Technical Report 1

ASHRAE Standard 62.1
& Standard 90.1 Evaluation

The Salvation Army Ray & Joan Kroc Corps Community Center of Salem Oregon

Mathias Kehoe
Mechanical Option
Advisor: Stephen Treado
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Table of Contents

Executive Summary

In the following report, a detailed analysis will be performed on the Ray & Joan Kroc Corps Community Center of Salem Oregon to determine whether or not the building complies with ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Standard 62.1 and Standard 90.1. Standard 62.1 analyzes the ventilation equipment and addresses ventilation requirements for each room based on occupancy and square footage. Standard 90.1 evaluates the energy usage of buildings. This standard addresses the tightness of the building envelope, the intelligence of the HVAC control system, the efficiency of the water heaters, the distribution of power, and the density of lighting. This report will break down each part of these standards to reveal how closely the Kroc Center adheres to ASHRAE's standards.

The Kroc Center followed ASHRAE's requirements remarkably well in section five of Standard 62.1. The building met or exceeded the requirements in all but one category. The area where the building failed to comply dealt with air filters in the air handling units; about half of the air handlers did not specify filters with high enough quality. The design team probably consulted ASHRAE Standard 62.1 when designing the building for it to perform this well.

The building met minimum design standards addressed in section six of Standard 62.1 for all but one of the air handlers. As addressed later in the report, the compliance failure was most likely a result of different assumptions which caused a few of the spaces to be grossly over ventilated. The two pools had very high ventilation rates, but that may have been an air quality issue that caused such high rates. The design team must have been much more conservative when laying out the ventilation system which would explain the high outdoor air rates. Whether the high ventilation rates are justifiable or not, they do present an area of potential energy savings.

The Kroc Center performed well in Standard 90.1, and it should have since the building was designed to achieve LEED Gold. The building envelope failed to meet the requirements for floor, roof, and window insulation values. These systems were close to passing but came up a little short. The building has a very advanced control system which allowed it meet the requirements for HVAC control and water heating. Also, a well thought out lighting and electrical scheme helped earn more energy savings. The Kroc Center performed very well with Standard 90.1, complying in nearly every section.

Building Summary

The Salvation Army Ray & Joan Kroc Corps Community Center of Salem Oregon was a new construction project located in Salem, Oregon. The Kroc Center is a one story, ninety-two thousand square foot facility located on a ten and a half acre campus. The building has a number of large, energy-intensive spaces including a full-size gymnasium, a competition pool, a leisure pool, a large chapel, a commercial size kitchen, and rooms to host community events. The Kroc Center also contains several offices, classrooms, small recreation rooms, and support spaces for the larger areas. The Kroc Center is surrounded by large athletic fields which are owned by the Salvation Army. The different building features enable the Kroc Center to be used by children, teens, families and adults from the community.

The Kroc Center was funded entirely by the Salvation Army. The Salvation Army allotted $35.5 million to build the Kroc Center, but the total cost of construction was slightly less then that at approximately $33.3 million. The Salvation Army also donated a matching $35.5 million endowment to operate the building.

Mechanical System Summary

The Kroc Center uses a variety of mechanical equipment to condition its many different spaces. All of the heating, cooling and ventilation loads are supplied by air handlers scattered across the roof of the building. The two pools are conditioned by very large, individual air handling units. The kitchen, community spaces, and most of the classrooms are conditioned by an individual packaged rooftop unit. Two rooftop units are used to condition the gymnasium space. Other packaged rooftop units are spread out across the roof and service smaller spaces around community center. Two fan coil units are used to condition the platform of the chapel and the backstage spaces. Also the Kroc Center has two make-up air units; one above the kitchen, and one above the restrooms and storage areas on the south side of the competition pool. All of the ventilation for the entire building is supplied through the above equipment. Also, there is a mechanical room by the leisure pool that supplies domestic hot water for the entire building and hot water for the two pools.

ASHRAE 62.1 Analysis

Section 5 - Systems and Equipment

Section 5.1 - Natural Ventilation

Natural Ventilation is not a viable option given the colder, northern climate of Oregon. As a result, the windows in the Kroc Center are not operable.

Section 5.2 – Ventilation Air Distribution

The individual air handlers were able to meet the ventilation requirements stated in section 6 of ASHRAE Standard 62.1 except one. Rooftop Unit 7 is about 200 CFM below the required level. The results will be discussed in more detail later in the report.

Section 5.3 – Exhaust Duct Location

The Kroc Center is a one-story building. All of the exhaust ductwork is exhausted directly through the roof or exterior walls; there is no potential for leakage between spaces. Also, the exhaust fans are located away from outdoor air inlets on the rooftop mechanical equipment, so there is no possibility of cross contamination there. The areas of most concern are the pool areas, but the air is returned to the air handling unit and exhausted away from the outdoor air inlet.

Section 5.4 – Ventilation System Controls

The Kroc Center uses a VAV system to distribute the conditioned air. Each VAV box has a minimum setting that meets the minimum outdoor airflow requirements as require by section 6 of ASHRAE Standard 62.1. Actuators are located on dampers upstream of the diffuser. The actuators are thermostatically reset to maintain airflows within ten percent of required load even at part load.

Section 5.5 – Airstream Surfaces

The Kroc Center uses both sheet metal and fabric ducts. Section 15880 of the project specifications states that all ductwork must conform to the requirements of UL181. The Kroc Center complies with ASHRAE's standards on this subject.

Section 5.6 – Outdoor Air Intakes

The outdoor air intakes on the rooftop units and air handling units exceed the minimum distance from exhaust vents as described in table 5-1 of Standard 62.1. Also, all exterior ductwork is designed to prevent the intrusion of moisture into the airflow, see Note 8/M702.

Section 5.7 – Local Capture of Contaminants

The major area for contamination is the two pool areas. A quick check with a ductulator reveals that the exhaust ductwork is large enough to handle airflows much higher than the supply air. By exhausting more air than is being supplied, the pools are negatively pressurized which will keep the chlorine and other chemicals from spreading into the building. The building complies with this section.

Section 5.8 – Combustion Air

There are five natural gas boilers housed in the mechanical room on the south side of the leisure pool. A large relief vent is located above the mechanical room to provide an adequate amount of combustion air to the space.

Section 5.9 – Particulate Matter Removal

Filters are specified to have a rating of MERV 6 for rooftop units from 20 to 75 tons. For the smaller units, filters are called for but are not specified strictly enough to meet the requirements of the ASHRAE standard. These filters are inadequate to fulfill the requirements, so the Kroc Center does not comply with this section.

Section 5.10 – Dehumidification Systems

The maximum humidity specified for the Kroc Center is 60% and occurs in summer mode; this is less than the 65% required by ASHRAE. The entire building has a net positive pressure which will help limit infiltration. The building complies with this section.

Section 5.11 – Drain Pans

Air Handling Units are to have stainless steel, insulated drain pans with two connections, one to each side of the unit. The packaged rooftop units are also specified to have drain pans under the entire unit. The Kroc Center complies with this section.

Section 5.12 – Finned-Tube Coils and Heat Exchangers

The air handling units are specified to have drain pans under the heat exchangers in the unit. The drain pans meet the requirements of Section 5.11, and comply with this section.

Section 5.13 – Humidifiers and Water-Spray Systems

The Kroc Center does not employ humidifiers or water-spray systems.

Section 5.14 – Access for Inspection, Cleaning, and Maintenance

An access panels to above the ceiling is provided for the series fan powered boxes inside the building. The remainder of the air handling equipment is located on the roof, so the maintenance staff has easy access to them.

Section 5.15 – Building Envelope and Interior Surfaces

Vapor barriers are provided throughout the entire building envelope to prevent liquid penetration through the walls and roof. All HVAC ductwork, condensate piping, cold water piping, and refrigerant piping is specified to have insulation to prevent condensation. The Kroc Center complies with this section.

Section 5.16 – Buildings with Attached Parking Garages

The Kroc Center does not have an attached parking garage.

Section 5.17 – Air Classification and Recirculation

Most of the building contains Class 1 air that can be recirculated throughout the building. The restrooms and locker rooms are considered Class 2 air and are exhausted through the roof. The gymnasium is also Class 2 air but some of the air is recirculated back into the gym only. The two pools have Class 3 air and recirculate a portion of the air but only in their respective spaces. The kitchen has Class 4 air, but that air is exhausted outdoors and not recirculated to other parts of the building.

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

The Kroc Center is a community center trying to reach LEED status, so the entire building is ETS-free. This section does not apply to this building.

Section 6 – Procedures

The Kroc Center was tested against ASHAE Standard 62.1-2007 to discover whether or not it complies with ASHRAE's minimum ventilation design requirements. With such a large variation of spaces within the Kroc Center, it was determined that all of the mechanical units that supply outside air should be checked for compliance. A spreadsheet was provided to run the tests, and the spreadsheet results for each of the units are listed in Appendix A. The following equations were used to determine compliance.

Breathing Zone Outdoor Airflow

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

Where: V_{bz} = breathing zone outdoor airflow (cfm)
R_p = required airflow rate per person (cfm/person)
P_z = zone population (people)
R_a = require airflow rate per unit area (cfm/sq.ft.)
A_z = zone floor area (sq. ft.)

Zone Outdoor Airflow

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

Where: V_{oz} = Zone Outdoor Flow
E_z = Zone Air Distribution Effectiveness = 1.0

Outdoor Air Intake Flow

$$V_{ot} = V_{oz}$$

Primary Outdoor Air Fraction

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

Where: V_{pz} = Zone Primary Airflow

For VAV systems V_{pz} is the minimum expected airflow

After analyzing the entire ventilation system for the Kroc Center, it was determined that the current ventilation system meets or exceeds minimum design requirements established by ASHRAE Standard 62.1 for all units except one. Rooftop unit 7 is a little below the required level. The main space that RTU 7 services is an aerobics exercise room. ASHRAE's suggested population density and required airflow per person seemed high, 40 (people / 1000 sq ft) and 20 (cfm / person) respectively. The design team most likely used less conservative assumptions for that space which could explain the small outdoor air deficit. Table 1 shows how the current system compares to ASHRAE's minimum standards.

Unit	Description	Scheduled OA	ASHRAE Required OA	Compliance	% Difference
AHU 1	Competition Pool	10488	5818	Y	80%
AHU 2	Leisure Pool	8988	4735	Y	90%
FCU 1	Stage - North	880	648	Y	36%
FCU 2	Stage - South	880	647	Y	36%
RTU 1	North Office Wing	9610	8188	Y	17%
RTU 2	Office Wing	1640	1094	Y	50%
RTU 3	Chapel	4800	1795	Y	167%
RTU 4	Climbing Wall	2300	342	Y	573%
RTU 5	Gym - North	2800	2203	Y	27%
RTU 6	Gym - South	2800	2203	Y	27%
RTU 7	Aerobics	1230	1430	N	-14%
RTU 8	Fitness	1200	1005	Y	19%
RTU 9	Wet Multi-Purpose	1360	370	Y	268%
RTU 10	Locker Rooms	2750	1142	Y	141%

Table 1 – Ventilation Compliance

A number of units have outside air measurements much higher than the required amount. The pool areas probably have much higher amounts to maintain a healthier indoor air quality level by flushing out the chlorine and other chemicals. The other areas that are significantly over the required values are the chapel, climbing wall, and the locker rooms. The locker rooms are probably high to maintain a better indoor environment, much like the pools. The chapel probably accounted for a higher density of people or a higher activity level for the people in the chapel. The climbing wall is a very unique space and doesn't fit well into any of ASHRAE's predetermined spaces. The closest option was selected, but the designers probably took a more conservative approach. Overall, the ventilation rates are a little larger than the minimum required amount to ensure that the ventilation requirements will be met, even when the VAV boxes are at partial load.

Standard 62.1 Summary

The Kroc Center complied very closely to ASHRAE Standard 62.1. A few small issues arose, but they do not pose serious problems. The failure of the filters to meet ASHRAE's requirements could be easily remedied, and the one ventilation deficit could be fixed by dispersing the air slightly differently. Overall, it was impressive how well the Kroc Center performed.

ASHRAE Standard 90.1 Analysis

Section 5 – Building Envelope

5.1.4 Climate

The Kroc Center was built in Salem, Oregon which is located in climate zone 4.

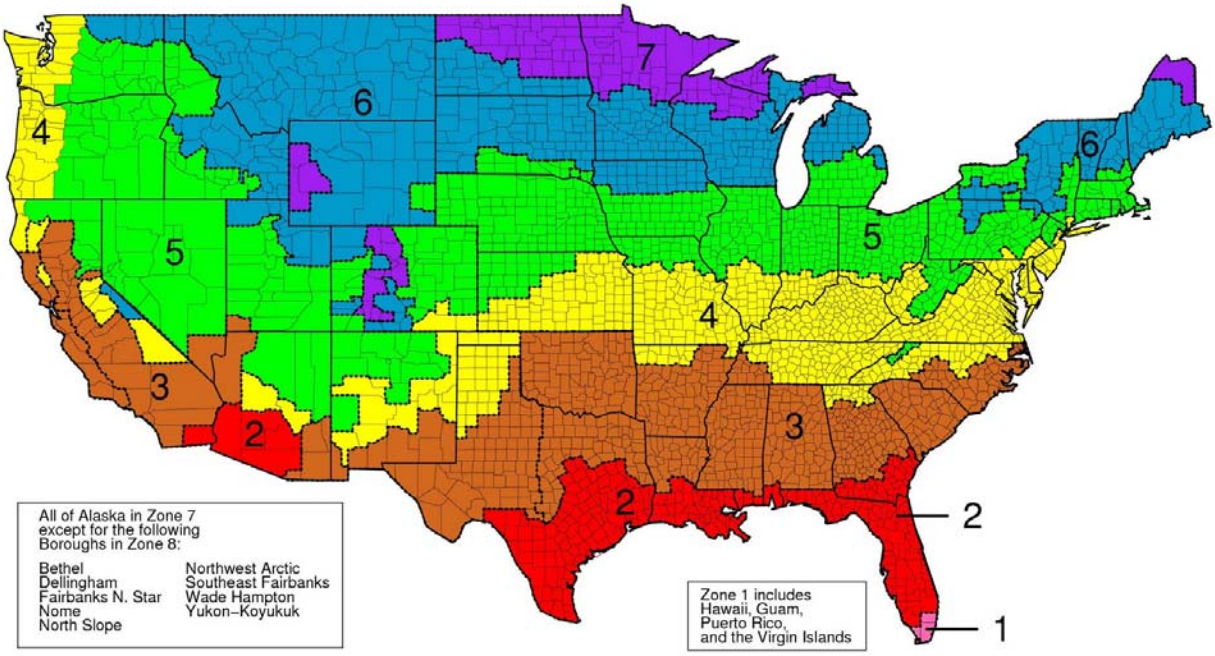

Figure 1 - United States Climate Map

5.4 Mandatory Provisions

All fenestrations and doors are to be sealed as mentioned in the drawings and the specifications. Additionally all fenestrations and doors in the pool areas are to use bituminous dampproofing to prevent moisture penetration in areas subject to high humidity, dampness, and direct water content.

The Kroc Center has two primary entrances. Both have sets of double doors more than seven feet apart when closed. Another back entrance has a set of double with close to seven feet in between the doors, which is acceptable because those doors are not used as a primary entrance.

5.5 Prescriptive Building Envelope Option

Verify that the building elements meet minimum Building Envelope Requirements for Climate Zone 4. The walls, roof, floor, and glazing were all evaluated. The results are listed below in Table 2 and Table 3.

		Prescribed by 90.1		As Designed		
Element	Description	Assembly U Max	Insulation Min R-Value	Assembly U Max	Insulation Min R-Value	Std. 90.1 Compliance
Roof	Insulation Entirely Above Deck	0.048	20	0.053	19	**No**
Walls Above Grade	Mass	0.104	9.5	0.077	13	Yes
Walls Below Grade	Below-Grade Walls	1.140	NR	NA	NA	Yes
SOG Floors	Unheated	0.073	NR	0.100	NA	**No**

Table 2 – Building Envelope Compliance

After a quick glance at the building elevations, one can see that the glazing is well under forty percent of the total surface area of the exterior of the building, which is a requirement for the building to comply with the ASHRAE standard.

		Prescribed by 90.1		As Designed		
Element	Description	Assembly U Max	Max SHGC	Assembly U Max	Max SHGC	Std. 90.1 Compliance
Glazing (Base)	Metal Framing (Curtain Wall)	0.50	0.40	0.35	0.50	**No**
Glazing (Alternate)	Metal Framing (Curtain Wall)	0.50	0.40	0.28	0.31	Yes

Table 3 – Building Glazing Compliance

There are several areas where the building envelope fails to comply with ASHRAE Standard 90.1. The roof u-value is just slightly under the ASHRAE standard, so it does not represent a major concern. The floors also failed to comply with ASHRAE Standard 90.1, but the U-value is still very low so the floors will not pose a problem either. Lastly the glazing. It could not be determined which glazing the contractor selected. If the contractor chose the base product it would fail to comply because the shading coefficient was too high. But if the contractor selected the alternate glazing, then it would comply with the standard. There were a lot of little areas where the building failed to comply, but none will present major problems moving forward.

Section 6 – Heating, Ventilating, and Air Conditioning

6.2 Compliance Paths

There are two methods for determining compliance with this standard: the simplified approach or the mandatory provisions. The simplified approach can only be used for buildings with less than 25,000 square feet, so this report used the mandatory provisions method.

6.4 Mandatory Provisions

The Building Control System is a Direct Digital Control (DDC) system which can perform all of the automatic temperature control and energy management functions as required in the plans and specifications. The system will independently control the building's HVAC equipment to maintain a controlled environment in an energy efficient manner. The building operator can communicate with the system and control the sequence of operation to maintain the desired temperature.

The control system allows for all of the mechanical equipment to be turned down or off according the owner's desire to allow for energy savings. The owner is given a lot of control over the system and the owner can determine the operating times for all of the equipment. Some of the mechanical equipment will shut off until the building drops below 60F. When the temperature of the building drops that low the equipment will turn back on to prevent the building from cooling too much and causing possible freezing damage. This allows the building to save the most energy without worrying about damaging the building. The Kroc Center meets all the control requirements and complies with this section.

All of the HVAC piping and ductwork is to be insulated. All exterior ductwork will have rigid insulation, and all interior ductwork will be covered in fiberglass insulation. Also, all hot and cold water piping will be wrapped in fiberglass insulation, elastometric foam, or cellular glass.

6.5 Prescriptive Path

All of the rooftop units are equipped with economizers that are capable of producing up to one hundred percent outdoor air to allow for free cooling. The DDC control system controls the adjusting of the dampers on the unit, but the owner can adjust the ventilation rates. The two large air handling units do not employ economizers because they are over 65,000 Btu/h and do not need economizers as required in Table 6.5.1 in ASHRAE Standard 90.1

All fan motors that are over 1 hp must meet the restrictions listed in Table 6.5.3.1.1A of ASHRAE Standard 90.1. Table 4 shows the compliance of all fans that exceed 1 hp; the smaller fans were left off to conserve space. The two large air handlers have VFD controls instead of VAV boxes, so they were still treated the same as the other variable systems.

Unit	HP	CFM	CFM x 0.0015	Compliance
AHU 1 Supply	25 (2)	41960	31.5 (2)	Y
AHU 1 Return	15 (2)	26170	20 (2)	Y
AHU 2 Supply	20 (2)	35950	27 (2)	Y
AHU 2 Return	10 (2)	21570	16 (2)	Y
REF R2	5	5400	8.1	Y
REF R5	5	7000	10.5	Y
REF R6	5	7000	10.5	Y
REF R8	5	8300	12.45	Y
MAU R2	5	5200	7.8	Y

Table 4 – Fan HP Compliance

There is a fume hood in the kitchen. However, the total cfm is under 5000, so no makeup air is necessary, although some is provided. The Kroc Center complies with this section.

6.7 Submittals

The specifications call for copies of all drawings and operating and maintenance manuals to be handed over to the owner upon completion of the building. Also, a testing and balancing report is to be performed after the entire system is installed. The Kroc Center is still going through the LEED certification process at this time, so the final commissioning report is not available.

Section 7 – Service Water Heating

There are four water heaters that supply the domestic hot water to the building. Two gas boilers are located in the mechanical room. Another gas boiler is located in the janitor closet near the kitchen, and an electric hot water heater is located in the janitor closet by the competition pool. The two satellite water heaters are primarily used to provide a quick source of hot water to areas of the building far from the mechanical room. All of the hot water heaters in the Kroc Center besides the two satellite heaters are tankless.

Three additional gas boilers are located in the mechanical room and supply hot water to the two pools and two air handling units. These boilers are connected and work together to meet the hot water demands; so when the pools are at partial load one or two of the boilers can shut off. The three pool boilers can also be manually shut off as is required in ASHRAE Standard 90.1. Overall the water heating service complies with ASHRAE Standard 90.1

Section 8 – Power

The specifications state that the maximum allowable voltage drop for feeders is two percent, and the maximum voltage drop for branch circuits is three percent. It is the responsibility of the contractor to increase cable sizes to ensure that proper voltage drop levels are achieved. This is exactly what is called for in section 8 of ASHRAE Standard 90.1, so the Kroc Center complies with this section.

Section 9 – Lighting

9.2 Compliance Path

There are two methods for determining the compliance of the Kroc Center: the Building Area Method and the Space-by-Space Method. This report will use the Building Area Method to check for compliance.

9.4 Mandatory Provisions

Photoelectric switches are to be used on exterior and interior lighting. The exterior switches will turn off the exterior lighting during the day. The interior switches will adjust interior lighting levels based on daylight levels within the building. Occupancy sensors are also to be installed in the rooms to prevent wasted electricity.

9.5 Building Area Method Compliance Path

The first step is to determine the building type which will give you a specific maximum lighting density. The Kroc Center is composed of a lot of different types of spaces, so I chose the Convention Center. It is an accurate depiction because it is a little higher than the gymnasiums to show the increased lighting density in the smaller areas. The results are summarized in Table 5, but the full worksheet can be seen in Appendix B.

Total Watts	Total SF	Design W/SF	Required W/SF	Compliance
104998	92000	1.14	1.20	Yes

Table 5 – Lighting Compliance

Standard 90.1 Summary

Overall the Kroc Center complied very well with the requirements established in ASHARE Standard 90.1. There were a few small issues with the building envelope, but these issues are minor and not cost-effective to change. Even as they stand, the envelope systems that fail to comply are very close to the ASHRAE requirements. The section on HVAC complied nearly perfectly with the standard 90.1. The Kroc Center has a very sophisticated control sequence enabling it to meet the requirements for optimal energy savings. Also, the fan power selections in the air handlers were well done; the design team kept them well below ASHRAE standards. The water heaters also benefited from the advanced control system, and fit within the standard 90.1 guidelines. The electrical power system also fulfills ASHRAE's requirements by maintaining low voltage drops throughout the whole system. Lastly, the lighting system came in just under the requirements, which was surprising considering the accent lighting and high-bay lighting throughout the building. Overall the Kroc Center fulfills the requirements of ASHRAE Standard 90.1 with only a few minor faults.

References

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

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

Construction Documents and Project Specifications for The Salvation Army Ray & Joan Kroc Corps Community Center of Salem Oregon. Courtesy of BRS Architecture.

Appendix A

Building:	Kroc Center					
System Tag/Name:	AHU 1					
Operating Condition Description:	Ventilation					
Units (select from pull-down list)	IP					

	Name	Units		System		
Inputs for System						
Floor area served by system	As	sf		12120		
Population of area served by system (including diversity)	Ps	P	100% diversity	10		
Design primary supply fan airflow rate	Vpsd	cfm		42,000		
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.48		
OA req'd per person for system area (Weighted average)	Rps	cfm/p		0.0		
Inputs for Potentially Critical zones					Potentially Critical Zones	
Zone Name			*Zone title turns purple italic for critical zone(s)*		*Competition Pool*	enter name
Zone Tag					E101	enter tag
Space type			Select from pull-down list		Swimming (pool & deck)	Office space
Floor Area of zone	Az	sf			12,120	
Design population of zone	Pz	P	(default value listed; may be overridden)		10	0
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			42,000	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A		ITU	
Local recirc. air % representative of ave system return air	Er				75%	
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				100%	
Results						
Ventilation System Efficiency	Ev			1.00		
Outdoor air intake required for system	Vot	cfm		5818		
Outdoor air per unit floor area	Vot/As	cfm/sf		0.48		
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		581.8		
Outdoor air as a % of design primary supply air	Ypd	cfm		14%		
Detailed Calculations						
Initial Calculations for the System as a whole						
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= VpdDs =	42000		
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	5818		
Uncorrected OA req'd as a fraction of primary SA	Xs		= Vou / Vps =	0.14		
Initial Calculations for individual zones						
OA rate per unit area for zone	Raz	cfm/sf			0.48	0.06
OA rate per person	Rpz	cfm/p			0.00	5.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm			42000	0
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		5817.6	0.0
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		5818	0
Fraction of zone supply not directly recirc. from zone	Fa		= Ep + (1-Ep)Er =		1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		= Ep =		1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		= 1-(1-Ez)(1-Ep)(1-Er) =		1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.14	0.00
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.14	0.00
System Ventilation Efficiency						
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		1.00	1.14
System Ventilation Efficiency (App A Method)	Ev		= min (Evz) =	1.00		
Ventilation System Efficiency (Table 6.3 Method)	Ev		= Value from Table 6.3 =	1.01		
Minimum outdoor air intake airflow						
Outdoor Air Intake Flow required to System	Vot	cfm	= Vou / Ev =	5818		
OA intake req'd as a fraction of primary SA	Y		= Vot / Vps =	0.14		
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= Vou / Ev =	5752	66.06	
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.14	0.01	
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 =	-51		

Building:						Kroc Center				
System Tag/Name:						AHU 2				
Operating Condition Description:						Ventilation				
Units (select from pull-down list)						IP				
Inputs for System		**Name**	**Units**				**System**			
	Floor area served by system	As	sf				9865			
	Population of area served by system (including diversity)	Ps	P	100%	diversity		10			
	Design primary supply fan airflow rate	Vpsd	cfm				36,000			
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.48			
	OA req'd per person for system area (Weighted average)	Rps	cfm/p				0.0			
Inputs for Potentially Critical zones								Potentially Critical Zones		
	Zone Name		*Zone title turns purple italic for critical zone(s)*					*Leisure Pool*	3	
	Zone Tag							D 147	enter tag	
	Space type		Select from pull-down list					Swimming (pool & deck)	Office space	
	Floor Area of zone	Az	sf					9,865		
	Design population of zone	Pz	P	(default value listed; may be overridden)				10	0	
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					36,000		
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A					ITU		
	Local recirc. air % representative of ave system return air	Er						75%		
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						100%		
Results										
	Ventilation System Efficiency	Ev					1.00			
	Outdoor air intake required for system	Vot	cfm				4735			
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.48			
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				473.5			
	Outdoor air as a % of design primary supply air	Ypd	cfm				13%			
Detailed Calculations										
Initial Calculations for the System as a whole										
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	36000			
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	4735			
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.13			
Initial Calculations for Individual zones										
	OA rate per unit area for zone	Raz	cfm/sf					0.48	0.06	
	OA rate per person	Rpz	cfm/p					0.00	5.00	
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					36000	0	
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		4735.2	0.0	
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		4735	0	
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00	
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.13	0.00	
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.13	0.00	
System Ventilation Efficiency										
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.13	
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00			
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	1.02			
Minimum outdoor air intake airflow										
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	4735			
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.13			
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	4649	85.86		
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.13	0.02		
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	=	-57			

Building:						Kroc Center				
System Tag/Name:						FCU 1				
Operating Condition Description:						Ventilation				
Units (select from pull-down list)						IP				
Inputs for System		**Name**	**Units**				**System**			
	Floor area served by system	As	sf				1190			
	Population of area served by system (including diversity)	Ps	P	100%	diversity		53			
	Design primary supply fan airflow rate	Vpsd	cfm				1,600			
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.08			
	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							Chapel Storage	Office	*Stage (Half)*
	Zone Tag							B118, 122, 123	B117	B119
	Space type					Select from pull-down list		Storage rooms	Office space	Stages, studios
	Floor Area of zone	Az	sf					315	130	745
	Design population of zone	Pz	P			(default value listed; may be overridden)		0	0.65	52.15
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					150	150	1300
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?					Select from pull-down list or leave blank if N/A		ITU	ITU	ITU
	Local recirc. air % representative of ave system return air	Er						75%	75%	75%
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
	Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00
	Primary air fraction of supply air at conditioned analyzed	Ep						100%	100%	100%
Results										
	Ventilation System Efficiency	Ev					0.95			
	Outdoor air intake required for system	Vot	cfm				648			
	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				12.3			
	Outdoor air as a % of design primary supply air	Ypd	cfm				41%			
Detailed Calculations										
Initial Calculations for the System as a whole										
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	1600			
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	615			
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.38			
Initial Calculations for Individual zones										
	OA rate per unit area for zone	Raz	cfm/sf					0.12	0.06	0.06
	OA rate per person	Rpz	cfm/p					0.00	5.00	10.00
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					150	150	1300
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		37.8	11.1	565.2
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		38	11	566
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		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
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.25	0.07	0.44
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.25	0.07	0.44
System Ventilation Efficiency										
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.13	1.31	0.95
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.95			
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.71			
Minimum outdoor air intake airflow										
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	648			
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.41			
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	861			
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.54			
OA Temp at which Min OA provides all cooling										
	OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTf	=	30			

Building:					Kroc Center				
System Tag/Name:					FCU 2				
Operating Condition Description:					Ventilation				
Units (select from pull-down list)					IP				
Inputs for System	**Name**	**Units**			**System**				
Floor area served by system	As	sf			1135				
Population of area served by system (including diversity)	Ps	P	100%	diversity	52				
Design primary supply fan airflow rate	Vpsd	cfm			1,600				
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			10.0				
Inputs for Potentially Critical zones						Potentially Critical Zones			
Zone Name						Chapel Storage	*Stage (Half)*		
Zone Tag					*Zone title turns purple italic for critical zone(s)*	B120, 121	B119		
Space type					Select from pull-down list	Storage rooms	Stages, studios		
Floor Area of zone	Az	sf				390	745		
Design population of zone	Pz	P			(default value listed; may be overridden)	0	52.15		
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				300	1300		
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?					Select from pull-down list or leave blank if N/A	ITU	ITU		
Local recirc. air % representative of ave system return air	Er					75%	75%		
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					100%	100%		
Results									
Ventilation System Efficiency	Ev				**0.95**				
Outdoor air intake required for system	Vot	cfm			**647**				
Outdoor air per unit floor area	Vot/As	cfm/sf			**0.57**				
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p			**12.4**				
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	=	1600			
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	613			
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.38			
Initial Calculations for Individual zones									
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.06	
OA rate per person	Rpz	cfm/p					0.00	10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					300	1300	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		46.8	566.2	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		47	566	
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	=		0.16	0.44	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.16	0.44	
System Ventilation Efficiency									
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.23	0.95	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.95**			
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.71			
Minimum outdoor air intake airflow									
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	**647**			
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	=	858			
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.54			
OA Temp at which Min OA provides all cooling									
OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTrf	=	30			

Building:	Kroc Center
System Tag/Name:	RTU 1
Operating Condition Description:	Ventilation
Units (select from pull-down list)	IP

	Name	Units		System	VAV N1.1	VAV N1.2	VAV N1.3	VAV N1.4	VAV N1.5	VAV N1.6	VAV N1.7	VAV N1.8	VAV N1.9	VAV N1.10
Inputs for System														
Floor area served by system	As	sf		18060										
Population of area served by system (including diversity)	Ps	P	100% diversity	580										
Design primary supply fan airflow rate	Vpsd	cfm		23,600										
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf		0.10										
OA req'd per person for system area (Weighted average)	Rps	cfm/p		8.3										
Inputs for Potentially Critical zones					Potentially Critical Z									
Zone Name			Zone title turns purple italic for critical zone(s)		VAV N1.1	VAV N1.2	VAV N1.3	VAV N1.4	*VAV N1.5*	VAV N1.6	VAV N1.7	*VAV N1.8*	VAV N1.9	VAV N1.10
Zone Tag					A101	A101	A137, 142, 143, 145, 146	A131, 132, 133, 135, 136	A102	A129, 130	A124, 125, 127	A102	A123, 126	A103
Space type			Select from pull-down list		Multi-use assembly	Multi-use assembly	Cafeteria/fast-food dining	Classrooms (ages 5–8)	Multi-use assembly	Classrooms (age 9 plus)	Art classroom	Multi-use assembly	Computer lab	Multi-use assembly
Floor Area of zone	Az	sf			550	550	2800	1340	700	660	780	700	680	555
Design population of zone	Pz	P	(default value listed; may be overridden)		40	40	20	33.5	60	23.1	15.6	60	17	40
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm			850	850	3010	1800	1050	1060	1100	1050	1060	850
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A		ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU
Local recirc. air % representative of ave system return air	Er				75%	75%	75%	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%	100%	100%	100%
Air distribution type at conditioned analyzed			Select from pull-down list		CS	CS	CS	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	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep				100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Results														
Ventilation System Efficiency	Ev			0.81										
Outdoor air intake required for system	Vot	cfm		8188										
Outdoor air per unit floor area	Vot/As	cfm/sf		0.45										
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p		14.1										
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 =	23600										
UncorrectedOA requirement for system	Vou	cfm	= Rps Ps + Ras As =	6653										
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			0.06	0.06	0.18	0.12	0.06	0.12	0.18	0.06	0.12	0.06
OA rate per person	Rpz	cfm/p			7.50	7.50	7.50	10.00	7.50	10.00	10.00	7.50	10.00	7.50
Total supply air to zone (at condition being analyzed)	Vdz	cfm			850	850	3010	1800	1050	1060	1100	1050	1060	850
Unused OA req'd to breathing zone	Vbz	cfm	= Rpz Pz + Raz Az =		333.0	333.0	618.0	495.8	492.0	310.2	296.4	492.0	251.6	333.3
Unused OA requirement for zone	Voz	cfm	= Vbz/Ez =		333	333	618	496	492	310	296	492	252	333
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	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	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	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd		= Voz / Vdz =		0.39	0.39	0.21	0.28	0.47	0.30	0.27	0.47	0.24	0.39
Unused OA fraction required in primary air to zone	Zp		= Voz / Vpz =		0.39	0.39	0.21	0.28	0.47	0.30	0.27	0.47	0.24	0.39
System Ventilation Efficiency														
Zone Ventilation Efficiency (App A Method)	Evz		= (Fa + FbXs - FcZ) / Fa =		0.89	0.89	1.08	1.01	0.81	0.99	1.01	0.81	1.04	0.89
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 =	8188										
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 =	9778										
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		= Vot / Vps =	0.41										
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:	Kroc Center																				
System Tag/Name:	RTU 1																				
Operating Condition Description:	Ventilation																				
Units (select from pull-down list)	IP																				
Inputs for System	**Name**	**Units**					**System**	ones													
Floor area served by system	As	sf					18000														
Population of area served by system (including diversity)	Ps	P	100%	diversity			680														
Design primary supply fan airflow rate	Vpsd	cfm					23,600														
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf					0.10														
OA req'd per person for system area (Weighted average)	Rps	cfm/p					8.3														
Inputs for Potentially Critical zones																					
Zone Name	*Zone title turns purple italic for critical zone(s)*							VAV N1.11	VAV N1.12	VAV N1.13	VAV N1.14	VAV N1.15	VAV N1.16	VAV N1.17	VAV N1.18	VAV N1.19					
Zone Tag								A103	A106, 107	A104, A105	A121, 122	A115, A120	A108, 128	B110, 111, 112	B 105	B107, 108, 109					
Space type		Select from pull-down list						Multi-use assembly	Classrooms (age 9 plus)	Classrooms (age 9 plus)	Libraries	Classrooms (age 9 plus)	Corridors	Classrooms (age 9 plus)	Lobbies/prefunction	Multi-use assembly					
Floor Area of zone	Az	sf						555	680	685	685	690	2550	700	1500	830					
Design population of zone	Pz	P	(default value listed; may be overridden)					40	23.8	23.275	6.85	24.15	0	27.65	45	40					
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm						850	900	950	940	920	1880	1020	1740	1730					
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A						ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU					
Local recirc. air % representative of ave system return air	Er							75%	75%	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%	100%	100%					
Air distribution type at conditioned analyzed		Select from pull-down list						CS	CS	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	1.00	1.00					
Primary air fraction of supply air at conditioned analyzed	Ep							100%	100%	100%	100%	100%	100%	100%	100%	100%					
Results																					
Ventilation System Efficiency	Ev						0.81														
Outdoor air intake required for system	Vot	cfm					8188														
Outdoor air per unit floor area	Vot/As	cfm/sf					0.45														
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p					14.1														
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	=	VpzDs	=	23600															
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	6663															
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						0.06	0.12	0.12	0.12	0.12	0.06	0.12	0.06	0.06					
OA rate per person	Rpz	cfm/p						7.50	10.00	10.00	5.00	10.00	0.00	10.00	7.50	7.50					
Total supply air to zone (at condition being analyzed)	Vdz	cfm						850	900	950	940	920	1880	1020	1740	1730					
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=			333.3	319.6	312.6	116.5	324.3	153.0	371.3	427.5	349.8					
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=			333	320	313	116	324	153	371	428	350					
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	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	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	1.00	1.00					
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=			0.39	0.36	0.33	0.12	0.35	0.08	0.36	0.25	0.20					
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=			0.39	0.36	0.33	0.12	0.35	0.08	0.36	0.25	0.20					
System Ventilation Efficiency																					
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=			0.89	0.93	0.95	1.16	0.93	1.20	0.92	1.04	1.08					
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	=	8188															
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	=	9778															
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.41															
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:	Kroc Center																				
System Tag/Name:	RTU 2																				
Operating Condition Description:	Ventilation																				
Units (select from pull-down list)	IP																				
Inputs for System	**Name**	**Units**					**System**														
Floor area served by system	As	sf					5500														
Population of area served by system (including diversity)	Ps	P	100%	diversity			84														
Design primary supply fan airflow rate	Vpsd	cfm					6,750														
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf					0.08														
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)*							VAV S1.1	VAV S1.2	*VAV S1.3*	VAV S1.4	VAV S1.5	VAV S1.6	VAV S1.7	VAV S1.8	VAV S1.9					
Zone Tag								C109, 110, 111, 112, 114	C119, 120, 121	C115, 116, 118	C113	C122, 123	C125, 126, 127, 128, 131	C132	C133, 137, 138	C119,141					
Space type		Select from pull-down list						Laundry rooms, central	Office space	Classrooms (ages 5–8)	Computer lab	Conferencerm eeting	Office space	Office space	Office space	Break rooms					
Floor Area of zone	Az	sf						885	1060	655	215	400	725	305	520	755					
Design population of zone	Pz	P	(default value listed; may be overridden)					8.85	5.3	16.375	5.375	20	5	1.525	2.6	18.875					
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm						800	860	920	580	690	640	420	840	1000					
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A						ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU	ITU					
Local recirc. air % representative of ave system return air	Er							75%	75%	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%	100%	100%					
Air distribution type at conditioned analyzed		Select from pull-down list						CS	CS	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	1.00	1.00					
Primary air fraction of supply air at conditioned analyzed	Ep							100%	100%	100%	100%	100%	100%	100%	100%	100%					
Results																					
Ventilation System Efficiency	Ev						0.88														
Outdoor air intake required for system	Vot	cfm					1094														
Outdoor air per unit floor area	Vot/As	cfm/sf					0.20														
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p					13.1														
Outdoor air as a % of design primary supply air	Ypd	cfm					16%														
Detailed Calculations																					
Initial Calculations for the System as a whole																					
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	6750															
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	951															
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.14															
Initial Calculations for individual zones																					
OA rate per unit area for zone	Raz	cfm/sf						0.12	0.08	0.12	0.12	0.08	0.08	0.08	0.08	0.08					
OA rate per person	Rpz	cfm/p						5.00	5.00	10.00	10.00	5.00	5.00	5.00	5.00	5.00					
Total supply air to zone (at condition being analyzed)	Vdz	cfm						800	860	920	580	690	640	420	840	1000					
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		147.1	90.1	242.4	79.6	124.0	68.5	25.9	44.2	139.7						
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		147	90	242	80	124	69	26	44	140						
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	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	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	1.00	1.00						
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.18	0.10	0.26	0.14	0.18	0.11	0.06	0.05	0.14						
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.18	0.10	0.26	0.14	0.18	0.11	0.06	0.05	0.14						
System Ventilation Efficiency																					
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		0.96	1.04	0.88	1.01	0.96	1.04	1.08	1.09	1.00						
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.88															
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.80															
Minimum outdoor air intake airflow																					
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	1094															
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.16															
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	1084	9.35														
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.16	0.01														
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	=	-33															

Building:							Kroc Center			
System Tag/Name:							RTU 3			
Operating Condition Description:							Ventilation			
Units (select from pull-down list)							IP			
Inputs for System		**Name**	**Units**				**System**			
	Floor area served by system	As	sf				2990			
	Population of area served by system (including diversity)	Ps	P	100%	diversity		318			
	Design primary supply fan airflow rate	Vpsd	cfm				7,680			
	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				5.0			
Inputs for Potentially Critical zones								Potentially Critical Zones		
	Zone Name		*Zone title turns purple italic for critical zone(s)*					Chapel	Support	
	Zone Tag							B101	B102, 103, 113	
	Space type		Select from pull-down list					Multipurpose assembly	Storage rooms	
	Floor Area of zone	Az	sf					2,650	340	
	Design population of zone	Pz	P	(default value listed; may be overridden)				318	0	
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					7,410	270	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A					ITU	ITU	
	Local recirc. air % representative of ave system return air	Er						75%	75%	
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						100%	100%	
Results										
	Ventilation System Efficiency	Ev					1.00			
	Outdoor air intake required for system	Vot	cfm				1795			
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.60			
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				5.6			
	Outdoor air as a % of design primary supply air	Ypd	cfm				23%			
Detailed Calculations										
Initial Calculations for the System as a whole										
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	7680			
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	1790			
	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	0.12	
	OA rate per person	Rpz	cfm/p					5.00	0.00	
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					7410	270	
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		1749.0	40.8	
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		1749	41	
	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	=		0.24	0.15	
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.24	0.15	
System Ventilation Efficiency										
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.08	
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00			
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.91			
Minimum outdoor air intake airflow										
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	1795			
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.23			
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	1958			
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.25			
OA Temp at which Min OA provides all cooling										
	OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTf	=	-1			

Building:						Kroc Center				
System Tag/Name:						RTU 4				
Operating Condition Description:						Ventilation				
Units (select from pull-down list)						IP				
Inputs for System	**Name**	**Units**				**System**				
Floor area served by system	As	sf				2700				
Population of area served by system (including diversity)	Ps	P	100%	diversity		32				
Design primary supply fan airflow rate	Vpsd	cfm				6,000				
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06				
OA req'd per person for system area (Weighted average)	Rps	cfm/p				5.0				
Inputs for Potentially Critical zones							Potentially Critical Zones			
Zone Name							*Lobby*	Climbing Wall	Storage	
Zone Tag							B105	D101	D102	
Space type							Main entry lobbies	Multipurpose assembly	Storage rooms	
Floor Area of zone	Az	sf					2,160	405	135	
Design population of zone	Pz	P					21.6	10	0	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					2,500	3300	200	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?							ITU	ITU	ITU	
Local recirc. air % representative of ave system return air	Er						75%	75%	75%	
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							CS	CS	CS	
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	
Primary air fraction of supply air at conditioned analyzed	Ep						100%	100%	100%	
Results										
Ventilation System Efficiency	Ev					0.96				
Outdoor air intake required for system	Vot	cfm				342				
Outdoor air per unit floor area	Vot/As	cfm/sf				0.13				
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				10.8				
Outdoor air as a % of design primary supply air	Ypd	cfm				6%				
Detailed Calculations										
Initial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	6000				
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	328				
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.05				
Initial Calculations for Individual zones										
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.12	
OA rate per person	Rpz	cfm/p					5.00	5.00	0.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					2500	3300	200	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		237.6	74.3	16.2	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		238	74	16	
Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00	
Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		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	
Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.10	0.02	0.06	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.10	0.02	0.06	
System Ventilation Efficiency										
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		0.96	1.03	0.97	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.96				
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	1.05				
Minimum outdoor air intake airflow										
Outdoor Air intake Flow required to System	Vot	cfm	=	Vou / Ev	=	342				
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.06				
Outdoor Air intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	311	30.89			
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.05	0.09			
OA Temp at which Min OA provides all cooling										
OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTf	=	-226				

Building:					Kroc Center				
System Tag/Name:					RTU 5				
Operating Condition Description:					Ventilation				
Units (select from pull-down list)					IP				
Inputs for System		**Name**	**Units**				**System**		
	Floor area served by system	As	sf				4590		
	Population of area served by system (including diversity)	Ps	P	100%	diversity		0		
	Design primary supply fan airflow rate	Vpsd	cfm				7,200		
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.48		
	OA req'd per person for system area (Weighted average)	Rps	cfm/p				0.0		
Inputs for Potentially Critical zones								**Potentially Critical Zones**	
	Zone Name		*Zone title turns purple italic for critical zone(s)*					*Gymnasium*	enter name
	Zone Tag							C101	enter tag
	Space type		Select from pull-down list					Swimming (pool & deck)	Office space
	Floor Area of zone	Az	sf					4,590	
	Design population of zone	Pz	P	(default value listed; may be overridden)				0	0
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					7,200	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A					ITU	
	Local recirc. air % representative of ave system return air	Er						75%	75%
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						100%	
Results									
	Ventilation System Efficiency	Ev					1.00		
	Outdoor air intake required for system	Vot	cfm				2203		
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.48		
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				#DIV/0!		
	Outdoor air as a % of design primary supply air	Ypd	cfm				31%		
Detailed Calculations									
Initial Calculations for the System as a whole									
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	7200		
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	2203		
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.31		
Initial Calculations for Individual zones									
	OA rate per unit area for zone	Raz	cfm/sf					0.48	0.06
	OA rate per person	Rpz	cfm/p					0.00	5.00
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					7200	0
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		2203.2	0.0
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		2203	0
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.31	0.00
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.31	0.00
System Ventilation Efficiency									
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.31
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00		
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.84		
Minimum outdoor air intake airflow									
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	2203		
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.31		
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	2610		
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.36		
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	=	16		

Building:					Kroc Center				
System Tag/Name:					RTU 6				
Operating Condition Description:					Ventilation				
Units (select from pull-down list)					IP				
Inputs for System		Name	Units				System		
	Floor area served by system	As	sf				4590		
	Population of area served by system (including diversity)	Ps	P	100%	diversity		0		
	Design primary supply fan airflow rate	Vpsd	cfm				7,200		
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.46		
	OA req'd per person for system area (Weighted average)	Rps	cfm/p				0.0		
Inputs for Potentially Critical zones								Potentially Critical Zones	
	Zone Name				Zone title turns purple italic for critical zone(s)			Gymnasium	enter name
	Zone Tag							C101	enter tag
	Space type				Select from pull-down list			Swimming (pool & deck)	Office space
	Floor Area of zone	Az	sf					4,590	
	Design population of zone	Pz	P		(default value listed; may be overridden)			0	0
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					7,200	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?				Select from pull-down list or leave blank if N/A			ITU	
	Local recirc. air % representative of ave system return air	Er						75%	
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						100%	
Results									
	Ventilation System Efficiency	Ev					1.00		
	Outdoor air intake required for system	Vot	cfm				2203		
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.48		
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				#DIV/0!		
	Outdoor air as a % of design primary supply air	Ypd	cfm				31%		
Detailed Calculations									
Initial Calculations for the System as a whole									
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	7200		
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	2203		
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.31		
Initial Calculations for Individual zones									
	OA rate per unit area for zone	Raz	cfm/sf					0.48	0.06
	OA rate per person	Rpz	cfm/p					0.00	5.00
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					7200	0
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		2203.2	0.0
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		2203	0
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		1.00	1.00
	Fraction of zone OA not directly recirc. from zone	Fc		=	1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.31	0.00
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.31	0.00
System Ventilation Efficiency									
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	1.31
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	1.00		
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.84		
Minimum outdoor air intake airflow									
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	2203		
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.31		
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	2610		
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.36		
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	=	16		

Building:						Kroc Center					
System Tag/Name:						RTU 7					
Operating Condition Description:						Ventilation					
Units (select from pull-down list)						IP					
Inputs for System		Name	Units				System				
	Floor area served by system	As	sf				2260				
	Population of area served by system (including diversity)	Ps	P		100%	diversity	51				
	Design primary supply fan airflow rate	Vpsd	cfm				2,000				
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.09				
	OA req'd per person for system area (Weighted average)	Rps	cfm/p				20.0				
								Potentially Critical Zones			
Inputs for Potentially Critical zones											
	Zone Name			Zone title turns purple italic for critical zone(s)				Storage	Aerobics	Storage	
	Zone Tag							C102	C103	C104	
	Space type							Storage rooms	Health club/aerobics room	Storage rooms	
				Select from pull-down list							
	Floor Area of zone	Az	sf					810	1270	180	
	Design population of zone	Pz	P	(default value listed; may be overridden)				0	50.8	0	
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					450	1440	100	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?			Select from pull-down list or leave blank if N/A				ITU	ITU	ITU	
	Local recirc. air % representative of ave system return air	Er						75%	75%	75%	
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	
	Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	
	Primary air fraction of supply air at conditioned analyzed	Ep						100%	100%	100%	
Results											
	Ventilation System Efficiency	Ev					0.85				
	Outdoor air intake required for system	Vot	cfm				1430				
	Outdoor air per unit floor area	Vot/As	cfm/sf				0.63				
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				28.1				
	Outdoor air as a % of design primary supply air	Ypd	cfm				71%				
Detailed Calculations											
Initial Calculations for the System as a whole											
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	2000				
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	1211				
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.61				
Initial Calculations for Individual zones											
	OA rate per unit area for zone	Raz	cfm/sf					0.12	0.06	0.12	
	OA rate per person	Rpz	cfm/p					0.00	20.00	0.00	
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					450	1440	100	
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		97.2	1092.2	21.6	
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		97	1092	22	
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00	
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		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	
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.21	0.76	0.22	
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.21	0.76	0.22	
System Ventilation Efficiency											
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.39	0.85	1.39	
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.85				
	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	=	1430				
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.71				
	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:					Kroc Center				
System Tag/Name:					RTU 8				
Operating Condition Description:					Ventilation				
Units (select from pull-down list)					IP				
Inputs for System	**Name**	**Units**				**System**			
Floor area served by system	As	sf				5760			
Population of area served by system (including diversity)	Ps	P	100%	diversity		32			
Design primary supply fan airflow rate	Vpsd	cfm				9,500			
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				20.0			
Inputs for Potentially Critical zones							Potentially Critical Zones		
Zone Name					*Zone title turns purple italic for critical zone(s)*		Fitness	*Hall*	
Zone Tag							C107	C108	
Space type							Health club/weight rooms	Corridors	
					Select from pull-down list				
Floor Area of zone	Az	sf					3,220	2560	
Design population of zone	Pz	P			(default value listed; may be overridden)		32.2	0	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					6,200	1300	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?					Select from pull-down list or leave blank if N/A		ITU	ITU	
Local recirc. air % representative of ave system return air	Er						75%	75%	
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						100%	100%	
Results									
Ventilation System Efficiency	Ev					**0.99**			
Outdoor air intake required for system	Vot	cfm				**1005**			
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				**31.2**			
Outdoor air as a % of design primary supply air	Ypd	cfm				**11%**			
Detailed Calculations									
Initial Calculations for the System as a whole									
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	9500			
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	991			
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.10			
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					20.00	0.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					6200	1300	
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		637.2	153.6	
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		637	154	
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	=		0.10	0.12	
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.10	0.12	
System Ventilation Efficiency									
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.00	0.99	
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.99**			
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	1.03			
Minimum outdoor air intake airflow									
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	**1005**			
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.11**			
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	960	**44.50**		
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.10	**0.04**		
OA Temp at which Min OA provides all cooling									
OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTrf	=	-89			

Building:						Kroc Center					
System Tag/Name:						RTU 9					
Operating Condition Description:						Ventilation					
Units (select from pull-down list)						IP					
Inputs for System		**Name**	**Units**				**System**				
	Floor area served by system	As	sf				1170				
	Population of area served by system (including diversity)	Ps	P	100%	diversity		45				
	Design primary supply fan airflow rate	Vpsd	cfm				2,600				
	OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06				
	OA req'd per person for system area (Weighted average)	Rps	cfm/p				5.0				
Inputs for Potentially Critical zones								Potentially Critical Zones			
	Zone Name							Meet Mgmt.	Multi-Purpose A & B	*Team Lockers*	
						Zone title turns purple italic for critical zone(s)					
	Zone Tag							E110	E111, 112	E113, 114	
	Space type							Office space	Conference/meeting	Conference/meeting	
			Select from pull-down list								
	Floor Area of zone	Az	sf					290	460	420	
	Design population of zone	Pz	P			(default value listed; may be overridden)		1.45	23	21	
	Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					740	1440	420	
	Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A					ITU	ITU	ITU	
	Local recirc. air % representative of ave system return air	Er						75%	75%	75%	
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	
	Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	
	Primary air fraction of supply air at conditioned analyzed	Ep						100%	100%	100%	
Results											
	Ventilation System Efficiency	Ev					**0.80**				
	Outdoor air intake required for system	Vot	cfm				**370**				
	Outdoor air per unit floor area	Vot/As	cfm/sf				**0.32**				
	Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				8.1				
	Outdoor air as a % of design primary supply air	Ypd	cfm				**14%**				
Detailed Calculations											
Initial Calculations for the System as a whole											
	Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	2600				
	UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	297				
	Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.11				
Initial Calculations for Individual zones											
	OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.06	
	OA rate per person	Rpz	cfm/p					5.00	5.00	5.00	
	Total supply air to zone (at condition being analyzed)	Vdz	cfm					740	1440	420	
	Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		24.7	142.6	130.2	
	Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		25	143	130	
	Fraction of zone supply not directly recirc. from zone	Fa		=	Ep + (1-Ep)Er	=		1.00	1.00	1.00	
	Fraction of zone supply from fully mixed primary air	Fb		=	Ep	=		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	
	Unused OA fraction required in supply air to zone	Zd		=	Voz / Vdz	=		0.03	0.10	0.31	
	Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.03	0.10	0.31	
System Ventilation Efficiency											
	Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.08	1.02	0.80	
	System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	**0.80**				
	Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.84				
Minimum outdoor air intake airflow											
	Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	**370**				
	OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	**0.14**				
	Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	354	15.67			
	OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.14	0.04			
OA Temp at which Min OA provides all cooling											
	OAT below which OA intake flow is @ minimum		Deg F	=	((Tp-dTsf)-(1-Y)*(Tr+dTrf	=	-46				

Building:						Kroc Center					
System Tag/Name:						RTU 10					
Operating Condition Description:						Ventilation					
Units (select from pull-down list)						IP					
Inputs for System	**Name**	**Units**				**System**					
Floor area served by system	As	sf				4500					
Population of area served by system (including diversity)	Ps	P	100%	diversity		101					
Design primary supply fan airflow rate	Vpsd	cfm				4,530					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.09					
OA req'd per person for system area (Weighted average)	Rps	cfm/p				6.2					
Inputs for Potentially Critical zones							Potentially Critical Zones				
Zone Name		*Zone title turns purple italic for critical zone(s)*					VAV S1.10	VAV S1.11	VAV S1.12	*VAV S1.13*	VAV S1.14
Zone Tag							D103	D105	D127, 128, 129	D109	D130, 131, 132, 135, 136
Space type							Conference/meeting	Conference/meeting	Office space	Mail common areas	Storage rooms
		Select from pull-down list									
Floor Area of zone	Az	sf					455	455	410	1270	1910
Design population of zone	Pz	P	(default value listed; may be overridden)				22.75	22.75	4	50.8	1
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					650	700	320	1360	1490
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select from pull-down list or leave blank if N/A					ITU	ITU	ITU	ITU	ITU
Local recirc. air % representative of ave system return air	Er						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%
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						100%	100%	100%	100%	100%
Results											
Ventilation System Efficiency	Ev					0.89					
Outdoor air intake required for system	Vot	cfm				1142					
Outdoor air per unit floor area	Vot/As	cfm/sf				0.25					
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				11.3					
Outdoor air as a % of design primary supply air	Ypd	cfm				25%					
Detailed Calculations											
Initial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	4530					
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	1013					
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	0.12
OA rate per person	Rpz	cfm/p					5.00	5.00	5.00	7.50	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm					660	700	320	1360	1490
Unused OA req'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		141.1	141.1	44.6	457.2	229.2
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		141	141	45	457	229
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	=		0.21	0.20	0.14	0.34	0.15
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.21	0.20	0.14	0.34	0.15
System Ventilation Efficiency											
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.01	1.02	1.08	0.89	1.07
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.89					
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.81					
Minimum outdoor air intake airflow											
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	1142					
OA intake req'd as a fraction of primary SA	Y		=	Vot / Vps	=	0.25					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	1245					
OA intake req'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	0.27					
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	=	5					

Appendix B

Lighting Compliance								
Fixture	A	B	C	D	E	Total	Watt/Fixture	Total Watts
A1	11	5	2			18	45	810
A1G	7			2		9	45	405
A2	13		2	6		21	66	1386
A3	4					4	53	212
B1		22				22	250	5500
B2		26				26	250	6500
B4		12				12	120	1440
B5		10				10	120	1200
BF		1				1	120	120
BF2		1				1	120	120
C1	8			10	8	26	28	728
C2	60	6				66	28	1848
C3		6				6	90	540
D1	2		2	1	1	6	27	162
D10		3				3	180	540
D11		2				2	240	480
D14		4				4	35	140
D2	10	3				13	70	910
D2L		3				3	105	315
D2S		6				6	35	210
D3		9				9	60	540
D4	7					7	27	189
D5				36		36	45	1620
D6				15		15	17	255
D8		1				1	180	180
D9	4					4	90	360
F1	87	23	17	4	9	140	35	4900
F1D	18		8			26	35	910
F2				15	7	22	35	770
F3D			7			7	35	245
F4	8	9		10	4	31	35	1085
H1			20			20	324	6480
H2			21			21	240	5040
K1	2		1		3	6	45	270
K1E	8	6	6	5	3	28	45	1260
L1	3					3	90	270
L2			2			2	90	180
L3			1			1	45	45
M1	19	8	33	1	12	73	60	4380
M1D		6				6	60	360
M1G	4	2				6	60	360
M2	27		19			46	34	1564
M2G	7					7	34	238
M3			18	12		30	45	1350
N	28					28	70	1960

N2			4			4	79	316
Q1				14	18	32	820	26240
Q2				2		2	820	1640
Q4			2	19	23	44	60	2640
R		1				1	66	66
S1	8	3	9	3	1	24	28	672
S1A			3		2	5	45	225
S2	4	10	6	11		31	88	2728
S2A					9	9	88	792
S3					2	2	27	54
T1		76				76	75	5700
T2		4				4	300	1200
T3	13					13	150	1950
T4		4	15			19	34	646
U1				2		2	28	56
U2		3				3	22	66
V6		1				1	85	85
W1				6	16	22	45	990
X1		1	6	6	6	19	5	95
X2	20	11	8			39	5	195
X3	1					1	10	10
XW			3			3	5	15
Y		4		4	4	12	10	120
YW			12			12	10	120

Total Lighting Wattage:	104998
Building SF:	92000

Total W/SF:	1.14
Required W/SF:	1.2
Compliance:	Yes