Technical Report 1: ASHRAE Standards 62.1 and 90.1 Analysis

Berks Classroom and Lab Building - Berks Campus Reading, PA

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1. Executive Summary

This report was used to analyze the compliance of The Berks Classroom and Lab Building with ASHRAE Standards 62.1 and 90.1.

ASHRAE Standard 62.1 focuses on indoor air quality for buildings; the analysis for the standard was done only on the three roof top units. After analyzing the building it was found that the building is compliant with this standard.

ASHRAE Standard 90.1 sets an energy standard for buildings except low-rise residential buildings. The building is almost completely compliant with this standard the two anomalies being the glazing and the slab on grade.

2. Introduction

Burks Classroom and Lab Building is located on Penn State's Burks Campus, located near Reading, Pennsylvania in Berks County. Penn State Burks sits among rolling hill and tree-lined pathways. The campus has a rich history, considering it was not always part of the Penn State system. The campus started as Wyomissing Polytechnic Institute (WPI) and became part of the Penn State System in 1958. In 1972 it moved to the Spring Township location and added residence halls in 1990. Even though there is rich history with the campus Penn State did not have to follow any historical requirements.

Burks Classroom and Lab Building is 62,188 square feet with all three levels above ground the occupancy for the building is designated as Group B – Business. The building was started in April 2010 and is scheduled to be completed in either August or September of 2011. The delivery method was design-bid-build. As with the new buildings at Penn State, Burks Classroom and Lab Building is designed using LEED certification and after completion is anticipated to achieve a LEED Silver rating under LEED 2.2.

The design team is as follows:

Owner: The Pennsylvania State University Berks Campus

General Contractor: Alvin H Butz, Inc.

Construction Cost Estimator: Becker & Frondorf

Building Architect: RMJM Hiller

Engineers:

Structural: Greenman-Pedersen, Inc.

MEP: H.F. Lenz Company

Civil: Gannett Fleming Engineers

Lighting Consultant: Illumination Arts, LLC

Acoustical Consultant: Shen Milsom Wilke, Inc.

They used multiple codes in the design of Burks Classroom and Lab Building; the codes are mostly 2006 with one exception being 2003. The code are as follows: International Building Code, International Mechanical Code, International Plumbing Code, International Energy Conservation Code, International Code Council Electrical Code, International Fire Code, and Accessibility Code ICC/ANSI 117.1 2003. There were some zoning requirements which included a Land Development Permit (LDP) from Springs Township and an NPDES permit was required from Burks County Conservation District (BCCD).

The building façade of the first floor is consists of two different types of façade, the first and closest to grade are Architectural precast concrete panels backed with an airspace rigid insulation air space and finally a masonry wall. The second part of the first floor façade has an aluminum curtain wall system in place of the architectural precast concrete panels, the two airspaces and rigid insulation. Above the first floor the façade changes again to have an exterior finish of terracotta rain screen backed by rigid insulation backed by cold formed metal framing (CMFM).

The roof system consists of metal decking covered by rigid composite insulation and a Kee membrane. KEE stands for ketone ethylene ester and is gaining popularity in Southern California because of its great waterproofing protection and lightweight design. The KEE membrane is a single-ply, lightweight vinyl and is extremely easy to install. The install for most types of the KEE membrane requires the contractors to use a simple hot air bonding technique; this creates a seamless molecular bond between each sheet of the membrane. This makes the membrane easy to repair and remains highly flexible with age, making it easy to uncover the substructure for repairs if needed.

Considering the Burks Classroom and Lab Building is designed to achieve a LEED Silver rating at completion. The building utilizes a gray water system; this system is designed to supply the restrooms within the building with water for their water closets and urinals. Other things considered for LEED rating was using materials that are made within a 500 mile radius from the site.

System Description

The building utilizes a VAV system that has an air side and hydronic side to it.

AIR SIDE:

On the air side there are three roof top air handling units (AHUs) that range from 26 tons to 70 tons.

HYDRONIC SIDE:

The water side consists of two gas fired boilers with a 6.2 gallon capacity and an output of 850 MBH. The building utilizes four Split system air conditioning units with rated capacities of either 1 or 1.5 tons. There are supplemental heaters located in two vestibules, two corridors and a stair well to help regulate the temperature of these spaces.

ZONE CONDITIONING:

The spaces are supplied air from Variable Air Volume Boxes (VAV Boxes). The server room is served by a computer room air conditioning unit (CRAC).

3. Standard 62.1 Analysis

3.1. Section 5

Section 5.1 – Natural Ventilation

The windows are not operational for this building, therefore this is not a valid means of ventilation.

Section 5.2 – Ventilation Air Distribution

All spaces are supplied air by ducts. According to documentation the system will be balanced prior to occupation.

Section 5.3 – Exhaust Duct Location

Exhaust ducts run up the building through similar spaces. At the exterior, the exhaust is not near any intakes.

Section 5.4 – Ventilation System Controls

The HVAC system is controlled by either Automated Logic Corporation or Johnson Controls Inc. control system.

Section 5.5 – Airstream Surfaces

The mineral-fiber board thermal insulation is designed to comply with ASTM C 612 type IB and the mineral-fiber blanked thermal insulation is designed to comply with ASTM C 553 type III since neither incorporate ASTM C 1338 this is not compliant.,

Section 5.6 – Out Door Air Intakes

All intakes are more than the minimum distance from the exhaust fans and exhaust air from the building.

Section 5.7 – Local Capture of Contaminates

The café and the kitchen lab on the first floor have ducted exhausts to the lower roof above the second floor.

Section 5.8 – Combustion Air

The kitchen lab and café have supply ducts that supply air very close to above the cooking surfaces.

Section 5.9 – Particulate Matter Removal

The roof top AHUs have two filters, the first filter is a pre-filter with a minimum efficiency reporting value or MERV of 7 and the final filter has a MERV of 13 since both are above the required MERV of 6 the AHUs are compliant. The computer room air conditioner and the split system air conditioning units do not have filter data listed, and therefore is hard to judge the compliance of these systems.

Section 5.10 – Dehumidification Systems

The AHU systems are compliant. This is a combination of the excess exhaust is made up by the supplemental systems located in the building and some of the lab spaces are negatively pressured.

Section 5.11 – Drain Pans

The roof top units are placed on the roof above slope to roof top drains.

Section 5.12 – Finned-Tube Coils and Heat Exchangers

Since only the three roof top units were analyzed in this report, the roof top units are place over roof top drains. this section is compliant.

Section 5.13 – Humidifiers and Water-Spray Systems

This section does not apply.

Section 5.14 – Access for Inspection, Cleaning and Maintenance

The Roof top AHUs have at minimum 48 inches around them to allow for inspection, cleaning and maintenance work to be done. Equipment located in the ceiling cavity is located above removable acoustic ceiling panels to provide access for any inspection, cleaning or maintenance required.

Section 5.15 – Building Envelope and Interior Surfaces

The building has a terra cotta rain screen that protects the exterior vertical surfaces from rain penetration and is backed by an air space to drain any rain that gets through. The roof is comprised of a Kee membrane system that keeps moisture from entering the roof structure.

Section 5.16 – Buildings with Attached Parking

This section does not apply to this building.

Section 5.17 – Air Classification and Recirculation

The air from the kitchen hoods are is not recalculated to the general building spaces.

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

This section does not apply; the building is a smoke-free building.

3.2. SECTION 6

For the purpose of section 6 analysis only the three roof top units (RTU) will be used.

Section 6.2.2.1 – Breathing Zone Outdoor Airflow (equation 6-1)

$V_{bz}=R_p*P_z + R_a*A_z$

Where

A_z = zone floor area: the net occupiable floor area of the zone in m2 (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 fluctuates, P_z may be estimated based on averaging approaches described in Section 6.2.6.2

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

Section 6.2.2.2 – Zone Air Distribution Effectiveness (Table 6-2)

$E_z = 1$

Section 6.2.2.3 – Zone Outdoor Airflow

$V_{oz} = V_{bz}/E_z$

Section 6.2.5.1 – Primary Outdoor Air Fraction

$Z_p = V_{oz}/V_{pz}$

Where

V_{pz} is the zone primary airflow

Section 6.2.5.2 – System Ventilation Efficiency

E_v from Table 6-3

Section 6.2.5.3 – Uncorrected Outdoor Air Intake

$V_{ou} = DS_{all\ zones}(R_p*P_z) + S_{all\ zones}(R_a*A_z)$

$D = P_s/S_{all\ zones}P_z$

Section 6.2.5.4 – Outdoor Air Intake

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

4. Standard 62.1 Findings

The Berks Classroom and Lab Building is compliant with section 5 of 62.1 per the analysis above. Per the analysis of Section 6 above for the three roof top AHUs the Berks Classroom and Lab Building is compliant with the standard. Please refer to Appendix for the supporting calculations.

5. Standard 90.1 Analysis

5.1. Section 5 – Building Envelope

Reading, PA is located in Berks County which by using both ASHRAE Figure B-1 and Table B-1 is in climate zone 5-A. This is consistent with most of the state. Being in climate 5-A there are some requirements that must be followed, see Table 1 for the opaque elements and Table 2 for the fenestration elements, information is from Table 5.5-5 in ASHRAE standard 90.1.

Opaque Elements	Assembly Maximum	Insulation Min R-Value
Roof: Insulation above Deck	U-0.048	R-20 c.i.
Walls, Above Grade: Steel Framed	U-0.064	R-13.0 + R-7.5 c.i.
Floors:		
Slab on Grade: Unheated	F-0.730	NR
Slab on Grade: Heated	F-0.860	R-15 for 24in
Opaque Doors: Swinging	U-0.700	-

TABLE 1. OPAQUE ELEMENTS REQUIREMENTS

Fenestration	Assembly Max U	Assembly Max SHGC
Vertical Glazing: Metal Framing (Curtainwall/Storefront)	U-0.45	0.40
Vertical Glazing: Metal Framing (Entrance Door)	U-0.80	0.40
Vertical Glazing: Metal Framing (All Other)	U-0.55	0.40
Vertical Glazing: Non-metal Framing (All)	U-0.34	0.40

TABLE 2 FENESTRATION REQUIREMENTS

Using the tables in appendix A of ASHRAE Standard 90.1 the values in Table 3 were obtained. Some assumptions were made in completing Table 3 and include a slight estimation of the thickness of materials and can affect the R-value for some materials. This was only done when a thickness was not indicated on the drawings and there is a slight difference from paper drawings to electronic pdf drawings.

Exterior Element	R-Value / max SHGC	U-Value for system	Compliant
Roof	R-20 insulation	U-0.060	U- Value compliant R-Value compliant
Walls	R-12.5 Terra Cotta R-15 Insulation	U-0.147 for walls	U-Value Walls is compliant
Glazing	0.30 SHGC	U- 0.19 for glazing	Not compliant
S.O.G.		U-5	

TABLE 3 U-VALUES OF EXTERIOR ELEMENTS COMPLIANCE

5.2. Section 6 – Heating, Ventilating, and Air Conditioning

According to the specifications the duct work is designed to meet ASHRAE Standard 90.1. The roof top AHRs are in two categories two of the three have a required minimum efficiency of 12.1 EER and the third has a required minimum efficiency of 11.3 EER. The two smaller units have designed EERs of 13.9 and 14.1 the largest unit has a designed EER of 12.5 making the equipment compliant.

5.3. Section 7 – Service Water Heating

The roof top units and VAV boxes are supplied hot water by two gas fired boilers the rest of the domestic hot water is supplied by electric water heaters.

5.4. Section 8 – Power

According to the drawings the building's electrical system is designed using the International Code Council Electrical Code 2006 but the specifications are referencing NFPA 70 which is also known as the National Electric Code. Since the NEC it states that feeder conductors should have a maximum voltage drop of 2% and a maximum branch circuits to have a maximum voltage drop of 3% at the design load condition, the building is compliant. In addition to the voltage drop requirements the working drawings should include floor plans as well as single line diagrams, the drawing set includes both and there for is compliant.

5.5. Section 9 – Lighting

The lighting for the Berks Classroom and Lab Building is controlled by occupancy sensors and therefore is compliant with the first part of this section. The second part of compliance is analyzed by the building area method described in Section 9.5 of Standard 90.1 and is summarized in Table 4. Assuming that the Berks Classroom and Lab Building is primarily offices for faculty members the Watts per square foot should be under 1.0 to see the calculation and the numbers see Table 4 below,.

Lighting Fixture	1st	2nd	3rd	W / fixture	total wattage
C	24	13	4	64	2624
D	8			64	512
E			9	64	576
LA	35	284	114	32	13856
LA-1	30			64	1920
LA-2	19	65	21	32	3360
LA-4	28			32	896
LA-6	14			32	448

LAA		2	13	85	1275
LB	102			32	3264
LB-1	60	59		32	3808
LC	12	20		64	2048
LC-1	6			32	192
LCC	4			4	16
LD	51	9	9	64	4416
LDD	1			32	32
LE	12	12	12	32	1152
LEE	2			50	100
LFF	4			50	200
LG		16		70	1120
LGG	3				0
LJ	2			64	128
LJ-3	2			64	128
LK	1	1		96	192
LK-1	1	13		64	896
LK-2	6	2	2	96	960
LK-3	9	12	4	32	800
LK-4		2		160	320
LK-5	3			64	192
LK-7	2	3	2	64	448
LK-8		1		32	32
LM			7	70	490
LN	9			8	72
LP	5	5	21	32	992
LP-1	10			64	640
LT	26			32	832
				Total	48937
				Building Area	62,188
				W/SF	0.79

TABLE 4 LIGHTING WATTAGE SUMMARY

Since the Wattage per square foot is 0.79 and it is less then both the office number of 1.0 and the school/university of 1.2 the building is compliant.

6. Standard 90.1 Findings

The Berks Classroom and Lab building is mostly compliant with Standard 90.1. There are two items that are not compliant and the both reside in the building envelope analysis section. The glazing and the slab on grade are not compliant with the standard.

7. APPENDIX A

	Name	Units	Formula	System	Learning Loft	Department Resource	Classroom	Classroom	Classroom	Classroom	Classroom
Building:	Berks Classroom and Lab Building										
System Tag/Name:	RTU-1										
Operating Condition Description:	Design Peak cooling										
Units (select from pull-down list)	IP										
Inputs for System											
Floor area served by system	As	sf		30217.5							
Population of area served by system (including diversity)	Ps	P	100% diversity	471							
Design primary supply fan airflow rate	Vpsd	cfm		30,500							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.07							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		6.3							
Inputs for Potentially Critical zones											
Zone Name			Zone title turns purple italic for critical zone(s)		Learning Loft	Department Resource	Classroom	Classroom	Classroom	Classroom	Classroom
Zone Tag					Q206	Q205	244	245	246	247	248
Space type		Select from pull-down list			Common corridors	Common corridors	Lecture classroom	Lecture classroom	Lecture classroom	Office space	Office space
Floor Area of zone	Az	sf			2496	420	1149.75	1152	1698	1932.25	1008.75
Design population of zone	Pz	P	(default value listed; may be overridden)		8	4	24	31	61	47	31
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			2,000	220	1200	1230	1600	1500	920
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A									
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list			CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.36							
Outdoor air intake required for system	Vot	cfm		14267							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.47							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		30.3							
Outdoor air as a % of design primary supply air	Ypd	cfm		70%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	20550							
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	5161							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.25							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			0.00	0.00	7.50	7.50	7.50	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			2000	220	1200	1230	1600	1500	920
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		149.8	25.2	249.0	301.6	555.8	314.9	215.2
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		150	25	249	302	556	315	215
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.07	0.11	0.21	0.25	0.35	0.21	0.23
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.07	0.11	0.21	0.25	0.35	0.21	0.23
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.18	1.14	1.04	1.01	0.90	1.04	1.02
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.36							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	n/a							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	14267							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.69							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	n/a							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	n/a							
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 =	48							

Building:	Berks Classroom and Lab Building										
System Tag/Name:	RTU-1										
Operating Condition Description:	Design Peak cooling										
Units (select from pull-down list)	IP										
Inputs for System	**Name**	**Units**		**System**							
Floor area served by system	As	sf		30217.5							
Population of area served by system (including diversity)	Ps	P	100% diversity	471							
Design primary supply fan airflow rate	Vpsd	cfm		20,600							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.07							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		6.3							
Inputs for Potentially Critical zones					Potentially Critical Zones						
Zone Name			*Zone title turns purple italic for critical zone(s)*		Connector	Graphics/MM Comp Lab	Learing Loft	Classroom	Classroom	Seminar Classroom	Bits & Bytes Cafe
Zone Tag					2	249	Q102	120	121	122	123
Space type			Select from pull-down list		Office space	Computer lab	Office space	Lecture classroom	Lecture classroom	Lecture hall (fixed seats)	Cafeteria/fast-food dining
Floor Area of zone	Az	sf				1022	2496	1054.5	774	436	640.5
Design population of zone	Pz	P	(default value listed; may be overridden)		0	25	12	31	61	21	21
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			420	820	929	1150	1750	530	1470
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er										
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
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Outdoor air as a % of design primary supply air	Ypd	cfm		70%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpsdDs =	20550							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As =	5101							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.25							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.12	0.06	0.06	0.06	0.06	0.18
OA rate per person	Rpz	cfm/p			5.00	10.00	5.00	7.50	7.50	7.50	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm			420	820	929	1150	1750	530	1470
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		0.0	372.6	209.8	295.8	503.9	186.7	272.8
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		0	373	210	296	504	187	273
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.00	0.45	0.23	0.26	0.29	0.32	0.19
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.00	0.45	0.23	0.26	0.29	0.32	0.19
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.25	0.80	1.02	0.99	0.96	0.93	1.06
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.36							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	n/a							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	14267							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.69							
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OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.07							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		6.3							
Inputs for Potentially Critical zones											
Zone Name			Zone title turns purple italic for critical zone(s)		*HRIM Lab Kitchen*	Lobby	Electrical Lab	Super/ Assistant	Equipment Storage	Engineering Automation	Electronics Lab
Zone Tag					123A	F102	116	115	115A	114	113
Space type			Select from pull-down list		Cafeteria/fast-food dining	Lobbies	Electrical equipment rooms	Office space	Storage rooms	Office space	Electrical equipment rooms
Floor Area of zone	Az	sf			868	768.5	1007.5	212.75	388.5	1116	852.5
Design population of zone	Pz	P	(default value listed; may be overridden)		10	0	10	1	0	29	10
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			260	520	780	120	150	920	800
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er										
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.36							
Outdoor air intake required for system	Vot	cfm		14267							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.47							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		30.3							
Outdoor air as a % of design primary supply air	Ypd	cfm		70%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	20550							
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	5161							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.25							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.18	0.06	0.06	0.06	0.12	0.06	0.06
OA rate per person	Rpz	cfm/p			7.50	5.00	0.00	5.00	0.00	5.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			260	520	780	120	150	920	800
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		231.2	61.1	60.5	17.8	46.6	212.0	51.2
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		231	61	60	18	47	212	51
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.89	0.12	0.08	0.15	0.31	0.23	0.06
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.89	0.12	0.08	0.15	0.31	0.23	0.06
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.36	1.13	1.17	1.10	0.94	1.02	1.19
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.36							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	n/a							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	14267							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.69							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	n/a							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	n/a							
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)}/Y =	48							

Building:	Berks Classroom and Lab Building							
System Tag/Name:	RTU-1							
Operating Condition Description:	Design Peak cooling							
Units (select from pull-down list)	IP							
Inputs for System	**Name**	**Units**				**System**		
Floor area served by system	As	sf				30217.5		
Population of area served by system (including diversity)	Ps	P		100% diversity		471		
Design primary supply fan airflow rate	Vpsd	cfm				20,500		
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.07		
OA req'd per person for system area (Weighted average)	Rps	cfm/p				6.3		
Inputs for Potentially Critical zones								
Zone Name		*Zone title turns purple italic for critical zone(s)*					Resource Center	Seminar Classroom
Zone Tag							111	112
Space type		Select from pull-down list					Office space	Lecture classroom
Floor Area of zone	Az	sf					475	589
Design population of zone	Pz	P		(default value listed; may be overridden)			8	17
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					540	700
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A						
Local recirc. air % representative of ave system return air	Er							
Inputs for Operating Condition Analyzed								
Percent of total design airflow rate at conditioned analyzed	Ds	%				100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list					CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep							
Results								
Ventilation System Efficiency	Ev					0.36		
Outdoor air intake required for system	Vot	cfm				14267		
Outdoor air per unit floor area	Vot/As	cfm/sf				0.47		
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				30.3		
Outdoor air as a % of design primary supply air	Ypd	cfm				70%		
Detailed Calculations								
Initial Calculations for the System as a whole								
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	20550		
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	5161		
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.25		
Initial Calculations for individual zones								
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06
OA rate per person	Rpz	cfm/p					5.00	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm					540	700
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		68.5	162.8
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		69	163
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.13	0.23
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.13	0.23
System Ventilation Efficiency								
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.12	1.02
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.36		
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	n/a		
Minimum outdoor air intake airflow								
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	14267		
OA intake req'd as a fraction of primary SA	Y		=	Vot/ Vps	=	0.69		
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	n/a		
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot/ Vps	=	n/a		
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	=	48		

Building:	Berks Classroom and Lab Building
System Tag/Name:	RTU-2
Operating Condition Description:	Design Peak Cooling
Units (select from pull-down list)	IP

Inputs for System	Name	Units			System
Floor area served by system	As	sf			[illegible]
Population of area served by system (including diversity)	Ps	P	100% diversity		212
Design primary supply fan airflow rate	Vpsd	cfm			12,810
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf			0.12
OA req'd per person for system area (Weighted average)	Rps	cfm/p			8.7

Inputs for Potentially Critical zones	Name	Units	Notes	Open Source Comp Lab	Lobby	Network Comp Lab	Server Room / IT Stor	Gen Purpose Comp Lab	Emerging Tech Lab	Corridor
Zone Name			Zone title turns purple italic for critical zone(s)	Open Source Comp Lab	Lobby	Network Comp Lab	Server Room / IT Stor	Gen Purpose Comp Lab	Emerging Tech Lab	Corridor
Zone Tag				300	F301	308	307 / 307A	304	306	C301
Space type			Select from pull-down list	Computer lab	Lobbies	Computer (not printing)	Computer lab	Computer lab	Computer (not printing)	Corridors
Floor Area of zone	Az	sf		963	877.5	962.5	433.5	1402.25	910	990
Design population of zone	Pz	P	(default value listed; may be overridden)	25	0	21	0	29	19	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm		820	220	840	320	1530	800	260
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A							
Local recirc. air % representative of ave system return air	Er			75%	75%	75%	75%	75%	75%	75%

Inputs for Operating Condition Analyzed	Name	Units	Notes	System	Open Source Comp Lab	Lobby	Network Comp Lab	Server Room / IT Stor	Gen Purpose Comp Lab	Emerging Tech Lab	Corridor
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.30	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										

Results	Name	Units	System
Ventilation System Efficiency	Ev		0.81
Outdoor air intake required for system	Vot	cfm	4483
Outdoor air per unit floor area	Vot/As	cfm/sf	0.31
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p	21.1
Outdoor air as a % of design primary supply air	Ypd	cfm	35%

Detailed Calculations	Name	Units	Formula	System	Open Source Comp Lab	Lobby	Network Comp Lab	Server Room / IT Stor	Gen Purpose Comp Lab	Emerging Tech Lab	Corridor
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	= 12810							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 3690							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.28							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.12	0.06	0.06	0.12	0.12	0.06	0.06
OA rate per person	Rpz	cfm/p			10.00	5.00	5.00	10.00	10.00	5.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			820	220	840	320	1530	800	260
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	365.5	52.7	162.8	52.7	458.3	149.6	59.4
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	366	53	163	53	458	150	59
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.45	0.26	0.19	0.16	0.30	0.19	0.23
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.45	0.26	0.19	0.16	0.30	0.19	0.23
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=	0.84	1.02	1.09	1.12	0.99	1.10	1.06
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.81							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.63							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 4483							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.35							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 5874							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.42							
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	= 23							

	Name	Units		System							
Building:	Berts Classroom and Lab Building										
System Tag/Name:	RTU-2										
Operating Condition Description:	Design Peak Cooling										
Units (select from pull-down list)	IP										
Inputs for System	**Name**	**Units**		**System**							
Floor area served by system	As	sf		14566.48							
Population of area served by system (including diversity)	Ps	P	100% diversity	212							
Design primary supply fan airflow rate	Vpsd	cfm		12,310							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.12							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		8.7							
Inputs for Potentially Critical zones					**Potentially Critical Zones**						
Zone Name			*Zone title turns purple italic for critical zone(s)*		Super / Assistance Office	Lobby	Prototype Lab	Receiving / Storage	Design Lab	*Projects Lab*	Research Lab
Zone Tag					107	F103	108	109 / 109A	103	106	104
Space type		Select from pull-down list			Office space	Lobbies	University/college laboratories	Shipping/receiving	University/college laboratories	University/college laboratories	University/college laboratories
Floor Area of zone	Az	sf			150	466	1865	574	998.875	1226.1	706
Design population of zone	Pz	P	(default value listed; may be overridden)		2	0	20	0	25	25	8
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			70	200	1750	420	1000	1000	690
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A									
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		100%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list			CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.81							
Outdoor air intake required for system	Vot	cfm		4483							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.31							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		21.1							
Outdoor air as a % of design primary supply air	Ypd	cfm		36%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpsdDs =	12310							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As =	3550							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.29							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.18	0.12	0.18	0.18	0.18
OA rate per person	Rpz	cfm/p			5.00	5.00	10.00	0.00	10.00	10.00	10.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			70	200	1750	420	1000	1000	690
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		19.0	27.4	535.7	68.9	429.8	470.7	206.5
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		19	27	536	69	430	471	207
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.27	0.14	0.31	0.16	0.43	0.47	0.30
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.27	0.14	0.31	0.16	0.43	0.47	0.30
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.01	1.15	0.98	1.12	0.86	0.81	0.99
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.81							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.68							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	4483							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.36							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	5274							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.42							
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)}/Y =	23							

Building:	Berks Classroom and Lab Building
System Tag/Name:	RTU-2
Operating Condition Description:	Design Peak Cooling
Units (select from pull-down list)	IP

	Name	Units				System		
Inputs for System								
Floor area served by system	As	sf				14566.48		
Population of area served by system (including diversity)	Ps	P	100% diversity			212		
Design primary supply fan airflow rate	Vpsd	cfm				12,810		
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.12		
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.7		
Inputs for Potentially Critical zones								
Zone Name			*Zone title turns purple italic for critical zone(s)*				**Measurement Lab**	**Seminar Classroom**
Zone Tag							105	308
Space type		Select from pull-down list					University/college laboratories	Lecture classroom
Floor Area of zone	Az	sf					1256.25	791
Design population of zone	Pz	P	(default value listed; may be overridden)				13	25
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					1410	1500
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A						
Local recirc. air % representative of ave system return air	Er							
Inputs for Operating Condition Analyzed								
Percent of total design airflow rate at conditioned analyzed	Ds	%				100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list					CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep							
Results								
Ventilation System Efficiency	Ev					0.81		
Outdoor air intake required for system	Vot	cfm				4483		
Outdoor air per unit floor area	Vot/As	cfm/sf				0.31		
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				21.1		
Outdoor air as a % of design primary supply air	Ypd	cfm				35%		
Detailed Calculations								
Initial Calculations for the System as a whole								
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	12810		
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	3650		
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.28		
Initial Calculations for individual zones								
OA rate per unit area for zone	Raz	cfm/sf					0.18	0.06
OA rate per person	Rpz	cfm/p					10.00	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1410	1500
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		356.1	235.0
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		356	235
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.25	0.16
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.25	0.16
System Ventilation Efficiency								
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.03	1.13
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.81		
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.68		
Minimum outdoor air intake airflow								
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	4483		
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.35		
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	5374		
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.42		
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	=	23		

Building:	Berks Classroom and Lab Building												
System Tag/Name:	RTU 3												
Operating Condition Description:	Design Cooling Load												
Units (select from pull-down list)	IP												
Inputs for System	**Name**	**Units**				**System**							
Floor area served by system	As	sf				13346.38							
Population of area served by system (including diversity)	Ps	P		100% diversity		176							
Design primary supply fan airflow rate	Vpsd	cfm				10,790							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06							
OA req'd per person for system area (Weighted average)	Rps	cfm/p				5.1							
Inputs for Potentially Critical zones													
Zone Name				Zone title turns purple italic for critical zone(s)			Faculty Office / Coorridor	Faculty Offices	Faculty Offices	Faculty Office	Conference	Faculty Offices	Corridor
Zone Tag							336 / Q304	333, 334 & 335	330, 331 & 332	329	325	324, 326 & 327	Q303
Space type		Select from pull-down list					Office space	Office space	Office space	Office space	Conference/meeting	Office space	Corridors
Floor Area of zone	Az	sf					408	370.6	370.6	163	160	351	
Design population of zone	Pz	P		(default value listed; may be overridden)			2	6	6	2	6	6	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					432	330	330	280	140	350	200
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A											
Local recirc. air % representative of ave system return air	Er						75%	75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed													
Percent of total design airflow rate at conditioned analyzed	Ds	%				102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list					CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep												
Results													
Ventilation System Efficiency	Ev					0.75							
Outdoor air intake required for system	Vot	cfm				2296							
Outdoor air per unit floor area	Vot/As	cfm/sf				0.17							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				13.0							
Outdoor air as a % of design primary supply air	Ypd	cfm				21%							
Detailed Calculations													
Initial Calculations for the System as a whole													
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	11082							
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.16							
Initial Calculations for individual zones													
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p					5.00	5.00	5.00	5.00	5.00	5.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm					432	330	330	280	140	350	200
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		45.5	52.2	52.2	19.7	40.1	51.1	0.0
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		45	52	52	20	40	51	0
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.11	0.16	0.16	0.07	0.29	0.14	0.00
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.11	0.16	0.16	0.07	0.29	0.14	0.00
System Ventilation Efficiency													
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.05	1.00	1.00	1.09	0.87	1.02	1.16
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.75							
Minimum outdoor air intake airflow													
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	2296							
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.21							
OA Temp at which Min OA provides all cooling													
DAT below which OA intake flow is @ minimum		Deg F	=	(Tp-dTsf)-(1-Y)(Tr+dTrf	=	-9							

	Name	Units				System							
Building:	Berks Classroom and Lab Building												
System Tag/Name:	RTU-3												
Operating Condition Description:	Design Cooling Load												
Units (select from pull-down list)	IP												
Inputs for System	**Name**	**Units**				**System**							
Floor area served by system	As	sf				13346.98							
Population of area served by system (including diversity)	Ps	P		100% diversity		176							
Design primary supply fan airflow rate	Vpsd	cfm				10,750							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06							
OA req'd per person for system area (Weighted average)	Rps	cfm/p				5.1							
Inputs for Potentially Critical zones													
Zone Name				*Zone title turns purple italic for critical zone(s)*			Lobby	Copy / Fax / Printer	PT Faculty Office	Corridor	Faculty Offices	Faculty Office	Faculty Offices
Zone Tag							F301	322	319	Q301	320, 321 & 323	304	305 & 306
Space type		Select from pull-down list					Lobbies	Office space	Office space	Corridors	Office space	Office space	Office space
Floor Area of zone	Az	sf									351	130.5	261
Design population of zone	Pz	P		(default value listed; may be overridden)			0	0	6	0	6	2	4
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					340	130	120	290	360	110	320
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A											
Local recirc. air % representative of ave system return air	Er												
Inputs for Operating Condition Analyzed													
Percent of total design airflow rate at conditioned analyzed	Ds	%				102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select from pull-down list					CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep												
Results													
Ventilation System Efficiency	Ev					0.75							
Outdoor air intake required for system	Vot	cfm				2296							
Outdoor air per unit floor area	Vot/As	cfm/sf				0.17							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				13.0							
Outdoor air as a % of design primary supply air	Ypd	cfm				21%							
Detailed Calculations													
Initial Calculations for the System as a whole													
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpsDs	=	11002							
Uncorrected OA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.16							
Initial Calculations for individual zones													
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p					5.00	5.00	5.00	0.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm					340	130	120	290	360	110	320
Unused OA req'd in breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		0.0	0.0	30.0	0.0	51.1	17.8	35.7
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		0	0	30	0	51	18	36
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.00	0.00	0.26	0.00	0.14	0.16	0.11
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.00	0.00	0.25	0.00	0.14	0.16	0.11
System Ventilation Efficiency													
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.16	1.16	0.91	1.16	1.02	0.99	1.05
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.75							
Minimum outdoor air intake airflow													
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	2296							
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.21							
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	=	-9							

	Name	Units		System							
Building:	Berks Classroom and Lab Building										
System Tag/Name:	RTU-3										
Operating Condition Description:	Design Cooling Load										
Units (select from pull-down list)	IP										
Inputs for System	**Name**	**Units**		**System**							
Floor area served by system	As	sf		13546.38							
Population of area served by system (including diversity)	Ps	P	100% diversity	176							
Design primary supply fan airflow rate	Vpsd	cfm		10,750							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.06							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.1							
Inputs for Potentially Critical zones											Total
Zone Name			Zone title turns purple italic for critical zone(s)		Conference	*PT Faculty Office*	Faculty Office	Conference	Admin Assistant	Chancellors Office	Reception
Zone Tag					317	313	303	311A	307A	307B	307
Space type			Select from pull-down list		Conference/meeting	Office space	Office space	Conference/meeting	Office space	Office space	Reception areas
Floor Area of zone	Az	sf			195.75	174	145	182.25	148.5	328	367.5
Design population of zone	Pz	P	(default value listed; may be overridden)		5	6	2	6	2	7	5
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			120	100	115	120	160	440	220
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er										
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.75							
Outdoor air intake required for system	Vot	cfm		2296							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.17							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		13.0							
Outdoor air as a % of design primary supply air	Ypd	cfm		21%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	11002							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As =	1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			5.00	5.00	5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			120	100	115	120	160	440	220
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		41.7	40.4	18.7	40.9	18.9	66.7	47.1
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		42	40	19	41	19	67	47
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.35	0.40	0.16	0.34	0.12	0.15	0.21
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.35	0.40	0.16	0.34	0.12	0.15	0.21
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.81	0.75	0.99	0.82	1.04	1.01	0.94
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.75							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	2296							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.21							
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)}/Y =	-9							

Building:	Berts Classroom and Lab Building									
System Tag/Name:	RTU-3									
Operating Condition Description:	Design Cooling Load									
Units (select from pull-down list)	IP									
Inputs for System	Name	Units		System						
Floor area served by system	As	sf		13346.38						
Population of area served by system (including diversity)	Ps	P	100% diversity	176						
Design primary supply fan airflow rate	Vpsd	cfm		10,750						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.06						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.1						
Inputs for Potentially Critical zones					Potentially Critical Zones					
Zone Name			*Zone title turns purple italic for critical zone(s)*		Conference	Faculty Offices	Faculty Offices	Faculty Office	Corridor	Computer Workroom	Storage
Zone Tag					311	315, 316 & 318	310, 312 & 314	309	Q301	209A	210A
Space type			Select from pull-down list		Conference/meeting	Office space	Office space	Office space	Corridors	Computer lab	Storage rooms
Floor Area of zone	Az	sf			243	351	351	148.5	999	153.125	258.75
Design population of zone	Pz	P	(default value listed; may be overridden)		6	6	6	2	0	2	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			200	360	360	165	290	150	220
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.75							
Outdoor air intake required for system	Vot	cfm		2296							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.17							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		13.0							
Outdoor air as a % of design primary supply air	Ypd	cfm		21%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	11002							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As =	1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.12	0.12
OA rate per person	Rpz	cfm/p			5.00	5.00	5.00	5.00	0.00	10.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			200	360	360	165	290	150	220
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		44.6	51.1	51.1	18.9	59.9	38.4	31.1
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		45	51	51	19	60	38	31
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz /Vdz =		0.22	0.14	0.14	0.11	0.21	0.26	0.14
Unused OA fraction required in primary air to zone	Zp		= Voz /Vpz =		0.22	0.14	0.14	0.11	0.21	0.26	0.14
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.93	1.02	1.02	1.04	0.95	0.90	1.02
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.75							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	2296							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.21							
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 =	-9							

Building:	Bertis Classroom and Lab Building										
System Tag/Name:	RTU-3										
Operating Condition Description:	Design Cooling Load										
Units (select from pull-down list)	IP										
Inputs for System	**Name**	**Units**		**System**							
Floor area served by system	As	sf		13346.38							
Population of area served by system (including diversity)	Ps	P	100% diversity	178							
Design primary supply fan airflow rate	Vpsd	cfm		10,750							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.06							
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.1							
Inputs for Potentially Critical zones											
Zone Name			*Zone title turns purple italic for critical zone(s)*		Admin Assistant	Directors Office	Faculty Offices	Faculty Offices	Faculty Offices	Faculty Offices	Faculty Office
Zone Tag					210B	210	211, 212 & 213	214, 215 & 216	217, 218 & 219	221, 223 & 224	220
Space type			Select from pull-down list		Office space	Office space	Office space	Office space	Office space	Office space	Office space
Floor Area of zone	Az	sf			195.5	270	371.25	371.25	371.25	371.25	138
Design population of zone	Pz	P	(default value listed; may be overridden)		2	5	6	6	6	6	2
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			220	330	330	330	420	330	120
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er										
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										
Results											
Ventilation System Efficiency	Ev			0.75							
Outdoor air intake required for system	Vot	cfm		2296							
Outdoor air per unit floor area	Vot/As	cfm/sf		0.17							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		13.0							
Outdoor air as a % of design primary supply air	Ypd	cfm		21%							
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpsdDs	= 11302							
Uncorrected OA requirement for system	Vou	cfm	= Rps Ps + Ras As	= 1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	= 0.16							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.06	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			5.00	5.00	5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			220	330	330	330	420	330	120
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=	21.7	41.2	52.3	52.3	52.3	52.3	18.
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=	22	41	52	52	52	52	18
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er)	=	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz	=	0.10	0.12	0.16	0.16	0.12	0.16	0.15
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=	0.10	0.12	0.16	0.16	0.12	0.16	0.15
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=	1.06	1.03	1.00	1.00	1.03	1.00	1.0
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	= 0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	= 0.75							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	= 2296							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	= 0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	= 2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	= 0.21							
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	= -9							

Building:	Borke Classroom and Lab Building	
System Tag/Name:	RTU-3	
Operating Condition Description:	Design Cooling Load	
Units (select from pull-down list)	IP	

Item	Name	Units			System
Inputs for System					
Floor area served by system	As	sf			13346.38
Population of area served by system (including diversity)	Ps	P	100% diversity		176
Design primary supply fan airflow rate	Vpsd	cfm			10,750
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf			0.06
OA req'd per person for system area (Weighted average)	Rps	cfm/p			5.1

Inputs for Potentially Critical zones

Zone title turns purple italic for critical zone(s)

Item	Name	Units	Note	System	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Zone Name					Mail Suppor	Faculty Offices	PT Fac. Lng & Corr	Faculty Offices	Conference	Faculty Offices	Faculty Offices
Zone Tag					222	225, 226 & 228	229 & C202	230, 232 & 233	231	235, 236 & 238	237, 239 & 241
Space type			Select from pull-down list		Shipping/receiving	Office space	Office space	Office space	Conference/meeting	Office space	Office space
Floor Area of zone	Az	sf			210	371.25	2103.75	371.25	210	371.25	371.25
Design population of zone	Pz	P	(default value listed; may be overridden)		0	6	7	6	6	6	6
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			110	330	440	330	140	330	260
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull down list or leave blank if N/A								
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	75%	75%	75%	75%
Inputs for Operating Condition Analyzed											
Percent of total design airflow rate at conditioned analyzed	Ds	%		102%	100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep										

Results	Name	Units	Value
Ventilation System Efficiency	Ev		0.75
Outdoor air intake required for system	Vot	cfm	2296
Outdoor air per unit floor area	Vot/As	cfm/sf	0.17
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p	13.0
Outdoor air as a % of design primary supply air	Ypd	cfm	21%

Detailed Calculations

Item	Name	Units	Formula	System	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5	Zone 6	Zone 7
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	11002							
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	1728							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16							
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf			0.12	0.06	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			0.00	5.00	5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			110	330	440	330	140	330	260
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		25.2	52.3	161.2	52.3	42.6	52.3	52.3
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		25	52	161	52	43	52	52
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00	1.00	1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.23	0.16	0.37	0.16	0.30	0.16	0.20
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.23	0.16	0.37	0.16	0.30	0.16	0.20
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.93	1.00	0.79	1.00	0.85	1.00	0.96
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.75							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.75							
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	2296							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	2318							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.21							
OA Temp at which Min OA provides all cooling											
OAT below which OA Intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTr)}/Y =	-9							

Building:	Berks Classroom and Lab Building				
System Tag/Name:	RTU-3				
Operating Condition Description:	Design Cooling Load				
Units (select from pull-down list)	IP				
Inputs for System	**Name**	**Units**		**System**	
Floor area served by system	As	sf		13346.38	
Population of area served by system (including diversity)	Ps	P	100% diversity	176	
Design primary supply fan airflow rate	Vpsd	cfm		10,750	
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.06	
OA req'd per person for system area (Weighted average)	Rps	cfm/p		5.1	
Inputs for Potentially Critical zones					
Zone Name			*Zone title turns purple italic for critical zone(s)*		Faculty Offices
Zone Tag					240 & 243
Space type		Select from pull-down list			Office space
Floor Area of zone	Az	sf			249.75
Design population of zone	Pz	P	(default value listed; may be overridden)		4
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			220
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A			
Local recirc. air % representative of ave system return air	Er				
Inputs for Operating Condition Analyzed					
Percent of total design airflow rate at conditioned analyzed	Ds	%		102%	100%
Air distribution type at conditioned analyzed		Select from pull-down list			CS
Zone air distribution effectiveness at conditioned analyzed	Ez				1.00
Primary air fraction of supply air at conditioned analyzed	Ep				
Results					
Ventilation System Efficiency	Ev			0.75	
Outdoor air intake required for system	Vot	cfm		2296	
Outdoor air per unit floor area	Vot/As	cfm/sf		0.17	
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		13.0	
Outdoor air as a % of design primary supply air	Ypd	cfm		21%	
Detailed Calculations					
Initial Calculations for the System as a whole					
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	11002	
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	1728	
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.16	
Initial Calculations for individual zones					
OA rate per unit area for zone	Raz	cfm/sf			0.06
OA rate per person	Rpz	cfm/p			5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			220
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		35.0
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		35
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.16
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.16
System Ventilation Efficiency					
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.00
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	0.75	
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.75	
Minimum outdoor air intake airflow					
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	2296	
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.21	
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	2318	
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.21	
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 =	-9	