Technical Assignment One

ASHREA Standard 62.1 and Standard 90.1 Compliance

Richard T. Flood Jr. & Sally Elliot Flood Athletic Center
Salisbury, CT

Prepared for:
Dr. William P. Bahnflath
Department of Architectural Engineering
The Pennsylvania State University

Prepared by:
Woong June Chung
Mechanical Option

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Executive Summary

Technical assignment one was given as a task to students in AE481. Student with mechanical option were required to use ASHRAE Standard 62.1 and ASHRAE Standard 90.1 to evaluate the building.

ASHRAE Standard 62.1 contains the information about ventilation. Certain ventilation is required for the building to control the air quality. In section 5, Local capture of contaminants was considered due to the consideration of amount of sulfur dioxide, particles, carbon monoxide, oxidants, nitrogen dioxide, and lead. Also, dehumidification was considered because of the mold growth in the building. Section 6 explains about procedure to calculate the required value of design outdoor air intake flow.

ASHRAE Standard 90.1 covers the energy design evaluation. Required R-value for the building can be calculated in section 5. Section 6 carries Heating, Ventilating, and Air Conditioning information, which deals with compliance of efficiency of equipments. In Section 7, efficiency of boiler can be evaluated. Section 9 contains data to calculate Lighting Power Density.

According to the results of data, Richard T. Flood Jr., & Sally Elliot Flood Athletic Center can be improved in outdoor air intake flow. Squash court and wrestling room do not allow enough outside air to enter the area and should be considered due to the air quality of the building.

ASHRAE 62.1 - 2007
Section 5

5.3 Exhaust Duct Location

All exhaust ducts are located away from occupied spaces.

5.5 Airstream Surfaces

Building system uses dehumidifier in the ice rink and material surfaces are determined to be resistant to mold growth.

5.7 Local Capture of Contaminants

All mechanical rooms use exhaust fans to discharge the potential contaminants generated by the equipment.

5.10 Dehumidification System

Building system provides ventilating and dehumidifying unit due to the ice rink in the building. Also, the air is heated and dehumidified in Air Handling Units. Occupied spaces in the building maintain relative humidity less than 65%.

5.14 Access for Inspection, Cleaning, and Maintenance

Ventilation equipment is installed with sufficient working spaces for routine inspection, maintenance, or calibration.

5.15 Building Envelope and Interior Surfaces

Exterior wall provides to prevent liquid water. All pipes and ducts are insulated due to the condensation on interior surfaces.

5.18 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

Building is part of school facilities and all spaces are non-smoking area.

ASHREAE 62.1 - 2007

Section 6 Procedure

The procedure to achieve the required value of design outdoor air intake flow is shown as below.

$V_{bz} = R_p * P_z + R_a * A_z$ (6-1)

A_z = zone floor area (ft2)
P_z = zone population (table 6-1)
R_p = outdoor air flow rate (table 6-1)
R_a = outdoor airflow rate (table 6-1)
V_{bz} = breathing zone outdoor air flow

$V_{oz} = V_{bz} / E_z$ (6-2)

V_{oz} = design zone outdoor airflow
E_z = 1 zone air distribution effectiveness (table 6-2)

$Z_p = V_{oz} / V_{pz}$ (6-5)

Z_p = zone primary outdoor air fraction
V_{pz} = zone primary air flow

$V_{ou} = D * \Sigma_{\text{all zones}} (R_p * P_z) + \Sigma_{\text{all zones}} (R_a * A_z)$ (6-6)

V_{ou} = design uncorrected outdoor air intake
D = occupant diversity

$D = P_s / \Sigma_{\text{all zones}} P_z$ (6-7)

P_s = system population

$V_{ot} = V_{ou} / E_v$ (6-8)

V_{ot} = design outdoor air intake flow
E_v = system ventilation efficiency (table 6-3)

	required OA	OA CFM		Comply?
AHU - 1, AHU - 2	4508	17600	basketball court	yes
AHU - 4	618	2950	Storage	yes
AHU - 5	1906	640	squash court	no
AHU - 6	1936	1500	wrestling room, locker room	no
AHU - 7	741	800	weight room, locker room	yes
AHU - 8	416	855	corridor of second floor	yes
AHU - 9	815	1400	athlete waiting room	yes
AHU - 10	69	360	Offices	yes

Air Handling Unit 1 and 2 have excessive amount of outside air intake due to the audiences of basketball game event. Air Handling Units for squash court and wrestling room do not comply with ASHRAE 62.1-2007.

The spread sheet for calculation is provided in Appendix A.

ASHRAE 90.1 - 2007
Section 5 Building Envelope

Vertical glazing area has to be less than 40% of gross area.

	Wall Gross Area(sf)	Glass Area(sf)	Max Glass Area(sf)	Comply?
West	13865	3028.15	5546	yes
East	13865	1541.37	5546	yes
North	11718	3520.29	4687.2	yes
South	11718	0	4687.2	yes

Climate Zone of Connecticut is 5 from ASHREAE 90.1 -2007 Appendix B Table B-1.
According to Table 5.5-5, required R-values of roof, wall above grade and slab on grade floor area shown as below.

		Required R-value	Actual R-value	Comply?
Roof	insulated	20	54.4	yes
Wall above grade	mass	11.4	40.941	yes
Slab on grade floors	unheated	NR	13.6	yes

All of actual R-values exceed greatly, because the facility holds ice rink which needs more insulation. If the heat enters the building easily, it will cost more money to maintain the ice rink condition.

ASHRAE 90.1 - 2007

Section 6 Heating, Ventilating, and Air Conditioning

The gross area of the building exceeds 25,000 ft^2. Mandatory provision method will be used to determine the compliance with ASHREAE 90.1 section 6. With variable volume, CFM*0.0015 should be greater than horsepower that was used for the equipment.

Ice Rink Ventilating & Dehumidifying Unit				
	CFM	CFM * 0.0015	HP	Comply?
IRDU-1	10000	15	15	yes

Fan	CFM	CFM * 0.0015	HP	Comply?
EF-1	2000	3	1	yes
EF-2	150	0.225	0.068	yes
EF-3	800	1.2	0.333	yes
EF-4	75	0.1125	0.027	yes
EF-5	740	1.11	0.346	yes
EF-6	900	1.35	0.333	yes
EF-7	75	0.1125	0.027	yes
EF-8	300	0.45	0.114	yes
EF-9	300	0.45	0.114	yes
EF-10	4400	6.6	2	yes
EF-11	6950	10.425	3	yes
EF-12	200	0.3	0.143	yes
EF-13	3500	5.25	0.75	yes
EF-14	340	0.51	0.125	yes
EF-15	12500	18.75	5	yes
EF-16	6270	9.405	3	yes
EF-17	11000	16.5	10	yes
EF-18	5675	8.5125	3	yes
EF-19	3100	4.65	3	yes
EF-20	3200	4.8	0.5	yes
SAF -1	400	0.6	0.167	yes

AHU	CFM	CFM * 0.0015	HP	Comply?
AHU-1	15400	23.1	10	yes
AHU-2	15400	23.1	10	yes
AHU-4	5675	8.5125	3	yes
AHU-5	11000	16.5	10	yes
AHU-6	6950	10.425	5	yes
AHU-7	6270	9.405	5	yes
AHU-8	10000	15	7.5	yes
AHU-9	4550	6.825	3	yes
AHU-10	1200	1.8	1	yes

All the equipment units comply with ASHRAE 90.1-2007.

Section 7 Service Water Heating

Boiler	IBR gross output (MBH)	IBR net output (MBH)	Efficiency	Required Efficiency	Comply?
B-1	3957	3441	86.96%	80%	yes
B-2	3957	3441	86.96%	80%	yes
B-3	1281	1114	86.96%	80%	yes
B-4	1281	1114	86.96%	80%	yes

The required efficiency for the boilers is 80%. All the boilers have an efficiency of 86.96% and complies with ASHRAE 90.1-2007.

Section 9 Lighting

According to the Table 9.5.1, Lighting Power Density for the gymnasium is 1.1 W/ft^2
The LPD of the facility is 0.93 W/ ft^2 does not exceed the allowable value. Therefore it complies with ASHRAE 90.1-2007

Appendix A
Calculation Spreadsheet for Outside Air Requirements

AHU – 1, AHU - 2

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent							
System Tag/Name:		AHU - 1, AHU - 2							
Operating Condition Description:	Add Zone	Basketball Court							
Units (select from pull-down list)		IP							
	OA req'd per person for system area (Weighted average	Rps	cfm/p				0.0		
Inputs for Potentially Critical zones								Potentially Critical Zones	
	Zone Name	*Zone title turns purple italic for critical zone(s)*						*enter name*	*enter name*
	Zone Tag	Show Values per Zone						AHU - 1	AHU - 2
	Space type		Select from pull-down list					Gym, stadium (play area)	Gym, stadium (play area)
	Floor Area of zone	Az	sf					7,513	7513
	Design population of zone	Pz	P	(default value listed; may be overridden				225.39	225.39
	Design total supply to zone (primary plus local recirculat	Vdzd	cfm					15,400	15400
	Induction Terminal Unit, Dual Fan Dual Duct or Transfe	Fan?	Select from pull-down list or leave blank if N/A						
	Local recirc. air % representative of ave system return ai	Er							
Inputs for Operating Condition Analyzed									
	Percent of total design airflow rate at conditioned analy	Ds	%				100%	100%	100%
	Air distribution type at conditioned analyzed		Select from pull-down li	Show codes for Ez				CS	CS
	Zone air distribution effectiveness at conditioned analyz	Ez						1.00	1.00
	Primary air fraction of supply air at conditioned analyze	Ep							
Results									
	Ventilation System Efficiency	Ev					1.00		
	Outdoor air intake required for system	Vot	cfm				4508		
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.30		
	Outdoor air per person served by system (including dive	Vot/Ps	cfm/p				10.0		
	Outdoor air as a % of design primary supply air	Ypd	cfm				15%		
Detailed Calculations									
Initial Calculations for the System as a whole									
	Primary supply air flow to system at conditioned analyze	Vps	cfm	=	VpdDs	=	30800		
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	4508		
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.15		
Initial Calculations for individual zones									
	OA rate per unit area for zone	Raz	cfm/sf					0.30	0.30
	OA rate per person	Rpz	cfm/p					0.00	0.00
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					15400	15400
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		2253.9	2253.9
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		2254	2254
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.15	0.15
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.15	0.15
System Ventilation Efficiency									
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.00
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00		
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	1.00		
Minimum outdoor air intake airflow									
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	4508		
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.15		
	Outdoor Air Intake Flow required to System (Table 6.3 M	Vot	cfm	=	Vou / Ev	=	4491	16.36	
	OA intake req'd as a fraction of primary SA (Table 6.3 M	Y		=	Vot / Vps	=	0.15	0.00	
OA Temp at which Min OA provides all cooling									
	OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-44		

AHU – 4

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent								
System Tag/Name:		AHU - 4								
Operating Condition Description:	Add Zone	Storage								
Units (select from pull-down list)		IP								
Inputs for System		**Name**	**Units**				**System**			
Floor area served by system		As	sf				5150			
Population of area served by system (including diversity		Ps	P	100%	diversity		0			
Design primary supply fan airflow rate		Vpsd	cfm				5,675			
OA req'd per unit area for system (Weighted average)		Ras	cfm/sf				0.12			
OA req'd per person for system area (Weighted average		Rps	cfm/p				0.0			
Inputs for Potentially Critical zones								**Potentially Critical Zones**		
Zone Name		*Zone title turns purple italic for critical zone(s)*						*enter name*	enter name	
Zone Tag	Show Values per Zone							enter tag	enter tag	
Space type			Select from pull-down list					Storage rooms	Office space	
Floor Area of zone		Az	sf					5,150		
Design population of zone		Pz	P	(default value listed; may be overridden				0	0	
Design total supply to zone (primary plus local recirculat		Vdzd	cfm					5,675		
Induction Terminal Unit, Dual Fan Dual Duct or Transfe		Fan?	Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return ai		Er						75%	75%	
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analy		Ds	%				100%	100%	100%	
Air distribution type at conditioned analyzed			Select from pull-down lis		Show codes for Ez			CS	CS	
Zone air distribution effectiveness at conditioned analyz		Ez						1.00	1.00	
Primary air fraction of supply air at conditioned analyze		Ep								
Results										
Ventilation System Efficiency		Ev					1.00			
Outdoor air intake required for system		Vot	cfm				618			
Outdoor air per unit floor area		Vot/As	cfm/sf				0.12			
Outdoor air per person served by system (including dive		Vot/Ps	cfm/p				#DIV/0!			
Outdoor air as a % of design primary supply air		Ypd	cfm				11%			
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyze		Vps	cfm	=	VpdDs	=	5675			
UncorrectedOA requirement for system		Vou	cfm	=	Rps Ps + Ras As	=	618			
Uncorrected OA req'd as a fraction of primary SA		Xs		=	Vou / Vps	=	0.11			
Initial Calculations for individual zones										
OA rate per unit area for zone		Raz	cfm/sf					0.12	0.06	
OA rate per person		Rpz	cfm/p					0.00	5.00	
Total supply air to zone (at condition being analyzed)		Vdz	cfm					5675	0	
Unused OA req'd to breathing zone		Vbz	cfm	=	Rpz Pz + Raz Az	=		618.0	0.0	
Unused OA requirement for zone		Voz	cfm	=	Vbz/Ez	=		618	0	
Fraction of zone supply not directly recirc. from zone		Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	
Fraction of zone supply from fully mixed primary air		Fb		=	Ep	=		1.00	1.00	
Fraction of zone OA not directly recirc. from zone		Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	
Unused OA fraction required in supply air to zone		Zd		=	Voz / Vdz	=		0.11	0.00	
Unused OA fraction required in primary air to zone		Zp		=	Voz / Vpz	=		0.11	0.00	
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)		Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.11	
System Ventilation Efficiency (App A Method)		Ev		=	min (Evz)	=	1.00			
Ventilation System Efficiency (Table 6.3 Method)		Ev		=	Value from Table 6.3	=	1.04			
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System		Vot	cfm	=	Vou / Ev	=	618			
OA intake req'd as a fraction of primary SA		Y		=	Vot / Vps	=	0.11			
Outdoor Air Intake Flow required to System (Table 6.3 M		Vot	cfm	=	Vou / Ev	=	594	24.40		
OA intake req'd as a fraction of primary SA (Table 6.3 M		Y		=	Vot / Vps	=	0.10	0.04		
OA Temp at which Min OA provides all cooling										
OAT below which OA Intake flow is @ minimum			Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-84			

AHU – 5

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent									
System Tag/Name:		AHU - 5									
Operating Condition Description:	Add Zone	Squash Court									
Units (select from pull-down list)		IP									
Population of area served by system (including diversity		Ps	P		100%	diversity		191			
Design primary supply fan airflow rate		Vpsd	cfm					11,000			
OA req'd per unit area for system (Weighted average)		Ras	cfm/sf					0.30			
OA req'd per person for system area (Weighted average		Rps	cfm/p					0.0			
Inputs for Potentially Critical zones									Potentially Critical Zones		
Zone Name		Zone title turns purple italic for critical zone(s)							*enter name*	enter name	
Zone Tag	Show Values per Zone								enter tag	enter tag	
Space type			Select from pull-down list						Gym, stadium (play area)	Office space	
Floor Area of zone		Az	sf						6,352		
Design population of zone		Pz	P	(default value listed; may be overridden					190.56	0	
Design total supply to zone (primary plus local recirculat		Vdzd	cfm						11,000		
Induction Terminal Unit, Dual Fan Dual Duct or Transfe		Fan?	Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return ai		Er									
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analy		Ds	%					100%	100%	100%	
Air distribution type at conditioned analyzed			Select from pull-down lis						CS	CS	
Zone air distribution effectiveness at conditioned analyz	Show codes for Ez	Ez							1.00	1.00	
Primary air fraction of supply air at conditioned analyze		Ep									
Results											
Ventilation System Efficiency		Ev						1.00			
Outdoor air intake required for system		Vot	cfm					1906			
Outdoor air per unit floor area		Vot/As	cfm/sf					0.30			
Outdoor air per person served by system (including dive		Vot/Ps	cfm/p					10.0			
Outdoor air as a % of design primary supply air		Ypd	cfm					17%			
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyze		Vps	cfm	=	VpdDs	=	11000				
UncorrectedOA requirement for system		Vou	cfm	=	Rps Ps + Ras As	=	1906				
Uncorrected OA req'd as a fraction of primary SA		Xs		=	Vou / Vps	=	0.17				
Initial Calculations for individual zones											
OA rate per unit area for zone		Raz	cfm/sf						0.30	0.06	
OA rate per person		Rpz	cfm/p						0.00	5.00	
Total supply air to zone (at condition being analyzed)		Vdz	cfm						11000	0	
Unused OA req'd to breathing zone		Vbz	cfm	=	Rpz Pz + Raz Az	=			1905.6	0.0	
Unused OA requirement for zone		Voz	cfm	=	Vbz/Ez	=			1906	0	
Fraction of zone supply not directly recirc. from zone		Fa		=	Ep + (1-Ep)Er	=			1.00	1.00	
Fraction of zone supply from fully mixed primary air		Fb		=	Ep	=			1.00	1.00	
Fraction of zone OA not directly recirc. from zone		Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=			1.00	1.00	
Unused OA fraction required in supply air to zone		Zd		=	Voz / Vdz	=			0.17	0.00	
Unused OA fraction required in primary air to zone		Zp		=	Voz / Vpz	=			0.17	0.00	
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)		Evz		=	(Fa + FbXs - FcZ) / Fa	=			1.00	1.17	
System Ventilation Efficiency (App A Method)		Ev		=	min (Evz)	=	1.00				
Ventilation System Efficiency (Table 6.3 Method)		Ev		=	Value from Table 6.3	=	0.98				
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System		Vot	cfm	=	Vou / Ev	=	1906				
OA intake req'd as a fraction of primary SA		Y		=	Vot / Vps	=	0.17				
Outdoor Air Intake Flow required to System (Table 6.3 M		Vot	cfm	=	Vou / Ev	=	1951				
OA intake req'd as a fraction of primary SA (Table 6.3 M		Y		=	Vot / Vps	=	0.18				
OA Temp at which Min OA provides all cooling											
OAT below which OA Intake flow is @ minimum			Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-26				

AHU – 6

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent								
System Tag/Name:		AHU - 6								
Operating Condition Description:	Add Zone	Wrestling Room, Locker Room								
Units (select from pull-down list)		IP								
Inputs for System		**Name**	**Units**				**System**			
Floor area served by system		As	sf				6454			
Population of area served by system (including diversity		Ps	P	100%	diversity		194			
Design primary supply fan airflow rate		Vpsd	cfm				6,950			
OA req'd per unit area for system (Weighted average)		Ras	cfm/sf				0.30			
OA req'd per person for system area (Weighted average		Rps	cfm/p				0.0			
Inputs for Potentially Critical zones								**Potentially Critical Zones**		
Zone Name		Zone title turns purple italic for critical zone(s)						*enter name*	enter name	
Zone Tag	Show Values per Zone							enter tag	enter tag	
Space type			Select from pull-down list					Gym, stadium (play area)	Office space	
Floor Area of zone		Az	sf					6,454		
Design population of zone		Pz	P	(default value listed; may be overridden				193.62	0	
Design total supply to zone (primary plus local recirculat		Vdzd	cfm					6,950		
Induction Terminal Unit, Dual Fan Dual Duct or Transfe		Fan?	Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return ai		Er								
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analy		Ds	%				100%	100%	100%	
Air distribution type at conditioned analyzed			Select from pull-down li					CS	CS	
Zone air distribution effectiveness at conditioned analyz	Show codes for Ez	Ez						1.00	1.00	
Primary air fraction of supply air at conditioned analyze		Ep								
Results										
Ventilation System Efficiency		Ev					1.00			
Outdoor air intake required for system		Vot	cfm				1936			
Outdoor air per unit floor area		Vot/As	cfm/sf				0.30			
Outdoor air per person served by system (including dive		Vot/Ps	cfm/p				10.0			
Outdoor air as a % of design primary supply air		Ypd	cfm				28%			
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyze		Vps	cfm	=	VpdDs	=	6950			
UncorrectedOA requirement for system		Vou	cfm	=	Rps Ps + Ras As	=	1936			
Uncorrected OA req'd as a fraction of primary SA		Xs		=	Vou / Vps	=	0.28			
Initial Calculations for individual zones										
OA rate per unit area for zone		Raz	cfm/sf					0.30	0.06	
OA rate per person		Rpz	cfm/p					0.00	5.00	
Total supply air to zone (at condition being analyzed)		Vdz	cfm					6950	0	
Unused OA req'd to breathing zone		Vbz	cfm	=	Rpz Pz + Raz Az	=		1936.2	0.0	
Unused OA requirement for zone		Voz	cfm	=	Vbz/Ez	=		1936	0	
Fraction of zone supply not directly recirc. from zone		Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	
Fraction of zone supply from fully mixed primary air		Fb		=	Ep	=		1.00	1.00	
Fraction of zone OA not directly recirc. from zone		Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	
Unused OA fraction required in supply air to zone		Zd		=	Voz / Vdz	=		0.28	0.00	
Unused OA fraction required in primary air to zone		Zp		=	Voz / Vpz	=		0.28	0.00	
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)		Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.28	
System Ventilation Efficiency (App A Method)		Ev		=	min (Evz)	=	1.00			
Ventilation System Efficiency (Table 6.3 Method)		Ev		=	Value from Table 6.3	=	0.87			
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System		Vot	cfm	=	Vou / Ev	=	1936			
OA intake req'd as a fraction of primary SA		Y		=	Vot / Vps	=	0.28			
Outdoor Air Intake Flow required to System (Table 6.3 M		Vot	cfm	=	Vou / Ev	=	2222			
OA intake req'd as a fraction of primary SA (Table 6.3 M		Y		=	Vot / Vps	=	0.32			
OA Temp at which Min OA provides all cooling										
OAT below which OA Intake flow is @ minimum			Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	11			

AHU – 7

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent									
System Tag/Name:		AHU - 7									
Operating Condition Description:	Add Zone	Weight Room, Locker Room									
Units (select from pull-down list)		IP									
Inputs for System		**Name**	**Units**						**System**		
Floor area served by system		As	sf						6178		
Population of area served by system (including diversity		Ps	P		100%	diversity			0		
Design primary supply fan airflow rate		Vpsd	cfm						6,270		
OA req'd per unit area for system (Weighted average)		Ras	cfm/sf						0.12		
OA req'd per person for system area (Weighted average		Rps	cfm/p						0.0		
Inputs for Potentially Critical zones										**Potentially Critical Zones**	
Zone Name		*Zone title turns purple italic for critical zone(s)*								*enter name*	enter name
Zone Tag	Show Values per Zone									enter tag	enter tag
Space type			Select from pull-down list							Storage rooms	Office space
Floor Area of zone		Az	sf							6,178	
Design population of zone		Pz	P	(default value listed; may be overridden						0	0
Design total supply to zone (primary plus local recirculat		Vdzd	cfm							6,270	
Induction Terminal Unit, Dual Fan Dual Duct or Transfe		Fan?	Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return ai		Er									
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analy		Ds	%						100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down lis	Show codes for Ez						CS	CS
Zone air distribution effectiveness at conditioned analyz		Ez								1.00	1.00
Primary air fraction of supply air at conditioned analyze		Ep									
Results											
Ventilation System Efficiency		Ev							**1.00**		
Outdoor air intake required for system		Vot	cfm						**741**		
Outdoor air per unit floor area		Vot/As	cfm/sf						**0.12**		
Outdoor air per person served by system (including dive		Vot/Ps	cfm/p						**#DIV/0!**		
Outdoor air as a % of design primary supply air		Ypd	cfm						**12%**		
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyze		Vps	cfm	=	VpdDs	=	6270				
UncorrectedOA requirement for system		Vou	cfm	=	Rps Ps + Ras As	=	741				
Uncorrected OA req'd as a fraction of primary SA		Xs		=	Vou / Vps	=	0.12				
Initial Calculations for individual zones											
OA rate per unit area for zone		Raz	cfm/sf							0.12	0.06
OA rate per person		Rpz	cfm/p							0.00	5.00
Total supply air to zone (at condition being analyzed)		Vdz	cfm							6270	0
Unused OA req'd to breathing zone		Vbz	cfm	=	Rpz Pz + Raz Az	=				741.4	0.0
Unused OA requirement for zone		Voz	cfm	=	Vbz/Ez	=				741	0
Fraction of zone supply not directly recirc. from zone		Fa		=	Ep + (1-Ep)Er	=				1.00	1.00
Fraction of zone supply from fully mixed primary air		Fb		=	Ep	=				1.00	1.00
Fraction of zone OA not directly recirc. from zone		Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=				1.00	1.00
Unused OA fraction required in supply air to zone		Zd		=	Voz / Vdz	=				0.12	0.00
Unused OA fraction required in primary air to zone		Zp		=	Voz / Vpz	=				0.12	0.00
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)		Evz		=	(Fa + FbXs - FcZ) / Fa	=				1.00	1.12
System Ventilation Efficiency (App A Method)		Ev		=	min (Evz)	=	**1.00**				
Ventilation System Efficiency (Table 6.3 Method)		Ev		=	Value from Table 6.3	=	1.03				
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System		Vot	cfm	=	Vou / Ev	=	**741**				
OA intake req'd as a fraction of primary SA		Y		=	Vot / Vps	=	**0.12**				
Outdoor Air Intake Flow required to System (Table 6.3 M		Vot	cfm	=	Vou / Ev	=	719			22.82	
OA intake req'd as a fraction of primary SA (Table 6.3 M		Y		=	Vot / Vps	=	0.11			**0.03**	
OA Temp at which Min OA provides all cooling											
OAT below which OA Intake flow is @ minimum			Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-72				

AHU – 8

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent									
System Tag/Name:		AHU - 8									
Operating Condition Description:	Add Zone	Corridor									
Units (select from pull-down list)		IP									
Inputs for System		**Name**	**Units**					**System**			
	Floor area served by system	As	sf					6938			
	Population of area served by system (including diversity	Ps	P	100%	diversity			0			
	Design primary supply fan airflow rate	Vpsd	cfm					10,000			
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf					0.06			
	OA req'd per person for system area (Weighted average	Rps	cfm/p					0.0			
Inputs for Potentially Critical zones										**Potentially Critical Zones**	
	Zone Name	*Zone title turns purple italic for critical zone(s)*								*enter name*	enter name
	Zone Tag	Show Values per Zone								enter tag	enter tag
	Space type		Select from pull-down list							Corridors	Office
	Floor Area of zone	Az	sf							6,938	
	Design population of zone	Pz	P	(default value listed; may be overridden						0	0
	Design total supply to zone (primary plus local recirculat	Vdzd	cfm							10,000	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer	Fan?	Select from pull-down list or leave blank if N/A								
	Local recirc. air % representative of ave system return ai	Er									
Inputs for Operating Condition Analyzed											
	Percent of total design airflow rate at conditioned analy	Ds	%					100%		100%	100%
	Air distribution type at conditioned analyzed		Select from pull-down li	Show codes for Ez						CS	CS
	Zone air distribution effectiveness at conditioned analyz	Ez								1.00	1.00
	Primary air fraction of supply air at conditioned analyze	Ep									
Results											
	Ventilation System Efficiency	Ev						1.00			
	Outdoor air intake required for system	Vot	cfm					416			
	Outdoor air per unit floor area	Vot/As	cfm/sf					0.06			
	Outdoor air per person served by system (including dive	Vot/Ps	cfm/p					#DIV/0!			
	Outdoor air as a % of design primary supply air	Ypd	cfm					4%			
Detailed Calculations											
Initial Calculations for the System as a whole											
	Primary supply air flow to system at conditioned analyze	Vps	cfm	=	VpdDs	=	10000				
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	416				
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.04				
Initial Calculations for individual zones											
	OA rate per unit area for zone	Raz	cfm/sf							0.06	0.06
	OA rate per person	Rpz	cfm/p							0.00	5.00
	Total supply air to zone (at condition being analyzed)	Vdz	cfm							10000	0
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=				416.3	0.0
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=				416	0
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=				1.00	1.00
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=				1.00	1.00
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=				1.00	1.00
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=				0.04	0.00
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=				0.04	0.00
System Ventilation Efficiency											
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=				1.00	1.04
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00				
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	1.11				
Minimum outdoor air intake airflow											
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	416				
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.04				
	Outdoor Air Intake Flow required to System (Table 6.3 M	Vot	cfm	=	Vou / Ev	=	376			40.70	
	OA intake req'd as a fraction of primary SA (Table 6.3 M	Y		=	Vot / Vps	=	0.04			0.10	
OA Temp at which Min OA provides all cooling											
	OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-336				

AHU – 9

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent									
System Tag/Name:		AHU - 9									
Operating Condition Description:	Add Zone	Athlete Wating Room									
Units (select from pull-down list)		IP									
Inputs for System		**Name**	**Units**				**System**				
	Floor area served by system	As	sf				3883				
	Population of area served by system (including diversity	Ps	P	100%	diversity		116				
	Design primary supply fan airflow rate	Vpsd	cfm				4,550				
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06				
	OA req'd per person for system area (Weighted average	Rps	cfm/p				5.0				
Inputs for Potentially Critical zones									**Potentially Critical Zones**		
	Zone Name	*Zone title turns purple italic for critical zone(s)*							*enter name*	enter name	
	Zone Tag	Show Values per Zone							enter tag	enter tag	
	Space type		Select from pull-down list						Reception areas	Storage rooms	
	Floor Area of zone	Az	sf						3,883		
	Design population of zone	Pz	P	(default value listed; may be overridden					116.49	0	
	Design total supply to zone (primary plus local recirculat	Vdzd	cfm						4,550		
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer	Fan?	Select from pull-down list or leave blank if N/A								
	Local recirc. air % representative of ave system return ai	Er									
Inputs for Operating Condition Analyzed											
	Percent of total design airflow rate at conditioned analy	Ds	%				100%		100%	100%	
	Air distribution type at conditioned analyzed		Select from pull-down li	Show codes for Ez					CS	CS	
	Zone air distribution effectiveness at conditioned analyz	Ez							1.00	1.00	
	Primary air fraction of supply air at conditioned analyze	Ep									
Results											
	Ventilation System Efficiency	Ev					1.00				
	Outdoor air intake required for system	Vot	cfm				815				
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.21				
	Outdoor air per person served by system (including diver	Vot/Ps	cfm/p				7.0				
	Outdoor air as a % of design primary supply air	Ypd	cfm				18%				
Detailed Calculations											
Initial Calculations for the System as a whole											
	Primary supply air flow to system at conditioned analyze	Vps	cfm	=	VpdDs	=	4550				
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	815				
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.18				
Initial Calculations for individual zones											
	OA rate per unit area for zone	Raz	cfm/sf						0.06	0.12	
	OA rate per person	Rpz	cfm/p						5.00	0.00	
	Total supply air to zone (at condition being analyzed)	Vdz	cfm						4550	0	
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=			815.4	0.0	
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=			815	0	
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=			1.00	1.00	
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=			1.00	1.00	
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=			1.00	1.00	
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=			0.18	0.00	
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=			0.18	0.00	
System Ventilation Efficiency											
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=			1.00	1.18	
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00				
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.97				
Minimum outdoor air intake airflow											
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	815				
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.18				
	Outdoor Air Intake Flow required to System (Table 6.3 M	Vot	cfm	=	Vou / Ev	=	840				
	OA intake req'd as a fraction of primary SA (Table 6.3 M	Y		=	Vot / Vps	=	0.18				
OA Temp at which Min OA provides all cooling											
	OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-23				

AHU – 10

Building:	Delete Zone	Richard T. Flood Jr. & Sally Elliot Flood Athletic Cent								
System Tag/Name:		AHU - 10								
Operating Condition Description:		Offices								
Units (select from pull-down list)	Add Zone	IP								
Inputs for System		**Name**	**Units**				**System**			
Floor area served by system		As	sf				815			
Population of area served by system (including diversity		Ps	P	100%	diversity		4			
Design primary supply fan airflow rate		Vpsd	cfm				1,200			
OA req'd per unit area for system (Weighted average)		Ras	cfm/sf				0.06			
OA req'd per person for system area (Weighted average		Rps	cfm/p				5.0			
Inputs for Potentially Critical zones								**Potentially Critical Zones**		
Zone Name		*Zone title turns purple italic for critical zone(s)*						*enter name*	enter name	
Zone Tag	Show Values per Zone							enter tag	enter tag	
Space type			Select from pull-down list					Office	Office	
Floor Area of zone		Az	sf					815		
Design population of zone		Pz	P	(default value listed; may be overridden				4.075	0	
Design total supply to zone (primary plus local recirculat		Vdzd	cfm					1,200		
Induction Terminal Unit, Dual Fan Dual Duct or Transfe		Fan?	Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return ai		Er								
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analy		Ds	%				100%	100%	100%	
Air distribution type at conditioned analyzed			Select from pull-down lis	Show codes for Ez				CS	CS	
Zone air distribution effectiveness at conditioned analyz		Ez						1.00	1.00	
Primary air fraction of supply air at conditioned analyze		Ep								
Results										
Ventilation System Efficiency		Ev					1.00			
Outdoor air intake required for system		Vot	cfm				69			
Outdoor air per unit floor area		Vot/As	cfm/sf				0.09			
Outdoor air per person served by system (including dive		Vot/Ps	cfm/p				17.0			
Outdoor air as a % of design primary supply air		Ypd	cfm				6%			
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyze		Vps	cfm	=	VpdDs	=	1200			
UncorrectedOA requirement for system		Vou	cfm	=	Rps Ps + Ras As	=	69			
Uncorrected OA req'd as a fraction of primary SA		Xs		=	Vou / Vps	=	0.06			
Initial Calculations for individual zones										
OA rate per unit area for zone		Raz	cfm/sf					0.06	0.06	
OA rate per person		Rpz	cfm/p					5.00	5.00	
Total supply air to zone (at condition being analyzed)		Vdz	cfm					1200	0	
Unused OA req'd to breathing zone		Vbz	cfm	=	Rpz Pz + Raz Az	=		69.3	0.0	
Unused OA requirement for zone		Voz	cfm	=	Vbz/Ez	=		69	0	
Fraction of zone supply not directly recirc. from zone		Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	
Fraction of zone supply from fully mixed primary air		Fb		=	Ep	=		1.00	1.00	
Fraction of zone OA not directly recirc. from zone		Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	
Unused OA fraction required in supply air to zone		Zd		=	Voz / Vdz	=		0.06	0.00	
Unused OA fraction required in primary air to zone		Zp		=	Voz / Vpz	=		0.06	0.00	
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)		Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.06	
System Ventilation Efficiency (App A Method)		Ev		=	min (Evz)	=	1.00			
Ventilation System Efficiency (Table 6.3 Method)		Ev		=	Value from Table 6.3	=	1.09			
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System		Vot	cfm	=	Vou / Ev	=	69			
OA intake req'd as a fraction of primary SA		Y		=	Vot / Vps	=	0.06			
Outdoor Air Intake Flow required to System (Table 6.3 M		Vot	cfm	=	Vou / Ev	=	63	5.85		
OA intake req'd as a fraction of primary SA (Table 6.3 M		Y		=	Vot / Vps	=	0.05	0.08		
OA Temp at which Min OA provides all cooling										
OAT below which OA Intake flow is @ minimum			Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+d	=	-222			

Reference

ASHRAE, 2007, ANSI/ASHARE, Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. Atlanta, GA

ASHRAE, 2007, ANSI/ASHARE, Standard 90.1-2007, Energy Standard for Buildings Except Low-rise Residential Buildings. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. Atlanta, GA

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