

Outside Air			Wheeled Outside Air			Inside Air			Mixed Air			Coil Leaving Air			Coil Leaving Air (DOAS)		
ASHRAE Fundamentals 1997 1%DD			Assume .8 efficiency for both latent and sensible			72 F 50% RH			90% RA 10% OA			Same as LWA spec equipment			All values based on 45 F leaving DBT and 90%RH		
DB (F)	WB (F)	Gr	DB (F)	WB (F)	Gr	DB (F)	WB (F)	Gr	DB (F)	WB (F)	Gr	DB (F)	WB (F)	Gr	DB (F)	WB (F)	Gr
91	74	100	75.8	62.8	66.4	72	60	58	73.9	61.4	62.2	52.9	50.4	48	45	41	35

Total Supply Air (from fixture count) 114036 CFM

Latent Load

Interior Cooling	Conventional	775,445	(BTU/h)
	DOAS	775,445	(BTU/h)
Coil Latent Load	Conventional	1,101,132	(BTU/h)
	DOAS	1,058,651	(BTU/h)
Conventional	needed CFM	114,036	(cfm)
DOAS	needed CFM	49,581	(cfm)

Sensible Load

Interior Cooling	Conventional	2,352,335	(BTU/h)
	DOAS	1,445,778	(BTU/h)
Coil Sens Load	Conventional	2,586,336	(BTU/h)
	DOAS	1,649,258	(BTU/h)
Remaining DOAS load for Parallel cooling system		906,556	(BTU/h)

Existing Cooling Systems	CFM cap per unit (CFM)	Units	CFM/unit (6 units) (CFM)	Total Cooling Cap (BTU/h)	Latent Cooling Cap (BTU/h)	Sensible Cooling Cap (BTU/h)	Max Elec Use (kW)	Normal Elec Use (kW)	Total Fan Power (hp)	Total Fan Energy (kW)
York DX packaged units	21000	6	19,006	4,074,336	1,216,656	2,857,680	423		156	145.5

Fan electrical power assumes .8 efficiency

Conventional Cooling Systems

Conventional Cooling Systems	CFM cap per unit (CFM)	Fan cap per unit (CFM)	Units	CFM/unit (6 units) (CFM)	Total Cooling Cap (BTU/h)	Latent Cooling Cap (BTU/h)	Sensible Cooling Cap (BTU/h)	Inlet H2O Temp (F)	Outlet H2O Temp (F)	Delta T H2O (F)	Coil Effectiveness (ε)	Chilled H2O Rate (lb/hr)	Chilled H2O Rate (gpm)	Chilled H2O Heat Gain (BTU/h)	Pumping Power (hp)	Pump Elec Power (kW)	Total Fan Power (hp)	Total Fan Energy (kW)
York Custom AHU with max 45sqft water coil area.	22,500	21,000	6	19,006	4,074,336	1,216,656	2,857,680	38	53	15	0.8	339,528.00	679.33	5,092,920	12	12.4	156	145.5

Tons/unit= 56.6

gpm/unit= 113

$$\dot{m} \text{dot} w = 1 \text{ BTU}/(\text{lb} \cdot \text{F}) \cdot (\text{Tot}w - \text{Ti}w) \cdot \epsilon = 1.08 \cdot 19006 \cdot (74 - 53) + .68 \cdot 19006 \cdot (62.2 - 48)$$

Fan Power assumes same ESP and SA volume as LWA specs

Fan electrical power assumes .8 efficiency

Hydronic Heating System

Hydronic Heating System	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	Box Size (kW)	380
Hydronic Heating Coils in Fan Powered VAV Boxes	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5		
Unit Heat Demand (BTU/hr)	5,118	6,824	8,530	10,236	11,942	13,648	15,354	17,060	18,766	20,472	22,178	23,884	25,590	199,602	
Incedence	6	16	21	39	5	12	7	3	3	1	2	1	2	118	
Hot Water Flowrate (gpm)	5.1	18.2	29.9	66.6	10.0	27.3	17.9	8.5	9.4	3.4	7.4	4.0	8.5	216.2	
Unit Cost (Dollars)				137.23											

Unit Costs from Lytron Product Selector
 Hot Water Flowrate assumes .8 coil efficiency
 Hot Water Flowrate assumes 15 degree Delta T

Selected Motor hp =	2.5
Motor Efficiency =	0.73
Input Power (kW) =	2.55

DOAS Cooling Systems

	CFM cap per unit (CFM)	Fan cap per unit (CFM)	Units	CFM/unit (3 units) (CFM)	Total Cooling (BTU/h)	Latent Cooling (BTU/h)	Sensible Cooling (BTU/h)	Inlet H2O Temp (F)	Outlet H2O Temp (F)	Delta T H2O (F)	Coil Effectiveness (ε)	Chilled H2O Rate (lb/hr)	Chilled H2O Rate (gpm)	Chilled H2O Heat Gain (BTU/h)	Pumping Power (hp)	Pump Elec Power (kW)	Total Fan Power (hp)	Total Fan Energy (kW)
York Custom AHU with max 45sqft water coil area.	22,500	19,000	3	16,527	3,113,112	1,217,064	1,896,048	38	52	14	0.8	277,956.43	556.14	3,891,390	7.5	7.3	51	47.6
													Tons/unit= 86.5					
													gpm/unit= 185					

Fan Power assumes same ESP as LWA specs and a SA volume of 19000CFM
Fan electrical power assumes .8 efficiency

Parallel Cooling/Heating Systems

Width of 1' Available Lengths of 3',4',5',6',7',8',9',10'

	Design Cooling capacity (BTU/h)	Design Heating capacity (BTU/h)	Maximum Cooling capacity (BTU/h)	Maximum Heating need (BTU/h)	Cig Inlet Water Temp (F)	Htg Inlet Water Temp (F)	Design Chilled H2O Rate (gpm)	Max Chilled H2O Rate (gpm)	Design Heated H2O Rate (gpm)	Max Heated H2O Rate (gpm)	Design Steam Rating (Therm)	Maximum Steam Need (Therm)	Parallel Cooling Pumping Power (hp)	Parallel Cooling Pump Elec Power (kW)	Parallel Heating Pumping Power (hp)	Parallel Heating Pump Elec Power (kW)
Trox Active Chilled or Heated Beam	219,412	28,357			60.8	150.0	245	277	10	126			1.5	1.5	1.25	1.5

Steam demand assumptions:
ε = .8
Twi = 55

available energy sink=4184J/L*K * (flow rate)L/h * 1h/3600s * (delta Tw)K = 1.162W*h/L*K * (flow rate) * (delta Tw)

	cooling (W)	delta T (K)	Flow Rate (l/h)	avail energy (W)	effectiveness					Cooling Water (l/h)	Cooling Water (gpm)	Total Cooling (BTU/h)
						Floor 0	Floor 1	Floor 2	Floor 3			
900 mm	125	1	135	156.87	0.7968	9	28	28	29	12,690	56	40,091
	144	1.1	141	180.23	0.7990	4	8	21	31	9,024	40	31,445
	159	1.2	143	199.40	0.7974	1	20	34	43	14,014	62	53,166
	172	1.3	143	216.02	0.7962		13	34	18	9,295	41	38,146
	183	1.4	141	229.38	0.7978		5	3	15	3,243	14	14,361
	193	1.5	139	242.28	0.7966	21		11	7	5,421	24	25,682
1800 mm	344	2.7	138	432.96	0.7945	4				552	2	4,695
	361	2.8	139	452.25	0.7982		10			1,390	6	12,317
											245	219,903

	heating (W)	delta T (K)	Flow Rate (l/h)	avail energy (W)	effectiveness					Heating Water (l/h)	Heating Water (gpm)	Total Heating (BTU/h)
						Floor 0	Floor 1	Floor 2	Floor 3			
900 mm	75	1.5	54	94.12	0.7968	13	1		12	1404	6.182	6,653
	100	2	54	125.50	0.7968	6			2	432	1.902	2,730
	130	2.5	56	162.68	0.7991	3			1	224	0.986	1,774
	200	3.5	62	252.15	0.7932	4		1		310	1.365	3,412
	240	2	130	302.12	0.7944	2	1			390	1.717	2,457
	269	4.6	63	336.75	0.7988	4	9	2	1	1008	4.438	14,685
	308	5.4	62	389.04	0.7917		3		1	248	1.092	4,204
	339	5.8	63	424.59	0.7984		1			63	0.277	1,157
	387	6.7	63	490.48	0.7890		1	2		189	0.832	3,961
1800 mm	725	12.5	63	915.08	0.7923		1			63	0.277	2,474
											19.1	43,506