ARC 523, Fall 2023
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Assignment #3
Due: Oct. 12th, 2023

Parameters & Values

Areas	Roof	2500 sqft
	Wall	1368 sqft
	Window	600 sqft
	Door	32 sqft
	Floor	2500 sqft
T_room		75℉
Total supply Air		1 CMF/sqft
Fresh/Outside/Ventilation Air		20% of total supply air
U-value	Roof	0.034 Btu/hr-sqft-℉
	Wall	0.065 Btu/hr-sqft-℉
	Door	0.320 Btu/hr-sqft-℉
Occupancy Density		200 sqft/person
People	Sensible heat	255 Btu/hr-person
	Latent heat	155 Btu/hr-person
Light heat gain		2 Btu/hr-sqft
Equipment heat gain		1 Btu/hr-sqft

		Charlotte, NC	Denver, CO	Washington, DC
T_db (℉)		93	91	91
T_wb (℉)		74	59	74
DETD (℉) (Table F.5)	Roof	42	40	40
	Wall	14.3	12.3	12.3
	Door	14	12	12
DCLF (Btu/hr-sqft) (Table F.6)	South	36.8	35.6	35.6
	North	22.8	21.6	21.6
	East & West	71.8	70.6	70.6

1) Cooling Loads

① Sensible Cooling Loads

Charlotte, NC		
q_roof	0.034*2500*42 =	3570 Btu/hr
q_wall	0.065*1368*14.3 =	1271.56 Btu/hr
q_door	0.320*32*14 =	143.36 Btu/hr
q_floor	0	0
q_window	(30*5*36.8) + (30*5*22.8) + (30*5*71.8)*2 =	30480 Btu/hr
q_people	(50*50) / 200 * 255 =	3187.5 Btu/hr
q_light	(50*50)*2 =	5000 Btu/hr
q_equip	(50*50)*1 =	2500 Btu/hr
q_vent	1.08*0.2*(50*50)*(93-75) =	9720 Btu/hr
Q_sens	-	55872.42 Btu/hr
Denver, CO		
q_roof	0.034*2500*40 =	3400 Btu/hr
q_wall	0.065*1368*12.3 =	1093.72 Btu/hr
q_door	0.320*32*12 =	122.88 Btu/hr
q_floor	0	0
q_window	(30*5*35.6) + (30*5*21.6) + (30*5*70.6)*2 =	29760 Btu/hr
q_people	(50*50) / 200 * 255 =	3187.5 Btu/hr
q_light	(50*50)*2 =	5000 Btu/hr
q_equip	(50*50)*1 =	2500 Btu/hr
q_vent	1.08*0.2*(50*50)*(91-75) =	8640 Btu/hr
Q_sens	-	53704.10 Btu/hr
Washington, DC		
q_roof	0.034*2500*40 =	3400 Btu/hr
q_wall	0.065*1368*12.3 =	1093.72 Btu/hr
q_door	0.320*32*12 =	122.88 Btu/hr
q_floor	0	0
q_window	(30*5*35.6) + (30*5*21.6) + (30*5*70.6)*2 =	29760 Btu/hr
q_people	(50*50) / 200 * 255 =	3187.5 Btu/hr
q_light	(50*50)*2 =	5000 Btu/hr
q_equip	(50*50)*1 =	2500 Btu/hr
q_vent	1.08*0.2*(50*50)*(91-75) =	8640 Btu/hr
Q_sens	-	53704.10 Btu/hr

② Latent Cooling Loads

Charlotte, NC		
Humidity ratio_OA		0.0138
Humidity ratio_RA		0.0092
q_people	((50*50)/200) * 155 =	1937.5 Btu/hr
q_vent	4840*(0.2*50*50)*(0.0138-0.0092) =	11132 Btu/hr
Q_lat	-	13069.5 Btu/hr
Denver, CO		
Humidity ratio_OA		0.0034
Humidity ratio_RA		0.0092
q_people	((50*50)/200) * 155 =	1937.5 Btu/hr
q_vent	-	-
Q_lat	-	1937.5 Btu/hr
Washington, DC		
Humidity ratio_OA		0.0142
Humidity ratio_RA		0.0092
q_people	((50*50)/200) * 155 =	1937.5 Btu/hr
q_vent	4840*(0.2*50*50)*(0.0142-0.0092) =	12100 Btu/hr
Q_lat	-	14037.5 Btu/hr

③ Total Cooling Loads

	Charlotte, NC	Denver, CO	Washington, DC
Q_total	68941.92 Btu/hr	55641.60 Btu/hr	67741.60 Btu/hr

2) Analyze results

2-1) Charlotte, NC > Washington, DC > Denver, CO

This order is reasonable because each city's rank for Cooling degree hours (CDH) is the same as its rank for total cooling loads. CDH base 74°F (Table A.1) is the cumulative sum of the difference between the hourly average temperature and the standard temperature for the times when the average hourly temperature in a specific area is higher than the standard temperature. Therefore, it can be said that the larger this value, the larger the cooling load.

	Charlotte, NC	Denver, CO	Washington, DC
Cooling degree hours base 74℉	15159	5908	12389

2-2) Outdoor air humidity ratio is the highest in Washington and the lowest in Denver. Therefore, Washington has the relatively humid climate (low SHF values), and Denver has the relatively dry climate (high SHF values).

	Charlotte, NC	Denver, CO	Washington, DC
Sensible Heat Factor	0.81	0.96	0.79

2-3)

	Charlotte, NC	Denver, CO	Washington, DC
Tons of Cooling	5.74	4.63	5.64

2-4) For the same amount of floor space, Charlotte requires the most tons of cooling, while Denver requires the least. In other words, charlotte requires more tons to cool 2500sqft because the area cooled by one ton is small, and Denver requires less tons because the cooling area covered by one ton is relatively large.

	Charlotte, NC	Denver, CO	Washington, DC
Square feet of area	435.14	539.16	442.85

2-5) ① To reduce the q_window value, decrease the area of the window (especially the east and west sides) ② To reduce the q_light value, turn off the light during the day ③ To reduce q_ventilation for sensible and latent loads, decrease infiltration