Technical Report 1

ASHRAE Standards 62.1 and 90.1 Compliance Evaluation

Delaware County Community College

STEM Center

Media, PA

Dan Saxton

Mechanical Option

Faculty Consultant: Dr. Stephen Treado

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Executive Summary

The Delaware County Community College Science, Technology, Engineering, and Mathematics (STEM) Center is a new addition to their Marple Campus, and is part of the two-building STEM Complex. At 105,000 square feet and four stories it is a focal point for the campus, and stands out with both architectural and sustainable features.

The purpose of this report is to evaluate the compliance of the building against American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standards 62.1 and 90.1.

A section-by-section analysis of Standard 62.1 Section 5 (Systems and Equipment) showed full perceivable compliance. This section considered a variety of criteria, including natural ventilation, airstream surfaces, particulate matter removal, and air distribution. The building specifications indicate a high standard for system quality in all areas considered.

ASHRAE Standard 62.1 Section 6 (Procedures) led to a detailed calculation of ventilation rate for the building. The mechanical system for the STEM Center includes (2) 80,000-cfm rated rooftop air handling units and a substantial amount of outdoor air intake requirements due to the presence of laboratory and other educational spaces. In Section 6, it was determined that the building system is well beyond compliance with the calculated requirements according to ASHRAE. Largely due to the high need for fresh air and air exhaustion within the spaces, as well as the meeting of pressurization requirements, the STEM Center is found to be fully compliant with Standard 62.1 Section 6.

Finally, for ASHRAE Standard 90.1, many systems were considered in a much broader building analysis. Compliance was checked across the building envelope, HVAC systems, service water heating, power, and lighting. In this standard, a few areas of non-compliance were discovered, including building envelope properties and equipment efficiencies. For the most part, compliance was achieved, including a significant difference between the maximum lighting power density and the much lower calculated power density.

Overall, the STEM Center is found to be mostly compliant, faltering in a few sections of the ASHRAE Standards 62.1 and 90.1. It is not surprising to see these limit pushed, however, as Delaware County Community College and the design team have put great efforts into developing a quality and sustainable LEED® certified building.

PART 1 – ASHRAE Standard 62.1, Section 5 Analysis

5.1 Natural Ventilation.

Mechanical ventilation is utilized in the STEM Center, and therefore the natural ventilation requirements do not apply.

5.2 Ventilation Air Distribution.

The ventilation system has the means to achieve the minimum ventilation airflow calculated in ASHRAE Standard 62.1 Section 6. This is made possible by the significant amount of outside air taken in by the two rooftop 80,000 cfm capacity air handlers, which is necessary to assure high air quality in such spaces as laboratories and classrooms.

5.3 Exhaust Duct Location.

Ductwork that contains potentially harmful contaminants comes from the numerous lab spaces and preparation rooms on the second and third floors. This ductwork is appropriately pressurized in accordance with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) standards using a space pressurization monitoring system. This directs exhaust air to the roof top exhaust fan units.

5.4 Ventilation System Controls.

Direct Digital Controls (DDC) are used on a peer-to-peer Carrier Sense Multiple Access/Collision Detect (CSMA/CD) Ethernet Local Area Network. The control language is both LonTalk™ and BACnet. Spaces are automatically controlled to maintain minimum ventilation and airflow balance. Passive infrared occupancy sensors are used to activate fan system.

5.5 Airstream Surfaces.

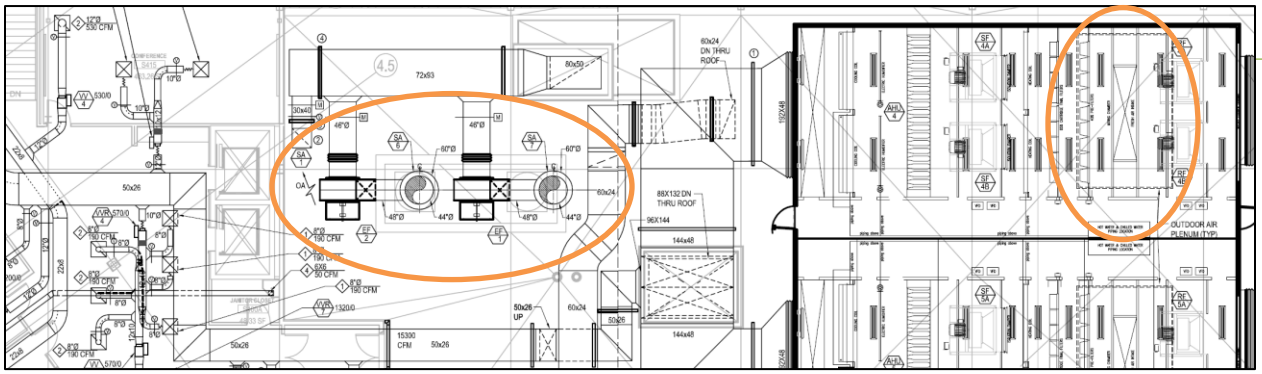
PVC-Coated Galvanized Steel ductwork is in accordance with UL 181 and ASTM A 653/A 653 M. Sheet metal surfaces and metal fasteners are used otherwise.

5.6 Outdoor Air Intakes.

Rooftop outdoor air intakes are located sufficiently far away from all exhaust, including the exhaust air coming from laboratory spaces. The roof plan is shown below (Figure 1: Roof Plan of Outdoor Air Intakes), illustrating that ASHRAE Standard 62.1 Table 5-1 for minimum separation distances required are all satisfied.

Outdoor air intake is "Louvered Penthouse" type, drawing air from four sides, and is designed to prevent snow or rain entrainment. Also, appropriate screening is included on the inside of the louvers.

Figure 1: Roof Plan of Outdoor Air Intakes



5.7 Local Capture of Contaminants.

All potentially contaminated air from equipment or otherwise is ducted to rooftop exhaust fan units. Two main Greenheck exhaust fans discharge air upward at 34,000 cfm, and they are shown in Figure 2 taken from the Exhaust Air Riser Diagram (Drawing M-504). Additional exhaust fans also exhaust air to the roof top.

5.8 Combustion Air.

The flue gas system for the STEM Center is designed and installed to prevent leakage of combustion products, using high temperature silicone sealant to be gastight. Sufficient air is provided for combustion, and an integral draft diverter is utilized to “assure precise air and flue gas mixture for efficient venting” according to Specification 236330 for Water Boilers.

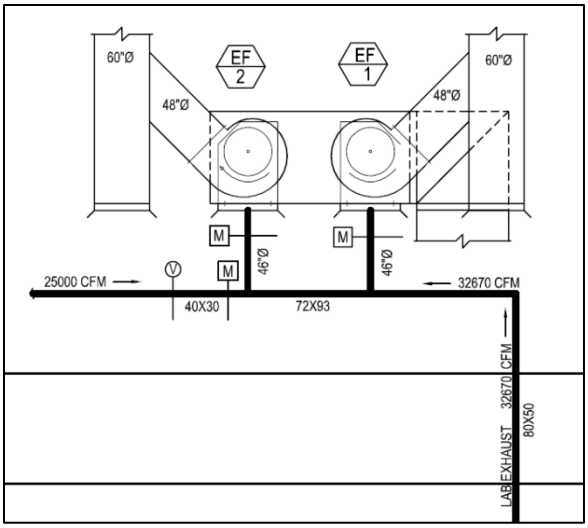


Figure 2: Exhaust Air Riser Diagram

5.9 Particulate Matter Removal.

Particulate filters are tested and rated in accordance with ASHRAE Standard 52.1 and 52.2 and are UL Class I or II rated. Table 1 shows compliance with necessary MERV ratings for filters.

Table 1: Particulate Matter Filters Compliance

Filters Used:	MERV Rating	Required MERV Rating	Compliance? (Y/N)
Camil Farr 30/30	8	6	Y
Viledon MV85	13	6	Y

5.10 Dehumidification Systems.

Each AHU is designed to bring in a maximum of 66,000 cfm of outdoor air (132,000 cfm total) and the maximum exhaust air cfm for all exhaust fans combined in 81,060 cfm, thus complying with the 5.10.2 standard for exfiltration. Breakdown of maximum exhaust air cfm for each exhaust fan and the comparison to maximum outdoor air cfm is shown below in Table 2.

Table 2: Outdoor Air – Exhaust Air Comparison

	Maximum Outdoor Air (cfm)	Maximum Exhaust Air (cfm)	
AHU-4	66,000	34,000	EF-1
AHU-5	66,000	34,000	EF-2
		260	EF-3
		1,480	EF-4
		3,390	EF-5
		830	EF-6
		4,600	EF-7
		1,500	EF-8
		1,000	EF-9
Total	**132,000**	**81,060**	Total

5.11 Drain Pans.

Hot water and chilled water coil drain pans are sloped in two directions appropriately (greater than 1/8" per foot) and encompass the full width of the coils. Piping for coil drain pans is 80 CPVC. Condensate recessed floor drain is continuously welded for a watertight seal.

5.12 Finned-Tube Coils and Heat Exchangers.

As previously mentioned, adequate number and sizing of drain pans are provided and addressed in specifications.

5.13 Humidifiers and Water-Spray Systems.

The STEM Center does not use humidifiers or water-spray systems; therefore this part of ASHRAE Standard 62.1 Section 5 does not apply.

5.14 Access for Inspection, Cleaning, Maintenance.

Full access has been required for all common HVAC work as per Specification 230500. This includes sufficient sizing of shafts, chases, clearances, access doors, as well as proper location of all equipment to ensure full accessibility.

5.15 Building Envelope and Interior Surfaces.

The STEM Center uses composite-HDPE/bentonite membrane waterproofing, as well as single-component, modified polyurethane waterproofing for perimeter foundation walls. Vapor seal is placed on concealed side of metal wall panels. Metal wall panel assembly includes components necessary for a weathertight system. Air infiltration is no more than 0.06 cfm/sq. ft. of wall area, tested according to ASTM E 283. Composite wall panels are fabricated in a manner that eliminates condensation on the interior side of panel.

5.16 Buildings with Attached Parking Garages.

There is no attached Parking Garage for the STEM Center; therefore this section of Standard 62.1 does not apply.

5.17 Air Classification and Recirculation.

All spaces in the STEM Center are Class 1 air class according to Standard 62.1 Table 6-1, with the exception of all laboratory spaces. For such rooms (Classes 2 and 4), air is exhausted straight to the rooftop exhaust fans and is not recirculated.

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

As a requirement for LEED® Certification, the STEM Center is a smoke-free building and therefore the requirements for ETS and ETS-Free areas in Standard 62.1 do not apply. Excerpt from the LEED® review is shown below with item "EQp 2 Envionmental Tobacco Smoke Control" highlighted.

	MR 6	Rapidly Renewable Materials	1			1	2.5% of materials from rapidly renewable resources
	MR 7	Certified Wood	1	1			50% of wood based materials from FSC certified sources
Enhance Indoor Environmental Quality	EQp 1	Minimum IAQ Performance		R			Must meet ASHRAE 62-2004
	EQp 2	Environmental Tobacco Smoke Control		R			Prohibit smoking in the building
	EQ 1	Outdoor Air Delivery Monitoring	1	1			Permanent CO2 monitoring w/ operation adjustments
	EQ 2	Increased Ventilation	1		1		$ Outdoor Air delivery 30% over ASHRAE 62-2004
	EQ 3.1	Construction IAQ- During Construction	1	1			comply with SMACNA standards, MERV 8 filters during construction
	EQ 3.2	Construction IAQ- Before Occupancy	1	1			employ building flush out or do indoor air quality testing
	EQ 4.1	Low-Emitting Materials- Adhesives/Sealants	1	1			Low VOC adhesives and sealants
	EQ 4.2	Low-Emitting Materials- Paints and Coatings	1	1			Low VOC paints, primers, anti-rust paints, anti-corrosives, sealers, stains
	EQ 4.3	Low-Emitting Materials- Carpet	1	1			CRI Green Labeled Plus carpet, Green Labeled cushion, low VOC adhesive
	EQ 4.4	Low-Emitting Materials- Composite wood/agrifiber	1	1			No-added-urea-formaldehyde composite wood or agrifiber products only
	EQ 5	Indoor Chemical Pollution Source Control	1	1			entryway systems, isolation of chemical pollutants, and MERV 13 filters
	EQ 6.1	Controllability of Systems- Lighting	1	1			Individual lighting controls for 90% of occupants
	EQ 6.2	Controllability of Systems- Thermal Comfort	1		1		Thermal controls as per ASHRAE 55-2004 for 50% of occupants
	EQ 7.1	Thermal Comfort- Design	1	1			HVAC and envelope design must meet ASHRAE 55-2004
	EQ 7.2	Thermal Comfort- Verification	1	1			Agreement for post-occupancy survey and remediation
	EQ 8.1	Daylighting	1	1			minimum 2% daylighting factor in 75% of regularly occupied spaces
	EQ 8.2	Views	1	1			views from 90% of regularly occupied spaces

Figure 3: Excerpt from LEED® Review

PART 2 – ASHRAE Standard 62.1, Section 6 Analysis

6.2 Ventilation Rate Procedure.

Ventilation rate calculations were conducted to determine the minimum outdoor air requirements for ventilation. This analysis was done for nearly all the spaces in the STEM Center (neglecting such spaces as toilet and mechanical rooms), and was based on floor area (A_z), number of occupants (P_z), design supply air cfm (V_{dzd}), and the space type. The rooms analyzed were those selected as potentially critical zones, and these included classrooms, offices, conference rooms, laboratories, preparation rooms, fitness rooms, and locker rooms.

6.2.2 Zone calculations:

The following equations and methods are provided by ASHRAE Standard 62.1 Section 6 for determining outdoor air ventilation rate. These equations, used in an Excel spreadsheet were used to for ventilation rate analysis.

Eqn. 6-1: $V_{bz} = R_p * P_z + R_a * A_z$

A_z = Zone floor area (ft^2)
P_z = Zone population (*people*)
R_p = Outdoor air flow rate ($\frac{cfm}{person}$)
R_a = Outdoor airflow rate ($\frac{cfm}{ft^2}$)

Zone Air Distribution Effectiveness:
E_z = 1.0 (As defined by Table 6-2)

Zone Outdoor Airflow:
Eqn. 6-2: $V_{oz} = \frac{V_{bz}}{E_z}$

Primary Outdoor Air Fraction:
Eqn. 6-5: $Z_p = \frac{V_{oz}}{V_{pz}}$

Occupant Diversity:
Eqn. 6-7: $D = \frac{Ps}{\sum all\ zones Pz}$
P_s = *System Population*

Uncorrected Outdoor Air Intake:
Eqn. 6-6: $V_{ou} = D\sum_{all\ zones}(R_p * P_z) + \sum_{all\ zones}(R_a * A_z)$

Outdoor Air Intake:

Eqn. 6-7: $V_{ot} = \frac{Vou}{Ev}$

Section 6 Results:

Excel spreadsheets of calculations can be found in Appendix A, showing analysis for the building's two air handlers, AHU-4 and AHU-5. All four floors were analyzed, and the total outdoor air intake required was determined to be 43,738 cfm. This compared to the minimum outdoor air cfm of each air handler (66,000 cfm) shows that the STEM Center design exceeds the ASHRAE standard for outdoor air by a significant amount. Because of the amount of air needed for adequate exhausting of laboratory spaces and supplying of numerous classrooms, a substantial amount of outdoor air is required to maintain indoor air quality for the building occupants. This analysis, shown in Table 3 below, concludes that the building design more than accounts for that need.

Table 3: Outdoor Air Intake Requirement

	Outdoor Air Intake Required (cfm)
First Floor	18,349
Second Floor	10,007
Third Floor	10,462
Fourth Floor	4,930
Total	**43,748**
Design Maximum Outdoor Air cfm	**132,000**

Because the air handling units greatly exceed the requirements, V_{oz} (unused outdoor air requirement for zone) totaled for all four floors is 22,978 cfm. This value is significant and gives a point of potential improvement for the air handling system.

PART 3 – ASHRAE Standard 90.1

Section 5: Building Envelope

The STEM Center, and the rest of the Delaware County Community College (Marple Campus), lies in **Climate Zone 4A** according to map seen below in Figure 3.

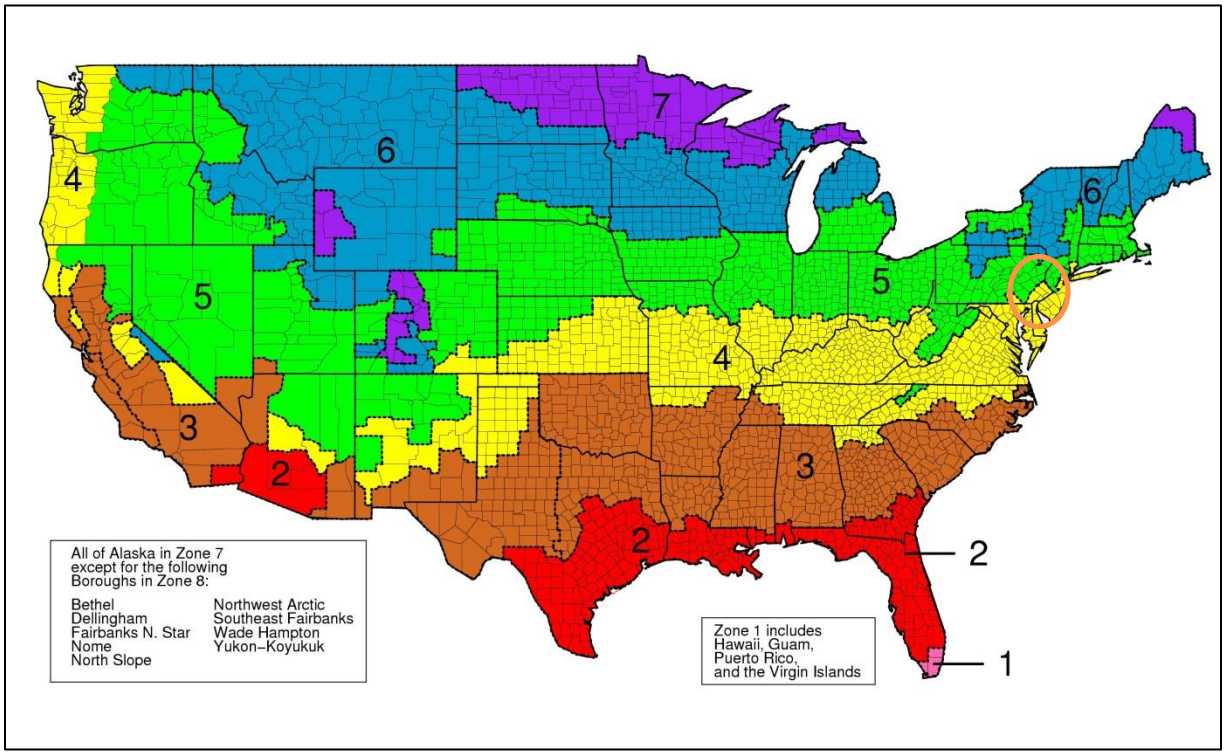


Figure 4: ASHRAE Standard 90.1 Climate Zones

Due mainly to a substantial glass curtain wall system on the south façade of the building, the STEM Center does not comply with the ASHRAE Standard 90.1 maximum allowable vertical fenestration area percentage of 40%. With 2,583 ft^2 of exterior windows and 19,558 ft^2 of glass curtain wall, the vertical glazing percentage is 46.61% as tallied in Table 4.

Table 4: Total Building Glazing Area

	Exterior Windows	Glass Curtain Wall	Exterior Walls (Gross)	Percentage Glazing	Max. Percent Allowed	Compliance? (Y/N)
Total Area (SF)	2,583.28	19,558.47	47,501.20	46.61%	40%	N

There is only one skylight, which is circular with an 8’ diameter. This is not nearly enough to exceed the maximum percent allowable as shown below in Table 5.

Table 5: Total Roof Skylight Area

	Dome Skylight	Roof Area (Gross)	Percentage Skylight	Max. Percent Allowed	Compliance? (Y/N)
Total Area (SF)	50.27	28,430.11	0.18%	5%	Y

Requirements for building envelope sealing as per section 5.4.3.1 of Standard 90.1 are met with elastomeric joint sealants. These sealants maintain watertight and airtight continuous joint seals for fenestration, wall systems, building assemblies, etc.

In regards to fenestration air leakage, glazed aluminum curtain-wall systems and all aluminum-framed systems have a maximum air leakage of 0.06 cfm/ft^2, and skylights have a maximum of 0.3 cfm/ft^2 according to ASTM E 283 testing. This justifies the standard of 0.4 cfm/ft^2.

There is a minimum distance between doors for vestibules in section 5.4.3.4. For the STEM Center, vestibules such as the main south side entrance have a distance between interior and exterior doors greater than 7 ft, satisfying the requirement.

Using the Prescriptive Building Envelope Option as per ASHRAE Standard 90.1 Section 5.5 for non-residential building type, and using Tables 5.5-1 through 5.5-8, the building's thermal properties is analyzed. Also used for calculation of thermal properties is Appendix A of ASHRAE Standard 90.1. Displayed below in Table 6 is the summary of that analysis, showing that according to the calculated U-Values and R-Values, all building envelope materials comply, except the floor properties do not satisfy the standard.

Table 6: Building Envelope Properties

	U-Value	Max Std. U-Value	R-Value	Min Std. R-Value	Compliance? (Y/N)
Roof	0.03446	0.048	28	20	Y
Walls	0.05052	0.113	26	13	Y
Floors	0.06733	0.038	30	30	N
Doors	0.2	0.7			Y
			SHGC	Min Std. SHGC	
Glass	0.29	0.5	0.41	0.4	Y
Skylight	1.2	1.3	0.68	0.65	Y

Section 6: Heating, Ventilating, and Air Conditioning

In this section of ASHRAE Standard 90.1, different equipment is analyzed for compliance in such criteria as efficiency and capacity. Tables 6.8.1A-6.8.1J provides the minimum efficiency requirements. Additionally, evaluation of compliance is performed for several other components of the HVAC system as well, and those are as follows:

Standard 6.4.4: All metal ducts have a class C seal level, meeting the requirements of Table 6.4.4.2A.

Standard 6.5.1: No economizer requirement for Climate Zone 4A according to ASHRAE Standard 90.1 Table.

Standard 6.5.6: Due to exhaust rate greater than 15,000 cfm, the STEM Center complies with ASHRAE Standard 90.1 section on fume hoods by using a heat recovery system in accordance with Section 6.5.6.1

Section 6.8 – Minimum Equipment Efficiency:

Unitary Air Conditioners and Condensing Units

Shown below in Table 7 is the evaluation of compliance for the split system condensing units, for which each unit has a Seasonal Energy Efficiency Ratio (SEER) or 13.5.

Table 7: Unitary Air Conditioners and Condensing Units

Mark	Service	MBH	SEER	Minimum SEER	Compliance? (Y/N)
ACC-1A	AH-1A	24,000	13.5	9.5	Y
ACC-1E	AH-1E	24,000	13.5	9.5	Y
ACC-2A	AH-2A	24,000	13.5	9.5	Y
ACC-2E	AH-2E	24,000	13.5	9.5	Y
ACC-3A	AH-3A	24,000	13.5	9.5	Y
ACC-4A	AH-4A	24,000	13.5	9.5	Y

Table 8 shows a comparison of fan horsepower and maximum horsepower required. The maximum horsepower is determined based on the equation is Table 6.5.3.1.1A. For several of the supply and return fans, maximum horsepower is exceeded and does not comply.

Table 8: Fan Power Limitation

	CFM	HP	Factor	Max HP	Compliance? (Y/N)
EF-1	34,000	50	0.0011	37.4	N
EF-2	34,000	50	0.0011	37.4	N
EF-3	260	0.167	0.0011	0.286	Y
EF-4	1,480	0.5	0.0011	1.628	Y
EF-5	3,390	1.5	0.0011	3.729	Y
EF-6	830	0.25	0.0011	0.913	Y
EF-7	4,600	2	0.0011	5.06	Y
EF-8	1,500	0.333	0.0011	1.65	Y
EF-9	1,000	0.333	0.0011	1.1	Y
SF-4A	44,750	60	0.0011	49.225	N
SF-4B	44,750	60	0.0011	49.225	N
RF-4A	21,500	30	0.0011	23.65	N
RF-4B	21,500	30	0.0011	23.65	N
SF-5A	44,750	60	0.0011	49.225	N
SF-5B	44,750	60	0.0011	49.225	N
RF-5A	21,500	30	0.0011	23.65	N
RF-5B	21,500	30	0.0011	23.65	N
SF-1	3,600	1.5	0.0011	3.96	Y

Water-cooled chillers are specified as meeting ASHRAE Standard 90.1 requirements for capacity, energy efficiency, IPLV, and NPLV for centrifugal chillers greater than 300 tons, according to ARI 550/590 rating and testing.

Compliance for duct insulation is checked through calculating R-Values from known insulation type (and subsequent k-values) and minimum thickness. Shown below in Table 9 is the evaluation of this comparison.

Table 9: Duct Insulation Properties

	Insulation Type	Min Thickness	R-Value	Standard R-Value	Compliance? (Y/N)
Supply - Concealed	I-3	2	5.6	6	N
Supply - Outdoors	I-2	2	8.7	6	Y
Return - Outdoors	I-2	2	8.7	3.5	Y
Return - Within 50 ft. of AHU	I-2	2	8.7	3.5	Y

The ASHRAE Standard 90.1 for pipe insulation is satisfied for the STEM Center, as piping insulation thickness is specified at 1" for piping 2" or smaller, and 1.5" for bigger than 2".

Section 7 – Service Water Heating

Two Bryan Model DR-350WT-FDG gas fired domestic water heaters are used for heating. Each has a capacity of 336 GPH, and complies with the minimum efficiency of 80 percent required for water heaters above 100,000 BTU/hr.

Section 8 – Power

ASHRAE Standard 90.1 Section 8 requires a maximum voltage drop of 2% for feeders and 3% for branch circuits. Specifications for wiring indicate a maximum voltage drop of 6%, which is higher than the standard, and therefore deemed not necessarily compliant with this section.

Section 9 – Lighting

9.4.1 Lighting Control

Automatic shutoff for lighting exists for the STEM Center using an internal scheduler that takes into account days of the week, holidays, daylight savings time, etc. This design feature satisfies requirements for Standard 90.1 9.4.1.1 for automatic lighting shutoff. For individual spaces, ceiling mount PIR occupancy sensors account for lighting shutoff when spaces are vacant.

9.5 Building Area Method Compliance Path

According to Standard 90.1 Table 9.5.1, the Lighting Power Densities (LPD) for School/University building area type is 1.2 W/ft^2. This value is multiplied by the gross lighted floor areas to give an interior lighting power allowance of 126 kW. Found in Appendix B is a breakdown of the building's lighting wattage per fixture in actual watts, totaling 89 kW. This is well under the allowable lighting power, a difference of 1.2 W/ft^2 to approximately 0.84 W/ft^2.

ASHRAE Standard 90.1 Summary:

Through evaluation of Standard 90.1, several instances were found in which the building design does not comply with the standard, as well as a handful of instances in which the building design greatly exceeds the requirements.

In the case of the building glazing area, the non-compliance is a result of a bold architectural feature in which one side of the building is colorful brick façade while the other is a four-story glass curtain wall. It is possible that a tradeoff occurred with the upgrade of the mechanical system in the way of ventilation. As previously discussed, the total maximum outdoor air intake for the two roof top air handling units is over 100,000 cfm, which is substantially higher than the calculated minimum required outdoor air (see Appendix A for breakdown). So whereas the excess of glazing may produce higher solar heat gain, it can be conceived that the increase in air ventilation will improve circulation and comfort as well as air quality.

The other main area of non-compliance is found with the air fans excessive horsepower. This limit may be pushed because of the large need for air exhaust due to the building occupancy types. Several laboratory spaces and preparation rooms make for a high requirement for exhaust air. This increases the need for fan power and raises the maximum horsepower. The number of fans may need to be reconsidered and recalculated.

Appendix A: Outside Air Ventilation Calculations

Building:	Delaware County Community College STEM Center											
System Tag/Name:												
Operating Condition Description:												
Units (select from pull-down list)	IP											
Inputs for System	**Name**	**Units**			**System**							
Floor area served by system	As	sf			13774							
Population of area served by system (including diversity)	Ps	P	100% diversity		383							
Design primary supply fan airflow rate	Vpsd	cfm			20,100							
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			9.1							
Inputs for Potentially Critical zones						Potentially Critical Zones						
Zone Name						S118 Computer Lab	S119 Large Meeting Room	S101 Aerobics	*S110A Men's Locker Room*	S111A Women's Locker Room	S113 Fitness Center	S112 Snack Bar
			Zone title turns purple italic for critical zone(s)									
Zone Tag						1st Floor	1st Floor	1st Floor	1st Floor	1st Floor	1st Floor	1st Floor
Space type		Select from pull-down list				Computer lab	Conference/meeting	Health club/aerobics room	Health club/weight rooms	Health club/weight rooms	Health club/weight rooms	Cafeteria/fast-food dining
Floor Area of zone	Az	sf				1,007	1422	1701	278	288	1509	51
Design population of zone	Pz	P	(default value listed; may be overridden)			30	95	43	7	7	37	1
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				1,200	1200	3370	160	170	2100	150
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				**0.24**							
Outdoor air intake required for system	Vot	cfm			**18349**							
Outdoor air per unit floor area	Vot/As	cfm/sf			**1.33**							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p			**47.9**							
Outdoor air as a % of design primary supply air	Ypd	cfm			**91%**							
Detailed Calculations												
Initial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	=	20100							
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	=	4370							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	=	0.22							
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	0.18
OA rate per person	Rpz	cfm/p				10.00	5.00	20.00	20.00	20.00	20.00	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm				1200	1200	3370	160	170	2100	150
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=		420.8	560.3	962.1	156.7	157.3	830.5	16.7
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=		421	560	962	157	157	831	17
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	0.47	0.29	0.98	0.93	0.40	0.11
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=		0.35	0.47	0.29	0.98	0.93	0.40	0.11
System Ventilation Efficiency												
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=		0.87	0.75	0.93	0.24	0.29	0.82	1.11
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	=	**0.24**							
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	=	**18349**							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	=	**0.91**							
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+dTr1	=	53							

Building:	Delaware County Community College STEM Center								
System Tag/Name:									
Operating Condition Description:									
Units (select from pull-down list)	IP								

Item	Name	Units	Formula / Notes	System	S121B Office	S100C Lower Lounge	S100E Upper Lounge	S100D Computer Lounge	S120 Auditorium
Inputs for System	**Name**	**Units**		**System**					
Floor area served by system	As	sf		13774					
Population of area served by system (including diversity)	Ps	P	100% diversity	383					
Design primary supply fan airflow rate	Vpsd	cfm		20,100					
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		9.1					
Inputs for Potentially Critical zones									
Zone Name			*Zone title turns purple italic for critical zone(s)*		S121B Office	S100C Lower Lounge	S100E Upper Lounge	S100D Computer Lounge	S120 Auditorium
Zone Tag					1st Floor	1st Floor	1st Floor	1st Floor	1st Floor
Space type			Select from pull-down list		Office space	Multipurpose assembly	Multipurpose assembly	Multipurpose assembly	Auditorium seating area
Floor Area of zone	Az	sf			80	1206	2975	1782	1475
Design population of zone	Pz	P	(default value listed; may be overridden)		1	20	44	44	54
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			120	3820	4130	1500	2180
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%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				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			**0.24**					
Outdoor air intake required for system	Vot	cfm		**18349**					
Outdoor air per unit floor area	Vot/As	cfm/sf		**1.33**					
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		**47.9**					
Outdoor air as a % of design primary supply air	Ypd	cfm		**91%**					
Detailed Calculations									
Initial Calculations for the System as a whole									
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	20100					
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	4370					
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.22					
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
OA rate per person	Rpz	cfm/p			5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			120	3820	4130	1500	2180
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		9.8	172.4	398.5	326.9	358.5
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		10	172	399	327	359
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		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
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
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.08	0.05	0.10	0.22	0.16
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.08	0.05	0.10	0.22	0.16
System Ventilation Efficiency									
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.14	1.17	1.12	1.00	1.05
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	**0.24**					
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 =	**18349**					
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	**0.91**					
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+dTr} =	53					

Daniel A. Saxton
10/4/10

Building:	Delaware County Community College STEM Center													
System Tag/Name:														
Operating Condition Description:														
Units (select from pull-down list)	IP													
Inputs for System	**Name**	**Units**				**System**								
Floor area served by system	As	sf				18409								
Population of area served by system (including diversity)	Ps	P	100%	diversity		461								
Design primary supply fan airflow rate	Vpsd	cfm				29,110								
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.13								
OA req'd per person for system area (Weighted average)	Rps	cfm/p				9.4								
Inputs for Potentially Critical zones														
Zone Name		*Zone title turns purple italic for critical zone(s)*					S209 Classroom	*S210 Classroom*	S211 Classroom	S219 Blueprint Reading	S222 Classroom	S202 Anatomy/Physiology	S206 Anatomy/Physiology	
Zone Tag							2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	
Space type		Select from pull-down list					Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Science laboratories	Science laboratories	
Floor Area of zone	Az	sf					862	972	754	1052	693	1502	1653	
Design population of zone	Pz	P	(default value listed; may be overridden)				44	49	38	32	35	32	34	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					1,300	1090	1200	1250	1840	3090	3090	
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					**0.68**								
Outdoor air intake required for system	Vot	cfm				**10007**								
Outdoor air per unit floor area	Vot/As	cfm/sf				**0.54**								
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				**21.7**								
Outdoor air as a % of design primary supply air	Ypd	cfm				**34%**								
Detailed Calculations														
Initial Calculations for the System as a whole														
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	29110								
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	6762								
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.23								
Initial Calculations for individual zones														
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.12	0.12	0.12	0.12	0.18	0.18	
OA rate per person	Rpz	cfm/p					10.00	10.00	10.00	10.00	10.00	10.00	10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1300	1090	1200	1250	1840	3090	3090	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		543.4	606.6	470.5	446.2	433.2	590.4	637.5	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		543	607	470	446	433	590	638	
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	=		0.42	0.56	0.39	0.36	0.24	0.19	0.21	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.42	0.56	0.39	0.36	0.24	0.19	0.21	
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		0.81	0.68	0.84	0.88	1.00	1.04	1.03	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.68**								
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	=	**10007**								
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.34**								
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+dTrl	=	23								

Advisor: Dr. Stephen Treado

Daniel A. Saxton
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Building:	Delaware County Community College STEM Center													
System Tag/Name:														
Operating Condition Description:														
Units (select from pull-down list)	IP													
Inputs for System	**Name**	**Units**					**System**							
Floor area served by system	As	sf					18409							
Population of area served by system (including diversity)	Ps	P	100%	diversity			461							
Design primary supply fan airflow rate	Vpsd	cfm					29,110							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf					0.13							
OA req'd per person for system area (Weighted average)	Rps	cfm/p					9.4							
Inputs for Potentially Critical zones														Potentially Critical Zones
Zone Name								S212 Biology	S215 Biology	S216 CAD	S217 Architectural Resource	S218 CAD	S203A Anatomy Storage	S213A Biology Storage
			Zone title turns purple italic for critical zone(s)											
Zone Tag								2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor
Space type			Select from pull-down list					Science laboratories	Science laboratories	Computer lab	Computer lab	Computer lab	Storage rooms	Storage rooms
Floor Area of zone	Az	sf						1421	1410	1083	568	1072	476	418
Design population of zone	Pz	P	(default value listed; may be overridden)					32	32	32	14	32	0	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm						2980	2980	1240	530	1180	600	400
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						**0.68**							
Outdoor air intake required for system	Vot	cfm					**10007**							
Outdoor air per unit floor area	Vot/As	cfm/sf					**0.54**							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p					**21.7**							
Outdoor air as a % of design primary supply air	Ypd	cfm					**34%**							
Detailed Calculations														
Initial Calculations for the System as a whole														
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	29110								
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	6762								
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.23								
Initial Calculations for individual zones														
OA rate per unit area for zone	Raz	cfm/sf						0.18	0.18	0.12	0.12	0.12	0.12	0.12
OA rate per person	Rpz	cfm/p						10.00	10.00	10.00	10.00	10.00	0.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm						2980	2980	1240	530	1180	600	400
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=			575.8	573.8	450.0	208.2	448.6	57.1	50.2
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=			576	574	450	208	449	57	50
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	=			0.19	0.19	0.36	0.39	0.38	0.10	0.13
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=			0.19	0.19	0.36	0.39	0.38	0.10	0.13
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=			1.04	1.04	0.87	0.84	0.85	1.14	1.11
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.68**								
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	=	**10007**								
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.34**								
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+dTrl	=	23								

Advisor: Dr. Stephen Treado

Daniel A. Saxton
10/4/10

Building:	Delaware County Community College STEM Center													
System Tag/Name:														
Operating Condition Description:														
Units (select from pull-down list)	IP													
Inputs for System	**Name**	**Units**				**System**								
Floor area served by system	As	sf				18409								
Population of area served by system (including diversity)	Ps	P	100%	diversity		461								
Design primary supply fan airflow rate	Vpsd	cfm				29,110								
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.13								
OA req'd per person for system area (Weighted average)	Rps	cfm/p				9.4								
Inputs for Potentially Critical zones														
Zone Name			*Zone title turns purple italic for critical zone(s)*				S200A Team Area	S201 Collaboration	S203B Preparation Room	S213B Preparation Room	S221 Administrative Assistant	S220 Medium Meeting	S221A Assistant Dean	
Zone Tag							2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor	
Space type			Select from pull-down list				Corridors	Conference/meeting	Science laboratories	Science laboratories	Office space	Conference/meeting	Office space	
Floor Area of zone	Az	sf					276	154	514	589	409	1135	165	
Design population of zone	Pz	P	(default value listed; may be overridden)				6	4	2	3	4	15	2	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					200	200	750	830	700	1340	400	
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					**0.68**								
Outdoor air intake required for system	Vot	cfm				**10007**								
Outdoor air per unit floor area	Vot/As	cfm/sf				**0.54**								
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				**21.7**								
Outdoor air as a % of design primary supply air	Ypd	cfm				**34%**								
Detailed Calculations														
Initial Calculations for the System as a whole														
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	29110								
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	6762								
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.23								
Initial Calculations for individual zones														
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.18	0.18	0.06	0.06	0.06	
OA rate per person	Rpz	cfm/p					0.00	5.00	10.00	10.00	5.00	5.00	5.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					200	200	750	830	700	1340	400	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		16.6	29.2	112.5	136.0	44.5	143.1	19.9	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		17	29	113	136	45	143	20	
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	=		0.08	0.15	0.15	0.16	0.06	0.11	0.05	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.08	0.15	0.15	0.16	0.06	0.11	0.05	
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.15	1.09	1.08	1.07	1.17	1.13	1.18	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.68**								
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	=	**10007**								
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.34**								
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+dTrl	=	23								

Advisor: Dr. Stephen Treado

Building:	Delaware County Community College STEM Center								
System Tag/Name:									
Operating Condition Description:									
Units (select from pull-down list)	IP								
Inputs for System	**Name**	**Units**		**System**					
Floor area served by system	As	sf		18409					
Population of area served by system (including diversity)	Ps	P	100% diversity	461					
Design primary supply fan airflow rate	Vpsd	cfm		29,110					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.13					
OA req'd per person for system area (Weighted average)	Rps	cfm/p		9.4					
Inputs for Potentially Critical zones									
Zone Name			*Zone title turns purple italic for critical zone(s)*		S221B Dean	S223 Office - 4 Person	S224 Office - 4 Person	S225 Office - 4 Person	S226 Office - 4 Person
Zone Tag					2nd Floor	2nd Floor	2nd Floor	2nd Floor	2nd Floor
Space type			Select from pull-down list		Office space	Office space	Office space	Office space	Office space
Floor Area of zone	Az	sf			232	249	249	252	249
Design population of zone	Pz	P	(default value listed; may be overridden)		3	4	4	4	4
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			560	340	340	340	340
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%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez				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			**0.68**					
Outdoor air intake required for system	Vot	cfm		**10007**					
Outdoor air per unit floor area	Vot/As	cfm/sf		**0.54**					
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		**21.7**					
Outdoor air as a % of design primary supply air	Ypd	cfm		**34%**					
Detailed Calculations									
Initial Calculations for the System as a whole									
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	29110					
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	6762					
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.23					
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
OA rate per person	Rpz	cfm/p			5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			560	340	340	340	340
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		28.9	34.9	34.9	35.1	34.9
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		29	35	35	35	35
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		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
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
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.05	0.10	0.10	0.10	0.10
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.05	0.10	0.10	0.10	0.10
System Ventilation Efficiency									
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.18	1.13	1.13	1.13	1.13
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	**0.68**					
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 =	**10007**					
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	**0.34**					
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 =	23					

Daniel A. Saxton
10/4/10

Building:	Delaware County Community College STEM Center													
System Tag/Name:														
Operating Condition Description:														
Units (select from pull-down list)	IP													
Inputs for System	**Name**	**Units**				**System**								
Floor area served by system	As	sf				19283								
Population of area served by system (including diversity)	Ps	P	100%	diversity		491								
Design primary supply fan airflow rate	Vpsd	cfm				36,410								
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.14								
OA req'd per person for system area (Weighted average)	Rps	cfm/p				9.6								
Inputs for Potentially Critical zones														
Zone Name							S308 Classroom	*S309 Classroom*	S310 Classroom	S317 Large Classroom	S318 Classroom	S321 Classroom	S301 Physics	
		Zone title turns purple italic for critical zone(s)												
Zone Tag							3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	
Space type		Select from pull-down list					Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Science laboratories	
Floor Area of zone	Az	sf					851	968	754	961	689	698	1968	
Design population of zone	Pz	P	(default value listed; may be overridden)				43	49	38	49	35	35	40	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					1,100	1240	1200	1500	1300	2800	3240	
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					**0.72**								
Outdoor air intake required for system	Vot	cfm				**10452**								
Outdoor air per unit floor area	Vot/As	cfm/sf				**0.54**								
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				**21.3**								
Outdoor air as a % of design primary supply air	Ypd	cfm				**29%**								
Detailed Calculations														
Initial Calculations for the System as a whole														
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	36410								
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	7493								
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.21								
Initial Calculations for individual zones														
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.12	0.12	0.12	0.12	0.12	0.18	
OA rate per person	Rpz	cfm/p					10.00	10.00	10.00	10.00	10.00	10.00	10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1100	1240	1200	1500	1300	2800	3240	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		532.1	606.2	470.5	605.3	432.7	433.8	754.2	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		532	606	470	605	433	434	754	
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	=		0.48	0.49	0.39	0.40	0.33	0.15	0.23	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.48	0.49	0.39	0.40	0.33	0.15	0.23	
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		0.72	0.72	0.81	0.80	0.87	1.05	0.97	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.72**								
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.66								
Minimum outdoor air intake airflow														
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	**10452**								
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.29**								
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	11334								
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.31								
OA Temp at which Min OA provides all cooling														
OAT below which OA Intake flow is @ minimum		Deg F	=	(Tp-dTsf)-(1-Y)*(Tr+dTrl	=	13								

Advisor: Dr. Stephen Treado

Building:	Delaware County Community College STEM Center											
System Tag/Name:												
Operating Condition Description:												
Units (select from pull-down list)	IP											
Inputs for System	**Name**	**Units**			**System**							
Floor area served by system	As	sf			19283							
Population of area served by system (including diversity)	Ps	P	100% diversity		491							
Design primary supply fan airflow rate	Vpsd	cfm			36,410							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf			0.14							
OA req'd per person for system area (Weighted average)	Rps	cfm/p			9.6							
Inputs for Potentially Critical zones												Potentially Critical Z
Zone Name						S305 Physics	S311 Organic Chemistry Lab	S314 General Chemistry Lab	S315 Earth and Space Lab	S316 Earth and Space Lab	S302A Physics Storage	S313B Storage
	Zone title turns purple italic for critical zone(s)											
Zone Tag						3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor
Space type		Select from pull-down list				Science laboratories	Science laboratories	Science laboratories	Science laboratories	Science laboratories	Storage rooms	Storage rooms
Floor Area of zone	Az	sf				1654	1474	1425	1436	1672	450	81
Design population of zone	Pz	P	(default value listed; may be overridden)			34	32	32	32	34	0	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				1600	8050	2770	2450	2860	620	180
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				**0.72**							
Outdoor air intake required for system	Vot	cfm			**10452**							
Outdoor air per unit floor area	Vot/As	cfm/sf			**0.54**							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p			**21.3**							
Outdoor air as a % of design primary supply air	Ypd	cfm			**29%**							
Detailed Calculations												
Initial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs	=	36410							
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As	=	7493							
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps	=	0.21							
Initial Calculations for individual zones												
OA rate per unit area for zone	Raz	cfm/sf				0.18	0.18	0.18	0.18	0.18	0.12	0.12
OA rate per person	Rpz	cfm/p				10.00	10.00	10.00	10.00	10.00	0.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm				1600	8050	2770	2450	2860	620	180
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az	=		637.7	585.3	576.5	578.5	641.0	54.0	9.7
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez	=		638	585	577	578	641	54	10
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	=		0.40	0.07	0.21	0.24	0.22	0.09	0.05
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz	=		0.40	0.07	0.21	0.24	0.22	0.09	0.05
System Ventilation Efficiency												
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa	=		0.81	1.13	1.00	0.97	0.98	1.12	1.15
System Ventilation Efficiency (App A Method)	Ev		= min (Evz)	=	**0.72**							
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3	=	0.66							
Minimum outdoor air intake airflow												
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev	=	**10452**							
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps	=	**0.29**							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev	=	11334							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps	=	0.31							
OA Temp at which Min OA provides all cooling												
OAT below which OA Intake flow is @ minimum		Deg F	= {(Tp-dTsf)-(1-Y)*(Tr+dTrl	=	13							

Daniel A. Saxton
10/4/10
Advisor: Dr. Stephen Treado

Building:	Delaware County Community College STEM Center												
System Tag/Name:													
Operating Condition Description:													
Units (select from pull-down list)	IP												
Inputs for System	**Name**	**Units**				**System**							
Floor area served by system	As	sf				19283							
Population of area served by system (including diversity)	Ps	P	100%	diversity		491							
Design primary supply fan airflow rate	Vpsd	cfm				36,410							
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.14							
OA req'd per person for system area (Weighted average)	Rps	cfm/p				9.6							
Inputs for Potentially Critical zones							ones						
Zone Name							S313C Hazardous Storage	S316A Storage	S300B Team Area	S300C Team Area	S319 Collaboration	S302B Preparation Room	S312 Instrumentation
		Zone title turns purple italic for critical zone(s)											
Zone Tag							3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor
Space type		Select from pull-down list					Storage rooms	Storage rooms	Corridors	Corridors	Conference/meeting	Science laboratories	Storage rooms
Floor Area of zone	Az	sf					167	80	265	265	477	488	318
Design population of zone	Pz	P	(default value listed; may be overridden)				0	0	2	3	4	2	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					190	100	200	200	480	600	400
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					**0.72**							
Outdoor air intake required for system	Vot	cfm				**10452**							
Outdoor air per unit floor area	Vot/As	cfm/sf				**0.54**							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				**21.3**							
Outdoor air as a % of design primary supply air	Ypd	cfm				**29%**							
Detailed Calculations													
Initial Calculations for the System as a whole													
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	36410							
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	7493							
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.21							
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	0.18	0.12
OA rate per person	Rpz	cfm/p					0.00	0.00	0.00	0.00	5.00	10.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm					190	100	200	200	480	600	400
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		20.0	9.6	15.9	15.9	48.6	107.8	38.2
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		20	10	16	16	49	108	38
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	0.10	0.08	0.08	0.10	0.18	0.10
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.11	0.10	0.08	0.08	0.10	0.18	0.10
System Ventilation Efficiency													
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.10	1.11	1.13	1.13	1.10	1.03	1.11
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.72**							
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.66							
Minimum outdoor air intake airflow													
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	**10452**							
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.29**							
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	11334							
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.31							
OA Temp at which Min OA provides all cooling													
OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+dTrl	=	13							

Item	Name	Units	Formula / Note	System	S313 Preparation Room	S320 Office - Adjunct Faculty	S322 Office - 4 Person	S323 Office - 4 Person	S324 Office - 4 Person	S325 Office - 4 Person
Building:	Delaware County Community College STEM Center									
System Tag/Name:										
Operating Condition Description:										
Units (select from pull-down list)	IP									
Inputs for System	**Name**	**Units**		**System**						
Floor area served by system	As	sf		19283						
Population of area served by system (including diversity)	Ps	P	100% diversity	491						
Design primary supply fan airflow rate	Vpsd	cfm		36,410						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.14						
OA req'd per person for system area (Weighted average)	Rps	cfm/p		9.6						
Inputs for Potentially Critical zones										
Zone Name			*Zone title turns purple italic for critical zone(s)*		S313 Preparation Room	S320 Office - Adjunct Faculty	S322 Office - 4 Person	S323 Office - 4 Person	S324 Office - 4 Person	S325 Office - 4 Person
Zone Tag					3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor	3rd Floor
Space type			Select from pull-down list		Science laboratories	Office space	Office space	Office space	Office space	Office space
Floor Area of zone	Az	sf			387	746	249	249	262	249
Design population of zone	Pz	P	(default value listed; may be overridden)		2	9	4	4	4	4
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			570	2000	190	190	190	190
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%
Air distribution type at conditioned analyzed			Select from pull-down list		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
Primary air fraction of supply air at conditioned analyzed	Ep									
Results										
Ventilation System Efficiency	Ev			**0.72**						
Outdoor air intake required for system	Vot	cfm		**10452**						
Outdoor air per unit floor area	Vot/As	cfm/sf		**0.54**						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		**21.3**						
Outdoor air as a % of design primary supply air	Ypd	cfm		**29%**						
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	36410						
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	7493						
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.21						
Initial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf			0.18	0.06	0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p			10.00	5.00	5.00	5.00	5.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			570	2000	190	190	190	190
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		89.7	89.8	34.9	34.9	35.7	34.9
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		90	90	35	35	36	35
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
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		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
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.16	0.04	0.18	0.18	0.19	0.18
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.16	0.04	0.18	0.18	0.19	0.18
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.05	1.16	1.02	1.02	1.02	1.02
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	**0.72**						
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	0.66						
Minimum outdoor air intake airflow										
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	**10452**						
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	**0.29**						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	11334						
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.31						
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} =	13						

Building:	Delaware County Community College STEM Center													
System Tag/Name:														
Operating Condition Description:														
Units (select from pull-down list)	IP													
Inputs for System	**Name**	**Units**					**System**							
Floor area served by system	As	sf					7741							
Population of area served by system (including diversity)	Ps	P	100%	diversity			347							
Design primary supply fan airflow rate	Vpsd	cfm					12,470							
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					9.9							
Inputs for Potentially Critical zones								Potentially Critical Zones						
Zone Name								S401 Classroom	S402 Classroom	S403 Classroom	S406 Classroom	S407 Classroom	S411 Classroom	*S412 Classroom*
		Zone title turns purple italic for critical zone(s)												
Zone Tag								4th Floor	4th Floor	4th Floor	4th Floor	4th Floor	4th Floor	4th Floor
Space type								Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Classrooms (age 9 plus)
		Select from pull-down list												
Floor Area of zone	Az	sf						611	1000	638	774	860	777	966
Design population of zone	Pz	P	(default value listed; may be overridden)					32	50	32	39	44	39	49
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm						1,430	1900	1000	1120	1200	1140	1300
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						**0.88**							
Outdoor air intake required for system	Vot	cfm					**4930**							
Outdoor air per unit floor area	Vot/As	cfm/sf					**0.64**							
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p					**14.2**							
Outdoor air as a % of design primary supply air	Ypd	cfm					**40%**							
Detailed Calculations														
Initial Calculations for the System as a whole														
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	12470								
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	4353								
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.35								
Initial Calculations for individual zones														
OA rate per unit area for zone	Raz	cfm/sf						0.12	0.12	0.12	0.12	0.12	0.12	0.12
OA rate per person	Rpz	cfm/p						10.00	10.00	10.00	10.00	10.00	10.00	10.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm						1430	1900	1000	1120	1200	1140	1300
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=			393.3	620.0	396.6	482.9	543.2	483.2	605.9
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=			393	620	397	483	543	483	606
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	=			0.28	0.33	0.40	0.43	0.45	0.42	0.47
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=			0.28	0.33	0.40	0.43	0.45	0.42	0.47
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=			1.07	1.02	0.95	0.92	0.90	0.93	0.88
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.88**								
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	=	**4930**								
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.40**								
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	6364								
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.51								
OA Temp at which Min OA provides all cooling														
OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+dTrl	=	29								

Daniel A. Saxton
10/4/10

Advisor: Dr. Stephen Treado

Building:	Delaware County Community College STEM Center
System Tag/Name:	
Operating Condition Description:	
Units (select from pull-down list)	IP

Inputs for System	Name	Units			System
Floor area served by system	As	sf			7741
Population of area served by system (including diversity)	Ps	P	100%	diversity	347
Design primary supply fan airflow rate	Vpsd	cfm			12,470
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			9.9

Inputs for Potentially Critical zones			S413 Classroom	S408 Conference	S415 Conference	S416 Astronomy Lab
Zone Name		*Zone title turns purple italic for critical zone(s)*	4th Floor	4th Floor	4th Floor	4th Floor
Zone Tag			Classrooms (age 9 plus)	Conference/meeting	Conference/meeting	Science laboratories
Space type		Select from pull-down list				
Floor Area of zone	Az	sf	709	297	417	692
Design population of zone	Pz	P (default value listed; may be overridden)	36	4	5	17
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm	1150	360	600	1270
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%
Air distribution type at conditioned analyzed		Select from pull-down list	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez		1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep					

Results			
Ventilation System Efficiency	Ev		**0.88**
Outdoor air intake required for system	Vot	cfm	**4930**
Outdoor air per unit floor area	Vot/As	cfm/sf	**0.64**
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p	**14.2**
Outdoor air as a % of design primary supply air	Ypd	cfm	**40%**

Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	12470					
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	4353					
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.35					
Initial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.06	0.06	0.18	
OA rate per person	Rpz	cfm/p					10.00	5.00	5.00	10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1150	360	600	1270	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		445.1	37.8	50.0	294.6	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		445	38	50	295	
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		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	
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	
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.39	0.11	0.08	0.23	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.39	0.11	0.08	0.23	
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		0.96	1.24	1.27	1.12	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.88**					
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	=	**4930**					
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.40**					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	6364					
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.51					
OA Temp at which Min OA provides all cooling											
OAT below which OA intake flow is @ minimum		Deg F	=	{(Tp-dT sf)-[1-Y)*(Tr+dTrl	=	29					

Appendix B: Lighting Power Schedule and Calculations

LUMINAIRE SCHEDULE

FIXTURE TYPE	FIXTURE DESCRIPTION	COMMERCIAL EXAMPLE: MANUFACTURER & CATALOG NUMBER	VOLTAGE	LAMPS	ACTUAL WATTS	INSTANCES	WATTAGE PER FIXTURE TYPE	MOUNTING
A	1' X 4' RECESSED HIGH EFFICIENCY ACRYLIC LENSED LUMINAIRE WITH DIMMING BALLAST	LEDALITE VECTRA 9714D1STT232-S-7-2-E FOCAL POINT FEQ ZUMTOBEL ML4	277	(2) 32W 830 T8	65	606	39390	RECESSED
A1	1' X 4' RECESSED HIGH EFFICIENCY ACRYLIC LENSED LUMINAIRE	LEDALITE VECTRA 9714D1STT132-S-1-2-E FOCAL POINT FEQ ZUMTOBEL ML4	277	(1) 32W 830 T8	33	79	2607	RECESSED
A2	1' X 4' RECESSED HIGH EFFICIENCY ACRYLIC LENSED LUMINAIRE	LEDALITE VECTRA 9714D1CRT232-S-1-2-E FOCAL POINT FEQ ZUMTOBEL ML4	277	(2) 32W 830 T8	65	71	4615	RECESSED
B	2' X4' RECESSED A0.125" ACRYLIC LENSED LUMINAIRE	COOPER METALUX 2GC8S-332A125-277V-EB81 LITHONIA LIGHTOLIER	277	(3) 32W 830 T8	94	17	1598	RECESSED
B2	2' X 2' RECESSED A0.125" ACRYLIC LENSED LUMINAIRE	COOPER METALUX 2GC-317A125-277V-EB81 LITHONIA LIGHTOLIER	277	(3) 17W 830 T8	61	9	549	RECESSED
C	6" OPEN DOWNLIGHT	COOPER PORTFOLIO C6226E-6251LI-WF LITHONIA LIGHTOLIER	277	(2) 26W TTT	58	148	8584	RECESSED
D	6" DIMMABLE OPEN DOWNLIGHT	COOPER PORTFOLIO C62182D-6251LI-WF LITHONIA LIGHTOLIER	277	(2) 18W TTT	43	125	5375	RECESSED
E	6" DIMMABLE OPEN DOWNLIGHT	COOPER PORTFOLIO C62262D-6251LI-WF LITHONIA LIGHTOLIER	277	(2) 26W TTT	58	88	5104	RECESSED
F	3' ROUND RECESSED ACRYLIC LENSED LUMINAIRE	PRUDENTIAL P-8930(4)T8CWATMWSC277X1 MARK LIGHTING MG34-T8EB277 OR APPROVED EQUAL	277	(4) 25W 830 T8	101	22	2222	RECESSED
G	6' ROUND RECESSED ACRYLIC LENSED LUMINAIRE	PRUDENTIAL P-8960(8)T8CWATMWSC277X1 OR APPROVED EQUAL	277	(8) 32W 830 T8	282	9	2538	SURFACE
H	DECORATIVE 6" RECESSED DOWNLIGHT	LIGHTOLIER D6A01-8051CL-6218HU OR APPROVED EQUAL	277	(2) 18W Q	39	48	1872	RECESSED
J	RECESSED PERIMETER OPEN WALL WASH LUMINAIRE WITH SLIDING SLEEVE AS REQUIRED. LENGTH AS INDICATED ON PLAN.	FOCAL POINT MARK LIGHTING MP1-T8EBEBB--2 OR APPROVED EQUAL	277	(1) 32W 830 T8 PER 4'	33	81	2673	RECESSED
K	4' RECESSED WALL WASH LUMINAIRE	FOCAL POINT FAVA-NS-1T5-1C-UNV-S-X-WH-4	277	(1) 28W 830 T5	33	12	396	RECESSED
L	6" SURFACE MOUNTED DOWNLOAD	COOPER PORTFOLIO C16032EP-LI LITHONIA LIGONIER	277	(2) 26 W TTT	59	5	295	COLUMN
M	6" OPEN WALL WASH DIMMABLE DOWNLIGHT	COOPER PORTFOLIO C62182D-6211LI-WF LITHONIA LIGHTOLIER	277	(2) 18W TTT	43	44	1892	RECESSED
N	CEILING SURFACE MOUNTED WET LOCATION	PRISMA DISCUS 28 072457 OR APPROVED EQUAL	277	(1) 26W TTT	29	19	551	SURFACE
P	EXTERIOR FULL CUT OFF FIXTURE ON 12' POLE	BEGA #8309MH OR APPROVED EQUAL	208	150W MH	166	0* *SITE LIGHTING	0	POLE
Q	4' STRIP FIXTURE WITH CAGE	COOPER SS232277VEB81 LITHONIA LIGHTOLIER	277	(2) 32W 830 T8	65	24	1560	PENDANT
Q2	8' STRIP FIXTURE WITH CAGE	COOPER 8TSS232277VEB81 LITHONIA LIGHTOLIER	277	(2) 32W 830 T8	65	22	1430	PENDANT
R	LED STAIR TREAD FIXTURE LENGTH AS INDICATED ON PLAN	PROLUME RIA-XX"-WWF WITH PSX24-100/0 AS REQUIRED OR APPROVED EQUAL	120	INCLUDED	27	32	864	STAIR
S	8' WALL MOUNTED UP/DOWN FIXTURE	NATIONAL LIGHTING S66-ID/D-W-4T8-A OR APPROVED EQUAL	277	(4)32W 830 T8	141	16	2256	SURFACE WALL
T	WALL MOUNTED INTERIOR DIRECT FLOOD LIGHT IN SKYLIGHT	 OR APPROVED EQUAL	277	(1) 26W	29	4	116	SURFACE WALL
U	ELEVATOR PIT LIGHT	COOPER VT2-232-DR-120-EB	120	(1) 26W TTT	29	3	87	WALL
U2	RECESSED VAPOR TIGHT FIXTURE	COOPER PORTFOLIO C6226E-6280LI4G LITHONIA LIGHTOLIER	277	(2) 26W TTT	58	4	232	RECESSED

V	12" 120° LED STRIPS TO BE CONTINUOUSLY MOUNTED IN COVE, LENGTH AS INDICATED ON PLAN	PHILIPS Ew523-000004-00 / 999-000284-00 OR APPROVED EQUAL	120	INCLUDED	0	0	**0**	COVE
W	MINI 3W LED SPOT FOR SIGNAGE WITH DRIVER	VISUAL LIGHTING BLUX-0401-080-W-NX WITH 901-006-700-U PER (2) SPOTS OR APPROVED EQUAL	120	INCLUDED	4	6	**24**	SURFACE
X	EXTERIOR RECESSED LENSED DOWNLIGHT	COOPER PORTFOLIO CL9142E-10002P LITHONIA LIGHTOLIER	277	(1) 26W TTT	29	52	**1508**	RECESSED
Y	RECESSED CHROME XENON DISPLAY CASE FIXTURE	PEGASUS PALPX-CH-PHD60 AMERICAN LIGHTING LVPX80CH OR APPROVED EQUAL	120	INCLUDED	0	10	**0**	RECESSED
Z	DECORATIVE PENDANT	TECH LIGHTING 700FJSDAFC OR APPROVED EQUAL	120	50W BIPIN HALOGEN	55	2	**110**	PENDANT
EXIT	EDGE LIT LED EXIT SIGN WITH RED LETTERS AND SILVER BACKING	COOPER LITHONIA LIGHTOLIER	277	INCLUDED	0	0 Negligible	**0**	MOUNTING, SIDES, CHEVRONS AS INDICATED ON PLANS
						TOTAL:	**88448**	

GENERAL NOTES:

1. PROVIDE ALL LAMPS WITH 3000K COLOR TEMPERATURE.
2. PROVIDE ALL LAMPS WITH 80+ CRI.
3. PROVIDE ALL FIXTURES WITH LINEAR FLUORESCENT LAMPS WITH AN INTEGRAL DISCONNECTING MEANS PER NEC ARTICLE 410-73 (G).

KEYED NOTES:

L1 PROVIDE DRYWALL KIT.