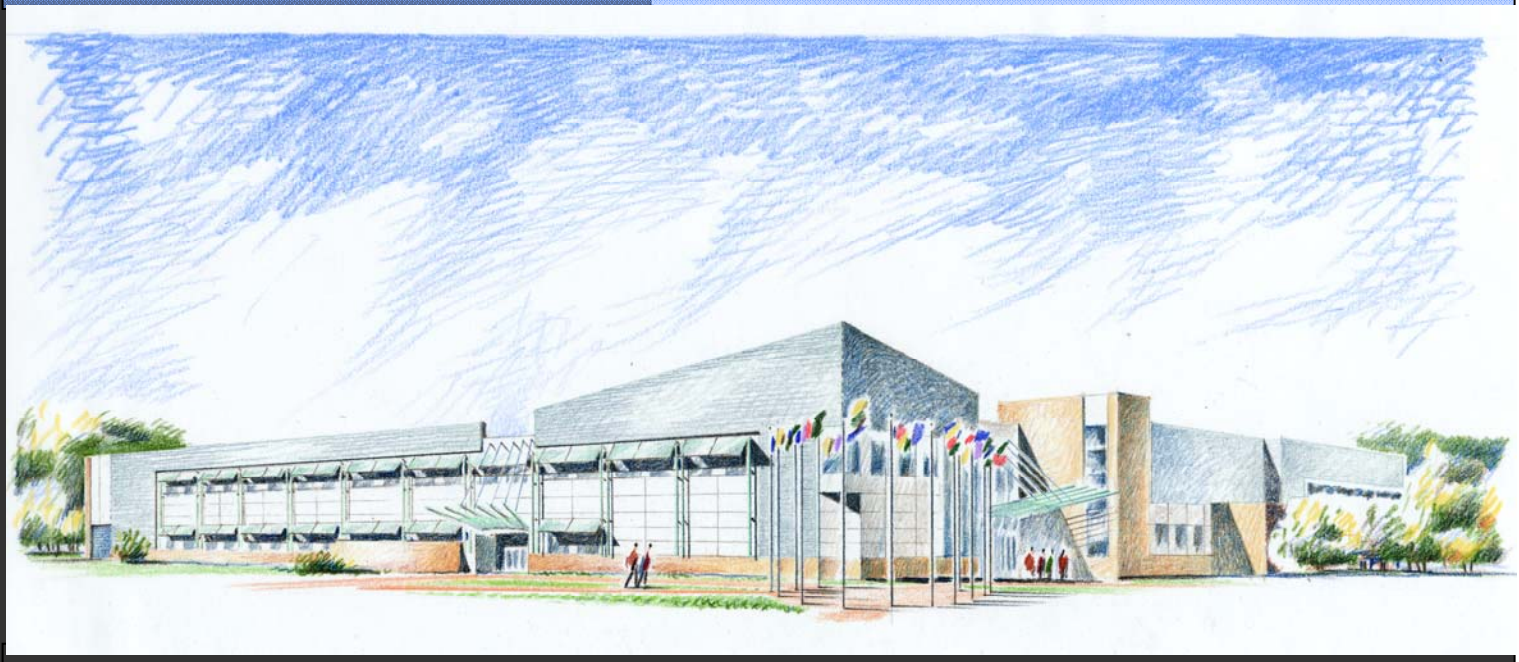
MECHANICAL TECHNICAL ASSIGNMENT 1

ASHRAE Standard 62.1 & 90.1 -2007 Compliance Report



The Regional Learning Alliance at Cranberry Woods

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EXECUTIVE SUMMARY

The Regional Learning Alliance Conference and Learning Center is a 76,000 ft^2, low-rise, mixed use, educational facility located in Cranberry Township, PA. The facility, which provides mainly classroom, conference and office space, also houses computer labs and training areas, along with a 2600 ft^2 wellness center, an 1800 ft^2 child development center, snack bar and a dining/ kitchen area. Business and conference use predominates during the daytime hours, Monday – Friday, 7AM-10PM, while the educational facilities are usually used in the evening and on Saturday's 9AM-3PM. Therefore, an Aaon single variable-volume, demand-controlled AHU was chosen to provide 22,500 CFM of 100% outdoor air for the various areas, while a separate 10,000 CFM unit serves the main lobby and atrium space.

ANSI/ASHRAE Standard 62.1-2007, *Ventilation for Acceptable Indoor Air Quality*, sets minimum ventilation rates and other requirements for commercial and institutional buildings. Section 5 of 62.1 sets forth standards the mechanical system and equipment should abide by to produce satisfactory air quality, while Section 6 introduces a detailed process used to calculate the minimum amount of outdoor that needs to be provided to each zone. In addition, ASHRAE Standard 90.1 is used to provide requirements for the energy-efficient design of buildings by analyzing the building envelope, lighting, HVAC and hydronic systems. The purpose of this report was to use what information was provided to conclude whether or not The Regional Learning Alliance Center complied with ASHRAE Standard 62.1-2007 and ASHRAE Standard 90.1-2007.

After extensive research and analysis, it can be shown that The Regional Learning Alliance Conference and Learning Center does comply with ASHRAE Standard 62.1. The building's main air handling unit can supply up to 22,500 CFM of outdoor air, which is almost twice the 13,771 CFM required by the standard. The excess outdoor air may be a result of more stringent design considerations, and/or the possibility of increased ventilation in order to obtain LEED points. Moreover, the building meets several of the requirements proposed in Section 5 of Standard 62, including restraints placed on outdoor air intake locations, ventilation equipment access, mold prevention and erosion protection.

In regards to Standard 90.1, the building complied with requirements set forth on the exterior envelope, equipment efficiency, economizer installation, and service water heating. However, it fell short when it came to electric motor efficiency and interior lighting power allowance. According to the Space-by-Space Method presented in Section 9 of Standard 90.1-2007, ASHRAE called for an interior lighting power allowance of 77,880 W, while the actual design allotted almost 85,000 W. While previous design calculations showed compliance with ASHRAE Standard 90.1-1999, the newer, 2007 version imposed more rigorous criteria that the building did not meet.

MECHANICAL SYSTEM OVERVIEW

A single, 22,500CFM demand controlled, dedicated Aaon Air Handling Unit (AHU) provides 100% conditioned outdoor air through variable air volume terminal boxes to (50) 4-pipe Fan Coil Units located throughout the space. Return air is recirculated out of the space and sent back to the fan coil unit to produce mixed, supply air to each zone. CO_2 sensors, connected into the main BAS system, are located in each zone and determine the amount of outdoor air that needs to be provided. If a sensor measures a level more then 530ppm above the ambient air CO_2 sensor, the VAV-box damper will open until the level drops below set point. In addition, the AHU is equipped with a total sensible heat recovery wheel, hot gas reheat for positive dehumidification and variable speed drives on the exhaust and supply fans. The heat wheel stops when outside conditions permit economizer operation and outdoor air is used to provide cooling for the spaces. The chiller is designed to not operate until the building cooling load can not be met with this outside air.

A second, 10,000 CFM constant-volume Aaon AHU, equipped with both chilled water and hot water coils, is dedicated to serving the lobby and two-story atrium. The unit, which has a 96" X 36" outdoor air intake, is located on the north end of the first floor in the Maintenance Garage.

(2) Lochinvar gas fired boilers and (1) 75 ton evaporatively-cooled chiller provide hot and chilled water to the buildings piping system. (5) Variable speed pumps along with 2-way valves are used to match the water flow to the load. Hot water wall heaters are located in the building's stairwells, and exhaust systems serve the toilet rooms, janitor's closets, kitchen, and mechanical and electrical rooms.

Such a system was chosen to provide high cooling and heating efficiencies, while keeping the overall energy costs to a minimum. The Regional Learning Alliance also hopes to implement an active solar system in the near future, and the current mechanical system would allow for this future integration.

ASHRAE STANDARD 90.1-2007

BUILDING ENVELOPE

ASHRAE Standard 90.1-2007 provides the minimum requirements for the design of energy efficient buildings. Section 5 presents the first component analyzed; the building's envelope.

In order to use the Prescriptive Building Envelope option presented in Section 5.5 of the Standard, the building must meet the following criteria:

- ►Vertical fenestration area shall not exceed 40% of the gross wall area for each space-conditioning category

- ►Skylight fenestration area shall not exceed 5% of the gross roof area for each space-conditioning category

According to the Final Energy Analysis Report provided by Tower Engineering, the building model included 26,650 ft^2 of exterior wall and 10,400ft^2 of windows, resulting in a window-to-gross-wall ratio of 28.1%. Since the vertical fenestration does not exceed 40% of the gross wall area, and no skylights are present, the Prescriptive Building Envelope method may be used.

Referencing TABLE B.1 of the standard, you can see that The Regional Learning Alliance falls in climate zone 5A. Therefore, the exterior of the building envelope will be analyzed using the Non-Residential requirements from Table 5.5.5 of Standard 90.1. This information is included in the report and can be found in **Appendix B.** For all opaque surfaces except doors, compliance is demonstrated by one of the following methods:

1. Minimum rated R-values of insulation for the thermal resistance of the added insulation in framing cavities and continuous insulation only.
2. Maximum U-factor, C-factor or F-factor for the entire assembly being analyzed.

The following R and U values were taken from The Final Energy Analysis Report and/or input information that was provided from the computer-generated energy model:

►Roof: · Built-up roof, R-28 insulation with steel deck
· U factor=0.034 BTU/Hr*F*SF
(Model includes 38,440 SF of roof area)

►Exterior Walls (above grade): · 4" face brick, R-19 insulation, 5/8" drywall
· Overall U-value = 0.045 (typical)

►Floors: (Information in process of receiving for verification)

►East & West Windows (tinted):
· 1" insulating glass (0.25" Azurlite, 0.625" of 90% argon fill, low-e film, 0.25" clear glass)
· Shading Coefficient=0.39
· SHGC (center of glass)=0.34
· Visible Transmittance=52%
· Overall Assembly U-factor=0.51 BTU/hr*F*SF
· Outside shading devices to control daylight and reduced solar heat gain

►North & South Windows(no tint):
· 1" insulating glass (0.25" clear, 0.625" of 90% argon fill, low-e film, 0.25" clear glass)
· Shading Coefficient=0.76
· SHGC (center of glass)=0.66
· Visible Transmittance=73%
· Overall Assembly U-factor=0.51 BTU/hr*F*SF

This information, along with the corresponding ASHRAE standards and compliance of each building element can be found in the following table:

[TABLE 1]: ASHRAE 90.1-2007 BUILDING ENVELOPE COMPLIANCE SUMMARY

BUILDING ELEMENT	ASHRAE STANDARD	DESIGNED VALUE	COMPLIANCE MET?
ROOFS	*Metal Building;* Assembly Max. U=0.065 or R=19	U=0.034 or R=28	✔
WALLS ABOVE GRADE	*Steel Framed Building;* Assembly Max. U=0.064 or R-13.0 + R-7.5 c.i	U=0.045 (typical) U=0.037 (curtain wall)	✔ ✔
FLOORS	*Mass:* U=0.074 or R=10.4 c.i.		
VERTICAL GLAZING			
East & West Windows (tint)	*Metal framing (all other);* Assembly Max. U=0.55 and Assembly Max. SHGC=0.40	U=0.51, SHGC=0.34	✔ U-Value ✔ SHGC
North & South Windows (no tint)	*Metal framing (all other);* Assembly Max. U=0.55 and Assembly Max. SHGC=0.40	U=0.51, SHGC=0.66	✔ U-Value ✘ SHGC

NOTE: *because of shading devices located on the east and west façade, the required SHGC could actually be reduced by a factor found in TABLE 5.5.4.4.1. This action is not necessary however, considering the SHGC is already less then the allowed value of 0.40*

As you can see from TABLE 1, all relevant systems, including the roof and wall assemblies, comply with the standard. The only discrepancy occurs with the SHGC of the windows on the north and south facades. Information regarding the floor construction is still in the process of being retrieved and will be included in the next report.

HVAC SYSTEMS

In addition to the building envelope requirements, Section 6 presents standards for the heating ventilating and air conditioning systems. Currently there are two paths one can take to confirm

compliance with this section; the Simplified Approach, or the Prescriptive Path. Since the gross floor area exceeds 25,000 ft^2, the Simplified Approach presented in Section 6.3 can not be used, and the more detailed, mandatory provisions in Section 6.4 were assessed.

►Equipment Efficiencies:
One of the most prevalent requirements of the section deals with equipment efficiencies. At the specified rating and operating conditions, the HVAC equipment should have the efficiencies shown in Tables 6.8.1A-6.8.1G of the standard. TABLE 2 of this report summarizes the more important air handling equipment and their compliances with ASHRAE 90.1-2007:

[TABLE 2]: ASHRAE 90.1-2007 EQUIPMENT EFFICIENCY COMPLIANCE SUMMARY

TYPE OF EQUIPMENT	ASHRAE TABLE & STANDARD	DESIGNED VALUE	COMPLIANCE MET?
AHU-1 (variable volume, DX coil)	**[TABLE 6.8.1A]** Air-cooled air conditioners >760,000BTU/h require an EER rating of atleast **9.2**	EER=12.5 with premium efficient motor	✔
AHU-2 (contant volume unit)	**[TABLE 6.8.1A]** EER rating of atleast **10.1**	EER=15.9	✔
SFC-1 (split fan coil unit with remote condensing unit)	**[TABLE 6.8.1A]** through the wall air cooled split system <30,000 BTU/h requires a 10.0 SEER rating	SEER=11.0	✔

Additionally, Section 5 also covers requirements such as the installation of economizers, heat recovery systems, demand controlled ventilation, service water heating, and electric motor efficiency; all of which will be briefly assessed on the following pages.

►Energy & Heat Recovery:
According to Section 6.5.6.1, entitled Exhaust Energy Recovery, "individual fan systems that have both a design supply air capacity of 5000cfm of greater and have a minimum outdoor air supply of 70% or greater of the design supply air quantity, shall have an energy recovery system with at least 50% recovery effectiveness." The design outdoor airflow of AHU-1 is 22,500CFM. When all thirteen of the designed exhaust fans are operating (along with any associated make up air), the net air that would be available is 9,575 CFM / 22,500 CFM= 43%. If only the exhaust fans considered "typical" would be operating, this value increases to 15,030CFM, and 67%. Since this value is less than the required 70%, *theoretically*, heat recovery is not required. However, a heat recovery wheel *has* been installed in AHU-1, used to provide 100% outdoor air to the FCU system.

►Economizers:
Section 6.5.1.1 sets forth the following stipulations for economizers: Air economizer systems shall be capable of modulating outdoor air and return air dampers to provide up to 100% of design supply air quantity for outdoor cooling. Both AHU-1 and AHU-2 required economizers since their cooling capacities exceeded 135,000 BTU/hr. Installation in both units resulted in compliance with Section 6.5.1.1 This information is summarized in Table 3 on Page 6.

[TABLE 3]: ASHRAE 90.1-2007 ECONOMIZER COMPLIANCE SUMMARY

UNIT	CAPACITY (BTU/HR)	ASHRAE REQUIREMENT	ECONOMIZER REQUIRED	ECONOMIZER INSTALLED	COMPLIANCE
AHU-1	867,000	If the cooling capacity >135,000 BTU/hr, then an economizer is required for Climate zone 5A	YES	YES	✔
AHU-2	221,000	If the cooling capacity >135,000 BTU/hr, then an economizer is required for Climate zone 5A	YES	NO	✔

►Demand Controlled Ventilation:
ASHRAE Standard 90.1, Section 6.4.3.9 states that "Demand control ventilation (DCV) is required for spaces larger than 500 ft^2 and with a design occupancy for ventilation of greater than 40 people per 1000 ft^2 of floor area and served by systems with one or more of the following: a.) air-side economizer, b.) automatic modulating control of the outdoor air damper or c.) a design outdoor airflow greater than 3000 CFM. Since this criterion is satisfied due to the variable-volume outdoor AHU, it would seem as though DCV would need to be implemented. However, referencing ASHRAE 90.1-1999, DCV was only required for systems serving areas having "an average design occupancy density exceeding 100 people per 1000 ft^2." Mechanical designers at Tower Engineering went further to investigate the areas served by AHU-1, noting that classrooms had a density=50 people/1000 ft^2, offices (7), reception areas (60), conference rooms (50), dining (70-100) and library (20) had a square-foot weighted average of ~25 people per 1000 ft^2. Although the DVC was not required by this standard, it was implemented anyway and therefore complies with ASHRAE Standard 90.1-2007.

The demand controlled ventilation requirement was achieved by installing a Carbon Dioxide sensor for every Fan Coil/terminal box combination. Where an FCU serves a single space, the sensor is simply placed in that zone. If it serves a group of similar spaces, one sensor is installed in the most logical room. In addition, to measure the ambient CO2 concentrations, a sensor is installed outside. When any room carbon dioxide level increases to a level 530ppm above the outdoor value, the VAV unit's damper opens to the maximum possible position until the CO2 levels fall below set-point. Once the level has decreased, the damper returns to its original position. All CO2 sensors are connected to a central BAS system for adjustments and monitoring.

ELECTRIC MOTOR EFFICIENCY

The standard also places limitations on the air handling unit's supply fan power, while Section 10 provides general minimum requirements for all motors. This required efficiency is based solely on the motor size, RPM and BHP. While an extensive search of the Greenheck website took place, data was still unable to be retrieved regarding the system's exhaust fans. Therefore, the only available information used to perform these calculations was taken from the Mechanical Schedules on H8.01

and H8.02. As seen in TABLE 4, variable volume unit AHU-1 does *not* comply with the standard, while the constant volume unit, AHU-2, serving the lobby and atrium, *does* meet ASHRAE constraints.

[TABLE 4]: ASHRAE 90.1-2007 AHU MOTOR COMPLIANCE SUMMARY

UNIT	SUPPLY AIR CFM	SUPPLY FAN HP	ASHRAE TABLE & STANDARD	CALCULATED VALUE	COMPLIANCE
AHU-1	22,500	40	**[TABLE 6.5.3.1.1A]** states that for a variable volume unit, the allowable motor HP should be <CFMsupply*0.0015	33.75	✗
AHU-2	10,000	1	**[TABLE 6.5.3.1.1A]** states that for a constant volume unit, the allowable motor HP should be <CFMsupply*0.0011	11.00	✔

SERVICE WATER HEATING

When installing a 4-Pipe fan coil unit system, the efficiency of your boiler(s) and chiller(s) tend to become an issue. Standard 90.1 addresses this concern through TABLE 7.8, by requiring minimum efficiencies for hot water system components. In addition, TABLE 6.8.1 lists the efficiency requirements for chillers and boilers. As you can see in TABLE 5, both boilers and chiller comply with Standard 90.1, having COP or efficiency values greater than those required in Section 8.

[TABLE 5]: ASHRAE 90.1-2007 CHILLER & BOILER COMPLIANCE SUMMARY

TYPE OF EQUIPMENT	ASHRAE TABLE & STANDARD	DESIGNED VALUE	COMPLIANCE MET?
CHILLER (CH-1)	**[TABLE 6.8.1C]** Water cooled, electrically operated, (rotary screw) requires COP=4.45, IPLV=5.2	COP=5.85, IPLV=6.12	✔
BOILER (B-1)	**[TABLE 6.8.1.F]** Hot Water, gas-fired boilers >300,000BTU/HR input but <2,500,000 BTU/HR require an 80% thermal efficiency	93% efficient	✔
DHW BOILER (B-2)	**[TABLE 6.8.1.F]** Hot Water, gas-fired boilers >300,000BTU/HR input but <2,500,000 BTU/HR require an 80% thermal efficiency	94% efficient	✔

POWER and LIGHTING

Addressing yet another energy concern, Section 9 of ASHRAE Standard 90.1-2007 provides two methods to analyze the building's interior lighting and wattage use. The Space-by-Space Method is the more detailed and flexible version, while the Building Area Method, is the more simplified approach for demonstrating compliance. Since the Space-by-Space Method was already used in the actual design calculations, the same procedure will be utilized in this report. The following (5)steps sum up the Space-by-Space Method:

- ►Step 1: Determine building area type from TABLE 9.6.1 of Standard 90.1-2007.
- ►Step 2: Determine the gross lighted floor area for each building type space with partitions 80% or greater than ceiling height.
- ►Step 3: Determine the interior lighting power allowance from TABLE 9.6.1. Multiply the floor areas by this LPD. The product will be your lighting power allowance for the space.
- ►Step 4: Sum up the installed interior lighting power in each room using the wattages from the luminaire schedule.
- ►Step 5. Sum up the total interior lighting power allowance of all the spaces. Trade-offs among spaces are permitted provided that the TOTAL installed interior lighting power does not exceed the interior lighting power allowance.

The following building specific space types are designated in the Regional Learning Alliance. Their Lighting Power Densities (in $W/ft^{2)}$ were taken from TABLE 9.6.1 of Standard 90.1-2007:

[TABLE 6]: LPD's USING THE SPACE-BY-SPACE METHOD

BUILDING AREA TYPE	LPD (W/SF)
Office	1.1
Corridors	0.5
Conference/Meeting/Multipurpose	1.3
Classroom/Lecture/Training	1.4
Lobby	1.3
Dining Area- Lounge/Leisure	1.4
Food Preparation	1.2
Restrooms	0.9
Dressing/Locker/Fitting	0.6
Active Storage	0.8
Electrical/Mechanical	1.5
Library	1.2
Stairs—Active	0.6

Calculations were performed to determine the maximum allowable lighting power for each space by multiplying the LPD from TABLE 9.6.1 by the illuminated floor area in square feet. The installed interior lighting power was calculated for each room by counting the number of luminaires in each space and multiplying it by the watts/luminaire that were provided for the fixture on the luminaire schedule. This information, including individual space compliance can be found in **APPENDIX C.** Table 7 on the following page exemplifies the summary of these calculations.

[TABLE 7]: ASHRAE 90.1-2007 LIGHTING POWER ALLOWANCE COMPLIANCE SUMMARY

Total Designed Lighting Power:	84,978 W
ASHRAE Lighting Power Allowance:	77,880 W
Designed Wattage/Allowable Wattage	= 84978/77880=1.091

While Tower Engineering's calculations show the original design complied with ASHRAE 90.1-1999 Standards, ASHRAE 90.1-2007 shows that the total designed wattage *exceeds* the allowable lighting power by ~9.1%. Therefore, the building does not comply with the new 2007 standards.

In regards to the building's power compliance, the feeder conductors have been sized for a maximum voltage drop = 2% at design load, while the branch circuit conductors have been sized for a man voltage drop = 3% at design load. This design criterion puts the building in compliance with Section 8.4.1.1 and 8.4.1.2 of the Standard 90.1-2007.

ASHRAE STANDARD 62.1-2007

While Standard 90.1 works to produce energy efficient buildings, ASHRAE Standard 62.1-2007's sole intent is to provide an adequate amount of outdoor air ventilation to produce acceptable indoor air quality. Section Five of the standard will be analyzed to review the Regional Learning Alliance's compliance with system and equipment requirements, while the Ventilation Calculation Procedure for Outdoor Air Intake will be completed in conjunction with Section Six.

SECTION 5: SYSTEMS & EQUIPMENT

After reviewing the standard and its components, it can be shown that The Regional Learning Alliance Center does comply with Section Five of ASHRAE Standard 62.1-2007.

All outdoor air intakes have been designed in accordance to ASHRAE Standard 62.1-2007, TABLE 5-1. A summary of this information can be found in TABLE 8. The shortest distance from any louver or intake to a specific outdoor contaminant is no more than 20 ft.

[TABLE 8]: ASHRAE 90.1-2007 AIR INTAKE DISTANCE COMPLIANCE SUMMARY

OBJECT	MINIMUM DISTANCE (FT)	ACTUAL DISTANCE	COMPLIANCE MET?
Significantly contaminanted exhaust	15	25	✔
Noxious or dangerous exhausts	30	N/A	N/A
Vents, chimneys, and flues from combustion appliances and equipment	15	20	✔
Drive way, street or parking place	5	24	✔
Truck loading area or dock, bus parking/idling area	25	42	✔
Cooling tower exhaust	25	N/A	N/A

In addition, Section 15834 of the Mechanical Specs (Air Inlet and Outlet Louvers) calls for louvers to have a minimum free area of 65%, and at least a ½" mesh bird screen. These stipulations comply with Section 5.6.5 of the Standard. Outside and exhaust rain hoods that extend at least 1" past the opening perimeter are also provided and conform to ASTM-547, along with the rain entrainment requirements present in Section 5.6.2.

According to Section 5.9, "particulate matter filters or air cleaners" are required to have a minimum efficiency report value (MERV) equal to or greater than six when rated in accordance to ANSI/ASHRAE Standard 52.2. Section 15880 of the Mechanical Specifications (Air Treatment Equipment) calls for a range of filter cartridges, including Medium Efficiency Pleated Media Filters, High Efficiency (MERV-13) Pleated Media Filters, and Medium Efficiency (MERV-7) Construction Filters, all of which comply with the stipulations presented in Standard 62.1. The specifications also note that filters conform to ASHRAE Standard 52-76, Underwriters Laboratory: UL 900 & UL 586, along with NFPA Standard 90A.

Resistance to mold growth is outlined in the Ductwork Specifications (15840), noting that all material surfaces must be resistant to "erosion and mold growth", covering the requirements of Section 5.5.2. Sheet Metal ductwork, which is used throughout the building, is an automatic exception to this condition.

Specifications and equipment cut sheets were analyzed to conclude compliance for assorted sections of the standard, including drain pan locations and slopes, vapor retarders on the building envelope and ventilation equipment access. Most access doors and panels were appropriately sized and seemed to be in a convenient location for inspection, cleaning and routine maintenance.

In conclusion, The Regional Learning Alliance implemented a number of these standards during its design and selection of systems and equipment. Therefore, I am confident in saying that the building complies with Section5 of Standard 62.1-2007.

SECTION 6: VENTILATION CALCULATIONS

The Regional Learning Alliance Learning and Conference Center is composed primarily of two main systems; a dedicated outdoor air handler that provides 100% outdoor air to the facility's (50) Fan Coil Units, and a separate indoor AHU that ventilates the main Lobby and Atrium. Since the first system is more complex and serves the majority of occupied space in the building, it has been selected for Section 6 Ventilation Analysis.

Assumptions

► When calculating the outdoor air ventilation requirements, TABLE 6.1 was used to approximate default values based off occupancy density if the actual zone occupancy (Rp) was not known. These areas are highlighted in grey on the corresponding spreadsheets attached in APPENDIX D.

Spaces that could be classified under numerous descriptions were designated to their "best-fit" use. The following assumptions were made during calculations:

- Kitchen and Servery was treated as dining space since no Food Preparation option was listed in Table 6.1
- Dining/Conference Rooms designed as Multiuse Assembly space.
- Child Development Center designed as Classroom (age 5-8) space.
- Special Training Room designed as Media space due to amount of equipment present.
- Interaction Space designated as office space.
- Lecture and Discussion Classrooms both modeled as Lecture Classrooms

► Square foot values for the corridors and lobby areas were clumped together for AHU-2. Therefore, when calculating the required outdoor, Ra was increased from 0.06 to 0.10 to account for the extra CFM that would be required per person in lobby areas.

►Spaces such as restrooms, shower rooms, electrical closets, janitor closets and storage, that are served by a dedicated exhaust system were not included in the calculations. Other zones such as the Telecomm Room were also exempt since the outdoor air required for their smaller systems was not provided from AHU-1.

► Occupancy value Pz was taken from original ASHRAE 62.1-1999 outdoor air calculations

► Floor areas were taken from original ASHRAE 62.1-1999 design spreadsheet and checked with values present on the architectural floor plans

► Ez=1.0 since the system contains a "ceiling supply of cold air"

► Use an Occupancy Diversity, D=1.0 when the system population is not known

PROCEDURE

The following procedures and calculations were performed in conjunction with Section 6 of ASHRAE 62.1-2007 to calculate the outdoor air intake for AHU-1. All assumptions made during calculations can be found in the preceding paragraph, while definitions of each variable can be found in APPENDIX A.

STEP 1: Obtain the floor area **Az,** and maximum design population, **Pz**, for each zone being analyzed. If Pz is unknown, it can be calculated by using the default occupancy density values found in TABLE 6.1.

STEP 2: Determine the outdoor air flow rate required per person, **Rp**, and the outdoor airflow rate required per unit area, **Ra**, from TABLE 6.1

STEP 3: Calculate the Breathing Zone Outdoor Airflow, **Vbz** by using (Equation 6.1) as follows:

$$Vbz = Rp*Pz+Ra*Az$$

STEP 4: Determine the Zone Air Distribution Effectiveness, **Ez** from Table 6-2. For the RLA system, cool air is supplied from the ceiling, therefore Ez=1.0

STEP 5: Calculate the Zone Outdoor Airflow Voz by using (Equation 6-2) as follows:

$$Voz=Vbz/Ez$$

NOTE : If 100% outdoor air is supplied from a dedicated outdoor air unit, as AHU-1 on the Regional Learning Alliance project, calculations can stop at STEP 5. Ez=1.0 when cooled air is supplied from overhead, therefore Vot=Voz. From this point, simply sum the Vot values for each space to find the required outdoor airflow for the system.

STEP 6: Calculate the zone Primary Outdoor Air Fraction, **Zp** by using (Equation 6-4) as follows:

$$Zp=Voz/Vpz$$

where Vpz is the zone primary airflow

STEP 7: Use **Zp** to determine the System Ventilation Efficiency, **Ev**, from Table 6-3

STEP 8: Determine the Occupant Diversity, D. If conservative calculations are to be made when the system population is unknown, choose a Dvalue=1.0

STEP 9: Calculate the Uncorrected Outdoor Air Intake, **Vou** using (Equation 6-6) as follows:

$$Vou = D\sum_{\text{all zones}}(Rp * Pz) + \sum_{\text{all zones}}(Ra * Apz)$$

STEP 10: Calculate the Outdoor Air Intake required, Vot, by using (Equation 6-8) as follows:

$$Vot = Vou / Ev$$

CALCULATIONS

An example calculation will be made using one of the typical Discussion Classrooms located on the first and second floors. For our purposes, we will examine Discussion Classroom 2113.

STEP 1: Floor Area Az=730 SF. Pz=actual amount of people, which was provided on the original outdoor air calculations as 35. An estimate value could also be calculated using the default occupancy values

STEP 2: From TABLE 6.1 for Educational Facilities, Lecture Classrooms have an Rp value of 7.5 CFM/person and a Ra value of 0.06 CFM/person.

STEP 3: Vbz=(7.5 CFM/person * 35people) + (0.06 CFM/SF * 730 SF)= 310 CFM

STEP 4: From Table 6-2, Ez=1.0 since cool air is supplied from the ceiling.

STEP 5: Voz= 310 CFM/1.0= 310 CFM

For 100% outdoor air systems, as AHU-1 provides to each fan coil unit, Vot=Voz. Therefore, 310 CFM of outside air needs to be provided to Discussion Classroom 2113 to comply with ASHRAE Standard 62.1-2007. A complete set of similar calculations can be found in **APPENDIX D.**

DISCUSSION OF RESULTS

In conclusion, The Regional Learning Alliance Center complies with Section 6 of ASHRAE 62.1-2007, providing 22,500 CFM of outdoor air, when 13,771 CFM is required.

[TABLE 9]: ASHRAE 62.1 OUTDOOR AIR COMPARISON

REQUIRED OA FROM AHU-1 :	13,771 CFM
SUPPLIED OA FROM AHU-1 :	22,500 CFM

The vast difference in values can be accounted to multiple reasons, the first being that during the original ASHRAE 62.1 calculations, Tower Engineering used more rigorous design criteria. Classroom and Discussion spaces were allotted 15 CFM/person, as opposed to the 7.5 CFM/person

used in the 62.1-2007 calculations, while office space regulations were bumped up from 5 CFM/person to 20 CFM/person. With a majority of the building being composed of office and conference/classroom discussion space, the variance in design criteria attributed a significant amount to the difference in outdoor air intake values.

Secondly, The Regional Learning Alliance Conference and Learning Center has been certified a LEED Silver building. According to LEED Version 2.2, one point is allotted in the Indoor Environmental Quality section if additional outdoor air ventilation is provided to mechanically ventilated spaces. To accomplish this, they require the design to increase the breathing zone outdoor air rate to all occupied spaces by *at least* 30% above the minimum required by ASHRAE Standard 62.1. This design tactic, along with the variance in design Rp values, could have caused the significant 63% overdesign that was calculated.

APPENDIX A- Definitions

Az: (zone floor area)
the net occupiable floor area of the zone in [SF]

Ev: (system ventilation efficiency)
the efficiency with which the system distributes air from the outdoor air intake to the breathing zone in the ventilation-critical zone, which requires the largest fraction of outdoor air in the primary air stream. Found using *TABLE 6.3* in ASHRAE Standard 62.1-2007

Ez: (zone air distribution effectiveness)
a measure of how effectively the zone distribution uses its supply air to maintain acceptable air quality in the breathing zones. Found using the type of system air delivery and *TABLE 6.2* in ASHRAE Standard 62.1-2007

Pz: (maximum design occupancy)
Number of people the space is designed to accomodate

Ra: (area outdoor air rate)
the outdoor airflow rate per unit area to be provided in the breathing zone to dilute contaminants that are emitted at a rate that is elate more to floor area than to populations. Found using *TABLE 6.1* in ASHRAE Standard 62.1-2007

Rp: (people outdoor air rate)
the outdoor airflow rate per person to be provided in the breathing zone to dilute contaminants that are emitted at a rate that is related more to population than floor area. Found using *TABLE 6.1* in ASHRAE Standard 62.1-2007

Vbz: (breathing zone outdoor air flow)
The outdoor airflow required in the breathing zone of an occupiable space

Vot: (outdoor air intake rate)
The design outdoor airflow required at the ventilation system outdoor air intake

Vou: (uncorrected outdoor air intake)
The outdoor air intake flow required if the system ventilation efficiency was 1

Voz: (zone outdoor airflow)
The design outdoor airflow required in the zone

Vpz: (zone primary airflow)
The primary airflow supplied to the zone from the AHU at which the outdoor air intake is located. Includes outdoor air intake air and recirculation air from the AHU

APPENDIX B- Standard 90.1 Requirements

BUILDING ENVELOPE REQUIREMENTS FOR CLIMATE ZONE 5 (A,B,C)

OPAQUE ELEMENT	ASSEMBLY MAXIMUM	INSULATION MIN R-VALUE
ROOFS		
Insulation entirely above deck	U-0.048	R-20.0 c.i.
Metal Building	U-0.065	R-19.0
Attic and Other	U-0.027	R-38.0
WALLS ABOVE GRADE		
Mass	U-0.090	R-11.4 c.i.
Metal Building	U-0.113	R-13.0
Steel Framed	U-0.064	R-13.0 + R-7.5 c.i.
Wood Framed & other	U-0.064	R-13.0+ R-3.8 c.i.
BELOW GRADE WALL	C-0.119	R-7.5 c.i.
FLOORS		
Mass	U-0.074	R-10.4 c.i.
Steel Joist	U-0.038	R-30.0
Wood Framed & other	U0.033	R-30.0
SOG FLOORS		
Unheated	F-0.730	NR
Heated	F-0.860	R-15 for 24 in
OPAQUE DOORS		
Swinging	U-0.700	
Non-swinging	U-0.500	

** c.i.= continuous insulation, NR= no insulation requirement*

FENESTRATION	ASSEMBLY MAXIMUM U-VALUE	ASSEMBLY MAX SHGC
VERTICAL GLAZING (% of wall)		
*Non-metal framing (all)***	U-0.35	0.40
*Metal framing (curtain wall/storefront)**	U-0.45	0.40
*Metal framing (entrance door)**	U-0.80	0.40
*Metal framing (all other)**	U-0.55	0.40

**metal framing includes framing with or without thermal break. The all other category includes operable windows, fixed windows and non-entrance doors*

APPENDIX C- Standard 90.1 Lighting Calculations

SPACE	ROOM NUMBER	AREA (SF)	SPACE DESIGNATION	ASHRAE LPD (W/SF)	LIGHTING POWER ALLOWANCE (W)	DESIGNED WATTAGE	DESIGN WATTAGE/ ALLOWANCE	COMPLIANCE?
Mechanical Rm.	0100	3,525	Mechanical	1.50	5287.5	1508	29%	□
Elevator Machine Rm.	0113	64	Mechanical	1.50	96.0	58	60%	□
Stair #3		188	Stairs-Active	0.60	112.8	58	51%	□
Lobby/Atrium	1000	3,023	Lobby	1.30	3929.9	2845	72%	□
Corridor	1100	1,070	Corridor	0.50	535.0	726	136%	
Corridor	1101	330	Corridor	0.50	165.0	237	144%	
Corridor	1102	170	Corridor	0.50	85.0	99	116%	
Corridor	1103-04	1,815	Corridor	0.50	907.5	1276	141%	
Kitchen Restroom	1103a	46	Restrooms	0.90	41.4	58	140%	
Kitchen Janitor	1103b	20	Active Storage	0.80	16.0	58	363%	
Electrical Closet	1103c	69	Electrical	1.50	103.5	58	56%	□
Telecom Closet	1103d	67	Electrical	1.50	100.5	116	115%	
Kitchen Restroom	1103e	46	Restrooms	0.90	41.4	58	140%	
Servery	1110	2,000	Dining Area	1.40	2800.0	1575	56%	□
Maintenance Garage	1111	278	Storage	1.30	361.4	348	96%	□
Kitchen/Scullery/ Dish Rm.	1112	1,260	Food Preperation	1.20	1512.0	1972	130%	
Dry Storage	1112b	102	Storage	0.80	81.6	116	142%	
Kitchen Office	1112f	62	Office-Enclosed	1.10	68.2	116	170%	
Recycle Area	1114	69	Office-Enclosed	1.10	75.9	116	153%	
Janitor's Closet	1115	20	Storage--Active	0.80	16.0	58	363%	
Women's Restroom/Entry	1116a-b	276	Restrooms	0.90	248.4	580	233%	
Men's Restroom/Entry	1117a-b	276	Restrooms	0.90	248.4	580	233%	
Storage Staging	1119	644	Storage--Active	0.80	515.2	406	79%	□
Discussion Classroom	1120	726	Classroom/Lecture	1.40	1016.4	870	86%	□
Discussion Classroom	1121	726	Classroom/Lecture	1.40	1016.4	870	86%	□
Discussion Classroom	1122	703	Classroom/Lecture	1.40	984.2	870	88%	□
Conference/Dining Reception	1123-24	3,978	Dining--Leisure	1.40	5569.2	12474	224%	□
Corridor/Vestibule	1200	1,319	Corridor	0.50	659.5	886	134%	
Lobbies	1202-1203	1,954	Lobby	1.30	2540.2	2282	90%	□
Vestibule	1210	85	Corridor	0.50	42.5	116	273%	
Large Meeting Room	1211	2,120	Conference/Mtg.	1.30	2756.0	2937	107%	
Storage	1211a	223	Storage--Inactive	0.30	66.9	174	260%	
Library/Study	1213	886	Library --Reading	1.20	1063.2	847	80%	□
Vestibule	1214	118	Corridor	0.50	59.0	116	197%	
Snack Bar/Cyber Café-prep	1220	300	Food Preperation	1.20	360.0	198	55%	□
Snack Bar/Cyber Café-dining	1220	350	Dining Area	1.40	490.0	198	40%	□

Standard 90.1 Lighting Calculations (cont'd)

Lecture Classroom	1221	742	Classroom/Lecture	1.40	1038.8	1044	100%	
Lecture Classroom	1222	742	Classroom/Lecture	1.40	1038.8	1044	100%	
Lecture Classroom	1223	742	Classroom/Lecture	1.40	1038.8	1044	100%	
Lecture Classroom	1224	742	Classroom/Lecture	1.40	1038.8	1044	100%	
Restroom/Entry	1225a-b	331	Restrooms	0.90	297.9	746	250%	
Men's Restroom/Entry	1226a-b	331	Restrooms	0.90	297.9	746	250%	
Child Development Center	1227	1,761	Conf/Mtg/Multi	1.30	2289.3	1972	86%	
Unisex Restroom	1227b	46	Restrooms	0.90	41.4	58	140%	
Staff Restroom	1227c	45	Restrooms	0.90	40.5	58	143%	
Office	1227d	61	Office-Enclosed	1.10	67.1	58	86%	
Wellness Training Center	1228	2,443	Multipurpose	1.30	3175.9	3132	99%	
Women's Toilet	1229a-c	186	Restrooms	0.90	167.4	356	213%	
Women's Locker Room	1229b	140	Locker Room	0.60	84.0	99	118%	
Women's Toilet	1230a-c	186	Restrooms	0.90	167.4	356	213%	
Women's Locker Room	1230b	140	Locker Room	0.60	84.0	99	118%	
Specialized Training/Exhibit	1231	1,986	Classroom/Training	1.40	2780.4	3744	135%	
Stair #1		268	Stairs-Active	0.60	160.8	39	24%	
Stair #3		192	Stairs-Active	0.60	115.2	97	84%	
Stair #4		177	Stairs-Active	0.60	106.2	39	37%	
Corridor	2100	1,117	Corridor	0.60	670.2	264	39%	
Corridor	2101	432	Corridor	0.60	259.2	309	119%	
Corridor	2102	330	Corridor	0.60	198.0	165	83%	
Electrical Closet	2103	24	Electrical	1.50	36.0	58	161%	
Breakout	2103	376	Office-Open	1.10	413.6	408	99%	
Breakout	2104	357	Office-Open	1.10	392.7	408	104%	
Breakout	2105	357	Office-Open	1.10	392.7	408	104%	
Board Room	2110	735	Conf/Mtg/Multi	1.30	955.5	606	63%	
Men's Restroom/Entry	2111	172	Restrooms	0.90	154.8	390	252%	
Women's Restroom/Entry	2112	172	Restrooms	0.90	154.8	390	252%	
Discussion Classroom	2113	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Discussion Classroom	2114	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Lecture Classroom	2115	618	Classroom/Lecture	1.40	865.2	870	101%	
Discussion Classroom	2116	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Discussion Classroom	2117	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Lecture Classroom	2118	618	Classroom/Lecture	1.40	865.2	870	101%	
Discussion Classroom	2119	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Discussion Classroom	2120	730	Classroom/Lecture	1.40	1022.0	1044	102%	
Seminar Room	2121	349	Conf/Mtg/Multi	1.30	453.7	348	77%	
Corridor	2200	1,185	Corridor	0.50	592.5	812	137%	
Corridor	2201	1,120	Corridor	0.50	560.0	627	112%	
Interaction Space	2202	751	Office--Open Plan	1.10	826.1	805	97%	
Waiting Area	2204	686	Office--Open Plan	1.10	754.6	630	83%	
Corridor	2205	735	Corridor	0.50	367.5	696	189%	
Corridor	2206	160	Corridor	0.50	80.0	198	248%	
Staff Clerical Area	2210	846	Office--Open Plan	1.10	930.6	1197	129%	

Standard 90.1 Lighting Calculations (cont'd)

Storage	2211	87	Active Storage	0.80	69.6	58	83%	
Office	2212	218	Office-Enclosed	1.10	239.8	261	109%	
Office	2213	179	Office-Enclosed	1.10	196.9	261	133%	
Office	2214	179	Office-Enclosed	1.10	196.9	261	133%	
Office	2215	179	Office-Enclosed	1.10	196.9	261	133%	
Technology Center/Server Rm.	2216	541	Training	1.40	757.4	783	103%	
Electrical Closet	2217	18	Electrical	1.50	27.0	58	215%	
Kitchen/Copy Rm.	2217	228	Food Preperation	1.20	273.6	285	104%	
Shared RLA/Tenant Reception	2218	261	Office--Open Plan	1.10	287.1	330	115%	
Seminar Rm.	2219	436	Conf/Mtg/Multi	1.30	566.8	546	96%	
Lecture Classroom	2220	592	Classroom/Lecture	1.40	828.8	870	105%	
Discussion Classroom	2221	720	Classroom/Lecture	1.40	1008.0	1044	104%	
Discussion Classroom	2222	720	Classroom/Lecture	1.40	1008.0	1044	104%	
Discussion Classroom	2223	720	Classroom/Lecture	1.40	1008.0	1044	104%	
Lecture Classroom	2224	720	Classroom/Lecture	1.40	1008.0	1044	104%	
Career/Conference Rm.	2225	194	Conf/Mtg/Multi	1.30	252.2	306	121%	
Consult Rm.	2226	180	Classroom/Lecture	1.40	252.0	306	121%	
Storage	2227	137	Storage--Active	0.80	109.6	116	106%	
Electrical Closet	2227	95	Electrical	1.50	142.5	116	81%	
Tenant Office	2228	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2229	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2230	179	Office-Enclosed	1.10	196.9	261	133%	
Faculty Work Area	2231	816	Office-Enclosed	1.10	897.6	1566	174%	
Tenant Office	2232	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2233	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2234	179	Office-Enclosed	1.10	196.9	261	133%	
Computer Lab	2235	791	Computer Lab	1.60	1265.6	1566	124%	
Tenant Office	2236	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2237	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2238	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2239	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2240	179	Office-Enclosed	1.10	196.9	261	133%	
Tenant Office	2241	179	Office-Enclosed	1.10	196.9	261	133%	
Women's Restroom/Entry	2250	219	Restrooms	0.90	197.1	506	257%	
Storage	2251	54	Storage-- Active	0.80	43.2	58	134%	
Janitor's Closet	2252	48	Storage--Active	0.80	38.4	58	151%	
Men's Restroom/Entry	2253	219	Restrooms	0.90	197.1	506	257%	
Stair #1		268	Stairs-Active	0.60	160.8	78	49%	
Stair #3		192	Stairs-Active	0.60	115.2	78	68%	
Stair #4		192	Stairs-Active	0.60	115.2	78	68%	
			TOTALS:		77880	84978		

APPENDIX D- Standard 62.1 Ventilation Calculations

The continuance of these calculations, along with the final total outdoor air requirement can be found on the second page of APPENDIX D.

Note that rooms with a dedicated exhaust (such as restrooms and storage rooms) have been excluded from the list of spaces.

ROOM NAME & NUMBER	Az (SF)	Occupant Load (people/1000 SF)	Calculated Number of People	Rp (cfm/person)	Ra (cfm/SF)	Pz (Actual Number of people provided)	RpPz (cfm)	RaAz (cfm)	Vbz (CFM)	Ez	Voz (CFM)
1000 Atrium/Lobby, 1101 & 1102 Corridors, 1200 Corridor, 1202 N. Lobby, 1212 Reception	8020	-	-	-	0.10	-	-	802	802	1.0	802
1103 & 1104 Corridor	1815	-	-	-	0.06	-	-	109	109	1.0	109
1110 Casual Dining	1600	70	112	7.50	0.18	96	720	288	1008	1.0	1008
1110a Servery	280	20	6	7.50	0.18	24	180	50	230	1.0	230
1112 Kitchen	1264	20	25	7.50	0.18		190	228	417	1.0	417
1112f Kitchen Office	62	5	0	5.00	0.06	1	5	4	9	1.0	9
1120 Class Disc.	737	65	48	7.50	0.06	35	263	44	307	1.0	307
1121 Class Disc.	737	65	48	7.50	0.06	23	173	44	217	1.0	217
1122 Class Disc. Int.	707	65	46	7.50	0.06	35	263	42	305	1.0	305
1123 Dining/Conf.	1938	100	194	7.50	0.06		1454	116	1570	1.0	1570
1124 Dining/Conf.	1972	100	197	7.50	0.06		1479	118	1597	1.0	1597
1211 Large Meeting	2025	50	101	5.00	0.06	55	275	122	397	1.0	397
1213 Library	875	10	9	5.00	0.06	20	100	53	153	1.0	153
1220 Snack Bar/Cyber Café	639	20	13	5.00	0.06	14	70	38	108	1.0	108
1221 Class Disc. W.	730	65	47	7.50	0.06		356	44	400	1.0	400
1222 Class Disc. W.	730	65	47	7.50	0.06		356	44	400	1.0	400
1223 Class Disc. W.	730	65	47	7.50	0.06		356	44	400	1.0	400
1227 Child Dev., 1227a Kitchen	1920	25	48	10.00	0.12	15	150	230	380	1.0	380
1231 Spec. Training E	2156	35	75	10.00	0.12	40	400	259	659	1.0	659
2110 Board Room	805	50	40	5.00	0.06	21	105	48	153	1.0	153
2113 Classroom Disc.	730	65	47	7.50	0.06	35	263	44	306	1.0	306
2114 Classroom Disc.	733	65	48	7.50	0.06	35	263	44	306	1.0	306
2115 Classroom Lect.	609	65	40	7.50	0.06	27	203	37	239	1.0	239
2116 Classroom Disc.	733	65	48	7.50	0.06	22	165	44	209	1.0	209
2117 Classroom Disc.	733	65	48	7.50	0.06	17	128	44	171	1.0	171
2118 Classroom Lect.	621	65	40	7.50	0.06	27	203	37	240	1.0	240
2119 Classroom Disc.	733	65	48	7.50	0.06	35	263	44	306	1.0	306
2120 Classroom Disc.	733	65	48	7.50	0.06	35	263	44	306	1.0	306
2121 Seminar Room	348	65	23	7.50	0.06	14	105	21	126	1.0	126

NOTE: *1. for 100% OA systems, Vot for each zone = Voz. Therefore, the total OA requirement is calculated by adding the Voz of each space.* 11028
2. Areas highlightedin blue are served by AHU-2 and are not included in calculations.
3. *Areas highlightedin yellow used the Default Occupancy Density to arrive at a suitable Pz value.*

Standard 62.1 Ventilation Calculations (cont'd)

ROOM NAME & NUMBER	Az (SF)	Occupant Load (people/1000 SF)	Calculated Number of People	Rp (cfm/person)	Ra (cfm/SF)	Pz (Actual Number of people provided)	RpPz (cfm)	RaAz (cfm)	Vbz (CFM)	Ez	Voz (CFM)
2100-02 Corr., 2103-05 Breakouts, 2200 Corridor, 2204 Waiting, 2205-06 Corridor, 2217 Kitchen, 2218 Reception	7630	-	-	-	0.06	-	-	458	458	1.0	458
2202 Interaction Space	750	5	4	5.00	0.06	4	20	45	65	1.0	65
2210 RLA Clerical	846	5	4	5.00	0.06	14	70	51	121	1.0	121
2212 RLA Office	217	5	1	5.00	0.06	2	10	13	23	1.0	23
2213 Office	177	5	0.89	5.00	0.06	1	5	11	16	1.0	16
2214 Office	177	5	0.89	5.00	0.06	1	5	11	16	1.0	16
2215 Office	177	5	0.89	5.00	0.06	1	5	11	16	1.0	16
2219 Seminar	442	65	29	7.50	0.06	12	90	27	117	1.0	117
2220 Classroom Lect.	621	65	40	7.50	0.06	25	188	37	225	1.0	225
2221 Classroom Disc.	730	65	47	7.50	0.06	30	225	44	269	1.0	269
2222 Classroom Disc.	730	65	47	7.50	0.06	22	165	44	209	1.0	209
2223 Classroom Disc.	730	65	47	7.50	0.06	35	263	44	306	1.0	306
2224 Classroom Lect.	720	65	47	7.50	0.06	17	128	43	171	1.0	171
2228 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2229 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2230 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2232 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2231 Faculty Work	820	5	4	5.00	0.06	20	100	49	149	1.0	149
2233 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2234 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2236 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2237 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2235 Computer Lab	800	25	20	10.00	0.12	21	210	96	306	1.0	306
2238 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2239 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2240 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2241 Tenant	178	5	1	5.00	0.06	2	10	11	21	1.0	21
2225 Career	200	5	1	5.00	0.06	2	10	12	22	1.0	22
2226 Consultation	180	5	1	5.00	0.06	2	10	11	21	1.0	21
1228 Wellness	2421	40	97	10.00	0.06	30	300	145	445	1.0	445
											2743

NOTE: *1. for 100% OA systems, Vot for each zone = Voz. Therefore, the total OA requirement is calculated by adding the Voz of each space.*
2. Areas highlightedin blue are served by AHU-2 and are not included in calculations.

AHU-1 TOTAL: 13771

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