Bentworth Middle School



Technical Report One

An analysis of ASHRAE Standard 62.1-2007 and ASHRAE Standard 90.1-2007

Prepared By

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Executive Summary

The purpose of this report is to determine whether Bentworth Middle School complies with ASHRAE Standard 62.1-2007 and ASHRAE Standard 90.1-2007.

The newly built Bentworth Middle School is located Bentleyville, PA. The school is considered a stateof-the-art facility and just opened its doors to students grades five through eight in January 2009. Ensuring that the students and staff were provided with a comfortable and functional learning and working environment was a priority. Directly related to this is air quality and energy efficiency of the building as clean, fresh air is ideal in any environment and schools are always looking to save money on energy expenditure in order to provide more money allowance to go into furthering student education. Therefore, ASHRAE Standards 62.1 and 90.1 are very relevant design parameters.

The evaluation of ASHRAE Standard 62.1-2007 showed that the building just fell short of complete compliance with the standard. The two primary sections of this standard that were evaluated were *Section 5 Systems and Equipment* and *Section 6 Procedures*. Bentworth Middle School complied with all parts of Section 5, displaying the school's excellence in system design and equipment use. However, when the school's ventilation rates were studied under the procedures outlined in Section 6 a discrepancy was found. It appeared that one of the rooftop heat pumps was not capable of providing the required amount of ventilation air. Since this rooftop unit is providing outdoor air to the heat pumps in the classroom wing, it is believed that it will still be able to provide adequate ventilation air to spaces as it is very unlikely that all of the spaces will require peak ventilation air rates at the same time. It is also believed that ASHRAE assumed a higher number of occupants in some of the spaces than what was actually designed for.

It was also determined that Bentworth Middle School was just shy of compliance with ASHRAE Standard 90.1-2007. The two primary areas where the building fell short were *Fan Power Limitation* and the flooring U-value. It was also difficult to differentiate whether or not the building's heat pumps met the minimum efficiency requirements outlined in this standard because the entering water temperatures ASHRAE used to determine the minimum COP and EER values were different than the design entering water temperatures at Bentworth Middle School.

Although Bentworth Middle School did not achieve complete compliance with either of the standards this report shows that the school's design was still incredibly accurate and energy efficient. If some additional considerations had been given to ASHRAE Standards 62.1 and 90.1 early on in the design process or if a few minor alterations are made to the building, Bentworth Middle School would easily be in accordance with the standards.



ASHRAE Standard 62.1-2007 Evaluation

Section 5 Compliance – Systems and Equipment

5.1 Natural Ventilation

Although many of the spaces are designed to include operable double hung windows, they were not intended to be the sole source for fresh air. However, many of the spaces, such as the classrooms, are capable of being naturally ventilated given the right outdoor air conditions as the amount of openable window area is at least 4% of the floor area and is within 25 feet of the space.

5.2 Ventilation Air Distribution

The specifications state that the various mechanical equipment responsible for providing ventilation have controls able to maintain an adjustable minimum ventilation rate under any load condition as required by Section 6 of ASHRAE 62.1. A full analysis of Section 6 can be found in this report.

5.3 Exhaust Duct Location

Spaces that contain potentially harmful contaminants are equipped with exhaust fans. Each of these fans exhaust air at high speeds of over 1000 fpm. Such speeds will create a negative pressure in the duct relative to the room, ensuring that the space is not polluted by the contaminant. Furthermore, all ducts are sealed in accordance with SMACNA standards.

5.4 Ventilation System Controls

The mechanical ventilation of the building is mainly provided by six rooftop heat pumps. Two of these rooftop units simply provide ventilation air to the heat pumps serving the classrooms, library, and office area. When any of these zones are in an occupied mode, the rooftop units will energize and operate to provide tempered ventilation air as required. This requirement is determined by a static pressure sensor installed in the ductwork which will increase the variable frequency drive supply and return fans' speed when the static pressure in the duct decreases or it will decrease the fans' speed if the static pressure increases. The remaining four rooftop units provide air to large spaces and use a demand controlled ventilation sequence which is dictated by CO_2 sensor in the space. This sensor measures the differential CO_2 level between the outdoor and indoor environments. If this differential rises above 700 ppm, then the outdoor air damper will modulate open as needed to maintain a differential below 700 ppm. As the differential CO_2 level drops below 700 ppm the outdoor air damper will close. As an energy saving feature, the enthalpy economizer controls are able to override the demand controlled ventilation controls if economizer cooling is available.

5.5 Airstream Surfaces

The specifications for basic mechanical requirements state that all product materials must be UL listed and the duct specifications require that all ductwork fabrication and support must be in accordance with SMACNA HVAC Duct Construction Standards. These standards state that a minimum resistance to mold growth and erosion must be met, satisfying this section.

5.6 Outdoor Air Intakes

All air intakes are located either in the mechanical mezzanine or on the roof and abide by the minimum separation distance. Both the wall louvers and mechanically operated dampers comply with AMCA 500. The wall louvers also have bird screens conforming to this section. This is all the information pertaining to this section available at this time.

5.7 Local Capture of Contaminants

Any equipment that produces building contaminants is equipped with an exhaust fan which routes the exhaust direct out of the building through the roof.

5.8 Combustion Air

All combustion equipment is provided with sufficient combustion air and is adequately exhausted. Specifically, the natural gas fired emergency generator was provided with a wall louver by the general contractor and it is specified that it was to be provided with a Schedule 40 black steel pipe exhaust.

5.9 Particulate Matter Removal

The rooftop heat pumps have pleated air filters with an atmospheric efficiency between 25% and 30% located upstream of their cooling coils. This is equivalent to a MERV 6 or MERV 7 filter and is therefore in compliance.

5.10 Dehumidification

The heat pumps are equipped with humidity sensors that maintain a relative humidity within the space at 60% or less. Additionally, a pressure sensor ensures that the room pressure remains at +0.05 in wg relative to the outdoor pressure in order to prevent infiltration.

5.11 Drain Pans

It is specified that all rooftop heat pumps be constructed of 20-guage stainless steel, sloped, and positioned under the evaporator coil and meet all requirements of ASHRAE 62.1.

5.12 Finned-Tube Coils and Heat Exchangers

Drain pans have been provided as necessary and in compliance with 5.11 and there are no finned-tube coils in series.

5.13 Humidifiers and Water-Spray Systems

No humidifiers or water-spray systems are used in the building so this section is not applicable.

5.14 Access for Inspection, Cleaning, and Maintenance

Appropriate clearances to allow unobstructed access to all equipment doors and panels as indicated in this section have been specified for the purposes of inspection, cleaning, and maintenance.

5.15 Building Envelope and Interior Surfaces

In order to prevent moisture penetration of the foundation, both a modified bituminous membrane sheet waterproofing and cold towel-applied asphalt bituminous dampproofing were used. A vapor barrier below the slab on grade is also provided. Within the exterior wall assembly there is 1 ½ inch rigid insulation board applied to the block in full bed mastic which acts as the vapor barrier. All exterior and interior joints and openings have been specified to be sealed or caulked.

All duct and pipe surfaces within the building that may fall to a temperature capable of producing condensation on their surface have been properly insulated in order to prevent moisture collection both on the exposed surface and within the insulating material.

5.16 Buildings with Attached Parking Garages

This section is not applicable as there is no parking garage attached to Bentworth Middle School.

5.17 Air Classification and Recirculation

All building air has a Class 1 designation which allows it to be recirculated or transferred to any space. The only exception to this would be the kitchen air, which is simply exhausted to the exterior of the building through the kitchen hood.

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

The property on which Bentworth Middle School is located is designated a tobacco free zone. Therefore, this section does not apply.

Section 6 Compliance – Procedures

Summary of Section 6

The purpose of ASHRAE Standard 62.1 Section 6 is to outline the proper procedure for calculating the outdoor air intake rates based on "space type/application, occupancy level, and floor area." This calculation procedure is very stringent and involves many considerations and equations. Therefore, the procedure for the calculations for Bentworth Middle School are outlined on the next page.



Breathing Zone Outdoor Airflow

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

where: $A_z = zone floor area:$ the net occupiable floor area of the zone (ft²)

 $P_z = zone \ population:$ the largest number of people expected to occupy the zone during typical usage. If the number of people expected to occupy the zone fluctuate, P_z may be estimated bases on averaging approaches described in Section 6.2.6.2. If P_z cannot be accurately predicted during design, it shall be an estimated value based on the zone floor area and the default occupant density listed in Table 6-1.

 R_p = outdoor airflow rate required per person as determined from Table 6-1

 R_a = outdoor airflow rate required per unit area as determined from Table 6-1

Zone Air Distribution Effectiveness

 $E_z = 1$ as determined by Table 6-2 of ASHRAE Standard 62.1

Zone Outdoor Airflow

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

Single-Zone Systems	
$V_{ot} = V_{oz}$	(Equation 6-3)

100% Outdoor Air Systems

 $V_{ot} = \sum_{all \ zones} V_{oz}$ (Equation 6-4)

Primary Outdoor Air Fraction

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

System Ventilation Efficiency

 E_v shall be determined using Table 6-3 of ASHRAE Standard 62.1 which is shown on the next page.

Uncorrected Outdoor Air Intake

$$\begin{split} V_{ou} &= D \sum_{all \ zones} (R_p * P_z) + \sum_{all \ zones} (R_a * A_z) & (Equation \ 6-6) \\ \text{where: } D &= P_s \ / \ \sum_{all \ zones} P_z & (Equation \ 6-7) \\ P_s &= system \ population: \ is \ the \ total \ population \ in \ the \ area \ served \ by \ the \ system \ begin{aligned} \hline \end{aligned} \end{array}$$

Outdoor Air Intake

 $V_{ot} = V_{ou} / E_v$

Max (Z _P)	E _v
≤0.15	1.0
≤0.25	0.9
≤0.35	0.8
≤0.45	0.7
≤0.55	0.6
>0.55	Use Appendix A

TABLE 6-3 System Ventilation Efficiency

1. "Max Z_p " refers to the largest value of Z_p , calculated using Equation 6-5, among all the zones served by the system.

2. For values of Z_p between 0.15 and 0.55, one may determine the corresponding value of E_v by interpolating the values in the table.

3. The values of \overline{E}_{ν} in this table are based on a 0.15 average outdoor air fraction for the system (i.e., the ratio of the *uncorrected outdoor air intake* V_{ou} to the total zone primary airflow for all the zones served by the air handler). For systems with higher values of the average outdoor air fraction, this table may result in unrealistically low

values of E_v and the use of Appendix A may yield more practical results.

Seven units provide ventilation air to Bentworth Middle School including six rooftop heat pump units and one energy recovery ventilator (ERV). However, for this analysis only five of the rooftop heat pump units were seen as critical pieces of ventilation equipment and therefore were considered to evaluate the building's compliance with Section 6. The ERV was not considered because it only provides a small amount of outdoor air (1300 cfm) to the locker room areas and ASHRAE Standard 62.1 does not specifically outline ventilation rates for this type of space. Rooftop heat pump B5 was also not considered because it only provides make-up air for the kitchen hood and does not actually ventilate the space.

Section 6 Compliance Results

An Excel spreadsheet was used to determine whether or not Bentworth Middle School's ventilation rates met ASHRAE's Standard 62.1 Section 6 expectations. This Excel spreadsheet uses the equations outlined above and user input values for a space's square footage, room occupancy type, and supply air. The complete results of these calculations are located in Appendix A, but below is a table summarizing the building's compliance.

As can be seen on the next page, not all of the rooftop heat pumps meet the ventilation requirements of the zones that they are supplying. It is worrisome that RTHP-A1 seems to be grossly undersized, but there could be reasons behind this and there is only a small discrepancy between the design and required outdoor air values for RTHP-B3 so this is not very bothersome as the unit should still be able to do its job.

RTHP	Design Max CFM	Design OA CFM	ASHRAE 62.1 Min OA	Compliance?
A1	11,500	11,500	18,487	No
B1	3,500	3,500	3,175	Yes
B2	6,000	4,110	3,538	Yes
B3	2,100	1,110	1,176	No
B4	10,000	8,000	4,791	Yes

Table 1 – Summary of Ventilation Rate Calculations

ASHRAE 62.1-2007 Summary

The design of Bentworth Middle School is completely compliant with Section 5 of ASHRAE 62.1 but one of the rooftop heat pumps appears to not meet its peak ventilation requirements as outlined by Section 6. This is troubling, further investigation will have to be done to see why this is. Perhaps, it is because it is unlikely that all of the spaces served by RTHP-A1 with require peak ventilation at the same time and that the average number of people that ASHRAE assumes to be the space is larger than what the building spaces were actually designed for.

ASHRAE Standard 90.1-2007 Evaluation

Section 5 Building Envelope

5.1.4 Climate

Using Figure B-1 from ASHRAE 90.1, shown below, it was determined that Bentworth Middle School, located in Bentleyville, PA, is in climate Zone 5A.



Figure B-1

5.4 Mandatory Provisions

The building is specified to have all joints, seams, fenestrations, and all other openings sealed or caulked. The main entrance to the building has a vestibule where the exterior and interior doors are separated by a distance of 20 feet. This distance is greater than the 7 foot minimum requirement. Bentworth Middle School has no cargo or loading dock doors.

5.5 Prescriptive Building Envelope Option

There are two ways to achieve compliance for the building envelope. The prescriptive path option was chosen over the trade-off path for this analysis. The two primary parameters that must be followed for this path are meeting the minimum building envelope requirements and having no more than the allowable 40% fenestration area. Both of these requirements were met. A summary of the necessary calculations needed to reach this conclusion are below in Table 2 and Table 3.

		Prescribed No	onresidential	Designed A	Assemblies	Compliance?
Area	Construction Method	Assembly Maximum	Insulation Minimum	Assembly Maximum	Insulation Minimum	
Roof	Attic	U-0.027	R-38.0	U-0.025	R-40	Yes
Walls Above Grade	Mass	U-0.090	R-11.4	0.076	R-13.2	Yes
Walls Below Grade	Below-Grade Wall	C-0.119	R-7.5	C-0.121	R-8.3	Yes
Floors	Mass	U-0.074	R-10.4	U-0.45	R-2.2	No
Slab on Grade Floors	Unheated	F-0.730	NR	F-0.721	NR	Yes
Fenestration	Metal Framing (storefront)	U-0.45	SHGC-0.40	U-0.42	SHGC-0.36	Yes
	Metal Framing (all other)	U-0.55	SHGC-0.40	U-0.51	SHGC-0.34	Yes

Table 2 –	Minimum	Building	Envelop	be Red	uirements

Table 3 – Building Fenestration Percentage Calculation

Fenestration Area	Wall Area	Percent Fenestration	Compliance?
5,800 ft ²	35,080 ft ²	16.5%	Yes

Section 6 Heating, Ventilating, and Air Conditioning

6.2 Compliance Path

There are two compliance paths that may be followed. For this analysis the Mandatory Provisions path shall be used as Bentworth Middle School is more than two stories and over $25,000 \text{ ft}^2$.

6.4 Mandatory Provisions

The primary mechanical equipment used in Bentworth Middle School is heat pumps, which are governed by this section. Although COP's and EER's were given for the heat pumps, without having the manufacturer information for these pieces of equipment it is hard to differentiate whether they satisfy this section or not. Table 6.8.1B of ASHRAE 90.1 mandates that all ground source heat pumps in cooling mode with an entering water temperature of 59 °F have an EER of 16.2 and while in heating mode with an entering water temperature of 32 °F have COP of 3.1. Bentworth Middle School's design is based on entering water temperatures of 75 °F and 42 °F for cooling and heating respectively. Nonetheless, at the design temperatures most of the given COP's for each of the heat pumps meet the set standard of 3.1, while very few of the heat pumps achieved an EER of 16.2.

Bentworth Middle School's rooftop heat pumps would be considered packaged terminal heat pump units which are also regulated by this section. Table 6.8.1D requires that these units have a minimum EER of 9.1. Unfortunately, the EER's for these units are unavailable at this time.

It is specified that there be a 5 F dead band as well as the appropriate amount of insulation be applied to all ductwork, plenums, and piping. The motorized dampers for all vents and air intakes have the appropriate controls as outlined in this section.

6.5 Prescriptive Path

Economizers are required on cooling equipment over 135,000 Btu/h in climate zone 5A. However, there are no economizers on the rooftop heat pumps which are over the specified cooling rate, but there are water economizers on the heat pumps serving the classroom spaces despite them being under the specified cooling rate.

All rooftop heat pumps are equipped with an enthalpy wheel for energy recovery from exhausted air. This is in compliance with this section of ASHRAE 90.1. It is also specified that all heat pumps have the capability to switch off their compressor should the refrigerant pressure drop below a safe operating point.

Table 4, below, shows how Bentworth Middle School meets ASHRAE 90.1's *Fan System Power Limitation*. Six out of the 13 analyzed fans do not comply with this section of ASHRAE's 90.1.

Equipment	HP	CFM	CFM*0.0011	Compliance?
RTHP-A1 Supply	15	11,500	12.56	No
RTHP-A1 Exhaust	15	11,500	12.56	No
RTHP-B1 Supply	3	3,500	3.85	Yes
RTHP-B1 Exhaust	3	3,500	3.85	Yes
RTHP-B2 Supply	5	6,000	6.60	Yes
RTHP-B2 Exhaust	5	6,000	6.60	Yes
RTHP-B3 Supply	5	2,100	2.31	No
RTHP-B3 Exhaust	3	2,100	2.31	No
RTHP-B4 Supply	15	10,000	11.00	No
RTHP-B4 Exhaust	10	10,000	11.00	Yes
RTHP-B5 Supply	15	4,270	4.70	No
EF-A1	1.5	3,800	4.18	Yes
EF-B3	3	4,500	4.95	Yes

Table 4 – Fan System Power Limitation Calculations

6.7 Submittals

All building drawings and manuals were provided to the building owner within the required 90 days and it is specified that all HVAC systems were to be balanced.

Section 7 Service Water Heating

Four gas-fired storage water heaters provide domestic hot water to Bentworth Middle School. Each of the water heaters has an efficiency of 90% or more which exceeds this section's minimum requirement of an efficiency of 80%. The water heaters are also equipped with a thermostat with adjustable temperature range from 110°F to 180°F. The service hot-water piping is specified to be insulated with a minimum of one inch of insulation which is the same amount that is required by this section.

Section 8 Power

No information pertaining to the maximum voltage drop for the feeders or branch circuits is available at this time. All design documents were submitted to the building owner within the specified amount of time in this section.

Section 9 Lighting

This section outlines the requirement for both interior and exterior lighting. There are two separate ways in which the interior lighting system can achieve compliance through lighting power density. In this analysis, the building area method is used opposed to the space-by-space method. Table 5, on the next page, shows that the Bentworth Middle School has a lighting power density of 1.11 W/ft^2 which is in compliance as schools must have a lighting power density equal to or less than 1.2 W/ft^2 . Let it also be known that most of the spaces are controlled with both a wall switch and occupancy sensor.

ASHRAE Standard 90.1-2007 Summary

Bentworth Middle School was largely compliant with ASHRAE Standard 90.1. The areas in which it did not meet the requirements of the standard were in fan power limitation and the overall U-value for the floors. Although it is obvious that the building designers were designing in an environmentally conscientious fashion, they were not trying to acquire any building accolades such as a LEED certification. Therefore, ASHRAE Standard 90.1 may have been overlooked during the design process, but with a few changes to the building's structural system and mechanical equipment, complete compliance should be easily attainable. Nonetheless, Bentworth Middle School's near compliance with ASHRAE Standard 90.1 further exemplifies the school as not only a great learning and working environment, but also as an energy efficient building.

		Floor			
Fixture	1st	2nd	3rd	Watts/Fixture	Total
					Watts
A/70	0	8	0	70	560
A/100	0	5	0	100	500
B/70	11	14	11	70	2520
B/100	0	13	0	100	1300
B/140	0	1	0	140	140
C/70	27	68	13	70	7560
C/100	0	0	113	100	11300
D/70	0	5	0	70	350
E/70	0	45	0	70	3150
E/100	118	124	0	100	24200
G/35	2	4	2	35	280
G70	0	1	0	70	70
H/40	52	97	52	40	8040
H/70	4	4	4	70	840
I/70	31	12	7	70	3500
I/100	3	0	0	100	300
I/140	0	16	0	140	2240
J/375	0	8	0	375	3000
К/70	2	4	2	70	560
L/500	0	1	0	500	500
M/70	0	12	4	70	1120
M/105	0	46	4	105	5250
O/360	0	29	0	360	10440
P/70	0	26	0	70	1820
P/100	0	22	0	100	2200
Q/48	1	0	0	48	48
R/70	0	8	0	70	560
R/35	0	4	0	35	140
S/40	2	2	2	40	240
U/15	0	6	0	15	90
AA/50	0	1	0	50	50
		Total	Build	ing Watts	92868
		Build	ing Sq	uare Footage	83800
		Light	ing Po	wer Density	1.11

Table 5 – Lighting Power Density Calculation

References

ANSI/ASHRAE. (2007). *Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality*. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

ANSI/ASHRAE. (2007). *Standard 90.1-2007, Energy Standard for Buildings Except Low-Rise Residential Buildings*. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

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Hayes Large Architects, LLP. Architectural Specifications. Hayes Large Architects, LLP., Altoona, PA.

Hayes Large Architects, LLP. Mechanical Specifications. Hayes Large Architects, LLP., Altoona, PA.

Hayes Large Architects, LLP. Electrical Specifications. Hayes Large Architects, LLP., Altoona, PA.

Building: Surform Taa Mamoo	Bentw	orth Midd	le Scho	DO						
Operating Condition Description:	Occup	ied Opera	tion M	ode						
Units (select from pull-down list)	٩									
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per person for system area (Weighted average)	Name As Vpsd Ras Rps	Units sf cfm/sf cfm/sf		100% diversity	System 33341 872 34,280 0.11					
Inputs for Potentially Critical zones Zone Name						Science	Corridor	Classroom	Classroom	Classroom
Zone Tag	Zone t	the turns p	urple ite	alic for critical zone(s)		A103	A102	A104	A105	A106
Space type		Select fr	lind mo	-down list		Classrooms (and 0 plus)	Corridors	Classrooms	Classrooms (and 0 nins)	Classrooms (and 9 plus)
Floor Area of zone Design menulation of zone	Az Pz	_ مر	Ind inc	the second se	(uch dow)	883 30 00E	780	10 90 992	1992 992	76 90 76 90
Design popuration of some (primary plus local recirculated) Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Vdzd	cfm Select fr	Ind wo	ir value listed, may be ove -down list or leave blank i	(IIIIIIII)	1,200	360	800	800	800
Local recirc. air % representative of ave system return air Inbuts for Oberating Condition Analyzed	ш						8		8	
Percent of total design airflow rate at conditioned analyzed	Ds	%			100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed	ı	Select fr	Ind mo	-down list		S	S	CS	S	CS
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	Ē					1.00	1.00	1.00	1.00	1.00
Results Vanilation Svetam Efficiency	ц				to U					
venuation system Entotency Outdoor air intake required for system		cfm			14184					
Outdoor air per unit floor area	Vot/As	cfm/sf			0.43					
Outdoor air person served by system (including diversity)	V ot/Ps	cfm/p			16.3					
Outdoor air as a % of design primary supply air	Хpd	cfm			41%					
Detailed Calculations										
Initial Calculations for the System as a whole Drive and standard and the system of and the system of the system o	Mac	vien	1	- Choo	10015 -					
rimitary supply an now to system at containoned analyzed Throntacted/04 requirement for system	sd v	ctm	> 02 I II	puus 2ns Ps + Ras As	= 34200 = 11752					
Uncorrected OA requirement of system Uncorrected OA require a fraction of primary SA	Xs	5	: >	ou / Vps	= 0.34					
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.06	0.12	0.12	0.12
UA rate per person Total supply air to zone (at condition being analyzed)	zdz	ctm/b				12.00 12.00	0.UU 360	008 800	10U1 800	10UT 800
Unused OA read to breathing zone	Vbz	cţm	<u>۳</u>	tpz Pz + Raz Az	11	415.0	46.8	360.0	360.0	360.0
Unused OA requirement for zone	Voz	cfm	>	'bz/Ez	П	415	47	360	360	360
Fraction of zone supply not directly recirc. from zone	E a		ш і	:p + (1-Ep)Er	Ш	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	2		ш - п 1	р а гъм гъм гъ	11 1	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not alrectly rectrc. from zone Unused OA fraction required in supply air to zone	74		- >	-(1-EZ)(1-EP)(1-Er) 102 / Vd7	u u	1.00 0.35	0.13	0.45	1.UU 0.45	1.UU 0.45
Unused OA fraction required in primary air to zone	Zp		=	zd//zo/	п	0.35	0.13	0.45	0.45	0.45
System Ventilation Efficiency	I					-	i c			
Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	л И И И И			-а+грХз-гс∠)/га nin (Fvz)	= 0.83	nn. r	12.1	68.0	68.0	68.0
Ventilation System Efficiency (Table 6.3 Method)	ш		=	alue from Table 6.3	= 0.64					
Minimum outdoor air intake airflow			2							
Outdoor Air Intake Flow required to System	< <od< td=""><td>cfm</td><td>> ></td><td>ou / Ev</td><td>= 14184</td><td></td><td></td><td></td><td></td><td></td></od<>	cfm	> >	ou / Ev	= 14184					
OA Intake regio as a traction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	> > 	ou/vps	= 0.41 = 18487					
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	7		=	'ot / Vps	= 0.54					
OA Termp at which Min OA provides all cooling		Ded F	1	Tn-dTsft-(1-V)*(Tr+dTrft	31					
	l	- 692	1	(in a in) (1 - 1) (in a in-di)						2

Appendix A – Ventilation Load Calculations

Building: Svstem Tag/Name:	Bentwo RTHP-/	V1	e Scho	0						
Operating Condition Description: Units (select from pull-down list)	Occupi	ed Opera	tion Mo	ode						19
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per transcon for system area (Weighted average) Innuts for Portentially Critical sources	<mark>Name</mark> As Ps Ras Rps	Units sf cfm/sf cfm/p		100% diversity	System 3334 87, 34,28 9.1					
niputs for retaining critical corres Zone Name						Learning Support	Computer Lab	IPC	Work Room	Corridor
Zone Tag	Zone tit	le turns p	irple ita	lic for critical zone(s)		A107	A109	A114	A117	A127
Space type		Select fr	om pull	-down list		Classrooms (age 9 plus)	Computer lab	Office space	Office space	Corridors
Floor Area of zone	Az	រ សី			1997 - 1997 1997 - 1997	766	820	433	155	780
Design population or zone Design total supply to zone (primary plus local recirculated)	Vdzd	τĘ	(deraul	r value listed; may be ove	(neaden)	808 808	1020	4 580	100	360
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? Local recirc. air % representative of ave system return air	Er	Select fr	om pull	down list or leave blank it.	N/A			108		
Inputs for Operating Condition Analyzed	Ż	2			1000	10.00	10000	10001	10000	10001
Percent of total design arritow rate at containoned analyzed Air distribution type at conditioned analyzed	S	% Select fr	-Ina ma	-down list	6001		SC S	SO SO	CS No.	SO SO
Zone air distribution effectiveness at conditioned analyzed Drimary air fraction of supply air at conditioned analyzed	EZ E					1.00	1.00	1.00	1.00	1.00
r minury an maximu of supply an accommence analyzed	2									
ventilation System Efficiency Outdoor air intake required for system Outdoor air per unit floor area Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ev Vot Vot/As Vot/Ps Ypd	cfm cfm/sf cfm/b			0.83 14184 0.43 16.3 41%					
Detailed Calculations Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm cfm	 	pdDs ns Ds ∔ Das ås	= 34281 = 1175	-				
Uncorrected OA regid as a fraction of primary SA	Xs		: >	sd / no	= 0.3					
Initial Calculations for Individual zones OA rate per unit area for zone	Raz	cfm/sf				0.12	0.12	0.06	0.06	0.06
OA rate person	Rpz	cfm/p				10.00	10.00	5.00	5.00	0.00
i otal supply air to zone (at contation peing analyzeu) I huised ⊖â ren'd to breathind zone	zn v Vhz	E U	с П	nz Pz + Raz Az	п	360.0	303.4	36U 46.0	13.2	360 46.8
Unused OA requirement for zone	Voz	ctm -	: >	bz/Ez	U	360	303	46	13	47
Fraction of zone supply not directly recirc. from zone	Б Ц			p + (1-Ep)Er	U.	9.1	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air Eraction of zone O8 not directly revire from zone	2 ů		н н ц с	p -(1-E-)(1-En)(1-Er)	11 11	10.1 20.1	00.1	00.1 00.1	00.1	00.1 00.1
Unused OA fraction required in supply air to zone	zd		- >	02 / Vdz	ı u	0.45	0.30	0.08	0.13	0.13
Unused OA fraction required in primary air to zone	Zp		>	oz / Vpz	11	0.45	0.30	0.08	0.13	0.13
Zone Ventilation Efficiency (App A Method)	Evz		н Г	a + FbXs - FcZ) / Fa	Ш	0.89	1.05	1.26	1.21	1.21
System Ventilation Efficiency (App A Method)	<mark>ل</mark> م		E >	in (Evz) olito from Toklo 6.2	= 0.83					
vennanon system cinclency (rapie o.o. mentou) Minimum outdoor air intake airflow	<u>ک</u>		>	alue II UIII Table 0.0	1					
Outdoor Air Intake Flow required to System	Vot	cfm	>	ou / Ev	= 1418	_				
OA intake regid as a fraction of primary SA Outdoor bit Intake Flow required to System (Table 6.3 Method)	× ×	cfm	> > 	ot / Vps	= 0.4					
Od intake reg'd as a fraction of primary SA (Table 6.3 Method)	72 ≻	ļ	>> 	ot / Vps	= 0.5					
<u>OA Temp at which Min OA provides all cooling</u>		L L C	1		¢					
OA I below which OA Intake flow is @ minimum		Deg F	₩ =	(1) p-d I st)-(1-Y) (1-H d I H	υ Π					

Building: Svetem Tan/Name:	Bentw.	A1	lle Sch	ool						
Operating Condition Description: Units (select from pull-down list)	Occup	oied Oper	ation N	lode						
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per person for system area (Weighted average)	<mark>Name</mark> As Ps Vpsd Ras	Units sf cfm cfm/sf cfm/p		100% diversity	System 33341 872 34,280 0.11					
Inputs for Potentially Critical zones						Classroom	Classroom	Classroom	Science	Classroom
2 One Name	Zone t	the turns p	urple #	alic for critical zone(s)					CIASSIOUTI	
Zone Tag						A118	A124	A123	A126	A125
Space type		Select f	Ind wo.	ll-down list		(age 9 plus)	(age 9 plus)	(age 9 plus)	(age 9 plus)	(age 9 plus)
Floor Area of zone Design population of zone	Az Pz	ъ ď	(defau	ilt value listed; may be oven	ridden)	766 26.81	766 26.81	766 26.81	30.905	766 26.81
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Ean Dual Duct or Transfer Fan?	Vdzd	cfm Select f	nd wo.	Il-down list or leave blank if	N/A	800	700	800	1060	700
LUCATION AN 2010 AN 2010 ANALYZED	ū									
Percent of total design airflow rate at conditioned analyzed	Ds	%			100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed	ſ	Select f	nd mou	Il-down list		CS	S	S S	CS S	S
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	₿ E					1.00	1.00	1.00	1.00	1.00
Results	ð				000					
Ventilation System Emclency Outdoor air intake required for system	≥ to	cfm			0.83					
Outdoor air march required for system	Vot/As	cfm/sf			0.43					
Outdoor air per person served by system (including diversity)	V ot/Ps	cfm/p			16.3					
Outdoor air as a % of design primary supply air	Ъd	cfm			41%					
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	et m		/pdDs	= 34280 - 11750					
UncorrectedOA requirement for system Uncorrected OA red'd as a fraction of primary SA	Xs			Aps FS Trds As	= 0.34					
Initial Calculations for individual zones	2		I		5.5					
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.12	0.12	0.12	0.12
OA rate per person Total supply air to zone (at condition heind analyzed)	Kpz Vd	cfm/p				10.00 800	10.00 700	10.00 RND	10.00 1060	10.00 700
Unused OA req'd to breathing zone	Vbz	cfm	"	Rpz Pz + Raz Az	п	360.0	360.0	360.0	415.0	360.0
Unused OA requirement for zone	Voz	cfm	"	/bz/Ez	11	360	360	360	415	360
Fraction of zone supply not directly recirc. from zone	Fa I			Ep + (1-Ep)Er	н	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	£ 1			Ep 1 (4 E-2/4 E-2/4 E-2)		1.00	1.00	00.1 00.1	1.00	1.00
Unused OA fraction required in supply air to zone	Zd			(oz / Vdz	1 11	0.45	0.51	0.45	01 0.39	0.51
Unused OA fraction required in primary air to zone	Zp		"	/oz / Vpz	п	0.45	0.51	0.45	0.39	0.51
System Ventilation Efficiency	Ĺ		1			000	000	00 0	10.0	
Zone Ventilation Efficiency (App A Method)				Fa + FbXs - Fc∠) / Fa	- 0.03	68.0	0.83	0.89	GR. D	0.83
Ventilation System Efficiency (Table 6.3 Method)	۵ L			/alue from Table 6.3	= 0.64					
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	≺ot	cfm	"	/ou / Ev	= 14184					
OA intake req'd as a fraction of primary SA	¥ •	-fm		/ot / Vps	= 0.41 - 10407					
Od intake red'd as a fraction of primary SA (Table 6.3 Method)	7. ≻	ļ		/ot / Vps	= 0.54					
OA Temp at which Min OA provides all cooling		1								
OAT below which OA Intake flow is @ minimum		Deg F	п	(Tp-dTsf)-(1-Y)"(Tr+dTrf)	= 31					

						-				
Building: Svstem Tad/Name:	Bentwo RTHP-4	rth Middl	e Scho	0						
Operating Condition Description: Units (select from pull-down list)	Occupi	ed Operat	tion Mo	ode		TT				2
Inputs for System Floor area served by system	<u>Name</u> As	<u>Units</u> sf	L		Syster 333	= 7				
Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per person for system area (Weighted average) Inputs for Potentially Critical zones	Ps Vpsd Ras Rps	P cfm cfm/sf cfm/b		100% diversity	34,2 0.	4 118 22				
Zone Name						Storage	Corridor	Art CR	Art Storage	Kiin
Z one Tag	Zone tử	le turns pu	rple ita	lic for critical zone(s)		A126A	A202	A203	A203A	A2 03B
Space type		Select fro	-Ind ma	down list		Storage rooms	Corridors	Art classroom	Storage rooms	Storage
Floor Area of zone Design movulation of zone	Az P	<u>م</u> ر	dofault	tralite listed - may be over	ridden)	220	780	900	175	02
Design population of zone Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Done (Fan Dual Duct or Transfer Fan?	Vdzd	cfm Select fro	-Ind m	down list or leave blank if	N/A	140	360	1040	120	220
Inputs for Operating Condition Analyzed	ī									
Percent of total design airflow rate at conditioned analyzed	Ds	% Colori 60		tell anneh	100	% 100%	100%	100%	100%	100%
Zone air distribution effectiveness at conditioned analyzed	Ez	n naiac				1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Бр									
Ventilation System Efficiency	Ъ				0.8					
Outdoor air intake required for system	Vot	cfm			1418	4				
Outdoor air per unit floor area Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/sf cfm/n			0.4	m, m				
Outdoor air as a % of design primary supply air	Урd	ctm			4	%				
Detailed Calculations										
Initial Calculations for the System as a whole Driver structure of four of a work of a conditioned analysis	Mac	Line	2	- 00	CV2 -	G				
UncorrectedOA requirement for system	Vou	Į Į		ps Ps + Ras As	117	22				
Uncorrected OA regid as a fraction of primary SA	Xs			sd// no	.0	34				
Initial Calculations for Individual zones OA rate per unit area for zone	Raz	cfm/sf				0.12	0.06	0.18	0.12	0.12
OA rate per person	Rpz	cfm/p				0.00	00.0	10.00	00.0	00.0
Total supply air to zone (at condition being analyzed)	Zdz	Ę,	0	- 0 0	1	140	360	1040	120	220
Unused OA requirement for zone	Voz	ctu c	25	bz/Ez	1 11	26	47	342	21	t œ
Fraction of zone supply not directly recirc. from zone	Fa		ш н	p + (1-Ep)Er	Ш	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	£ 1			p (1 E=)(1 En)(1 En)	11 1	1.00	1.00 00.1	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Z PZ		- > 	02 / Vdz	1 11	0.19	0.13	0.33	0.18	0.04
Unused OA fraction required in primary air to zone	Zp		5	oz / Vpz	11	0.19	0.13	0.33	0.18	0.04
zystem vermauon emotency Zone Ventilation Efficiency (App A Method)	Evz		= =	a + FbXs - FcZ) / Fa	11	1.15	1.21	1.01	1.17	1.30
System Ventilation Efficiency (App A Method)	БV		E 	in (Evz)	= 0.8					
Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor air intake airflow	Ъ.		>	alue from Table 6.3	9.0 =	4				
Outdoor Air Intake Flow required to System	Vot	cfm	> =	ou / Ev	= 141	84				
OA intake req'd as a fraction of primary SA	7		>	ot / Vps	.0.	41				
Outdoor Air Intake Flow required to System (Table 6.3 Method) OA intake ren'd as a fraction of nrimary SA (Table 6.3 Method)	≺ <	Ê	> > 	ou / EV of / V/ns	= = 184	87 54				
<u>OA Temp at which Min OA provides all coling</u>		L I I		ATT	,					
UAT below which UA Intake flow IS @ minimum		Degr	₩ 	(JI D+JI).(J-L)-(JSI D-d)	u	51				

		and the set of a	100							
Bullaing: System Tag/Name:	RTHP-	A1 MIGG	lo scu	100						
Óperating Condition Description: Units (select from pull-down list)	Occup	ied Opera	tion M	lode						
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per transcon for system area (Weighted average) Innuts for Pohentially Critical zonoes	<mark>Name</mark> As Ps Ras Rps	Units sf cfm cfm/sf cfm/p		100% diversity	System 3334 87, 87, 34,28 0.1					
nipus tor totentany ortical cortes 7 ana Nama						Seminar	Seminar	Gifted	Seminar	Office
	Zone ti	the turns p	urple #	alic for critical zone(s)						
Zone Tag						A204	A205	A206	A208	A233
Space type		Select fr	Ind mo	I-down list		eeting	comerencerm eeting	(age 9 plus)	eeting	Ollice space
Floor Area of zone Design population of zone	Az Pz	Ъ sť	(defau	lt value listed; may be over	ridden)	37.8	37.8	758 26.53	375 18.75	125 0.625
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? Local nactice air %, representative of ave system return air	Vdzd	cfm Select fr	Ind mo	l-down list or leave blank if	N/A	800	800	800	425	100
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed Air distribution type at conditioned analyzed	S	% Select fr	lun mo	Ldown list	100%	100%	100%	100%	100%	100%
Zone air farthurtion of entropy of contraction of an alyzed	Ē					1.00	1.00	1.00	1.00	1.00
Primary air iraciiori of supply air ai conditiorieu analyzeu Results	d. L									
Ventilation System Efficiency	Ъ				0.83					
Outdoor air intake required for system	Vot	cfm ,			14184					
Outdoor air per unit floor area Outdoor air per person served by system (including diversity)	Vot/As Vot/Ps	cfm/sf cfm/b			0.43					
Outdoor air as a % of design primary supply air	Уpd	ctm			419					
Detailed Catculations										
Initial Calculations for the System as a whole		-	1	1-410-5	10010					
Frimary suppry air now to system at containoned analyzed UncorrectedOA requirement for system	Vou	ctu c	> LC. 	r puus Rps Ps + Ras As	= 3420(= 1175;					
Uncorrected OA regid as a fraction of primary SA Initial Calculations for individual zones	Xs		-	sd// no/	= 0.34	_				
OA rate per unit area for zone	Raz	cfm/sf				0.06	0.06	0.12	0.06	0.06
OA rate per person Total sunnly air to zone (at condition being analyzed)	Rpz Vdz	cfm/p				5.00 800	5.00 800	10.00 800	5.00	5.00 100
Unused OA req'd to breathing zone	Vbz	cţm	"	<pre>kpz Pz + Raz Az</pre>	"	234.4	234.4	356.3	116.3	10.6
Unused OA requirement for zone	Voz	cţm		/bz/Ez		234	234	356	116	13
Fraction of zone supply not already rearc, nom zone Fraction of zone supply from fully mixed brimary air	e q			ер + (I-сруст Ер	1 11	00.1	00.1	00.1	00.1	00.1
Fraction of zone OA not directly recirc. from zone	с Ц		"	-r -(1-Ez)(1-Ep)(1-Er)	11	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Σd		-	/ vz / Vdz	п	0.29	0.29	0.45	0.27	0.11
Unused OA fraction required in primary air to zone	Zp		"	/ oz / Vpz	11	0.29	0.29	0.45	0.27	0.11
Zone Ventilation Efficiency (App A Method)	Evz		"	Fa + FbXs - FcZ) / Fa	11	1.05	1.05	06.0	1.07	1.24
System Ventilation Efficiency (App A Method)	<u>а</u>			nin (Evz)	= 0.83					
Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor air intake airflow	à		11	/alue from Table 6.3	= 0.64					
Outdoor Air Intake Flow required to System	Vot	cfm	"	/ou / Ev	= 1418-					
OA intake req'd as a fraction of primary SA	≻		"	/ot / Vps	= 0.4	_				
Outdoor Air Intake Flow required to System (Table 6.3 Method)	< <ot< td=""><td>Ę</td><td></td><td>/ou/Ev</td><td>= 1848</td><td></td><td></td><td></td><td></td><td></td></ot<>	Ę		/ou/Ev	= 1848					
OA Imake req'd as a traction of primary SA (Table 5.3 Method) OA Temp at which Min OA provides all cooling	-		> II	101 / VpS	-0.0					
OAT below which OA Intake flow is @ minimum		Deg F		(Tp-dTsf)-(1-Y)*(Tr+dTrf)	3					

building: System Tag/Name:	RTHP-	A1 MIGG	luoc a	100		T				
Operating Condition Description: Units (select from pull-down list)	Occupi IP	ed Opera	tion M	ode						
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per person for system area (Weighted average) Inputs for Potentially Critical zones	Name As Ps Vpsd Ras Rps	Units sf cfm/sf cfm/b		100% diversity	System 3334 334,26 34,26 9.0	Pote	ntially Critical 2 AV Room	zones Comes	Da	Work Room
Zone Name Zone Tag	Zone th	le turns pu	ırple ite	alic for critical zone(s)		A212	A211	A213	A215	A218
Space type		Select fr	Ind mo	-down list		Office space	Storage	Computer lab	Office space	Office space
Floor Area of zone Design population of zone Design total supply to zone (primary plus local recirculated)	Az Pz Vdzd	sf P cfm Select fr	(defaul	It value listed; may be over	ridden) Nưã	150 0.75 150	220 0 225	0 827 0 20.675 0 1020	435 4 680	155 0.775 100
Local recirc. air % representative of ave system return air	Ц	10000						88		
Inputs for Operating Condition Analyzed Percent of total design airflow rate at conditioned analyzed	Ds	8 (100	% 100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed Primary air fraction Supply air at conditioned analyzed	Ē	Select II	lind wo	1SII UMOD-		1.00	1.00	1.00	1.00	1.00
<mark>Results</mark> Ventilation Svstem Efficiency	Ъ.				0.8	~				
Outdoor air intake required for system	Vot	cfm			1418	. +				
Outdoor air per unit floor area	Vot/As	cfm/sf			0.4					
oudoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ypd	ctm/p			41	° %				
Detailed Calculations										
Initial Calculations for the System as a whole			3	<u>1</u>						
Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system	vps Vou	ctm ctm	> 02 II II	pdDs tos Ps + Ras As	= 3428 = 1175	2 2				
Uncorrected OA requares a fraction of primary SA	Xs		. >	sd / no	=	4				
OA rate per unit area for zone	Raz	cfm/sf				0.06	0.12	0.12	0.06	0.06
OA rate per person Total supply air to zone (at condition being anaMzed)	Rpz Vdz	cfm/p cfm				5.00 150	0.00	10.00	5.00 680	5.00 100
Unused OA require to breathing zone	Vbz	cfm		tpz Pz + Raz Az		12.8	26.4	306.0	46.1	13.2
Fraction of zone supply not directly recirc. from zone	Fa	5	»Ш I II	b + (1-Ep)Er		1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	8 I		ш.	- - -	11	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone	Zd		- > 	-(1-Ez)(1-Ep)(1-Er) oz / Vdz		0.09	1.00 0.12	0.30	0.1 0.07	1.00 0.13
Unused OA fraction required in primary air to zone	Zp		>	zdV/ zo	11	0.0	0.12	0.30	20.0	0.13
System Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Evz		=	⁼ a + FbXs - FcZ) / Fa	Ш	1.26	1.23	1.04	1.28	1.21
System Ventilation Efficiency (App A Method)	ы Ш		=	iin (Evz)	= 0.8					
Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor air intake airflow	Ъ.		> II	alue from Table 6.3	9.0	+				
Outdoor Air Intake Flow required to System	Vot	cfm	>	ou / Ev	= 1418	7				
OA intake req'd as a fraction of primary SA	کر ۲	rêm	>>	ot / Vps	= 0.4 -	5.0				
Outdoor All Intere Flow required to System (Table 6.3 Method) OA intere req'd as a fraction of primary SA (Table 6.3 Method)	× ۲	5		ot / Vps		- 4				
<u>OA Temp at which Min OA provides all cooling</u> OAT below which OA Intake flow is @ minimum		Deg F	=	Tp-dTsf)-(1-Y)*(Tr+dTrf)		r.				

Building:	Bentw	orth Mido	le Sch	ool						
System Tag/Name: Operating Condition Description:	Occup	A1 ied Oper	ation N	lode						
Units (select from pull-down list)	4									139
Inputs for System	Name	Units			Svsten					
Floor area served by system	As	s			3334	1				
Population of area served by system (including diversity)	Ps	с,		100% diversity	18	210				
Design primary supply ran airriow rate	vpsd				34,20					
OA req'd per unit area ror system (Weighted average) OA req'd per person for system area (Weighted average)	Rps	ctm/st cfm/p				- 4				
Inputs for Potentially Critical zones						Emotional	Corridor		Constitutor	Construction
Zone Name						Support		2	ScienceClassr	consulacion
	Zone ti	the turns p	urple A	alic for critical zone(s)					moo	
Lone lag						Classrooms	AZZ/ Corridors	Computer lah	Classrooms	AZZ6 Mond/metal
Space type		Select f	nd wo.	ll-down list		(age 9 plus)			(age 9 plus)	shop
Floor Area of zone	Az	s				766	780	166	1190	766
Design population of zone Design total supply to zone (with any abus local projectifated)	PZ	Ч,	(defau	llt value listed; may be ove	rridden)	26.81	0	19.15	41.65	15.32
Design total suppry to zone (primery puts local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	nzna	Select f	nd wo.	Il-down list or leave blank if	N/A	000	000	0701	0001	00+-
Local recirc. air % representative of ave system return air	Er		2					2012	2	6
Inputs for Operating Condition Analyzed	ć	à			001	1000	10001	10001	10001	1000
Percent of total design airflow rate at conditioned analyzed	S	% Coloct	10 000	toin lint	nni.	RUUT R	%00L	%00L	%OOL	%00L
All utstitution type at containoned analyzed Zone air distribution effectiveness at conditioned analyzed	ů	nalac				5 5	100	507	50	50
Primary air fraction of supply air at conditioned analyzed	1 B					00.1	00.1	00.1	00.1	00.1
Results					1					Π.
Ventilation System Efficiency	<u>а</u> :				0.8					
Outdoor air intake required for system	VotiAs	ctm cfm lef			1418	+ 0				
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/b			16.					
Outdoor air as a % of design primary supply air	Ypd	cfm .			41	%				
Dotailod Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	"	/pdDs	= 3426	0				
UncorrectedOA requirement for system	Nou	cfm		Rps Ps + Ras As	= 1175	2				
Uncorrected OA req'd as a fraction of primary SA	Xs		"	sd / no /	=	4				
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.06	0.12	0.12	0.18
OA rate per person	Rpz	cfm/p				10.00	00.0	10.00	10.00	10.00
Total supply air to zone (at condition being analyzed)	ZbV	cfm				800	360	1020	1600	1490
Unused OA requirement for zone	202			<pre><pre><pre>thaz Hz</pre><pre>/haz/Fa</pre></pre></pre>		360.0	45.8 47	283.4	559.3 559	1.1'8'2 1'PC
Fraction of zone supply not directly recirc. from zone	Fa	ļ	11	Ep + (1-Ep)Er	Ш	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		"	d	11	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	с Ц			I-(1-Ez)(1-Ep)(1-Er)	11	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone Unused OA fraction required in primerication and air to zone	07 7			/ 02 / Vd2		0.45	0.13	0.28	0.35	0.20 0.20
Sustem Ventilation Efficiency	7		I.	1 0C / v PC	ſ		2.5	07.0	00.0	07.0
Zone Ventilation Efficiency (App A Method)	Evz			Fa + FbXs - FcZ) / Fa	Ш	0.89	1.21	1.06	0.99	1.15
System Ventilation Efficiency (App A Method)	<u>ک</u>			nin (Evz)	= 0.8					
Ventilation System Efficiency (Table 6.3 Method)	Ā		11	/alue from Table 6.3	= 0.6	4				
Outdoor Air Intake Flow required to System	Vot	cfm		/ou/Ev	= 1418	1				
OA intake req'd as a fraction of primary SA	≻			/ot / Vps	= 0.4	Ξ				
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot :	cţm	11	/ou/Ev	= 1848	1				
OA Town at which Min OA wrounded all cooling	~		11	/ot / Vps	=	4				
OAT FILLING AN WILLING AND A PLOYICES AN COUNTY OAT below which OA Intake flow is @ minimum		Deg F	"	(Tp-dTsf)-(1-Y)*(Tr+dTrf)	u	11				

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Building:	Bentwo	rth Middl	e School							
System I aginame: Onerating Condition Description:	Occupie	1 Onoral	ion Mod							
Operating Condition Description: Units (select from pull-down list)	IP Uccupie	a upera		0						
						F				
	Name	<u>or</u>			system					
Flour area served by system Population of area served by system (including diversity)	čď	δΩ		100% diversity	872					
Design primary supply fan airflow rate	Vpsd	cfm			34,280					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf			0.11					
OA red'd per person for system area (Weighted average)	Rps	cfm/p			9.4					
Inputs for Potentially Critical zones						Storade	Science	Storade	Corridor	Classroom
Zone Name							Classroom	0 8 1		
	Zone tith	e turns pu	rple italic	for critical zone(s)						
Zone Tag						A226A	A303	A303A	A302	A304
Space type		Select fro	op-Ind m	wn list		rooms	(ade 9 plus)	rooms	Collinois	(ade 9 plus)
Floor Area of zone	Az	sf				205	883	220	780	766
Design population of zone	Pz	٩.	(default va	alue listed; may be ove	rridden)	0	30.905	0	0	26.81
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				110	920	100	360	800
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	ľ	Select fro	op-Ind m	wn list or leave blank i	I N/A					
Local recirc, air % representative or ave system return air Innuts for Onersting Condition Analyzed	L									
Dercent of total desirn airflow rate at conditioned analyzed	č	%			100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed	ł	Select fro	op-Ind m	wn list		CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	E7					1 00	1 00	1 00	1 00	1 00
Primary air fraction of supply air at conditioned analyzed	Шb									
<u>Results</u>										
Ventilation System Efficiency	Ň	1			0.83					
Outdoor air intake required for system	Vot	cfm			14184					
Outdoor air per unit floor area	Vot/As	cfm/sf efer /e			0.43					
Outdoor air as a % of desion brimary subbly air	Ynd	cfm p			41%					
					2.000					
Detailed Calculations										
Initial Calculations for the System as a whole			3		00010					
Primary supply air flow to system at conditioned analyzed	Vps	t d		Ds i Baa Aa	= 34280 - 44750					
Uncorrected OA road as a fraction of brimany SA	۲e uu	1		12 1 1 445 7 5						
Diffial Calculations for individual zones	ę		100 A	ed a l	1	2				
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.12	0.12	0.06	0.12
OA rate per person	Rpz	cfm/p				00.0	10.00	0.00	00.0	10.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm				110	920	100	360	800
Unused OA req'd to breathing zone	ZdV	ctm	= Rpz	Pz + Raz Az		24.6	415.0	26.4	46.8	360.0
Eraction of zone sumbly not directly recirc from zone	La K	3			1 11	1 00	1001	1 00	1 00	1 00
Fraction of zone supply from fully mixed primary air	. e				11	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	, L		= 1-(1-	-Ez)(1-Ep)(1-Er)	11	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz	/Vdz	IJ	0.22	0.45	0.26	0.13	0.45
Unused OA fraction required in primary air to zone	Zp		= Voz	/Vpz	Ш	0.22	0.45	0.26	0.13	0.45
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	EVZ		= (Fa	+ FbXs - FcZ) / Fa	1	1.12	0.89	1.08	1.21	0.89
System Ventilation Efficiency (App A Method)	<u>ک</u> ر			(Evz)	= 0.83					
Ventuation System Efficiency (Table 5.3 Method) Minimum outdoor sir intske sinflow	х Ц		= vaiu	le trom Table 6.3	= 0.b4					
Outdoor Air Intake Flow required to System	Vot	cfm	- Vou	/ Fv	= 14184					
Od intake red as a fraction of brimary SA		ij	= Vot	Vbs	= 0.41					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou	/Ev	= 18487					
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	۲		= Vot	/Vps	= 0.54					
<u>OA Temp at which Min OA provides all cooling</u>			1							
OAT below which OA Intake flow is @ minimum		Deg F	-(1b	-dlsf)-(1-Y)°((lr+dlff)	= 31					

Bentworth Middle School: Technical Report One

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Building: System Tag/Name:	Bentwor RTHP-A	th Middl	e Scho	0						
Operating Condition Description: Units (select from pull-down list)	Occupie IP	d Operat	ion Mc	de						
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average) OA req'd per person for system area (Weighted average)	<u>Name</u> As Ps Vpsd Ras Rps	units sf cfm/sf cfm/p		100% diversity	System 33341 872 34,280 0.11 0.11					
inputs for Foremainy Critical zones. Zone Name						Classroom	Classroom	Learning Support	Computer Lab	Work room
	Zone tikk	turns pu	rpie ita	lic for critical zone(s)		1001				
∠one lag						A305 Classrooms	Classrooms	Classrooms	Computer lab	A31/ Office space
Space type		Select fro	-Ind m	down list		(age 9 plus)	(age 9 plus)	(age 9 plus)		
Floor Area of zone Design population of zone	Pz Az	Ъ б	default	value listed; may be over	ridden)	766 26.81	766 26.81	766 26.81	820 20.5	0.775
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? I ocal recirc air % representative of ave system return air	Vdzd	cfm Select fro	m pull-	down list or leave blank if	NIA	800	800	800	1020	100
Inputs for Operating Condition Analyzed										
Percent of total design airflow rate at conditioned analyzed	Ds	%			100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed	ļ	Select fro	m pull-	down list		CS	S	SS 1 25	CS 1 22	S
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	E E					1.00	1.00	1.00	1.00	1.00
Results	ů				0 0					
Verninghon System Eniclency Outdoor of intolo youring for mutum	2 2				14104					
Outdoor air intake required for system Outdoor air ber unit floor area	Vot/As	cfm /sf			0.43					
Outdoor air per person served by system (including diversity)	V ot/Ps	cfm/p			16.3					
Outdoor air as a % of design primary supply air	Уpd	cfm			41%					
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	ctm	<u>-</u>	pdDs	= 34280					
UncorrectedOA requirement for system	Vou	ctm	₩ :	ps Ps + Ras As	= 11752					
Uncorrected UA regid as a fraction of primary SA Initial Calculations for individual zones	XS		5	sd v no	= U.34					
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.12	0.12	0.12	0.06
OA rate per person	Rpz	cfm/p				10.00	10.00	10.00	10.00	5.00
Tutal supply all to zolle (al collulitori pellig allaryzeu) Thursod 0.4 maid to broathing zono	707 707	E H	0 1	07 D7 ± Pa7 &7	"	360.0	000 10035	360.0	303.4	13.2
Unused OA requirement for zone	Voz	ctm.		bz/Ez		360	360	360	303	13
Fraction of zone supply not directly recirc. from zone	Fa		ш п	p + (1-Ep)Er	п	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		ш Ш	0	11	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	ы Ц		÷: "	(1-Ez)(1-Ep)(1-Er)	11	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone Unused OA fraction required in primany air to zone	07 20		5	ZD/ / ZD ZD/ / ZD	u 11	0.45 0.45	0.45 0.45	0.45 0.45	U.SU 0.30	U.13 D 13
Sostem Ventilation Efficiency	2			~ ~ ~		01.0		01.0	0000	2.5
Zone Ventilation Efficiency (App A Method)	Evz		н П	a + FbXs - FcZ) / Fa	Ш	0.89	0.89	0.89	1.05	1.21
System Ventilation Efficiency (App A Method)	<u>ل</u> ا س		E 5	in (Evz) ohio foom Toblo 6.2	= 0.83					
veninanou system Eniclency (rable o.s.meniou) Minimum outdoor air intake airflow	à		5	alue II UIII Table 0.0	ta:5					
Outdoor Air Intake Flow required to System	Vot	cfm	> =	ou / Ev	= 14184					
OA intake req'd as a fraction of primary SA	۲		> =	ot / Vps	= 0.41					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cţm	5 : =	ou / Ev	= 18487					
OA Torms at which Min OA movides all continues	≻		> "	ot / Vps	= 0.54					
OAT below which OA Intake flow is @ minimum	1944	Deg F	.)} =	Tp-dTsf)-(1-Y)*(Tr+dTff)	= 31					

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Building:	Bentwi	orth Middl	e Schi	pol						
system Lag/Name: Oberating Condition Description:	Occup	ed Opera	tion M	ode						
Units (select from pull-down list)	Р									
lanacta for Contour	Mamo	1 Inite			Cuton	5				
<u>inputs for system</u> Floor area served by system Poorliation of area served by system (including diversity)	As Ps	л s		100% diversity	3334 87	22-				
Design primary supply fan airflow rate OA req'd per unit area for system (Weighted average)	Vpsd Ras	cfm cfm/sf	1		34,26					
OA red a per person for system area (weighted average) Inputs for Potentially Critical zones	sdy	duny			'n	Ŧ		a na mariana	Alasana an	
Zone Name	i					2	Corrigor	Support	Classroom	Classroom
Zone Tag	Zone th	le turns pu	irple #	alic for critical zone(s)		A314	A327	A318	A323	A324
Space type		Salart fr	lun me	-down list		Office space	Corridors	Classrooms	Classrooms	Classrooms
Floor Area of zone	Az	sf				435	780	1992	1992 Jenn - 268	1992 1992
Design population of zone	Pz	а 4	(defau	It value listed; may be over	ridden)	4	0	26.81	26.81	26.81
Design rotal supply to zone (primary pus rocal recirculated) Induction Terminal Unit, Duble Fan Duble Duct on Transfer Fan? I noval racing air & neuroscentative of ava system radium air	V QZQ	cim Select fr	lluq mo	-down list or leave blank if	N/A	noc	090	000	800	900
Inputs for Operating Condition Analyzed	ī				8					
Percent of total design airflow rate at conditioned analyzed	Ds	%			100	% 100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select fr	Ind wo	-down list		CS	CS	CS	CS	S
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	E C					1.00	1.00	1.00	1.00	1.00
Results	ī									
Ventilation System Efficiency	Ъ				0.8					
Outdoor air intake required for system	Vot	cfm			1418	4				
Outdoor air per unit floor area Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/b			16.0					
Outdoor air as a % of design primary supply air	Ypd	ct m			41	%				
Descripted Andrews	l	l			l					
Detailed Catculations Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	vps	cfm	>	pdDs	= 3426	0				
UncorrectedOA requirement for system	Vou	cfm	ш. Ш	tps Ps + Ras As	= 1175	22				
Uncorrected OA req'd as a fraction of primary SA Initial Calculations for individual zones	Xs		>	ou / Vps	0 0	4				
OA rate per unit area for zone	Raz	cfm/sf				0.06	0.06	0.12	0.12	0.12
OA rate per person	Rpz	cfm/p				5.00	00.0	10.00	10.00	10.00
Total supply air to zone (at condition being analyzed)	Zdz	ctm	L		1	580	360	800	800	800
Unused OA requirement for zone Unused OA requirement for zone	Voz	li j		фи ми + маи жи МилЕт	1 11	40.1 46	40.0	360	360	360.0
Fraction of zone supply not directly recirc. from zone	Fa		. Ш Ш	:p + (1-Ep)Er	"	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		ш		11	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		"	-(1-Ez)(1-Ep)(1-Er)	"	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	2d		> :	zp / / dz	11	0.08	0.13	0.45	0.45	0.45
Unused OA fraction required in primary air to zone	Zp		>	oz / Vpz	11	0.08	0.13	0.45	0.45	0.45
System Venuiauon Emcrency Zone Ventilation Efficiency (App A Method)	Evz		=	=a + FbXs - FcZ) / Fa	"	1.26	1.21	0.89	0.89	0.89
System Ventilation Efficiency (App A Method)	Ъ		"	nin (Evz)	= 0.8					
Ventilation System Efficiency (Table 6.3 Method)	БV			alue from Table 6.3	= 0.6	4				
Minimum outdoor air intake airflow	1		1	L	-	,				
Outdoor Air Intake Flow required to System	ы У >	CIII	> > 	ou / EV	- 141°	4 5				
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm		ou / Ev	= 1846	10				
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	۲		=	ot / Vps	= 0.6	54				
OA Temp at which Min OA provides all cooling		L P C	-	General Andreas and Andreas and						
UAI DEIOW WHICH UAIMAKE TIOW IS @ MINIMUM		Degr		(11 p-a 1 s1)-(1 - 1)-(1 s1 p-d1)	.,	1				

Building:	Bentwo	rth Middl	e Sch	ool				
System Tag/Name:	RTHP-A	-				_		
Operating Condition Description: Units (select from pull-down list)	Occupie	ed Opera	tion M	lode				
Inputs for System	Name	Units			System			
Floor area served by system	As	sf	5		33341			
Population of area served by system (including diversity)	Ps	Ф.		100% diversity	872			
Design primary supply fan airflow rate	Vpsd	cfm			34,280	_		
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf			0.11			
OA req'd per person for system area (Weighted average)	Rps	cfm/p			9.4			
Inputs for Potentially Crucal zones						Claceroom	Crianca	Storado
Zone Name							Classroom	afining
	Zone titl	e turns pu	irple #	alic for critical zone(s)				
Zone Tag						A325	A326	A326A
						Classrooms	Classrooms	Storage
Space type		Select fro	Ind mo	I-down list		(age 9 plus)	(age 9 plus)	rooms
Floor Area of zone	Az	sf				766	883	220
Design population of zone	Pz	٩	(defau	It value listed: may be ove	erridden)	26.81	30.905	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				800	1060	140
Induction Terminal Unit. Dual Fan Dual Duct or Transfer Fan?		Select fro	Ind mo	I-down list or leave blank i	f N/A			
Local recirc. air % representative of ave system return air	ц		5					100
Inputs for Operating Condition Analyzed								
Percent of total design airflow rate at conditioned analyzed	Ds	%			100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select fr	lua ma	l-down list		SO	SS	SS
Zone air distribution effectiveness at conditioned analyzed	ĥ					1 00	001	5 0
Primary air diarribation of subniv air at conditioned analyzed	цП					001	2011	2011
e minary an manion of supply an accommunical analyzed	1							
Ventilation System Efficiency	Ň				0.83			
Outdoor air intake required for system		cfm			14184			
Outdoor air neurologanou o guran	Vot/As	cfm /cf			0.43			
Outdoor air per diin itool area Outdoor air ner nerson served by system (including diversity)	VotPe	cfm/n			16.31			
Outdoor air as a % of design primary supply air	Yed	cfm			41%			
	t							
Detailed Calculations								
Initial Calculations for the System as a whole								
Primary supply air flow to system at conditioned analyzed	Vps	cfm	"	/pdDs	= 34280			
UncorrectedOA requirement for system	Vou	cfm	11	<pre>kps Ps + Ras As</pre>	= 11752	-		
Uncorrected OA req'd as a fraction of primary SA	Xs		"	/ou//bs	= 0.34			
Initial Calculations for individual zones								
OA rate per unit area for zone	Raz	cfm/sf				0.12	0.12	0.12
OA rate per person	Rpz	cfm/p				10.00	10.00	00.0
Total supply air to zone (at condition being analyzed)	ZbV	cfm				800	1060	140
Unused OA req'd to breathing zone	Vbz	ctm	IL	<pre>kpz Pz + Raz Az</pre>	11	360.0	415.0	26.4
Unused OA requirement for zone	Voz	ctm	ב וו	/bz/Ez	11	360	415	26
Fraction of zone supply not directly recirc. from zone	Fa			Ep + (1-Ep)Er	11.	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	đ			d	11	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	ц			I-(1-Ez)(1-Ep)(1-Er)	11	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	pZ -			/ oz / Vdz	11	0.45	0.39	0.19
Unused OA fraction required in primary air to zone	Zp		"	/oz / Vpz	11	0.45	0.39	0.19
System Ventilation Efficiency	-							
Zone Ventilation Efficiency (App A Method)	ZX I			Fa + FbXs - FcZ) / Fa	90 0 11 11	0.89	66.0	1.15
System Veniliation Emiciency (App A Method)				llill (EVZ) Johns from Toblo 6-3	- 1			
vennanon system cinclency (table o.3 Meniou) Minimum authoor sir intsko sirflow	2		1	diue ironi Table 0.0	to:n			
Outdoor & Interests Elow required to Sveter	Vot	rfm	1	four / Exc	= 14484			
Outdoor An Interer Tow required to System Of intere reads as a fraction of primery SA		j		int ///ns				
On make req u as a nacion of primary on Outdoor Air Intake Flow remuted to System (Table 6.3 Method)	Vot	cfm		Voir / Ev	= 18487			
OA intake red'd as a fraction of brimary SA (Table 6.3 Method)		ļ		/ot / Vps	= 0.54			
OA Temp at which Min OA provides all cooling								
OAT below which OA Intake flow is @ minimum		Deg F	=	(Tp-dTsf)-(1-Y)*(Tr+dTrf)	= 31			

Buildina:	Bentwo	rth Middl	e School								ľ
System Tag/Name: Dperating Condition Description: Units (select from pull-down list)	RTHP-E Occupi	81 ed Opera	cion Mode								
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA reqd per unit area for system area (Weighthed average) OA redd per person for system area (Weighthed average)	Name As Vpsd Rps Rps	Units sf cfm cfm/sf cfm/p	100% diversity	System 9220 10,110 0.08 8.0							
Zone Name	Zone tit	le turns pi	mle italic for critical zone(s)		Health Classroom	Music Classroom	Office	Storage	Instrument Repair	Concession	Instrument Practice
Zone Tag					B217	B215	B214F	B214E	B214D	B212	B214A
Space type		Select fr	om pull-down list		Classrooms (age 9 plus)	Classrooms (age 9 plus)	Office space	Storage	Office space	Cafeteria/fast- food dining	Office space
Floor Area of zone	Az	sf			823	823	109	92	64	96	29
Design population of zone Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Pz Vdzd	P cfm Select fn	default value listed; may be ove m pull-down list or leave blank i	f N/A	28.805	28.805 800	0.545 125	75	0.32	165	0.145
Local recire, air % representative of ave system return air Inputs for Operating Condition Analyzed	à										
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed Demonstrate feasions for involution and conditioned analyzed	Ez	Select fr	om pull-down list		CS 1.00	CS 1.00	1.00	1.00	1.00	1.00 1.00	CS 1.00
Frimary air traction of supply air at conditioned analyzed	2										
Accessing Accessing Outdoor air intake required for system Outdoor air per unit floor area Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ev Vot Vot/Ps Ypd	cfm cfm/sf cfm/p cfm		0.73 2916 0.32 16.9 29%							
Detailed Calculations Initial Calculations for the Svstem as a whole											
Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system UncorrectedOA requirement for system Initial Calonialance for individual zones	Vps Vou Xs	cfm cfm	= VpdDs = Rps Ps + Ras As = Vou / Vps	= 10110 = 2116 = 0.21							
OA rate per unit area for zone OA rate per person	Raz Rpz	cfm/sf cfm/p			0.12 10.00	0.12 10.00	0.06	0.12	0.06	0.18 7.50	0.06 5.00
Total supply air to zone (at condition being analyzed) Unused OA read to breathing zone	Vdz Vb7	cfm cfm	= Rnz Pz + Raz Az	n	800 386 8	800 386 8	125 9.3	11 0	50	165 47 1	50 2.5
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	Ш	387	387	9	12 8	τρ 6	47	2
rraction of zone supply not already rearce, from zone Fraction of zone supply from fully mixed primary air	га Fb		= Ep + (1-Ep)Er = Ep	11 11	1.00	1.00	1.00	0.1 0.1	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone	Fc Zd		= 1-(1-Ez)(1-Ep)(1-Er) = Voz / Vdz	11 11	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in primary air to zone System Ventilation Efficiency	Zp		= Voz / Vpz	л	0.48	0.48	0.07	0.15	0.11	0.29	0.05
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	11	0.73	0.73	1.14	1.06	1.10	0.92	1.16
system vertiliation Emiciency (App A Method) Ventilation System Efficiency (Table 6.3 Method)	<u>ы</u> П		 min (EVZ) Value from Table 6.3 	= 0.67							
Minimum outdoor air intake airflow Orithdoor Air Intake Flow required to System	Vot	cfm	= Vour/Ev	= 2916							
OA intake req'd as a fraction of primary SA		ļ	= Vot / Vps	= 0.29							
Outdoor Air Intake Flow required to System (Table 6.3 Method) OA intake req'd as a fraction of primary SA (Table 6.3 Method)	√ vot	cţm	= Vou/Ev = Vot/Vps	= 3175 = 0.31							
<mark>OA Temp at which Min OA provides all cooling</mark> OAT helow which OA Intake flow is @ minimum		Ded F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr1	= 13							
			The work of the state of the	5							

Building: System Tag/Name: Decommentary Consultion Decontrition -	RTHP-B1	Aiddle S	chool Mode								
Uperating condition description. Units (select from pull-down list)	IP Uccupied O		2001AI 1								
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA redd per unit area for system (Weighted average) OA redd per person for system area (Weighted average) inputs for Potentially Critical zones	<u>Name</u> As As Sf Ps P Vpsd cfm Ras cfm Rps cfm	b st	100% diversity	System 9220 172 10,110 8.0						Potentially C	ritical Zones
Zone Name	Zone title tur	iuniu su	a italic for critical zona(s)		Instrument	Band	Corridor	Office space	Office space	Lobby	Library
Zone Tag					B214C	B214	B204	B211A	B205A	A230	A232
Space type	Sele	ect from	pull-down list		Office space	Music/theater/ dance	Corridors	Office space	Office space	Main entry Iobbies	Libraries
Floor Area of zone	Az sf				80	1246	500	86	85	2060	1020
Design population of zone Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Pz P Vdzd cfm Sela	(de ect from	fault value listed; may be ove pull-down list or leave blank	erridden) if N/A	0.4	43.61 1360	0 450	0.43	0.425	20.6 1840	10.2 2200
Local rectrol air % representative of ave system return air inputs for Oberating Condition Analyzed	Ľ.										
Percent of total design airflow rate at conditioned analyzed	Ds %			100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed	Sele F7	ect from	pull-down list		CS 1 00	CS 1 nn	CS 1 00	CS 1 00	CS 1 00	CS 1 00	CS 1 00
Primary air fraction of supply air at conditioned analyzed	E t				00-1	001	00.1	00.1	00	001	00.1
Results	į			01.0							
Venulation System Emclency Outdoor air intake required for system	Vot ofm			2916							
Outdoor air mane required to system Outdoor air per unit floor area	Vot/As cfm	'sf		0.32							
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Vot/Ps cfm Ypd cfm	ģ		16.9 29%							
Detailed Calculations											
Initial Calculations for the System as a whole Dismon concernation of Parate content of accelerate	Vinc Am	1	MadDe	- 40440							
UncorrectedOA requirement for system	Vou cfm	1 11	kpuus Rps Ps + Ras As	= 2116							
Uncorrected OA regid as a fraction of primary SA	Xs	п	Vou / Vps	= 0.21							
Initial Calculations for individual 20nes	Raz cfm	'sf			0.06	0.06	0.06	0.06	0.06	0.06	0 12
OA rate per person	Rpz cfm	i d			5.00	10.00	00.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz cfm	1	Da- D D A-	1	60	1360	450	100	100	1840	2200
Unused OA requirement for zone	Voz cfm	1 11	Vbz/Ez	1 11	0.0	511	30.00	5 	ч г- -	227	173
Fraction of zone supply not directly recirc. from zone	Fa	Ш	Ep + (1-Ep)Er	11	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	£ ú	11 1	Ep 4 /1 E=2/1 En V1 E-1	11 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not alrectly recirc. Itom zone Unused OA fraction required in supply air to zone	7d 7d	1 11	1-(1-EZ/(1-EP/) 1-E1/ Voz / Vdz	1 11	0.11	0.38	0.17	0.07	0.07	0.12	0.08
Unused OA fraction required in primary air to zone	Zp	н	Voz / Vpz	11	0.11	0.38	0.07	0.07	0.07	0.12	0.08
System Ventilation Efficiency	ţ	1	IEA 1 ENVA EAZA IEA	1	40	0.03	44 6	44 F	1 14	1 00	4 12
System Ventilation Efficiency (App A Method)	EV 2	1 11	min (Evz)	= 0.73	2.1	0.0	±	<u>+</u> -	<u>+</u>	80.T	2
Ventilation System Efficiency (Table 6.3 Method)	Ev	0	Value from Table 6.3	= 0.67							
<u>Minimum outdoor air intake airtiow</u> Outdoor Air Intake Flow required to Suctem	Viat ofm	1	Vour / Eu	- 2016							
OA intake req'd as a fraction of primary SA		1 11	Vot / Vps	= 0.29							
Outdoor Air Intake Flow required to System (Table 6.3 Method, On interior and an effortion of environment SA (Table 6.3 Method)	Vot cfm	11 4	Vou / Ev	= 3175							
OA Temp at which Min OA provides all cooling	-	1	VUL/ VIDS	2							
OAT below which OA Intake flow is @ minimum	Dec	н ц	{(Tp-dTsf)-(1-Y)*(Tr+dTr1	= 13							

Building: System Tag/Name: Operating Condition Description: Units (select from pull-down list)	Bentwo RTHP-E Occupie	rth Middl 31 ed Opera	e School tion Mode								
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA redd per unit area for system (Weighted average) OA redd per person for system area (Weighted average)	Name As Vpsd Ras Rps	Units sf cfm cfm/sf cfm/p	100% diversity	System 9220 177 10,111 0.08							
Zone Name	Zone Ht	la hurne nu	umla italic for critical zona(c)		Office space	Storage	Exam	Health	Cots	Corridor	File Room
Zone Tag	011 0110-7		felousz inovi o vol olimi ovdi		B203E	B203D	B203C	B203	B203A	B202D	B202B
Space type		Select fro	om pull-down list		Office space	Storage rooms	Office space	Office space	Office space	Corridors	Storage
Floor Area of zone	Az	sf			70	48	83	175	176	214	84
Design population of zone Design total supply to zone (primary plus local recirculated) Induction Temninal Unit, Dual Fan Duat Duct or Transfer Fan?	Pz Vdzd	P cfm Select fr	(default value listed; may be ove om pull-down list or leave blank i	'N/A	0.35	0 20	0.415	100	3 85	0 170	50
Local rectrc. air % representative of ave system return air	ц.										
Inputs for Uperating Condition Analyzed Percent of total design airflow rate at conditioned analyzed	Ds	%		1009	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed	Ez	Select fro	om pull-down list		CS 1.00	CS 1.00	CS 1.00	CS 1.00	CS 1.00	CS 1.00	CS 1.00
Primary-air fraction of supply air at conditioned analyzed	Еþ										
Results Venthlation System Efficiency Outdoor air intake required for system Outdoor air per unit floor area Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ev Vot Vot/As Vot/Ps Ypd	cfm cfm/sf cfm/p cfm		0.73 2916 0.32 16.9 29%							
<u>Detailed Calculations</u> Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system Uncorrected OA mord as a fraction of nimery SA	Vps Vou Xs	cfm cfm	= VpdDs = Rps Ps + Ras As = Voirt / Vns	= 1011(= 2116	0.00						
Initial Calculations for Individual zones	ę		3	1	-						
OA rate per unit area for zone OA rate per person	Rpz Rpz	ctm/st cfm/p			0.06 5.00	0.12 0.00	0.06 5.00	0.06 5.00	0.06 5.00	0.06 0.00	0.12 0.00
Total supply air to zone (at condition being analyzed)	ZbV ZbV	cfm ef	- Dot Dt 4 Dat At	Т	100	50 F o	50 7.4	100	85 75 6	170	40.4
Unused OA requirement for zone	Voz	ctm	= Vbz/Ez	1 11	0 0 0	0 0 0	L- 1	21	26	12.0	10.1
Fraction of zone supply not directly regire, from zone	60 4 10 4		= Ep + (1-Ep)Er - Es	11 1	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	с ч		- = = 1-(1-Ez)(1-Ep)(1-Er)	1 11	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd 7a		= Voz / Vdz	11 1	0.06	0.12	0.14	0.21	0.30	0.08	0.20
Onused OA naction required in primary all to zone System Ventilation Efficiency	7		747 / 2014 -	ī	00.0	71 'N		17:0	DC.D	on in	0.20
Zone Ventilation Efficiency (App A Method) Svstem Ventilation Efficiency (App A Method)	EVZ F		<pre>= (Fa + FbXs - FcZ) / Fa = min (Fvz)</pre>	= 0.73	1.15	1.09	1.07	1.00	0.91	1.13	1.01
Ventilation System Efficiency (Table 6.3 Method)	ШĂ		= Value from Table 6.3	= 0.67							
Minimum outdoor air intake airtiow Oritdoor Air Intake Flow required to System	Vot	cfm	= Voir/Ev	= 2916							
OA intake req'd as a fraction of primary SA	; • ≻		= Vot / Vps	= 0.25							
Outdoor Air Intake Flow required to System (Table 6.3 Method) OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Vot Y	cfm	= Vou / Ev = Vot / Vps	= 317 = 0.3	10 -						
OA Temp at which Min OA provides all cooling OAT halow which OA Inhate flow is ® minimum		Ded F	= {(Tr-dTsf)-(1-))*(Tr+dTr	-	~						
	L	- 55	in a state of the second state	10							

											200
Building System 7	j: TagName: 	RTHP-	B1 Midd	le Sch	00						
Uperatin Units (se	rg Condition Description: elect from pull-down list)	Uccup IP	lea Upera		90 0						2
Inputs fo	or System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate OA redd per unit area for system (Weighted average) OA redd per person for system area (Weighted average)	Name As Ps Vpsd Ras Rps	Units sf cfm/sf cfm/sf		100% diversity	Syster 92 10,1 01 8	2 8 9 3 8				
Inputs fc	or Potentially Critical zones Zone Name	Zone th	te turns pu	imple its	alle for critical zone(s)		Work Room	Office	Office	Conference	Reception
	Zone Tag Snars tune		1000				B202A Office space	B202G Office space	B202F Office space (B202E Conference/m	B201 Reception
	Floor Area of zone	AZ	Select fr sf	Ind mo	l-down list		140	223	182	eeting 213	areas 500
	Design population of zone Design total supply to zone (primary plus local recirculated) Induction Teminal Unit Vouel Fan Dual Duct or Transfer Fan?	Pz Vdzd	P cfm Select fr	(defau om pull	It value listed; may be ove I-down list or leave blank ii	f N/A	100	1.115 250	0.91	330	15 400
Inputs fo	or Operating Condition Andream and the second	Ds	%			100	100%	100%	100%	100%	100%
	Air distribution type at condition due and/cardinal and/cardinal Zone air distribution effectiveness at conditioned analyzed Primary ar franchion of supply airs i conditioned analyzed	EZ	Select fr	Ind mo	I-down list		1.00	1.00	1.00	1.00	1.00
Results	a national framework of the second of the second										
	Ventilation System Efficiency Outdoor air intake required for system Outdoor air per unit floor area Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ev Vot Vot/As Vot/Ps Ypd	cfm cfm/sf cfm/p cfm			0.7 291 16. 29	6050%				
<u>Detailed</u> Initial Ca	<u>Calculations</u> siculations for the System as a whole										
	Primary supply air flow to system at conditioned analyzed UncorrectedOA requirement for system and SA Uncorrected OA read as a fraction of primary SA	vps Vou Xs	ctm ctm	> (x > 	'pdUs ?ps Ps + Ras As 'ou / Vps	= 101 = 21	10 16 21				
Initial Ca	alculations for individual zones OA rate per unit area for zone	Raz	cfm/sf				0.06	0.06	0.06	0.06	0.06
	OA rate per person Total supply air to zone (at condition heing analyzed)	Rpz Vd7	cfm/p				5:00	5:00	5:00	5.00 330	5.00
	Unused OA req'd to breathing zone	ZdV	cfm	11	tpz Pz + Raz Az	11	11.9	19.0	15.5	66.0	105.0
	Unused OA requirement for zone Fraction of zone supply not directly regire, from zone	Voz Fa	cfm	>Ш 	(bz/Ez ip + (1-Ep)Er	11 11	1.00	19	15 1.00	1.00 1.00	105 1.00
	Fraction of zone supply from fully mixed primary air	Fb		Ш	<u>, 0</u>	11	1.00	1.00	1.00	1.00	1.00
	Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone	Fc		>	-(1-Ez)(1-Ep)(1-Er) 'oz / Vdz	11 11	0.12	1.00	1.00 0.06	1.00 0.20	1.00 0.26
Svstem \	Unused OA fraction required in primary air to zone Ventilation Efficiency	Zp			zd/ / zo	11	0.12	0.08	0.06	0.20	0.26
	Zone Ventilation Efficiency (App A Method) Sortem Voortilation Efficiency (App A Mathod)	Evz Evz			Fa + FbXs - FcZ) / Fa	F C	1.09	1.13	1.15	1.01	0.95
	Ventilation System Efficiency (Table 6.3 Method)	Ш			alue from Table 6.3	= 0.6	2				
Minimun	n outdoor air intake airflow Outdoor Air Intake Flow required to Svstem	Vot	cfm		'ou / Ev	= 29	16				
	OA intake req'd as a fraction of primary SA	7		=	ot / Vps	= 0.	59				
	Outdoor Air Intake Flow required to System (Table 5.3 Method) OA intake reqid as a fraction of primary SA (Table 6.3 Method)	vot ≺	Ę		ou / EV ot / Vps		31				
<u>OA lem</u>	p at which min UA provides all cooling OAT below which OA Intake flow is @ minimum		Deg F	=	Tp-dTsf)-(1-Y)*(Tr+dTrt	н	13				

Building: Sustem Tar/Name:	Bentwo	rth Middl	e School				
Operating Condition Description:	Occupie	ed Opera	tion Mode				
Units (select from pull-down list)	٩						
Inputs for System	Name	Units		System	_		
Floor area served by system	As	sf		4059			
Population of area served by system (including diversity)	Å	۵.	1 00% diversity	219			
Design primary supply fan airflow rate	VpsdV	cfm		5,600			
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.18			
OA red'd per person for system area (Weighted average)	Rps	cfm/p		7.5			
Inputs for Potentially Critical zones					Poten	tially Critical Zo	ones
Zone Name	Zone titl	e turns pu	urple italic for critical zone(s)		Cafeteria	Kitchen	Office
Zone Tag					B219	B232	B230
Concert time					Cafeteria/fast-	Cafeteria/fast-	Office space
ohare rype		Select fro	om pull-down list		food dining	food dining	
Floor Area of zone	Az	sf			2,090	1800	169
Design population of zone	PA DA	а.	(default value listed: may be	overridden)	209	ດ	0.845
Design total supply to zone (mimary blus local recirculated)	Vdzd	cfm			4 000	1500	100
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select fro	om pull-down list or leave bla	ank if N/A			
Local recirc. air % representative of ave system return air	ш				6		
Inputs for Operating Condition Analyzed							
Percent of total design airflow rate at conditioned analyzed	Š	%		100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select fro	om pull-down list		S	S	SS
Zone air distribution effectiveness at conditioned analyzed	Å				1 00	1 00	1 00
Primary air fraction of supply air at conditioned analyzed	р Ш						
Results							
Ventilation System Efficiency	Ъ			0.93			
Outdoor air intake required for system	Vot	chu		2517			
Outdoor air nar unit floor area	Vint/Ac	cfinitef		0.62			
Outdoor of your period area		official of		11 5			
Outdoor air per person served by system (including diversity)	SHOON	cimp					
Outdoor air as a % of design primary supply air	pdi	cm		VC+			
Detailed Calandations							
luitial Calculations for the Cristam as a whole							
Dimute Concuration 101 mic System as a winor Dimonstrational analysis	1400	- Here		- 5600			
Filmary supply all now to system at containance anaryzed TheorrectedOA requirement for system	vps Nou	Li Li	= Pric Do 4 Pac Ac	- 2350			
Uncorrected OA reach as a fraction of brimany SA	Ye	5	= \/oi! (\/oc				
Diffiel Calculations for individual zones	ę			1			
	Raz	cfm/cf			0 1R	0 1R	0.06
Of nate per ann and an and		chindro			7 50	7 ED	5.00 F. 00
Total supplication (at condition being analyzed)	742	cimp cfm			4000	1500	0.0
Initsed Oå red'd to breathing zone	-4/	cfm	= Rnz Dz + Raz Az	II	1943 7	301 5	14.4
Intered OA requirement for zone	702	, mi	= Vhz/Fz	11	1944	392	14
Fraction of zone supply not directly recirc from zone	ц е		= En + (1-En)Er	IJ	1 00	00	1 00
Fraction of zone supply from fully mixed brimary air	: £			11	100	001	1 00
Fraction of zone OA not directly recirc from zone	ц		= 1-(1-E>)(1-En)(1-En)	11	100	001	1 00
Unused OA fraction required in supply air to zone	2q		= Voz / Vdz	11	0.49	0.26	0.14
Unused OA fraction required in primary air to zone	Zp		= \\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	H	0.49	0.26	0.14
System Ventilation Efficiency	ł				2	2	
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	11	0.93	1.16	1.28
Svstem Ventilation Efficiency (App A Method)			= min (Evz)	= 0.93			
Ventilation System Efficiency (Table 6.3 Method)	Ъ		= Value from Table 6.3	= 0.66			
Minimum outdoor air intake airflow							
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 2517			
OA intake req'd as a fraction of primary SA	≻		= Vot / Vps	= 0.45			
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 3538			
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	۲		= Vot / Vps	= 0.63			
OA Temp at which Min OA provides all cooling		נ נ	T - TAAAA 12 A TI - TAA				
OAT below which UA Intake flow is @ minimum		Deg F	= {(ib-aist)-('i-1')	रू = ==			

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Building: Svetem TadName:	Dentw.	orth Middl B3	School				
or sector restriction: Units Generating Condition Description: Units Generation pull-down list)	Occup	ied Opera	ion Mode				
							ñ
Inputs for System	Name	Units			System		
Floor area served by system	A C	o م		V all south 1	1,048		
Population of area served by system (including diversity)		L 4	5 NO1	voluivei suy	100		
Design primary supply ran annow rate	nsd v	E E			2,101		
OA req'd per unit area for system (Weighted average)	Ser (ctm/st			10. U		
OA req'd per person for system area (Weighted average)	sdr	ctm/p			10.1	: : : :	
Inputs for Potentially Critical zones				100 miles 100 mi		Potentially Critical Lones	Ξr
Zone Name	Zone th	tie turns pu	typle Italic for (critical zone(s)		Stage new zone	-
Zone Tag						enter tag New zone ID	
Snace type						Stages, Restaurant	
Opace type		Select fro	im pull-down l	ist		studios dining rooms	
Floor Area of zone	Az	গ				1,548	
Design population of zone	Рд	م	default value	listed; may be ov	erridden)	108.36	0
Design total supply to zone (primary plus local recirculated	Vdzd	cfm				2.100	-
Induction Terminal Unit, Dual Fan Dual Duct or Transfer F.	n?	Select fro	I myob-llud mi	list or leave blank	if N/A		
Local recirc. air % representative of ave system return air	Ъ						-
Inputs for Operating Condition Analyzed							1
Percent of total design airflow rate at conditioned analyzer	Ds	%			100%	100% 100%	
A indication type of conditioned analysis	1	Soloct fre	I among this and	+0;			
An unstribution type at containoned analyzed Zono di distribution officiali providitioned analyzed	Ľ	כמוברו ווו	I IIMOD-IIDd IIII	101			
20ne air distribution effectiveness at conditioned analyzed	μ					1.00.1	-
Frimary air fraction of supply air at conditioned analyzed	D L						-
Results	ļ						
Ventilation System Efficiency	Ъ				1.00		
Outdoor air intake required for system	Vot	dm			1176		
Outdoor air per unit floor area	VotAs	cfm/sf			0.76		
Outdoor air per person served by system (including divers)	v) Vnt/Ps	cfm/n			10.9		
Outdoor air as a % of design primary supply air	Ynd	du 1			56%		
Detailed Palculatione							P
Detailed Calculations							
			<u>(</u>		040		
Frimary supply air now to system at conditioned analyzed	s d >	E,	- vpans	ſ			
UncorrectedOA requirement for system	Nov	đ	+ SH SqH =	- Kas As	11 VI L		
Uncorrected OA reg'd as a fraction of primary SA	Xs		d//no/ =	S	= 0.5		
Initial Calculations for individual zones							
OA rate per unit area for zone	Raz	cfm/sf				0.06 0.18	œ.
OA rate per person	Kpz	ctm/p				10.00 7.50	-
Total supply air to zone (at condition being analyzed)	ZbV	ofm				2100 0	-
Unused OA reg'd to breathing zone	Vbz	đm	= Rpz Pz +	- Raz Az	11	1178.5 0.0	-
Unused OA requirement for zone	Voz	đm	= Vbz/Ez		11	1176 0	m.
Fraction of zone supply not directly recirc. from zone	Ба		= Ep + (1-E	Ep)Er	11	1.00 1.00	-
Fraction of zone supply from fully mixed primary air	Бb		= Ep		u	1.00 1.00	0
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	11	1.00 1.00	-
Unused OA fraction required in supply air to zone	Zd		$= V_0 z / V d$	Z	н	0.56 0.00	-
Unused OA fraction required in primary air to zone	Zn		= Voz/Vo:	2	11	0.56 0.00	-
System Ventilation Efficiency	-		-				
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + Fb)	Xs - FcZ) / Fa	11	1.00 1.56	100
System Ventilation Efficiency (App A Method)	Д		= min (Evz	1	= 1.00		
Ventilation System Efficiency (Table 6.3 Method)	Щ		= Value fro	m Table 6.3	= n/		
<u>Minimum outdoor air intake airflow</u>							
Outdoor Air Intake Flow required to System	Vot	đm	= Vou/Ev		= 1170		
OA intake regid as a fraction of primary SA	Υ		= Vot/Vps	(0)	= 0.50		
Outdoor Air Intake Flow required to System (Table 6.3 Met	Tod) Vot	đ	= Vou/EV		1		
OA milake requias a nacuon of primary OA (nacie ola mer Ob Tamm at which Min Ob myouides all continue	1 (00)		- vuu vhs		-		
OAT helnw which OA Intake flow is @ minimum		Deg F	= {(Tp-dTs	f)-(1-Y)*(Tr+dTr	п 4		
		0		11111			I.

	1						1
Building: System Tag/Name:	Bentwo RTHP-E	rth Middl	e School				
Operating Condition Description: Units (select from pull-down list)	Occupi	ed Operat	ion Mode				l
Inputs for System Floor area served by system Population of area served by system (including diversity) Design primary supply fan airflow rate Design primary supply fan airflow rate OA red'd per unit area for system area (Weighted average) OA red'd per person for system area (Weighted average) DA red'd per person for system area (Weighted average) Cone Name Zone Name Zone Name Zone Name Space type Floor Area of zone Design population of zone Design population of zone Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	Name As As Ps Vpsd Rps Zone tit Pz Vdzd	Linits Marks dm/p e turms pu belect fro Select fro Select fro Select fro	100 ⁻ 100 ⁻ 10	io diversity oritical zone(s) listed, may be ove listed reave blank	System 6.809 10 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 10000 100000 100000 100000 1000000000000000000000000000000000000	Potentially Critical Zones Gym Floor Bleachers Gym Floor Gym, stadium Stadium Stadium Stadium Stadium Stadium Stadium Span="2">Stadium Stadium Span="2">Stadium Span="2">Stadium <th>000</th>	000
Inputs for Operating Condition Analyzed Percent of total design airflow rate at conditioned analyzed Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	EZ DS	% Select fro	m pull-down	list	100%	100% 100 CS (0	SO OS
Results Ventilation System Efficiency Outdoor air intake required for system Outdoor air per unit floor area Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ev Vot VotAs VotPs Ypd	dm dm/s dm/p			0.95 3751 0.55 9.1 38%		8
Detailed Calculations Initial Calculations for the System as a whole Primary supply air flow to system at conditioned analyzed Uncorrected OA requirement for system Uncorrected OA requirement for system Uncorrected OA requirement for system OA rate per unit area for zone OA rate per unit area for zone Durused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone OA not directly recirc. from zone Intered OA fraction record on A rate for a conducted in entry.	V Vou K Kaz V Vbz V Vbz F F F F F F F F F F F F F F F F F F F	dfm dfm dfm dfm	= VpdDs = RpsPs+ = Vou/Vp = RpzPz+ = Vou/Vp = 1-(1-fz)	- Ras As s Raz Az ep)Er - T-Ep)(1-Er)	10000 3561 10.36 1351 10.38	0.30 0.30 0.00 0.00 1527.9 1528 1528 1528 1.00 1.10 1.00 1.10 1.00 1.10 1.00 1.10	
Unused OA fraction required in primary air to zone System Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	Zp Evz Evz		= Voz/Vp = (Fa + Fb = min (Evz	z Xs - FcZ) / Fa)		0.31 0.	.95
Ventuation System Enterency (Lable 6.3 Method) Winimum outdoor air intake airNow Outdoor Air Intake Flow required to System Oat intake red as a fraction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method OA intake red'd as a fraction of primary SA (Table 6.3 Method OA intake red'd as a fraction of primary SA (Table 6.3 Method OA Tenp at which Min OA provides all cooling OAT below which OA Intake flow is @ minimum	rvot ≺ vot	cfm Ceg F	= Value fro = Vou / Ev = Vou / Ev = Vou / Ev = Vot / Vps = (Tp-dTs	іт Table 6.3 в 0-(1-Y)*(Tr+dTrt	= 0.44 = 3751 = 4781 = 0.48 = 0.48		