW) and Cockpit to Main Gear (CMG) distance.

Table H-1 - Classification Systems

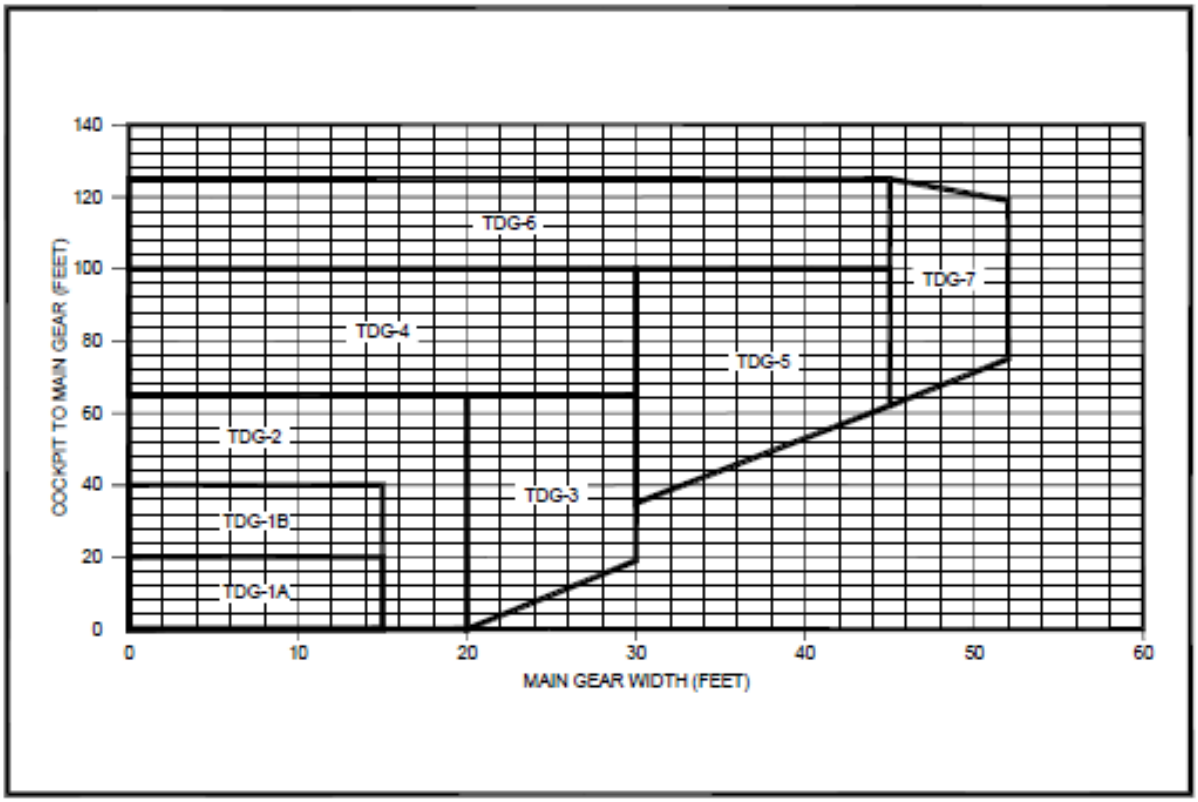
Aircraft Approach Categories	
Aircraft Approach Category	**Approach Speed**
A	Less than 91 knots
B	91 knots or more but less than 121 knots
C	121 knots or more but less than 141 knots
D	141 knots or more but less than 166 knots
E	166 knots or more

Airplane Design Groups		
Airplane Design Group	**Wingspan**	**Tail Height**
I	Less than 49 feet	Less than 20 feet
II	49 feet or more but less than 79 feet	20 feet or more but less than 30 feet
III	79 feet or more but less than 118 feet	30 feet or more but less than 45 feet
IV	118 feet or more but less than 171 feet	45 feet or more but less than 60 feet
V	171 feet or more but less than 214 feet	45 feet or more but less than 60 feet
VI	214 feet or more but less than 262 feet	66 feet or more but less than 80 feet

Visibility Minimums	
RVR (feet)	**Instrument Flight Visibility Category (statute miles)**
5000	Not lower than 1 mile
4000	Lower than 1 mile but not lower than 3/4 mile
2400	Lower than 3/4 mile but not lower than 1/2 mile (CAT-I Precision Approach)
1600	Lower than 1/2 mile but not lower than 1/4 mile (CAT-II Precision Approach)
1200	Lower than 1/4 mile (CAT-III Precision Approach)

Source: FAA AC 150/5300-13A, Airport Design

Figure H-1 - Taxiway Design Group



Source: FAA AC 150/5300-13A, Airport Design

TDG categories range from TDG-1A to TDG-7, with specific standards found in AC 150/5300-13A. Pavement width requirements for taxiing aircraft are based on the TDG. The TDG is also used to determine standards for taxiway safety areas, clearances and the geometry of taxiway intersections. **Table H-2** shows a sample of some basic taxiway dimensions as related to the TDG. However, please see AC 150/5300-13A for complete details.

Table H-2 - TDG Groups and Select Design Standards

TDG Number	1A	1B	2	3	4	5	6	7
Taxiway Width	25 ft.	25 ft.	35 ft.	50 ft.	50 ft.	75 ft.	75 ft.	82 ft.
Taxiway Shoulder	10 ft.	10 ft.	15 ft.	20 ft.	20 ft.	30 ft.	30 ft.	40 ft.

Source: FAA AC 150/5300-13A, Airport Design

Airport Design Principles

The following airport design principles are important to consider for a safe and efficient airport design:

- **Runway/Taxiway Configuration:** The configuration of runways and taxiways affects the airport's capacity/delay, risk of incursions with other aircraft on the runway and overall operational safety. Location of and type of taxiways connecting with runways correlates to runway occupancy time. The design of taxiway infrastructure should promote safety by minimizing confusing or complex geometry to reduce risk of an aircraft inadvertently entering the runway environment.
- **Approach and Departure Airspace & Land Use**: Runways each have imaginary surfaces that extend upward and outward from the runway end to protect normal flight operations. Runways also have land use standards beyond the runway end to protect the flying public as well as persons and property on the ground from potential operational hazards. Runways must meet grading and clearance standards considering natural and man-made obstacles that may obstruct these airspace surfaces. Surrounding land use should be compatible with airport operations. Airports should develop comprehensive land use controls to prevent new hazards outside the airport property line. Obstructions can limit the utility of a runway.
- **Meteorological Conditions**: An airport's runways should be designed so that aircraft land and takeoff into the prevailing wind. As wind conditions change, the addition of an additional runway may be needed to mitigate the effects of significant crosswind conditions that occur more than five percent of the year. Airports that experience lower cloud ceiling and/or visibility should also consider implementing an instrument procedures and related navigational aids to runways to maximize airport utility.
- **Navigation Aids & Critical Areas:** Visual navigational aids (NAVAIDs) to a runway or the airfield require necessary clear areas for these NAVAIDs to be effective for pilots. Instrument NAVAIDs on an airport require sufficient clear areas for the NAVAID to properly function without interference to provide guidance to pilots. These NAVAID protection areas restrict development.
- **Airfield Line of Sight:** Runways need to meet grading standards so that objects and aircraft can be seen along the entire runway. A clear line of sight is also required for intersecting runways within the Runway Visibility Zone to allow pilots to maintain visual contact with other objects and/or aircraft that may pose a hazard.
- **Interface with Landside:** The airfield configuration should be designed to provide for the safe and efficient operation of aircraft as they transition from the airfield to landside facilities such as hangars and terminals.
- **Environmental Factors:** Airport development must consider potential impacts in and around the airport environs through the National Environmental Policy Act (NEPA). Additionally, development should also reduce the risk of potential wildlife hazards such as deer and birds that may cause hazards to flight operations.

Design Codes

Using the codes from **Table H-1**, there are several ways in which the codes are used. This includes codes that recognize existing conditions, codes that identify planned capabilities, codes that are for specific runways and codes for the airport as a whole. In summary these codes are:

- **Airport Reference Code (ARC)**: an airport designation that signifies the airport's highest Runway Design Code (RDC), minus the third (visibility) component of the RDC.
- **Runway Design Code (RDC)**: a code signifying the design standards to which the runway is to be built.
- **Approach Reference Code (APRC)**: a code signifying the current operational capabilities of a runway and associated parallel taxiway with regard to landing operations.
- **Departure Reference Code (DPRC)**: a code signifying the current operational capabilities of a runway with regard to takeoff operations.

Airport Reference Code (ARC)

The Airport Reference Code (ARC) is an airport designation that represents the AAC and ADG of the aircraft that the airfield is intended to accommodate on a regular basis. The ARC is used for planning and design only and does not limit the aircraft that may be able to operate safely on the airport.

Runway Design Code (RDC)

Runway designs are based on specific FAA runway design standards. These standards, found in FAA AC 150/5300-13A, provide basic guidelines for a safe and efficient airport system, and are based on the most demanding or "design" aircraft expected to use the runway. Runway lengths are related to the design aircraft but are determined in accordance with procedures detailed in the current version of FAA AC 150/5325-4. All other critical dimensions related to the design aircraft are found in FAA AC 150/5300-13A, including dimensions for runway widths, safety areas and separations from other infrastructure.

APRC and DPRC (formerly Runway Reference Codes)

The APRC and DPRC were previously known jointly as the Runway Reference Code (RRC) and was defined as the current operational capabilities of a runway and its associated parallel taxiway. The RRC described the operational capabilities of the runway where no special procedures are necessary. In an effort to develop a code more indicative of a runway's operational capabilities, Change 1 to FAA AC 150/5300-13A replaced RRC with two new codes: Approach Reference Code (APRC) and Departure Reference Code (DPRC). **Table H-3** and **H-4** summarize the data for APRC and DPRC but refer to FAA AC 150/5300-13A for more specific information on the use of these codes.

Like the RDC, the APRC is composed of three components: the AAC, the ADG, and the visibility minimums. In contrast, the RDC is composed of the same three components, but is based on planned development and has no operational application. APRC signifies the current operational capabilities of a runway and associated parallel taxiway with regard to landing operations. The visibility minimums are linked to critical standards that determine which aircraft can operate on taxiways adjacent to a runway under particular meteorological conditions with no special operational procedures necessary.

DPRC signifies the runway's operational capabilities with regard to takeoff operations. The DPRC code is the similar to the APRC code, but is comprised of two components, AAC and ADG. It represents those aircraft that can takeoff from a runway while any aircraft are present on adjacent taxiways, under particular meteorological condition with no special procedures necessary.

Table H-3 - Approach Reference Code (APRC)

Visibility Minimums	Runway to Taxiway Separation (ft)									
	≥150	≥200	≥225	≥240	≥250	≥300	≥350	≥400	≥500	≥550
Visual	B/I(S)/VIS	B/I(S)/VIS	B/I/VIS	B/II/VIS	B/II/VIS	B/III/VIS D/II/VIS	B/III/VIS	D/IV/VIS D/V/VIS	D/VI/VIS	D/VI/VIS
Not lower than 1 mile	B/I(S)/5000	B/I(S)/5000	B/I/5000	B/II/5000	B/II/5000	B/III/5000 D/II/5000	B/III/5000	D/IV/5000 D/V/5000	D/VI/5000	D/VI/5000
Not lower than 3/4 mile	B/I(S)/4000	B/I(S)/4000	B/I/4000	B/II/4000	B/II/4000	B/III/4000 D/II/4000	B/III/4000	D/IV/4000 D/V/4000	D/VI/4000	D/VI/4000
Lower than 3/4 mile but not lower than 1/2 mile		B/I(S)/2400	B/I/4000 B/I(S)/2400	B/II/4000	B/I/2400	B/III/4000 [1] D/II/4000 B/II/2400	B/III/2400	D/IV/2400 D/V/2400	D/VI/2400	D/VI/2400
Lower than 1/2 mile								D/V/2400 D/IV/1600	D/VI/2400 D/V/1600	D/VI/1600

Notes: (S) denotes small aircraft
Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.

Source: FAA AC 150/5300-13A, Airport Design

Table H-4 - Departure Reference Code (DPRC)

Runway to Taxiway Separation (ft)					
≥ 150	≥ 225	≥ 240	≥ 300	≥ 400	≥ 500
B/I(S)	B/I	B/II	B/III D/II	D/IV D/V [1]	D/VI [2]

Notes: (S) denotes small aircraft
Entries for Approach Category D also apply to Approach Category E. However, there are no Approach Category E aircraft currently in the civil fleet.

Source: FAA AC 150/5300-13A, Airport Design

Generally, runway standards are related to aircraft approach speed, aircraft wingspan, and designated or planned approach visibility minimums. Runway to taxiway and taxiway/taxilane to taxiway/taxilane separation standards are related to ADG, TDG, and approach visibility minimums. **Table H-5** summarizes aircraft classifications and their related design components. This information will be covered in greater detail later in this appendix.

Table H-5 - Classification and Design Components

Aircraft Classification	Related Design Components
Aircraft Approach Category (AAC) Approach Speed	Runway Safety Area (RSA), Runway Object Free Area (ROFA), Runway Protection Zone (RPZ), runway width, runway-to- taxiway separation, runway-to-fixed object
Airplane Design Group (ADG) Aircraft Width/Height	Runway Protection Zone (RPZ), Taxiway and apron Object Free Areas (OFAs), parking configuration, hangar locations, taxiway-to-taxiway separation, runway-to-taxiway separation

Source: FAA AC 150/5300-13A, Airport Design

Code Context

It's critical to determine the context in which the specific code is being used. Depending where the code is being used, a C-II-2400 code could have the following meanings:

- **Critical Design Aircraft:** A C-II aircraft is what the runway was either built for, or is the aircraft that the runway is being designed for. Looking at **Table H-1** above or FAA AC 150/5300-13A, a C-II aircraft is an aircraft with an approach speed between 121 and 140 knots, and a wingspan between 49 and 78 feet or a tail height between 20 and 29 feet.
- **Runway Design Code (RDC):** The planned runway will be designed to meet the FAA runway design standards for a C-II aircraft with a visibility minimum as low as ½ mile.
- **Approach Reference Code (APRC)**: The runway currently meets the FAA runway design standards for a C-II aircraft with a visibility minimum as low as ½ mile and with a C-II aircraft on the adjacent parallel taxiway.
- **Departure Reference Code (DPRC):** The runway currently meets the FAA runway design standards for a C-II aircraft departing the runway with a C-II aircraft on the adjacent parallel taxiway.
- **Airport Reference Code (ARC):** The ARC can be used to discuss the operational capability of an existing airport, i.e., if the highest RDC of existing runways at an airport is C-II, the airport would have an ARC of C-II. The ARC can also be used to discuss the planned capability of an airport, i.e., an airport will be designated as an ARC C-II airport when the highest RDC of the planned runways is C-II.

Summary

All codes discussed in this section consist of at least two, and sometimes three, characters: a letter, a roman numeral and sometimes a number. As discussed above, the same code can represent planned or actual characteristics of aircraft, runways or airports in a number of different situations. Like many other acronyms, these codes have become a type of "shorthand" in discussions regarding airport design. To avoid confusion, it is important to understand the context in which a code is being used and the specific standards associated with it. This section is a summary of airport design standards found in FAA AC 150/5300-13A and the AC should be referred to for more detailed information.

As an example, a runway designed to accommodate C-II aircraft with minimums lower than ¾ mile but not lower than ½ mile (Category I approach), would have a RDC code of C-II-2400. For general discussions, an RDC designation, such as C-II, is normally sufficient to identify the critical or design aircraft, as well as the specific standards used as the basis for the runway design.

MOT Runway Design Aircraft & Codes

The overall critical design aircraft type for MOT is an ARC D-III aircraft with TDG-4. This is based on the following table with 2014 aircraft operations:

Table H-6 - Minot International Airport Existing Design Aircraft

Aircraft Type	MTOW	AAC	ADG	TDG	2014 Operations
MD-83/-88	160,000 lbs.	D	III	4	545
Boeing 737-800	174,200 lbs.	D	III	3	20
CRJ-200	47,450 lbs.	D	II	3	4,107

Source: KLJ Analysis, FAA Traffic Flow Management System Counts (TFMSC)
MTOW = Maximum Takeoff Weight
Green = Meets or exceeds 500 annual operations for applicable design code

Runway 13-31 and the parallel taxiway is currently built to accommodate up to ARC D-III aircraft and TDG-5. The existing aircraft operations at MOT feature regular use of D-III aircraft with TDG-4 (MD-83/88 operated by Allegiant Airlines). The basic runway and taxiway separation distances meets standards to accommodate aircraft up to ARC D-IV assuming approach minimums lower than ½ mile.

Runway 8-26 is currently built to accommodate up to C-III aircraft including the Embraer 170 aircraft operated by a regional carrier for Delta Air Lines. The runway width however does not meet the 150-foot width requirement for ADG C-III and D-III aircraft. The associated taxiway to Runway 8-26 varies from TDG-2 to TDG-4. Runway 8-26 is required for the airport to achieve 95 percent wind coverage for up to ARC B-II aircraft. This runway is used frequently by the airlines because of its close proximity to the airline terminal. The City has historically elected to maintain Runway 8-26 according to C-III design standards for the flexibility to accommodate larger aircraft. The basic runway and taxiway separation distances meets standards to accommodate aircraft up to ARC D-IV assuming approach minimums no lower than ½ mile.

Within the next 10 years, the overall MOT design aircraft is expected to transition as the MD-83/-88 aircraft will be replaced with the Airbus A320 by Allegiant Airlines. This aircraft has an ARC of C-III with a TDG-3 classification and 171,961 lbs. maximum takeoff weight. Other Approach Category D aircraft expected to utilize MOT include the CRJ-200 through the mid-term with at least 500 annual operations. Other large business jets occasionally using also have an AAC of D. When the CRJ-200 is retired ultimately the design aircraft ARC may change so this should be monitored closely. An ultimate ARC of D-III is still used for this Master Plan.

In accordance with FAA AC 150/5300-13A based on the current critical aircraft and airfield configuration, the information in **Table H-7** describe the runways and airfield at MOT:

Table H-7 - Minot International Airport Design Codes

Runway End	RDC	APRC	DPRC	TDG
13	D-III-5000	D-IV-2400	D-IV	4
31	D-III-2400	D-IV-2400	D-IV	4
8	C-III-5000	D-IV-2400	D-IV	3
26	C-III-5000	D-IV-2400	D-IV	3

Overall RDC	Existing	Future	Ultimate
	D-III-2400	D-III-2400	D-III-2400

Source: KLJ Analysis

Runway Design Standards

The FAA design and safety standards related to runways are described below.

- **Runway Width:** The physical width of the runway pavement.
- **Runway Safety Area (RSA)**: Graded surface centered on the runway centerline. The RSA shall be free of objects and capable, under dry conditions, of supporting snow removal equipment, aircraft rescue and firefighting equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.
- **Runway Object Free Area (ROFA)**: The ROFA is also centered on the runway centerline and requires the clearing of all above-ground objects protruding above the RSA edge elevation (unless objects need to be located in the OFA for air navigation or aircraft ground maneuvering purposes).

- **Runway Obstacle Free Zone (OFZ)**: The ROFZ is a defined volume of airspace centered above the runway centerline that extends 200 feet beyond each end of the runway surface that precludes taxiing or parked airplanes and object penetrations, except for frangible visual NAVAIDs that need to be located in the OFZ because of their function.
- **Runway Protection Zone (RPZ):** The RPZ is a trapezoidal area located 200 feet beyond the runway end and centered on the extended runway centerline. The RPZ is primarily a land use control that is meant to enhance the protection of people and property near the airport through airport control. Such control includes clearing of RPZ areas of incompatible objects and activities. If a special application of declared distances is used, separate approach and departure RPZs are required.

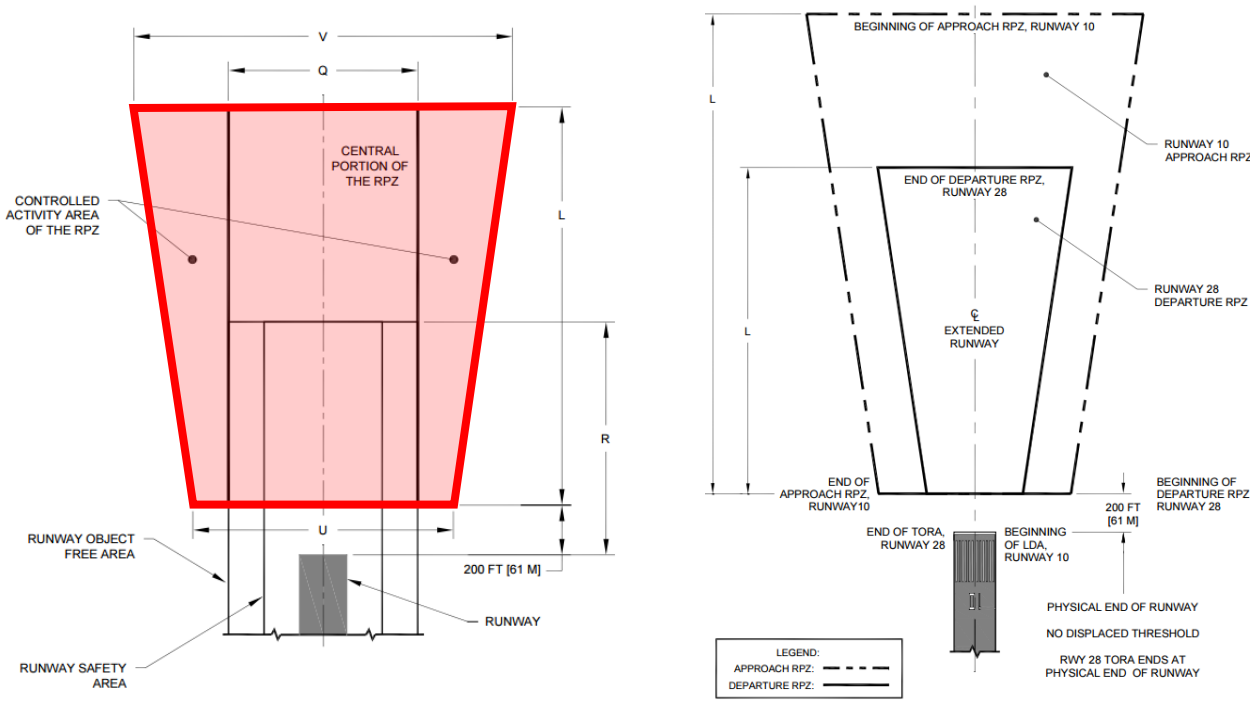
RUNWAY PROTECTION ZONES

The RPZ's are addressed in more detail at this point due to recent changes in how FAA is handling land use in these areas. The RPZ is intended to protect people and property on the ground for approach and departure areas beyond the runway end. It also mitigates the risk of an aircraft collision with an object on the ground. According to FAA, the function of the RPZ is as follows:

> *"The RPZ function is to enhance the protection of people and property on the ground. Where practical, airport owners should own the property under the runway approach and departure areas to at least the limits of the RPZ. It is desirable to clear the entire RPZ of all above-ground objects. Where this is impractical, airport owners, as a minimum, should maintain the RPZ clear of all facilities supporting incompatible activities."*

Formerly known as clear zones, there are two components of RPZs that are evaluated and analyzed in the master planning process. One component is the required dimensions of the RPZ, which are functions of the design aircraft, type of operation and visibility minimums. There are separate approach and departure RPZs however the most stringent RPZ will control which is usually the approach RPZ. The second component is the use of the land within the boundaries of the RPZ, which must meet FAA criteria and regulations, and is commonly discussed as an element of compatible land use. FAA desires a clear RPZ and airport control within its limits. **Figure H-2** identifies the shape of a typical approach and departure RPZ.

Figure H-2 - Runway Protection Zone



Source: [FAA AC 150/5300-13A, Airport Design]

RPZs and the effort to ensure compatible land use within them are currently a high priority for the FAA. Protection of the RPZ is achieved through airport control over RPZs including fee title ownership or clear zone easement. The increased emphasis has resulted in additional requirements to monitor and analyze RPZs for conformance to established policies and standards.

In September 2012, FAA published *Interim Guidance on Land Uses Within a Runway Protection Zone* providing airports with guidance on land use compatibility standards. In some cases, a separate RPZ Alternatives Analysis must be prepared to meet these requirements. The standards from the interim guidance are summarized below:

- **New or Modified Land Uses:** FAA coordination is required for new or modified land uses within the RPZ as a result of an airfield project, change in RPZ dimensions or local development proposal.
- **Land Uses Requiring FAA Coordination:** Building and structures, residential land uses, transportation facilities (i.e. roads, parking, rail), fuel storage, hazardous material storage, wastewater treatment, above-ground utility infrastructure
- **Alternatives Analysis:** A full range of alternatives must be evaluated prior to FAA coordination that avoid introducing the land use into the RPZ, minimize the impact of the land use in the RPZ and mitigate risk to people and property on the ground.
- **Existing Land Uses in the RPZ:** No change in policy, airports should work with FAA to remove or mitigate the risk of any existing incompatible land uses in the RPZ. Incompatible land uses in the RPZ from previous FAA guidance include but are not limited to residences, places of public assembly (i.e. uses with high concentration of persons), fuel storage facilities and wildlife attractants.

FAA has acknowledged the ongoing update to the land use compatibility advisory circular where an RPZ land use consideration section will be added. As of the writing of this Master Plan, the document has not yet been released by FAA in draft form.

MOT EXISTING CONDITIONS

The RPZ standards for the existing runway configurations at MOT are identified in **Table H-8**. The existing RPZs were evaluated to determine existing land uses and airport control. A graphical illustration of the RPZs is identified in **Exhibit H-1**. A summary is below:

- **Runway 8:** The approach and departure RPZs near the Runway 8 end extend off-airport property and contain residential and commercial structures. A total of approximately 17 acres of property is located outside of Airport control.
- **Runway 26:** This RPZ is entirely within Airport property.
- **Runway 13:** The airport owns all but approximately 0.1 acres of land under the Runway 13 RPZ. This land is within the public roadway right-of-way for U.S. Highway 83.
- **Runway 31:** There is approximately 4.0 acres of open space within the Runway 31 RPZ that is not currently owned or controlled by the Airport.

Incompatible land uses exist near the Runway 8 end for RPZs required for C-III runway design standards. The Runway 8 end is proposed to be shifted to the east and Runway 8-26 reclassified to B-II to remove incompatible land uses. Because a clear RPZ is desired, all existing land uses shall be addressed in other RPZs with any future airfield design modification.

MOT FUTURE/ULTIMATE CONDITIONS

The standards future and ultimate runway configurations at MOT are also identified in **Table H-8**.

The future RPZs were evaluated to determine existing land uses and airport control. The size of the approach RPZ will increase for Runway 13 in the future. When approach visibility minimums reduce from 1 mile to ¾ mile, the inner width increases by 500 feet to a total inner width of 1,000 feet. As a result of this size increase, a 250-foot long portion of U.S. Highway 83 would be located within the future Runway 13 RPZ. Approximately 1.3 acres of the future RPZ would be located within roadway right-of-way.

Runway 8-26 is planned to be downgraded to an ARC B-II runway to reflect the existing design aircraft. This reduces the size of the RPZ. The future Runway 8 runway end is proposed to shift to the east which will place the entire Runway 8 approach and departure RPZ within airport property. Options will be evaluated in **Chapter 5: Alternatives Analysis**. The Runway 26 RPZ would also reduce in size and remain within airport property.

There is a planned ultimate 800-foot extension of Runway 13-31 to the southeast. The ultimate Runway 31 RPZ would remain the same size but shift southeast with the new runway end and encompass a commercial/industrial equipment storage area.

No RPZ land use alternatives analysis is required for Runway 8-26 unless new land uses are introduced into the RPZ. An RPZ land use alternative analysis is expected is required by the FAA for Runway 13 to upgrade visibility minimums to ¾ mile. This would increase the size of the RPZ. The project is proposed beyond the initial planning period of 0-5 years as identified in **Chapter 6: Implementation Plan**. Therefore, a simple planning-level alternatives review was completed in **Chapter 5: Alternatives Analysis**. A formal FAA RPZ analysis will be completed later when the project is in the planning stage and within five years of implementing.

Runway 8-26 is planned to be downgraded to an ARC B-II runway to reflect the existing design aircraft. This reduces the size of the RPZ. The future Runway 8 runway end is proposed to shift to the east which will place the entire Runway 8 approach and departure RPZ within airport property. The Runway 26 RPZ would also reduce in size and remain within airport property.

Table H-8 - FAA RPZ Dimensional Standards

Runway End(s)	Operation	Design Code	Distance from End	Inner Width	Outer Width	Length	Acres
EXISTING							
13	Approach	D-III-5000	200’	500’	1,010’	1,700’	29.465
31	Approach	D-III-2400	200’	1,000’	1,750’	2,500’	78.914
13-31	Departure	D-III	200’	500’	1,010’	1,700’	29.465
8	Approach	C-III-5000	200’	500’	1,010’	1,700’	29.465
26	Approach	C-III-5000	200’	500’	1,010’	1,700’	29.465
8-26	Departure	C-III	200’	500’	1,010’	1,700’	29.465
FUTURE							
13	Approach	D-III-4000	200’	1,000’	1,510’	1,700’	48.978
8	Approach	B-II-5000	200’	500’	700’	1,000’	13.770
26	Approach	B-II-5000	200’	500’	700’	1,000’	13.770
8-26	Departure	B-II	200’	500’	700’	1,000’	13.770
ULTIMATE							
No planned RPZ dimensional standard change from Future phase							

Source: FAA AC 150/5300-13A, Airport Design, KLJ Analysis
Note: Changes from previous phase shown in Blue.

MOT Runway Design Standards

Table H-9 provides a complete summary of existing, future and ultimate design standards for the airport’s runways and associated taxiways. The runway design standards matrix from FAA AC 150/5300-13A for each runway is included in **Figure H-3 and H-4.** In addition, the notes to these figures are provided in **Figure H-5**.

A cursory review for existing runway design standard compliance was completed. For Runway 13-31 (ARC D-III), an internal airport maintenance road penetrates a small portion of the Runway Object Free Area (ROFA) south of the Runway 31 end. The published strength of Runway 13-31 is 150,000 lbs. for dual-wheel landing gear configuration. The MD-83 has this gear configuration and has a maximum takeoff weight of 160,000 lbs., slightly greater than published.

For Runway 8-26 with a Sponsor-selected design aircraft of C-III, the current runway width of 100 feet does not meet current standards of 150 feet. Runway 8-26 does not feature a blast pad which is recommended for turbine runway takeoff operations to mitigate soil erosion. With the exception of the blast pad, this Runway 8-26 meets or exceeds design standards for an ARC B-II classification.

Exhibit H-1 – Airfield Design Standards

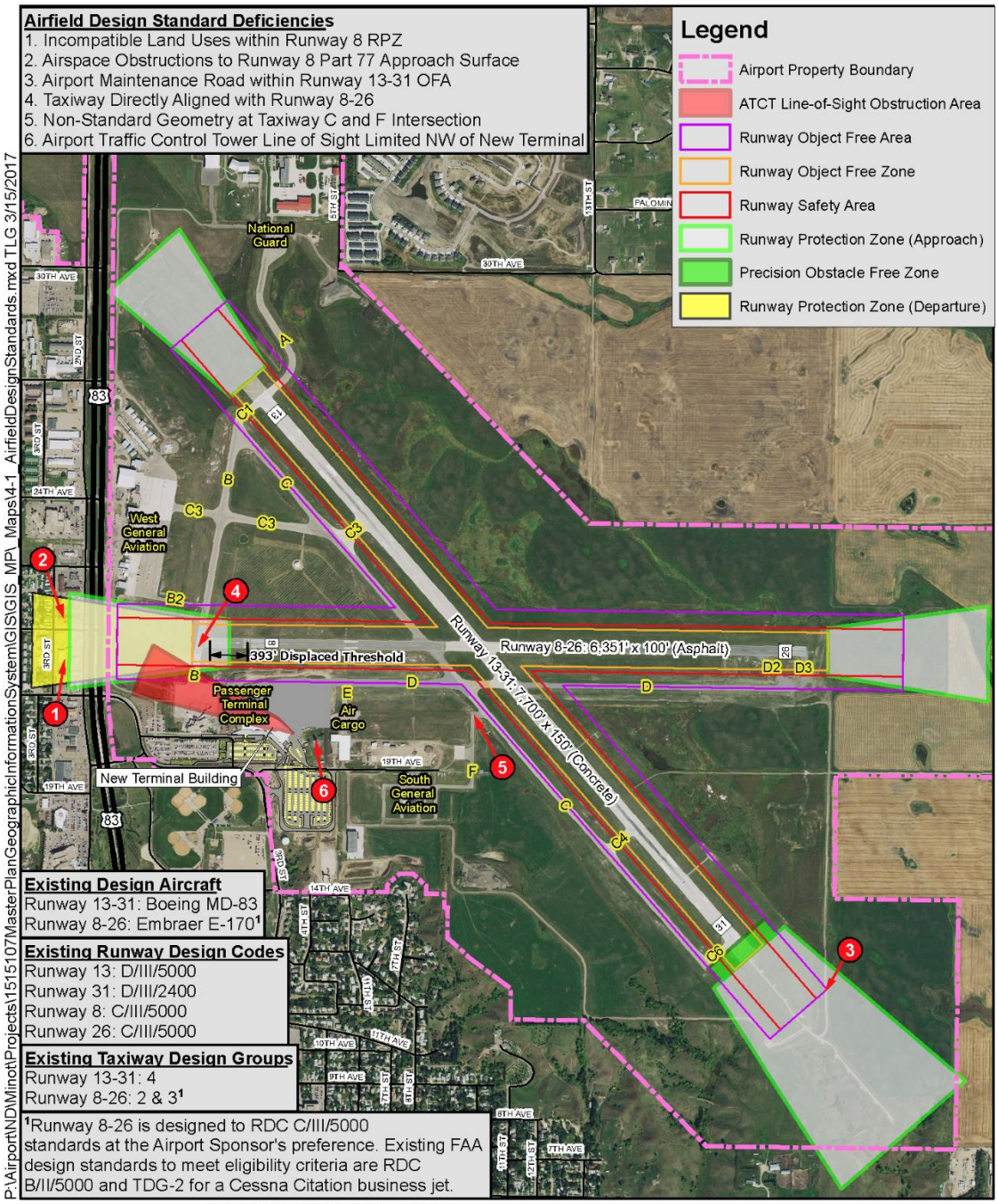


Table H-9 – MOT Design Standards

	Existing	Future Need	Ultimate Need
Primary Runway 13-31			
AAC and ADG	D-III	D-III	D-III
Critical Aircraft Type(s)	MD-83	MD-83	Boeing 737-800
Critical Aircraft Weight	166,000 lbs.	166,000 lbs.	172,500 lbs.
Dimensions	7,700' x 150'	7,700' x 150'	8,500' x 150'
Runway 31 Visibility Minimums	½ mile	½ mile	½ mile
Runway 13 Visibility Minimums	1 mile	¾ mile	¾ mile
TDG/Critical Aircraft	4	4	3
Parallel Taxiway Width	75'	50'	50'
Secondary Runway 08-26			
AAC and ADG	C-III	B-II	B-II
Critical Aircraft Type (s)	EMB-175	Business Jet	Business Jet
Maximum Takeoff Weight	82,700 lbs.	Up to 60,000 lbs.	Up to 60,000 lbs.
Dimensions	6,351' x 100'	5,500' x 75'[2]	5,500' x 75'
Runway 8 Visibility Minimums	1 mile	1 mile	1 mile
Runway 26 Visibility Minimums	1 mile	1 mile	1 mile
TDG/Critical Aircraft	3	2	2
Parallel Taxiway Width	Varies (35'-50')	35'	35'

Source: KLJ Analysis

[2] It is recommended that Runway 8-26 be maintained at 6,200' x 100' as much as is practical since this pavement is in generally good condition and because of the runways close proximity to the terminal continues to be a readily used option for some airline activity. The western portion of the runway also serves as a taxi route alternative when other airliners are using Taxiway D.

Figure H-3 - Runway 13-31 Existing/Future/Ultimate, Runway 8-26 Existing

Table A7-9. Runway design standards matrix, C/D/E - III

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		C/D/E - III			
ITEM	**DIM** [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A		*Refer to paragraphs 302 and 304*		
Runway Width [12]	B	150 ft	150 ft	150 ft	150 ft
Shoulder Width [12]		25 ft	25 ft	25 ft	25 ft
Blast Pad Width [12]		200 ft	200 ft	200 ft	200 ft
Blast Pad Length		200 ft	200 ft	200 ft	200 ft
Crosswind Component		16 knots	16 knots	16 knots	16 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	C	500 ft	500 ft	500 ft	500 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Length prior to threshold [11]	P	600 ft	600 ft	600 ft	600 ft
Width	Q	800 ft	800 ft	800 ft	800 ft
Runway Obstacle Free Zone (ROFZ)					
Length			*Refer to paragraph 308*		
Width			*Refer to paragraph 308*		
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	1,010 ft	1,010 ft	1,510 ft	1,750 ft
Acres		29.465	29.465	48.978	78.914
Departure Runway Protection Zone (RPZ)					
Length	L	1,700 ft	1,700 ft	1,700 ft	1,700 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	1,010 ft	1,010 ft	1,010 ft	1,010 ft
Acres		29.465	29.465	29.465	29.465
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H		*Refer to paragraph 316*		
Holding Position [8]		250 ft	250 ft	250 ft	250 ft
Parallel taxiway/taxilane centerline [2]	D	400 ft	400 ft	400 ft	400 ft
Aircraft parking area	G	500 ft	500 ft	500 ft	500 ft
Helicopter touchdown pad			*Refer to AC 150/5390-2*		

Note:

- Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.

Source: FAA AC 150/5300-13A, Airport Design

Figure H-4 - Runway 8-26 Future/Ultimate

Table A7-4. Runway design standards matrix, A/B – II

Aircraft Approach Category (AAC) and Airplane Design Group (ADG):		A/B - II			
ITEM	**DIM** [1]	VISIBILITY MINIMUMS			
		Visual	Not Lower than 1 mile	Not Lower than 3/4 mile	Lower than 3/4 mile
RUNWAY DESIGN					
Runway Length	A	*Refer to paragraphs 302 and 304*			
Runway Width	B	75 ft	75 ft	75 ft	100 ft
Shoulder Width		10 ft	10 ft	10 ft	10 ft
Blast Pad Width		95 ft	95 ft	95 ft	120 ft
Blast Pad Length		150 ft	150 ft	150 ft	150 ft
Crosswind Component		13 knots	13 knots	13 knots	13 knots
RUNWAY PROTECTION					
Runway Safety Area (RSA)					
Length beyond departure end [9, 10]	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	C	150 ft	150 ft	150 ft	300 ft
Runway Object Free Area (ROFA)					
Length beyond runway end	R	300 ft	300 ft	300 ft	600 ft
Length prior to threshold	P	300 ft	300 ft	300 ft	600 ft
Width	Q	500 ft	500 ft	500 ft	800 ft
Runway Obstacle Free Zone (ROFZ)					
Length		*Refer to paragraph 308*			
Width		*Refer to paragraph 308*			
Precision Obstacle Free Zone (POFZ)					
Length		N/A	N/A	N/A	200 ft
Width		N/A	N/A	N/A	800 ft
Approach Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,700 ft	2,500 ft
Inner Width	U	500 ft	500 ft	1,000 ft	1,000 ft
Outer Width	V	700 ft	700 ft	1,510 ft	1,750 ft
Acres		13.770	13.770	48.978	78.914
Departure Runway Protection Zone (RPZ)					
Length	L	1,000 ft	1,000 ft	1,000 ft	1,000 ft
Inner Width	U	500 ft	500 ft	500 ft	500 ft
Outer Width	V	700 ft	700 ft	700 ft	700 ft
Acres		13.770	13.770	13.770	13.770
RUNWAY SEPARATION					
Runway centerline to:					
Parallel runway centerline	H	*Refer to paragraph 316*			
Holding Position		200 ft	200 ft	200 ft	250 ft
Parallel taxiway/taxilane centerline [2, 4]	D	240 ft	240 ft	240 ft	300 ft
Aircraft parking area	G	250 ft	250 ft	250 ft	400 ft
Helicopter touchdown pad		*Refer to AC 150/5390-2*			

Note:

- Values in the table are rounded to the nearest foot. 1 foot = 0.305 meters.

Source: FAA AC 150/5300-13A, Airport Design

Figure H-5 Runway Design Standards Matrix Footnotes

Footnotes:

1. Letters correspond to the dimensions in Figure 3-26.
2. The runway to taxiway/taxilane centerline separation standards are for sea level. At higher elevations, an increase to these separation distances may be required to keep taxiing and holding aircraft clear of the inner-transitional OFZ (refer to paragraph 308.c). Using this standard to justify a decrease in runway to taxiway/taxilane separation is not permitted.
3. The standard runway centerline to parallel taxiway centerline separation distance is 400 feet for airports at or below an elevation of 1,345 feet; 450 feet for airports between elevations of 1,345 feet and 6,560 feet; and 500 feet for airports above an elevation of 6,560 feet.
4. For approaches with visibility less than ½-statute mile, runway centerline to taxiway/taxilane centerline separation increases to 400 feet.
5. For approaches with visibility less than ½-statute mile, the separation distance increases to 500 feet.
6. For approaches with visibility less than 3/4 statute mile, the separation distance may increase by an elevation adjustment. For approaches with visibility less than ½-statute mile, the separation distance increases to 550 feet.
7. This distance is increased 1 foot for each 100 feet above 5,100 feet above sea level.
8. This distance is increased 1 foot for each 100 feet above sea level.
9. The RSA length beyond the runway end begins at the runway end when a stopway is not provided. When a stopway is provided, the length begins at the stopway end.
10. The RSA length beyond the runway end may be reduced to that required to install an Engineered Materials Arresting System (EMAS) (the designed set-back of the EMAS included) designed to stop the design aircraft exiting the runway end at 70 knots.
11. This value only applies if that runway end is equipped with electronic or visual vertical guidance. If visual guidance is not provided, use the value for "length beyond departure end."
12. For airplanes with maximum certificated takeoff weight of 150,000 lbs or less, the standard runway width is 100 feet, the shoulder width is 20 feet, and the runway blast pad width is 140 feet.
13. An RSA width of 400 feet is permissible.

Source: FAA AC 150/5300-13A, Airport Design

Taxiway Design Standards

Taxiways provide for the safe and efficient movement of aircraft between the runway and other operational areas of the airport. The taxiway system should provide critical links to airside infrastructure, increase capacity and reduce the risk of an incursion with traffic on the runway.

System Design

FAA has placed a renewed emphasis on taxiway design in their updated airport design standards. Fundamental elements help develop and efficient system to meet demands, reduce pilot confusion and enhance safety. Considerations include:

- Design taxiways to meet FAA design standards for existing and future users considering expandability of airport facilities.
- Design taxiway intersections so the cockpit is over the centerline with a sufficient taxiway edge safety margin.
- Simplify taxiway intersections to reduce pilot confusion using the three-node concept, where a pilot has no more than three choices at an intersection.
- Eliminate "hot spots" identified by the FAA Runway Safety Action Team where enhanced pilot awareness is encouraged.
- Minimize the number of runway crossings and avoid direct access from the apron to the runway.
- Eliminate aligned taxiways whose centerline coincides with a runway centerline.
- Other considerations include avoiding wide expanses of pavement and avoiding "high energy intersections" near the middle third of a runway.

Design Standards

Taxiways are subject to FAA design requirements such as pavement width, edge safety margins, shoulder width, and safety and object free area dimensions. The FAA standards in relation to taxiways (as defined in FAA AC 150/5300-13A, *Airport Design*) are described below.

- **Taxiway Width**: The physical width of the taxiway pavement.
- **Taxiway Edge Safety Margin**: The minimum acceptable distance between the outside of the airplane wheels and the pavement edge.
- **Taxiway Shoulder Width**: Taxiway shoulders provide stabilized or paved surfaces to reduce the possibility of blast erosion and engine ingestion problems associated with jet engines which overhang the edge of the taxiway pavement.
- **Taxiway/Taxilane Safety Area (TSA)**: The TSA is located on the taxiway centerline and shall be cleared and graded, properly drained, and capable, under dry conditions, of supporting snow removal equipment, ARFF equipment, and the occasional passage of aircraft without causing structural damage to the aircraft.
- **Taxiway Edge Safety Margin (TESM):** The minimum acceptable distance between the outside of the airplane wheels and the pavement edge.
- **Taxiway/Taxilane Object Free Area (TOFA):** The TOFA is centered on the taxiway centerline and prohibits service vehicle roads, parked airplanes, and above ground objects, except for objects that need to be in the TOFA for air navigation or aircraft ground maneuvering purposes.
- **Taxiway Separation Standards:** Separation standards between the taxiways and other airport facilities are established to ensure operational safety of the airport and are as follows:

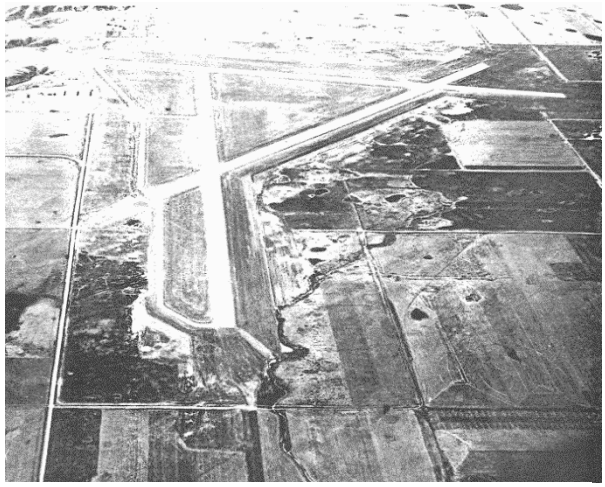
- Taxiway centerline to parallel taxiway/taxilane centerline
- Taxiway centerline to fixed or moveable object

MOT Taxiway Design

The dimensions for each of the taxiway design standards vary according to the group of aircraft they currently or are intended to accommodate. **Figure H-7** shows AC 150/5300-13A taxiway design standards based on Airplane Design Group (ADG) and Taxiway Design Group (TDG).

The required MOT taxiway design standards are defined by the critical design aircraft. ADG-III aircraft is the current critical design airplane for the overall airport. The critical design airplane with the largest TDG is the MD-83 aircraft with a TDG-4 classification. The current taxiways serving Runway 13-31 accommodate aircraft up to TDG-5. The taxiways serving Runway 8-26 vary in width from 50 to 35 feet meeting TDG-4 to TDG-2 standards, respectively.

The MOT taxiway configuration dates to the original runway configuration paved in the early 1940's. At that time, there were three runways and taxiways were configured to connect with each runway threshold. Some of these taxiway alignments still exist today as shown in **Figure H-6.** The old Runway 1-19 alignment is now Taxiway B, and the general aviation development was designed in alignment with this infrastructure.



Minot Airport, Looking West (1944)

A cursory review for taxiway design standard compliance was completed. There are two "hot spots" defined by FAA (See **Figure H-6 - FAA Airport Diagram).** These are locations with a history of a potential risk of collision or runway incursion, where heightened attention by pilots and drivers is necessary. Hot spots at MOT include:

1. Taxiway B crossing the approach end to Runway 8. Holding positions are identified by red and white 8 APCH signs.
2. Taxiway C crossing Runway 8-26 at an angle. Pilots sometimes miss the holding position signs and markings for Runway 8-26.

Improvements will be considered to mitigate Hot Spot #1 including flashing runway guard lights and other options.

Configuration modifications to mitigate Hot Spot #2 would create more of a non-standard condition. Parallel taxiways are essentially required for efficient operation of the airfield. Rather than reconfiguration, **flashing runway guard lights are recommended to help mitigate Hot Spot #2.**

Taxiway C, the parallel taxiway serving Runway 13-31, is currently 75-feet in width. **The taxiway width exceeds the current required width of 50 feet to accommodate the current design aircraft (TDG-4).**

Taxiway B is aligned based on the alignment of an old north-south runway. **Taxiway B currently provides an aligned taxiway to the Runway 8 end and crosses the inner approach surface. This configuration is not recommended and should be considered for realignment. This taxiway also has limited line of sight from the Airport Traffic Control Tower with the new passenger terminal.**

Taxiway C3 is 75 feet wide which meets standards for up to TDG-5 aircraft. **Taxiway C3 would only require a 50-foot-wide taxiway for TDG-4 and TDG-3 aircraft standards.**

The intersection of Taxiway F and Taxiway C to the south of the runway intersection is based on the original airfield taxiway configuration. **The intersection is a non-standard configuration and should be corrected to meet current airfield design standards.**

Runway 8-26 does not have a full-length parallel taxiway but this is planned once the Runway 8 end is shifted. Taxiway D east of Runway 8-26 is designed for small aircraft exclusively with a 35-foot width and a pavement strength of 12,500 pounds or less. A meandering taxiway once connected the old Runway 26 end with the air cargo apron. This has since been realigned to be a partial parallel taxiway with Runway 8-26. **Taxiway D should be strengthened to accommodate aircraft up to 60,000 pounds.**

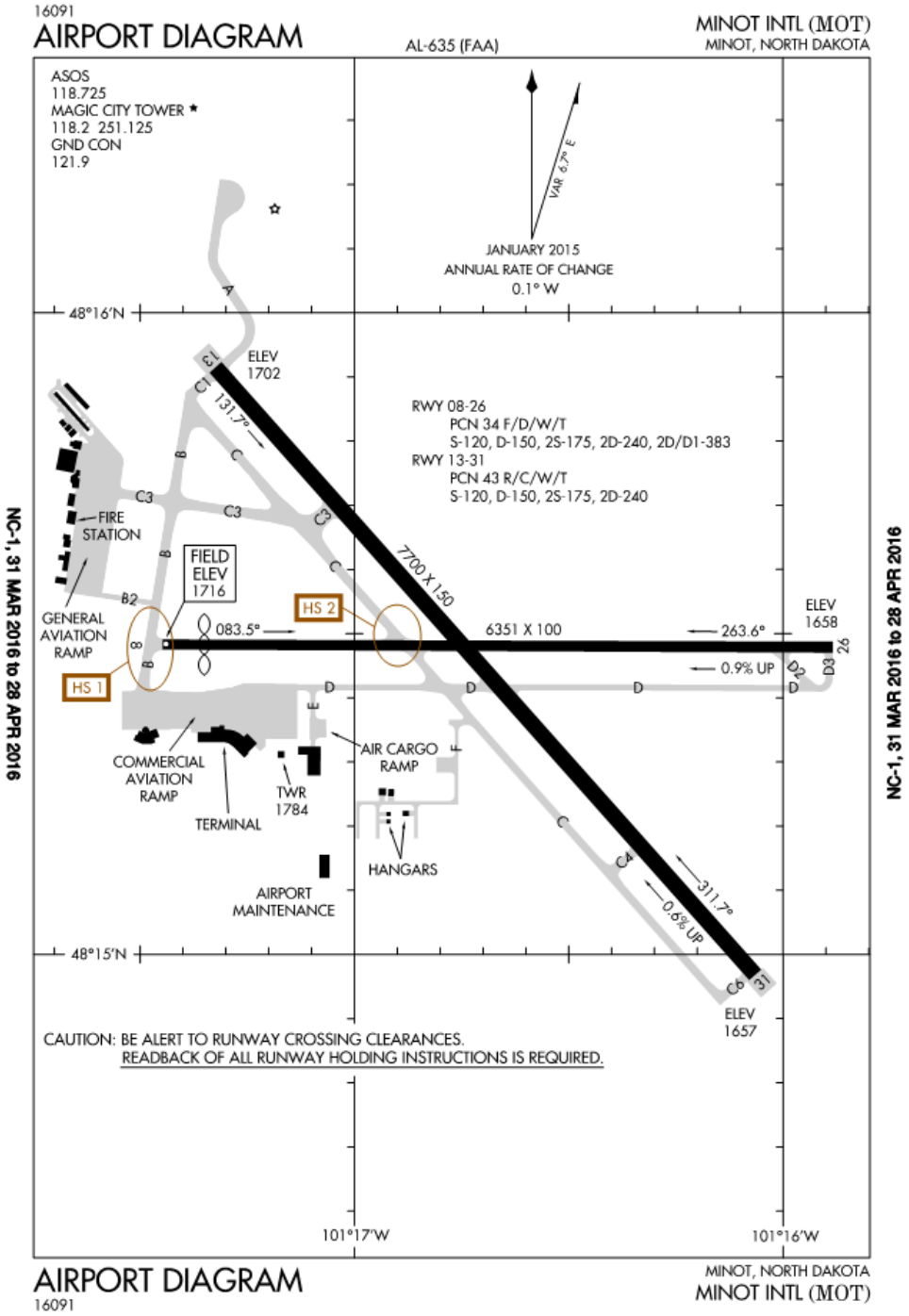
Runway departure delays can be caused by aircraft awaiting departure clearance or completing pre-flight checks. **There are currently no holding bays or bypass taxiways close to the runway ends. These should be considered near the Runway 13 and 31 ends** to improve capacity and overall flow when sequential departure operations are expected.

Runway 13-31 has four exit taxiway turnoffs. The configuration of the exit taxiways appears to be sufficient to accommodate efficient landing operations on either Runway 13 or 31 without causing substantial delays from aircraft occupying the runway.

Please see **Exhibit H-2, H-3, H-4, and H-5** for Runway 13-31 connector taxiway exhibits depicting the existing taxiway safety margin for an MD-83 aircraft along with TDG-4 fillet requirements per AC 150/5300-13. The exhibits indicate sufficient taxiway pavement to meet the needs of the critical design aircraft (MD-83). However, if TDG-4 fillet requirements are to be met in the future, reconfiguration of some taxiway segments would be necessary. **Exhibit H-6** illustrates pavement requirements for the MD-83 and TDG-4 aircraft turning onto or off Taxiway D from Taxiway C. Pavement requirements for the MD-83 and TDG-4 aircraft to enter or exit Runway 13-31 were not depicted on this exhibit since is highly unlikely MD-83 or TDG-4 aircraft would exit or enter Runway 13-31 from Taxiway D due to the limited distance from runway touchdown markings.

There are currently two exit taxiways for Runway 8-26 landing operations. The exit taxiways are currently available at the end of each runway and where the runway crosses Taxiway C. **Improved exit taxiways at each end with an additional mid-field exit east of the runway intersection for small aircraft should be considered to help increase operational flow and capacity.**

Figure H-6 - FAA Airport Diagram



Source: [FAA Airport Diagrams]

Figure H-7 - FAA Taxiway Design Standards

Table 4-1. Design standards based on Airplane Design Group (ADG)

ITEM	DIM (See Figure 3-26)	ADG					
		I	II	III	IV	V	VI
TAXIWAY PROTECTION							
TSA	E	49 ft (15 m)	79 ft (24 m)	118 ft (36 m)	171 ft (52 m)	214 ft (65 m)	262 ft (80 m)
Taxiway OFA		89 ft (27 m)	131 ft (40 m)	186 ft (57 m)	259 ft (79 m)	320 ft (98 m)	386 ft (118 m)
Taxilane OFA		79 ft (24 m)	115 ft (35 m)	162 ft (49 m)	225 ft (69 m)	276 ft (84 m)	334 ft (102 m)
TAXIWAY SEPARATION							
Taxiway Centerline to Parallel Taxiway/Taxilane Centerline [1]	J	70 ft (21 m)	105 ft (32 m)	152 ft (46.5 m)	215 ft (65.5 m)	267 ft (81 m)	324 ft (99 m)
Taxiway Centerline to Fixed or Movable Object	K	44.5 ft (13.5 m)	65.5 ft (20 m)	93 ft (28.5 m)	129.5 ft (39.5 m)	160 ft (48.5 m)	193 ft (59 m)
Taxilane Centerline to Parallel Taxilane Centerline [1]		64 ft (19.5 m)	97 ft (29.5 m)	140 ft (42.5 m)	198 ft (60 m)	245 ft (74.5 m)	298 ft (91 m)
Taxilane Centerline to Fixed or Movable Object		39.5 ft (12 m)	57.5 ft (17.5 m)	81 ft (24.5 m)	112.5 ft (34 m)	138 ft (42 m)	167 ft (51 m)
WINGTIP CLEARANCE							
Taxiway Wingtip Clearance		20 ft (6 m)	26 ft (8 m)	34 ft (10.5 m)	44 ft (13.5 m)	53 ft (16 m)	62 ft (19 m)
Taxilane Wingtip Clearance		15 ft (4.5 m)	18 ft (5.5 m)	27 ft (6.5 m)	27 ft (8 m)	31 ft (9.5 m)	36 ft (11 m)

Note: 1. These values are based on wingtip clearances. If direction reversal between parallel taxiways is needed, use this dimension or the dimension specified in Table 4-14 or Table 4-15, whichever is largest.

Table 4-2. Design standards based on Taxiway Design Group (TDG)

ITEM	DIM (See Figure 4-6)	TDG							
		1A	1B	2	3	4	5	6	7
Taxiway Width	W	25 ft (7.5 m)	25 ft (7.5 m)	35 ft (10.5 m)	50 ft (15 m)	50 ft (15 m)	75 ft (23 m)	75 ft (23 m)	82 ft (25 m)
Taxiway Edge Safety Margin	TESM	5 ft (1.5 m)	5 ft (1.5 m)	7.5 ft (2 m)	10 ft (3 m)	10 ft (3 m)	15 ft (4.6m)	15 ft (4.6m)	15 ft (4.6m)
Taxiway Shoulder Width		10 ft (3 m)	10 ft (3 m)	15 ft (3 m)	20 ft (6 m)	20 ft (6 m)	30 ft (9 m)	30 ft (9 m)	40 ft (12 m)
Taxiway/Taxilane Centerline to Parallel Taxiway/Taxilane Centerline w/ 180 Degree Turn	J	See Table 4-14							
TAXIWAY FILLET DIMENSIONS		Table 4-3	Table 4-4	Table 4-5	Table 4-6	Table 4-7	Table 4-8	Table 4-9	Table 4-10

Source: [FAA AC 150/5300-13A, Airport Design]

Exhibit H-2 – Taxiway C1

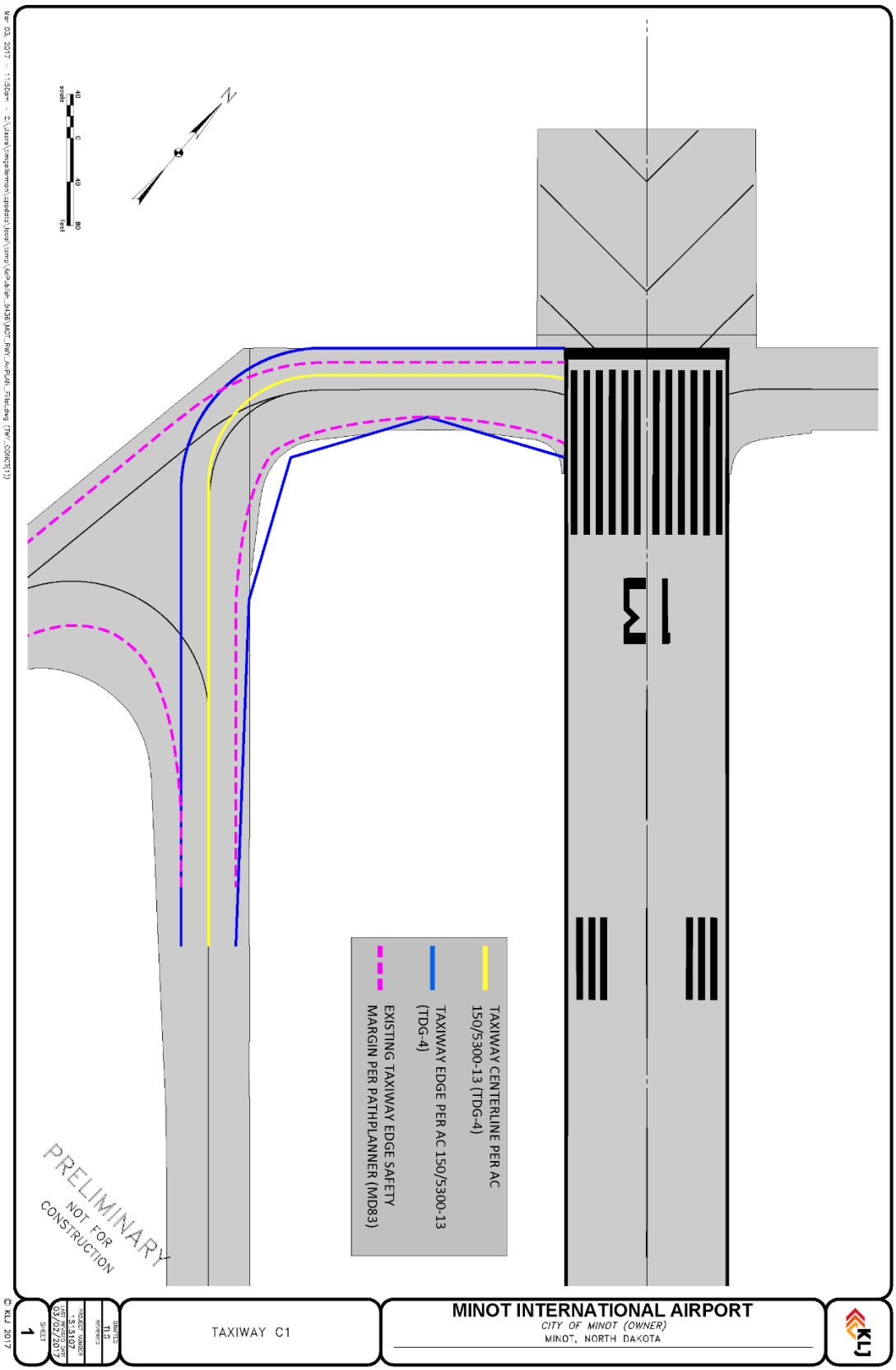


Exhibit H-3 – Taxiway C3

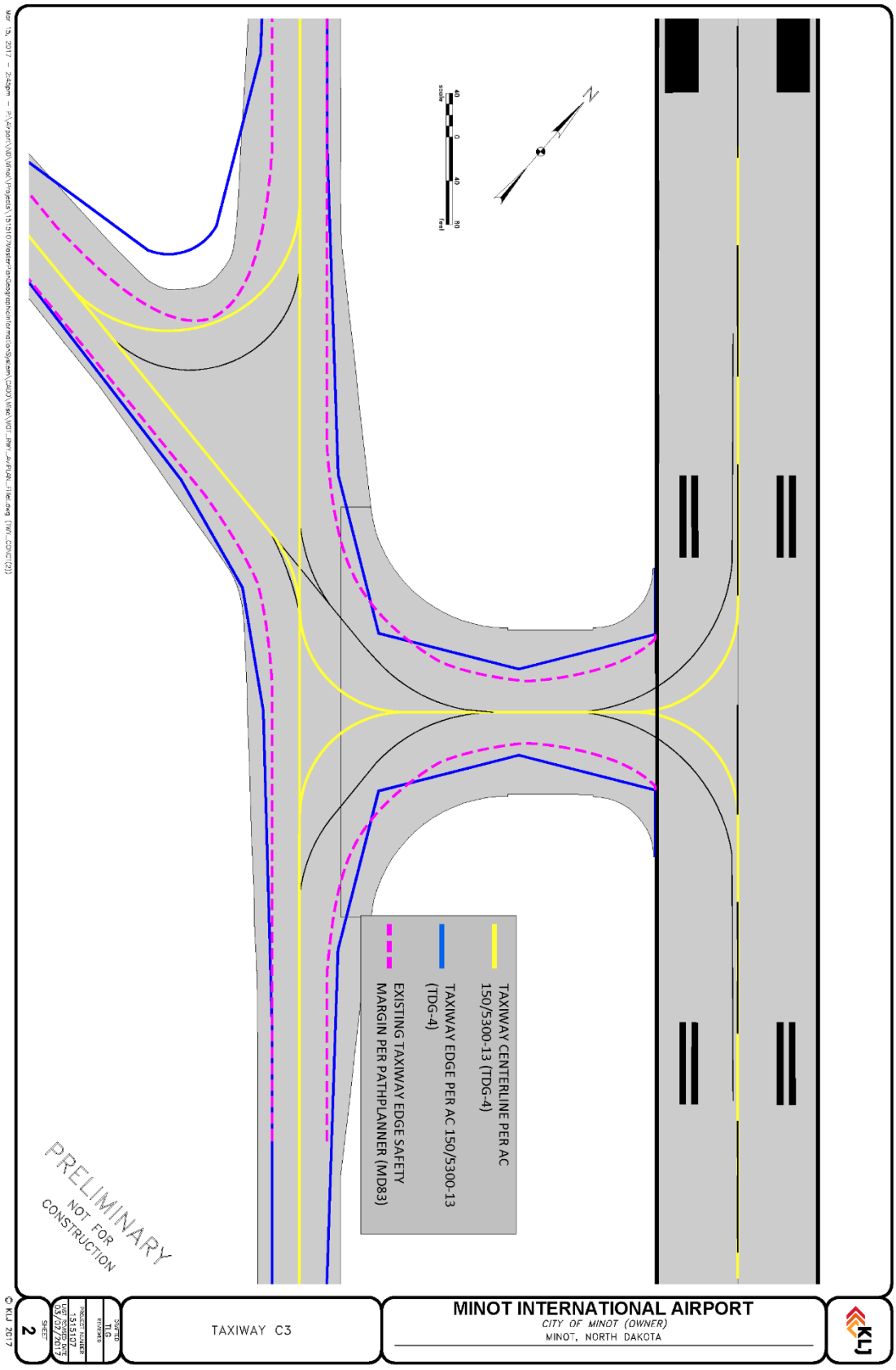


Exhibit H-4 – Taxiway C4

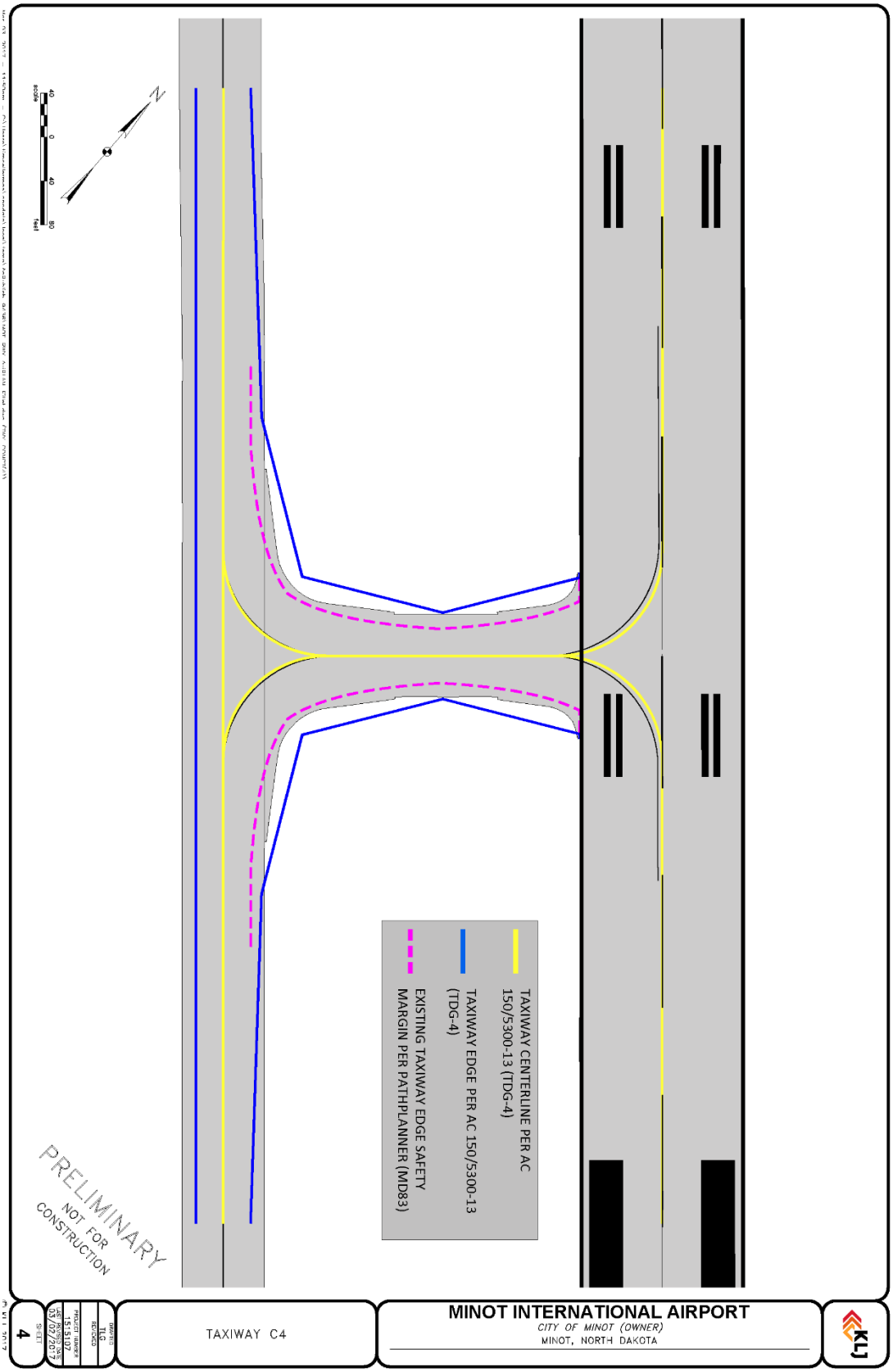


Exhibit H-5 – Taxiway C6

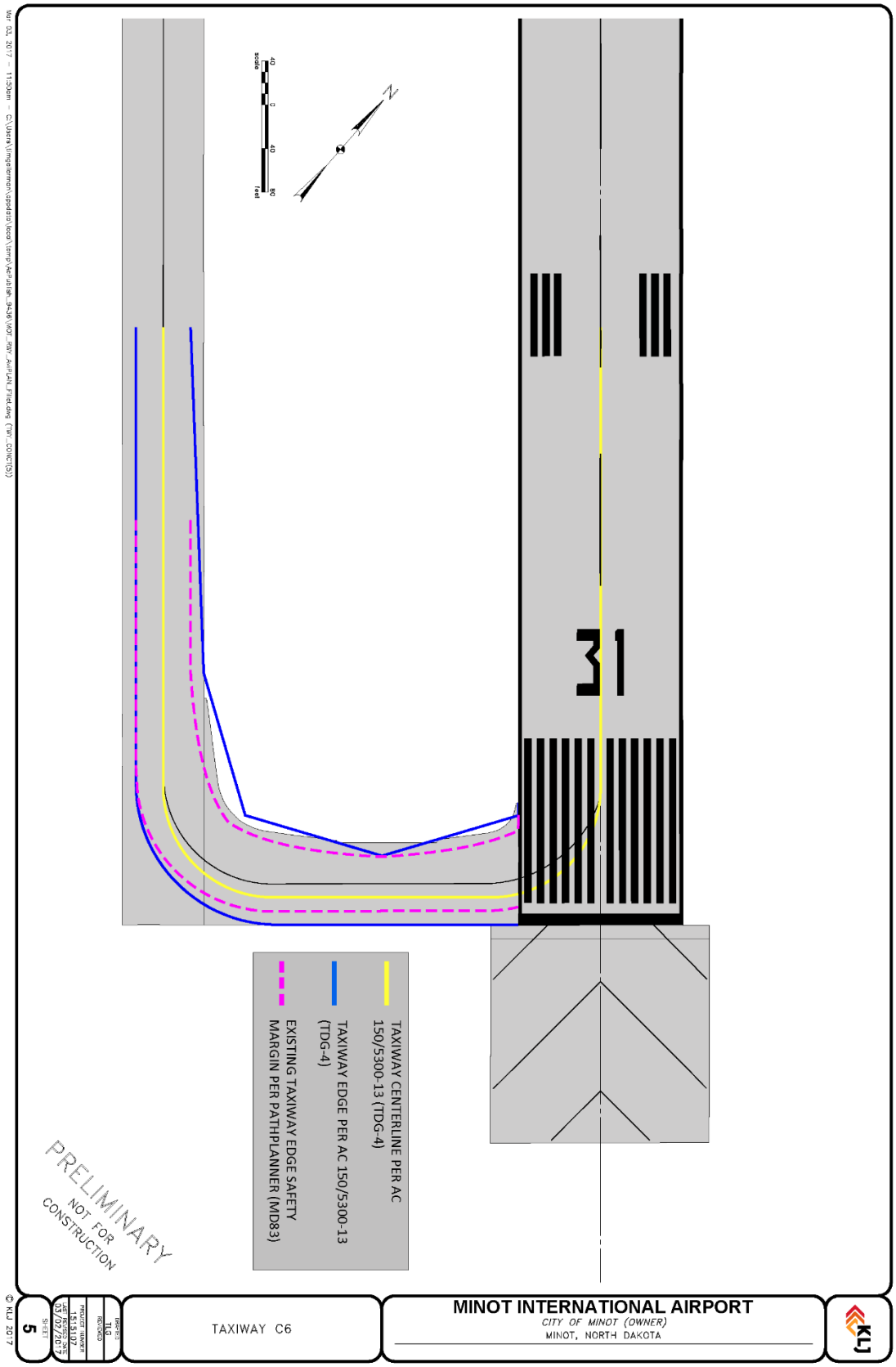
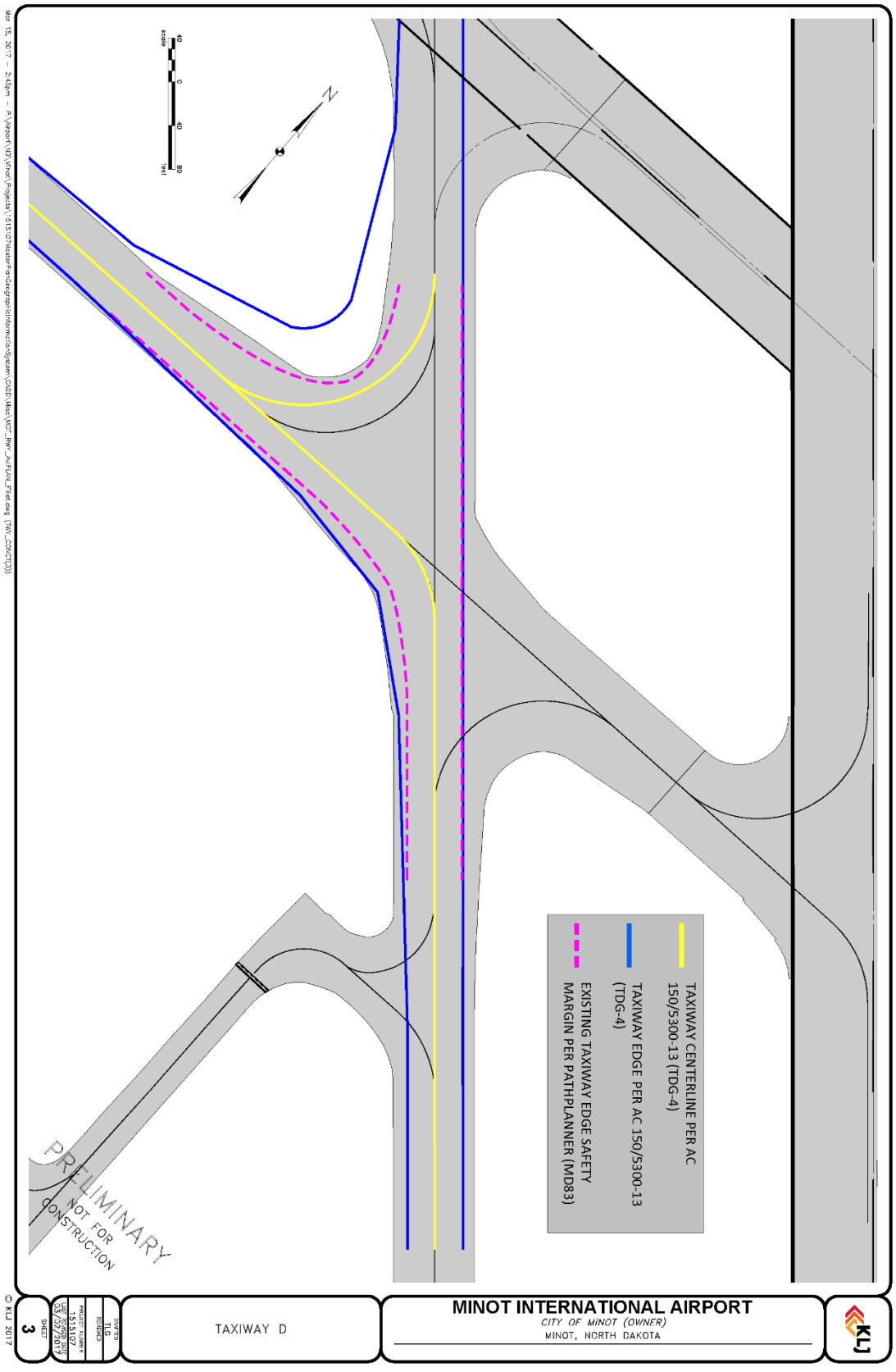


Exhibit H-6 – Taxiway D



Runway Length

Current Conditions

Runway 13-31 is the primary air carrier runway at the Minot International Airport. It is 7,700 feet long by 150 feet wide. Runway 8-26, the crosswind and secondary air carrier runway, is 6,351 feet long by 100 feet wide.

Runway Length Requirements

FAA Advisory Circular 150/5325-4B, *Runway Length Requirements for Airport Design* provides guidance on runway length requirements. The AC uses a five-step process to determine recommended runway lengths for a selected list of critical design airplanes. The five steps are as follows:

- **Step #1.** Identify the list of critical design airplanes that will make regular use of the proposed runway for an established planning period of at least five years. Critical design airplanes are the listing of airplanes (or a single airplane) that results in the longest recommended runway length. Federally funded projects require that critical design airplanes have at least 500 or more annual itinerant operations at the airport (landings and takeoffs are considered as separate operations).
- **Step #2.** Identify the airplanes that will require the longest runway lengths at maximum certificated takeoff weight (MTOW). This will be used to determine the method for establishing the recommended runway length. Except for regional jets, when the MTOW of listed airplanes is 60,000 pounds or less, the recommended runway length is determined according to a *family grouping of airplanes* having similar performance characteristics and operating weights. Although a number of regional jets have a MTOW less than 60,000 pounds, the exception acknowledges the long-range capability of the regional jets and the necessity to offer regional jet operators the flexibility to interchange regional jet models according to passenger demand without suffering operating weight restrictions. When the MTOW of listed airplanes is over 60,000 pounds, the recommended runway length is determined according to *individual airplanes*. The recommended runway length in the latter case is a function of the most critical individual airplane's takeoff and landing operating weights, which depend on wing flap settings, airport elevation and temperature, runway surface conditions (dry or wet), and effective runway gradient. The procedure assumes that there are no obstructions that would preclude the use of the full length of the runway.
- **Step #3.** Determine the method that will be used for establishing the recommended runway length. *Potential design airplanes* are categorized according to their MTOWs. MTOW is used because of the significant role played by airplane operating weights in determining runway lengths. Small airplanes, defined as airplanes with MTOW of 12,500 pounds or less, are further subdivided according to approach speeds and passenger seating. Regional jets are assigned to the same category as airplanes with a MTOW over 60,000 pounds. Airplane manufacturers' airport planning manuals (APM) provide the takeoff and landing runway lengths that an airport designer will in turn apply to the associated guidelines set forth by AC 150/5325-4B to obtain runway lengths.
- **Step #4.** Select the recommended runway length from among the various runway lengths generated by step #3 per the process identified in AC 150/5325-4B chapters 2, 3, or 4, as applicable.
- **Step #5.** Apply any necessary adjustment to the obtained runway length, when instructed by the applicable chapter of AC 150/5325-4B, to the runway length generated by step #4 to obtain

a final recommended runway length. For instance, an adjustment to the length may be necessary for runways with non-zero effective gradients. Chapter 5 of AC 150/5325-4B provides the rationale for these length adjustments.

In July 2013, FAA published draft guidance to determine runway lengths. FAA AC 150/5325-4C, *Runway Length Recommendations for Airport Design* uses a different process to determine recommended runway length. Large aircraft over 12,500 pounds and light jets require a review of the individual aircraft performance charts identified in APMs. This draft AC eliminates the standard charts available for aircraft greater than 12,500 pounds but less than 60,000 pounds in the -4B version of the AC. Based on industry feedback, the FAA is now reevaluating the analysis recommended in the -4C draft version but does not expect more definitive guidance until approximately 2018. In the interim, this plan uses the current -4B guidance with special consideration for specific demanding general aviation aircraft.

Determinations of Runway Length

The recommended runway lengths for both Runway 13-31 and Runway 8-26 have been determined based on the FAA process previously outlined.

AIRCRAFT LESS THAN AND EQUAL TO 60,000 POUNDS

The overall MOT design aircraft is a regional jet and other commercial aircraft greater than 60,000 pounds. However, the runway length needs of smaller aircraft that utilize MOT have also been evaluated. A summary of these results is in **Table H-10 and H-11** with supporting documentation found in **Figures H-10 through H-12**.

Table H-10 – FAA Recommended Runway Lengths (≤ 60,000 lbs.)

Standard	Runway Length
Small Aircraft (12,500 lbs. or less)	
Small Aircraft Less Than 10 Passengers	4,200 feet
Small Aircraft 10 or More Passengers	4,400 feet
Large Aircraft (Greater than 12,500 lbs. but less than 60,000 lbs.)	
75% of Aircraft Fleet @ 60% Useful Load, Dry Runway	5,400 feet
75% of Aircraft Fleet @ 60% Useful Load, Wet Runway	5,500 feet
75% of Aircraft Fleet @ 90% Useful Load, Dry Runway	6,900 feet
75% of Aircraft Fleet @ 90% Useful Load, Wet Runway	7,000 feet
100% of Aircraft Fleet @ 60% Useful Load, Wet Runway	6,100 feet
100% of Aircraft Fleet @ 90% Useful Load, Wet Runway	8,700 feet

Source: FAA AC 150/5325-4B, KLJ Analysis
NOTES: 75 percent of fleet aircraft are adjusted for Runway 8-26 slope gradient, 100 percent of fleet adjusted for Runway 13-31 slope gradient

The table above identifies general aviation aircraft flown for private and commercial purposes. Private and fractional ownership flights are subject to rules under Federal Aviation Regulation (FAR) Part 91 and commercial on-demand flights are subject to another more stringent set of rules under FAR Part 135. The recommended runway length is based on the type of aircraft, takeoff weight, runway condition and operating rules.

In 2015, there were 1,286 documented aircraft operations in business jet aircraft at MOT per FAA Traffic Flow Management System Count (TFMSC) data. A total of 936 operations were in an aircraft classified by FAA as 75 percent of the general aviation business jet fleet. Individual aircraft examples include:

- Cessna Citation I (ARC B-I, TDG-2): 177 annual operations
- Cessna Citation V/Ultra/Encore (ARC B-II, TDG-2): 110 annual operations

The length of Runway 13-31 is recommended to meet 75 percent of fleet at 90 percent useful load requirements. The 90 percent useful load category was selected because several destinations are more than 1,000 nautical miles away from MOT including airports in Alaska, Arizona, California and Texas. Under the current FAA guidance, the existing recommended runway length for up to 60,000-pound turbojet aircraft with a wet/slippery runway is 7,000 feet. Aircraft at 90 percent useful load would utilize Runway 13-31 for the prevailing wind. The number of operations by aircraft at 90 percent useful load that need Runway 8-26 is not anticipated to exceed the FAA's regular use threshold.

Operations on Runway 8-26 are needed during critical crosswind conditions for turboprop and turbojet aircraft over 12,500 pounds classified as ARC B-II. A total of 594 documented 2014 IFR operations were in ARC B-II business jet aircraft classified as 75 percent of fleet. There are also nearly 890 operations in large ARC B-II turboprop aircraft including the Metroliner III operated by Encore Air Cargo. ARC B-II aircraft need the use of Runway 8-26 to meet 13-knot all-weather wind coverage requirements. This occurs 5.49% of the time based on weather observations.

The FAA recommended runway length for large turboprop aircraft is 5,400 feet (dry runway). The recommend length for a turbojet runway with wet/slippery runways is 5,500 feet at 75 percent of fleet and 60 percent useful load.

The useful load was assumed to be 90 percent because common destinations are more than 1,000 nautical miles away from MOT including airports in Alaska, Arizona, California, and Texas. **Under the current FAA guidance, the existing recommended runway length for up to 60,000-pound aircraft is 7,000 feet. This standard would apply to Runway 8-26.**

In 2015 there were 350 annual operations in larger business jet aircraft that generally identify in the 100 percent of fleet category. This fleet mix is forecast to grow to ultimately exceed 500 annual operations. The FAA recommended runway length for 100 percent of fleet aircraft is 6,100 feet for a 60 percent useful load, and 8,700 feet based for a 90 percent useful load. These aircraft will utilize Runway 13-31 for length needs as they are higher crosswind-capable airplanes. This category of aircraft is not anticipated to regularly operate at 90 percent useful load at MOT. Examples of 100% of Fleet

- Gulfstream G100 (ARC C-II, TDG-2): 64 annual operations
- Cessna Citation IV: 60 annual operations (ARC B-II, TDG-2): 60 annual operations
- Gulfstream G400/G500 (ARC C-II, TDG-2): 51 annual operations

Individual aircraft characteristics were also reviewed to validate runway length needs. As an example, the Cessna Citation 680 Sovereign (ARC B-II) would require 5,500. The results are shown in **Table H-11**.

Table H-11 – Selected Aircraft Performance (≤ 60,000 lbs.)

Aircraft	ARC	Runway Length
Cessna Citation 680	B-II	5,500 feet

Source: Cessna Aircraft, KLJ Analysis

AIRCRAFT GREATER THAN 60,000 POUNDS

For aircraft greater than 60,000 pounds, IFR operations in 2014 were evaluated to determine the design aircraft and runway length requirements. The existing design aircraft with more than 500 annual operations is a MD-83 aircraft operated by Allegiant Airlines. This aircraft alone exceeds the FAA's regular use threshold. On a typical flight to Las Vegas or Phoenix/Mesa, the MD-83 requires 7,700 feet accounting for an 81.5° F (27.5° C) degree day and the actual Runway 13-31 runway slope gradient. This meets the existing runway length for Runway 13-31. Runway length requirements increase during individual peak hot days. On average, MOT experiences 3.7 days per year where the high temperature meets or exceeds 95° F (35° C). During these situations, the payload is reduced.

Allegiant Airlines MD-83 (Airliners.net)

The summary of the existing runway length requirements for Runway 13-31 are identified in **Table H-12**. **Figures H-13 through H-20** depict the airplane performance charts for each applicable airplane operating from MOT.

Table H-12 – Existing Aircraft Fleet Runway Length Analysis

Airline	Destination(s)	Aircraft	2014 Operations	Runway Length
United/Delta	Denver (DEN), Minneapolis/St. Paul (MSP)	CRJ-200	4,107	6,700 feet
Delta	Minneapolis/St. Paul (MSP)	E-170	1,821	5,500 feet
United, Other	Denver (DEN) Houston (IAH)	ERJ-135/145XR	764	6,400 feet[3]
Allegiant	Phoenix/Mesa (IWA), Las Vegas (LAS)	MD-83	545	**7,700 feet**[4]
Delta, Allegiant, United	Minneapolis/St. Paul (MSP), Phoenix/Mesa (IWA), Denver (DEN)	A319	438	5,000 feet
Delta/United	Minneapolis/St. Paul (MSP), Denver (DEN)	CRJ-700/900	352	7,100 feet
Other	Various	E-190	24	5,900 feet
Other	Laughlin, NV (IFP)/Various	Boeing 737-800	40	7,700 feet

Source: FAA Traffic Flow Management System, Boeing, Embraer, Airbus, Bombardier, KLJ Analysis
Note: Includes 450-foot increase in takeoff distance from 45-foot runway gradient on Runway 13-31
Green = Exceeds FAA regular use threshold of 500 annual operations

[3] Runway length assumes flights to Denver. Flights to Houston (charter; 105 departures in 2014) require 7,200 feet.
[4] MD-83 runway length increases to approximately 7,900 feet during a peak hot day of the year (95° F/35° C).

The future design aircraft with more than 500 annual operations is expected to evolve to an Airbus A320 as Allegiant airlines begins to phase out the MD-83 aircraft and emphasize the Airbus A320. Expected future service includes a nearly 1,500 nautical mile route to Orlando-Sanford. On this flight the A320 requires 7,700 feet accounting for an 81.5° F (27.5° C) degree day and the actual Runway 13-31 runway slope gradient. Warmer conditions may require additional runway length. If the MD-83 were to fly this route it would require upwards of 9,000 feet of runway length.

Allegiant Airlines Airbus A320 (Airliners.net)

Ultimate runway length planning includes considering new routes and aircraft types that require longer runway lengths. Examples include a longer-haul flight to Atlanta, for example, in a CRJ-900 regional jet may require as long as 8,500 feet during an 81.5° F degree day. A Boeing 737-800 may require the same length for a 1,800-mile stage length route to Cancun, Mexico.

The summary of the forecasted future/ultimate runway length requirements for Runway 13-31 are identified in **Table H-13**. **Figures H-21 through H-27** depict the airplane performance charts for potential future and ultimate phase design aircraft that may operate from MOT.

Table H-13 – Future/Ultimate Design Aircraft Fleet Runway Length Analysis

Airline	Destination(s)	Aircraft	Runway Length	Phase
Allegiant	Las Vegas, Los Angeles, Phoenix	Airbus A320	7,400 feet	Future
Allegiant	Orlando/Sanford (SFB)	Airbus A320	**7,700 feet**[5]	Future
United	Houston/Intercontinental (IAH)	EMB-145XR	7,200 feet	Ultimate
Delta	Atlanta/Hartsfield (ATL)	CRJ-900	**8,500 feet**	Ultimate
Other	Cancun, Mexico (CUN)	Boeing 737-800	**8,500 feet**	Ultimate

Source: Trillion Aviation, Boeing, Embraer, Airbus, Bombardier, KLJ Analysis
Note: Includes 450-foot increase in takeoff distance from 45-foot runway gradient on Runway 13-31

Table H-14 summarizes the recommended runway lengths for MOT.

Table H-14 – MOT Recommended Runway Lengths

	Existing Needs	Future	Ultimate
Primary Runway 13-31			
Runway Length	7,700 feet	7,700 feet	8,500 feet
Aircraft Type(s)	MD-83	Airbus A320	Boeing 737-800
Secondary Runway 8-26			
Runway Length	7,000 feet	7,000 feet	7,000 feet
Basis / Aircraft Type(s)	75% of Fleet, 90% Useful Load*	75% of Fleet, 90% Useful Load*	75% of Fleet, 90% Useful Load*

Source: FAA AC 150/5325-4B, Aircraft Performance Manuals, KLJ Analysis
**Aircraft greater than 12,500 pounds and up to 60,000 pounds.*

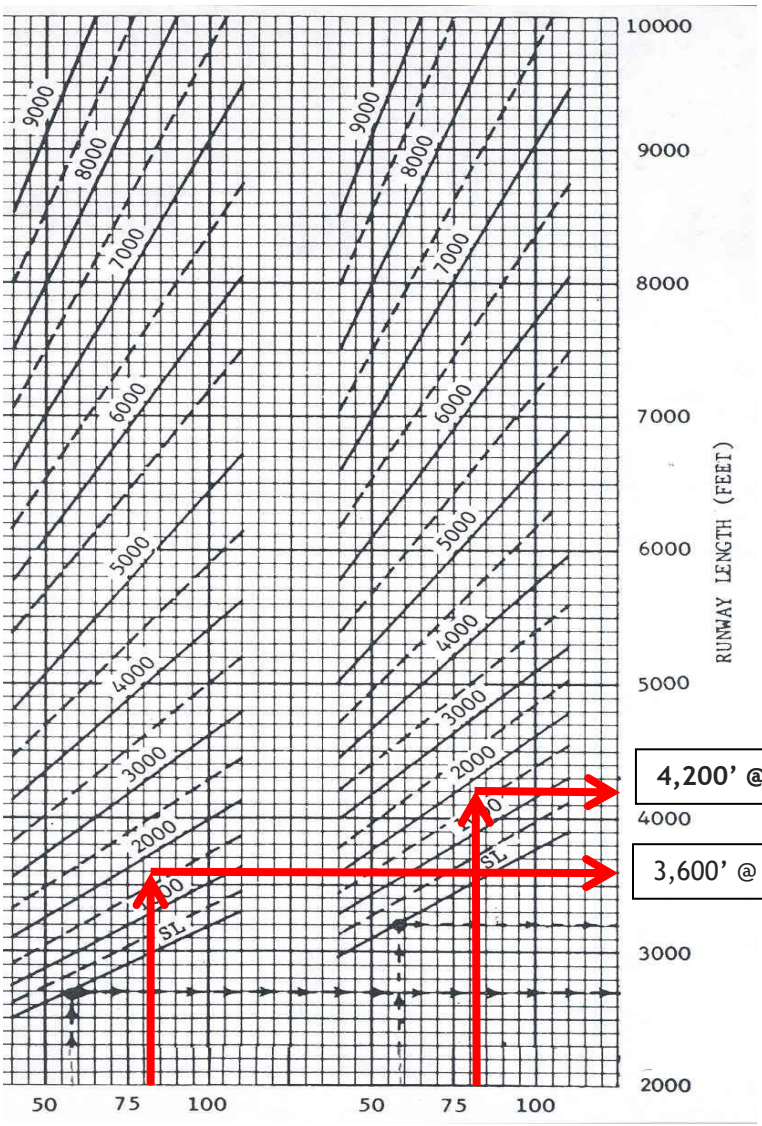
[5] A320 runway length increases to approximately 7,800 feet during a peak hot day of the year (95° F/35° C).

Figure H-8 - Small Aircraft Less than 10 Passengers

Minot International Airport (MOT)
Temperature: 81.5° F / 27.5° C - Airport Elevation: 1,716' MSL

Airport Elevation (feet)

95 Percent of Fleet 100 Percent of Fleet



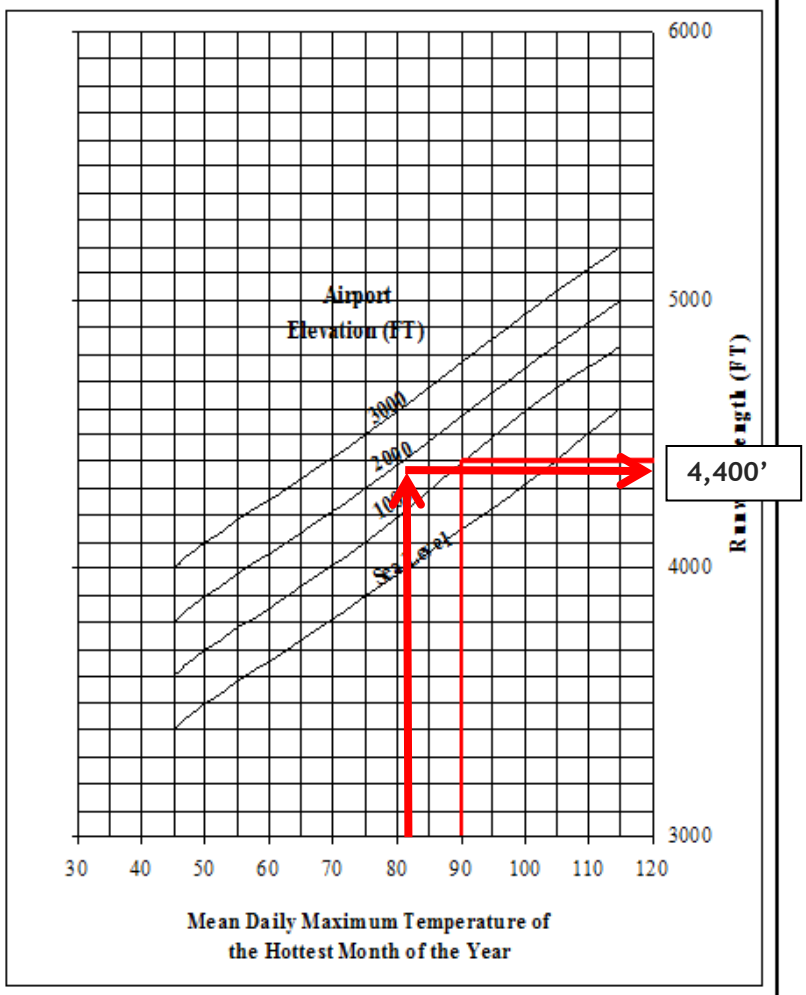
Mean Daily Maximum Temperature of the Hottest Month of Year
(Degrees F)

Recommended Runway Length @ 95 Percent of Fleet: **3,600 feet**
Recommended Runway Length @ 100 Percent of Fleet: **4,200 feet**

Figure H-9 - Small Aircraft Greater than 10 Passengers

Minot International Airport (MOT)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL

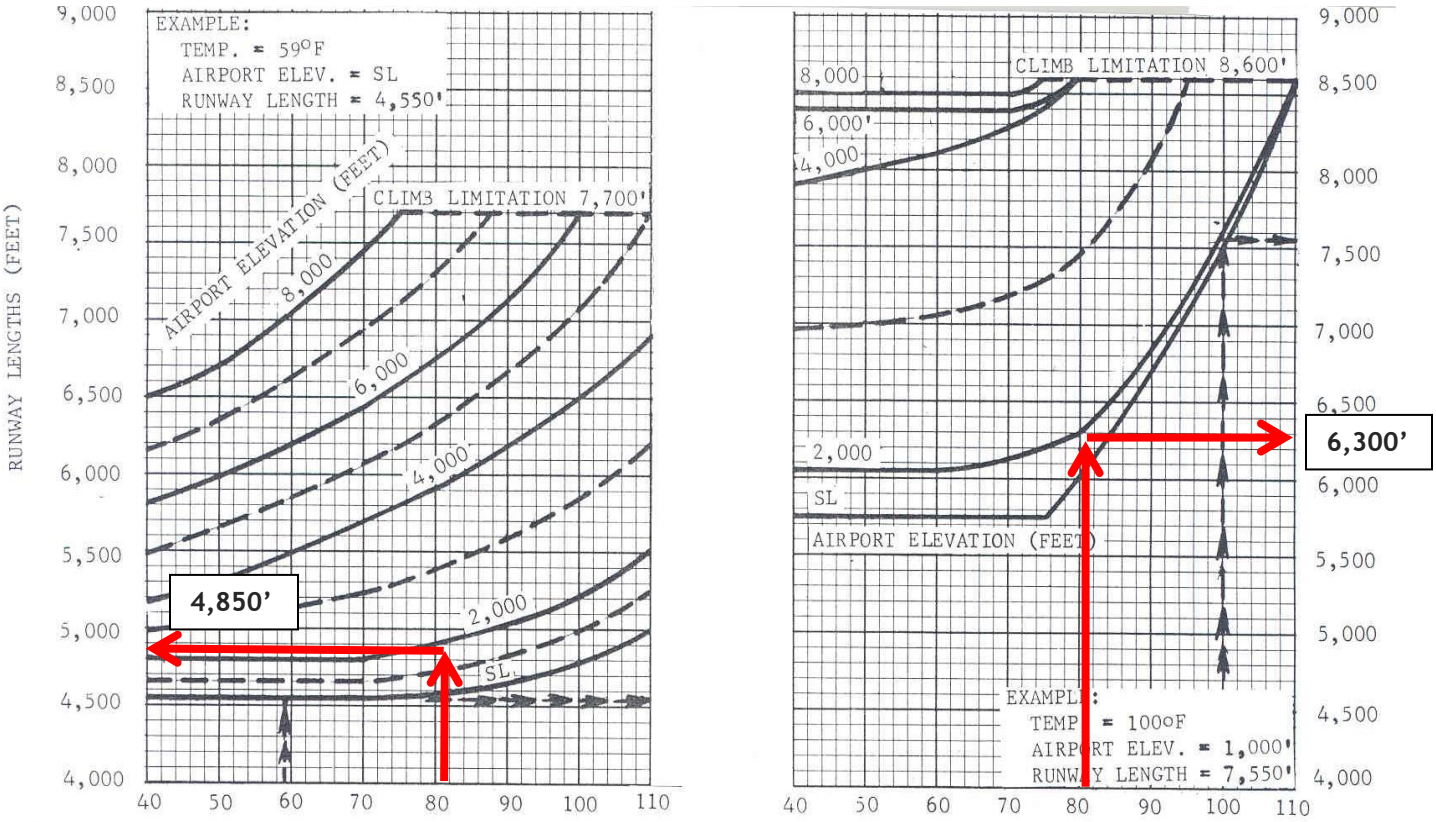
Representative Airplanes	Runway Length Curves
Raytheon B80 Queen Air **Raytheon** E90 King Air **Raytheon** B99 Airliner **Raytheon** A100 King Air (Raytheon formerly Beech Aircraft) **Britten-Norman** Mark III-I Trilander **Mitsubishi** MU-2L **Swearigen** Merlin III-A **Swearigen** Merlin IV-A **Swearigen** Metro II	**Example:** Temperature (mean day max hot month) 90° F (32° C) Airport Elevation (msl) 1,000 feet (328 m) Recommended Runway Length 4,400 feet (1,341 m) **Note:** For airport elevations above 3,000 feet (915 m), use the 100 percent of fleet grouping in figure 2-1.



Recommended Runway Length: **4,400 feet**

Figure H-10 - 75% of Aircraft More than 12,500 lbs. through 60,000 lbs.

Minot International Airport (MOT)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Distance
Maximum Difference in Runway 8-26 Centerline Elevation: 57 feet = 570 feet in Distance

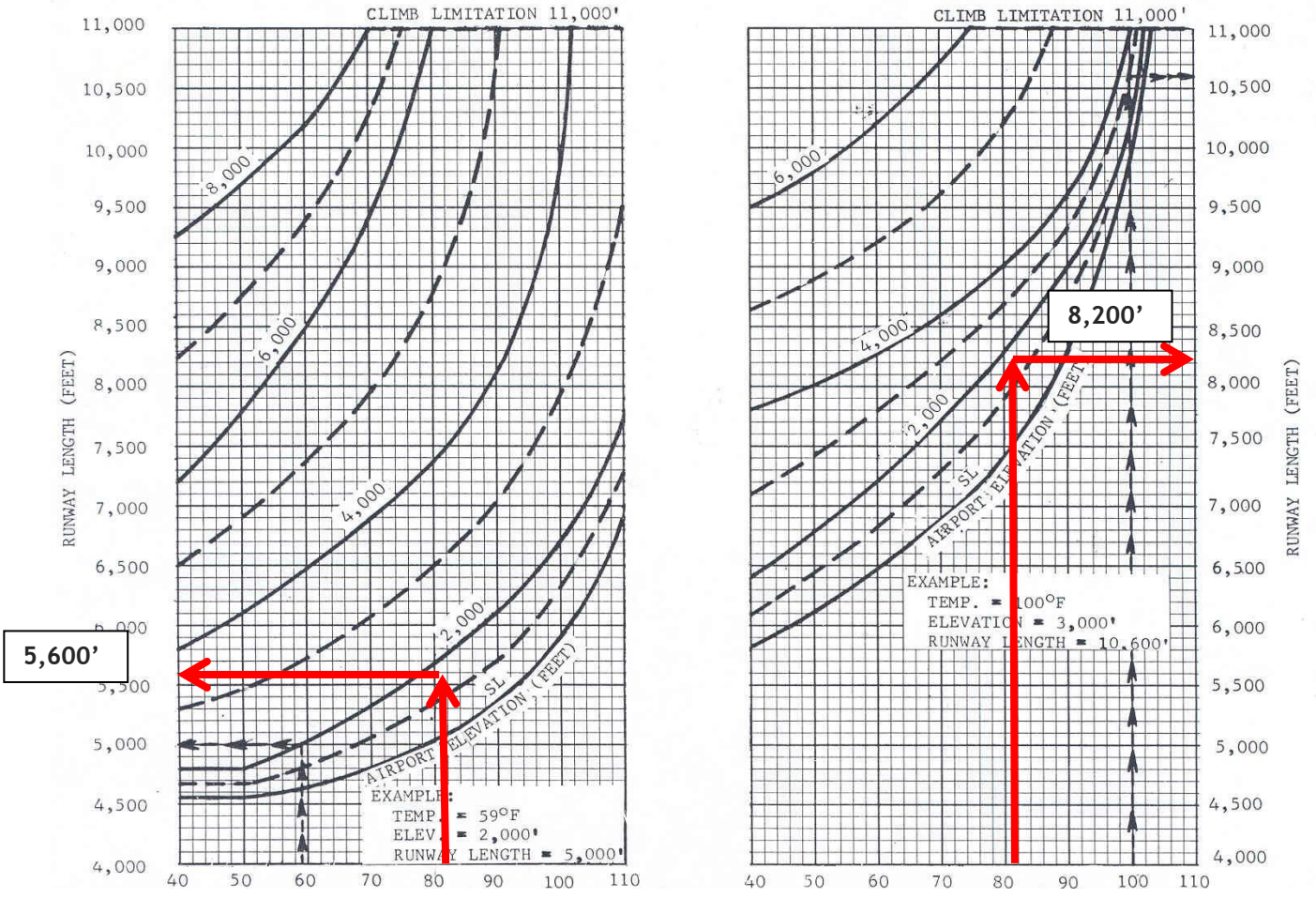


Recommended Runway Length @ 60 percent load (Dry Runway): 4,850' + 450' = **5,300 feet**
Recommended Runway Length @ 60 percent load (Dry Runway): 4,850' + 570' = **5,420 feet**
Recommended Runway Length @ 60 percent load (Wet Runway): **5,500 feet**

Recommended Runway Length @ 90 percent load (Dry Runway): 6,300' + 450' = **6,750 feet**
Recommended Runway Length @ 90 percent load (Dry Runway): 6,300' + 570' = **6,870 feet**
Recommended Runway Length @ 90 percent load (Wet Runway): **7,000 feet**

Figure H-11 - 100% of Aircraft More than 12,500 lbs. through 60,000 lbs.

Minot International Airport (MOT)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Distance
Maximum Difference in Runway 8-26 Centerline Elevation: 57 feet = 570 feet in Distance



Recommended Runway Length @ 60 percent load: 5,600' + 450' = **6,050 feet**
Recommended Runway Length @ 60 percent load: 5,600' + 570' = **6,170 feet**

Recommended Runway Length @ 90 percent load: 8,200' + 450' = **8,650 feet**
Recommended Runway Length @ 90 percent load: 8,200' + 570' = **8,770 feet**

Figure H-12 – Cessna Citation 680 - Sovereign (Example B-II Aircraft)

TAKEOFF PERFORMANCE

TAKEOFF FIELD LENGTH - 15° FLAPS
(Over 35 Foot Screen Height)
Dry Runway, Zero Wind, Anti-Ice Off, Cabin Bleed Air On

Elevation = 2,000 Feet

Ambient Temp °C / °F	Takeoff Weight (lb) 30,300	30,000	29,000	28,000	27,000	25,000	23,000	21,000
0 / 32	3,700	3,640	3,460	3,320	3,300	3,260	3,220	3,200
10 / 50	3,820	3,770	3,580	3,430	3,400	3,350	3,310	3,290
15 / 59	3,890	3,830	3,640	3,470	3,440	3,400	3,360	3,330
20 / 68	3,950	3,890	3,690	3,520	3,490	3,440	3,400	3,370
25 / 77	4,050	3,980	3,780	3,590	3,520	3,460	3,420	3,390
30 / 86	4,250	4,180	3,960	3,750	3,550	3,410	3,360	3,320
35 / 95	4,470	4,390	4,150	3,920	3,710	3,360	3,300	3,260
40 / 104	4,800	4,680	4,380	4,120	3,890	3,450	3,240	3,190
45 / 113	5,280	5,140	4,720	4,360	4,080	3,610	3,190	3,130
50 / 122	—	5,740	5,220	4,750	4,350	3,790	3,330	3,070
Climb Wght Temp Limits °C/°F	49/120	50/122	50/122	50/122	50/122	50/122	50/122	50/122
Field Length at Temp Limits (ft)	5,770	5,740	5,220	4,750	4,350	3,790	3,330	3,070

LANDING PERFORMANCE

LANDING DISTANCE - ACTUAL
(Distance from 50 Feet Above the Runway)
Flaps 35°, Dry Runway, Zero Wind, Anti-Ice On or Off

Elevation = 2,000 Feet

Ambient Temp °C / °F	Landing Weight (lb) 27,100	26,000	25,000	24,000	23,000	22,000	21,000	20,000
0 / 32	2,680	2,610	2,550	2,480	2,410	2,330	2,260	2,190
10 / 50	2,750	2,670	2,600	2,540	2,460	2,390	2,310	2,230
15 / 59	2,780	2,710	2,640	2,570	2,490	2,420	2,340	2,260
20 / 68	2,820	2,740	2,670	2,600	2,520	2,450	2,370	2,290
25 / 77	2,850	2,780	2,700	2,630	2,560	2,480	2,400	2,320
30 / 86	2,890	2,810	2,740	2,660	2,590	2,510	2,430	2,350
35 / 95	2,920	2,840	2,770	2,690	2,620	2,540	2,450	2,370
40 / 104	2,960	2,880	2,800	2,730	2,650	2,570	2,480	2,400
45 / 113	2,990	2,910	2,830	2,760	2,680	2,600	2,510	2,430
50 / 122	3,020	2,940	2,860	2,790	2,710	2,620	2,540	2,450
Lndg Wght Temp Limits °C/°F	50/122	50/122	50/122	50/122	50/122	50/122	50/122	50/122
V_{REF} (KIAS)	110	107	105	103	101	99	96	94

Part 91 Recommended Takeoff Length (Dry Runway) = **4,150 feet**
Part 91 Recommended Landing Length (Dry Runway) = **2,870 feet**

Part 91 Recommended Landing Length (Wet Runway): 2,870' + 15% = **3,300 feet**

Part 91K/135 Recommended Landing Length (Dry Runway): 2,870' + 60% = **4,783 feet**
Part 91K/135 Recommended Landing Length (Wet Runway): 4,783' + 15% = **5,500 feet**

Part 91K/135 Recommended Landing Length (Dry Runway @ 35°C): 2,920' + 60% = **4,933 feet**
Part 91K/135 Recommended Landing Length (Wet Runway @ 35°C): 4,933 + 15% = **5,700 feet**

EXISTING DESIGN AIRCRAFT FLEET

Aircraft	Airline	Destination Airport(s)	Figures
CRJ200	Delta, United	DEN – Denver International (CO) MSP – Minneapolis - St. Paul International (MN)	Figure H-13
E170	Delta	MSP – Minneapolis – St. Paul International (MN)	Figure H-14
E145XR	United	DEN – Denver International (CO)	Figure H-15
MD83	Allegiant	LAS – Las Vegas McCarran International (NV) IWA – Phoenix-Mesa Gateway International (AZ)	Figure H-16
A319	Delta	MSP – Minneapolis - St. Paul International (MN)	Figure H-17
CRJ900	Delta	MSP – Minneapolis - St. Paul International (MN)	Figure H-18
E190	Delta	MSP – Minneapolis - St. Paul International (MN)	Figure H-19
B737-800	Sun Country	IFP – Laughlin-Bullhead International (AZ)	Figure H-20

FUTURE DESIGN AIRCRAFT FLEET

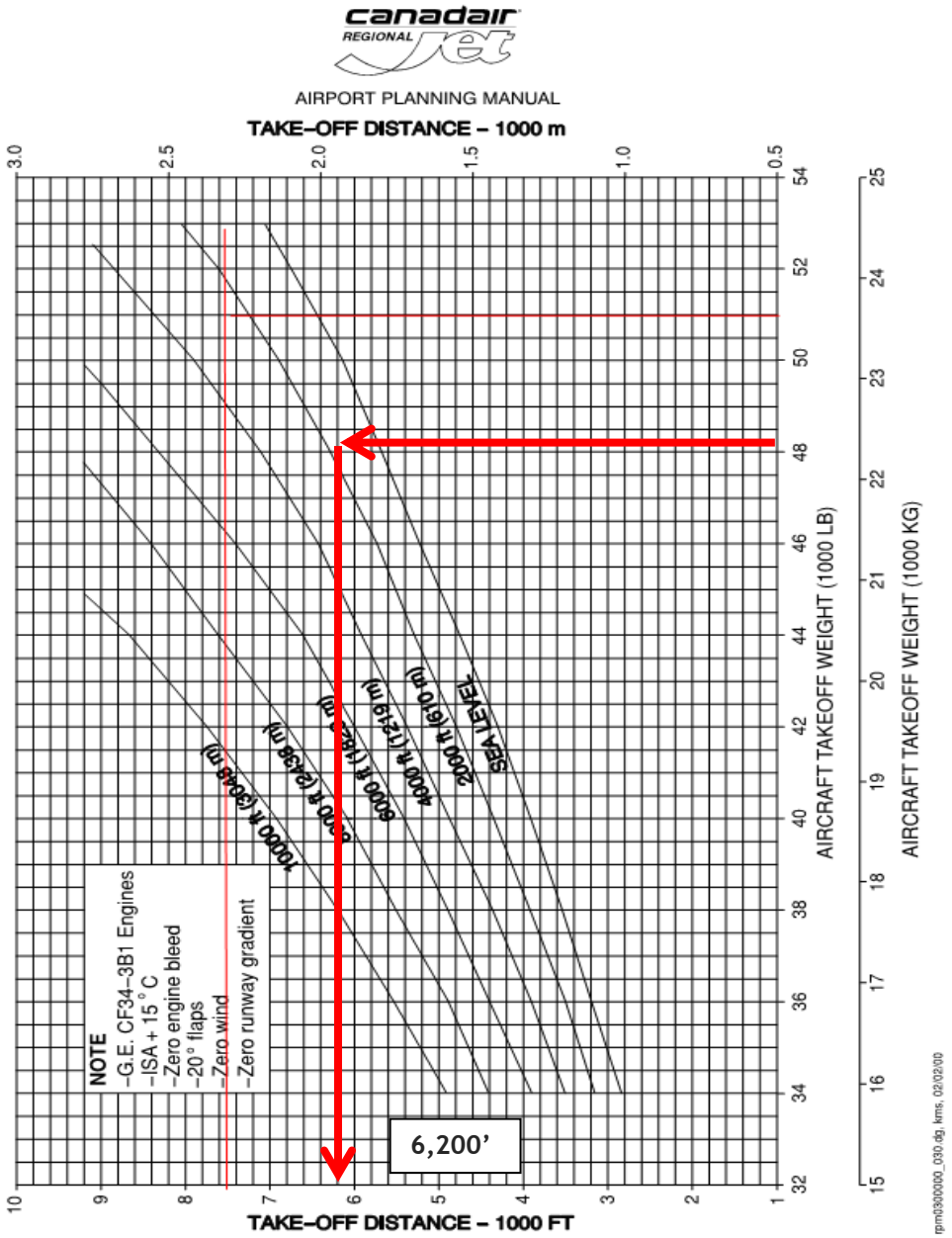
Aircraft	Airline	Destination Airport(s)	Figures
MD83	Allegiant	SFB – Orlando-Sanford International (FL)	Figure H-21
A320	Allegiant	LAS – Las Vegas McCarran International (NV) IWA – Phoenix-Mesa Gateway International (AZ) LAX – Los Angeles International (CA)	Figure H-22
A320	Allegiant	SFB – Orlando-Sanford International (FL)	Figure H-23

ULTIMATE DESIGN AIRCRAFT FLEET

Aircraft	Airline	Destination Airport(s)	Figures
E145XR	United	IAH – Bush Intercontinental (TX)	Figure H-24
CRJ900	Delta	ATL – Hartsfield-Jackson Atlanta International (GA)	Figure H-25
B737-800	Sun Country	CUN – Cancun International Airport (Mexico)	Figure H-26
B757-200	Allegiant	SFB – Orlando-Sanford International (FL)	Figure H-27

Figure H-13 - CRJ-200 Runway Length Requirements (DEN, MSP)

Maximum Takeoff Weight = 52,000 lbs.
Estimated Takeoff Weight for Route = 48,265 lbs. (79% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway 13-31 Length = 6,200' + 450' = 6,650' (**6,700 feet**)

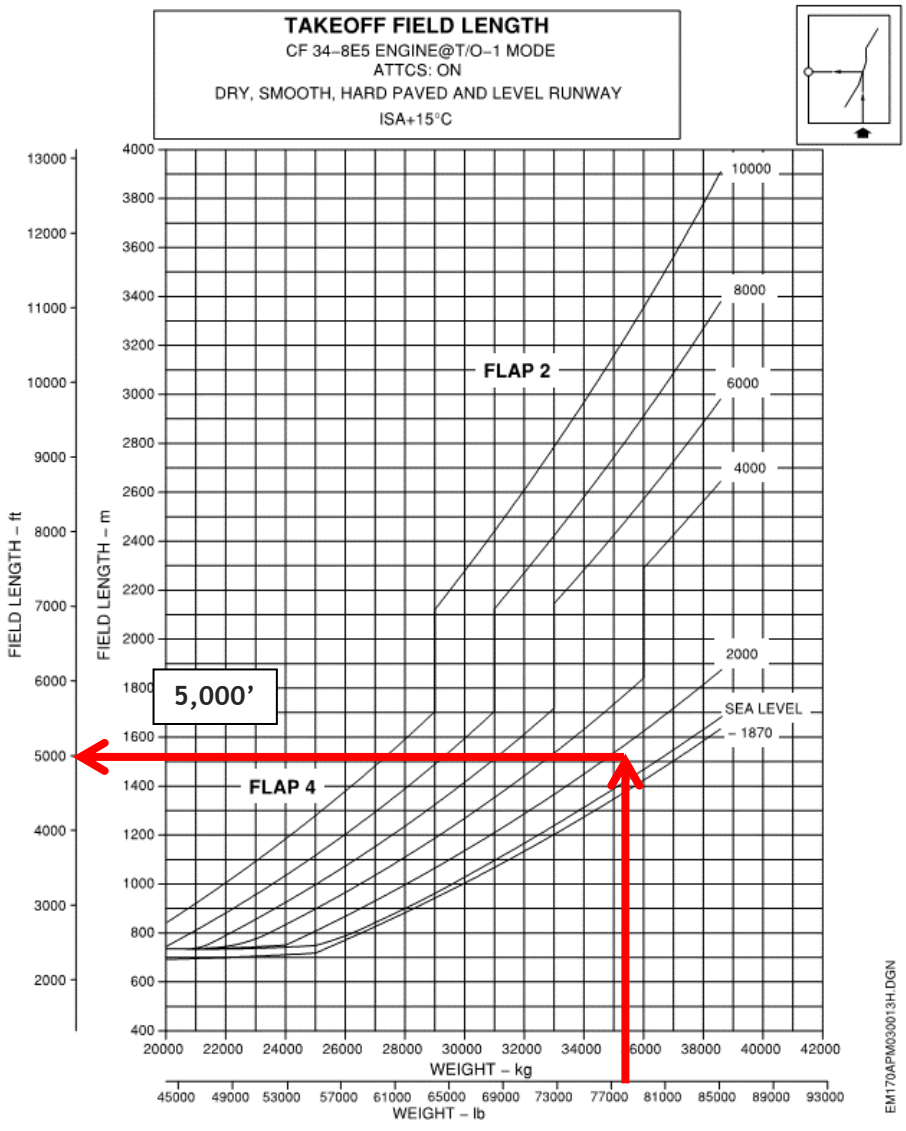


3.5.6. FAR Takeoff Runway Length Requirements – ISA + 15°C – CRJ200
Model CL–600–2B19

Figure H-14 – E170 Runway Length Requirements (MSP)

Maximum Takeoff Weight = 79,344 lbs.
Estimated Maximum Takeoff Weight for Route = 77,500 lbs. (94% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 5,000' + 450' = 5,450' (**5,500 feet**)

EMBRAER 170 AIRPORT PLANNING MANUAL



Takeoff Field Lengths - ISA + 15 °C Conditions
Figure 3.6

Figure H-15 – E-145XR Runway Length Requirements (DEN)

Maximum Takeoff Weight = 53,131 lbs.
Estimated Maximum Takeoff Weight for Route = 47,700 lbs. (78% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 5,900' + 450' = 6,350' (**6,400 feet**)

EMB145 EMBRAER AIRPORT PLANNING MANUAL

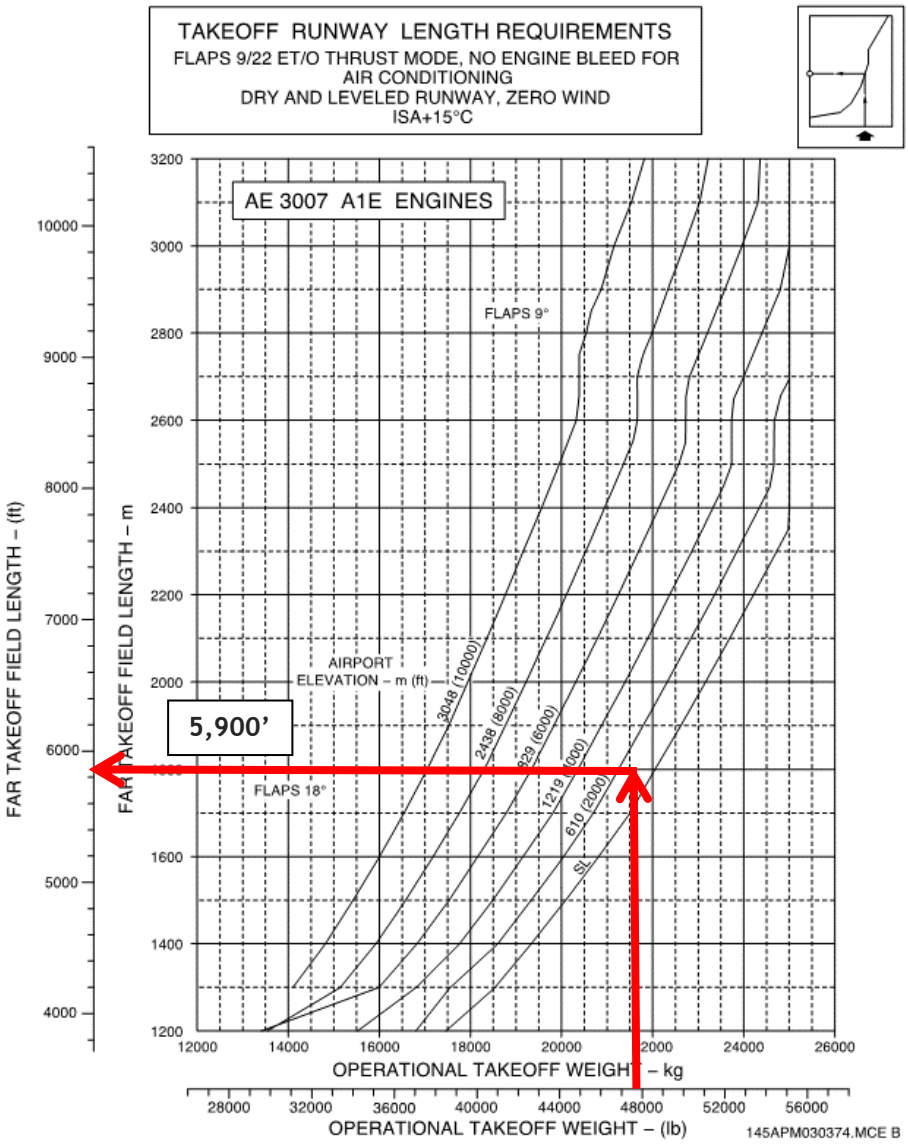
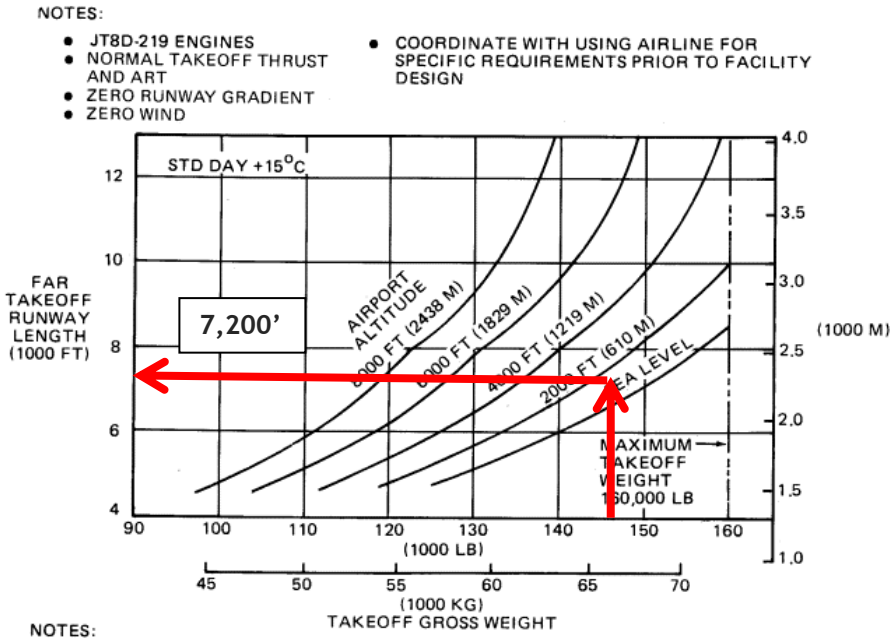
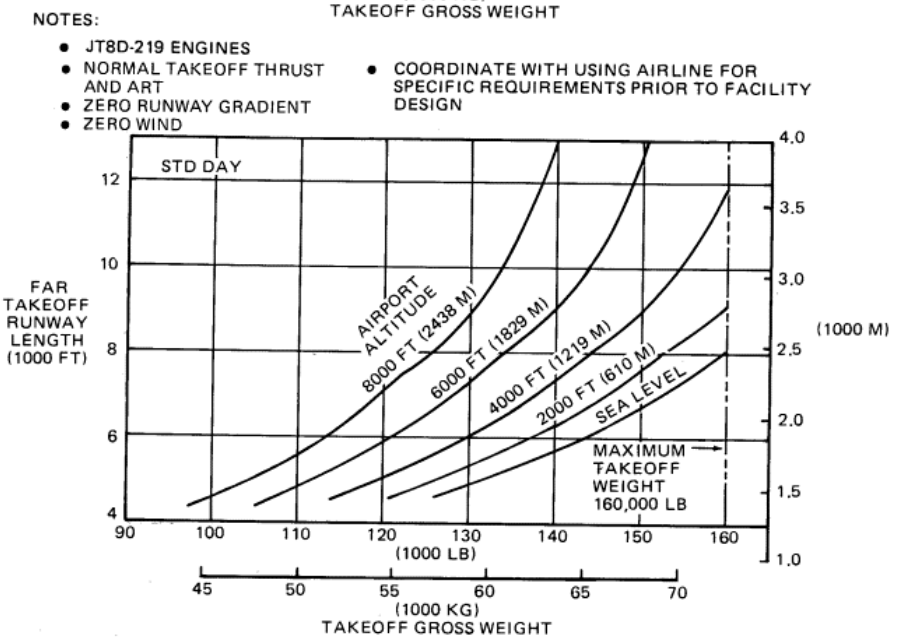


Figure 3.3.2 - FAR Takeoff Runway Length Requirements - ISA + 15°C Conditions
Sheet 3

Figure H-16 – MD-83 Runway Length Requirements (LAS, IWA)

Maximum Takeoff Weight = 160,000 lbs.
Estimated Maximum Takeoff Weight for Route = 146,600 lbs. (83% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 7,200' + 450' = 7,650' (**7,700 feet**)





3.3 FAR TAKEOFF RUNWAY LENGTH REQUIREMENTS
MODEL MD-83

Figure H-17 – Airbus A319 Runway Length Requirements (MSP)

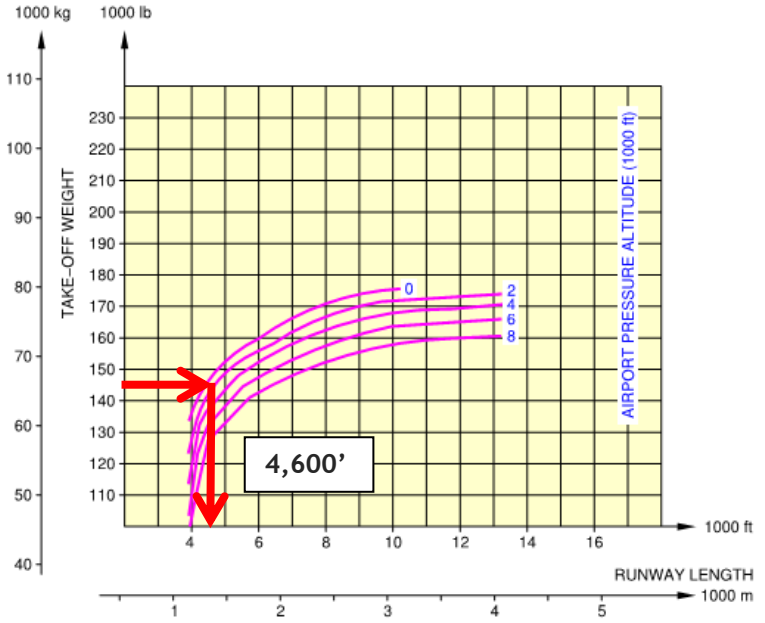
Maximum Takeoff Weight = 154,324 lbs.
Estimated Maximum Takeoff Weight for Route = 144,000 lbs. (83% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 4,600' + 450' = 5,050' (**5,100 feet**)

A319

AIRCRAFT CHARACTERISTICS - AIRPORT AND MAINTENANCE PLANNING

**ON A/C A319-100

NOTE: THESE CURVES ARE GIVEN FOR INFORMATION ONLY
THE APPROVED VALUES ARE STATED IN THE "OPERATING MANUALS" SPECIFIC TO THE AIRLINE OPERATING THE AIRCRAFT.



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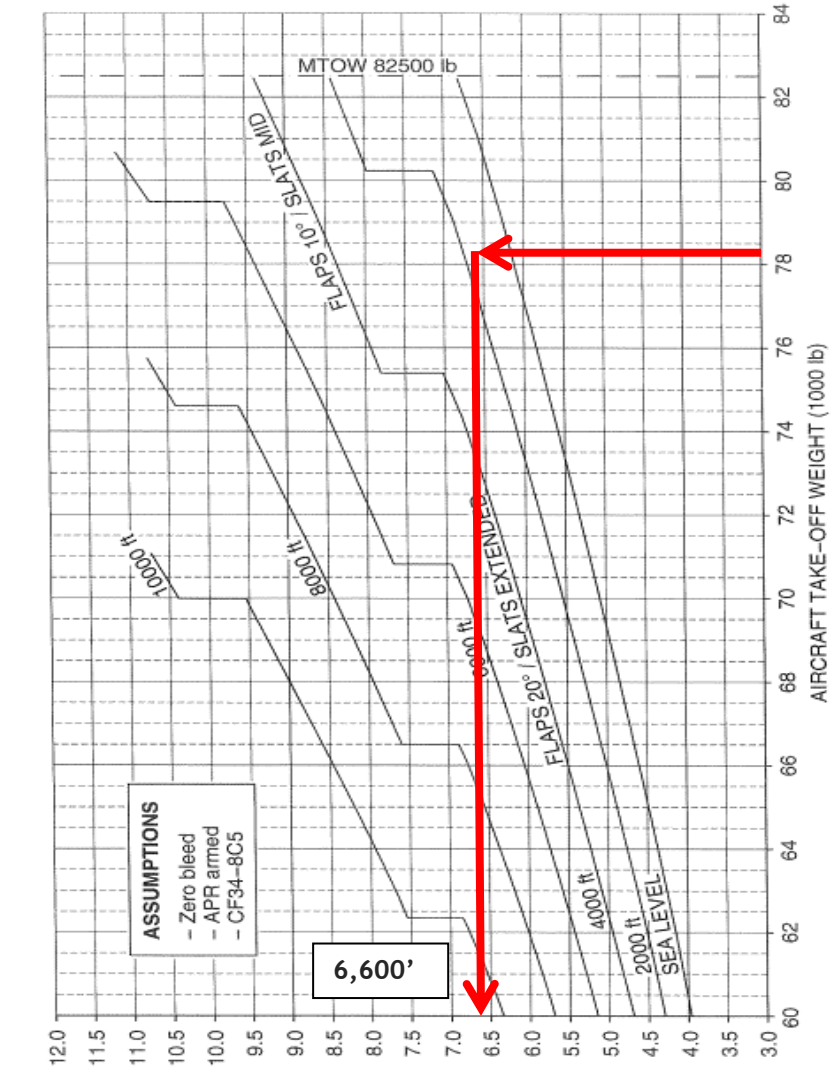
Take-Off Weight Limitation - ISA +15°C (+59°F) Conditions
IAE V2500 Series Engine
FIGURE-3-3-2-991-004-A01

Figure H-18 - CRJ-900 Runway Length Requirements (DEN, MSP)

Maximum Takeoff Weight = 82,500 lbs.
Estimated Maximum Takeoff Weight for Route = 80,300 lbs. (94% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 6,600' + 450' = 7,050' (**7,100 feet**)

CRJ SERIES Regional Jet
AIRPORT PLANNING MANUAL

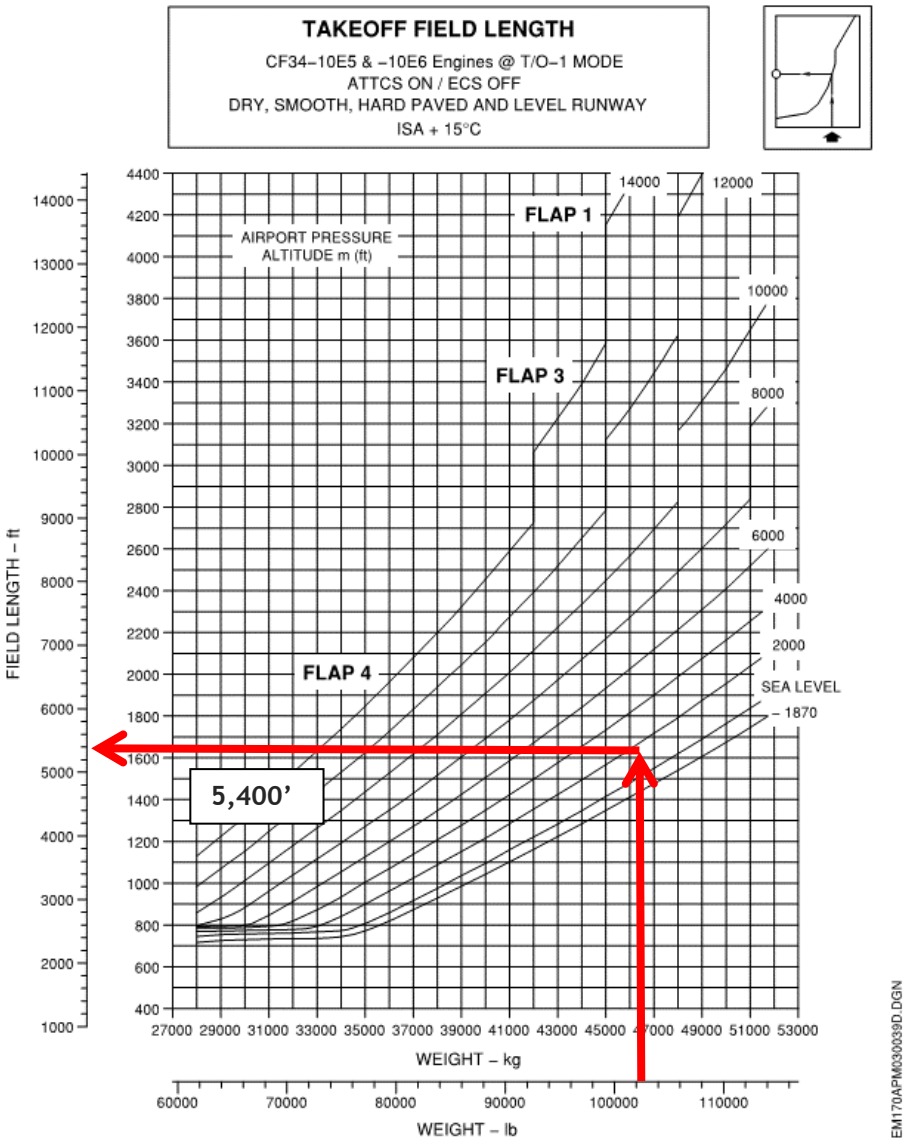


Take–Off Field Length – ISA + 15 Degrees C – Effectivity: 15001 – 15035
Figure 3

Figure H-19 – E-190 Runway Length Requirements (MSP, DEN)

Maximum Takeoff Weight = 105,359 lbs.
Estimated Maximum Takeoff Weight for Route = 102,900 lbs. (95% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 5,400' + 450' = 5,850' (**5,900 feet**)

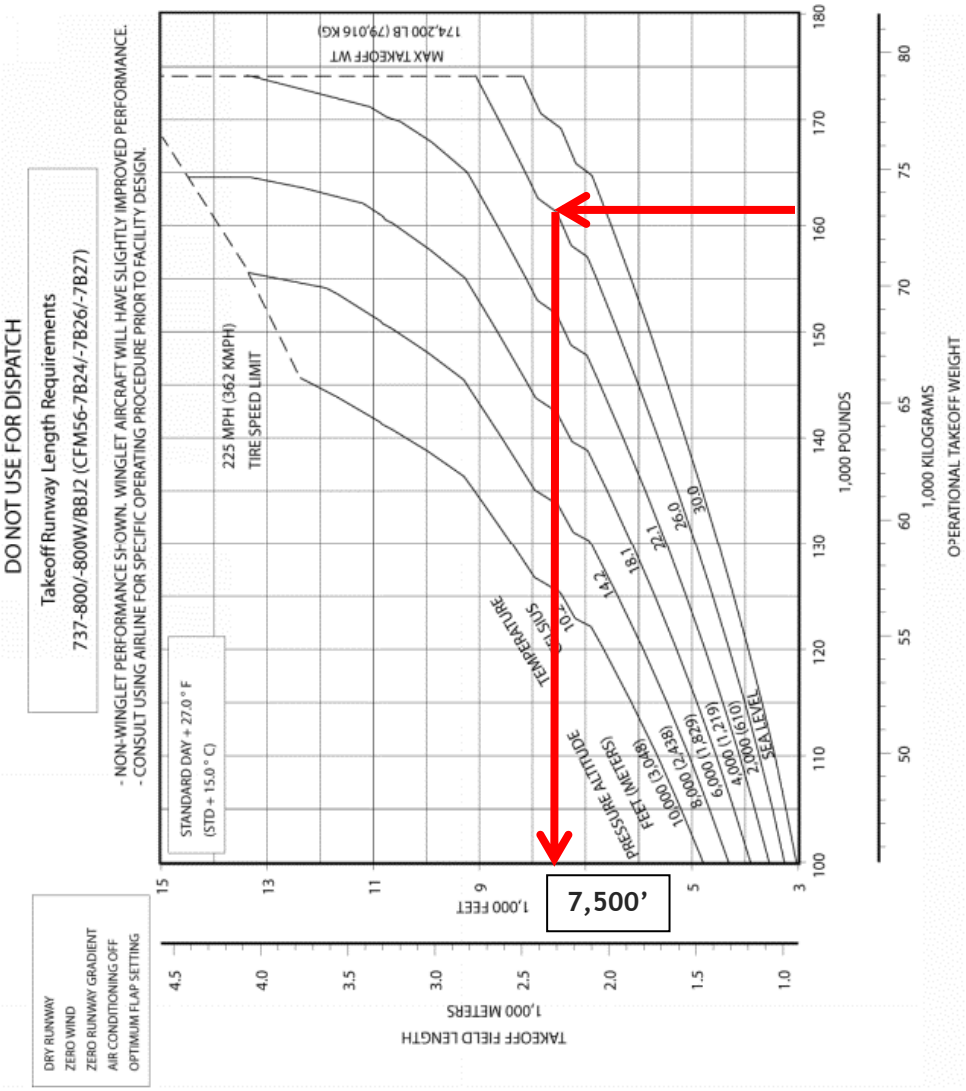
EMBRAER 190 AIRPORT PLANNING MANUAL



Takeoff Field Lengths - ISA + 15 °C Conditions
Figure 3.10

Figure H-20 – B737-800 Runway Length Requirements (IFP)

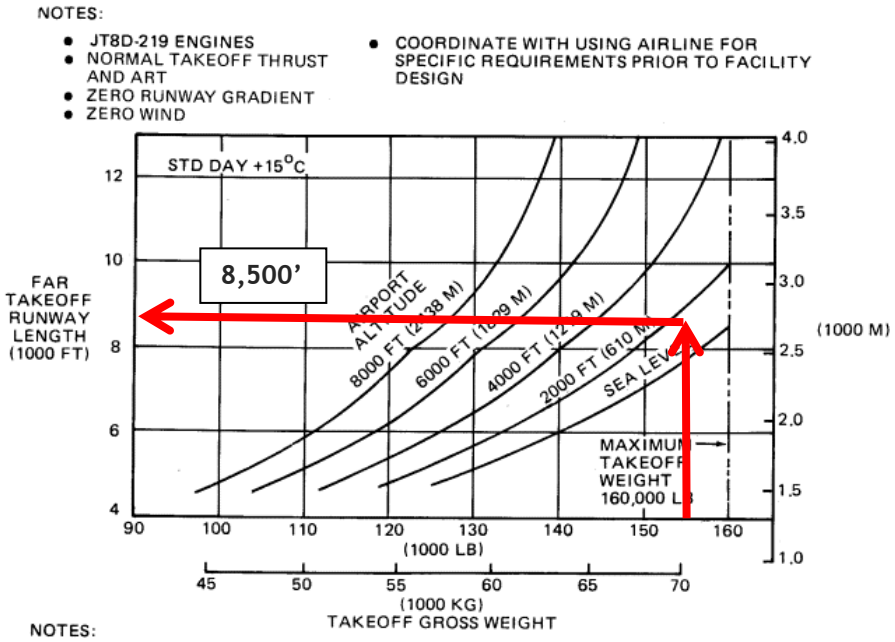
Maximum Takeoff Weight = 174,200 lbs.
Estimated Maximum Takeoff Weight for Route = 161,200 lbs. (85% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 7,500' + 450' = 7,950' (**8,000 feet**)

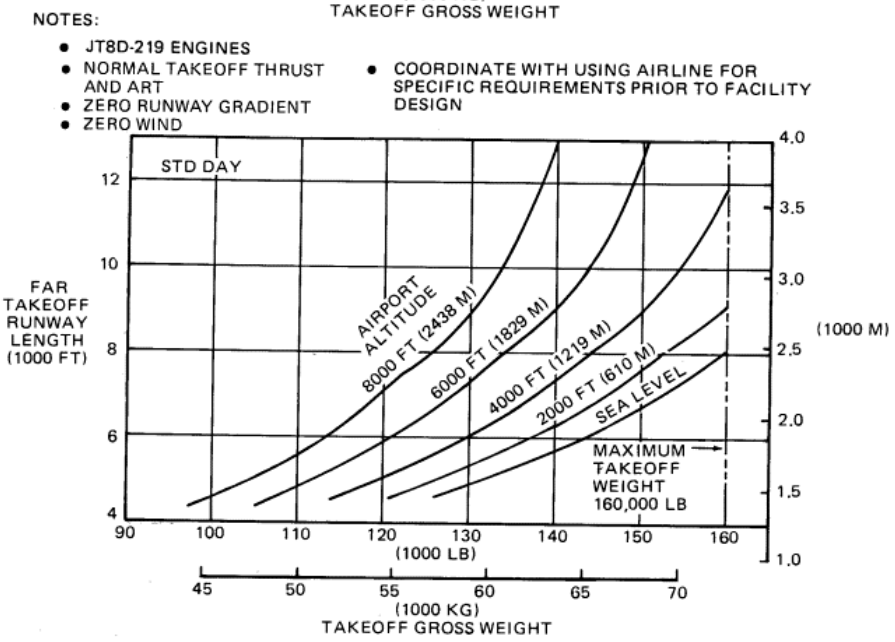


3.3.48 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS
STANDARD DAY +27°F (STD + 15°C), DRY RUNWAY
MODEL 737-800/-800W/BBJ2 (CFM56-7B24/-7B26/-7B27 ENGINES AT 26,000 LB SLST)

Figure H-21 – MD-83 Runway Length Requirements (SFB)

Maximum Takeoff Weight = 160,000 lbs.
Estimated Maximum Takeoff Weight for Route = 154,500 lbs. (93% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 8,500' + 450' = 8,950' (**9,000 feet**)





3.3 FAR TAKEOFF RUNWAY LENGTH REQUIREMENTS
MODEL MD-83

Figure H-22 – A320 Runway Length Requirements (LAS, IWA, LAX)

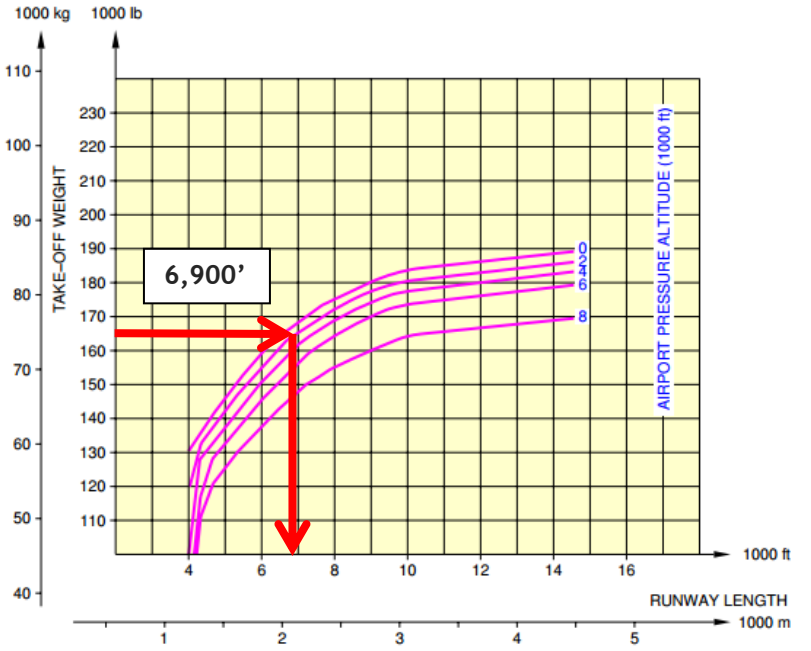
Maximum Takeoff Weight = 171,961 lbs.
Estimated Maximum Takeoff Weight for Route = 164,290 lbs. (90% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 6,900' + 450' = 7,350' (**7,400 feet**)

A320

AIRCRAFT CHARACTERISTICS - AIRPORT AND MAINTENANCE PLANNING

**ON A/C A320-200

NOTE: THESE CURVES ARE GIVEN FOR INFORMATION ONLY
THE APPROVED VALUES ARE STATED IN THE "OPERATING MANUALS" SPECIFIC TO THE AIRLINE OPERATING THE AIRCRAFT.



N_AC_030302_1_0060101_01_00

Take-Off Weight Limitation - ISA +15°C (+59°F) Conditions
IAE V2500 Series Engine
FIGURE-3-3-2-991-006-A01

Figure H-23 – A320 Runway Length Requirements (SFB)

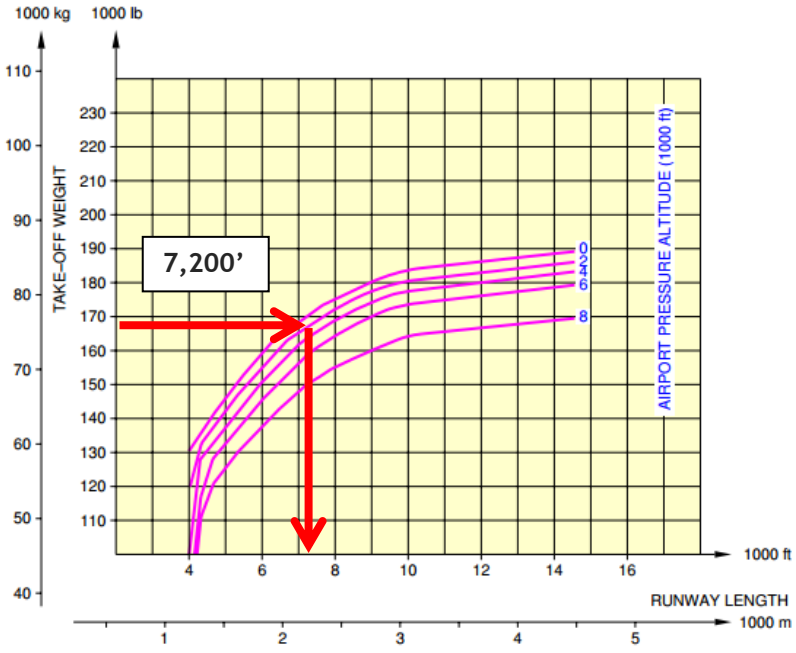
Maximum Takeoff Weight = 171,961 lbs.
Estimated Maximum Takeoff Weight for Route = 168,510 lbs. (96% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 7,200' + 450' = 7,650' (**7,770 feet**)

A320

AIRCRAFT CHARACTERISTICS - AIRPORT AND MAINTENANCE PLANNING

**ON A/C A320-200

NOTE: THESE CURVES ARE GIVEN FOR INFORMATION ONLY
THE APPROVED VALUES ARE STATED IN THE "OPERATING MANUALS" SPECIFIC TO THE AIRLINE OPERATING THE AIRCRAFT.



N_AC_030302_1_0060101_01_00

Take-Off Weight Limitation - ISA +15°C (+59°F) Conditions
IAE V2500 Series Engine
FIGURE-3-3-2-991-006-A01

Figure H-24 – E-145XR Runway Length Requirements (IAH)

Maximum Takeoff Weight = 53,131 lbs.
Estimated Maximum Takeoff Weight for Route = 50,300 lbs. (89% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 6,700' + 450' = 7,150' (**7,200 feet**)

EMB145 EMBRAER AIRPORT PLANNING MANUAL

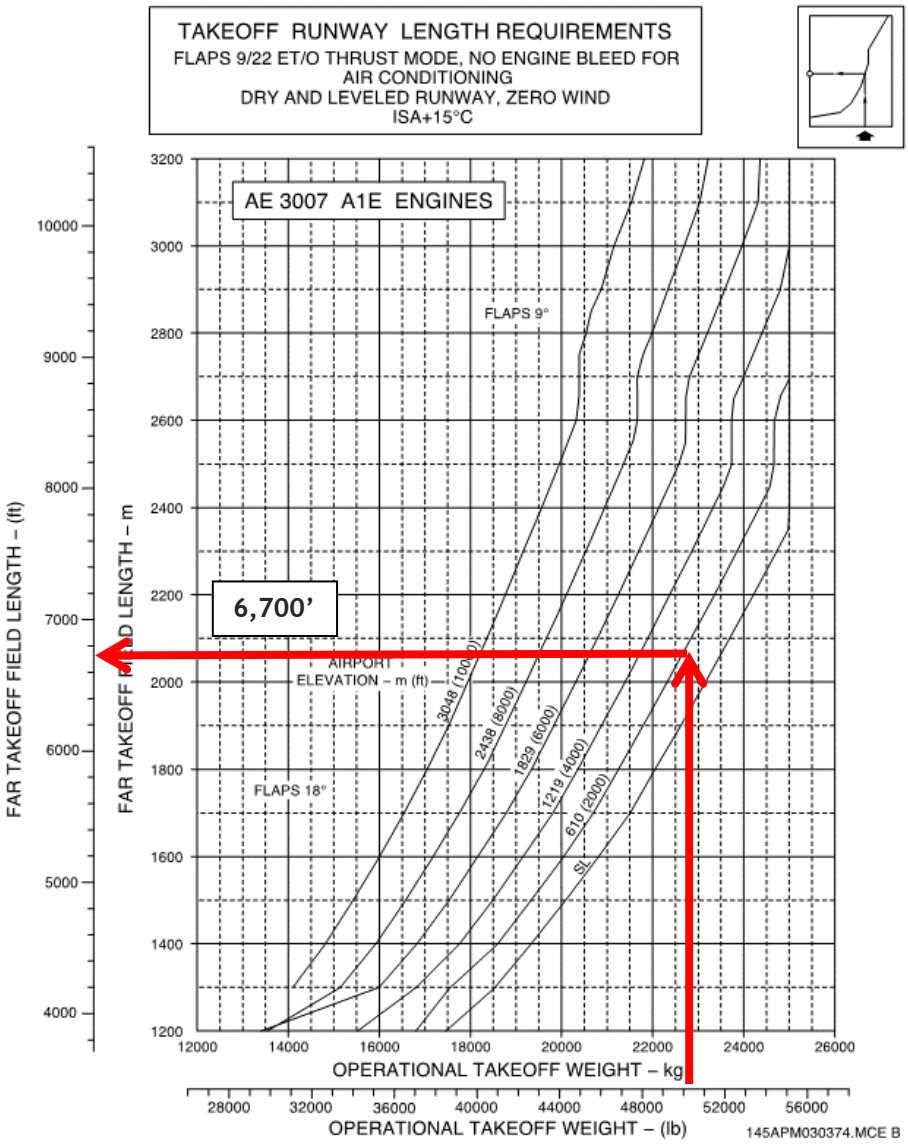
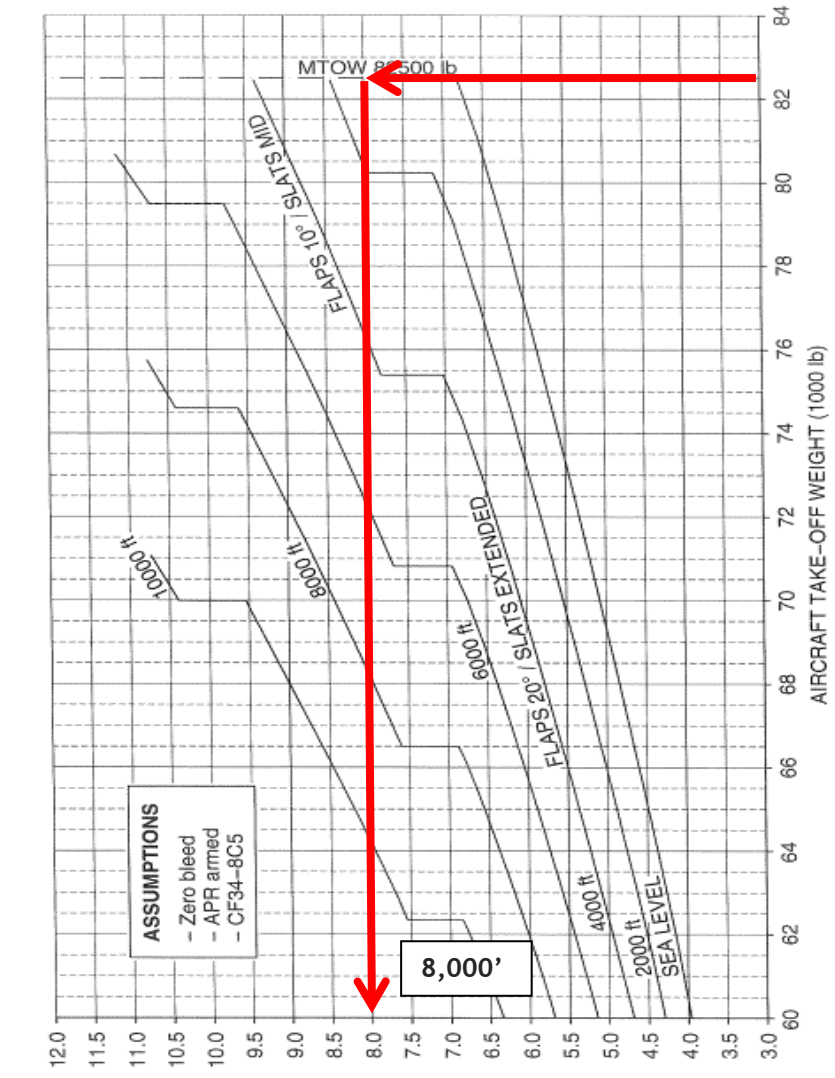


Figure 3.3.2 - FAR Takeoff Runway Length Requirements - ISA + 15°C Conditions
Sheet 3

Figure H-25 - CRJ-900 Runway Length Requirements (ATL)

Maximum Takeoff Weight = 82,500 lbs.
Estimated Maximum Takeoff Weight for Route = 82,500 lbs. (100% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 8,000' + 450' = 8,450' (**8,500 feet**)

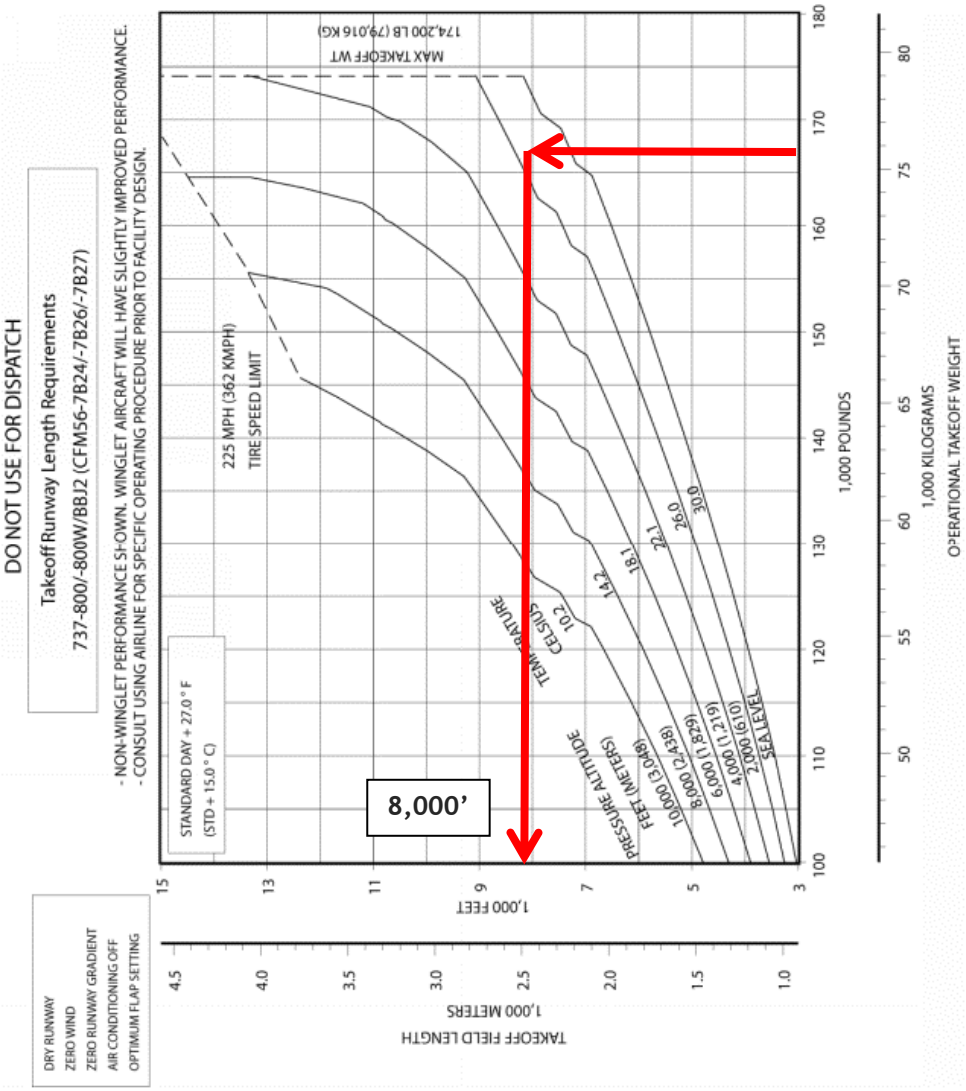
CRJ SERIES Regional Jet
AIRPORT PLANNING MANUAL



Take–Off Field Length – ISA + 15 Degrees C – Effectivity: 15001 – 15035
Figure 3

Figure H-26 – B737-800 Runway Length Requirements (CUN)

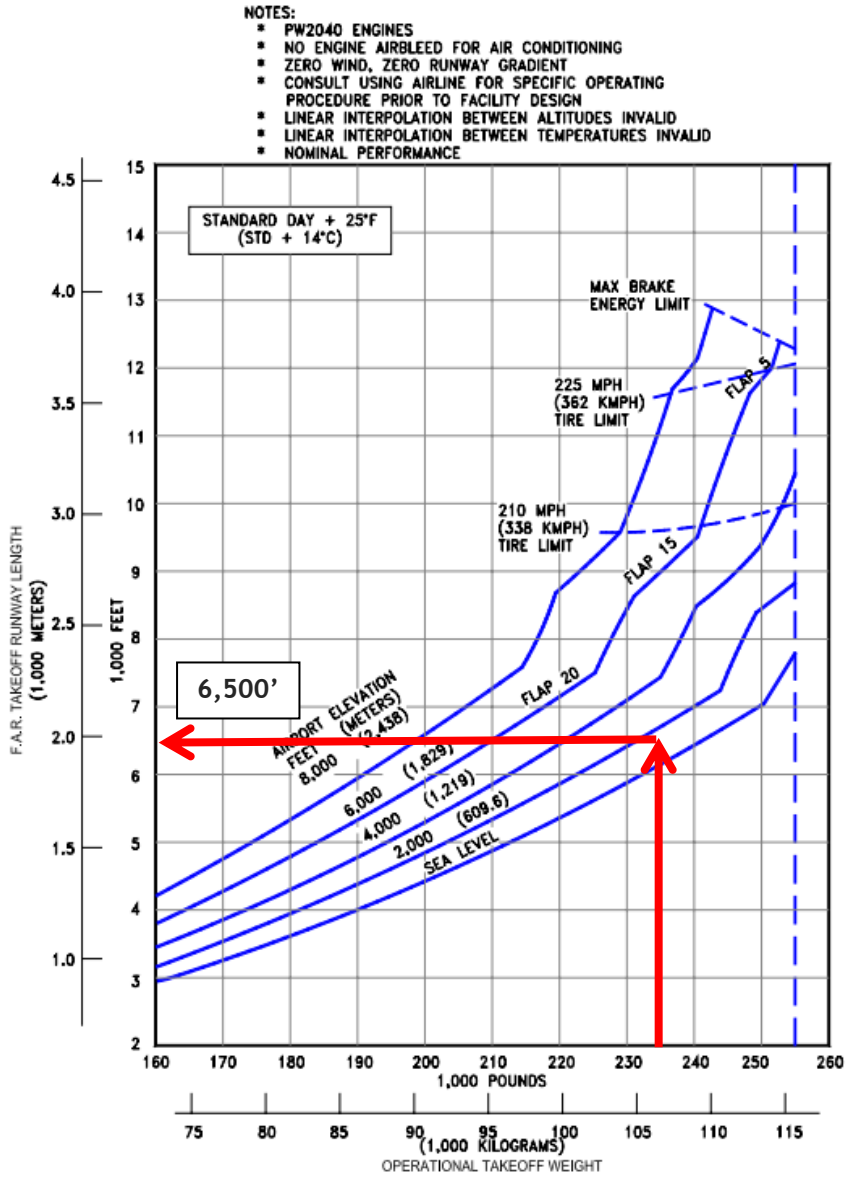
Maximum Takeoff Weight = 174,200 lbs.
Estimated Maximum Takeoff Weight for Route = 166,800 lbs. (91% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 8,000' + 450' = 8,450' (**8,500 feet**)



3.3.48 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS
STANDARD DAY +27°F (STD + 15°C), DRY RUNWAY
MODEL 737-800/-800W/BBJ2 (CFM56-7B24/-7B26/-7B27 ENGINES AT 26,000 LB SLST)

Figure H-27 – B757-200 Runway Length Requirements (SFB)

Maximum Takeoff Weight = 255,000 lbs.
Estimated Maximum Takeoff Weight for Route = 235,000 lbs. (84% Load)
Temperature: 81.5°F / 27.5°C - Airport Elevation: 1,716' MSL
Maximum Difference in Runway 13-31 Centerline Elevation: 45 feet = 450 feet in Takeoff Distance
Recommended Runway Length = 6,500' + 450' = 6,950' (**7,000 feet**)



3.3.10 F.A.R. TAKEOFF RUNWAY LENGTH REQUIREMENTS - STANDARD DAY +25°F (STD + 14°C)
MODEL 757-200 (PW2040 ENGINES)