

Compute the runway length requirements for a Boeing 737-200 aircraft landing and taking off at an airport at an elevation of 500 m (1640 ft) at a normal maximum temperature of 30°C (86°F). Assume 25° flaps for landing and 5° flaps for take-off. Maximum operational take-off weight is 102,000 kg (224,686 lb) and maximum operational landing weight is 84,000 kg (185,035 lb). The airplane has two Pratt & Whitney 2037 engines.

**Landing runway requirement** Referring to the FAA manual [1], the landing table shown in Table 18-1 would be used, reflecting the choice of 25° flaps and the PW engine 2037. Using the upper part of the table, entering with an airport elevation of 500 m and a temperature of 30°C, the maximum permissible landing weight is given as 89,800 kg (197,811 lb). The operational limit is below this and is therefore permissible.

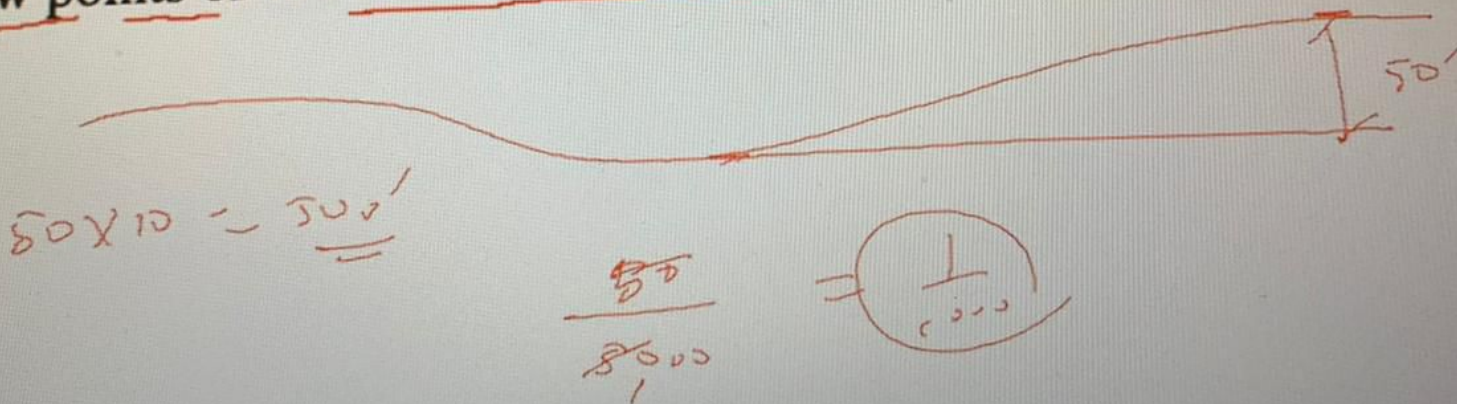
Entering the lower part of the table with 185,035 lb and an elevation of 1640 ft, interpolation between 5.72 and 5.86 in the table gives 5.57 or 5570 ft (1389 m). <sup>5.50 - 5.63</sup>

**Take-off runway requirement** For the take-off runway requirement, with 5° flaps and two PW 2037 engines the appropriate FAA table is shown in Table 18-2. Entering the top of the table with maximum temperature 30°C and elevation 500 m, the maximum permissible take-off weight is 108,900 kg (239,885 lb). This is greater than the maximum operational weight to be used and the operational weight is therefore permitted. <sup>5607 ft</sup>

Entering the middle table with 30°C and 500 m elevation the reference factor  $R$  is found to be 59.7. This factor is then used to enter the lowest part of the table in combination with the operational weight of 102,000 kg. This gives 2581 m (8468 ft) by interpolation. <sup>2577</sup>

## Runway gradient

Examples of FAA runway length tables are shown in Tables 18-1 and 18-2, which are based on the performance of a Boeing 757-232 series. These and similar performance curves and tables are based on an effective runway gradient of zero percent. Effective runway gradient is defined as the maximum difference in runway centerline elevations divided by the runway length. The FAA specifies that the runway lengths for take-off should be increased by 10 ft per foot of difference in centerline elevation between the high and low points of the runway centerline elevations.



**The FAA airport reference code:** See table 18.3, p. 551

**Longitudinal grade design for runways and taxiways:** See figure 18.3, p. 552 (note errors/ changes on text)

**Runway and Taxiway cross-section:** see fig. 18.4, p. 554, tables 18.4 – 18.6, pp. 555 – 558

Taxiways (and exists from runways), turnarounds, holding bays: see fig. 18.5-18.7, pp. 559 – 561

**Table 18-3** Determinants of the FAA Airport Reference Code

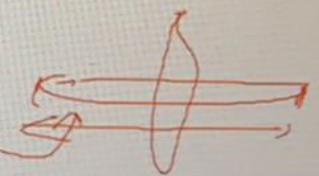
FAA Aircraft Approach Category	
Approach Speed	Aircraft Approach Category
Speed less than 91 knots	A
Speed 91 knots or more but less than 121 knots	B
Speed 121 knots or more but less than 141 knots	C
Speed 141 knots or more but less than 166 knots	D
Speed 166 knots or more	E

FAA Airplane Design Groups	
Wingspan	Airplane Design Group (ADG)
Up to but not including 15 m (49 feet)	I
15 m (49 feet) up to but not including 24 m (79 feet)	II
24 m (79 feet) up to but not including 36 m (118 feet)	III
36 m (118 feet) up to but not including 52 m (171 feet)	IV
52 m (171 feet) up to but not including 65 m (214 feet)	V
65 m (214 feet) up to but not including 80 m (262 feet)	VI

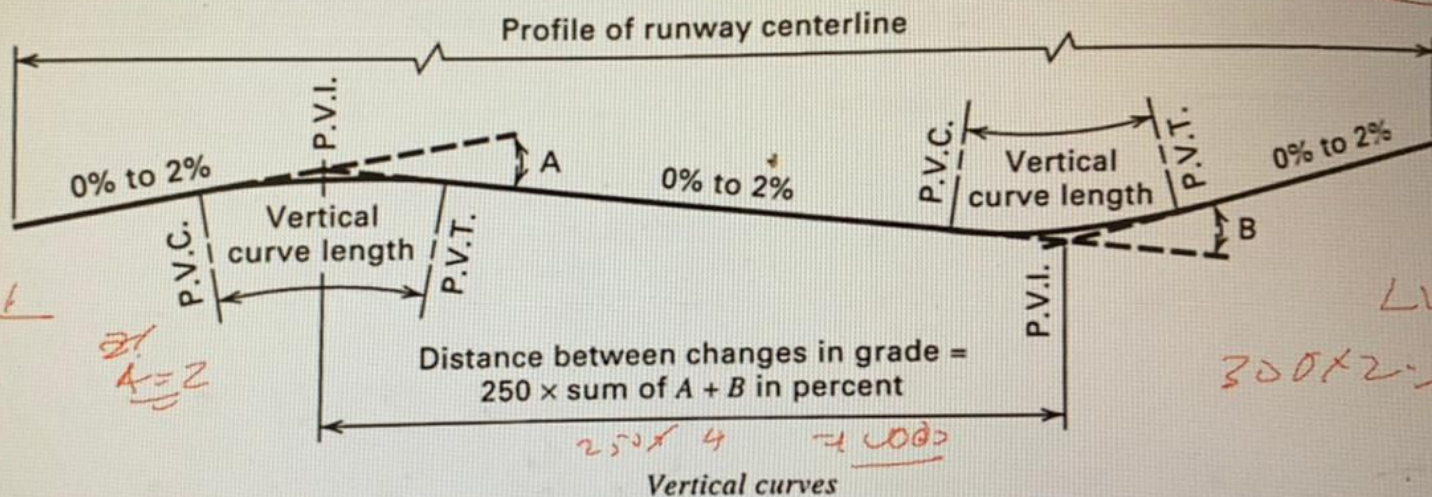
BY

n. m. to 6075'



Source: *Airport Design*, FAA Advisory Circular 150/5300-13, including Changes 1-4, Federal Aviation Administration, Washington, DC, September 29, 1989.

552 Chapter 18 Airport Design Standards and Procedures

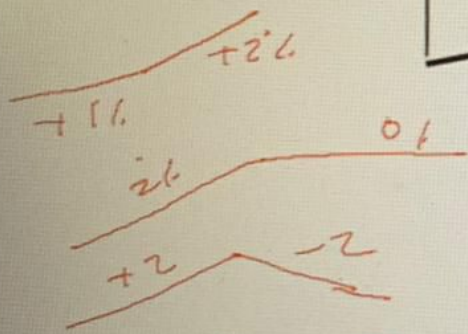


Length of vertical curves will not be less than 300' for each 1% grade change, except that no vertical curve will be required when grade change is less than 0.4%.

Grade change

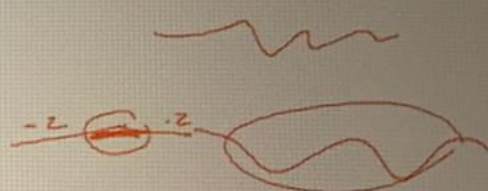
Maximum grade change such as (A) or (B) should not exceed 2%.

Figure 18-3a Longitudinal grade limitations for aircraft approach categories A and B. (Source: *Airport Design*, FAA Advisory Circular 150/5300-13, Changes 1-4, September 29, 1989.)



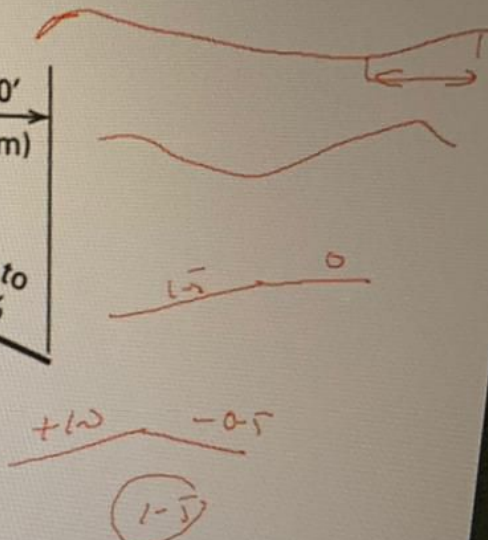
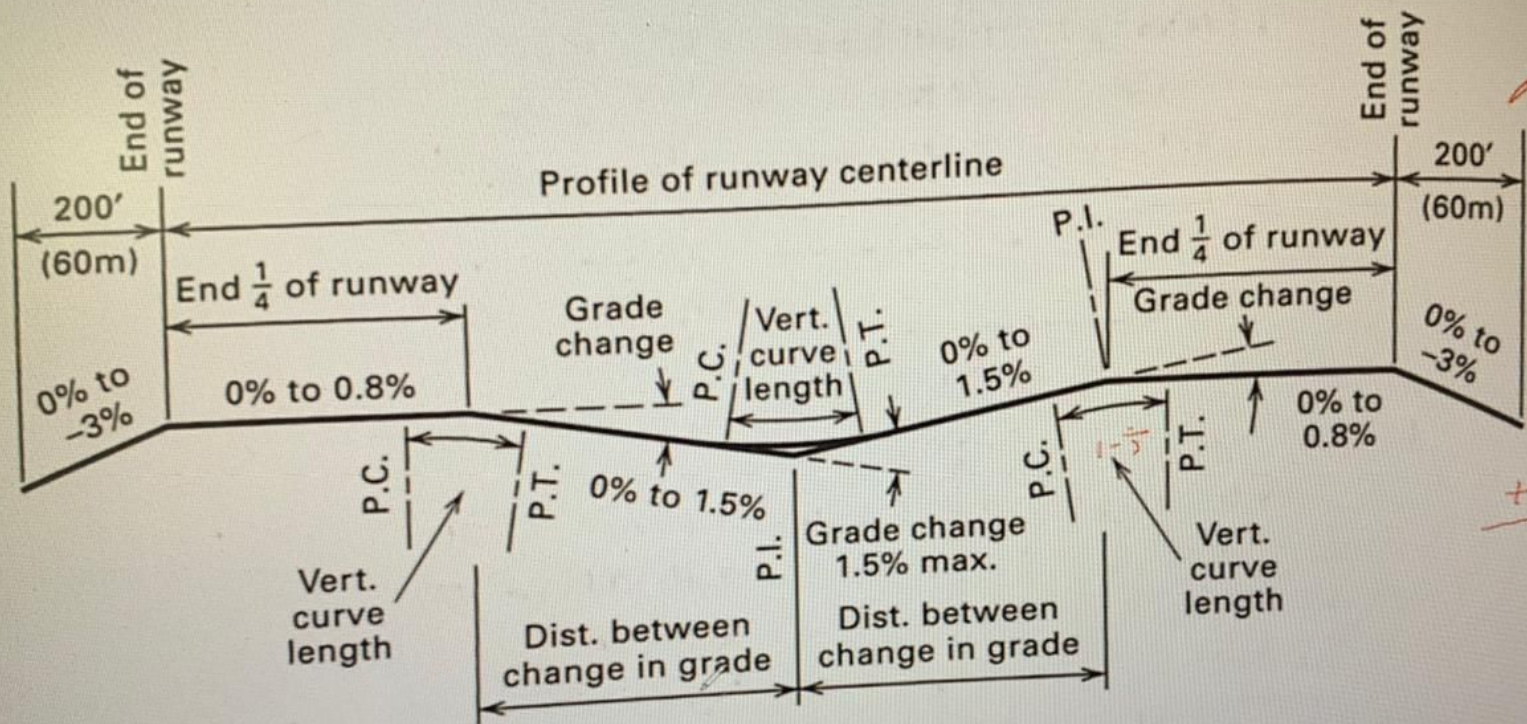
$+2 - (-2) = 4$

$1 - 2 = -1$



LVC

$300 \times 2 = 600'$



Minimum distance between change in grade = 1000' (300m) · sum of grade changes (in percent).  
 Minimum length of vertical curves = 1000' (300m) · grade change (in percent).

**Figure 18-3b** Longitudinal grade limitations for aircraft approach categories C and D.  
 (Source: *Airport Design*, FAA Advisory Circular 150/5300-13, Changes 1-4, September 29, 1989.)

**Table 18-4a** Runway Design and Separation Standards for Aircraft Approach Category A & B  
Visual Runways and Runways With Not Lower Than  $3/4$  statute mile (1200 m)  
Approach Visibility Minimums

Item	Airplane Design Group				
	I <sup>a</sup>	I	II	III	IV
Runway Width	60 ft 18 m	60 ft 18 m	75 ft 23 m	100 ft 30 m	150 ft 45 m
Runway Shoulder Width	10 ft 3 m	10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m
Runway Blast Pad Width	80 ft 24 m	80 ft 24 m	95 ft 29 m	140 ft 42 m	200 ft 60 m
Runway Blast Pad Length	60 ft 18 m	100 ft 30 m	150 ft 45 m	200 ft 60 m	200 ft 60 m
Runway Safety Area Width	120 ft 36 m	120 ft 36 m	150 ft 45 m	300 ft 90 m	500 ft 150 m
Runway Safety Area Length	240 ft 72 m	240 ft 72 m	300 ft 90 m	600 ft 180 m	1,000 ft 300 m
Beyond RW End	250 ft 75 m	400 ft 120 m	500 ft 150 m	800 ft 240 m	240 m
Runway Object Free Area Width	240 ft 72 m	240 ft 72 m	300 ft 90 m	600 ft 180 m	1,000 ft 300 m
Runway Object Free Area Length Beyond RW end					
Runway Centerline to:					
Taxiway/Taxilane	150 ft 45 m	225 ft 67.5 m	240 ft 72 m	300 ft 90 m	400 ft 120 m
Centerline	125 ft	200 ft	250 ft	400 ft	500 ft
Aircraft Parking Area	37.5m	60 m	75 m	102 m	150 m

<sup>a</sup>These dimensional standards pertain to facilities for small airplanes exclusively.  
Source: Airport Design, Federal Aviation Administration Advisory Circular 150/5300-13, including Change 4, Washington, DC, September 20, 1989.

5280'  
nautical mile 6076'

**Table 18-4b** Runway Design and Separation Standards for Aircraft Approach Category A and B Runways With Lower Than 3/4-statute mile (1200 m) Approach Visibility Minimums

Item	Airplane Design Group				
	I <sup>a</sup>	I	II	III	IV
Runway Width	75 ft	100 ft	100 ft	100 ft	150 ft
	23 m	30 m	30 m	30 m	45 m
Runway Shoulder Width	10 ft	10 ft	10 ft	20 ft	25 ft
	3 m	3 m	3 m	6 m	7.5 m
Runway Blast Pad Width	95 ft	120 ft	120 ft	140 ft	200 ft
	29 m	36 m	36 m	42 m	60 m
Runway Blast Pad Length	60 ft	100 ft	150 ft	200 ft	200 ft
	18 m	30 m	45 m	60 m	60 m
Runway Safety Area Width	300 ft	300 ft	300 ft	400 ft	500 ft
	90 m	90 m	90 m	120 m	150 m
Runway Safety Area Length Beyond RW End	600 ft	600 ft	600 ft	800 ft	1,000 ft
	180 m	180 m	180 m	240 m	300 m
Runway Object Free Area Width	800 ft	800 ft	800 ft	800 ft	800 ft
	240 m	240 m	240 m	240 m	240 m
Runway Object Free Area Length Beyond RW End	600 ft	600 ft	600 ft	800 ft	1,000 ft
	180 m	180 m	180 m	240 m	300 m
<i>Runway Centerline to:</i>					
Taxiway/Taxilane Centerline	200 ft	250 ft	300 ft	350 ft	400 ft
	60 m	75 m	90 m	105 m	120 m
Aircraft Parking Area	400 ft	400 ft	400 ft	400 ft	500 ft
	120m	120 m	120 m	120 m	150 m

<sup>a</sup>These dimensional standards pertain to facilities for small airplanes exclusively.

Source: *Airport Design*, Federal Aviation Administration Advisory Circular 150/5300-13, including Change 4, Washington, DC, September 20, 1989.



Table 18-5 Runway Design and Separation Standards for Aircraft Approach Categories C &amp; D

Item	Airplane Design Group					
	I	II	III	IV	V	VI
Runway Width	100 ft	100 ft	100 ft	150 ft	150 ft	200 ft
Runway Shoulder Width	30 m	30 m	30 m	45 m	45 m	60 m
Runway Blast Pad Width	10 ft	10 ft	20 ft	25 ft	35 ft	40 ft
	3 m	3 m	6 m	7.5 m	10.5 m	12 m
Runway Blast Pad Length	120 ft	120 ft	140 ft	200 ft	220 ft	280 ft
	36 m	36 m	42 m	60 m	66 m	84 m
Runway Safety Area Width	100 ft	150 ft	200 ft	200 ft	400 ft	400 ft
	30 m	45 m	60 m	60 m	120 m	120 m
Runway Safety Area Length	500 ft	500 ft	500 ft	500 ft	500 ft	500 ft
	150 m	150 m	150 m	150 m	150 m	150 m
Runway Safety Area Length Beyond RW End	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft
	300 m	300 m	300 m	300 m	300 m	300 m
Runway Object Free Area Width	800 ft	800 ft	800 ft	800 ft	800 ft	800 ft
	240 m	240 m	240 m	240 m	240 m	240 m
Runway Object Free Area Length Beyond RW End	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft	1,000 ft
	300 m	300 m	300 m	300 m	300 m	300 m
<i>Visual runways and runways with not lower than 3/4-statute mile (1200 m) approach visibility minimums</i>						
Runway Centerline to:					a	600 ft
Taxiway/Taxilane	300 ft	300 ft	400 ft	400 ft	a	180 m
Centerline	90 m	90 m	120 m	120 m	500 ft	500 ft
Aircraft Parking	400 ft	400 ft	500 ft	500 ft	150 m	150 m
Area	120 m	120 m	150 m	150 m		
<i>Runways with lower than 3/4-statute mile (1200 m) approach visibility minimums</i>						
Runway Centerline to:					a	600 ft
Taxiway/Taxilane	400 ft	400 ft	400 ft	400 ft	a	180 m
Centerline	120 m	120 m	120 m	120 m	500 ft	500 ft
Aircraft Parking	500 ft	500 ft	500 ft	500 ft	150 m	150 m
Area	150 m	150 m	150 m	150 m		

\*Varies with airport elevation. See source.

Source: Airport Design, Federal Aviation Administration Advisory Circular 150/5300-13, including Change 4, Washington.

Table 18-4b Runway Design and Separation Standards for Aircraft Approach Category A and B  
Runways With Lower Than 3/4-statute mile (1200 m) Approach Visibility Minimums

Item	Airplane Design Group				
	I*	I	II	III	IV
Runway Width	75 ft 23 m	100 ft 30 m	100 ft 30 m	100 ft 30 m	150 ft 45 m
Runway Shoulder Width	10 ft 3 m	10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m
Runway Blast Pad Width	95 ft 29 m	120 ft 36 m	120 ft 36 m	140 ft 42 m	200 ft 60 m
Runway Blast Pad Length	60 ft 18 m	100 ft 30 m	150 ft 45 m	200 ft 60 m	200 ft 60 m
Runway Safety Area Width	300 ft 90 m	300 ft 90 m	300 ft 90 m	400 ft 120 m	500 ft 150 m
Runway Safety Area Length Beyond RW End	600 ft 180 m	600 ft 180 m	600 ft 180 m	800 ft 240 m	1,000 ft 300 m
Runway Object Free Area Width	800 ft 240 m	800 ft 240 m	800 ft 240 m	800 ft 240 m	800 ft 240 m
Runway Object Free Area Length Beyond RW End	600 ft 180 m	600 ft 180 m	600 ft 180 m	800 ft 240 m	1,000 ft 300 m
<i>Runway Centerline to:</i>					
Taxiway/Taxilane Centerline	200 ft 60 m	250 ft 75 m	300 ft 90 m	350 ft 105 m	400 ft 120 m
Aircraft Parking Area	400 ft 120 m	400 ft 120 m	400 ft 120 m	400 ft 120 m	500 ft 150 m

\*These dimensional standards pertain to facilities for small airplanes exclusively.

Source: Airport Design, Federal Aviation Administration Advisory Circular 150/5300-13, including Change 4, Washington, DC, September 20, 1989.

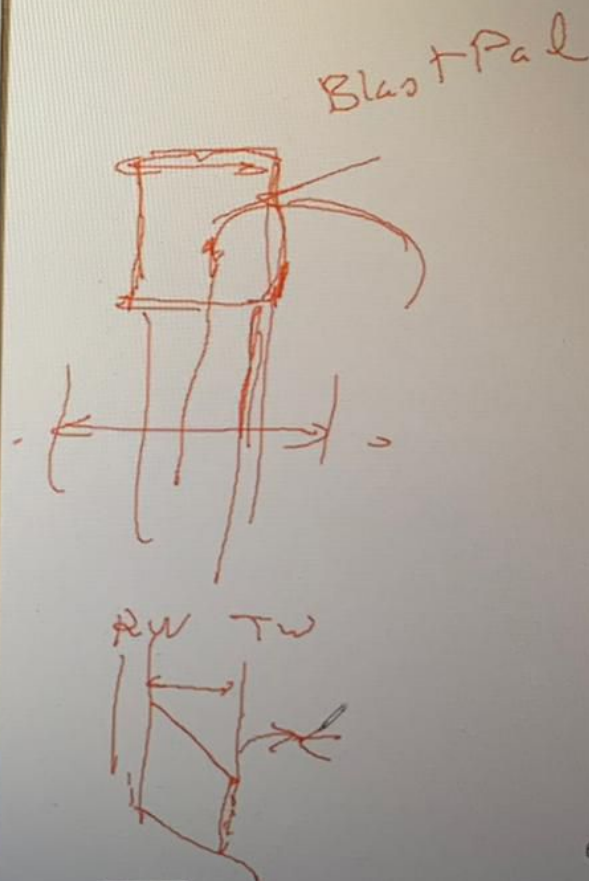


Table 18-6 Taxiway Dimensional and Separation Standards

Item	Airplane Design Group					
	I	II	III	IV	V	VI
Taxiway Width	25 ft 7.5 m	35 ft 10.5 m	50 ft <sup>a</sup> 15 m <sup>a</sup>	75 ft 23 m	75 ft 23 m	100 ft 30 m
Taxiway Edge Safety Margin <sup>b</sup>	5 ft 1.5 m	7.5 ft 2.25 m	10 ft <sup>c</sup> 3 m <sup>c</sup>	15 ft 4.5 m	15 ft 4.5 m	20 ft 6 m
Taxiway Shoulder Width	10 ft 3 m	10 ft 3 m	20 ft 6 m	25 ft 7.5 m	35 ft <sup>d</sup> 10.5 m <sup>d</sup>	40 ft <sup>d</sup> 12 m <sup>d</sup>
Taxiway Safety Area Width	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 Object Free Area Width	89 ft 27 m	131 ft 40 m	186 ft 57 m	259 ft 79 m	320 ft 97 m	386 ft 118 m
Taxilane Object Free Area Width	79 ft 24 m	115 ft 35 m	162 ft 49 m	225 ft 68 m	276 ft 84 m	334 ft 102 m
<i>Taxiway Centerline to:</i>						
Parallel Taxiway/ Taxilane Centerline	69 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
Fixed or Movable Object	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
<i>Taxilane Centerline to:</i>						
Parallel Taxilane Centerline	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
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

<sup>a</sup>For airplanes in Airplane Design Group III with a wheelbase equal to or greater than 60 feet (18 m), the standard taxiway width is 60 feet (18 m).

<sup>b</sup>The taxiway edge safety margin is the minimum acceptable distance between the outside of the airplane wheels and the pavement edge.

<sup>c</sup>For airplanes in Airplane Design Group III with a wheelbase equal to or greater than 60 feet (18 m), the taxiway edge safety margin is 15 feet (4.5 m).

<sup>d</sup>Airplanes in Airplane Design Groups V and VI normally require stabilized or paved taxiway shoulder surfaces.

Source: *Airport Design*, Federal Aviation Administration Advisory Circular 150/5300-13, including Change 4, Washington DC, September 20, 1989.

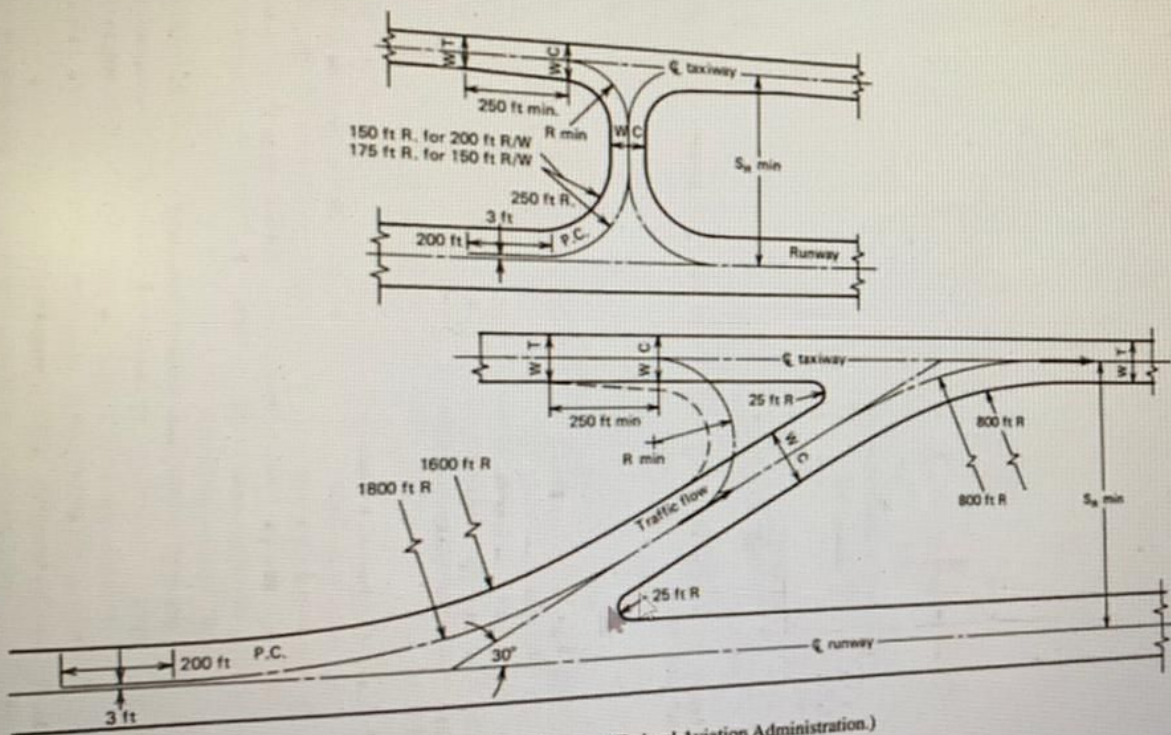


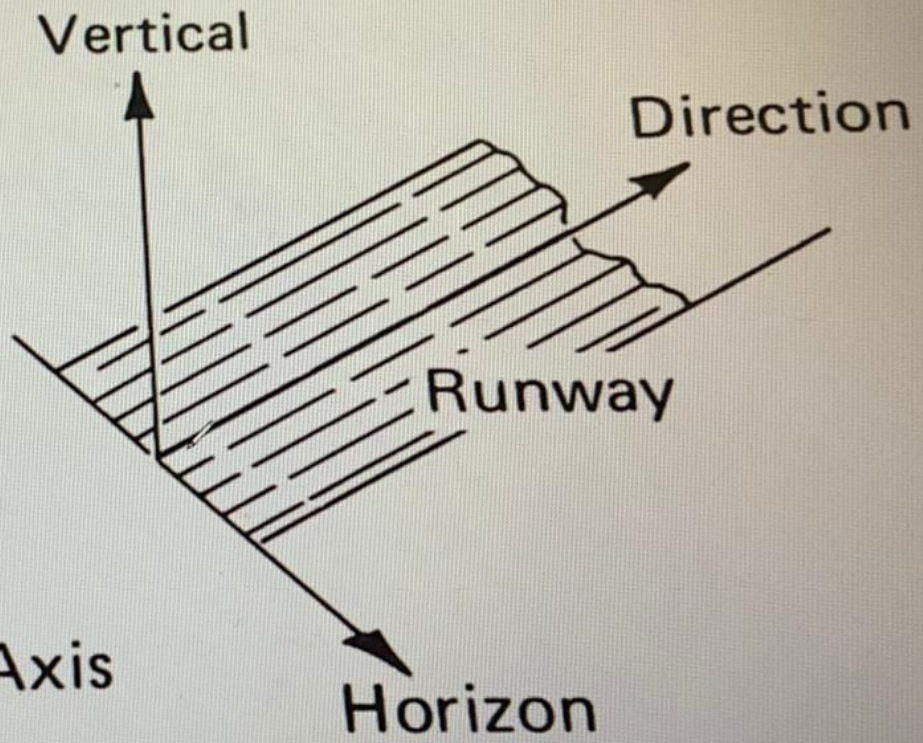
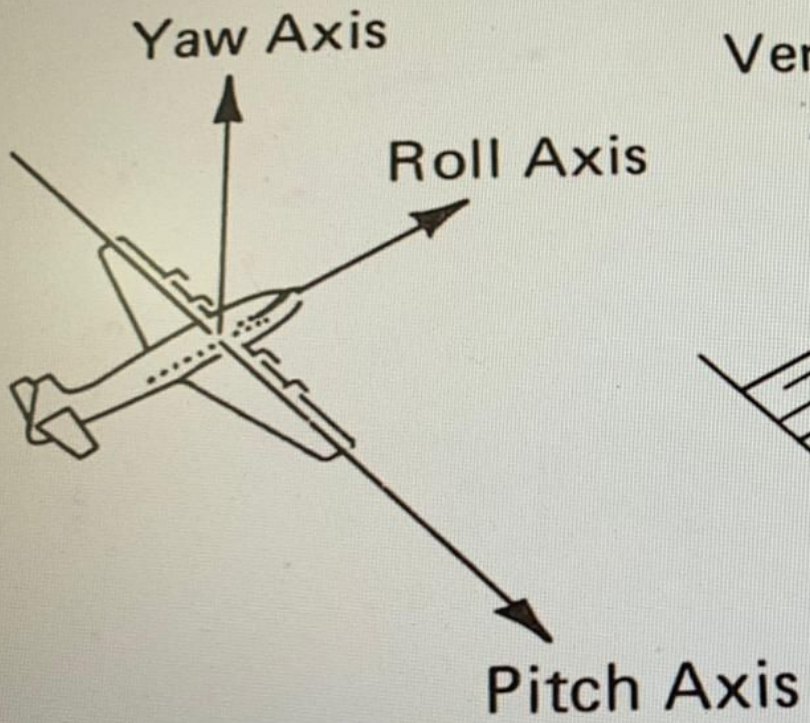
Figure 18-6 Recommended design for exit taxiways. (Courtesy Federal Aviation Administration.)

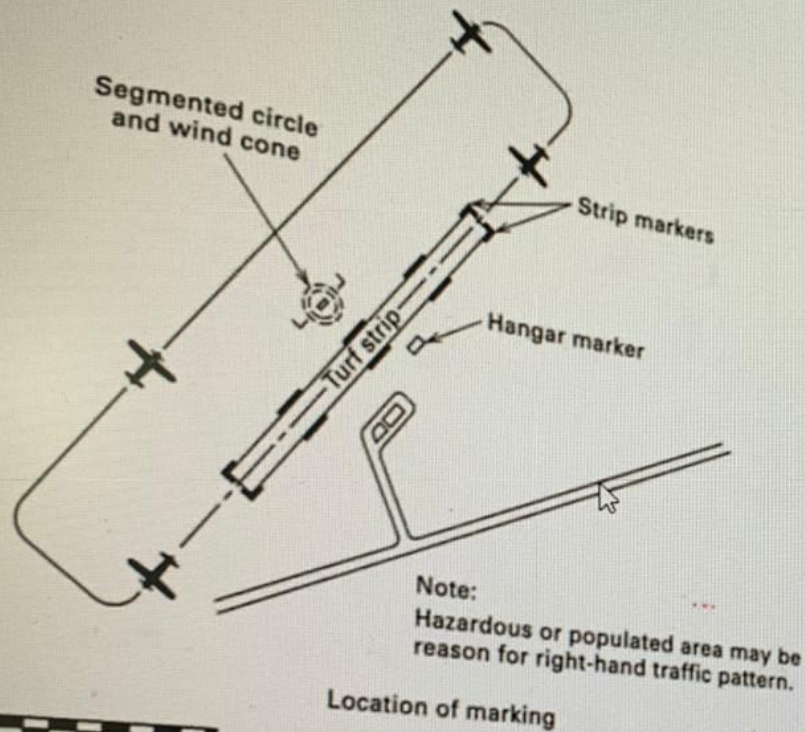
## Airport Marking and Lighting

Landing most difficult and needs most visual aids. It requires:

- Alignment
- Roll (yaw, roll, and pitch axes, fig. 18.13, p. 569)
- Height above runway
- Distance from runway

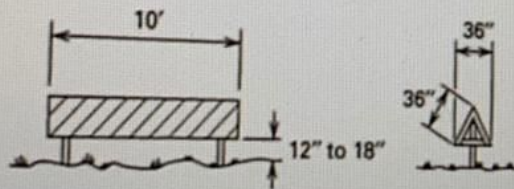






Note:  
Arrow indicates true north

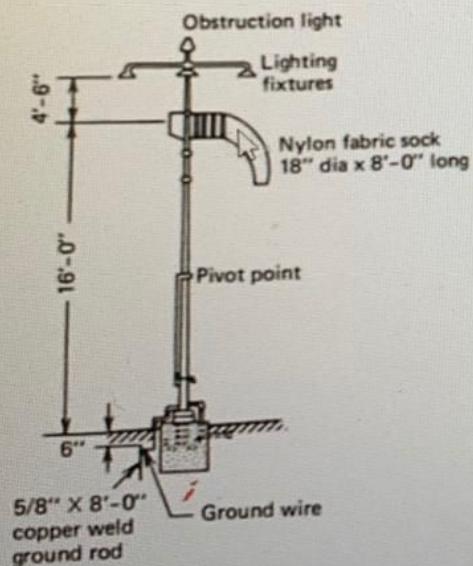
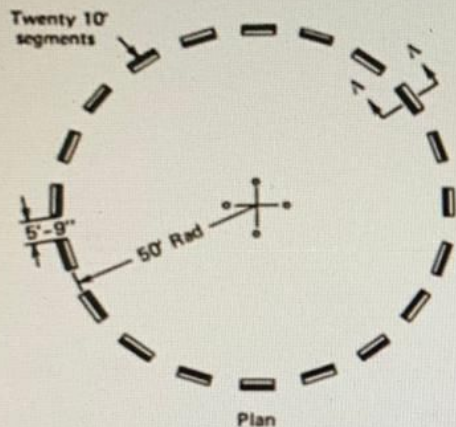
Hanger marker



Strip marker

## Hanger and Strip Markers + segmented circle system

Figure 18-14 Hanger and strip markers for small airports. (Courtesy Federal Aviation Administration)



Note

1. White  
 International orange

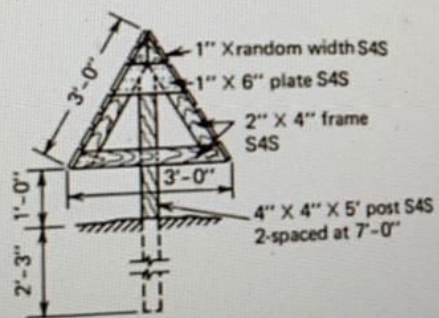
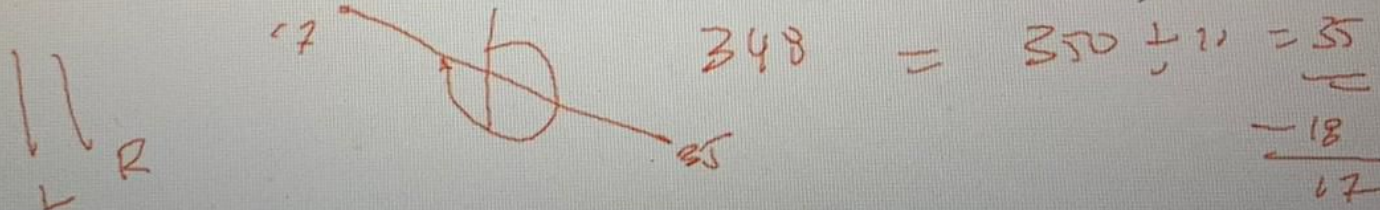


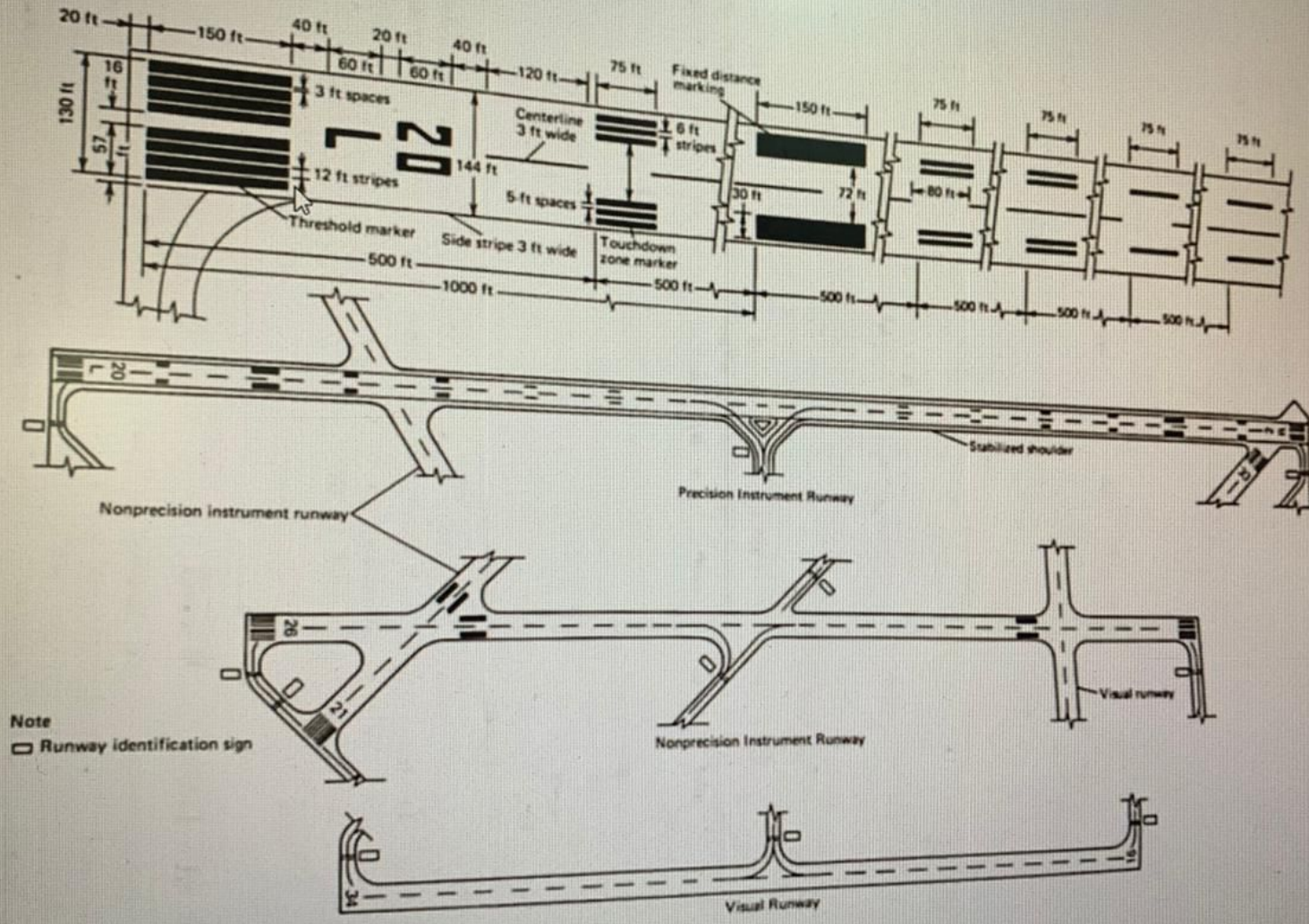
Figure 18-15 Segmented circle airport marker system. (Courtesy Federal Aviation Administration)



## Runway and Taxiway Marking: see fig. 18.6, p. 572

- Dashed centerline stripe (runway – white, taxiway – yellow)
- Threshold markers
- Side stripes
- Markers indicating distance from end of runway
- Runway numbering marker: magnet azimuth closest to 10 degrees and divided by 10 (e.g., Azimuth 348 degrees would be numbered 35 on south end and 17 and north end), parallel L, C, R (Taipei Singapore airline crash – 2000)





Note  
 □ Runway identification sign

Figure 18-16 Runway and taxiway marking. (Source: Reference 9.)