Assignment 7: Airport Geometric Design Standards

Solution
Instructor: Trani

Problem 1

A new airport is designed with two satellite terminal buildings, as shown in Figure 1. The gates can accommodate aircraft up to the size of an Airbus A321neo.

a) Find the dimensions A through R in Figure 1. Ensure that your design allows pilots entering the gate position to maneuver with steering angles no more than 50 degrees. Assume the service roads have 12-foot wide lanes. Use the new design criteria to satisfy the taxilane object-free areas.

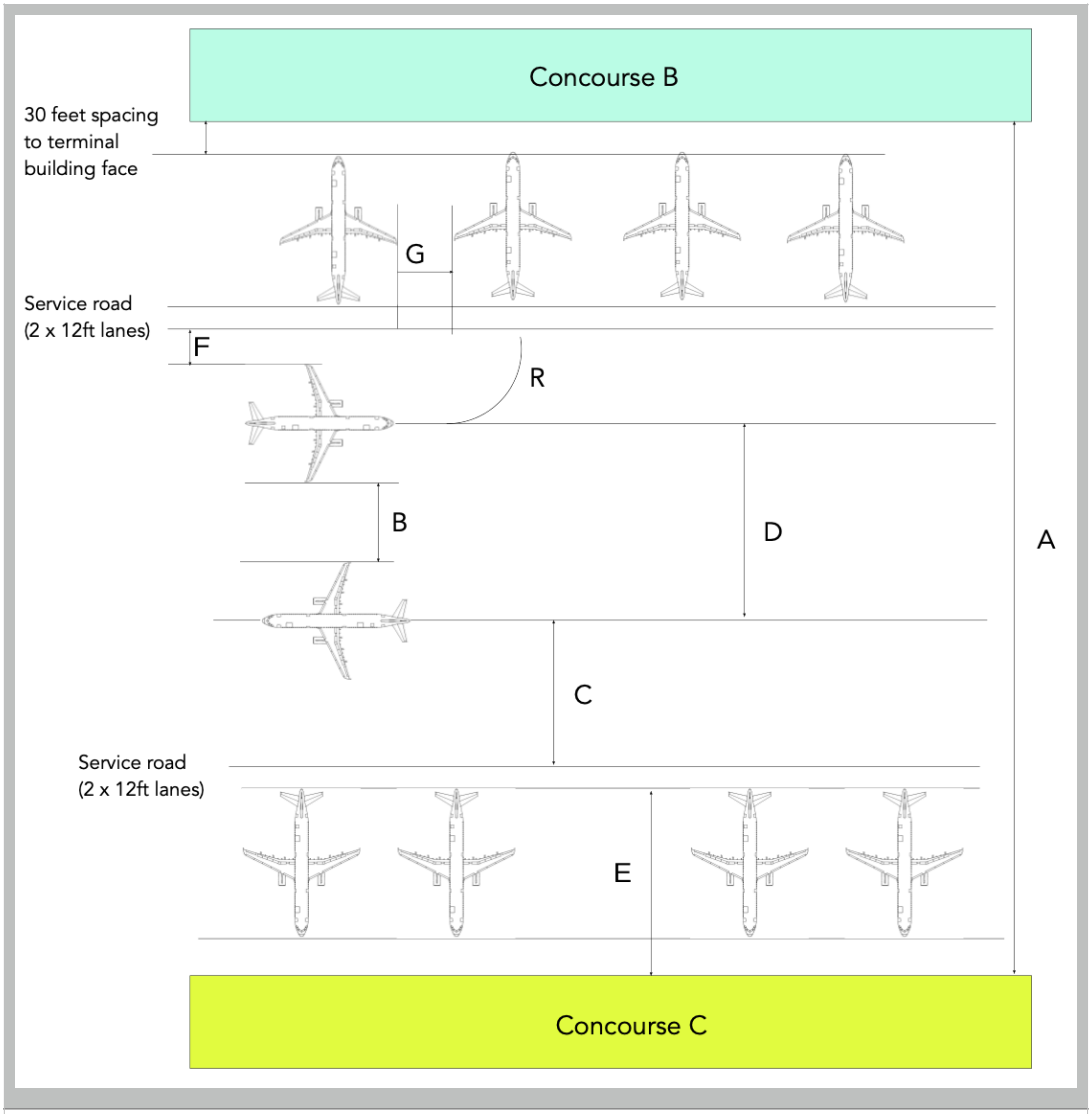


Figure 1. Airport Dual-Taxilane Configuration for Problem 1.

Table 4-1. Design Standards Based on Airplane Design Group (ADG)

Item	ADG					
	I	II	III	IV	V	VI
Taxiway and Taxilane Protection						
TSA (maximum ADG wingspan)	49 ft (14.9 m)	79 ft (24.1 m)	118 ft (36.0 m)	171 ft (52.1 m)	214 ft (65.2 m)	262 ft (79.9 m)
TOFA [2]	89 ft (27.1 m)	124 ft (37.8 m)	171 ft (52.1 m)	243 ft (74.1 m)	285 ft (86.9 m)	335 ft (102.1 m)
TLOFA [2]	79 ft (24.1 m)	110 ft (33.5 m)	158 ft (48.2 m)	224 ft (68.3 m)	270 ft (82.3 m)	322 ft (98.1 m)
Taxiway and Taxilane Separation						
Taxiway centerline to parallel taxiway centerline [1]	70 ft (21.3 m)	101.5 ft (30.9 m)	144.5 ft (44.0 m)	207 ft (63.1 m)	249.5 ft (76.1 m)	298.5 ft (91.0 m)
Taxiway centerline to fixed or movable object [2]	44.5 ft (13.6 m)	62 ft (18.9 m)	85.5 ft (26.1 m)	121.5 ft (37.0 m)	142.5 ft (43.4 m)	167.5 ft (51.1 m)
Taxilane centerline to parallel taxilane centerline [1]	64 ft (19.5 m)	94.5 ft (28.8 m)	138 ft (42.1 m)	197.5 ft (60.2 m)	242 ft (73.8 m)	292 ft (89.0 m)
Taxilane centerline to fixed or movable object [2]	39.5 ft (12.0 m)	55 ft (16.8 m)	79 ft (24.1 m)	112 ft (34.1 m)	135 ft (41.1 m)	161 ft (49.1 m)
Wingtip Clearance						
Taxiway wingtip clearance	20 ft (6.1 m)	22.5 ft (6.9 m)	26.5 ft (8.1 m)	36 ft (11.0 m)	35.5 ft (10.8 m)	36.5 ft (11.1 m)
Taxilane wingtip clearance	15 ft (4.6 m)	15.5 ft (4.7 m)	20 ft (6.1 m)	26.5 ft (8.1 m)	28 ft (8.5 m)	30 ft (9.1 m)

Design aircraft: Airbus A321neo

Design aircraft ADG: III

Design aircraft TDG: 3

B = 20 ft

C = 79 ft

D = 138 ft

E = 30 ft + aircraft length (reference: Aircraft Characteristics Database) = 30 ft + 146 ft = 176 ft

Table 4-2. Design Standards Based on Taxiway Design Group (TDG)

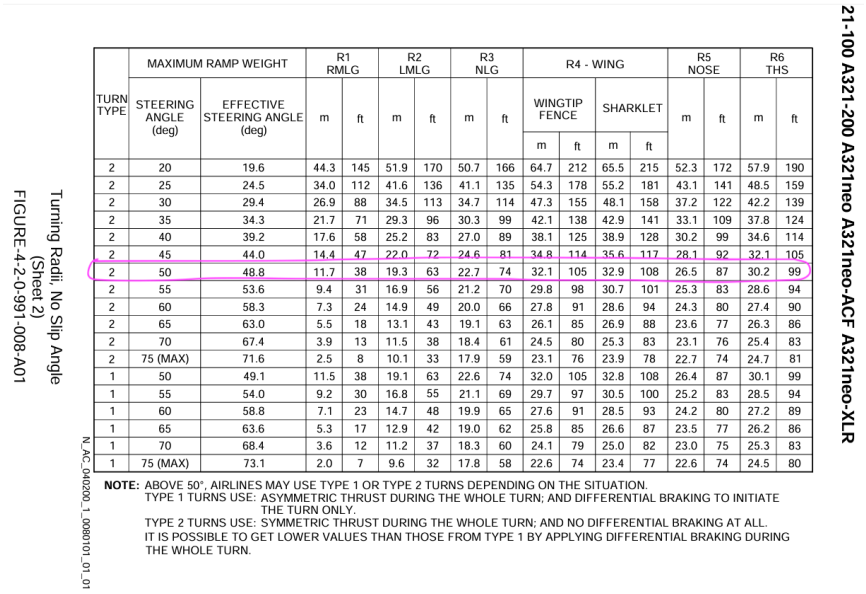
Item	TDG							
	1A	1B	2A	2B	3	4	5	6
Taxiway/Taxilane Width [2]	25 ft (7.6 m)	25 ft (7.6 m)	35 ft (10.7 m)	35 ft (10.7 m)	50 ft (15.2 m)	50 ft (15.2 m)	75 ft (22.9 m)	75 ft (22.9 m)
Taxiway Edge Safety Margin [1]	5 ft (1.5 m)	5 ft (1.5 m)	7.5 ft (2.3 m)	7.5 ft (2.3 m)	10 ft (3.0 m)	10 ft (3.0 m)	14 ft (4.3 m)	14 ft (4.3 m)
Taxiway Shoulder Width [3]	10 ft (3.0 m)	10 ft (3.0 m)	15 ft (4.6 m)	15 ft (4.6 m)	20 ft (6.1 m)	20 ft (6.1 m)	30 ft (9.1 m)	30 ft (9.1 m)

F = 20 ft

Table 5-1. Parking Position Clearance.

Airplane Design Group (ADG)	Recommended Minimum Clearances
I and II	10 ft (3 m)
III, IV, V, and VI	25 ft (7.6 m)

G = 25 ft (or 15 ft based on the CEE4674 handout)



21-100 A321-200 A321neo A321neo-ACF A321neo-XLR

TURN TYPE	MAXIMUM RAMP WEIGHT		R1 RMLG		R2 LMLG		R3 NLG		R4 - WING				R5 NOSE		R6 THS	
	STEERING ANGLE (deg)	EFFECTIVE STEERING ANGLE (deg)	m	ft	m	ft	m	ft	WINGTIP FENCE		SHARKLET		m	ft	m	ft
									m	ft	m	ft				
2	20	19.6	44.3	145	51.9	170	50.7	166	64.7	212	65.5	215	52.3	172	57.9	190
2	25	24.5	34.0	112	41.6	136	41.1	135	54.3	178	55.2	181	43.1	141	48.5	159
2	30	29.4	26.9	88	34.5	113	34.7	114	47.3	155	48.1	158	37.2	122	42.2	139
2	35	34.3	21.7	71	29.3	96	30.3	99	42.1	138	42.9	141	33.1	109	37.8	124
2	40	39.2	17.6	58	25.2	83	27.0	89	38.1	125	38.9	128	30.2	99	34.6	114
2	45	44.0	14.4	47	22.0	72	24.6	81	34.8	114	35.6	117	28.1	92	32.1	105
2	50	48.8	11.7	38	19.3	63	22.7	74	32.1	105	32.9	108	26.5	87	30.2	99
2	55	53.6	9.4	31	16.9	56	21.2	70	29.8	98	30.7	101	25.3	83	28.6	94
2	60	58.3	7.3	24	14.9	49	20.0	66	27.8	91	28.6	94	24.3	80	27.4	90
2	65	63.0	5.5	18	13.1	43	19.1	63	26.1	85	26.9	88	23.6	77	26.3	86
2	70	67.4	3.9	13	11.5	38	18.4	61	24.5	80	25.3	83	23.1	76	25.4	83
2	75 (MAX)	71.6	2.5	8	10.1	33	17.9	59	23.1	76	23.9	78	22.7	74	24.7	81
1	50	49.1	11.5	38	19.1	63	22.6	74	32.0	105	32.8	108	26.4	87	30.1	99
1	55	54.0	9.2	30	16.8	55	21.1	69	29.7	97	30.5	100	25.2	83	28.5	94
1	60	58.8	7.1	23	14.7	48	19.9	65	27.6	91	28.5	93	24.2	80	27.2	89
1	65	63.6	5.3	17	12.9	42	19.0	62	25.8	85	26.6	87	23.5	77	26.2	86
1	70	68.4	3.6	12	11.2	37	18.3	60	24.1	79	25.0	82	23.0	75	25.3	83
1	75 (MAX)	73.1	2.0	7	9.6	32	17.8	58	22.6	74	23.4	77	22.6	74	24.5	80

NOTE: ABOVE 50°, AIRLINES MAY USE TYPE 1 OR TYPE 2 TURNS DEPENDING ON THE SITUATION.
TYPE 1 TURNS USE: ASYMMETRIC THRUST DURING THE WHOLE TURN; AND DIFFERENTIAL BRAKING TO INITIATE THE TURN ONLY.
TYPE 2 TURNS USE: SYMMETRIC THRUST DURING THE WHOLE TURN; AND NO DIFFERENTIAL BRAKING AT ALL.
IT IS POSSIBLE TO GET LOWER VALUES THAN THOSE FROM TYPE 1 BY APPLYING DIFFERENTIAL BRAKING DURING THE WHOLE TURN.

Turning Radii, No Slip Angle (Sheet 2)
FIGURE-4-2-0-991-008-A01

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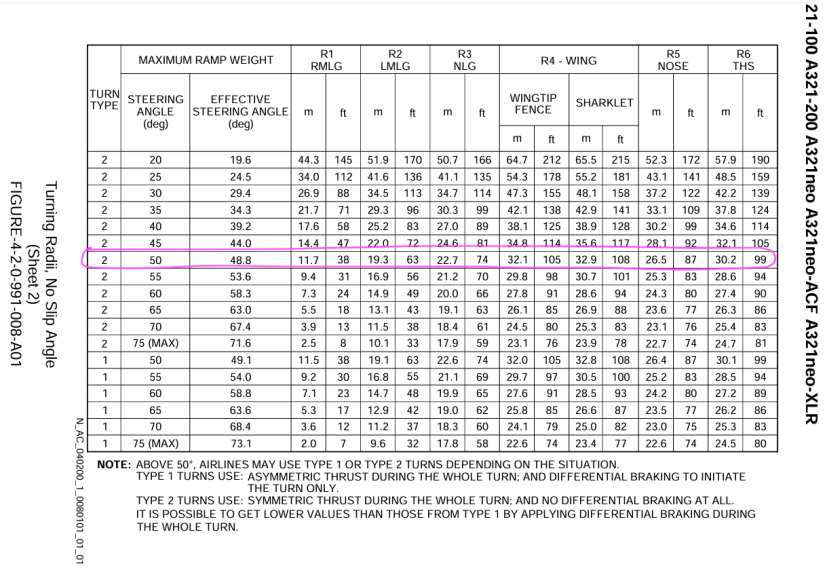
R = 74 ft

A = E + 24 ft + C + D + (Aircraft Width/2) + F + 24 ft + E = 176 ft + 24 ft + 79 ft + 138 ft + (117.5 ft/2) + 20 ft + 24 ft + 176 ft = 695.6 feet

b) Estimate the steering angle and wingtip radius of the Airbus A321neo for the centerline radius R selected in part (a) of the problem. Consult Section 4 of the corresponding Airbus airport design and planning document.

Steering angle = 50 degrees

Wingtip radius (A321neo has sharklet) = 108 ft



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TURN TYPE	MAXIMUM RAMP WEIGHT		R1 RMLG		R2 LMLG		R3 NLG		R4 - WING				R5 NOSE		R6 THS	
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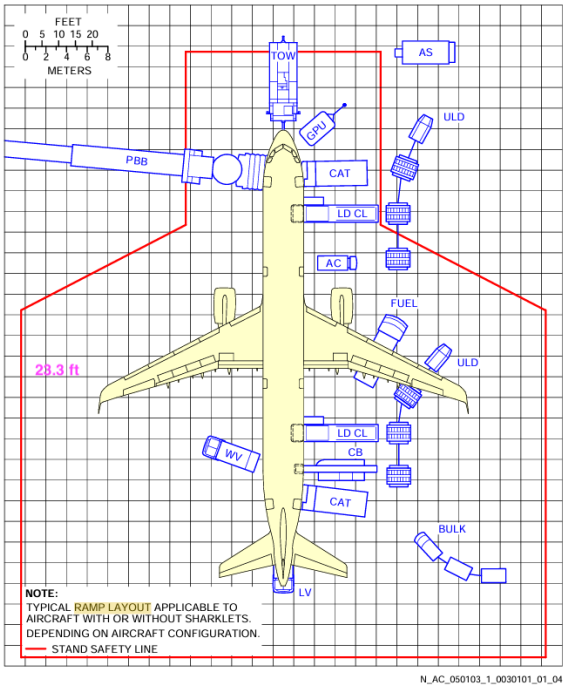
Turning Radii, No Slip Angle (Sheet 2)
FIGURE-4-2-0-991-008-A01

N_AC_040200_1_0080101_01_01

c) Compare the dimensions of your design at the gate with the typical gate layout dimensions recommended by Airbus for the A321neo (Section 5 in the Airbus A321neo airport design document - see the Typical Ramp Layout (Gate) figure). Comment on any differences.

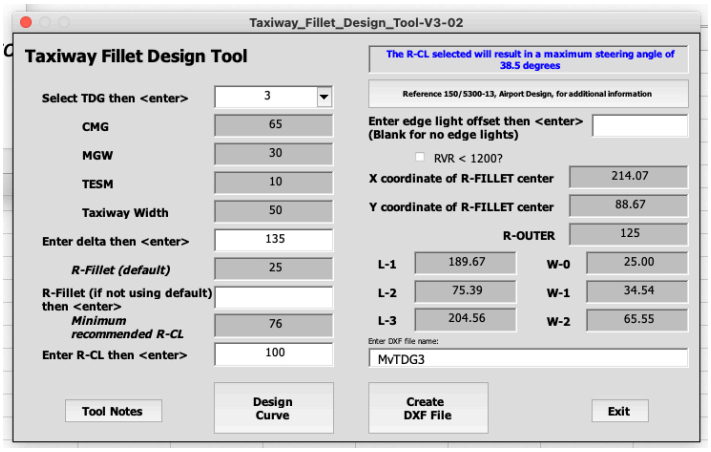
Comment: in part a, based on the FAA document, G (wingtip to wingtip distance) was calculated to be 25 ft, while based on the Airbus airport design document the same type of distance would be 23.3*2 = 46.6 ft.



Typical Ramp Layout
Gate
FIGURE-5-1-3-991-003-A01

Problem 2

a) Use the FAA Taxiway Fillet Design Tool to design a 135-degree taxiway-taxiway connector for the Airbus A220-300(see Figure 2). Your design should include all dimensions needed to construct the taxiway fillets (three segment lengths L-1, L-2, L-3; three taxiway widths W-0, W-1, W-2, W-3; and two radii dimensions R-Fillet and R-Outer. For your design, use a 100-foot centerline radius.



b) Tell me the steering angle produced in the design of part (a). Is the steering angle acceptable?

The reported steering angle is 38.5 degrees. This is acceptable because the steering angle must be less than 50 degrees based on the FAA standards.

c) For the Airbus A220-300 what does FAA require the minimum centerline radius on the 135-deg. Taxiway junction?

Minimum centerline radius = 76 ft

d) Find the steering angle required for the design implemented in part (a).

Steering angle required = 38.5 degree

e) Use the FAA FAA Taxiway Fillet Design Tool to produce a simple CAD drawing of the taxiway-taxiway connector design in part (a). Show the detailed geometry in the CAD software with dimensions (no hand sketches accepted). You can export the DXF file produced by the FAA Taxiway Design Tool.

Note: If the FAA Taxiway Design Tool does not work on your computer, use the tables in Appendix J of the FAA Advisory Circular 150/5300-13B to implement your design. You must still draw the solution in part (a) using CAD.

Figure 2. Airbus A220-300 Landing at Atlanta Hartsfield-Jackson International Airport (A. Trani).

Problem 3

An airport is expected to have two parallel taxiways to serve Airbus A321neo and Boeing 737-Max9 aircraft taxiing in opposite directions. Specify the following dimensions:

Table 4-1. Design Standards Based on Airplane Design Group (ADG)

Item	ADG					
	I	II	III	IV	V	VI
Taxiway and Taxilane Protection						
TSA (maximum ADG wingspan)	49 ft (14.9 m)	79 ft (24.1 m)	118 ft (36.0 m)	171 ft (52.1 m)	214 ft (65.2 m)	262 ft (79.9 m)
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Wingtip Clearance						
Taxiway wingtip clearance	20 ft (6.1 m)	22.5 ft (6.9 m)	26.5 ft (8.1 m)	36 ft (11.0 m)	35.5 ft (10.8 m)	36.5 ft (11.1 m)
Taxilane wingtip clearance	15 ft (4.6 m)	15.5 ft (4.7 m)	20 ft (6.1 m)	26.5 ft (8.1 m)	28 ft (8.5 m)	30 ft (9.1 m)

Table 4-2. Design Standards Based on Taxiway Design Group (TDG)

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Taxiway Edge Safety Margin [1]	5 ft (1.5 m)	5 ft (1.5 m)	7.5 ft (2.3 m)	7.5 ft (2.3 m)	10 ft (3.0 m)	10 ft (3.0 m)	14 ft (4.3 m)	14 ft (4.3 m)
Taxiway Shoulder Width [3]	10 ft (3.0 m)	10 ft (3.0 m)	15 ft (4.6 m)	15 ft (4.6 m)	20 ft (6.1 m)	20 ft (6.1 m)	30 ft (9.1 m)	30 ft (9.1 m)

Note: based on the information in the Aircraft Characteristics Database (ACD):

Airbus A321neo ADG is III, and TDG is 3.

Boeing 737-Max9 ADG is III, and TDG is 3.

Therefore, the design is for ADG III and TDG 3.

a) Distance between parallel taxiway centerlines.

144.5 ft

b) Find the minimum distance between the taxiway centerline and a movable object.

85.5 ft

c) Find the dimension of the taxiway shoulder used in the design.

20 ft

d) Find the taxiway edge safety margin used in the design.

10 ft

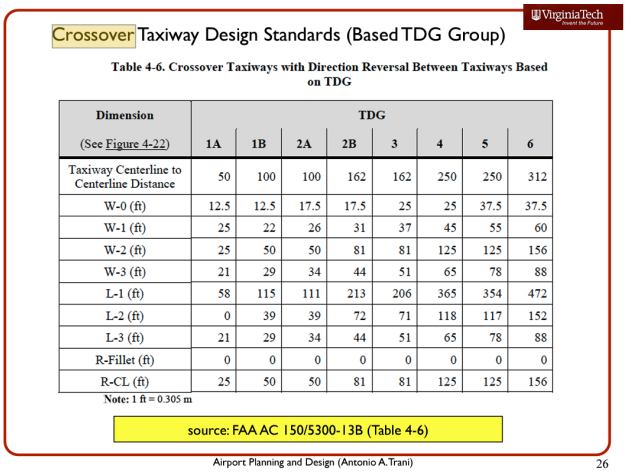
e) State the dimensions of the Taxiway TOFA and Taxiway Safety Areas (TSA).

Taxiway TOFA = 171 ft

Taxiway Safety Areas = 118 ft

Problem 4

Specify the dimensions of a crossover taxiway designed for the Boeing 737-Max9 and Airbus A321neo. Your design should be based on the TDG group design criteria. Assume the aircraft will reverse direction while using the crossover taxiway.



Dimension (See Figure 4-22)	TDG 1A	1B	2A	2B	3	4	5	6
Taxiway Centerline to Centerline Distance	50	100	100	162	162	250	250	312
W-0 (ft)	12.5	12.5	17.5	17.5	25	25	37.5	37.5
W-1 (ft)	25	22	26	31	37	45	55	60
W-2 (ft)	25	50	50	81	81	125	125	156
W-3 (ft)	21	29	34	44	51	65	78	88
L-1 (ft)	58	115	111	213	206	365	354	472
L-2 (ft)	0	39	39	72	71	118	117	152
L-3 (ft)	21	29	34	44	51	65	78	88
R-Fillet (ft)	0	0	0	0	0	0	0	0
R-CL (ft)	25	50	50	81	81	125	125	156

Note: based on the information in the Aircraft Characteristics Database (ACD):

Airbus A321neo TDG is 3.

Boeing 737-Max9 TDG is 3.

Therefore, the design is for TDG 3.

a) Find the recommended taxiway centerline to taxiway centerline distance.

162 ft

b) Find the three fillet lengths L-1, L-2, and L-3 for the crossover taxiway.

L-1 = 206 ft L-2 = 71 ft L-3 = 51 ft

c) Find the taxiway fillet design widths (W-0, W-1, W-2, and W-3).

W-0 = 25 ft W-1 = 37 ft W-2 = 81 ft W-3 = 51 ft

d) Find the recommended centerline and fillet radii.

Centerline radii = 81 ft
Fillet radii = 0 ft