Airport Design Standards

The selection of appropriate design standards for the development of airfield facilities is based primarily upon the characteristics of the aircraft projected to use the Airport on a regular basis, along with the types of approaches to be provided to each runway end. The Federal Aviation Administration (FAA) has established a set of airport classifications known as the Airport Reference Code (ARC) to relate airport design criteria to the operational and physical characteristics of the most demanding airplane. The ARC has two components relating to the design aircraft: aircraft approach category and airplane design group.

Aircraft Approach Category – Designated by a letter (A – E), this component describes the operational characteristic of aircraft approach speed, with 'A' being the slowest and 'E' being the fastest.

Airplane Design Group – Designated by a Roman Numeral (I-VI), the second component relates to the physical characteristic of airplane wingspan with "I" being the shortest and "VI" being the longest.

The design aircraft is defined by the FAA as the most critical type of aircraft using, or anticipated to use the airport on a regular basis (at least 500 operations per year). Table 3A, *Airport Design Standards,* provides a comprehensive list of key airport design elements potentially applicable to PMRA from the present through the long term. Other critical airplane characteristics include:

- Airplane Weight
- Landing Gear Type and Characteristics
- Runway Length Requirements

As determined in Chapter 2, *Activity Projections and Design Aircraft Selection,* regularly scheduled operations by the Bombardier Q-400 are sufficient to place the airport into ARC C-III. In the longer term (20+ years), regular operations by large corporate jets could increase the ARC to D-III.

For purposes of developing an initial template from which to evaluate runway alignment alternatives, the design standards will assume a fully compliant ARC C-III airport equipped with a precision instrument approach with visibility minimums of ½-mile to at least one runway end.

The template may later be refined to consider other combinations of runway lengths, instrument approach minimums, instrument procedures, operating considerations, and topographic constraints to the extent necessary to optimize the balance of the various evaluation criteria.

Aircraft Approach Category

- Category A: airplane approach speed < 91 knots.
- Category B: airplane approach speed at least 91 knots but <121 knots.
- Category C: airplane approach speed at least 121 knots but <141 knots.
- Category D: airplane approach speed at least 141 knots but <166 knots.
- Category E: airplane approach speed of at least 166 knots.

Airplane Design Group

- Group I: airplane wingspan up to but not including 49 ft.
- Group II: airplane wingspan at least 49 ft but <79 ft.
- Group III: airplane wingspan at least 79 ft but <118 ft.
- Group IV: airplane wingspan at least 118 ft but <171 ft.
- Group V: airplane wingspan at least 171 ft but < 214 ft.
- Group VI: airplane wingspan of at least 214 ft.

Table 3A

Airport Design Standards
Pullman-Moscow Regional Airport

Item	FAA Airport Design Standards[1]							
Airport Reference Code	Existing[2]	B-III[3,4]	B-III	B-III	C-III.[5]	C-III.[5]	D-III[6]	D-III[6]
Aircraft Approach Speed	<121 kts	<121 kts	<121 kts	<121 kts	<141 kts	<141 kts	<141kts	<141 kts
Aircraft Wingspan	<90 ft.	<90 ft.	<118 ft.	<118 ft.	<118 ft.	<118 ft.	93.4 ft.	93.4 ft.
Aircraft Tail Height (lbs)	< 45 ft.	< 45 ft.	< 45 ft.	< 45 ft.	< 45 ft.	< 45 ft.	< 45 ft.	< 45 ft.
Aircraft Weight Group (lbs)	<65,000	<65,000	<65,000	<65,000	<175,000	<175,000	<95,000	<95,000
Approach Visibility Minimums	≥ 1 mile	≥ 1 mile	¾ mile	≤ ½ mile	¾ mile	≤ ½ mile	¾ mile	≤ ½ mile
Runway Design								
Length (feet)	6,730[7]	5 – 6,500[8]	5 – 6,500[8]	5 – 6,500[8]	6 – 8000[8]	6 – 8,000[8]	7 – 8,500[8]	7 – 8,500[8]
Width	100 ft.	100 ft.	100 ft.	100 ft.	100 ft.[8]	100 ft.[8]	100 ft.	100 ft.
Blast Pad								
Width	N/A	140 ft.	140 ft.	140 ft.	**140 ft.**	**140 ft.**	140 ft.	140 ft.
Length beyond Runway End	N/A	200 ft.	200 ft.	200 ft.	**200 ft.**	**200 ft.**	200 ft.	200 ft.
Safety Area								
Width	300 ft.	300 ft.	300 ft.	400 ft.	**500 ft.**	**500 ft.**	552 ft.	552 ft.
Length prior to threshold	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.
Length beyond Stop end	1,000 ft.[10]	600 ft.	600 ft.	800 ft.	1,000 ft.	1,000 ft.	1,000 ft.	1,000 ft.
Obstacle Free Zone[11]								
Shape[12]	A	A	A	C	A	C	A	C
Width (W)	**341 ft.**[13]	400 ft.	400 ft.	400 ft.	**400 ft.**	**400 ft.**	400 ft.	400 ft.
Vertical Height (H) [14, 15]	NA	NA	NA	43 ft.	NA	43 ft.	NA	45 ft.
Slope (S)	NA	NA	NA	6:1	NA	6:1	NA	6:1
Object Free Area								
Width	**578 ft.**[16]	800 ft.	800 ft.	800 ft.	**800 ft.**	**800 ft.**	800 ft.	800 ft.
Length prior to threshold[17]	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.	600 ft.
Length beyond Stop End[17]	**1,000 ft.**[18]	600 ft.	600 ft.	800 ft.	**1,000 ft**	**1,000 ft.**	1,000 ft.	1,000 ft.
Gradient (maximum)	1.04%	2.0%	2.0%	2.0%	1.5%[19]	1.5%[19]	1.5%[19]	1.5%[19]
Runway Setbacks								
From Runway Centerline to:								
Hold Line[20]	**155 ft.**	200 ft.	200 ft.	250 ft.	**250 ft.**	**250 ft.**	272 ft.	272 ft.
Parallel Taxiway	**200 ft.**	300 ft.	300 ft.	350 ft.	**400 ft.**	**400 ft.**	400 ft.	400 ft.
Aircraft Parking Line	**280 ft.**	400 ft.	400 ft.	400 ft.	**500 ft.**	**500 ft.**	500 ft.	500 ft.
Building Restriction Line[21]	**320 ft.**[22]	495 ft.	745 ft.	745 ft.	**745 ft.**	**745 ft.**	745 ft.	745 ft.
Taxiway Design								
Width	60 ft.	54 ft.[23]	54 ft.[23]	54 ft.[23]	54 ft.[23]	54 ft.[23]	54 ft.[23]	54 ft.[23]
Safety Area Width	90 ft.	90 ft.	118 ft.	118 ft.	**118 ft.**	**118 ft.**	94 ft.	94 ft.
Taxiway and Taxilane Setbacks								
From Taxiway Centerline to:								
Parallel Taxiway/Taxilane [24, a]	N/A	118 ft.	152 ft.	152 ft.	152 ft.	152 ft.	122 ft.	122 ft.
Fixed or Movable Object [b]	78 ft.	73 ft.	93 ft.	93 ft.	**93 ft.**	**93 ft.**	76 ft.	76 ft.
From Taxilane Centerline to:								
Fixed or Movable Object [c]	N/A	64 ft.	81 ft.	81 ft.	81 ft.	81 ft.	66 ft.	66 ft.
Runway Protection Zone[25]								
Width at Inner End	500 ft.[26]	500 ft.	1,000 ft.	1,000 ft.	**1,000 ft.**	**1,000 ft.**	1,000 ft.	1,000 ft.
Width at Outer End	700 ft.[26]	700 ft.	1,510 ft.	1,750 ft.	**1,510 ft.**	**1,750 ft.**	1,510 ft.	1,750 ft.
Length	1,000 ft.[26]	1,000 ft.	1,700 ft.	2,500 ft.	**1,700 ft.**	**2,500 ft.**	1,700 ft.	2,500 ft.

NOTES:

[1] Source: FAA Advisory Circular 150/5300-13, Change 9, *Airport Design* (September 2005).

[2] Existing Non-Standard Conditions shown in **SHADED**, **BOLD TYPE**.

[3] Existing airfield design standards applicable to Pullman-Moscow Regional Airport based on approach category B and 90-foot wingspans.

[4] Aircraft currently in use at Pullman-Moscow Regional Airport.

[5] Design standards most applicable to long range planning.

[6] Airport design standards specific to Gulfstream-V / Bombardier Global Express, and Q-400

[7] Current Published Length (Declared Distances Apply)

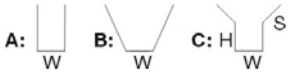
[8] Approximate runway length requirement for typical aircraft in the specified design group.

[9] For airplane design group III serving airplanes with maximum certificated takeoff weights greater than 150,000 pounds, the standard runway width is 150 feet, the shoulder width is 25 feet, and the blast pad width is 200 feet.

[10] Declared distances apply. RSA length available beyond declared stop end of runway.

[11] Object Free Zone normally extends 200 feet beyond end of runway; additional length is required for runways with approach light systems.

[12] Runway Obstacle Free Zone cross-section shapes:



[13] 141 feet north and 200 feet south.

[14] Applies to runways with approach visibility minimums < ¾ mile. Height varies according to aircraft wingspan and increases 3 feet per 1,000 feet of airport elevation.

[15] Indicated dimensions for runways with approach visibility minimums <¾ mile are for Category I instrument runways. Criteria for Category II and Category III runways are more restrictive.

[16] 278 feet north (aircraft parking and building) and 300 feet south (terrain). Terrain restricts OFA beyond runway ends to less than standard width.

[17] OFA length beyond runway end coincides with RSA end.

[18] The width of the OFA beyond the runway ends is less than standard due to terrain.

[19] Maximum of 0.8% in first and last quarters of runway.

[20] Source: FAA Advisory Circular 150/5340-1J, *Standards for Airport Markings* (April 2005).

[21] The FAA no longer has fixed-distance standards for the Building Restriction Line location. The indicated setback distances are based on providing 7:1 transitional slope clearance over a 35-foot building situated at the same base elevation as the adjacent runway and can be adjusted in accordance with local conditions.

[22] Actual Distance between the existing runway centerline and the nearest building structure (T-hangar units).

[23] 50 feet required for Airport Design Group (ADG) – III. Taxiway width is greater than standard to provide adequate taxiway edge safety margin for the Q-400, which has an undercarriage width of 33.2 feet.

[24] Assumes same size airplane uses both the first taxiway/taxilane and the adjacent taxiway/taxilane. Distance can be reduced if secondary taxiway/taxilane is limited to use only by smaller airplanes.

[25] Dimensions provided are for the runway direction having the lowest approach minimums. Opposing runway direction may use a smaller RPZ.

[26] Approach and departure RPZs are in effect due to the application of declared distances.

Modification of Standards:

The values obtained from the following equations may be used to show that a modification of standards will provide an acceptable level of safety.

[a.] Taxiway centerline to parallel taxiway/taxilane centerline equals 1.2 times airplane wingspan plus 10 feet.
[b.] Taxiway centerline to fixed or movable object equals 0.7 times airplane wingspan plus 10 feet.
[c.] Taxilane centerline to fixed or movable object equals 0.6 times airplane wingspan plus 10 feet.

Table 3A, continued

Runway Length Requirements

FAA Advisory Circular (AC) 150/5325-4B, *Runway Length Requirements for Airport Design (July 2005),* provides guidelines for airport designers and planners for determining recommended runway lengths for new runways or extensions to existing runways at civil airports. The AC highlights the fact that the length of *usable* runway length made *available* by an airport may not be entirely *suitable* for all types of airplane operations. Key factors influencing the *suitability* of available runway length include:

- airport elevation
- temperature
- wind velocity
- airplane operating weights
- flap settings
- runway surface condition
- runway gradient
- presence of obstructions
- locally imposed noise abatement restrictions
- other locally imposed prohibitions

According to this AC, the overall goal is to construct an available runway length that is suitable for the forecasted critical design airplanes. To accomplish this, the evaluation uses a five step procedure recommended by the FAA.

Runway Length Definitions:

- *Critical/Design Airplanes- The airplane(s) resulting in the longest recommended runway length.*
- *Maximum Takeoff Weight (MTOW)- The maximum certificated weight for the airplane at takeoff.*
- *Small Airplane- An airplane of 12,500 pounds or less MTOW.*
- *Large Airplane- An airplane of more than 12,500 pounds MTOW.*
- *Regional Jets (RJs)- For purposes of runway length recommendations, an RJ is a commercial jet airplane that carries fewer than 100 passengers.*

Initial Design Assumptions:

- *No obstructions in the departure area.*
- *Zero wind.*
- *Wet runway surfaces.*
- *Zero effective runway gradient.*

Step No. 1, Identify Potential Critical Airplanes

A list of potential design airplanes and their associated characteristics is contained in Table 3B, *Airplane Characteristics*. These, or similar aircraft, are anticipated to use the airport on a regular basis through the established 20-year planning horizon. Federally funded projects require that critical design airplanes have at least 500 or more annual itinerant operations at the airport for an individual airplane or a family grouping of airplanes. Although similar to the previous analysis for determining ARC, it should be noted that the determination of a critical aircraft for purposes of making runway length recommendations is a distinctly separate evaluation.

Step No. 2, Identify the Most Demanding Airplanes

The primary purpose of this step is to determine which method will ultimately be used for establishing the recommended runway length. When the maximum takeoff weight (MTOW) of the listed airplanes is 60,000 pounds or less, the recommended length is determined according to a family grouping of airplanes with similar characteristics. When the MTOW of listed airplanes is over 60,000 pounds, the recommended runway length is determined according to individual airplanes. Regional jets, regardless of MTOW, are evaluated on an individual basis even though many of these aircraft types have MTOW of less than 60,000 pounds.

Based on the list of aircraft identified in Table 3B and the types of activity presently occurring and forecast to occur through the 20-year planning horizon and beyond (see Table 2-20), the most demanding aircraft can be identified as follows:

- Current– Citation-X (35,700 pounds)
- Long Term– CRJ-700/900 or similar

Table 3B
Airplane Characteristics

Typical Runway Length Requirements for Various Aircraft Types

Aircraft	PAX Seats	MTOW	MLW[1]	Wingspan[1]	Length[1]	App. Speed	ARC class	TO Length[1]	LDG Length[1]	LDG Length [2]
Commercial Turbo-Props										
Q200 3	37-39	36,300	34,500	85.0	73.0	101	B-III	5,000	2,650	3,048
Q4003	68-78	64,500	61,750	93.3	107.8	125	C-III	6,100	5,010	5,762
Commercial Turbo-Jets										
CRJ 200 LR 3	50	53,000	47,000	69.7	87.1	140	C-II	8,300	5,200	5,980
ERJ 145 3	50	46,275	42,549	65.8	98.0	135	C-II	7,874	4,669	5,369
CRJ 700 LR 3	70-75	72,750	67,000	76.3	106.8	130	C-II	6,372	5,100	5,865
ERJ 170 4	70-78	82,011	72,310	85.3	98.1	140	C-III	5,784	4,320	4,968
CRJ 900 LR 3	90	84,500	73,500	76.3	119.4	125	C-II	8,650	7,000	8,050
ERJ 190 4	98-108	105,359	94,799	94.2	118.9	140	C-III	7,695	4,520	5,198
Business / Charter Turbo-Props										
Beechcraft King Air 350 4	9-15	15,000	15,000	57.9	46.7	100	B-II	3,527	2,903	3,338
Business / Charter Turbo-Jets										
Raytheon Hawker 800XP 4	8-12	28,000	23,350	51.4	51.1	126	C-II	5,939	3,128	3,597
Citation X 5	12	35,700	31,800	63.6	72.4	132	C-II	7,232	6,653	7,651
Dassault Falcon 2000 4	8-19	41,300	39,300	63.4	66.3	126	C-II	5,922	3,580	4,117
Gulfstream IV 3	3-19	73,900	66,000	77.8	88.3	161	D-II	6,432	3,847	4,424
Gulfstream V 3	3-19	91,000	75,300	93.5	96.4	156	D-III	6,078	3,269	3,759
Global Express 4	8-19	95,250	78,600	94.0	99.4	126	C-III	7,960	4,200	4,830
Airbus A-319 6	2-124	166,450	137,800	111.8	111.0	130	C-III	6,500	5,375	6,181
Boeing Business Jet (BBJ) 6	2-63	171,000	134,000	117.4	110.3	132	C-III	7,200	5,800	6,670
Boeing Business Jet (BBJ2) 6	2-100	174,200	146,300	117.4	129.5	142	D-III	8,500	6,550	7,533

Notes

1 Aircraft specification from manufacturer website and manuals.
2 LDG runway length requirements increased by 15% in anticipation of revised certification standards.
3 Aircraft manufacturer charts using: airport elevation, mean maximum temperatures, wet/slippery conditions, maximum takeoff weight and maximum structural landing weight.
4 Approximated using FAA adjustment conversion calculator from sea level, standard atmospheric conditions
5 Performance specifications in use by existing based operator using: TO Flaps-15, LDG Flaps-Full, Temp-28C, Wind-0, Thrust Reverse Avail.- Yes, Weight- MTOW, MLW
6 Aircraft manufacturer charts using: airport elevation, mean maximum temperatures, max weight for up to 2,000 mile trip length, and max structural landing weight.

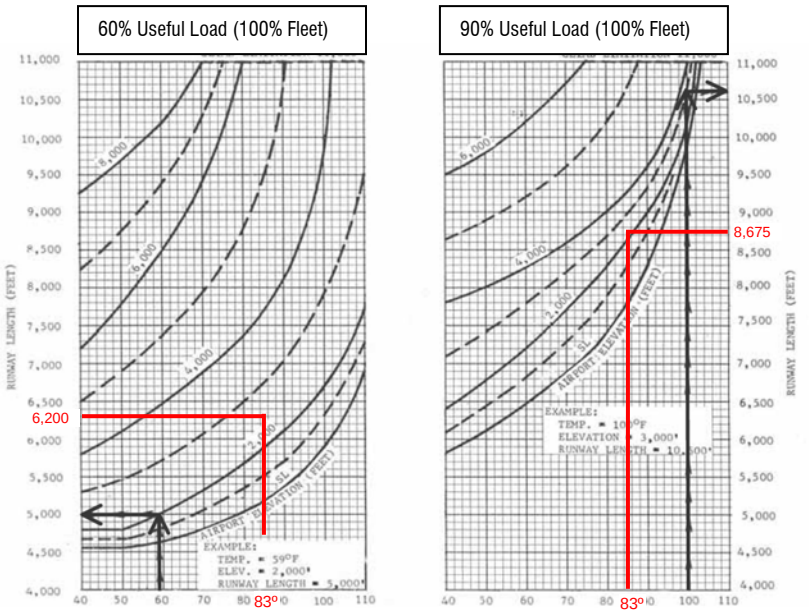
Table 3C, *Estimated Departures by Stage* Table 3C, *Estimated Departures by Stage Length,* groups the Citation-X operations into stage distances. Generally, longer trips require higher takeoff weights necessary for fuel carriage and consumption. The overall trend includes an increasing shift to longer stage lengths as the existing operator's business expands regionally.

Table 3C
Estimated Departures by Stage Length (Citation X)

Stage Length (NM)	2005	2010	2015	2025
< 500	63	127	187	278
500 – 999	40	88	142	232
1,000 – 1,999	55	127	210	351
> 2,000	0	11	29	65
Total Departures	205	353	568	926

Step No. 3, Determine Method

This step compares the aircraft identified in Step No. 2 with an FAA Chart which categorizes potential design airplanes into 3 groupings according to MTOW: small aircraft, large aircraft, and regional jets. Small airplanes are further subdivided according to approach speeds and passenger seating. The regional jet category essentially requires that small air carrier jets be evaluated individually even if they have a MTOW of less than 60,000 pounds. Accordingly, the appropriate planning references for determining runway length recommendations are as follows:



Note: Useful load consists of passengers, cargo, and fuel.
Adjustment: Increased takeoff length at a rate of 10 feet for each foot of elevation difference between high and low points.

Source: FAA Advisory Circular 150/5325-4B (7/1/2005)

Figure 3A

Recommended Runway Lengths
(Large Airplanes of 60,000 Pounds or Less)

Current—Use family grouping of large airplanes (reference AC 150/5325-4B, Chapter 3). In cases where the airplane planning manual shows a longer runway length requirement than would otherwise be recommended, then the airplane manufacturer guidelines should be used and the recommendations should follow the same guidance which would apply to individual large airplane requirements.

Long-Term—Use individual large airplane references provided by the airplane manufacturer (reference AC 150/5325-4B, Chapter 4 and airplane manufacturer references).

Step No. 4, Select the Recommended Runway Length

Only after all of the data required under Step 3 has been gathered and analyzed can a recommended runway length be derived. This analysis is described as follows:

Current—Apply FAA guidance to evaluate all large turbo-jets with MTOW of less than 60,000 pounds as a single group. The grouping is divided into two categories: airplanes comprising 75% of these large airplanes and airplanes comprising 100% of these large airplanes. The FAA lists the Citation-X in the remaining 25% of Airplanes that Make Up 100% of the fleet. Given the number of operations by these aircraft, the second classification is the most appropriate. Figure 3A, *Recommended Runway Lengths (Large Airplanes of 60,000 Pounds or Less)*, depicts the runway length requirements using useful load factors of 60% and 90%, respectively. The two input parameters include temperature (average mean high of the hottest month) and airport elevation resulted in an unadjusted recommended length of 6,200 feet for 60% useful load and 8,625 feet at 90%.

The Citation-X operator's manual was consulted for purposes of comparison. Using the same input parameters assumed for the above analysis, the following results were derived for this specific aircraft:

- Takeoff (flat / wet runway): 7,127'
- Landing (flat / wet runway): 6,557'

To evaluate the effect that runway gradient would have on future operations a 1% gradient was applied to achieve the following:

- Takeoff (1% gradient / dry): 7,156'
- Takeoff (1% gradient / wet): 7,731'

FAA guidance permits the evaluation of a family of airplanes which results in a recommended runway length of 8,625 feet. A flat runway of at least 7,127 feet in length (adjusted for net gradient) and retaining a minimum unadjusted landing length available of 6,557 feet would remove most restrictions. The aircraft performance charts also revealed that a runway length of 7,500 feet would maximize the operational utility of the aircraft up to ambient temperatures of 90° F (32° C). Above this temperature, the airplane experiences climb gradient restrictions which reduce its utility (e.g., takeoff weight). As a result, the optimum runway length (unadjusted for grade) for the Citation-X at the existing PMRA site is 7,500 feet.

Long-Term—The 70-seat Bombardier CRJ-700 (a "regional" or "small" jet) was evaluated for long term planning. The following parameters were evaluated using the airport planning manual (APM) available for the CRJ-200: 83°F, current airport elevation, zero wind, flat runway, and maximum usable flap settings. The unadjusted runway length requirements were determined as follows:

CRJ-700 (70-seat RJ)

- Takeoff— 6,950 feet
- Landing— 5,125 feet

For comparison, the same input data was entered into the smaller and older version, the CRJ-200 with the following results:

CRJ-200 (50-seat RJ)

- Takeoff— 8,600 feet
- Landing— 5,200 feet

Although the general trend points to increasing volumes of 70-120 seat "small" jets, it also points to improved engine and wing designs which result in shorter overall runway length requirements. A final comparison evaluated the 90-seat CRJ-900:

CRJ-900 (90-seat)

- Takeoff— 8,000 feet
- Landing— 6,950 feet

In conclusion, for purposes of long-term planning, the following unadjusted runway lengths are recommended:

- Takeoff— 8,000 feet
- Landing— 7,000 feet

Step No. 5, Adjustments

The initial runway length calculations documented in the proceeding steps are adequate for developing a design template from which to develop and screen alternative runway alignments. Although runway surfaces should be constructed as flat as possible, the surrounding topography may restrict this potential for some alignments. As a result the runway lengths that are ultimately recommended for final evaluation may be adjusted to counter the net effect of sloping terrain on airplane departures.