Grunenwald Science and Technology Building

Clarion University- Clarion, PA

Technical Report One:

ASHRAE Standard 62.1 Ventilation and Standard 90.1 Energy Design Evaluation

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Executive Summary:

In this report, the Grunenwald Science and Technology Building on Clarion University's campus was analyzed to check for compliance with ASHRAE Standard 62.1 and ASHRAE Standard 90.1. The Science and Technology Building are 98,000 square feet of new construction, along with 10,000 square feet of building renovation from the previous science building on the site. The building is comprised of university labs, classrooms, and faculty office space for science and math based areas of study.

ASHRAE Standard 62.1 was the first to be evaluated for Section 5 and 6 of the standard to check for building compliance. The analysis of Section 5 went through and checked for compliance in areas dealing with mold prevention, outdoor air intakes, humidification, particulate filtration, and drain pans employed in the building design. The analysis determined that the building did meet all minimum requirements of Section 5. Following Section 5, an analysis of Section 6 was done to determine whether the building was meeting the ventilation rate requirements set forth by ASHRAE to obtain an acceptable indoor air quality. Through calculations for each of the spaces for the particular systems, it was found through the ventilation rate procedure that all of the systems for the Science and Technology Building did meet the minimum ventilation rates.

ASHRAE Standard 90.1 was performed to see whether the building meet the minimum equipment efficiencies, and building envelope insulation values. In Section 5, the climate zone of the building was determined and used to determine the minimum U-values to be used in the building design. All construction types for walls, roof, and windows were found to comply, while the floor U-value did not comply as the air is conditioned to the same temperature below and above the slab so insulation would not be required. In Section 6, the building's HVAC system was determined to be compliant with all of the mandatory provisions, while some fans did not meet the fan power limitations set by ASHRAE. Section 7 covered the electrical water heater compliance check, in which all heaters did meet the minimum requirements. The voltage drop was then analyzed to check for compliance with Section 8. The voltage drops were designed to be less than 2% for feeders and 3% for branch circuits meeting the section guidelines. The lighting was analyzed in Section 9 using the building area method, which stipulates the Watts per square foot for a particular building type allowed. The Science and Technology Building meet the standard for Lighting Power Density (LPD).

Overall the building met nearly all of ASHRAE Standard 62.1 and 90.1 that were analyzed, with the exception of the fans in Section 6. The building design is to be energy efficient as the designers strive for a LEED Silver or Gold rating for Clarion University.

ASHRAE Standard 62.1- 2007 Section 5- Systems & Equipment:

Section 5.1- Natural Ventilation

Natural ventilation was not considered as a ventilation strategy for the Science and Technology Building due to the complex ventilation and exhaust requirements for the research labs located in the building. The research labs and chemical storage have the need for accurate humidity control as well as containing high internal equipment loads and dangerous contaminants. All windows are inoperable for both occupant safety and security reasons for the university research taking place within the building.

Section 5.2- Ventilation Air Distribution

The building is served by three 100 % outdoor air units to meet the requirements of Section 6 for all Laboratories, and chemical storage spaces. The use of two variable air volume units, consisting of VAV reheat boxes, will continually supply the adequate ventilation required by Section 6 to the offices, and standard classrooms. The outdoor air entering the system cannot be less than that of the designed ventilation requirement, but through the use of an economizer the system can have greater CFM than the required outdoor air for the (2) VAV systems. A full analysis of Section 6 is provided in the next section of this report.

Section 5.3- Exhaust Duct Location

The exhaust that contains potentially dangerous contaminants is negatively pressurized relative to all the spaces the exhaust duct does pass through, so no contaminants from the storage or research labs will enter the building through leakage through the duct. The negative pressure is produced by the 3 primary and 1 secondary exhaust fans located on the roof of the Science and Technology Building. The exhaust goes through a smoke stack to make sure that is does not enter back into the building or into neighboring buildings or homes.

Section 5.4- Ventilation System Controls

The ventilation control works with occupancy sensors in each of the spaces in the Science and Technology Building, and is controlled by four different modes of operation which are; unoccupied heating or cooling, and occupied heating or cooling. The modes of operation will allow the system to have a setback when it is not occupied, but will still meet the minimum required ventilation air for the VAV systems. The VAV systems in the building do have an economizer to control the outdoor air damper to allow for more than the required outdoor air from Section 6 based on the outdoor air temperature. The building automation system used for the building is a BACNet communication protocol linked between the workstations and the servers on the network.

Section 5.5- Airstream Surfaces

All airstream surfaces for rectangular ducts and equipment are made of sheet metal and use metal fasteners to resist mold growth and erosion. The flexible ducts specified in the specifications are to be in accordance with the UL-181 test method.

Section 5.6- Outdoor Air Intakes

All the outdoor air intakes are at least the required minimum distance specified in Table 5-1 of ASHRAE 62.1-2007, even though the equipment is located on the roof. The exhaust air exits the building through stacks with a velocity of 7186 fpm with an effective stack height of 69 feet corresponding to a wind speed of 15 mph, meeting the minimum distance requirements for intake locations on the roof. The exhaust stacks do extend 26 feet above the roof, which would also meet the requirements as the intake is not located near the stacks on the roof plan.

The use of rain hoods and bird screens are used on every outdoor air intake for the building air handling units. The material for both is aluminum and the surface of the bird screen is vertical to prevent nesting and $\frac{1}{2}$ " by $\frac{1}{2}$ " mesh to prevent intrusion.

Object	Minimum Distance, ft (m)
Significantly contaminated exhaust (Note 1)	15 (5)
Noxious or dangerous exhaust (Notes 2 and 3)	30 (10)
Vents, chimneys, and flues from combustion appliances and equipment (Note 4)	15 (5)
Garage entry, automobile loading area, or drive-in queue (Note 5)	15 (5)
Truck loading area or dock, bus parking/idling area (Note 5)	25 (7.5)
Driveway, street, or parking place (Note 5)	5 (1.5)
Thoroughfare with high traffic volume	25 (7.5)
Roof, landscaped grade, or other surface directly below intake (Notes 6 and 7)	1 (0.30)
Garbage storage/pick-up area, dumpsters	15 (5)
Cooling tower intake or basin	15 (5)
Cooling tower exhaust	25 (7.5)

Table 1- Minimum Distances between Outdoor Air Intake and Exhaust Air

Note 1: Significantly contaminated exhaust is exhaust air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor. Note 2: Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45-1991³ and ANSI/AIHA Z9.5-1992.⁴

Note 3: Noxious or dangerous exhaust is exhaust air with highly objectionable fumes or gases and/or exhaust air with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered harmful. Information on separation criteria for industrial environments can be found in the ACGIH Industrial Ventilation Manual⁵ and in the ASHRAE Handbook-HVAC Applications.

Note 4: Shorter separation distances are permitted when determined in accordance with (a) Chapter 7 of ANSI Z223.1/NFPA 54-2002⁷ for fuel gas burning appliances and equipment, (b) Chapter 6 of NFPA 31-2001⁸ for oil burning appliances and equipment, or (c) Chapter 7 of NFPA 211-2003⁹ for other combustion appliances and equipment. Note 5: Distance measured to closest place that vehicle exhaust is likely to be located.

Note 6: No minimum separation distance applies to surfaces that are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.

Note 7: Where snow accumulation is expected, distance listed shall be increased by the expected average snow depth.

Section 5.7- Local Capture of Contaminants

Fume hoods and self-supporting snorkels are used in the laboratory and chemical storage spaces in order to directly exhaust the contaminated air using ducts with exhaust fans located on the roof of the building.

Section 5.8- Combustion Air

The Science and Technology Building uses the campus generated steam to generate the hot water through a plate and frame heat exchanger making there no need to have a boiler. The natural gas emergency generator is located outside in a weatherproof enclosure. With no combustion equipment located within the Science and Technology Building no further analysis was needed.

Section 5.9- Particle Removal

The AHU's serving the Lab and storage spaces uses a MERV 14 for the final filter along with a MERV 7 pre-filter, and the AHU's serving the classrooms and offices uses a MERV 7. These all meet the required efficiency of at least a MERV 6, and all of the filters are located upstream of the cooling coils.

Section 5.10- Dehumidification System

The relative humidity is maintained at 50 % for summer conditions and at 35 % for winter conditions in the occupied spaces of the building, which is less than the limit of 65 % relative humidity. For the laboratory spaces, the relative humidity is maintained year round at 50 % by using both dehumidification by the cooling coil and then passing the supply air through a humidifier to get the same conditions in the lab all the time. The typical classrooms and offices are kept at a positive pressure as more air is supplied than exhausted from a space, while the labs and chemical storage rooms are kept at negative pressure to ensure no contaminates will infiltrate into adjacent rooms.

Section 5.11- Drain Pans

The use of galvanized steel drain pans with a slope of at minimum of 1/8" is used with the drain located at the lowest point of the drain pan. The galvanized steel is used to prevent corrosion of the drain pan. The location of the drain pans is under the cooling coils, beginning at the leading face and extending past to catch water droplets in the air, as through dehumidification

condensation will form, and drain pans are also located under all water-producing devices located in the mechanical room. The drain pans are connected to the plumbing of the roof drains, for the HVAC modular units, and to floor drains inside the mechanical room of the building.

Section 5.12- Finned-Tube Coils and Heat Exchangers

All drain pans are compliant with Section 5.11 as described above, and are located below all condensate-producing heat exchangers. In each of the modular units, access sections are provided on both sides of the cooling and heating coils, which are greater than 18 inches in width as specified in the equipment manufacture's information.

Section 5.13- Humidifiers and Water Spray Systems

The use of a Humidifier is used to insure the designated humidity percentage is delivered to the Lab and Chemical Storage rooms. The source of the steam used to humidify is potable domestic water from the campus steam system. There are no obstructions within the absorption distance of 2.46 feet specified for each system.

Section 5.14- Access for Inspection, Cleaning, and Maintenance

Access sections are provided in the (5) modular air handling units, allowing access to all sections of the modular units including; cooling coils, heating coils, filters, humidifiers and fans. Access panels were provided in walls and inaccessible ceilings in order to access the VAV boxes, dampers, valves, and other concealed equipment.

Section 5.15- Building Envelope and Interior Surfaces

The wall and roof construction consist of a vapor barrier in order to prevent liquid penetration into the building envelope, and the foundation also has specifications for a vapor barrier placed on top of gravel rock to keep the moisture from entering through the slab on grade. The specifications also call for the proper insulation to be installed on pipes and ducts to prevent condensation from forming.

Section 5.16- Buildings with Attached Parking Garages

No parking structures are connected to the Science and Technology Building; therefore this section is not applicable.

Section 5.17- Air Classification and Recirculation

The air classification for both the lecture classrooms and offices found on Table 6-1 is an air class 1, while for University/college laboratories have an air class 2. The class 1 air can have recirculation, and in the case for this building is only used as recirculation air to the same spaces, but could go to any other air class. The class 2 air may only be recirculated within a space used for the same purpose either class 2, 3, or 4. The class 2 air is not recirculated as the University Labs require 100 % outdoor air in the Science and Technology Building.

Section 5.18- Requirements for Buildings Containing ETS Areas and Non-ETS Areas

The Grunenwald Science and Technology Center is a LEED certified building, therefore smoking is not allowed within 25 feet of the building. The contaminate from smoking would be at a distance greater than that in Section 5.6.1, since all of the outdoor air intakes are located on the roof of the three story building.

ASHRAE Standard 62.1- 2007 Section 6- Procedures:

In Section 6, the prescriptive procedure for calculating the ventilation rate required based on "the space type/application, occupancy level, and floor area." The outline for the ventilation rate procedure allows the ventilation systems to be designed for the entire building. The procedure also outlines other considerations and restrictions that must be factored in to any ventilation design.

The entire mechanical ventilation system of Grunenwald Science and Technology Building was checked for compliance with Section 6 in this study. The ventilation systems include (3) 100% outdoor air units, (2) variable air volume units, and (2) energy recovery wheels. At the site outdoor air quality has been classified as acceptable in accordance to Section 4-1 of ASHRAE Standard 62.1- 2007. Air-cleaning devices do not need to be provided for Ozone as the one-hour maximum average concentration does not exceed 0.160 ppm.

The following calculations outlined come directly from ASHRAE Standard 62.1-Section 6, and are used to calculate the compliance of building ventilation systems with Section 6.

Breathing Zone Outdoor Airflow (V_{bz})

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

(Equation 6-1)

where,

- A_z = zone floor area: net occupiable floor area of the zone m² (ft²)
- P_z= zone population: the largest number of people expected to occupy the zone during typical usage.
- R_p= outdoor air flow rate required per person as determined by Table 6-1 of ASHRAE Standard 62.1
- R_a= outdoor air flow rate required per unit area as determined by Table 6-1 of ASHRAE Standard 62.1

Zone Air Distribution Effectiveness

The Zone Air Distribution Effectiveness (E_z) was determined by using Table 6-2, and the E_z was found to be 1.0 for the building. (E_z =1.0)

Zone Outdoor Air Flow	
$V_{oz} = V_{bz} / E_z$	(Equation 6-2)
100 % Outdoor Air Systems	
$V_{ot} = \sum_{all \ zone} V_{oz}$	(Equation 6-4)
Primary Outdoor Air Fraction	
$Z_p = V_{oz} / V_{pz}$	(Equation 6-5)
where, V_{pz} = zone primary air flow, including outdoor air and recirculated air	
Uncorrected Outdoor Air Intake	
$V_{ou} = D\Sigma_{all \ zones}(R_{p}^{*}P_{z}) + \Sigma_{all \ zones}(R_{a}^{*}A_{z})$	(Equation 6-6)
Occupant Diversity	
$D=P_s/(\Sigma_{all \ zones} P_z)$	(Equation 6-7)

where, P_s = total population in the area served by the system

Standard 62.1 Compliance Check

All (5) systems were analyzed with the results for each of the systems contained within Appendix A and Appendix B. The calculations were completed using the ASHRAE Standard 62.1 User Manual, which includes a Microsoft Excel based spreadsheet. The spreadsheet has inputs such as; type of space, assumed population, and square footage of the room. For the purpose of this study all spaces were analyzed for the (3) 100 % outdoor air units. The ventilation rate was found to always meet the minimum requirement of outdoor air provided to each space except for two spaces which are labeled as the critical spaces for the analysis of AHU-1, 2, 5. The two spaces that do not comply with Section 6 are a Clean Room and Cold Room as they do not receive the minimum ventilation rate.

The VAV systems were analyzed using the same process as the 100 % outdoor air units, and all spaces in the VAV system comply with the minimum ventilation rates stated in Section 6 of ASHRAE Standard 62.1- 2007. The ventilation system efficiency (E_v) can be found on in the spreadsheet highlighted in blue for the VAV system. The VAV systems as designed is greater than the CFM required of outdoor air when the calculation requires 11,500 CFM, therefore it complies with Section 6.

ASHRAE Standard 62.1- 2007 Conclusion:

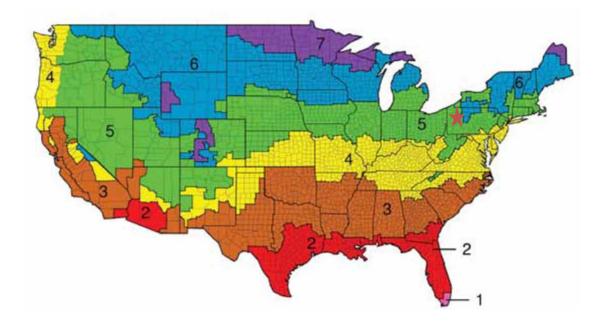
The Science and Technology Building is nearly 100 % compliant with both Sections 5 and 6 of ASHRAE Standard 62.1-2007. The building meets all requirements set forth by Section 5, but has two small rooms that do not meet the required ventilation rate for the space. Each of these spaces requires 60 CFM of outdoor air, while only receiving 50 CFM outdoor air. This may be the case do to the interior loads of those spaces controlling the needed CFM and the difference between 60 and 50 not being to great would not be noticed within those spaces as they are not occupied continuously throughout the day. The building does supply a greater percentage of outdoor air than is required through the ventilation rate procedure. By complying with ASHRAE Standard 62.1, the designers have supplied the students and faculty with an acceptable indoor air quality that provides a healthy learning and research environment in the Science and Technology Building.

ASHRAE Standard 90.1- 2007 Section 5- Building Envelope:

Section 5.1.4- Climate

The Science and Technology Building in Clarion, PA is located within Climate Zone 5A according to the following figure obtained from Appendix B of the ASHRAE Standards. The exact location of Clarion, PA is represented by the red star on Figure 1.

Figure 1- Minimum R Value Map United States Climate Zones



Section 5.4- Mandatory Compliance

All fenestrations and door frames are sealed, calked, or gasketed to prevent infiltration of outdoor air into the conditioned spaces. The utility openings through the exterior walls and the roof are also sealed in accordance with ASHRAE 90.1. The vestibules used in the Science and Technology Building are a depth of 12'-3" in compliance with the minimum requirement of a depth of 7 feet, this is so that the opening of the interior and exterior doors at the same time is not required to enter/exit the building.

Section 5.5- Prescriptive Building Envelope Method

This method requires that the vertical fenestration is not to exceed 40 % of the gross wall area, and for the Science and Technology Building the window to gross wall area is 34 % complying with ASHRAE Standard 90.1. The Science and Technology Building does not contain any skylight fenestrations, therefore it is in accordance with ASHRAE Standard 90.1 that states the skylight fenestrations must be less than 5 % of the the gross roof area. The compliance check for the building envelope is contained in Table 3. The ASHRAE requirements for the U values are from Table 5.5-5 from ASHRAE Standard 90.1-2007.

Elements	ASHRAE Assembly Max U-value	Designed Assembly Max U-value	Compliance
Roofs	0.048	0.044	Achieved
Walls	0.104	0.056	Achieved
Floors/Slabs			
Unheated Slab on	No Insulation	Not Required	Achieved
grade	Required		
Elevated Slabs	0.087	0.76	Not Achieved
Windows			
Curtain Wall Metal	0.50	0.40	Achieved
Framing			
Metal Framing (All	0.55	0.40	Achieved
Othet)			

Table 2- Building Envelope Compliance Check

The Science and Technology Building complies with nearly all of Section 5 in ASHRAE Standard 90.1. The building envelope check showed that the elevated slabs to do not meet the required U-value for the assembly. The elevated slabs do not comply because the spaces above and below the floor slabs is to be conditioned to similar design conditions. The floors used between levels are 4" thick concrete slabs. The wall construction used to obtain a design U-value was 4" face brick, 1" air space, and 2" rigid insulation, while the roof construction is a roof membrane, ½" sheathing, and 4" rigid insulation. The SHGC for the curtain wall and metal framed windows analyzed above was found to be compliant as both had SHGC values less than 0.40.

ASHRAE Standard 90.1- 2007 Sect. 6-Heating, Ventilating, & Air Conditioning:

Section 6.3- Simplified Approach Option for HVAC Systems

The simplified approach cannot be used for the Science and Technology Building has a square footage of 108,000 which exceeds 25,000 square feet maximum. The building has three floors exceeding the limit of 2 stories or fewer for this approach to be used.

Section 6.4- Mandatory Provisions

All the equipment that is used must meet the minimum standards and efficiencies at operating conditions. This equipment must also be labeled by the manufacturer that it does meet Standard 90.1. The Science and Technology Building uses automatic setback controls through the building automation system to automatically adjust the set point when the building is in unoccupied mode. This occurs in this building during the overnight hours and none of the zones are scheduled to be occupied for 24 hours. All AHU's use optimized start up controls to bring the temperature to the set point prior to the scheduled occupancy in the particular zones.

Section 6.5- Prescriptive Path

The use of an air economizer in the Science and Technology Building is done for the (2) VAV AHU's as required for Climate Zone 5A for cooling loads greater than 135,000 BTU/h. The economizer makes use of dampers that control the exhaust air from these spaces and the outdoor air required to meet the cooling load CFM. The economizer operates with a high limit shut off dependent on fixed outdoor air temperature, which is in compliance for climate zone 5A according to Table 6.5.1.1.3B.

The requirements for fan power limitations of HVAC equipment with horsepower greater than 5 have to comply with those outlined in Table 6.5.3.1.1A. The fans were compared to the ASHRAE Standards of Section 6 in Table 3 to see if compliance was achieved. The exhaust fans EF-1 to EF-4 are exempt from this requirement as they are the exhaust from fume hoods, which is can explain the non-compliance with fan power limitation. There were three other fans that did not comply with Table 6.5.3.1.1A, and they were the supply fans for the AHU-1, AHU-2, and

AHU-5. These are the 100 % outdoor air units which do contain VFD motors to control the supply fans. All other fans have been calculated to satisfy Standard 90.1 Section 6.5.3.

Fan Tag	Flow Rate (CFM)	ASHRAE Hp	Actual Hp	Compliance
EF-1	38000	57	60	Not Achieved
EF-2	38000	57	60	Not Achieved
EF-3	38000	57	60	Not Achieved
EF-4	38000	57	60	Not Achieved
RAF-3	22000	33	25	Achieved
RAF-4	19400	29.1	25	Achieved
EF-5	4500	6.75	3	Achieved
EF-6	2895	4.3	3/4	Achieved
EF-7	1750	2.6	1/6	Achieved
EF-8	1000	1.5	1/8	Achieved
EF-9	1000	1.5	1/8	Achieved
EF-10	2100	3.2	2	Achieved
EF-11	750	1.13	1/4	Achieved
AHU-1	40890	61.3	75	Not Achieved
AHU-2	41735	62.6	75	Not Achieved
AHU-3	27500	41.25	25	Achieved
AHU-4	24000	36	25	Achieved
AHU-5	22450	33.7	40	Not Achieved
ERU-1 Supply	13000	19.5	10	Achieved
ERU-1 Exhaust	14050	21.1	15	Achieved
ERU-2 Supply	4553	6.8	3	Achieved
ERU-2 Exhaust	4891	7.3	5	Achieved

Table 3- Fan Power Limitation Compliance Check

The service water heaters do not need to use a heat recovery method as the building is not scheduled to be in operation for 24 hours. The Science and Technology building does contain a fume hood system that exhausts more than 15,000 CFM. To comply with ASHRAE Standard 90.1, the exhaust from the fume hoods is used in a heat recovery system to precondition the outdoor air for the 100 % outdoor air systems. The energy recovery for buildings requiring 5,000 CFM and at least 70 % outdoor air, is also fulfilled by the use of the exhaust air being used for heat recovery.

Section 6.8- Minimum Equipment Efficiency Tables

In this section, the compliance of the centrifugal chillers and cooling towers was analyzed for compliance with Standard 90.1. Both of the centrifugal chillers used in the Science and Technology Building meet the minimum equipment efficiency in ASHRAE Standard 90.1 Section 6.8. The cooling towers used in the Science and Technology Building uses two axial fan cooling towers, which comply with the ASHRAE Table 6.8.1G.

Table 4- Centrifugal Chiller Compliance Check

Label	Capacity	Condensor Flow	Temp Leaving	Temp Ent.	ASHRAE	Chiller	Compliance
	(Tons)	Rate	Chilled Water	Cond	СОР	СОР	
CH-1	250	3 gpm/ton	48	85	5.89	6.1	Achieved
CH-2	250	3 gpm/ton	44	85	5.55	6.1	Achieved

Table 5- Cooling Tower Compliance Check

Label	Capacity	EWT (F)	ASHRAE	Equipment	Compliance
			gpm/hp	gpm/hp	
CT-1A and	2.4 gpm/ton, 15	95	38.2	50	Achieved
CT-1B	hp				

ASHRAE Standard 90.1- 2007 Section 7- Service Water Heating:

Domestic hot water is supplied in the Science and Technology Building through a variety of electrical water heaters. The types of water heaters include electric vertical storage heaters and electric instant heaters. The following Table 6 lists the various types of water heaters, and was used in the analysis of each heater to compliance with Section 7. The ASHRAE requirements were obtained from equations found for electric water heaters based on volume ratings found on Table 7.8 of ASHRAE Standard 90.1.

Symbol	Fuel	Input (kW)	Storage	ASHRAE	Compliance
			Capacity	Requirement.	
EWH-1	Electric	90	250	573.4	Achieved
EWH-2	Electric	4.5	30	.89	Achieved
EWH-3	Electric	4.5	30	.89	Achieved
EWH-4	Electric	24	0	20	Achieved
EWH-5	Electric	126	0	20	Achieved

Table 6- Electric Water Heater Compliance Check

All of the electric water heaters were designed to meet the ASHRAE requirements as follows; EWH-1, EWH-4 and EWH-5 will according to the specifications need to be selected based on whether the equipment can achieve compliance with Standard 90.1 and both EWH-1 and EWH-2 are to be greater than 92 % efficient as stated in the plumbing specifications. Therefore, the water heaters selected for the Grunenwald Science and Technology Building will be compliant with Standard 90.1

ASHRAE Standard 90.1- 2007 Section 8- Power:

The requirements of Section 8 that must be followed to achieve compliance are maximum voltage drops for the feeders and branch circuits. For the feeders the maximum allowed is a 2% voltage drop and for branch circuits the maximum voltage drop is 3%. Stated in the specifications, the maximum design voltage drops have to comply with ASHRAE Standard 90.1, which implies that the building will comply with Section 8.

ASHRAE Standard 90.1- 2007 Section 9- Lighting:

Section 9.4- Mandatory Provisions

The use of automatic shut offs for the lighting systems is used in all labs, classrooms, and offices. The lighting is controlled by motion sensors which shut off the lights in the particular space when no motion has been detected within 10 minutes, which is less than the maximum time for shut off to occur of 30 minutes. The interior lighting is controlled by photoelectric sensors, which will automatically dim the lights in that space based on the natural daylight to a space. The exterior lights are controlled by a time-of-day operated control to turn the lights on or off at programmed times. The exit signs within the building are LEDs specified to use less than the maximum required value per face of 5 watts.

Section 9.5- Building Area Compliance Path

The method takes the building type and sets a requirement of watts per square footage that must be achieved for compliance with Standard 90.1. Table 7 outlines the calculated value versus the ASHRAE requirement to show whether the building complies with Section 9.

Table 7- Lighting Density Compliance Check

Building	Туре	ASHRAE Required	As Designed	Compliance
Science and	School/University	1.2 W/sf	0.87 W/sf	Achieved
Technology				
Building				

ASHRAE Standard 90.1- 2007- Conclusion:

The prescriptive performance evaluation method was used to determine whether the Science and Technology Building complied with Standard 90.1. In the areas that were evaluated, the building was found to comply with nearly all of the requirements set forth. When the requirement was reached, the design of the building lead to higher efficiencies than required being meet, as the Science and Technology Building has been designed to achieve a LEED Silver rating. The areas that did not meet ASHRAE Standard 90.1 where found to be in the two following system types, the 100 % outdoor air AHU's and the pumps used in the HVAC equipment. The reason that these may not have met the Standard is the use of variable frequency drives on the supply fans and the pump motors to have a better efficiency at part load. Other than these two specific components the Science and Technology Building was found to meet the minimum requirements of ASHRAE Standard 90.1.

References:

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Appendix A- ASHRAE Standard 62.1 Section 6 Calculations- 100 % Outdoor Air AHU's 1, 2,

Building:	Gruner	wald Sci	ence a	nd Technology Building	C		9					
System Tag/Name:		2,5-Leve			-							
Operating Condition Description:	Occupi	ied Opera	ation C	onditons								
Units (select from pull-down list)	IP					-						
Inputs for System	Name	Units				System						
Floor area served by system	As	sf				39411						
Population of area served by system (including diversity)	Ps	P	Г	100% diversity		936						
Design primary supply fan airflow rate	Vpsd	cfm	-			62,640						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15						
OA reg'd per person for system area (Weighted average)	Rps	cfm/p				8.6						
Inputs for Potentially Critical zones					-							
7							Corridor	Corridor	Mudroom	Biology	Soils	Rock Prep
Zone Name	Zopo N	lo turne o	umin il	alic for critical zone(s)						Storage		
Zone Tag	2009.00	e wins p	ulhie ii	and for critical zona(a)			100C	100F	101A	101	103	105
2010 Tag							Corridors	Corridors	Corridors	Storage	Health	Science
Space type							Contracta	Contracts	Contracta	rooms	club/weight	laboratories
		Select fr	om pul	I-down list		I				0.0000000	rooms	000000.0000000.0
Floor Area of zone	Az	sf				[380	900	100	150	220	290
Design population of zone	Pz	P	(defau	It value listed; may be ove	errido	len)	0	0	0	0	1	1
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					250	2050	75	300	350	425
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select fr	om pul	I-down list or leave blank	if N//	N .		2 2				
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	96				100%	100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed	Ds		om nui	I-down list		100%	CS	100% CS	CS	CS	CS	CS
Zone air distribution effectiveness at conditioned analyzed	Ez	Oelett II	on pu	I-DOMITINSE		-	1.00	1.00	1.00	1.00	1.00	1.00
Primary air fraction of supply air at conditioned analyzed	Ep						1.00	1.00	1.00	1.00	1.00	1.00
Results	hody?											
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7						
Outdoor air as a % of design primary supply air	Ypd	cfm				98%						
Detailed Calculations	_	_	_		_	_						
Initial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm	= \	/pdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	=	13960						
Uncorrected OA reg'd as a fraction of primary SA	Xs			/ou / Vps	=	0.22						
Initial Calculations for individual zones												
OA rate per unit area for zone	Raz	cfm/st					0.06	0.06	0.06	0.12	0.06	0.18
OA rate per person	Rpz	cfm/p					0.00	0.00	0.00	0.00	20.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					250	2050	75	300	350	
Unused OA reg'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		22.8	54.0	6.0	18.0	33.2	
Unused OA requirement for zone	Voz	cfm		/bz/Ez	=		23	54	6	18	33	
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		= 8		=		1.00	1.00	1.00	1.00	1.00	
Fraction of zone OA not directly recirc. from zone	Fc			-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	1.00	1.00	1.00	
Unused OA fraction required in supply air to zone	Zd			/oz / Vdz	=		0.09	0.03	0.08	0.06	0.09	
Unused OA fraction required in primary air to zone	Zp		=)	/oz / Vpz	Ξ		0.09	0.03	0.08	0.06	0.09	0.15
System Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Evz		- 1	Fa + FbXs - FcZ) / Fa	=		1.13	1.20	1.14	1.16	1.13	1.08
System Ventilation Efficiency (App A Method)	Ev			nin (Evz.)	2	0.23	1.15	1.20	1.14	1.10	1.15	1.00
Ventilation System Efficiency (App A Method)	EV			alue from Table 6.3	-	0.23 n/a						
Minimum outdoor air intake airflow						110						
Outdoor Air Intake Flow required to System	Vot	cfm	= \	/ou / Ev	=	61536						
OA intake reg'd as a fraction of primary SA	Y	20032		/ot / Vps	=	0.98						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	= \	/ou / Ev	=	n/a						
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)			= \	/ot / Vps	=	n/a						
OA Temp at which Min OA provides all cooling												
OAT below which OA Intake flow is @ minimum		DealE	- 1	(Tp-dTsf)-(1-Y)*(Tr+dTrl	-	55						

Shane Helm

Building:	Gruner	wald Scie	nce	and Technology Building							
System Tag/Name:		2,5-Level			_						
Operating Condition Description:	Occupi			Conditons							
Inits (select from pull-down list)	IP										
nputs for System	Name	Units			Г	System					
Floor area served by system	As	sf				39411					
Population of area served by system (including diversity)	Ps	P		100% diversity		936					
Design primary supply fan airflow rate	Vpsd	cfm				62,640					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15					
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6					
nputs for Potentially Critical zones											
							Chem/Bio	Physics	Experimental	Animal	Holding
Zone Name	-			And a second second second second			Storage	Machine	Physics	Facility	Aquarium
Zone Tag	Zone w	le turns pl	inple	italic for critical zone(s)		ŀ	114A	113	115	116	116A
Zone rag						ŀ	Storage			University/coll	
Space type							rooms	ege	ege	ege	ege
Charles (type		Select fr	om r	ull-down list			rooms	laboratories	laboratories	laboratories	laboratories
Floor Area of zone	Az	sf				l l	128	200	648	730	22
Design population of zone	Pz		(def	ault value listed; may be ov	errido	den)	0	6	16	0	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					200	325	850	1825	55
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select fro	om p	ull-down list or leave blank	if N//	A					
Local recirc, air % representative of ave system return air	Er										
puts for Operating Condition Analyzed	-					10001					
Percent of total design airflow rate at conditioned analyzed	Ds	%				100%	100%	100%	100%	100%	1009
Air distribution type at conditioned analyzed	-	Select In	om p	ull-down list		· · · ·	CS	CS	CS	LS LOS	C
Zone air distribution effectiveness at conditioned analyzed	Ez					-	1.00	1.00	1.00	1,00	1.0
Primary air fraction of supply air at conditioned analyzed esults	Ep										
Ventilation System Efficiency	Ev					0.23					
Outdoor air intake required for system	Vot	cfm				61536					
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56					
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7					
Outdoor air as a % of design primary supply air	Ypd	cfm				98%					
Petailed Calculations			_		_						
nitial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	62640					
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	=	13960					
Uncorrected OA reg'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.22					
itial Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf					0.12				0.1
OA rate per person	Rpz	cfm/p					0.00				10.0
Total supply air to zone (at condition being analyzed)	Vdz	cfm					200				55
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		15.4				39
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		15				4
Fraction of zone supply not directly recirc. from zone	Fa			Ep + (1-Ep)Er	=		1.00				1.0
Fraction of zone supply from fully mixed primary air	Fb			Ep	=		1.00				1.0
Fraction of zone OA not directly recirc. from zone	Fc			1-(1-Ez)(1-Ep)(1-Er)	=		1.00				1.0
Unused OA fraction required in supply air to zone	Zd			Voz / Vdz	=		0.08				0.0
Unused OA fraction required in primary air to zone	Zp		18	Voz / Vpz	=		0.08	0.30	0.33	0.07	0.0
vstem Ventilation Efficiency	Evz			(Fa + FbXs - FcZ) / Fa	=		1.15	0.93	0.90	1.15	1.1
Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	Evz			min (Evz)		0.23	1.15	0.93	0.90	1,15	3.0
Ventilation System Efficiency (App A Method)	EV		-	Value from Table 6.3	-	0.23 n/a					
inimum outdoor air intake airflow				Forder in our Found of S	-	11/8					
Outdoor Air Intake Flow required to System	Vot	cfm	-	Vou / Ev	-	61536					
OA intake reg'd as a fraction of primary SA	Y			Vot / Vps	=	0.98					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	S.	cfm		Vou / Ev	-	n/a					
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)		121/22		Vot / Vps	=	n/a					
A Temp at which Min OA provides all cooling				the second se							
		Deg F		{(Tp-dTsf)-(1-Y)*(Tr+dTri		55					

uilding: ystem Tag/Name:		wald Scie		and Technology Building	1							_
perating Condition Description:				Conditons								
nits (select from pull-down list)	IP											_
puts for System	Name	Units			Г	System						
Floor area served by system	As	sf				39411						
Population of area served by system (including diversity)	Ps	P		100% diversity		936						
Design primary supply fan airflow rate	Vpsd	cfm				62,640						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15						
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6						
outs for Potentially Critical zones							Martin I.			10110		
Zone Name							Vestibule	Plasma Research	Nanotech Research	ADV-Comp Physics	Biology Facility	J
Zone Name	Zone tit	le turns pu	India	italic for critical zone(s)				Research	Research	Flysics	Facility	L
Zone Tag		a marrie pro	- pres	the state of the s			New zone ID	New zone ID	New zone ID	New zone ID	New zone ID	
										University/coll		
Space type							ege	ege	ege	ege	ege	1
		Select fro	om p	ull-down list			laboratories	laboratories	laboratories	laboratories	laboratories	
Floor Area of zone	Az	sf				- 282	225	540	1080	110	570	
Design population of zone	Pz		(def	ault value listed; may be ov	errido	den)	4	16	32	3	13	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					400	850	925	175	900	0
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	20	Select fro	om p	ull-down list or leave blank	if N/A	A						+
Local recirc. air % representative of ave system return air	Er											L
uts for Operating Condition Analyzed Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	1009	6
Air distribution type at conditioned analyzed	05		om r	ull-down list		100%	100% CS	CS	CS	CS	CS	5
Zone air distribution effectiveness at conditioned analyzed	Ez	Join of In	an k	an avent nat			1.00	1.00	1.00	1.00	1.00	
Primary air fraction of supply air at conditioned analyzed	Ep						1.00	1.00	1.00	1,00	1.00	1
sults												
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7						
Outdoor air as a % of design primary supply air	Ypd	cfm				98%						
tailed Calculations		_				_						
ial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm		VpdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	=	13960						
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.22						
al Calculations for individual zones												
OA rate per unit area for zone	Raz	cfm/sf					0.18	0.18				
OA rate per person	Rpz	cfm/p					10.00	10.00	10.00		10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm		12101200200000			400	850	925			
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		80.5	257.2	514.4		272.6	
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	-		81	257	514		273	
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 Zd			1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz	=		1.00	1.00	1.00		1.00	
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone	Zp			Voz / Voz Voz / Vpz	-		0.20	0.30	0.56		0.30	
em Ventilation Efficiency	zp		122	VOL / VPZ			0.20	0.30	0.50	0.28	0.30	
Zone Ventilation Efficiency (App A Method)	Evz		-	(Fa + FbXs - FcZ) / Fa	122		1.02	0.92	0.67	0.94	0.92	2
System Ventilation Efficiency (App A Method)	Ev			min (Evz)	-	0.23	1.02	5.52	0.07	0.04	0.5.	
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	n/a						
mum outdoor air intake airflow	1000			CONTRACTOR OF THE OWNER OWN		1000						
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	61536						
OA intake reg'd as a fraction of primary SA	Y			Vot / Vps	=	0.98						
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm	=	Vou / Ev	=	n/a						
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)			Ξ	Vot / Vps	=	n/a						
Temp at which Min OA provides all cooling												
OAT below which OA Intake flow is @ minimum		Deg F	1222	{(Tp-dTsf)-(1-Y)*(Tr+dTrt	10.000	55						

uilding:	Gruner	wald Scie	ence	and Technology Building	g							-
ystem Tag/Name:		2,5-Level										
perating Condition Description:	Occupi			Conditons								
nits (select from pull-down list)	IP											_
puts for System	Name	Units			Г	System						
Floor area served by system	As	sf				39411						
Population of area served by system (including diversity)	Ps	P		100% diversity		936						
Design primary supply fan airflow rate	Vpsd	cfm				62,640						
OA regid per unit area for system (Weighted average)	Ras	cfm/sf				0.15						
OA req'd per person for system area (Weighted average)	Rps	cfm/p			L	8.6						
uts for Potentially Critical zones							Lounge	Corridor	Biology	Faculty	Ecology	
Zone Name							Lounge	Comuor	Research	Musuem	Ecology	
and the state of t	Zone til	le turns ou	Inple	italic for critical zone(s)					Research	musuem		
Zone Tag	allowing the	a turring pro	- pris	the content and a straig of			200A	200C	201	202	203	1
							Corridors	Corridors		Museums/gall		ш
Space type							3330320233	Constant Constant State	ege	eries	ege	
121 122			om p	oull-down list					laboratories		laboratories	
Floor Area of zone	Az	sf	-	1 10 10 10 10 10 10 10 10 10 10 10 10 10		1.00	885	1500	640		92	
Design population of zone	Pz		(def	ault value listed; may be ov	errid	den)	0	0	11	17	2	× .
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					1450	1225	900	800	150	0
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? Local recirc, air % representative of ave system return air	Er	Select fro	om t	oull-down list or leave blank	IT N/	e			-			4
uts for Operating Condition Analyzed	<u>C1</u>				-							1
Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	100	16
Air distribution type at conditioned analyzed			om r	oull-down list		10070	CS	CS	CS	CS	C	S
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.0	0
Primary air fraction of supply air at conditioned analyzed	Ep							1100		100		1
sults						to approximate						
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7						
Outdoor air as a % of design primary supply air	Ypd	cfm				98%						
tailed Calculations	_											
tial Calculations for the System as a whole				0.92								
Primary supply air flow to system at conditioned analyzed	Vps	cfm		VpdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	-	13960						
Uncorrected OA reg'd as a fraction of primary SA	Xs		-	Vou / Vps	370	0.22						
al Calculations for individual zones	Raz	otrolot					0.06	0.06	0.18	3 0.06	0.1	0
OA rate per unit area for zone OA rate per person	Rpz	cfm/sf cfm/p					0.06	0.06				
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1450	1225				
Unused OA reg'd to breathing zone	Vbz	cfm	-	Rpz Pz + Raz Az	:==:		53.1	90.0				
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		53	90				
Fraction of zone supply not directly recirc. from zone	Fa	054040		Ep + (1-Ep)Er	=		1.00	1.00				
Fraction of zone supply from fully mixed primary air	Fb			Ep	=		1.00	1.00				
Fraction of zone OA not directly recirc. from zone	Fc			1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00				
Unused OA fraction required in supply air to zone	Zd			Voz / Vdz	=		0.04	0.07				
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.04	0.07	0.34	0.20	0.3	0
em Ventilation Efficiency												
Zone Ventilation Efficiency (App A Method)	Evz			(Fa + FbXs - FcZ) / Fa	=		1.19	1.15	0.88	3 1.02	0.9	3
System Ventilation Efficiency (App A Method)	Ev			min (Evz)	=	0.23						
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	n/a						
mum outdoor air intake airflow	10000	50 C		1999-1992		100000						
Outdoor Air Intake Flow required to System	Vot	cfm		Vou / Ev	=	61536						
OA intake reg'd as a fraction of primary SA	Y	-		Vot / Vps	=	0.98						
Outdoor Air Intake Flow required to System (Table 6.3 Method)		cfm		Vou / Ev	=	n/a						
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)	X		=	Vot / Vps	-	n/a						
Temp at which Min OA provides all cooling		-			11122							
OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+dTrl	=	55	1					

uilding: ystem Tag/Name:		wald Scie 2,5- Level		and Technology Building	1							_
perating Condition Description:				Conditons								
nits (select from pull-down list)	IP	eu opera		Conditoria			1					
puts for System	Name	Units			E	System	1					
Floor area served by system	As	sf				39411	1					
Population of area served by system (including diversity)	Ps	P		100% diversity		936	1					
Design primary supply fan airflow rate	Vpsd	cfm				62,640	1					
OA reg'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15	1					
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6						
outs for Potentially Critical zones												-
Zone Name						1	Bio Prep/Storage	Chem.	Chem.	Freshman	General Chem	
Zone Name	Zone tit	le turns ou	mla	italic for critical zone(s)			Prep/Storage	Principle	Instruction	Majors		F
Zone Tag	accertar da	- surra po	-pred	the second second of			205A	206	206A	207	208	+
								University/coll		Lecture	University/col	1
Space type							rooms	ege	ege	classroom	ege	1
		Select fro	om p	ull-down list				laboratories	laboratories		laboratories	
Floor Area of zone	Az	sf				1.00	490	890	1150	890	1190	
Design population of zone	Pz		(def	ault value listed; may be ov	errido	den)	15	27	35	27	36	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					950	1490	1750	1450	1525	5
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	-	Select fro	om p	ull-down list or leave blank	if N/A	A						+
Local recirc, air % representative of ave system return air	Er											1
Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	100%	6
Air distribution type at conditioned analyzed			om n	ull-down list		10030	CS	CS	CS	CS	CS	1
Zone air distribution effectiveness at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.00	0
Primary air fraction of supply air at conditioned analyzed	Ep						1.00					
sults	1000 C					1 colores and						
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7 98%						
Outdoor air as a % of design primary supply air	Ypd	cfm				30%	8					
tailed Calculations	_	_								_		
tial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm		VpdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	-	13960						
Uncorrected OA regid as a fraction of primary SA al Calculations for individual zones	Xs		-	Vou / Vps	1	0.22						
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.18	0.18	0.06	0.18	
OA rate per unit area for zone OA rate per person	Rpz	cfm/st					0.12	10.00	10.00	7.50	10.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					950	1490	1750	1450	1525	
Unused OA reg'd to breathing zone	Vbz	cfm	-	Rpz Pz + Raz Az	=		58.8	430.2	557.0	255.9	574.2	
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	-		59	430	557	256	574	
	Fa	02000		Ep + (1-Ep)Er	=		1.00	1.00	1.00	1.00	1.00	
Fraction of zone supply not directly regirc from zone				Ep	=		1.00	1.00	1.00	1.00	1.00	
Fraction of zone supply not directly recirc, from zone Fraction of zone supply from fully mixed primary air	Fb						1.00	1.00	1.00	1.00		
Fraction of zone supply not directly redrc, from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc, from zone	Fb Fc			1-(1-Ez)(1-Ep)(1-Er)	=			1.00			1.00	з.
Fraction of zone supply from fully mixed primary air			=	1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz	=		0.06	0.29	0.32	0.18	0.38	
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone	Fc		п п									3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency	Fc Zd Zp			Voz / Vdz Voz / Vpz	=		0.06 0.06	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Fc Zd Zp Evz			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa	= = =		0.06	0.29	0.32	0.18	0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	Fc Zd Zp Evz Ev			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz)		0.23	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method)	Fc Zd Zp Evz			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa	= = =	0.23 n/a	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outd oor air Intake airflow	Fc Zd Zp Evz Ev Ev			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6:3		n/a	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	8
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air intake airflow Outdoor Air Intake Flow required to System	Fc Zd Zp Evz Ev Ev Vot	cfm		Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev		n/a 61536	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Venblation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake req'd as a fraction of primary SA	Fc Zd Zp Evz Ev Ev Ev Vot Y			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6:3 Vou / Ev Vot / Vps		n/a 61536 0.98	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone unused OA fraction required in primary air to zone stem Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) <u>imum outdoor air Intake airflow</u> Outdoor Air Intake Flow required to System OA intake regid as a fraction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method)	Fc Zd Zp Evz Ev Ev Vot Y Vot	cfm cfm		Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz.) Value from Table 6.3 Vou / Ev Vot / Vps Vou / Ev		n/a 61536 0.98 n/a	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3
Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone stem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air intake airflow Outdoor air intake airflow OA intake req/d as a fraction of primary SA	Fc Zd Zp Evz Ev Ev Vot Y Vot			Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6:3 Vou / Ev Vot / Vps		n/a 61536 0.98	0.06 0.06 1.16	0.29 0.29	0.32 0.32	0.18 0.18	0.38 0.38	3

Building:	Gnuper	wald Sci	ence	and Technology Building	n .							_
System Tag/Name:		2.5- Leve					2					
Operating Condition Description:				Conditons								
Jnits (select from pull-down list)	IP											_
nputs for System	Name	Units				System						
Floor area served by system	As	sf				39411						
Population of area served by system (including diversity)	Ps	P		100% diversity		936						
Design primary supply fan airflow rate	Vpsd	cfm				62,640						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15						
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8,6	1					
nputs for Potentially Critical zones							ones					_
Zone Name							Bio	Physics	Physics	Genetics	Bio Storage	P
Zone Name	Zone ti	tio turne n	umk	italic for critical zone(s)			Prep/Storage		Prep/Storage			
Zone Tag	20119 0	na mina h	npre	nalio for chikai zonejoj			209A	210	210A	211	211A	
2010 109							Storage	University/coll	Storage	University/coll	Storage	Ur
Space type							rooms	ege	rooms	ege	rooms	
		Select fr	om p	oull-down list				laboratories		laboratories		1
Floor Area of zone	Az	sf					250	1190	750	890	100	
Design population of zone	Pz	P	(def	ault value listed; may be ov-	errido	ien)	8	36	23	27	3	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				100	300	1800	1050	1400	200	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	122	Select fr	om p	oull-down list or leave blank	if N/A	4						
Local recirc, air % representative of ave system return air	Er											
nputs for Operating Condition Analyzed	Ds	96				10.00/	10.0%	10.0%	10.005	10.005	10.006	-
Percent of total design airflow rate at conditioned analyzed	Ds			oull-down list		100%	100% CS	100% CS	100% CS	100% CS	100% CS	-
Air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed	Ez	Select II	om	Juli-down list			1.00	1.00	1.00	1.00	1.00	-
Primary air fraction of supply air at conditioned analyzed	Ep						1.00	1.00	1.00	1.00	1.00	-
Results	h-p											-
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7						
Outdoor air as a % of design primary supply air	Ypd	cfm				98%						
Detailed Calculations			_									_
nitial Calculations for the System as a whole												
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	13960						
Uncorrected OA reg'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.22						
nitial Calculations for individual zones												
OA rate per unit area for zone	Raz	cfm/sf					0.12		0.12		0.12	
OA rate per person	Rpz	cfm/p					0.00		0.00		0.00	
Total supply air to zone (at condition being analyzed)	Vdz	cfm					300		1050		200	
Unused OA reg'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		30.0		90.0		12.0	
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		30		90		12	
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 Fc			Ep	=		1.00		1.00		1.00	
Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone	FC Zd			1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz	-		1.00		1.00		1.00	
Unused OA fraction required in supply all to zone	Zp			Voz / Vpz	=		0.10		0.09		0.06	
System Ventilation Efficiency	et.			TWE T YES	10.75.2		0.10	0.52	0.09	0.51	0.00	
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	=		1.12	0.90	1.14	0.92	1.16	
System Ventilation Efficiency (App A Method)	Ev			min (Evz)	=	0.23	1000	0.00		0.02		
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	n/a						
Ainimum outdoor air intake airflow												
Outdoor Air Intake Flow required to System	Vot	cfm	Ξ	Vou / Ev	=	61536						
OA intake req'd as a fraction of primary SA	Y			Vot / Vps	=	0.98						
Outdoor Air Intake Flow required to System (Table 6.3 Method)		cfm		Vou / Ev	=	n/a						
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)	Y		=	Vot / Vps	=	n/a						
DA Temp at which Min OA provides all cooling		-										
OAT below which OA Intake flow is @ minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+dTrt	=	55	10 C					

uilding:	Gruner	wald Scie	nce	and Technology Building	1						
ystem Tag/Name:		2,5- Level									
perating Condition Description:		ed Operat	tion	Conditons							
nits (select from pull-down list)	IP										
puts for System	Name	Units				System					
Floor area served by system	As	sf				39411					
Population of area served by system (including diversity)	Ps	P		100% diversity		936					
Design primary supply fan airflow rate	Vpsd	cfm				62,640					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15					
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6					
uts for Potentially Critical zones							0		-		0.11.21
Zone Name							Corridors	Clean Cellular	Clean Room	Systematic Lab	Cell Tissue Culture Room
Zone Name	Zone til	le turns pu	mle	italic for critical zone(s)						Lab	Culture Room
Zone Tag				interest of interest and of a		ł	300A	301	301A	302	303
						1	Corridors	University/coll	University/coll	University/coll	University/col
Space type								ege	ege	ege	ege
			om p	ull-down list				laboratories	laboratories	laboratories	laboratories
Floor Area of zone	Az	sf					1500	900	110	580	350
Design population of zone	Pz		defa	ault value listed; may be ov	erndo	ien)	0	27	3	17	11
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm Select fre		ull down liet as leave http:/			2950	1300	50	875	475
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? Local regire, air % representative of ave system return air	Er	Select fro	an p	ull-down list or leave blank	11 14/7				/		
uts for Operating Condition Analyzed	part				12						
Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select fro	om p	ull-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										
ults Vestilates Salar Efficiency	Ev					0.00					
Ventilation System Efficiency Outdoor air intelve required for surfam	Ev Vot	cfm				0.23 61536					
Outdoor air intake required for system Outdoor air per unit floor area	Vot/As	cfm/sf				1.56					
Outdoor air per unit floor area Outdoor air per person served by system (including diversity)	Vot/As Vot/Ps	cfm/st				1.55					
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ypd	cfm				98%					
as a to a good at build a sobbit an		1000									
ailed Calculations											
al Calculations for the System as a whole	1000			MadDa		00040					
Primary supply air flow to system at conditioned analyzed	Vps	cfm		VpdDs	=	62640					
UncorrectedOA requirement for system Uncorrected OA req'd as a fraction of primary SA	Vou Xs	cfm		Rps Ps + Ras As Vou / Vps	-	13960					
al Calculations for individual zones	7.5		-	vou / vps	374	0.22					
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.18	0.18	0.18	0.18
over the per unit died for zone		cfm/p					0.00	10.00	10.00		10.00
OA rate per person	RDZ										
OA rate per person Total supply air to zone (at condition being analyzed)	Rpz Vdz								50	875	
Total supply air to zone (at condition being analyzed)	Rpz Vdz Vbz	cfm cfm	=	Roz Pz + Raz Az	=		2950 90.0	1300	50 49.8		475
	Vdz	cfm		Rpz Pz + Raz Az Vbz/Ez	=		2950			274.4	475
Total supply air to zone (at condition being analyzed) Unused OA req'd to breathing zone Unused OA requirement for zone	Vdz Vbz	cfm cfm	=	Vbz/Ez			2950 90.0	1300 432.0	49.8	274.4 274	475 173.0
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Unused OA requirement for zone Fraction of zone supply not directly recirc, from zone	Vdz Vbz Voz	cfm cfm	= =		=		2950 90.0 90	1300 432.0 432	49.8 50	274 4 274 1.00	475 173.0 173
Total supply air to zone (at condition being analyzed) Unused OA req'd to breathing zone Unused OA requirement for zone	Vdz Vbz Voz Fa	cfm cfm		Vbz/Ez Ep + (1-Ep)Er	=		2950 90.0 90 1.00	1300 432.0 432 1.00	49.8 50 1.00	274.4 274 1.00 1.00	475 173.0 173 1.00
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air	Vdz Vbz Voz Fa Fb	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep			2950 90.0 90 1.00 1.00	1300 432.0 432 1.00 1.00	49.8 50 1.00 1.00	274 4 274 1 00 1 00 1 00	475 173.0 173 1.00 1.00
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone	Vdz Vbz Voz Fa Fb Fc	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er)			2950 90.0 90 1.00 1.00 1.00	1300 432.0 432 1.00 1.00 1.00	49.8 50 1.00 1.00 1.00	274 4 274 1.00 1.00 1.00 0.31	475 173.0 173 1.00 1.00 1.00
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply not directly recirc. from zone Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone Monted on Efficiency	Vdz Vbz Voz Fa Fb Fc Zd Zp	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz			2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone EXPENDENTIALISTIC Zone Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa			2950 90.0 90 1.00 1.00 1.00 0.03	1300 432.0 432 1.00 1.00 1.00 0.33	49 8 50 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 1.00 0.36
Total supply air to zone (at condition being analyzed) Unused OA requ'to breathing zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone oA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency (App A Method)	Vdz Vbz Fa Fb Fc Zd Zp Evz Evz	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz)		0.23	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply not directly recirc. from zone Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone Unused OA fraction required (not primary air to zone Unused OA fraction required (not primary air to zone Unused OA fraction Efficiency Zone Ventilation Efficiency Ventilation System Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method)	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa		0.23 n/a	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone em Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method) mum outdoor air intake airflow	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev	cfm cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3		n/a	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone supply from fully mixed primary air Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone Unused OA fraction terce (at the supply air to zone Unused OA fraction terce) (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) Unused OA fraction terce (Table 6.3 Method) Outdoor Air Intake airflow Outdoor Air Intake airflow	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Vot	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev		n/a 61536	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply not directly recirc. from zone Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction (App A Method) System Ventilation Efficiency Ventilation System Efficiency (Table 6.3 Method) Unusultation System Efficiency (Table 6.3 Method) Outdoor air Intake airflow Outdoor Air Intake Filow required to System OA intake req'd as a fraction of primary SA	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Vot Y	cfm cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps		n/a 61536 0.98	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA req'd to breathing zone Unused OA req'd to breathing zone Fraction of zone supply not directly recirc, from zone Fraction of zone supply from fully mixed primary air Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Vertilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (App A Method) Undoor Air Intake Flow required to System OA intake req'd as a fraction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz Ev Vot Y Vot	cfm cfm cfm		Vbz/Ez Ep (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vdz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6:3 Vou / Ev Vot / Vps Vou / Ev		n/a 61536 0.98 n/a	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36
Total supply air to zone (at condition being analyzed) Unused OA requitement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply air to zone Unused Ventilation Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method) Utdoor air Intake airflow Outdoor Air Intake Filow required to System OA intake req'd as a fraction of primary SA	Vdz Vbz Voz Fa Fb Fc Zd Zp Evz Ev Vot Y Vot	cfm cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps		n/a 61536 0.98	2950 90.0 90 1.00 1.00 0.03 0.03	1300 432.0 432 1.00 1.00 0.33 0.33	49.8 50 1.00 1.00 1.00 1.00 1.00	274 4 274 1.00 1.00 0.31 0.31	475 173.0 173 1.00 1.00 0.36 0.36

uilding:	Gruner	wald Scie	ence	and Technology Building	1							-
stem Tag/Name:		2,5-Level										
perating Condition Description:				Conditons								
nits (select from pull-down list)	IP											_
puts for System	Name	Units				System						
Floor area served by system	As	sf				39411						
Population of area served by system (including diversity)	Ps	P		100% diversity		936						
Design primary supply fan airflow rate	Vpsd	cfm		100 000 000 000 000 000		62,640						
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15						
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6	1					
uts for Potentially Critical zones							Culture Day	1	Die De eren	Ded Dee	Cham Ota	
Zone Name							Culture Room	Lounge	Bio Research	Dark Room	Chem Storag	je
a vite regite	Zone til	le turns o	umle	italic for critical zone(s)								
Zone Tag		es turris pi	- and	nano nan winnout a wind[0/			303C	304	305	305A	307	ī
							University/coll	Corridors	University/coll		Storage	
Space type							ege	E Contractor of the	ege		rooms	
			om p	ull-down list			laboratories		laboratories			
Floor Area of zone	Az	sf				- 88	135	445	920	245	25	5
Design population of zone	Pz		(defa	ult value listed; may be ov	erridd	ien)	4	0	28	7		
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					450	1200	1300	625	62	2
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	F -	Select fro	om p	ull-down list or leave blank	If N/A	۹.						
Local recirc, air % representative of ave system return air ts for Operating Condition Analyzed	Er									L	1	
Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	100	Ģ
Air distribution type at conditioned analyzed	0.5		om p	ull-down list		100%	CS	100% CS	CS	CS	100	-
Zone air distribution effectiveness at conditioned analyzed	Ez	Service In	-in p	and a second mark			1.00	1.00	1.00	1.00	1.0	
Primary air fraction of supply air at conditioned analyzed	Ep							1100	1.00	1100		ĺ
ults						Long and the						
Ventilation System Efficiency	Ev					0.23						
Outdoor air intake required for system	Vot	cfm				61536						
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56						
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7						
Outdoor air as a % of design primary supply air	Ypd	cfm				98%						
ailed Calculations	_	_				_						ļ
al Calculations for the System as a whole				1.92								
Primary supply air flow to system at conditioned analyzed	Vps	cfm		VpdDs	=	62640						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	-	13960						
Uncorrected OA req'd as a fraction of primary SA	Xs		-	Vou / Vps	370	0.22						
Calculations for individual zones	Raz	ofmici					0.18	0.06	0.18	0.06	0.1	
OA rate per unit area for zone OA rate per person	Rpz	cfm/sf cfm/p					10.00	0.06				
Total supply air to zone (at condition being analyzed)	Vdz	cfm					450	1200				
Unused OA reg'd to breathing zone	Vbz	cfm	=	Rpz Pz + Raz Az	=		64.3	26.7	445.6			
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		64	27	446			
Fraction of zone supply not directly recirc. from zone	Fa	0023020		Ep + (1-Ep)Er	=		1.00	1.00				
Fraction of zone supply from fully mixed primary air	Fb		=		=		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	0.02				
Unused OA fraction required in primary air to zone	Zp		1. 1.	Voz / Vpz	=		0.14	0.02	0.34	0.08	0.0	
em Ventilation Efficiency	-											
Zone Ventilation Efficiency (App A Method)	Evz			(Fa + FbXs - FcZ) / Fa	=	121222	1.08	1.20	0.88	1.14	1.1	
System Ventilation Efficiency (App A Method)	Ev			min (Evz.)	=	0.23						
MARKEN CONTRACTOR AND A CARDINAL	Ev		=	Value from Table 6.3	=	n/a						
Ventilation System Efficiency (Table 6.3 Method)					-	61536						
num outdoor air intake airflow	Mat	alm										
num outdoor air intake airflow Outdoor Air Intake Flow required to System	Vot	cfm		Vou / Ev								
mum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake reg'd as a fraction of primary SA	Y		=	Vot / Vps	Ξ	0.98						
mum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake req'd as a fraction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method)	Y Vot	cfm cfm	= =	Vot / Vps Vou / Ev	=	0.98 n/a						
mum outdoor air Intake airflow Outdoor Air Intake Flow required to System OA intake req'd as a fraction of primary SA	Y Vot		= =	Vot / Vps	Ξ	0.98						

Building:	Gruner	wald Sci	ence	and Technology Building							
System Tag/Name:		2.5-Leve			_		1				
Operating Condition Description:	Occup	ed Opera	tion	Conditons							
Jnits (select from pull-down list)	IP										
nputs for System	Name	Units			[System					
Floor area served by system	As	sf				39411					
Population of area served by system (including diversity)	Ps	P		100% diversity		936					
Design primary supply fan airflow rate	Vpsd	cfm				62,640					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15	1				
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6					
nputs for Potentially Critical zones							Observators	Oham Dava	Missekister	Di-	Bio Chemistry
Zone Name							Chemistry	Chem Prep	Microbiology Lab	Bio Prep/Storage	Bio Criemistry
	Zone ti	le turns p	urple	italic for critical zone(s)						1. reprototage	
Zone Tag							310	310A	311	311A	312
							University/coll	Storage	University/coll	Storage	University/col
Space type							ege	rooms	ege	rooms	ege
First Annual Annual			om p	ull-down list			laboratories		laboratories		laboratories
Floor Area of zone	Az	sf P	(de f	with under a link of a more from our	and of a	100	900	250	920	250	900
Design population of zone	Pz Vdzd	P cfm	(def	ault value listed; may be ove	ernad	en)	27	8	28	400	27
Design total supply to zone (primary plus local recirculated) Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	vuza		om -	ull-down list or leave blank	if NZ		1400	350	1300	400	1250
Local recirc. air % representative of ave system return air	Er	Select II	Such	ou-oosti list oi leave piglik	1110/2				-	-	
nputs for Operating Condition Analyzed					11-	_	· · · · ·				
Percent of total design airflow rate at conditioned analyzed	Ds	96				100%	100%	100%	100%	100%	100%
Air distribution type at conditioned analyzed		Select fr	om p	ull-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										
tesults	-										
Ventilation System Efficiency	Ev Vot	cfm				0.23					
Outdoor air intake required for system	Vot/As	cfm/sf				61536					
Outdoor air per unit floor area Outdoor air per person served by system (including diversity)	Vot/Ps					65.7					
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ypd	cfm				98%					
	0.0259	036939				25092	5.C				
Detailed Calculations nitial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	62640					
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	=	13960					
Uncorrected OA reg/d as a fraction of primary SA	Xs			Vou / Vps	=	0.22					
nitial Calculations for individual zones	1000					1000					
OA rate per unit area for zone	Raz	cfm/sf					0.18	0.12	0.18		
OA rate per person	Rpz	cfm/p					10.00	0.00	10.00		
Total supply air to zone (at condition being analyzed)	Vdz	cfm					1400	350	1300		
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		432.0	30.0	445.6		
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		432	30	446		
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	=		0.31	0.09	0.34	0.08	
Unused OA fraction required in primary air to zone system Ventilation Efficiency	Zp			Voz / Vpz	177 C		0.31	0.09	0.34	0.08	0.35
Zone Ventilation Efficiency (App A Method)	Evz		-	(Fa + FbXs - FcZ) / Fa	-		0.91	1.14	0.88	1.15	0.88
System Ventilation Efficiency (App A Method)	EVZ			min (Evz)	=	0.23	0.91	1.14	0.00	1.15	0.00
Ventilation System Efficiency (Table 6.3 Method)	Ev			Value from Table 6.3	=	n/a					
inimum outdoor air intake airflow	1000			Contraction (Series of Series		120					
Outdoor Air Intake Flow required to System	Vot	cfm	=	Vou / Ev	=	61536					
OA intake reg'd as a fraction of primary SA	Y			Vot / Vps	=	0.98					
Outdoor Air Intake Flow required to System (Table 6.3 Method)	Vot	cfm		Vou / Ev	=	n/a					
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)			=	Vot / Vps	=	n/a					
A Temp at which Min OA provides all cooling											
OAT below which OA Intake flow is @ minimum		Deg F	172212	{(Tp-dTsf)-(1-Y)*(Tr+dTrl		55					

uilding:				and Technology Building	1		1				
ystem Tag/Name:		2,5-Level									
perating Condition Description:				Conditons	_						
nits (select from pull-down list)	IP										
puts for System	Name	Units				System					
Floor area served by system	As	sf				39411					
Population of area served by system (including diversity)	Ps	P		100% diversity		936					
Design primary supply fan airflow rate	Vpsd	cfm		And the second state of the second		62,640					
OA req'd per unit area for system (Weighted average)	Ras	cfm/sf				0.15					
OA req'd per person for system area (Weighted average)	Rps	cfm/p				8.6					
puts for Potentially Critical zones									-		
Zana Mama							Bio	Organic	Prep	NMR	Instructor
Zone Name	Zone M	to turne ou	mie	italic for critical zone(s)			Prep/Storage	Chemistry			Room
Zone Tag	Soura at	e ums pu	i pie	nano foi critical zone(S)			New zone ID	New zone ID	New zone ID	New zone ID	New zone ID
Zone rag							Storage	University/coll	Storage	University/coll	Office space
Space type							rooms	ege	rooms	ege	onnee opace
		Select fro	om p	oull-down list				laboratories		laboratories	
Floor Area of zone	Az	sf					95	2130	250	360	14
Design population of zone	Pz	P (defa	ault value listed; may be ove	errido	len)	3	64	8	11	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				100	200	5400	400	600	22
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select fro	om p	oull-down list or leave blank	if N/A	A					
Local recirc. air % representative of ave system return air	Er			A A MORAL OF VILLEY AND A DECKET STATES AND A	1.0355						
uts for Operating Condition Analyzed	De					1000	40.000	10.001	40.000	10000	1000
Percent of total design airflow rate at conditioned analyzed	Ds	% Soloct fre		uill down liet		100%	100% CS	100%	100%	100%	1009
Air distribution type at conditioned analyzed	5	Select fro	m p	oull-down list			CS 1.00	CS	CS 1.00	CS	C
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.0
sults	cp					_					
Ventilation System Efficiency	Ev					0.23					
Outdoor air intake required for system	Vot	cfm				61536					
Outdoor air per unit floor area	Vot/As	cfm/sf				1.56					
Outdoor air per person served by system (including diversity)	Vot/Ps	cfm/p				65.7					
Outdoor air as a % of design primary supply air	Ypd	cfm				98%					
tailed Calculations									_		
ial Calculations for the System as a whole											
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	62640					
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	13960					
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.22					
al Calculations for individual zones											
OA rate per unit area for zone	Raz	cfm/sf					0.12	0.18	0.12		0.0
OA rate per person	Rpz	cfm/p					0.00	10.00	0.00		5.0
Total supply air to zone (at condition being analyzed)	Vdz	cfm					200	5400	400		22
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		11.4	1023.4	30.0		28
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		11	1023	30		2
Fraction of zone supply not directly recirc. from zone	Fa			Ep + (1-Ep)Er	=		1.00	1.00	1.00		1.0
Fraction of zone supply from fully mixed primary air	Fb			Ep	=		1.00	1.00	1.00		1.0
	Fc			1-(1-Ez)(1-Ep)(1-Er)	=		1.00	1.00	1.00		1.0
Fraction of zone OA not directly recirc. from zone				Voz / Vdz	=		0.06	0.19	0.08		0.1
Unused OA fraction required in supply air to zone	Zd			Voz / Vpz	=		0.06	0.19	0.08	0.29	0.1
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone	Zd Zp		1000	Ton Color							
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency	Zp						4.47	4.00	4.45	0.00	
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Zp Evz		=	(Fa + FbXs - FcZ) / Fa	=	0.02	1.17	1.03	1.15	0.93	1.1
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	Zp Evz Ev			(Fa + FbXs - FcZ) / Fa min (Evz)	=	0.23	1.17	1.03	1.15	0.93	1.
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method)	Zp Evz			(Fa + FbXs - FcZ) / Fa		0.23 n/a	1.17	1.03	1.15	0.93	1.
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outd oor air Intake airflow	Zp Evz Ev Ev	cfm		(Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3	=	n/a	1.17	1.03	1.15	0.93	1,1
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone stem Ventilation Efficiency Zone Venblation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air Intake airflow Outdoor Air Intake Flow required to System	Zp Evz Ev Ev Ev	cfm		(Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev		n/a 61536	1.17	1.03	1.15	0.93	1.1
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone tem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation System Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air intake airflow Outdoor Air Intake airflow Outdoor Air Intake fow required to System OA intake req'd as a fraction of primary SA	Zp Evz Ev Ev Vot			(Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps	=	n/a 61536 0.98	1.17	1.03	1.15	0.93	1.1
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone stem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) himum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake reqid as a fraction of primary SA Outdoor Air Intake Flow required to System (Table 6.3 Method)	Zp Evz Ev Ev Vot Y Vot	cfm cfm		(Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps Vou / Ev		n/a 61536 0.98 n/a	1,17	1.03	1.15	0.93	1.3
Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone stem Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation System Efficiency (Table 6.3 Method) Ventilation System Efficiency (Table 6.3 Method) imum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake req'd as a fraction of primary SA	Zp Evz Ev Ev Vot Y Vot			(Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps		n/a 61536 0.98	1.17	1.03	1.15	0.93	1.1

Appendix B- ASHRAE Standard 62.1 Section 6 Calculations- VAV AHU's 3 & 4

Building:			ience	and Technology Building	1							
System Tag/Name: Operating Condition Description:	AHU-3,		ation	Conditons	_							
Operating Condition Description: Units (select from pull-down list)	IP	ed Oper	ation	Conditions	_							
and factor used han addit that	1		-			_	9					
Inputs for System	Name	Units				System						
Floor area served by system	As	sf				46169						
Population of area served by system (including diversity)	Ps	P		100% diversity		851						
Design primary supply fan airflow rate	Vpsd	cfm				72,805						
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				7.1						
Inputs for Potentially Critical zones						ł	Offices 3rd	Office	DC Office	Office	DC Office	Ages/Ch
Zone Name	Zone til	te turns p	unpk	Italic for critical zone(s)			Floor	Office	De Onice	Onice	De onice	Dept.
Zone Tag						ļ	357	353	355	351	387	389
Space type		Select	rom r	oull-down list		1	Office space	Office space	Office space	Office space	Office space	Storage
Floor Area of zone	Az	sf				ł	1,950	130	182	130	290	
Design population of zone	Pz	P	(def	ault value listed; may be ov	emidd	ien)	15	1	1	1	1	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				1	3,150	550	550	820	520	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select 1	rom p	oull-down list or leave blank	if N/A					3		
Local recirc. air % representative of ave system return air	Er		1000									
Inputs for Operating Condition Analyzed	De	96			-	1008	10.00	40.000	40.000	40.00	40.000	
Percent of total design airflow rate at conditioned analyzed Air distribution type at conditioned analyzed	Ds		-	oull-down list		100%	100%	100%	100%	100%	100%	1
Zone air distribution type at conditioned analyzed Zone air distribution effectiveness at conditioned analyzed	Ez	Select	rom t	ui-down list		ŀ	1.00	1.00	1.00	1.00	1.00	
Primary air fraction of supply air at conditioned analyzed	ED					ŀ	7.00	1.00	1.00	1.00	2.00	
Results												
Ventilation System Efficiency	Ev					0.78						
Outdoor air intake required for system	Vot	cfm				11530						
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				13.5						
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		72805						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As		8979						
Uncorrected OA reg'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.12						
Initial Calculations for Individual zones	-	30,02								1000	1	
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	
	Mala											
Total supply air to zone (at condition being analyzed)	Vdz	cfm	141	Dog Dt & Dog At	125		3150	550	550	820	520	
Total supply air to zone (at condition being analyzed) Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	-		192.0	12.8	15.9	12.8	22.4	
Total supply air to zone (at condition being analyzed) Unused OA req'd to breathing zone Unused OA requirement for zone	Vbz Voz		=	Vbz/Ez	= =		192.0 192	12.8 13	15.9 16	12.8 13	22.4 22	
Total supply air to zone (at condition being analyzed) Unused OA requit to breathing zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone	Vbz Voz Fa	cfm	=	Vbz/Ez Ep + (1-Ep)Er	=		192.0 192 1.00	12.8 13 1.00	15.9 16 1.00	12.8 13 1.00	22.4 22 1.00	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regularement for zone Fraction of zone supply mort directly redrc, from zone Fraction of zone supply from fully mixed primary air	Vbz Voz	cfm	= = =	Vbz/Ez Ep * (1-Ep)Er Ep	=		192.0 192	12.8 13	15.9 16 1.00	12.8 13	22.4 22	
Total supply air to zone (at condition being analyzed) Unused OA regid to breating zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone OA not directly recirc. from zone	Vbz Voz Fa Fb	cfm		Vbz/Ez Ep + (1-Ep)Er	= = =		192.0 192 1.00 1.00	12.8 13 1.00 1.00	15.9 16 1.00 1.00	12.8 13 1.00 1.00	22.4 22 1.00 1.00	
Total supply air to zone (at condition being analyzed) Unused OA requirement for zone Unused OA requirement for zone Fraction of zone supply mort directly redro, from zone Fraction of zone supply from fully mixed primary air	Vbz Voz Fa Fb Fc	cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er)	н н н н		192 0 192 1.00 1.00 1.00	12.8 13 1.00 1.00 1.00	15.9 16 1.00 1.00 1.00	12.8 13 1.00 1.00 1.00	22.4 22 1.00 1.00 1.00	
Total supply air to zone (at condition being analyzed) Unused OA regid to breating zone Unused OA regidmement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone of An to directly recirc. from zone Unused OA fraction reguined in supply air to zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency	Vbz Voz Fa Fb Fc Zd Zp	cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz	= = = = =		192.0 192 1.00 1.00 1.00 0.06 0.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regid to breathing zone Fraction of zone supply not directly redrc. from zone Fraction of zone supply tom fully mixed primary air Fraction of zone ozophy tom fully mixed primary air Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency Zone Ventilation Efficiency (App A Method)	Vbz Voz Fa Fb Fc Zd Zp Evz	cfm		Vbz/Ez Ep + (1-Ep)Er Ep + (1-Ep)(1-Er) Voz / Vdz Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa	= = = = =		192 0 192 1.00 1.00 1.00 0.06	12.8 13 1.00 1.00 1.00 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12 8 13 1.00 1.00 1.00 0.02	22 4 22 1 00 1 00 1 00 0 04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breating zone Unused OA regimement for zone Fraction of zone supply not drivedly recirc. from zone Fraction of zone oA not directly recirc. from zone Unused OA fraction required in supply art to zone Unused OA fraction required in supply art to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method)	Vbz Voz Fa Fb Fc Zd Zp Evz Ev	cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz)		0.78	192.0 192 1.00 1.00 1.00 0.06 0.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regid to breathing zone Fraction of zone supply not directly redrc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone supply from fully mixed primary air Unused OA fraction required in supply air to zone Unused OA fraction required in supply air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (App A Method)	Vbz Voz Fa Fb Fc Zd Zp Evz	cfm		Vbz/Ez Ep + (1-Ep)Er Ep + (1-Ep)(1-Er) Voz / Vdz Voz / Vdz Voz / Vpz (Fa + FbXs - FcZ) / Fa		0.78 0.81	192.0 192 1.00 1.00 1.00 0.06 0.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regimement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply from fully mixed primary air Fraction of zone supply from fully mixed primary air Unused OA fraction required in supply ar to zone Unused OA fraction required in primary air to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor air intake airflow	Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev	cfm cfm		Vbz/Ez Ep (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vdz Voz / Vdz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3		0.81	192.0 192 1.00 1.00 1.00 0.06 0.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regit boreathing zone Unused OA regit boreathing zone Fraction of zone supply not drivedly recirc. from zone Fraction of zone supply tom fully mixed primary air Fraction of zone supply tom fully mixed primary air Unused OA fraction required in supply air to zone Unused OA fraction required in supply air to zone Unused OA fraction required in supply air to zone System Ventilation Efficiency Zone Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor Air Intake airflow Outdoor Air Intake Flow required to System	Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Ev	cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vbz Voz / Vbz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev		0.81	192.0 192 1.00 1.00 1.00 0.06 0.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regid to breathing zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply torm tilly mixed primary air Fraction of zone supply torm tilly mixed primary air Unused OA fraction required in primary art to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation Efficiency (Table 6:3 Method) Ventilation Efficiency (Table 6:3 Method) Minimum outdoor air intake airflow OA intake regid as a fraction of primary SA	Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Vot Y	cfm cfm		Vbz/Ez Ep (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vbz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Voz / Vps		0.81 11530 0.16	192.0 192 1.00 1.00 0.06 0.06 1.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA reqid to breathing zone Unused OA requirement for zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply form tilly mixed primary air Fraction of zone OA not directly recirc. from zone Unused OA fraction required in supply ar to zone Unused OA fraction required in supply ar to zone Unused OA fraction required in primary air to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation System Efficiency (Table 6.3 Method) Minimum outdoor air intake airflow Outdoor Air Intake Flow required to System OA intake reqid as a fraction of primary SA Outdoor Air Intake Flow required to System	Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Vot Y Vot	cfm cfm		Vbz/Ez Ep + (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vbz Voz / Vbz (Fa + FbXs - Fc2) / Fa min (Evz) Value from Table 6.3 Vou / Ev Vot / Vps Vou / Ev		0.81 11530 0.16 11148	192 0 192 1 000 1 00 0 06 0 06 1 06 381.75	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	
Total supply air to zone (at condition being analyzed) Unused OA regid to breathing zone Unused OA regid to breathing zone Fraction of zone supply not directly recirc. from zone Fraction of zone supply torm tilly mixed primary air Fraction of zone supply torm tilly mixed primary air Unused OA fraction required in primary art to zone System Ventilation Efficiency (App A Method) System Ventilation Efficiency (App A Method) Ventilation Efficiency (Table 6:3 Method) Ventilation Efficiency (Table 6:3 Method) Minimum outdoor air intake airflow OA intake regid as a fraction of primary SA	Vbz Voz Fa Fb Fc Zd Zp Evz Ev Ev Vot Y Vot	cfm cfm		Vbz/Ez Ep (1-Ep)Er Ep 1-(1-Ez)(1-Ep)(1-Er) Voz / Vbz Voz / Vpz (Fa + FbXs - FcZ) / Fa min (Evz) Value from Table 6.3 Vou / Ev Voz / Vps		0.81 11530 0.16	192.0 192 1.00 1.00 0.06 0.06 1.06	12.8 13 1.00 1.00 0.02 0.02	15.9 16 1.00 1.00 1.00 0.03 0.03	12.8 13 1.00 1.00 1.00 0.02 0.02	22.4 22 1.00 1.00 1.00 0.04 0.04	

Shane Helm

Building:			ence	and Technology Building	1							
System Tag/Name:	AHU-3,											
Operating Condition Description: Units (select from pull-down list)	Occupi	ed Opera	tion	Conditons		_						
	Constant-				-							
Inputs for System	Name As	Units			H	System						
Floor area served by system Population of area served by system (including diversity)	Ps	sf		100% diversity		46169 851						
Design primary supply fan airflow rate	Vpsd	cfm		100 % diversity		72,805						
OA reg'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06						
OA reg'd per person for system area (Weighted average)	Rps	cfm/p				7.1						
Inputs for Potentially Critical zones					-							
Zone Name	Zone ti	tle turns p	unpik	italic for critical zone(s)			Corridor	Corridor	Corridor	Seminar	Ages GIS Lab	Server Pl
Zone Tag						ļ	300B	300C	300D Corridors	319	334	336
Space type		Select fr	om p	oull-down list			Corridors	Corridors	Corridors	Lecture	Lecture	Storage
Floor Area of zone	Az	sf				1	2850	1040	1040	705	1025	1000000000
Design population of zone	Pz		(def	ault value listed; may be over	emidd	ien)	0	0	0	15	31	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm					2900	1040	1040	1530	1450	
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?	1223	Select fr	om p	oull-down list or leave blank	if N/A		8					
Local recirc, air % representative of ave system return air	Er											
Inputs for Operating Condition Analyzed	Ds	96				100%	100%	100%	100%	100%	100%	10
Percent of total design airflow rate at conditioned analyzed Air distribution type at conditioned analyzed	05	200 Contractor	om -	oull-down list		100%	100% CS	100%	100%	100%	100%	1
Zone air distribution effectiveness at conditioned analyzed	Ez	Select II	ourt	Juli-down list		ŀ	1.00	1.00	1.00	1.00	1.00	-
Primary air fraction of supply air at conditioned analyzed	Ep					•	1.00	1.00	1.00	1.00	1.00	
Results												
Ventilation System Efficiency	Ev					0.78						
Outdoor air intake required for system	Vot	cfm				11530						
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				13.5						
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	(1 = 1)	VpdDs	(#)	72805						
UncorrectedOA requirement for system	Vou	cfm		Rps Ps + Ras As	=	8979						
Uncorrected OA regid as a fraction of primary SA	Xs		=	Vou / Vps	=	0.12						
Initial Calculations for individual zones	100											
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.06			
OA rate per person	Rpz	cfm/p					0.00	0.00	0.00			
Total supply air to zone (at condition being analyzed)	Vdz Vbz	cfm cfm	7723	Roz Pz + Raz Az			2900 171.0	1040 62.4	1040 62.4			
Unused OA req'd to breathing zone Unused OA requirement for zone	Voz	cfm		Vbz/Ez	-		171	62.4	62.4			
Fraction of zone supply not directly recirc. from zone	Fa	CHII		Ep + (1-Ep)Er	-		1.00	1.00	1.00			
Fraction of zone supply from fully mixed primary air	Fb			Ep	<u>1</u>		1.00	1.00	1.00			
Fraction of zone OA not directly recirc. from zone	Fc		=	1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1	=		1.00	1.00	1.00			
Unused OA fraction required in supply air to zone	Zd		-	Voz / Vdz	-		0.06	0.06	0.06			
Unused OA fraction required in primary air to zone	Zp			Voz / Vpz	=		0.06	0.06	0.06			
System Ventilation Efficiency												
Zone Ventilation Efficiency (App A Method)	Evz		=	(Fa + FbXs - FcZ) / Fa	÷.		1.06	1.06	1.06	1.02	0.92	7 3
System Ventilation Efficiency (App A Method)	Ev			min (Evz)	=	0.78						
Ventilation System Efficiency (Table 6.3 Method)	Ev		-	Value from Table 6.3	=	0.81						
Minimum outdoor air intake airflow	145262	<u></u>		10.000		1012269						
Outdoor Air Intake Flow required to System	Vot	cfm		Vou / Ev	=	11530						
OA intake reg'd as a fraction of primary SA	Y	-		Vot / Vps	=	0.16						
Outdoor Air Intake Flow required to System (Table 6.3 Method)		cfm		Vou / Ev	-	11148 0.15						
OA intake regid as a fraction of primary SA (Table 6.3 Method) OA Temp at which Min OA provides all cooling	19		-	Vot / Vps	-	0.15						
OAT below which OA Intake flow is @ minimum		DealE	114	{(Tp-dTsf)-(1-Y)*(Tr+dTrt	100	-35						
OAT below which UA Intake flow is (2 minimum		Deg F		(ip-disi)-(i-r)-(ir+diri	-	-35						

Building:			ence	and Technology Building								
System Tag/Name:	AHU-3,				_							
Operating Condition Description: Units (select from pull-down list)	Occupi	ed Opera	tion	Conditons								
Inputs for System	Name	Units				System						
Floor area served by system	As	sf			H	46169						
Population of area served by system (including diversity)	Ps	P		100% diversity		851						
Design primary supply fan airflow rate	Vpsd	cfm		100 Id diversity		72,805						
OA reg'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06						
OA reg'd per person for system area (Weighted average)	Rps	cfm/p				7.1						
Inputs for Potentially Critical zones									ritical Zones	(c)		
Zone Name	Zone til	te turns p	Incla	Italic for critical zone(s)		4	Meteorology	Ages Hydro	Ages Faculty	Office	Bio/Sci Department	DC Offic
Zone Tag							340	342	345	257	289	255
Space type		Select fr	om r	ull-down list			Lecture	Science laboratories	Lecture	Office space	Office space	Office spa
Floor Area of zone	Az	sf					360	550	565	2210	575	
Design population of zone	Pz	P	(def	ault value listed; may be ove	emidd	ien)	18	28	17	17	4	
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm				60270	600	1100	1200	4450	1275	1
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan?		Select fr	om p	ull-down list or leave blank	if N/A	۹.	0					
Local recirc. air % representative of ave system return air	Er											
Inputs for Operating Condition Analyzed					-	10.001						
Percent of total design airflow rate at conditioned analyzed	Ds	96 Galactic	21.1	all down link		100%	100%	100%	100%	100%	100%	10
Air distribution type at conditioned analyzed	C -	Select fr	om p	ull-down list			1.00	1.00	CS 1.00	CS 1.00	CS 1.00	-
Zone air distribution effectiveness at conditioned analyzed Primary air fraction of supply air at conditioned analyzed	Ez						1.00	1.00	1.00	1.00	1.00	-
Results	cp		_									
Ventilation System Efficiency	Ev					0.78						
Outdoor air intake required for system	Vot	cfm				11530						
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				13.5						
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	=	72805						
UncorrectedOA requirement for system	Vou	cfm	=	Rps Ps + Ras As	=	8979						
Uncorrected OA reg'd as a traction of primary SA	Xs		=	Vou / Vps	=	0.12						
Initial Calculations for individual zones												
OA rate per unit area for zone	Raz	.cfm/sf					0.06	0.18	0.06			
OA rate per person	Rpz	cfm/p					7.50	10.00				
Total supply air to zone (at condition being analyzed)	Vdz	cfm					600	1100	1200			
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		156.6	379.0		217.6		
Unused OA requirement for zone	Voz	cfm		Vbz/Ez	=		157	379	161	218		
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	=		0.26	0.34	0.13			
Unused OA fraction required in primary air to zone System Ventilation Efficiency	Zp		8등)	Voz / Vpz			0.26	0.34	0.13	0.05	0.04	a 3
Zone Ventilation Efficiency (App A Method)	Evz			(Fa + FbXs - FcZ) / Fa	=		0.86	0.78	0.99	1.07	1.08	
System Ventilation Efficiency (App A Method)	Evz			min (Evz)	-	0.78	0.00	0.70	0.00	1.07	1,00	C
Ventilation System Efficiency (App A Method)	Ev			Value from Table 6.3	=	0.81						
Minimum outdoor air intake airflow				Targe Harry Come wild								
Outdoor Air Intake Flow required to System	Vot	cfm	-	Vou / Ev	=	11530						
OA intake reg'd as a fraction of primary SA	Y			Vot / Vps	=	0.16						
Outdoor Air Intake Flow required to System (Table 6.3 Method)		cfm		Vou / Ev	=	11148						
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)				Vot / Vps	-	0.15						
OA Temp at which Min OA provides all cooling				and the second s								
OAT below which OA Intake flow is @ minimum		TRACTICES		{(Tp-dTsf)-(1-Y)*(Tr+dTr1		-35						

		ence	and Technology Building			6						
Occupi	ed Opera	tion	Conditons									
Mama	Unite				Custom							
				H								
	P		100% diversity									
	cfm		tee is all cloudy									
Ras	cfm/sf				0.06							
Rps	cfm/p				7.1							
				-				-				
Zone til	te turns p	unpik	italic for critical zone(s)			Classrooms	Biology Resource	Rock Storage	Planeterium	Seminar	Lounge	
						236	243	234	224	217	219 Corridor	
	Select fr	om	ull-down list				Office space				Corridor	
Az	sf						683		2945	705	1	
Pz	P	(def	ault value listed; may be ove	emidd	ten)	92	10	0	25	15		
Vdzd	cfm					6050	1010	200	2500	1520	2	
	Select fr	om p	ull-down list or leave blank	if N/A	Α [9	2					
Er			***************************************									
Dr	06				1000	10.00	1000	1000	1000	4000	10	
US	200 Contractor	-	ull down list		100%	100%	100%				1	
E7	Select II	om t	iuii-down list			1.00	1.00					
					-	1.00	1.00	(1.00	1.00	1.00		
		_		_								
Ev					0.78							
Vot	cfm				11530							
Vot/As	cfm/sf				0.25							
Vot/Ps	cfm/p				13.5							
Ypd	cfm				16%							
		-		-								
Vps	cfm	(1 = 1)	VpdDs	=	72805							
Vou	cfm			=								
Xs		=	Vou / Vps	=	0.12							
120												
		7723	Des De L Des As	1233								
	CHII											
				<u>.</u>								
				=								
				=		0.14				0.10		
Zp				=		0.14				0.10		
Evz		=	(Fa + FbXs - FcZ) / Fa	÷.		0.98	1.03	0.95	0.98	1.02	17 - 18 17	
				=								
Ev			Value from Table 6.3	=	0.81							
12222			10 m		1010-001							
	ctm											
	-		1000/00000									
	cim											
		-	anti abs	-	0.15							
	AHU3, 3 Occup IP Name As Ps Vpsd Ras Rps Zone b V Vsd Rps Er Ds Ez Ep Ev V vdzd Er E Ds Ez Ep V votAv S votPs V votPs V votPs V votPs V votPs V votPs Fa Ras Ras Ez Ez Ep Fa V votPs Ras Fa S votPs V vot Ras Fa S vot Ras Fa S vot Ras Fa S vot V vot Ras Fa S vot V vot V V V vot V v	AHU3,4 Occupied Opera- IP Name Units As sf Ps P Vps P Vpd cfm Ras cfm/yf Zone blw turns p Select fr Pz P Vdz cfm Select fr Er Ds % Select fr Er Vot cfm Vps cfm/yf Vps cfm/yf Vps cfm/sf Vot cfm Vbz cfm	AHU3,4 Occupied Operation PS Ps Ps Ras cfm/sf Rps Cone bible turns pumple Select from p Cone bible turns pumple Select from p Pz P (def Vdz cfm Select from p Er Vdz cfm Vdz cfm Vdz cfm Vdz cfm VotVAs cfm/sf VotVAs cfm/sf VotVAs cfm VotVAs cfm VotVAs cfm Select from p Er Er Cone bible turns pumple Select from p Er Cone bible turns pumple Select from p Er Vot cfm Er Vot cfm Select from p Er Vot cfm Select from p Er Vot cfm Select from p Er Vot cfm Er Select from p Er Vot cfm Er Select from p Er Vot cfm Select from 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VotAPs christ VotAPs christ Vot cfm Vpd cfm Pr Vpd cfm Pr Vpd cfm Vpd cfm <</td><td>AHU3, 4 Occupied Operation Conditions Preprint System As sf Ps P Vpad cfm 100% diversity T2,805 72,805 Ras cfm/sf Zone bible turns purple (tails for critical zone(s)) Select from pull-down list Az sf P2 P (default value listed; may be overridden) Vdzd cfm Select from pull-down list 2 Er Select from pull-down list Ds % Select from pull-down list 100% Ez Ep Ev 0.78 Vol/As cfm Vol/As cfm Vol/As cfm Vol/As cfm Volu cfm Raz cfm/p Ypd cfm Volu cfm Ray cfm/p Vol m Raz cfm/p Volu cfm Raz cfm/p</td><td>Exturbulation System As sf Ps P Vpad cfm Ras cfm/sf Zone bile tums Select from pull-down list 72,805 Az sf Select from pull-down list 2006 Az sf Pz P (default value listed; may be overnidden) 60000 Vdzd cfm Select from pull-down list CS Az sf Pz P (default value listed; may be overnidden) 0006 Vdzd cfm Er 0.078 Select from pull-down list CS Ez 0.006 Ep 0.007 Vol/As cfm Vol/As cfm Vol/As cfm Vps cfm Vpd cfm Vpd cfm Vol/As cfm/sp Vol/As cfm/sp Vol/As cfm/sp Vol/As cfm/sp</td><td>AHU3.4 Occupied Operation Conditions Ps P 100% diversity System As sf 72.505 Vpad cfm 72.505 Ras cfm/st 0.06 Zone bile turns purple italic for critical zone(s) Ceology Biology Zone bile turns purple italic for critical zone(s) Ceology Biology Zone bile turns purple italic for critical zone(s) Ceology Biology Zone bile turns purple italic for critical zone(s) Ceology Ceology Vid fm 0.07 236 Vid cfm Select from puli-down list 100% Er 0.06 100% 100% Er 0.07 1530 0.06 Vol cfm 1530 0.26 Vol/As cfm/st 0.26 0.08 0.06 Ev 0.07 13.5 0.06 0.00 Vol cfm Rps Ps + Ras As = 8379 3.00 100 Vol cfm Rps Ps + Ras As = 8379 3.00 100</td><td>Artura, 3.4 Occupied Operation Conditions Ps p Topological diversity System As sf T2,505 Pps recupied diversity 46169 Ras cfm/sf 72,505 Ras cfm/sf 72,505 Ras cfm/sf 234 Select from puli-down list accupied diversity 683 Az sf 3070 683 234 Vad cfm 92 10 0 Vdzd cfm 92 10 0 Select from puli-down list or leave 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Building:		Grunenwald Science and Technology Building								
System Tag/Name: Operating Condition Description:		AHU-3, 4 Occupied Operation Conditons								
Units (select from pull-down list)	IP									
inputs for System	Name	Units			13	System	ř.			
Floor area served by system	As	sf				46169				
Population of area served by system (including diversity)	Ps	P		100% diversity		851				
Design primary supply fan airflow rate	Vpsd	cfm				72,805				
OA reg'd per unit area for system (Weighted average)	Ras	cfm/sf				0.06				
OA reg'd per person for system area (Weighted average)	Rps	cfm/p				7.1				
Inputs for Potentially Critical zones										
Zone Name	Zone ti	tle turns n	umk	italic for critical zone(s)			Math Resources	Classroom	Lobby	Corridors
Zone Tag							127	120	101	102
Space type							Office space	Lecture	Lobbies	Corridors
	A		om	oull-down list				classroom	0000	110
Floor Area of zone	Az	sf P (default value listed: may be overridden)					1436	7960	3260	119
Design population of zone	Pz		(det	ault value listed; may be ove	ernda	ien)	38	444	15	070
Design total supply to zone (primary plus local recirculated)	Vdzd	cfm Salact 6		ull down link on longer bland.	id hird		3995	14550	850	378
Induction Terminal Unit, Dual Fan Dual Duct or Transfer Fan? Local recirc. air % representative of ave system return air	Er	Select I	om	oull-down list or leave blank	IT IN/A	`				
Inputs for Operating Condition Analyzed	-				-					
Percent of total design airflow rate at conditioned analyzed	Ds	%				100%	100%	100%	100%	1009
Air distribution type at conditioned analyzed		Select fr	om p	oull-down list			CS	CS	CS	C
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	Ev					0.78				
Ventilation System Efficiency		alex				11530				
Outdoor air intake required for system	Vot	cfm				0.25				
Outdoor air per unit floor area	Vot/As Vot/Ps	cfm/sf cfm/p				13.5				
Outdoor air per person served by system (including diversity) Outdoor air as a % of design primary supply air	Ypd	cfm				13.6				
Outdoor air as a re or design prinary suppry air	ipu	Addite.				1070				
Detailed Calculations										
nitial Calculations for the System as a whole										
Primary supply air flow to system at conditioned analyzed	Vps	cfm	=	VpdDs	=	72805				
UncorrectedOA requirement for system	Vou	cfm	=		=	8979				
Uncorrected OA req'd as a fraction of primary SA	Xs		=	Vou / Vps	=	0.12				
nitial Calculations for individual zones										
OA rate per unit area for zone	Raz	cfm/sf					0.06	0.06	0.06	0.06
OA rate per person	Rpz	cfm/p					5.00	7.50	5.00	0.00
Total supply air to zone (at condition being analyzed)	Vdz	cfm					3995	14550	850	3780
Unused OA req'd to breathing zone	Vbz	cfm		Rpz Pz + Raz Az	=		276.2	3807.6	270.6	71,4
Unused OA requirement for zone	Voz	cfm	=	Vbz/Ez	=		276	3808	271	7
Fraction of zone supply not directly recirc. from zone	Fa		=		=		1.00	1.00	1.00	1.00
Fraction of zone supply from fully mixed primary air	Fb		=		=		1.00	1.00	1.00	1.00
Fraction of zone OA not directly recirc. from zone	Fc		=		π		1.00	1.00	1.00	1.00
Unused OA fraction required in supply air to zone	Zd			Voz / Vdz	#		0.07	0.26	0.32	0.03
Unused OA fraction required in primary air to zone	Zp		=	Voz / Vpz	=		0.07	0.26	0.32	0.03
System Ventilation Efficiency	-									
Zone Ventilation Efficiency (App A Method)	Evz		=	the record comprise	=		1.05	0.86	0.80	1.10
System Ventilation Efficiency (App A Method)	Ev		=	min (Evz)	=	0.78				
Ventilation System Efficiency (Table 6.3 Method)	Ev		=	Value from Table 6.3	=	0.81				
Minimum outdoor air intake airflow	Mak	alm		Man (Ex		44550				
Outdoor Air Intake Flow required to System	Vot	cfm		Vou / Ev	=	11530				
OA intake req'd as a fraction of primary SA	Y	. die		Vot / Vps	=	0.16				
Outdoor Air Intake Flow required to System (Table 6.3 Method)		cfm		Vou / Ev	=	11148				
OA intake reg'd as a fraction of primary SA (Table 6.3 Method)	a.		11	Vot / Vps	=	0.15				
OA Temp at which Min OA provides all cooling OAT below which OA Intake flow is @ minimum		Deel								
UAL DEIOW Which UA Intake Tow is (2) minimum		Deg F	=	{(Tp-dTsf)-(1-Y)*(Tr+dTr1	=	-35				