# Technical Report 1

*Evaluation of ASHRAE 62.1-2010: Ventilation for Acceptable Indoor Air Quality & ASHRAE 90.1-2010: Energy Standard for Buildings except Low Rise Residential*

*September 18, 2013*

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## Executive Summary

Technical Report 1 evaluated the compliance of the Auditorium, a performing arts theater and office space, located in Lemma, MN. The building is owned and operated by Francis Michael Performing Arts Academy (FMPAA) and was originally constructed in 1929. The Auditorium was recently renovated to accommodate the needs of FMPAA and is set to be completed in April 2014. The basis of this evaluation is ASHRAE Standard 62.1-2010 Ventilation for Acceptable Indoor Air Quality and ASHRAE Standard 90.1-2010 Energy Standard for Buildings except Low Rise Residential.

Through investigation of ASHRAE 62.1-2010, the Auditorium falls in accordance with the requirements set forth by the standard to protect the health of the building occupants and exceeds the requirements in some areas. The systems and controls in place are designed to prevent the growth of mold, provide adequate ventilation, and minimize the amount of contamination through cleaning and maintenance.

After assessing the Auditorium in relation the requirements for ASHRAE 90.1-2010, the building falls under a general compliance. All of the heating, cooling and ventilation equipment are acceptable and even exceed the standard in some areas, however the building envelope falls short of the thermal requirements. Considering that this building was originally built in the early 1900s, adding more insulation or increasing the tightness of construction could cause more harm to the building in terms of moisture build-up.

## Building Overview

The Auditorium is a historic building located on the campus of the Francis Michael Performing Arts Academy (FMPAA). It was built in 1929, and has recently undergone a renovation to revitalize the performance space and allow for greater usage of the ancillary public spaces. After completion of construction the Academy Honors Program will permanently reside in the Auditorium

A pediment entrance way with ionic columns faces the prominent campus mall. The building facade is a 3 wyth historic brick construction with classical ornamentation. The building is approximately 172,000SF, five stories tall and located in the very cold climate of Lemma, Minnesota.

The plan below (Figure 1) shows the expanded performance space (green), audience chamber (maroon), and horseshoe of public office spaces (orange) surrounding.

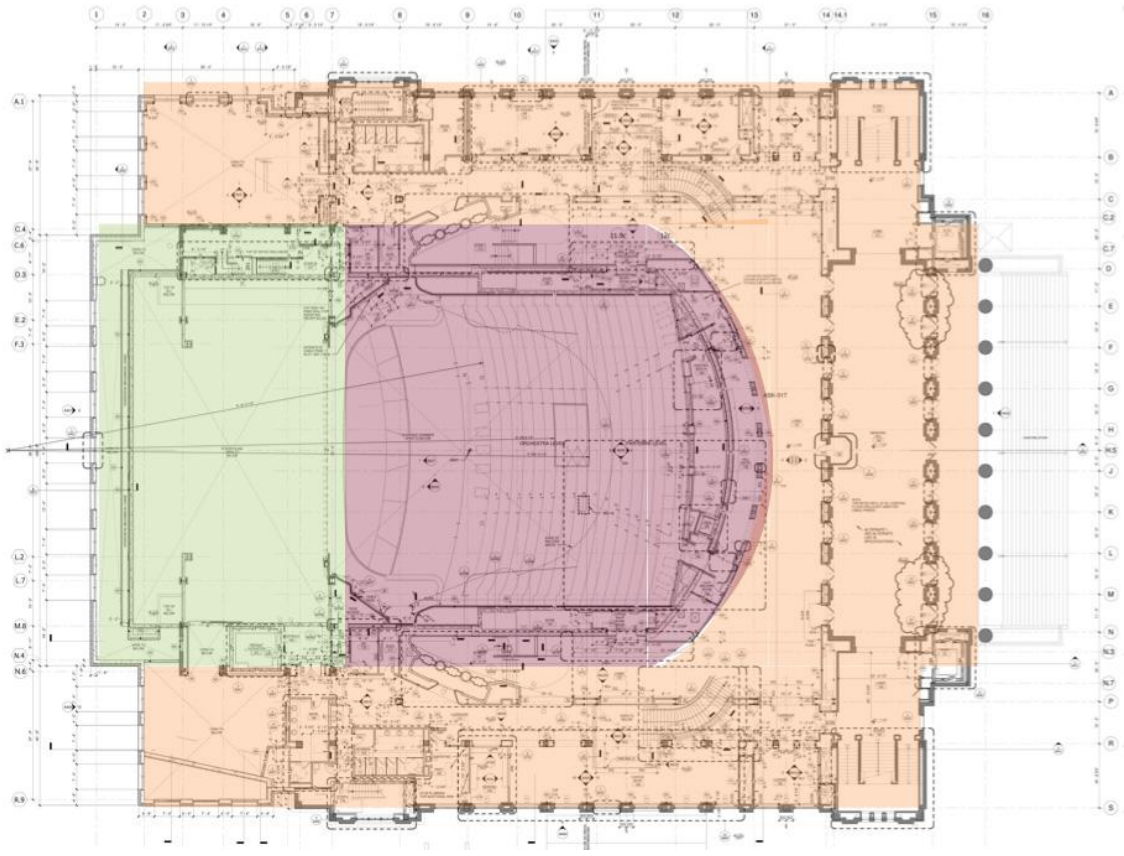


Figure 1 First Floor Level (Source: Architect of Record)

## Mechanical Systems Overview

The mechanical system of the auditorium employs several technologies to distribute heating and cooling to the building occupants. The primary heat source for the building is from a campus steam plant. The steam plant provides 150°F steam to a flooded high pressure heat exchanger to create hot water. The hot water is then distributed to fin tube radiation units, fan-powered boxes and four air handling units. Steam is also utilized in the air handling units humidification systems.

Located in the basement of the Auditorium is the campus cooling plant. It includes three -1000 ton centrifugal chillers, which accommodate the northwest corner of campus including the Auditorium. Chilled water is distributed to the air handling units, in addition to the active chilled beams which serve the performance support spaces.

Four air handling units serve the building. Each unit is sized to accommodate the following program spaces:

- AHU-1: Public Spaces - Variable Air Volume
- AHU-2: Audience Chamber - Displacement Ventilation via Underfloor Air Distribution
- AHU-3: Performance Spaces - Variable Air Volume
- AHU-5: Performance Support Spaces - DOAS with dual-energy recovery wheel
- *Note: AHU-4 was not used and does not exist in the final construction documentation*

AHU-5 is a dedicated outdoor air system (DOAS) and has a dual-energy recovery wheel that serves the active chilled beam system. The design team approximates that it reduces the amount of conditioned air by 35%. Please see the end of section 6.2 Ventilation Rate Procedure for the breakdown and calculations of airflow values for each of air handling units.

# ASHRAE Standard 62.1 - 2010 Evaluation

This section will analysis how the mechanical design of the Auditorium complies with ASHRAE Standard 62.1-2010. Please note sections 1 - 4 of ASHRAE 62.1-2010 are related to the scope the standard applies to and definitions of terminology used in the standard.

## ASHRAE 62.1 Section 5: Systems & Equipment

### 5.1 Ventilation Air Distribution

The Auditorium is designed to comply with Section 5.1. The drawings indicate appropriate balancing information for compliant ventilation distribution in both ducted and plenum distribution. The drawings indicate requirements for sealing the underfloor supply plenum and reference SMACNA Class A Leakage seal requirements, along with additional leakage testing information.

### 5.2 Exhaust Duct Location

The exhaust duct locations in The Auditorium are negatively pressurized to mitigate the risk of harmful contaminants leaking into adjacent spaces or air supply or return ductwork. Two general exhaust fans are located on the east (EF-1) and west (EF-2) rooftops rated at an airflow of 4160 cfm and 4350 cfm respectively, to expel contaminants.

### 5.3 Ventilation System Controls

Francis Michael Performing Arts Academy requires all equipment control systems to interface with their Building Systems Automation Center (BSAC). All air terminal units are under the control of the BSAC and interface with occupancy sensors located in regularly occupied spaces to supply required ventilation.

### 5.4 Air Stream Surfaces

All air stream surfaces are constructed of sheet metal and connected using metal fasteners to comply with section 5.4.1 Resistance to Mold Growth and section 5.4.2 Resistance to Erosion.

### 5.5 Outdoor Air Intakes

All outdoor intakes are located on the north and west roofs. Each outdoor air inlet is located at least 10 feet from any exhaust or relief outlet, based on Class 2 exhaust air per Table 5-1 in Figure 2 on the following page. All inlets exceed this minimum distance significantly. Additionally, each inlet is protected with a mesh screen and operable louvers that comply with sections 5.5.2 - 5.5.4, protecting the equipment from rain, snow and birds. Each outdoor air handling unit is also designed with access doors for periodic cleaning and maintenance.

**TABLE 5-1 Air Intake Minimum Separation Distance**

| Object | Minimum Distance, ft (m) |
|---|---|
| Class 2 air exhaust/relief outlet (Note 1) | 10 (3) |
| Class 3 air exhaust/relief outlet (Note 1) | 15 (5) |
| Class 4 air exhaust/relief outlet (Note 2) | 30 (10) |
| Plumbing vents terminating less than 3 ft (1 m) above the level of the outdoor air intake | 10 (3) |
| Plumbing vents terminating at least 3 ft (1 m) above the level of the outdoor air intake | 3 (1) |
| Vents, chimneys, and flues from combustion appliances and equipment (Note 3) | 15 (5) |
| Garage entry, automobile loading area, or drive-in queue (Note 4) | 15 (5) |
| Truck loading area or dock, bus parking/idling area (Note 4) | 25 (7.5) |
| Driveway, street, or parking place (Note 4) | 5 (1.5) |
| Thoroughfare with high traffic volume | 25 (7.5) |
| Roof, landscaped grade, or other surface directly below intake (Notes 5 and 6) | 1 (0.30) |
| Garbage storage/pick-up area, dumpsters | 15 (5) |
| Cooling tower intake or basin | 15 (5) |
| Cooling tower exhaust | 25 (7.5) |

Note 1: This requirements applies to the distance from the outdoor air intakes for one ventilation system to the exhaust/relief outlets for any other ventilation system.
Note 2: Minimum distance listed does not apply to laboratory fume hood exhaust air outlets. Separation criteria for fume hood exhaust shall be in compliance with NFPA 45[5] and ANSI/AIHA Z9.5.[6] Information on separation criteria for industrial environments can be found in the *ACGIH Industrial Ventilation Manual* [7] and in the *ASHRAE Handbook—HVAC Applications*.[8]
Note 3: Shorter separation distances shall be permitted when determined in accordance with (a) ANSI Z223.1/NFPA 54[9] for fuel gas burning appliances and equipment, (b) NFPA 31[10] for oil burning appliances and equipment, or (c) NFPA 211[11] for other combustion appliances and equipment.
Note 4: Distance measured to closest place that vehicle exhaust is likely to be located.
Note 5: Shorter separation distance shall be permitted where outdoor surfaces are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.
Note 6: Where snow accumulation is expected, the surface of the snow at the expected average snow depth constitutes the "other surface directly below intake."

Figure 2 (Source: ASHRAE 62.1-2010)

## 5.6 Local Capture of Contaminants

Equipment generating contaminates is captured at directed outdoors away from any intake openings to be in compliance with section 5.6.

## 5.7 Combustion Air

The Auditorium does not utilize any combustion equipment therefore this section is not applicable. The heating system for this building is feed from the Academy's steam plant and converted to hot water through a flooded steam heat exchangers, as stated more thoroughly in the previous section, Mechanical Systems Overview.

## 5.8 Particulate Matter Removal

All filters specified are at minimum MERV 8 with additional filters rated at a minimum of MERV 11, therefore exceeding the MERV 6 requirement for section 5.8.

## 5.9 Dehumidification Systems

The outdoor air handling units were selected with a base relative humidity of 50%. This exceeds the 65% requirement. Also, in accordance with section 5.9.2 the total supply airflow far exceeds the exhausted air. Total maximum supply airflow from four outdoor air handling units accounts to 172,000 cfm compared to a total general exhaust airflow of 8,510 cfm.

## 5.10 Drain Pans

Specification section 233119 on condensate drain pans cites compliance with ASHRAE Standard 62.1-2010. The specification section also indicates that all drain pans shall extend a minimum of 12 inches past the cooling coil.

## 5.11 Finned-Tube Coils and Heat Exchangers

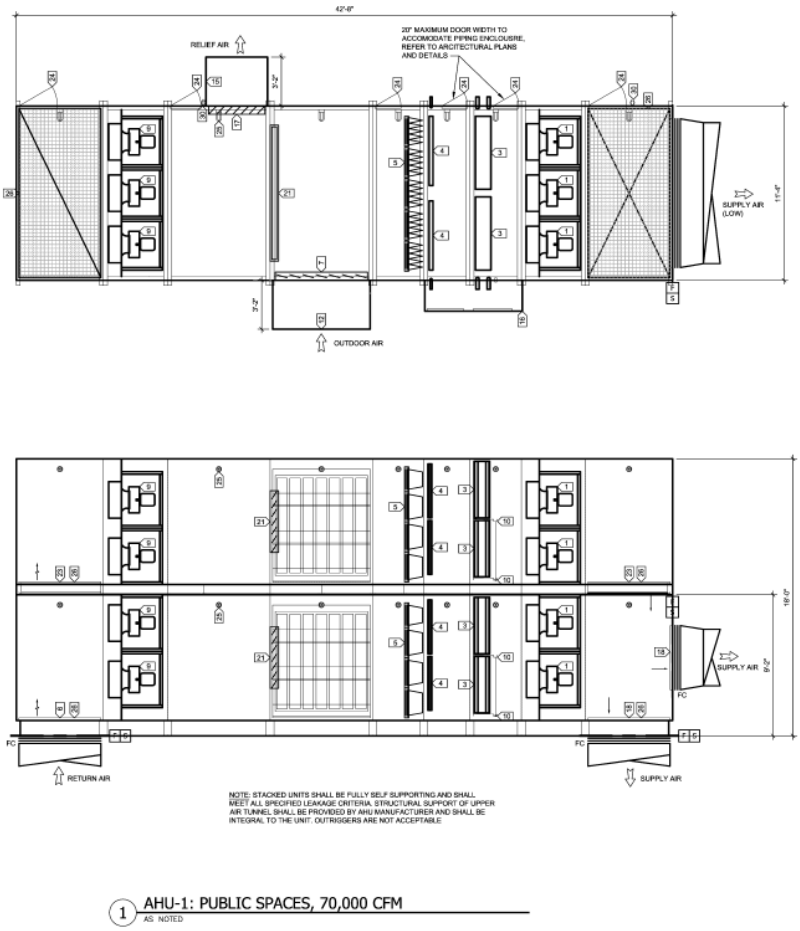
Drain pans are provided for all finned-tube coils and heat exchangers per section 5.10 to be in compliance with section 5.11. Finned tube coils are installed with 18 inches of access space for cleaning.

## 5.12 Humidifiers and Water-Spray Systems

The installation of the four types of humidifiers used in the Auditorium; steam injection, electric self-contained, heat exchangers, and electric steam, are specified to be in compliance with ASHRAE 62.1-2010. Each type uses potable water and a drain pan is installed underneath each humidifier.

## 5.13 Access for Inspection, Cleaning, and Maintenance

Sufficient access to HVAC equipment, ventilation equipment, and air distribution systems has been designed to comply with ASHRAE 62.1-2010 section 5.12. Access doors to clean and inspect air terminal units in ceilings have been included in addition to service spaces in the outdoor handling units. See Figure 3 below for an example schematic of AHU-1 and the access spaces for routine maintenance.




1 AHU-1: PUBLIC SPACES, 70,000 CFM
AS NOTED

Figure 3 (Source: Architect of Record)

## 5.14 Building Envelope and Interior Surfaces

The envelope of the Auditorium includes a moisture barrier as indicated in Figure 4 from architectural section detail on sheet A462. Additionally, specification section 230719 details what piping systems are to be insulated to prevent condensation.

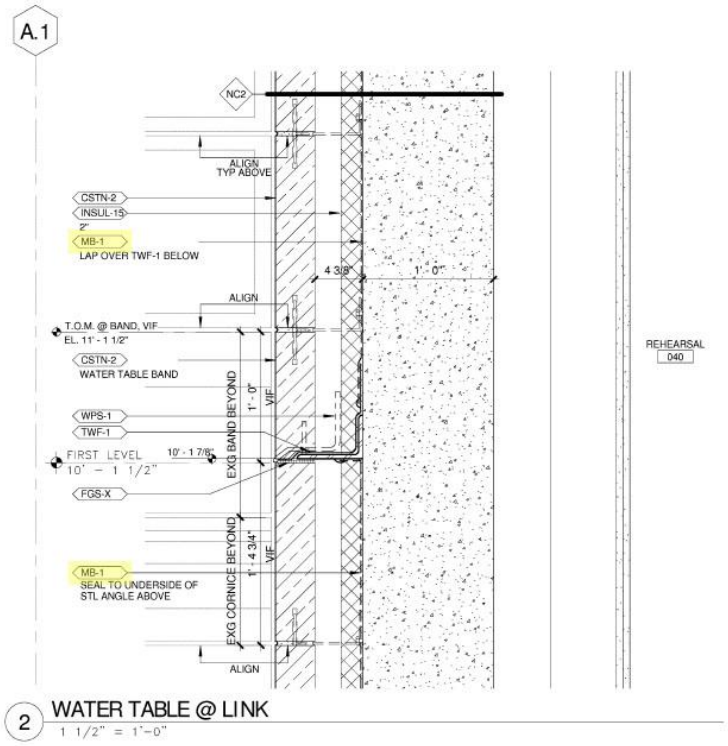



Figure 4 (Source: Architect of Record)

## 5.15 Buildings with Attached Parking Garages

The Auditorium is not attached to a parking garage, therefore this section does not apply.

## 5.16 Air Classification and Recirculation

The Auditorium spaces are classified as Class 1 or Class 2 as per Table 6-1 in ASHRAE 62.1-2010. However, most if not all air in the performance spaces, audience chamber, and public spaces is returned to AHU-1, AHU-2, and AHU-3. The performance support spaces, which are served by an active chilled beam system, recirculates Class 1 air before being returned the DOAS AHU-5 for heat recovery.

## 5.17 ETS Air

The Auditorium is a non-smoking facility and all spaces can be classified as ETS-free spaces. Additionally, all inlets for air circulation are located on the roof of the building eliminating any exposure from smoking locations near to the building. Therefore this section's requirements are not applicable.

# ASHRAE 62.1 Section 6: Procedures

## 6.1 General

The outdoor air is deemed acceptable for purposes of ventilation of the Auditorium. The airflow rates for achieving proper amounts of outdoor air follow the ventilation rate procedure and exhaust rate procedure. Natural ventilation strategies are not used in the building.

## 6.2 Ventilation Rate Procedure

Breathing zone air flows are calculated by using Equation 6-1 from ASHRAE 62.1-2010 for each space.

$$Vbz = Rp \times Pz + Ra \times Az \qquad (6\text{-}1)$$

*Az: Occupiable area of the zone* [ft²]
*Pz: Population of the zone during typical usage* [People]
*Ra: Outdoor air rate per unit area* [cfm/ft²]
*Rp: Outdoor air rate per person in the zone* [cfm/person]

Values for Ra and Rp, listed by space use, are located in ASHRAE 62.1-2010 Table 6-1 which is included in Figure 1 of Appendix B for reference. The outdoor air requirement for the zone is then calculated based on the Zone Air Distribution Effectiveness (Ez). Values for Ez can be found in ASHRAE 62.1-2010 Table 6-2, included below (Figure 5) and are based on how the air is supplied and returned to the zone.

$$Voz = Vbz/Ez \qquad (6\text{-}2)$$

**TABLE 6-2 Zone Air Distribution Effectiveness**

| Air Distribution Configuration | $E_z$ |
|---|---|
| Ceiling supply of cool air. | 1.0 |
| Ceiling supply of warm air and floor return. | 1.0 |
| Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return. | 0.8 |
| Ceiling supply of warm air less than 15°F (8°C) above space temperature and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft (1.4 m) of floor level. ***Note:*** For lower velocity supply air, $E_z = 0.8$. | 1.0 |
| Floor supply of cool air and ceiling return provided that the 150 fpm (0.8 m/s) supply jet reaches 4.5 ft (1.4 m) or more above the floor. ***Note:*** Most underfloor air distribution systems comply with this proviso. | 1.0 |
| Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification. | 1.2 |
| Floor supply of warm air and floor return. | 1.0 |
| Floor supply of warm air and ceiling return. | 0.7 |
| Makeup supply drawn in on the opposite side of the room from the exhaust and/or return. | 0.8 |
| Makeup supply drawn in near to the exhaust and/or return location. | 0.5 |

1. "Cool air" is air cooler than space temperature.
2. "Warm air" is air warmer than space temperature.
3. "Ceiling" includes any point above the *breathing zone.*
4. "Floor" includes any point below the *breathing zone.*
5. As an alternative to using the above values, $E_z$ may be regarded as equal to air change effectiveness determined in accordance with ANSI/ASHRAE Standard 129[17] for all air distribution configurations except unidirectional flow.

Figure 5 (Source: ASHRAE 62.1-2010)

These outdoor airflows are tabulated in Table 1 in Appendix A. The Auditorium's AHU-1, AHU-2 and AHU-3 fall under the classification of section 6.2.5 Multiple-zone Recirculating System and therefore additional calculations are required to determine the total outdoor air requirement for the building. To determine the effectiveness of the air handling units to recirculate outdoor air (Ev) the Primary Outdoor Air Fraction (Zp) must be determined from ASHRAE 62.1-2010 Equation 6-5 as follows:

$$Zp = Voz/Vpz \quad (6\text{-}5)$$

*Voz: the corrected outdoor air required as determined by Equation 6-2* [cfm]
*Vpz: the total outdoor and recirculated air to the zone based on the design condition.* [cfm]

Looking at all the zones in a given system, the maximum Zp is used to determine Ev from ASHRAE 62.1-2010 Table 6-3, included below (Figure 6).

**TABLE 6-3 System Ventilation Efficiency**

| Max ($Z_P$) | $E_v$ |
|---|---|
| ≤0.15 | 1.0 |
| ≤0.25 | 0.9 |
| ≤0.35 | 0.8 |
| ≤0.45 | 0.7 |
| ≤0.55 | 0.6 |
| >0.55 | Use Appendix A |

1. "Max ($Z_{pz}$)" refers to the largest value of $Z_{pz}$, calculated using Equation 6-5, among all the *ventilation zones* served by the system.
2. For values of Max ($Z_{pz}$) between 0.15 and 0.55, the corresponding value of $E_v$ may be determined by interpolating the values in the table.
3. The values of $E_v$ in this table are based on a 0.15 average outdoor air fraction for the system (i.e., the ratio of the uncorrected outdoor air intake ($V_{ou}$) to the total zone primary airflow for all the zones served by the air handler). For systems with higher values of the average outdoor air fraction, this table may result in unrealistically low values of $E_v$ and the use of Appendix A may yield more practical results.

Figure 6 (Source: ASHRAE 62.1-2010)

Additionally, since the population of the Auditorium will fluctuate the population diversity is calculated for each AHU to determine an uncorrected outdoor air intake (Vou), which is calculated in accordance with ASHRAE 62.1-2010 Equation 6-6.

$$Vou = D \Sigma_{\text{all zones}}(Rp \times Pz) + \Sigma_{\text{all zones}}(Ra \times Az) \quad (6\text{-}6)$$

$$\text{where, } D = Ps/\Sigma_{\text{all zones}}Pz \quad (6\text{-}7)$$

*Ps: maximum population served by the system at a given time* [People]
$\Sigma_{\text{all zones}}Pz$: *summation of all the zone populations in the building* [People]

Lastly, the total outdoor air for each air handling unit is calculated by following ASHRAE 62.1-2010 Equation 6-8.

$$Vot = Vou/Ev \quad (6\text{-}8)$$

The final outdoor air requirement is used to size AHU-1, AHU-2, AHU-3 and a summary of the results is tabulated below in Table 1.

AHU-5 is a 100% outdoor air system and therefore the outdoor air intake requirement is sized under section 6.2.4. The total outdoor air required is equal to the summation of the outdoor air required by each zone, in accordance with ASHRAE 61.1-2010 Equation 6-3

$$Vot = \Sigma_{all\ zones} Voz \qquad (6\text{-}3)$$

The final airflow requirements for AHU-5 are included in Table 1 below. AHU-5 is sized for the outdoor air requirement. Additional heating & cooling is supplied through the chilled beam system and finned-tube radiation.

| System Name | Total Supply CFM | Total OA | Max Z Crit | AHU Ventilation Efficiency | AHU OA Required | Exhaust CFM | Total OA/Makeup Air Required | AHU OA % |
|---|---|---|---|---|---|---|---|---|
| AHU-1 : Public Spaces | 68,325 | 15,475 | 0.99 | 0.8 | 19,343 | 3,359 | 19,343 | 28% |
| AHU-2 : Audience Chamber | 58,325 | 11,137 | 0.23 | 0.8 | 13,922 | 0 | 13,922 | 24% |
| AHU-3 : Performance Spaces | 32,260 | 5,973 | 0.99 | 0.8 | 7,466 | 0 | 7,466 | 23% |
| AHU-5: Performance Support Spaces | 9,680 | 2,307 | 0.96 | 0.8 | 2,884 | 2,738 | 2,884 | 30% |

Table 1 System Calculations

Note: AHU-4 was not used and does not exist in the final construction documentation.

### 6.5 Exhaust Ventilation

Exhaust airflows were taken into account based on ASHRAE 62.1-2010 Table 6-4, included in Figure 2 Appendix B and calculated to achieve proper ventilation requirements. Exhaust ventilation calculations can be seen in Table 1 of Appendix A.

## ASHRAE 62.1 Evaluation Conclusions

As indicated previously, the Auditorium utilizes four outdoor air handling units. AHU-1 is sized to accommodate the public spaces, AHU-2 the audience chamber, AHU-3 the performance spaces, and AHU-5 the performance support spaces. (Note: AHU-4 was not used and does not exist in the final construction documentation.) Complete procedural verification calculations for each zone are tabulated in an Excel spreadsheet and summarized in Table 1 of Appendix A.

The Auditorium is fully compliant with ASHRAE Standard 62.1-2010 and in many aspects far exceeds the standards set forth. The systems and design conditions all abide by the criteria required by Standard 62.1-2010 section 5 to prevent harmful contaminants, resist mold growth, and maintain a healthy system through routine maintenance and cleaning. The design team also followed proper prescriptive methods to calculate required outdoor air flows for ventilation purposes in designing ventilation equipment.

# ASHRAE Standard 90.1 Evaluation

This section evaluates at how the Auditorium's equipment and systems compare to ASHRAE Standard 90.1-2010. Efficiency, energy consumption and building construction are the focus of this standard.

## ASHRAE 90.1 Section 5: Building Envelope

The Auditorium's location in Lemma, Minnesota falls under climate zone 6A. This zone is characterized as cold and moist. This area receives heavy snowfall throughout the winter months. Figure 7 below shows the climate zone breakdown by county. Individual county climate zones are also listed in ASHRAE 90.1-2010.

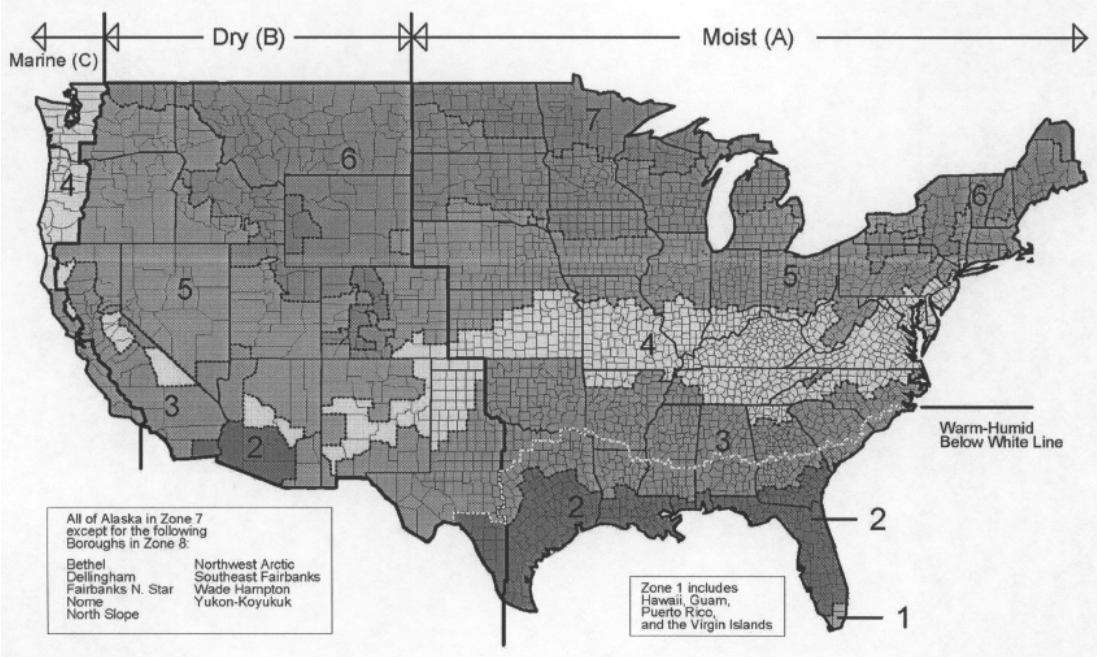



Figure 7 Climate Zones (Source: ASHRAE 90.1-2010)

### 5.2 Compliance Path

As illustrated in Table 2 below, the window to wall percentage is far below the 40% maximum allowable. Additionally the skylights located on the south roof account for far less than 5% of the building roof area.

| | N | S | E | W | Roof |
|---|---|---|---|---|---|
| Wall Area | 20224 | 20224 | 23750 | 23750 | 59400 |
| Window/Skylight Area | 0 | 1340 | 3360 | 3360 | 380 |
| % Window Area | 0.00% | 6.63% | 14.15% | 14.15% | 0.64% |

Table 2 Window-Wall Ratio

### 5.4 Mandatory Provisions

The entrances to the Auditorium each have an enclosed vestibule space in accordance the the standard to separate the exterior environment with the interior conditioned spaces. Also, there is a continuous air barrier enclosing the building. Appropriate insulations and sealants have been utilized to insulated and seal the building against thermal and air leakage. Additionally all fenestration and door are in accordance with the leakage requirements set forth in ASHRAE 90.1-2010 Section 5.4.3.2.

### 5.5 Prescriptive Building Envelope

Table 3, shown below, details how the above and below grade walls, roof construction, and windows perform against Standard 90.1-2010 Section 5.5 minimum R-values and maximum U-values for climate zone 6A. Considering the building was originally constructed in 1929, the high U-values for the walls, roof and window are acceptable, but noted.

| Building Construction | | | | | | |
|---|---|---|---|---|---|---|
| Type | Description | Actual U-Value | | ASHRAE 90.1-2010 U-Value | | Compliant [Yes/No] |
| Wall | Face brick, 12" HW Conc, 1" Insul | 0.168 | btu/h-ft$^2$-F | 0.080 | btu/h-ft$^2$-F | No |
| Below-Grade Wall | 12" HW Conc 6" Insul | 0.045 | btu/h-ft$^2$-F | 0.119 | btu/h-ft$^2$-F | Yes |
| Roof | Steel Sheet. 4" Insul | 0.068 | btu/h-ft$^2$-F | 0.048 | btu/h-ft$^2$-F | No |
| Slab | 4" LW Concrete | 0.213 | btu/h-ft$^2$-F | 0.540 | btu/h-ft$^2$-F | Yes |
| Window | Double Clear 1/4" | 0.600 | btu/h-ft$^2$-F | 0.550 | btu/h-ft$^2$-F | No |

Table 3 - Building Construction Thermal Resistance

## ASHRAE 90.1 Section 6: Heating, Ventilation and Air Conditioning

### 6.4 Mandatory Provisions

All equipment selected in The Auditorium meets the minimum efficiency standards in accordance with ASHRAE 90.1-2010 Table 6.8.1A through Table 6.8.1H and Table 6.8.1K. The mechanical system does not use a variable refrigerant flow system, therefore those standards are not applicable. All load calculations followed prescriptive methods listed in ANSI/ASHRAE/ACCA Standard 183-2007 to size systems and equipment. Additionally, all zones are controlled individually by thermostat controls and all equipment is controlled in accordance with ASHRAE 90.1-2010 Section 6.4.3. Furthermore all equipment construction, installation and insulation follows the standard requirements listed in ASHRAE 90.1-2010 Section 6.4.4.

### 6.5 Prescriptive Path

The air handling equipment is equipped with economizers and control systems that are in accordance with ASHRAE 90.1-2010 Section 6.5.1. Additionally, the fan power levels comply with the requirements in ASHRAE 90.1-2010 Tables 6.5.3.1.1A/B, included in Figure 3 of Appendix B.

Per Table 1 located in section 6.2 Ventilation Rate Procedure the percentage of outdoor air required at design condition for AHU-1, AHU-2, and AHU-3 are below the required amount to need an energy recovery system per ASHRAE 90.1-2010 Section 6.5.6 Table 6.5.6.1 (Figure 8).

AHU-5 is a dedicated outdoor air handling system and utilizes a dual wheel energy recovery system.

**TABLE 6.5.6.1 Energy Recovery Requirement**

| Zone | % *Outdoor Air* at Full Design Airflow Rate | | | | | |
|---|---|---|---|---|---|---|
| | ≥30% and < 40% | ≥40% and < 50% | ≥50% and < 60% | ≥60% and < 70% | ≥70% and < 80% | ≥80% |
| | Design Supply Fan Airflow Rate (cfm) | | | | | |
| 3B, 3C, 4B, 4C, 5B | NR | NR | NR | NR | ≥5000 | ≥5000 |
| 1B, 2B,5C | NR | NR | ≥26000 | ≥12000 | ≥5000 | ≥4000 |
| 6B | ≥11000 | ≥5500 | ≥4500 | ≥3500 | ≥2500 | ≥1500 |
| 1A, 2A, 3A, 4A, 5A, 6A | ≥5500 | ≥4500 | ≥3500 | ≥2000 | ≥1000 | >0 |
| 7,8 | ≥2500 | ≥1000 | >0 | >0 | >0 | >0 |

NR—Not required

Figure 8 (Source: ASHRAE 901.-2010)

## ASHRAE 90.1 Section 7: Service Water Heating

The service water for heating purposes is supplied through a flood steam heat exchanger, from which the steam supplied comes from the campus steam generation plant at 12,000lbs/hr of steam. All equipment and piping located in the building is properly insulated in accordance with section 7.4.3. Additionally, the control system is controlled from a temperature sensor on the condensate supply side to regulate the amount of heat needed.

## ASHRAE 90.1 Section 8: Power

The 2007 Minnesota Building adopted the 2008 National Electrical Code (NEC) which supersedes this section. The 2008 NEC specifies a 3% voltage drop on all feeders and 5% voltage drop on feeders and inclusive branch circuits. The Auditorium power requirements follow these requirements.

## ASHRAE 90.1 Section 9: Lighting

The lighting controls for the Auditorium are broken down into different control zones:

- 24hr Egress Lighting,
- Digital Time Control,
- Occupancy Sensor,
- Stand Alone Preset Dimming,
- Time of Day with Maintenance/Security Override
- Time of Day without Override
- Time of Day with User Override

Figure 9, shown on the following page details an example break down of these zones for the second level lighting plan. These controls are in compliance with ASHRAE 90.1 Section 9. The audience chamber and performance lighting are user controlled depending on the performance.

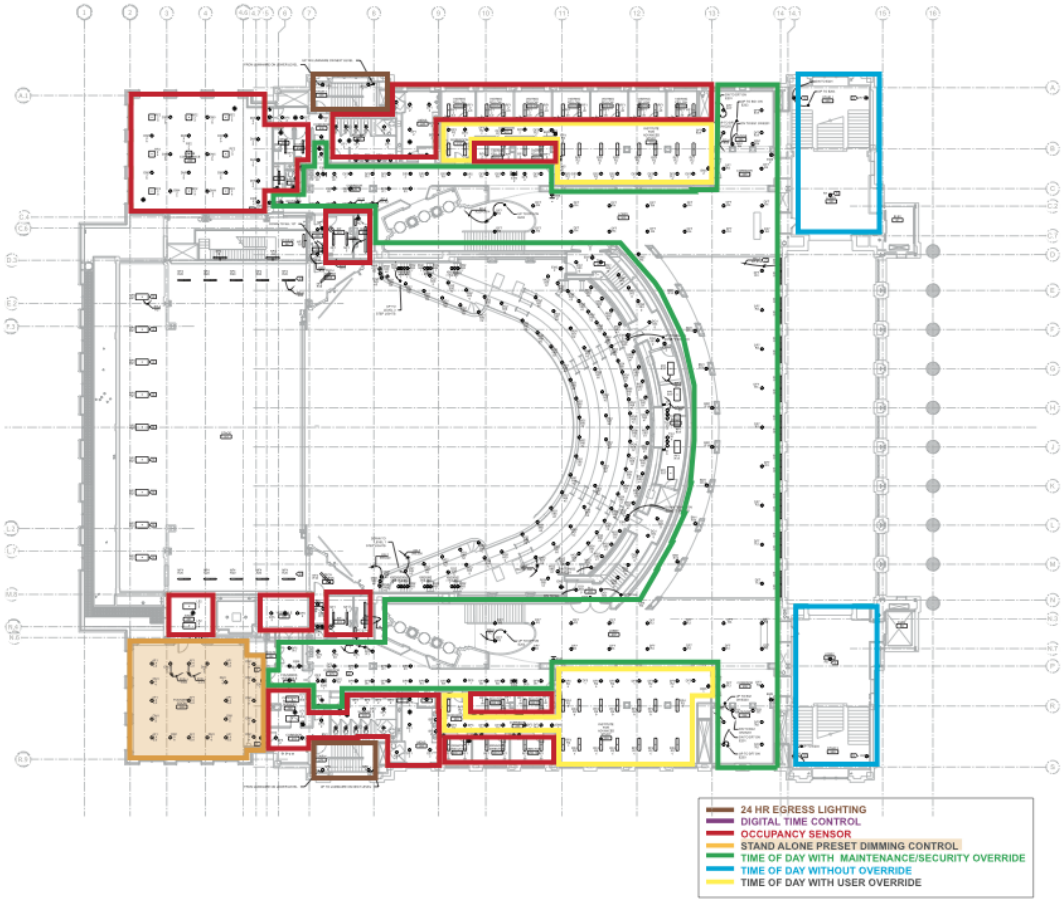



Figure 9 Lighting Control Zones (Source: Architect of Record)

The Space-by-Space method for determining the lighting power densities is tabulated in Table 3 included in Appendix A. All the spaces in the Auditorium comply with the standard limits.

## ASHRAE 90.1 Section 10: Other Equipment

Per specification section 230513 Common Motor Requirements for HVAC Equipment, NEMA MG1 is cited as the requirements for all motors in the Auditorium. This meets the requirements set by ASHRAE 90.1-2010 section 10.

## ASHRAE 90.1 Evaluation Conclusions

The systems used in the Auditorium are in general compliance with ASHRAE 90.1-2010 considering the historic nature of the building. All of the heating and cooling systems updated or replaced, comply, if not exceed, the standard efficiencies and power requirements set forth. The area where the Auditorium lacks compliance is in the performance of the building envelope, which is to be expected. Improving the quality of insulation and air tightness of the building could cause more thermal and moisture problems for the building later on.

# References

ANSI/ASHRAE. (2010). *Standard 62.1-2010, Ventilation for Acceptable Indoor Air Quality*. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

ANSI/ASHRAE. (2010). *Standard 90.1-2010, Energy Standard for Buildings Except Low Rise Residential Buildings*.Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

Note: *At the request of the owner, the identity of the project team is not to be published. For the sources related to the drawings or specifications referenced, please contact Erin Miller at erin.c.miller@psu.edu.*

# Appendix A

**The Auditorium**
Francis Michael Performing Arts Academy
Lemma, MN
Revised: 09.17.2013

**Printed 9/17/2013**

| Manual Inputs | | | | | | | | | | Calculations | | | | | | Engineering Checks | | | | Lookups | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room Number and Description | ASHRAE 62 Space Type (Pulldown Menu) | Area $ft^2$ | Height ft | People | Load Calc Peak cfm | People Diversity | ASHRAE 62 Zone Distribution System (Pulldown Menu) | Heating Min cfm | Exhaust cfm | Peak cfm | OA cfm | Z Crit | People # | Heating cfm | Exhaust cfm | Peak AC/HR | Peak CFM/$ft^2$ | OA CFM/$ft^2$ | OA CFM/ft2 Provided | ASHRAE cfm/person | ASHRAE CFM/$ft^2$ | ASHRAE People Density | Zone Dist. Effectiveness | People OA cfm | Area OA cfm |
| **The Auditorium** | **Building Totals** | **130,856** | | **6,327** | | | | | **6,038** | **168,590** | **34,892** | **59** | **6,177** | **50,577** | **6,152** | | **1.29** | | | | | | | **25,994** | **8898** |
| **AHU-1 : Public Spaces** | **System Totals** | **72,530** | | **2,578** | | | | | **3359** | **68,325** | **15,475** | **56** | **2,578** | **20,498** | **3,359** | | **0.94** | | | | | | | **9,905** | **5570** |
| B08 MECH/STOR | Storage rooms | 2,803 | 9 | 5 | 523 | 100% | A-Ceiling supply, cooling | 30% | 0 | **525** | 336 | 0.64 | 5 | 158 | 0 | 1.2 | 0.19 | 0.12 | 0.07 | 0 | 0.12 | 0 | 1.0 | 0 | 336 |
| B08.1 MECH/STOR | Storage rooms | 1,027 | 9 | 12 | 336 | 100% | A-Ceiling supply, cooling | 30% | 0 | **340** | 123 | 0.36 | 12 | 102 | 0 | 2.2 | 0.33 | 0.12 | 0.12 | 0 | 0.12 | 0 | 1.0 | 0 | 123 |
| B09 FIRE STATION | Storage rooms | 172 | 9 | 1 | 21 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 21 | 0.82 | 1 | 8 | 0 | 1.0 | 0.15 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 21 |
| B10 MECH | Storage rooms | 1,748 | 9 | 5 | 250 | 100% | A-Ceiling supply, cooling | 30% | 0 | **250** | 210 | 0.84 | 5 | 75 | 0 | 1.0 | 0.14 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 210 |
| 003 Lobby | Lobbies | 572 | 9 | 50 | 465 | 100% | A-Ceiling supply, cooling | 30% | 0 | **465** | 284 | 0.61 | 50 | 140 | 0 | 5.4 | 0.81 | 0.50 | 0.28 | 5 | 0.06 | 150 | 1.0 | 250 | 34 |
| 003.1 Unisex | Restrooms | 58 | 9 | 1 | 35 | 100% | A-Ceiling supply, cooling | 30% | 29 | **40** | 18 | 0.45 | 1 | 12 | 29 | 4.6 | 0.68 | 0.31 | 0.24 | 7.5 | 0.18 | 70 | 1.0 | 8 | 11 |
| 004 Mens | Restrooms | 298 | 9 | 3 | 249 | 100% | A-Ceiling supply, cooling | 30% | 149 | **250** | 76 | 0.30 | 3 | 75 | 149 | 5.6 | 0.84 | 0.26 | 0.29 | 7.5 | 0.18 | 70 | 1.0 | 23 | 54 |
| 008 First Aid | Office space | 99 | 9 | 1 | 26 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 11 | 0.36 | 1 | 9 | 0 | 2.0 | 0.30 | 0.11 | 0.11 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 009 Fire Command | Storage rooms | 152 | 9 | 1 | 18 | 100% | A-Ceiling supply, cooling | 30% | 0 | **20** | 18 | 0.91 | 1 | 6 | 0 | 0.9 | 0.13 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 18 |
| 010 Womens | Restrooms | 591 | 9 | 5 | 680 | 100% | A-Ceiling supply, cooling | 30% | 296 | **685** | 144 | 0.21 | 5 | 206 | 296 | 7.7 | 1.16 | 0.24 | 0.41 | 7.5 | 0.18 | 70 | 1.0 | 38 | 106 |
| 011 Coat Check | Office space | 169 | 9 | 1 | 45 | 100% | A-Ceiling supply, cooling | 30% | 0 | **45** | 15 | 0.34 | 1 | 14 | 0 | 1.8 | 0.27 | 0.09 | 0.09 | 5 | 0.06 | 5 | 1.0 | 5 | 10 |
| 013 Box office | Office space | 420 | 9 | 4 | 111 | 100% | A-Ceiling supply, cooling | 30% | 0 | **115** | 45 | 0.39 | 4 | 35 | 0 | 1.8 | 0.27 | 0.11 | 0.10 | 5 | 0.06 | 5 | 1.0 | 20 | 25 |
| 017 Call Center | Office space | 219 | 9 | 2 | 58 | 100% | A-Ceiling supply, cooling | 30% | 0 | **60** | 23 | 0.39 | 2 | 18 | 0 | 1.8 | 0.27 | 0.11 | 0.10 | 5 | 0.06 | 5 | 1.0 | 10 | 13 |
| 074 Corridor | Corridors | 294 | 9 | 8 | 28 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 18 | 0.59 | 8 | 9 | 0 | 0.7 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 18 |
| 088 West Entry | Lobbies | 565 | 9 | 36 | 504 | 100% | A-Ceiling supply, cooling | 30% | 0 | **505** | 214 | 0.42 | 36 | 152 | 0 | 6.0 | 0.89 | 0.38 | 0.31 | 5 | 0.06 | 150 | 1.0 | 180 | 34 |
| 089 Will Call | Office space | 288 | 9 | 3 | 76 | 100% | A-Ceiling supply, cooling | 30% | 0 | **80** | 32 | 0.40 | 3 | 24 | 0 | 1.9 | 0.28 | 0.11 | 0.10 | 5 | 0.06 | 5 | 1.0 | 15 | 17 |
| 090 Open Office | Office space | 439 | 9 | 4 | 116 | 100% | A-Ceiling supply, cooling | 30% | 0 | **120** | 46 | 0.39 | 4 | 36 | 0 | 1.8 | 0.27 | 0.11 | 0.10 | 5 | 0.06 | 5 | 1.0 | 20 | 26 |
| 090.2 Admin Office | Office space | 112 | 9 | 1 | 221 | 100% | A-Ceiling supply, cooling | 30% | 0 | **225** | 12 | 0.05 | 1 | 68 | 0 | 13.4 | 2.01 | 0.10 | 0.70 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| 090.4 IT Support | Office space | 112 | 9 | 1 | 232 | 100% | A-Ceiling supply, cooling | 30% | 0 | **235** | 12 | 0.05 | 1 | 71 | 0 | 14.0 | 2.11 | 0.10 | 0.74 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| 090.6 Bldg Mngr | Office space | 146 | 9 | 2 | 255 | 100% | A-Ceiling supply, cooling | 30% | 0 | **260** | 19 | 0.07 | 2 | 78 | 0 | 11.8 | 1.78 | 0.13 | 0.62 | 5 | 0.06 | 5 | 1.0 | 10 | 9 |
| 091 Coat Check | Office space | 448 | 9 | 2 | 118 | 100% | A-Ceiling supply, cooling | 30% | 0 | **120** | 37 | 0.31 | 2 | 36 | 0 | 1.8 | 0.27 | 0.08 | 0.09 | 5 | 0.06 | 5 | 1.0 | 10 | 27 |
| 093 Womens | Restrooms | 473 | 9 | 4 | 284 | 100% | A-Ceiling supply, cooling | 30% | 236 | **285** | 115 | 0.40 | 4 | 86 | 236 | 4.0 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 30 | 85 |
| 097 Lobby | Lobbies | 706 | 9 | 35 | 595 | 100% | A-Ceiling supply, cooling | 30% | 0 | **600** | 217 | 0.36 | 35 | 180 | 0 | 5.7 | 0.85 | 0.31 | 0.30 | 5 | 0.06 | 150 | 1.0 | 175 | 42 |
| 097 Unisex | Restrooms | 61 | 8 | 1 | 37 | 100% | A-Ceiling supply, cooling | 30% | 31 | **40** | 19 | 0.46 | 1 | 12 | 31 | 4.9 | 0.65 | 0.30 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 11 |
| 097.2 Vending | Breakrooms | 69 | 9 | 4 | 22 | 100% | A-Ceiling supply, cooling | 30% | 21 | **25** | 24 | 0.97 | 4 | 8 | 21 | 2.4 | 0.36 | 0.35 | 0.13 | 5 | 0.06 | 25 | 1.0 | 20 | 4 |
| 098 Mens | Restrooms | 330 | 9 | 3 | 270 | 100% | A-Ceiling supply, cooling | 30% | 165 | **275** | 82 | 0.30 | 3 | 83 | 165 | 5.6 | 0.83 | 0.25 | 0.29 | 7.5 | 0.18 | 70 | 1.0 | 23 | 59 |
| 100 MEM HALL | Corridors | 2,878 | 10 | 190 | 3,163 | 100% | A-Ceiling supply, cooling | 30% | 0 | **3,165** | 173 | 0.05 | 190 | 950 | 0 | 6.6 | 1.10 | 0.06 | 0.38 | 0 | 0.06 | 0 | 1.0 | 0 | 173 |
| 101 LOBBY | Lobbies | 616 | 10 | 50 | 730 | 100% | A-Ceiling supply, cooling | 30% | 0 | **735** | 287 | 0.39 | 50 | 221 | 0 | 7.2 | 1.19 | 0.47 | 0.42 | 5 | 0.06 | 150 | 1.0 | 250 | 37 |
| 104 LOUNGE | Lobbies | 298 | 10 | 10 | 1,043 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,045** | 68 | 0.06 | 10 | 314 | 0 | 21.1 | 3.51 | 0.23 | 1.23 | 5 | 0.06 | 150 | 1.0 | 50 | 18 |
| 105 CORRIDOR | Corridors | 491 | 10 | 25 | 46 | 100% | A-Ceiling supply, cooling | 30% | 0 | **50** | 29 | 0.59 | 25 | 15 | 0 | 0.6 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 29 |
| 106 CONF | Conference / meeting | 388 | 10 | 15 | 1,076 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,080** | 98 | 0.09 | 15 | 324 | 0 | 16.7 | 2.78 | 0.25 | 0.97 | 5 | 0.06 | 50 | 1.0 | 75 | 23 |
| 107 CONCESSION | Breakrooms | 255 | 10 | 4 | 82 | 100% | A-Ceiling supply, cooling | 30% | 77 | **85** | 35 | 0.42 | 4 | 26 | 77 | 2.0 | 0.33 | 0.14 | 0.12 | 5 | 0.06 | 25 | 1.0 | 20 | 15 |
| 109 STOR | Storage rooms | 156 | 10 | 1 | 19 | 100% | A-Ceiling supply, cooling | 30% | 0 | **20** | 19 | 0.94 | 1 | 6 | 0 | 0.8 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 19 |
| 110 INNO LAB | Conference / meeting | 591 | 10 | 5 | 1,622 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,625** | 60 | 0.04 | 5 | 488 | 0 | 16.5 | 2.75 | 0.10 | 0.96 | 5 | 0.06 | 50 | 1.0 | 25 | 35 |
| 110.1 CONF | Conference / meeting | 201 | 10 | 2 | 912 | 100% | A-Ceiling supply, cooling | 30% | 0 | **915** | 22 | 0.02 | 2 | 275 | 0 | 27.3 | 4.54 | 0.11 | 1.59 | 5 | 0.06 | 50 | 1.0 | 10 | 12 |
| 125 CORRIDOR | Corridors | 2,032 | 10 | 101 | 244 | 100% | A-Ceiling supply, cooling | 30% | 0 | **245** | 122 | 0.50 | 101 | 74 | 0 | 0.7 | 0.12 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 122 |
| 128 MENS | Restrooms | 220 | 10 | 3 | 433 | 100% | A-Ceiling supply, cooling | 30% | 110 | **435** | 62 | 0.14 | 3 | 131 | 110 | 11.9 | 1.98 | 0.28 | 0.69 | 7.5 | 0.18 | 70 | 1.0 | 23 | 40 |
| 131 ELEC | Storage rooms | 74 | 10 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.89 | 1 | 3 | 0 | 0.8 | 0.14 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 134 WOMENS | Restrooms | 266 | 10 | 2 | 160 | 100% | A-Ceiling supply, cooling | 30% | 133 | **160** | 63 | 0.39 | 2 | 48 | 133 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 48 |
| 137 CORRIDOR | Corridors | 398 | 10 | 19 | 38 | 100% | A-Ceiling supply, cooling | 30% | 0 | **40** | 24 | 0.60 | 19 | 12 | 0 | 0.6 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 24 |
| 155 HALL ENTRY | Lobbies | 761 | 10 | 38 | 619 | 100% | A-Ceiling supply, cooling | 30% | 0 | **620** | 236 | 0.38 | 38 | 186 | 0 | 4.9 | 0.81 | 0.31 | 0.28 | 5 | 0.06 | 150 | 1.0 | 190 | 46 |
| 157 LOBBY | Lobbies | 4,190 | 10 | 209 | 3,406 | 100% | A-Ceiling supply, cooling | 30% | 0 | **3,410** | 1,296 | 0.38 | 209 | 1,023 | 0 | 4.9 | 0.81 | 0.31 | 0.28 | 5 | 0.06 | 150 | 1.0 | 1045 | 251 |
| 163 VEST | Lobbies | 162 | 10 | 8 | 131 | 100% | A-Ceiling supply, cooling | 30% | 0 | **135** | 50 | 0.37 | 8 | 41 | 0 | 5.0 | 0.84 | 0.31 | 0.29 | 5 | 0.06 | 150 | 1.0 | 40 | 10 |
| 168 MENS | Restrooms | 233 | 10 | 2 | 140 | 100% | A-Ceiling supply, cooling | 30% | 116 | **140** | 57 | 0.41 | 2 | 42 | 116 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 42 |
| 175 CORRIDOR | Corridors | 2,316 | 10 | 115 | 219 | 100% | A-Ceiling supply, cooling | 30% | 0 | **220** | 139 | 0.63 | 115 | 66 | 0 | 0.6 | 0.09 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 139 |
| 178 WOMENS | Restrooms | 265 | 10 | 2 | 159 | 100% | A-Ceiling supply, cooling | 30% | 133 | **160** | 63 | 0.39 | 2 | 48 | 133 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 48 |
| 182 PREP | Breakrooms | 250 | 10 | 14 | 483 | 100% | A-Ceiling supply, cooling | 30% | 75 | **485** | 85 | 0.18 | 14 | 146 | 75 | 11.6 | 1.94 | 0.34 | 0.68 | 5 | 0.06 | 25 | 1.0 | 70 | 15 |
| 184 SERVING | Coffee Stations | 185 | 10 | 10 | 488 | 100% | A-Ceiling supply, cooling | 30% | 55 | **490** | 122 | 0.25 | 10 | 147 | 55 | 15.9 | 2.65 | 0.66 | 0.93 | 10 | 0.12 | 25 | 1.0 | 100 | 22 |
| 190 COFFEE SHOP | Coffee Stations | 1,067 | 10 | 55 | 2,918 | 100% | A-Ceiling supply, cooling | 30% | 320 | **2,920** | 678 | 0.23 | 55 | 876 | 320 | 16.4 | 2.74 | 0.64 | 0.96 | 10 | 0.12 | 25 | 1.0 | 550 | 128 |
| 195 CORRIDOR | Corridors | 503 | 10 | 25 | 47 | 100% | A-Ceiling supply, cooling | 30% | 0 | **50** | 30 | 0.60 | 25 | 15 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 30 |
| 196 LOUNGE | Lobbies | 300 | 10 | 12 | 1,098 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,100** | 78 | 0.07 | 12 | 330 | 0 | 22.0 | 3.66 | 0.26 | 1.28 | 5 | 0.06 | 150 | 1.0 | 60 | 18 |
| 198 LOBBY | Lobbies | 614 | 10 | 31 | 729 | 100% | A-Ceiling supply, cooling | 30% | 0 | **730** | 192 | 0.26 | 31 | 219 | 0 | 7.1 | 1.19 | 0.31 | 0.42 | 5 | 0.06 | 150 | 1.0 | 155 | 37 |
| 201 LOBBY | Lobbies | 556 | 10 | 18 | 682 | 100% | A-Ceiling supply, cooling | 30% | 0 | **685** | 123 | 0.18 | 18 | 206 | 0 | 7.4 | 1.23 | 0.22 | 0.43 | 5 | 0.06 | 150 | 1.0 | 90 | 33 |
| 203 LOBBY | Lobbies | 1,320 | 10 | 44 | 1,073 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,075** | 299 | 0.28 | 44 | 323 | 0 | 4.9 | 0.81 | 0.23 | 0.29 | 5 | 0.06 | 150 | 1.0 | 220 | 79 |
| 204 LOUNGE | Lobbies | 338 | 10 | 3 | 1,075 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,080** | 35 | 0.03 | 3 | 324 | 0 | 19.2 | 3.19 | 0.10 | 1.12 | 5 | 0.06 | 150 | 1.0 | 15 | 20 |
| 205 CORRIDOR | Corridors | 258 | 10 | 9 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 15 | 0.62 | 9 | 8 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 15 |
| 210 INST ADV STD | Conference / meeting | 597 | 10 | 5 | 420 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 61 | 0.14 | 5 | 126 | 0 | 4.2 | 0.70 | 0.10 | 0.25 | 5 | 0.06 | 50 | 1.0 | 25 | 36 |
| 210.02 VST FELLOW | Office space | 85 | 10 | 1 | 381 | 100% | A-Ceiling supply, cooling | 30% | 0 | **385** | 10 | 0.03 | 1 | 116 | 0 | 27.0 | 4.51 | 0.12 | 1.58 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 210.04 VST FELLOW | Office space | 109 | 10 | 1 | 416 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 12 | 0.03 | 1 | 126 | 0 | 23.2 | 3.86 | 0.11 | 1.35 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| 210.06 VST FELLOW | Office space | 106 | 10 | 1 | 415 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 11 | 0.03 | 1 | 126 | 0 | 23.7 | 3.96 | 0.11 | 1.38 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 210.08 VST FELLOW | Office space | 106 | 10 | 1 | 415 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 11 | 0.03 | 1 | 126 | 0 | 23.7 | 3.95 | 0.11 | 1.38 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 210.10 VST FELLOW | Office space | 106 | 10 | 1 | 415 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 11 | 0.03 | 1 | 126 | 0 | 23.7 | 3.95 | 0.11 | 1.38 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 210.11 VST FELLOW | Office space | 90 | 10 | 1 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 10 | 0.42 | 1 | 8 | 0 | 1.7 | 0.28 | 0.12 | 0.10 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 210.12 VST FELLOW | Office space | 106 | 10 | 1 | 415 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 11 | 0.03 | 1 | 126 | 0 | 23.7 | 3.95 | 0.11 | 1.38 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 210.13 VST FELLOW | Office space | 86 | 10 | 1 | 23 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 10 | 0.41 | 1 | 8 | 0 | 1.7 | 0.29 | 0.12 | 0.10 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 210.14 VST FELLOW | Office space | 97 | 10 | 1 | 384 | 100% | A-Ceiling supply, cooling | 30% | 0 | **385** | 11 | 0.03 | 1 | 116 | 0 | 23.7 | 3.95 | 0.11 | 1.38 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 215 CORRIDOR | Corridors | 105 | 10 | 5 | 10 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 6 | 0.63 | 5 | 3 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 6 |
| 217 WKRM | Conference / meeting | 125 | 10 | 2 | 88 | 100% | A-Ceiling supply, cooling | 30% | 0 | **90** | 17 | 0.19 | 2 | 27 | 0 | 4.3 | 0.72 | 0.14 | 0.25 | 5 | 0.06 | 50 | 1.0 | 10 | 7 |
| 225 CORRIDOR | Corridors | 1,303 | 10 | 44 | 123 | 100% | A-Ceiling supply, cooling | 30% | 0 | **125** | 78 | 0.63 | 44 | 38 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 78 |
| 228 MENS | Restrooms | 274 | 10 | 2 | 439 | 100% | A-Ceiling supply, cooling | 30% | 137 | **440** | 64 | 0.15 | 2 | 132 | 137 | 9.6 | 1.61 | 0.23 | 0.56 | 7.5 | 0.18 | 70 | 1.0 | 15 | 49 |
| 231 ELEC | Storage rooms | 74 | 10 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.88 | 1 | 3 | 0 | 0.8 | 0.14 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |

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Francis Michael Performing Arts Academy
Lemma, MN
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**Printed 9/17/2013**

| Manual Inputs | | | | | | | | | | Calculations | | | | | | Engineering Checks | | | | Lookups | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room Number and Description | ASHRAE 62 Space Type (Pulldown Menu) | Area $ft^2$ | Height ft | People | Load Calc Peak cfm | People Diversity | ASHRAE 62 Zone Distribution System (Pulldown Menu) | Heating Min cfm | Exhaust cfm | Peak cfm | OA cfm | Z Crit | People # | Heating cfm | Exhaust cfm | Peak AC/HR | Peak CFM/$ft^2$ | OA CFM/$ft^2$ | OA CFM/ft2 Provided | ASHRAE cfm/person | ASHRAE CFM/$ft^2$ | ASHRAE People Density | Zone Dist. Effectiveness | People OA cfm | Area OA cfm |
| 234 WOMENS | Restrooms | 266 | 10 | 2 | 159 | 100% | A-Ceiling supply, cooling | 30% | 133 | **160** | 63 | 0.39 | 2 | 48 | 133 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 48 |
| 241 UNISEX | Restrooms | 49 | 10 | 1 | 29 | 100% | A-Ceiling supply, cooling | 30% | 24 | **30** | 16 | 0.54 | 1 | 9 | 24 | 3.7 | 0.61 | 0.33 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 8 | 9 |
| 242 CUST | Storage rooms | 186 | 10 | 1 | 23 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 22 | 0.89 | 1 | 8 | 0 | 0.8 | 0.13 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 22 |
| 244 STOR | Storage rooms | 61 | 10 | 1 | 7 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 7 | 0.73 | 1 | 3 | 0 | 1.0 | 0.17 | 0.12 | 0.06 | 0 | 0.12 | 0 | 1.0 | 0 | 7 |
| 255 CORRIDOR | Corridors | 962 | 10 | 32 | 91 | 100% | A-Ceiling supply, cooling | 30% | 0 | **95** | 58 | 0.61 | 32 | 29 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 58 |
| 268 CATERING | Breakrooms | 145 | 10 | 2 | 46 | 100% | A-Ceiling supply, cooling | 30% | 43 | **50** | 19 | 0.37 | 2 | 15 | 43 | 2.1 | 0.35 | 0.13 | 0.12 | 5 | 0.06 | 25 | 1.0 | 10 | 9 |
| 275 CORRIDOR | Corridors | 1,562 | 10 | 52 | 147 | 100% | A-Ceiling supply, cooling | 30% | 0 | **150** | 94 | 0.62 | 52 | 45 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 94 |
| 277 ELEC | Storage rooms | 79 | 10 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.94 | 1 | 3 | 0 | 0.8 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 278 WOMENS | Restrooms | 266 | 10 | 2 | 160 | 100% | A-Ceiling supply, cooling | 30% | 133 | **160** | 63 | 0.39 | 2 | 48 | 133 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 48 |
| 282 MENS | Restrooms | 266 | 10 | 2 | 470 | 100% | A-Ceiling supply, cooling | 30% | 133 | **470** | 63 | 0.13 | 2 | 141 | 133 | 10.6 | 1.77 | 0.24 | 0.62 | 7.5 | 0.18 | 70 | 1.0 | 15 | 48 |
| 283 WKRM | Conference / meeting | 106 | 10 | 1 | 74 | 100% | A-Ceiling supply, cooling | 30% | 0 | **75** | 11 | 0.15 | 1 | 23 | 0 | 4.2 | 0.71 | 0.11 | 0.25 | 5 | 0.06 | 50 | 1.0 | 5 | 6 |
| 285 CORRIDOR | Corridors | 114 | 10 | 3 | 11 | 100% | A-Ceiling supply, cooling | 30% | 0 | **15** | 7 | 0.45 | 3 | 5 | 0 | 0.8 | 0.13 | 0.06 | 0.05 | 0 | 0.06 | 0 | 1.0 | 0 | 7 |
| 290 INST ADV STD | Conference / meeting | 957 | 10 | 11 | 2,384 | 100% | A-Ceiling supply, cooling | 30% | 0 | **2,385** | 112 | 0.05 | 11 | 716 | 0 | 15.0 | 2.49 | 0.12 | 0.87 | 5 | 0.06 | 50 | 1.0 | 55 | 57 |
| 290.10 DIR | Office space | 128 | 10 | 1 | 432 | 100% | A-Ceiling supply, cooling | 30% | 0 | **435** | 13 | 0.03 | 1 | 131 | 0 | 20.3 | 3.39 | 0.10 | 1.19 | 5 | 0.06 | 5 | 1.0 | 5 | 8 |
| 290.11 VST FELLOW | Office space | 90 | 10 | 1 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 10 | 0.42 | 1 | 8 | 0 | 1.7 | 0.28 | 0.12 | 0.10 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 290.12 MNG DIR | Office space | 105 | 10 | 1 | 396 | 100% | A-Ceiling supply, cooling | 30% | 0 | **400** | 11 | 0.03 | 1 | 120 | 0 | 23.0 | 3.83 | 0.11 | 1.34 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 290.13 VST FELLOW | Office space | 95 | 10 | 1 | 25 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 11 | 0.36 | 1 | 9 | 0 | 1.9 | 0.31 | 0.11 | 0.11 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 290.14 GRANTS CNSLT | Office space | 88 | 10 | 1 | 417 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 10 | 0.02 | 1 | 126 | 0 | 28.6 | 4.77 | 0.12 | 1.67 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 295 CORRIDOR | Corridors | 304 | 10 | 10 | 29 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 18 | 0.61 | 10 | 9 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 18 |
| 296 LOUNGE | Lobbies | 300 | 10 | 10 | 1,097 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,100** | 68 | 0.06 | 10 | 330 | 0 | 22.0 | 3.66 | 0.23 | 1.28 | 5 | 0.06 | 150 | 1.0 | 50 | 18 |
| 297 LOBBY | Lobbies | 1,296 | 10 | 44 | 1,054 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,055** | 298 | 0.28 | 44 | 317 | 0 | 4.9 | 0.81 | 0.23 | 0.28 | 5 | 0.06 | 150 | 1.0 | 220 | 78 |
| 298 LOBBY | Lobbies | 574 | 10 | 20 | 697 | 100% | A-Ceiling supply, cooling | 30% | 0 | **700** | 134 | 0.19 | 20 | 210 | 0 | 7.3 | 1.22 | 0.23 | 0.43 | 5 | 0.06 | 150 | 1.0 | 100 | 34 |
| 301 LOBBY | Lobbies | 652 | 10 | 32 | 759 | 100% | A-Ceiling supply, cooling | 30% | 0 | **760** | 199 | 0.26 | 32 | 228 | 0 | 7.0 | 1.17 | 0.31 | 0.41 | 5 | 0.06 | 150 | 1.0 | 160 | 39 |
| 303 LOBBY | Lobbies | 1,211 | 10 | 60 | 984 | 100% | A-Ceiling supply, cooling | 30% | 0 | **985** | 373 | 0.38 | 60 | 296 | 0 | 4.9 | 0.81 | 0.31 | 0.28 | 5 | 0.06 | 150 | 1.0 | 300 | 73 |
| 304 LOUNGE | Lobbies | 342 | 10 | 17 | 1,078 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,080** | 106 | 0.10 | 17 | 324 | 0 | 19.0 | 3.16 | 0.31 | 1.11 | 5 | 0.06 | 150 | 1.0 | 85 | 21 |
| 305 CORRIDOR | Corridors | 233 | 10 | 11 | 22 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 14 | 0.56 | 11 | 8 | 0 | 0.6 | 0.11 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 14 |
| 307 CORRIDOR | Corridors | 127 | 10 | 6 | 12 | 100% | A-Ceiling supply, cooling | 30% | 0 | **15** | 8 | 0.51 | 6 | 5 | 0 | 0.7 | 0.12 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 8 |
| 310 HONORS | Office space | 904 | 10 | 8 | 635 | 100% | A-Ceiling supply, cooling | 30% | 0 | **635** | 94 | 0.15 | 8 | 191 | 0 | 4.2 | 0.70 | 0.10 | 0.25 | 5 | 0.06 | 5 | 1.0 | 40 | 54 |
| 310.02 PRO ADVR | Office space | 85 | 10 | 1 | 408 | 100% | A-Ceiling supply, cooling | 30% | 0 | **410** | 10 | 0.02 | 1 | 123 | 0 | 28.8 | 4.80 | 0.12 | 1.68 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 310.04 PRO ADVR | Office space | 106 | 10 | 1 | 387 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 11 | 0.03 | 1 | 117 | 0 | 22.1 | 3.69 | 0.11 | 1.29 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.06 PRO ADVR | Office space | 105 | 10 | 1 | 387 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 11 | 0.03 | 1 | 117 | 0 | 22.2 | 3.71 | 0.11 | 1.30 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.08 PRO ADVR | Office space | 106 | 10 | 1 | 387 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 11 | 0.03 | 1 | 117 | 0 | 22.1 | 3.69 | 0.11 | 1.29 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.10 PRO ADVR | Office space | 106 | 10 | 1 | 25 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 11 | 0.38 | 1 | 9 | 0 | 1.7 | 0.28 | 0.11 | 0.10 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.11 PRO ADVR | Office space | 95 | 10 | 1 | 387 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 11 | 0.03 | 1 | 117 | 0 | 24.6 | 4.10 | 0.11 | 1.43 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.12 PRO ADVR | Office space | 106 | 10 | 1 | 22 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 11 | 0.45 | 1 | 8 | 0 | 1.4 | 0.24 | 0.11 | 0.08 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 310.13 PRO ADVR | Office space | 86 | 10 | 1 | 389 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 10 | 0.03 | 1 | 117 | 0 | 27.3 | 4.55 | 0.12 | 1.59 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 310.14 PRO ADVR | Office space | 114 | 10 | 1 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 12 | 0.47 | 1 | 8 | 0 | 1.3 | 0.22 | 0.10 | 0.08 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| 310.15 PRO ADVR | Office space | 90 | 10 | 1 | 393 | 100% | A-Ceiling supply, cooling | 30% | 0 | **395** | 10 | 0.03 | 1 | 119 | 0 | 26.2 | 4.37 | 0.12 | 1.53 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 310.16 PRO ADVR | Office space | 124 | 10 | 1 | 387 | 100% | A-Ceiling supply, cooling | 30% | 0 | **390** | 12 | 0.03 | 1 | 117 | 0 | 18.8 | 3.13 | 0.10 | 1.10 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| 310.17 CORRIDOR | Corridors | 158 | 10 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.95 | 1 | 3 | 0 | 0.4 | 0.06 | 0.06 | 0.02 | 0 | 0.06 | 0 | 1.0 | 0 | 9 |
| 318 WKRM | Conference / meeting | 134 | 10 | 2 | 94 | 100% | A-Ceiling supply, cooling | 30% | 0 | **95** | 18 | 0.19 | 2 | 29 | 0 | 4.3 | 0.71 | 0.13 | 0.25 | 5 | 0.06 | 50 | 1.0 | 10 | 8 |
| 327 CORRIDOR | Corridors | 1,226 | 10 | 61 | 116 | 100% | A-Ceiling supply, cooling | 30% | 0 | **120** | 74 | 0.61 | 61 | 36 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 74 |
| 334 WOMENS | Restrooms | 233 | 10 | 2 | 140 | 100% | A-Ceiling supply, cooling | 30% | 116 | **140** | 57 | 0.41 | 2 | 42 | 116 | 3.6 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 42 |
| 335 CUST | Storage rooms | 32 | 10 | 1 | 4 | 100% | A-Ceiling supply, cooling | 30% | 0 | **5** | 4 | 0.76 | 1 | 2 | 0 | 1.0 | 0.16 | 0.12 | 0.06 | 0 | 0.12 | 0 | 1.0 | 0 | 4 |
| 341 MENS | Restrooms | 162 | 10 | 2 | 97 | 100% | A-Ceiling supply, cooling | 30% | 81 | **100** | 44 | 0.44 | 2 | 30 | 81 | 3.7 | 0.62 | 0.27 | 0.22 | 7.5 | 0.18 | 70 | 1.0 | 15 | 29 |
| 356 CORRIDOR | Corridors | 278 | 10 | 14 | 26 | 100% | A-Ceiling supply, cooling | 30% | 0 | **30** | 17 | 0.56 | 14 | 9 | 0 | 0.6 | 0.11 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 17 |
| 368 MENS | Restrooms | 166 | 10 | 2 | 100 | 100% | A-Ceiling supply, cooling | 30% | 83 | **100** | 45 | 0.45 | 2 | 30 | 83 | 3.6 | 0.60 | 0.27 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 30 |
| 375 CORRIDOR | Corridors | 1,284 | 10 | 64 | 121 | 100% | A-Ceiling supply, cooling | 30% | 0 | **125** | 77 | 0.62 | 64 | 38 | 0 | 0.6 | 0.10 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 77 |
| 377 ELEC | Storage rooms | 78 | 10 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.94 | 1 | 3 | 0 | 0.8 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 378 WOMENS | Restrooms | 230 | 10 | 2 | 138 | 100% | A-Ceiling supply, cooling | 30% | 115 | **140** | 56 | 0.40 | 2 | 42 | 115 | 3.7 | 0.61 | 0.25 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 41 |
| 382 CONFERENCE | Conference / meeting | 297 | 10 | 13 | 646 | 100% | A-Ceiling supply, cooling | 30% | 0 | **650** | 83 | 0.13 | 13 | 195 | 0 | 13.1 | 2.19 | 0.28 | 0.77 | 5 | 0.06 | 50 | 1.0 | 65 | 18 |
| 385 CORRIDOR | Corridors | 1,527 | 10 | 76 | 144 | 100% | A-Ceiling supply, cooling | 30% | 0 | **145** | 92 | 0.63 | 76 | 44 | 0 | 0.6 | 0.09 | 0.06 | 0.03 | 0 | 0.06 | 0 | 1.0 | 0 | 92 |
| 390 HONORS | Office space | 1,301 | 10 | 11 | 2,630 | 100% | A-Ceiling supply, cooling | 30% | 0 | **2,635** | 133 | 0.05 | 11 | 791 | 0 | 12.2 | 2.03 | 0.10 | 0.71 | 5 | 0.06 | 5 | 1.0 | 55 | 78 |
| 390.1 ASC DIR | Office space | 93 | 10 | 1 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 11 | 0.42 | 1 | 8 | 0 | 1.6 | 0.27 | 0.11 | 0.09 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 390.2 ASC DIR | Office space | 130 | 10 | 1 | 406 | 100% | A-Ceiling supply, cooling | 30% | 0 | **410** | 13 | 0.03 | 1 | 123 | 0 | 18.9 | 3.14 | 0.10 | 1.10 | 5 | 0.06 | 5 | 1.0 | 5 | 8 |
| 390.3 HNR STD ASSC | Office space | 89 | 10 | 1 | 23 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 10 | 0.41 | 1 | 8 | 0 | 1.7 | 0.28 | 0.12 | 0.10 | 5 | 0.06 | 5 | 1.0 | 5 | 5 |
| 390.4 HNR DIR | Office space | 195 | 10 | 1 | 840 | 100% | A-Ceiling supply, cooling | 30% | 0 | **845** | 17 | 0.02 | 1 | 254 | 0 | 26.0 | 4.33 | 0.09 | 1.52 | 5 | 0.06 | 5 | 1.0 | 5 | 12 |
| 390.5 WKRM | Conference / meeting | 121 | 10 | 1 | 85 | 100% | A-Ceiling supply, cooling | 30% | 0 | **85** | 12 | 0.14 | 1 | 26 | 0 | 4.2 | 0.70 | 0.10 | 0.25 | 5 | 0.06 | 50 | 1.0 | 5 | 7 |
| 396 LOUNGE | Lobbies | 337 | 10 | 17 | 1,127 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,130** | 105 | 0.09 | 17 | 339 | 0 | 20.1 | 3.35 | 0.31 | 1.17 | 5 | 0.06 | 150 | 1.0 | 85 | 20 |
| 397 LOBBY | Lobbies | 1,174 | 10 | 58 | 955 | 100% | A-Ceiling supply, cooling | 30% | 0 | **955** | 360 | 0.38 | 58 | 287 | 0 | 4.9 | 0.81 | 0.31 | 0.28 | 5 | 0.06 | 150 | 1.0 | 290 | 70 |
| 398 LOBBY | Lobbies | 619 | 10 | 31 | 733 | 100% | A-Ceiling supply, cooling | 30% | 0 | **735** | 192 | 0.26 | 31 | 221 | 0 | 7.1 | 1.19 | 0.31 | 0.42 | 5 | 0.06 | 150 | 1.0 | 155 | 37 |
| 400 LEC GALLERY | Lecture Classroom | 1,483 | 10 | 90 | 4,232 | 100% | A-Ceiling supply, cooling | 30% | 0 | **4,235** | 764 | 0.18 | 90 | 1,271 | 0 | 17.1 | 2.86 | 0.52 | 1.00 | 7.5 | 0.06 | 65 | 1.0 | 675 | 89 |
| 403 LOBBY | Lobbies | 1,389 | 10 | 100 | 1,390 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,390** | 583 | 0.42 | 100 | 417 | 0 | 6.0 | 1.00 | 0.42 | 0.35 | 5 | 0.06 | 150 | 1.0 | 500 | 83 |
| 404 CORRIDOR | Corridors | 152 | 10 | 5 | 55 | 100% | A-Ceiling supply, cooling | 30% | 0 | **55** | 9 | 0.17 | 5 | 17 | 0 | 2.2 | 0.36 | 0.06 | 0.13 | 0 | 0.06 | 0 | 1.0 | 0 | 9 |
| 416 UNISEX | Restrooms | 54 | 10 | 1 | 33 | 100% | A-Ceiling supply, cooling | 30% | 27 | **35** | 17 | 0.49 | 1 | 11 | 27 | 3.9 | 0.65 | 0.32 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 10 |
| 418 MENS | Restrooms | 281 | 10 | 3 | 169 | 100% | A-Ceiling supply, cooling | 30% | 140 | **170** | 73 | 0.43 | 3 | 51 | 140 | 3.6 | 0.61 | 0.26 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 23 | 51 |
| 420 LOBBY | Lobbies | 1,230 | 10 | 9 | 1,307 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,310** | 119 | 0.09 | 9 | 393 | 0 | 6.4 | 1.06 | 0.10 | 0.37 | 5 | 0.06 | 150 | 1.0 | 45 | 74 |
| 422 CONCESSIONS | Breakrooms | 162 | 9 | 1 | 52 | 100% | A-Ceiling supply, cooling | 30% | 49 | **55** | 15 | 0.27 | 1 | 17 | 49 | 2.3 | 0.34 | 0.09 | 0.12 | 5 | 0.06 | 25 | 1.0 | 5 | 10 |
| 436 PIPE ORGAN LOFT E | Storage rooms | 619 | 10 | 2 | 74 | 100% | A-Ceiling supply, cooling | 30% | 0 | **75** | 74 | 0.99 | 2 | 23 | 0 | 0.7 | 0.12 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 74 |
| 460 RECITAL HALL | Stages, studios | 1,960 | 10 | 250 | 3,000 | 100% | A-Ceiling supply, cooling | 30% | 0 | **3,000** | 2,618 | 0.87 | 250 | 900 | 0 | 9.2 | 1.53 | 1.34 | 0.54 | 10 | 0.06 | 70 | 1.0 | 2500 | 118 |
| 462 STOR | Storage rooms | 417 | 10 | 1 | 50 | 100% | A-Ceiling supply, cooling | 30% | 0 | **55** | 50 | 0.91 | 1 | 17 | 0 | 0.8 | 0.13 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 50 |
| 463 CORRIDOR | Corridors | 145 | 10 | 1 | 14 | 100% | A-Ceiling supply, cooling | 30% | 0 | **15** | 9 | 0.58 | 1 | 5 | 0 | 0.6 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 9 |
| 467 CORRIDOR | Corridors | 230 | 10 | 1 | 22 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 14 | 0.55 | 1 | 8 | 0 | 0.7 | 0.11 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 14 |
| 470 ELEC | Storage rooms | 287 | 10 | 1 | 34 | 100% | A-Ceiling supply, cooling | 30% | 0 | **35** | 34 | 0.98 | 1 | 11 | 0 | 0.7 | 0.12 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 34 |
| 478.1 STOR | Storage rooms | 54 | 10 | 1 | 7 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 7 | 0.65 | 1 | 3 | 0 | 1.1 | 0.18 | 0.12 | 0.06 | 0 | 0.12 | 0 | 1.0 | 0 | 7 |
| 478.2 STOR | Storage rooms | 65 | 10 | 1 | 8 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 8 | 0.77 | 1 | 3 | 0 | 0.9 | 0.15 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 8 |

**The Auditorium**
Francis Michael Performing Arts Academy
Lemma, MN
Revised: 09.17.2013

**Printed 9/17/2013**

| Manual Inputs | | | | | | | | | | Calculations | | | | | | Engineering Checks | | | | Lookups | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room Number and Description | ASHRAE 62 Space Type (Pulldown Menu) | Area $ft^2$ | Height ft | People | Load Calc Peak cfm | People Diversity | ASHRAE 62 Zone Distribution System (Pulldown Menu) | Heating Min cfm | Exhaust cfm | Peak cfm | OA cfm | Z Crit | People # | Heating cfm | Exhaust cfm | Peak AC/HR | Peak CFM/$ft^2$ | OA CFM/$ft^2$ | OA CFM/ft2 Provided | ASHRAE cfm/person | ASHRAE CFM/$ft^2$ | ASHRAE People Density | Zone Dist. Effectiveness | People OA cfm | Area OA cfm |
| 482 MISC | Storage rooms | 86 | 10 | 1 | 10 | 100% | A-Ceiling supply, cooling | 30% | 0 | **15** | 10 | 0.68 | 1 | 5 | 0 | 1.1 | 0.18 | 0.12 | 0.06 | 0 | 0.12 | 0 | 1.0 | 0 | 10 |
| 485 CORRIDOR | Corridors | 1,283 | 10 | 46 | 418 | 100% | A-Ceiling supply, cooling | 30% | 0 | **420** | 77 | 0.18 | 46 | 126 | 0 | 2.0 | 0.33 | 0.06 | 0.11 | 0 | 0.06 | 0 | 1.0 | 0 | 77 |
| 485 WOMENS | Restrooms | 397 | 10 | 3 | 280 | 100% | A-Ceiling supply, cooling | 30% | 199 | **285** | 94 | 0.33 | 3 | 86 | 199 | 4.3 | 0.72 | 0.24 | 0.25 | 7.5 | 0.18 | 70 | 1.0 | 23 | 71 |
| 491 VEST | Corridors | 182 | 10 | 7 | 148 | 100% | A-Ceiling supply, cooling | 30% | 0 | **150** | 11 | 0.07 | 7 | 45 | 0 | 4.9 | 0.82 | 0.06 | 0.29 | 0 | 0.06 | 0 | 1.0 | 0 | 11 |
| 493 VEST | Corridors | 249 | 10 | 9 | 203 | 100% | A-Ceiling supply, cooling | 30% | 0 | **205** | 15 | 0.07 | 9 | 62 | 0 | 4.9 | 0.82 | 0.06 | 0.29 | 0 | 0.06 | 0 | 1.0 | 0 | 15 |
| 496 CORRIDOR | Corridors | 93 | 10 | 3 | 11 | 100% | A-Ceiling supply, cooling | 30% | 0 | **15** | 6 | 0.37 | 3 | 5 | 0 | 1.0 | 0.16 | 0.06 | 0.06 | 0 | 0.06 | 0 | 1.0 | 0 | 6 |
| 497 LOBBY | Lobbies | 1,340 | 10 | 48 | 1,089 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,090** | 320 | 0.29 | 48 | 327 | 0 | 4.9 | 0.81 | 0.24 | 0.28 | 5 | 0.06 | 150 | 1.0 | 240 | 80 |
| **AHU-2 : Audience Chamber** | **System Totals** | **20,472** | | **2,700** | | | | | **0** | **58,325** | **11,137** | **0.23** | **2,550** | **17,498** | **0** | | **2.85** | | | | | | | **10,114** | **1024** |
| B22 CHAIR WAGON SEATING/ORCH PIT | Auditorium seating area | 2,944 | 56 | 150 | 3,840 | 100% | F-Displacement ventilation, cooling | 30% | 0 | **3,840** | 772 | 0.20 | 150 | 1,152 | 0 | 1.4 | 1.30 | 0.26 | 0.46 | 5 | 0.06 | 150 | 1.2 | 625 | 147 |
| 150 GROUND LEVEL SEATING | Auditorium seating area | 9,311 | 76 | 1,009 | 19,990 | 100% | F-Displacement ventilation, cooling | 30% | 0 | **19,990** | 4,670 | 0.23 | 1,009 | 5,997 | 0 | 1.7 | 2.15 | 0.50 | 0.75 | 5 | 0.06 | 150 | 1.2 | 4204 | 466 |
| 250 1ST BALCONY | Auditorium seating area | 3,909 | 10 | 409 | 12,624 | 70% | F-Displacement ventilation, cooling | 30% | 0 | **12,625** | 1,388 | 0.11 | 409 | 3,788 | 0 | 19.4 | 3.23 | 0.36 | 1.13 | 5 | 0.06 | 150 | 1.2 | 1193 | 195 |
| 350 2ND BALCONY | Auditorium seating area | 3,909 | 8 | 492 | 12,569 | 100% | F-Displacement ventilation, cooling | 30% | 0 | **12,570** | 2,245 | 0.18 | 492 | 3,771 | 0 | 24.1 | 3.22 | 0.57 | 1.13 | 5 | 0.06 | 150 | 1.2 | 2050 | 195 |
| 450 3RD BALCONY | Auditorium seating area | 3,342 | 16 | 640 | 13,140 | 100% | F-Displacement ventilation, cooling | 30% | 0 | **13,140** | 2,834 | 0.22 | 640 | 3,942 | 0 | 14.7 | 3.93 | 0.85 | 1.38 | 5 | 0.06 | 150 | 1.2 | 2667 | 167 |
| **AHU-3 : Performance Spaces** | **System Totals** | **10,388** | | **770** | | | | | **0** | **32,260** | **5,973** | **0.99** | **770** | **9,678** | **0** | | **3.11** | | | | | | | **5,340** | **633** |
| 040 REHERSAL | Music/theater/dance | 1,707 | 25 | 150 | 2,751 | 100% | A-Ceiling supply, cooling | 30% | 0 | **2,755** | 1,602 | 0.58 | 150 | 827 | 0 | 3.9 | 1.61 | 0.94 | 0.56 | 10 | 0.06 | 35 | 1.0 | 1500 | 102 |
| 051 STAGE | Stages, studios | 5,655 | 50 | 370 | 24,724 | 70% | A-Ceiling supply, cooling | 30% | 0 | **24,725** | 2,929 | 0.12 | 370 | 7,418 | 0 | 5.2 | 4.37 | 0.52 | 1.53 | 10 | 0.06 | 70 | 1.0 | 2590 | 339 |
| 059 STAGE STORAGE | Storage rooms | 165 | 35 | 0 | 20 | 100% | A-Ceiling supply, cooling | 30% | 0 | **20** | 20 | 0.99 | 0 | 6 | 0 | 0.2 | 0.12 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 20 |
| 240 LG CONFERENCE | Conference / meeting | 1,528 | 14 | 120 | 2,213 | 100% | A-Ceiling supply, cooling | 30% | 0 | **2,215** | 692 | 0.31 | 120 | 665 | 0 | 6.2 | 1.45 | 0.45 | 0.51 | 5 | 0.06 | 50 | 1.0 | 600 | 92 |
| 260 FOUNDERS ROOM | Conference / meeting | 1,332 | 14 | 130 | 2,543 | 100% | A-Ceiling supply, cooling | 30% | 0 | **2,545** | 730 | 0.29 | 130 | 764 | 0 | 8.2 | 1.91 | 0.55 | 0.67 | 5 | 0.06 | 50 | 1.0 | 650 | 80 |
| **AHU-5: Performance Support Spaces** | **System Totals** | **23,355** | | **279** | | | | | **2624** | **9,680** | **2,307** | **0.95** | **279** | **2,904** | **2,738** | | **0.41** | | | | | | | **635** | **1672** |
| B23 TLT | Restrooms | 228 | 8 | 1 | 137 | 100% | A-Ceiling supply, cooling | 30% | 114 | **140** | 49 | 0.35 | 1 | 42 | 114 | 4.6 | 0.61 | 0.21 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 8 | 41 |
| B27 DRESSING | Dressing Room/Locker Room | 439 | 8 | 19 | 299 | 100% | A-Ceiling supply, cooling | 30% | 219 | **300** | 0 | 0.00 | 19 | 90 | 219 | 5.1 | 0.68 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B34 DRESSING | Dressing Room/Locker Room | 174 | 8 | 8 | 118 | 100% | A-Ceiling supply, cooling | 30% | 87 | **120** | 0 | 0.00 | 8 | 36 | 87 | 5.2 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B36 TLT | Restrooms | 75 | 8 | 1 | 45 | 100% | A-Ceiling supply, cooling | 30% | 38 | **50** | 21 | 0.42 | 1 | 15 | 38 | 5.0 | 0.66 | 0.28 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 14 |
| B40 DRESSING | Dressing Room/Locker Room | 175 | 8 | 9 | 119 | 100% | A-Ceiling supply, cooling | 30% | 88 | **120** | 0 | 0.00 | 9 | 36 | 88 | 5.1 | 0.68 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B42 TLT | Restrooms | 76 | 8 | 1 | 46 | 100% | A-Ceiling supply, cooling | 30% | 38 | **50** | 21 | 0.42 | 1 | 15 | 38 | 4.9 | 0.66 | 0.28 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 14 |
| B43 LKR RM | Dressing Room/Locker Room | 326 | 8 | 7 | 222 | 100% | A-Ceiling supply, cooling | 30% | 163 | **225** | 0 | 0.00 | 7 | 68 | 163 | 5.2 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B44 DRESSING | Dressing Room/Locker Room | 131 | 8 | 6 | 89 | 100% | A-Ceiling supply, cooling | 30% | 65 | **90** | 0 | 0.00 | 6 | 27 | 65 | 5.2 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B46 TLT | Restrooms | 86 | 8 | 1 | 51 | 100% | A-Ceiling supply, cooling | 30% | 43 | **55** | 23 | 0.42 | 1 | 17 | 43 | 4.8 | 0.64 | 0.27 | 0.22 | 7.5 | 0.18 | 70 | 1.0 | 8 | 15 |
| B47 UNISEX | Restrooms | 44 | 8 | 1 | 27 | 100% | A-Ceiling supply, cooling | 30% | 22 | **30** | 15 | 0.52 | 1 | 9 | 22 | 5.1 | 0.68 | 0.35 | 0.24 | 7.5 | 0.18 | 70 | 1.0 | 8 | 8 |
| B48 DRESSING | Dressing Room/Locker Room | 139 | 8 | 6 | 95 | 100% | A-Ceiling supply, cooling | 30% | 70 | **95** | 0 | 0.00 | 6 | 29 | 70 | 5.1 | 0.68 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B49 BRK RM | Breakrooms | 206 | 8 | 9 | 76 | 100% | A-Ceiling supply, cooling | 30% | 62 | **80** | 57 | 0.72 | 9 | 24 | 62 | 2.9 | 0.39 | 0.28 | 0.14 | 5 | 0.06 | 25 | 1.0 | 45 | 12 |
| B50 TLT | Restrooms | 93 | 8 | 1 | 56 | 100% | A-Ceiling supply, cooling | 30% | 47 | **60** | 24 | 0.40 | 1 | 18 | 47 | 4.8 | 0.64 | 0.26 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 17 |
| B51 TECH DIR | Office space | 118 | 8 | 1 | 36 | 100% | A-Ceiling supply, cooling | 30% | 0 | **40** | 12 | 0.30 | 1 | 12 | 0 | 2.6 | 0.34 | 0.10 | 0.12 | 5 | 0.06 | 5 | 1.0 | 5 | 7 |
| B52 DRESSING | Dressing Room/Locker Room | 131 | 8 | 6 | 89 | 100% | A-Ceiling supply, cooling | 30% | 66 | **90** | 0 | 0.00 | 6 | 27 | 66 | 5.1 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B53 TECH OFFICE/WKRM | Conference / meeting | 148 | 8 | 2 | 45 | 100% | A-Ceiling supply, cooling | 30% | 0 | **45** | 19 | 0.42 | 2 | 14 | 0 | 2.3 | 0.30 | 0.13 | 0.11 | 5 | 0.06 | 50 | 1.0 | 10 | 9 |
| B54 TLT | Restrooms | 90 | 8 | 1 | 54 | 100% | A-Ceiling supply, cooling | 30% | 45 | **55** | 24 | 0.43 | 1 | 17 | 45 | 4.6 | 0.61 | 0.26 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 8 | 16 |
| B56 DRESSING | Dressing Room/Locker Room | 214 | 8 | 9 | 146 | 100% | A-Ceiling supply, cooling | 30% | 107 | **150** | 0 | 0.00 | 9 | 45 | 107 | 5.3 | 0.70 | 0.00 | 0.25 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B57 HOUSE SOUND/ELEC | Office space | 208 | 8 | 3 | 63 | 100% | A-Ceiling supply, cooling | 30% | 0 | **65** | 27 | 0.42 | 3 | 20 | 0 | 2.3 | 0.31 | 0.13 | 0.11 | 5 | 0.06 | 5 | 1.0 | 15 | 12 |
| B58 TLT | Restrooms | 100 | 8 | 1 | 60 | 100% | A-Ceiling supply, cooling | 30% | 50 | **65** | 26 | 0.39 | 1 | 20 | 50 | 4.9 | 0.65 | 0.25 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 18 |
| B59 STG MNGR | Office space | 123 | 8 | 2 | 37 | 100% | A-Ceiling supply, cooling | 30% | 0 | **40** | 17 | 0.43 | 2 | 12 | 0 | 2.4 | 0.33 | 0.14 | 0.11 | 5 | 0.06 | 5 | 1.0 | 10 | 7 |
| B60 DRESSING | Dressing Room/Locker Room | 525 | 8 | 21 | 357 | 100% | A-Ceiling supply, cooling | 30% | 262 | **360** | 0 | 0.00 | 21 | 108 | 262 | 5.1 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B61 WKRM/STOR | Storage rooms | 173 | 8 | 2 | 142 | 100% | A-Ceiling supply, cooling | 30% | 0 | **145** | 21 | 0.14 | 2 | 44 | 0 | 6.3 | 0.84 | 0.12 | 0.29 | 0 | 0.12 | 0 | 1.0 | 0 | 21 |
| B62 TLT | Restrooms | 241 | 8 | 2 | 145 | 100% | A-Ceiling supply, cooling | 30% | 121 | **145** | 58 | 0.40 | 2 | 44 | 121 | 4.5 | 0.60 | 0.24 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 15 | 43 |
| B63 PROP REPAIR | Office space | 154 | 8 | 2 | 47 | 100% | A-Ceiling supply, cooling | 30% | 0 | **50** | 19 | 0.38 | 2 | 15 | 0 | 2.4 | 0.32 | 0.12 | 0.11 | 5 | 0.06 | 5 | 1.0 | 10 | 9 |
| B64 DRESSING | Dressing Room/Locker Room | 519 | 8 | 21 | 353 | 100% | A-Ceiling supply, cooling | 30% | 259 | **355** | 0 | 0.00 | 21 | 107 | 259 | 5.1 | 0.68 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B66 TLT | Restrooms | 233 | 8 | 1 | 140 | 100% | A-Ceiling supply, cooling | 30% | 116 | **140** | 49 | 0.35 | 1 | 42 | 116 | 4.5 | 0.60 | 0.21 | 0.21 | 7.5 | 0.18 | 70 | 1.0 | 8 | 42 |
| B69 MUSICIAN | Office space | 206 | 8 | 3 | 100 | 100% | A-Ceiling supply, cooling | 30% | 0 | **100** | 27 | 0.27 | 3 | 30 | 0 | 3.6 | 0.49 | 0.13 | 0.17 | 5 | 0.06 | 5 | 1.0 | 15 | 12 |
| B80 CUST MAIN | Janitorial | 202 | 8 | 2 | 28 | 100% | A-Ceiling supply, cooling | 30% | 202 | **30** | 0 | 0.00 | 2 | 9 | 202 | 1.1 | 0.15 | 0.00 | 0.05 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B82 SOUND WKRM | Office space | 201 | 8 | 2 | 61 | 100% | A-Ceiling supply, cooling | 30% | 0 | **65** | 22 | 0.34 | 2 | 20 | 0 | 2.4 | 0.32 | 0.11 | 0.11 | 5 | 0.06 | 5 | 1.0 | 10 | 12 |
| B83 PIANO STOR | Storage rooms | 200 | 8 | 2 | 24 | 100% | A-Ceiling supply, cooling | 30% | 0 | **25** | 24 | 0.96 | 2 | 8 | 0 | 0.9 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 24 |
| B84 CORR | Corridors | 3,330 | 8 | 19 | 340 | 100% | A-Ceiling supply, cooling | 30% | 0 | **340** | 200 | 0.59 | 19 | 102 | 0 | 0.8 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 200 |
| B88 UNISEX | Restrooms | 46 | 8 | 1 | 28 | 100% | A-Ceiling supply, cooling | 30% | 23 | **30** | 16 | 0.53 | 1 | 9 | 23 | 4.9 | 0.65 | 0.34 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 8 |
| B90 LAUNDRY | Laundries | 129 | 8 | 1 | 53 | 100% | A-Ceiling supply, cooling | 30% | 0 | **55** | 0 | 0.00 | 1 | 17 | 0 | 3.2 | 0.43 | 0.00 | 0.15 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| B92 BOH STOR | Storage rooms | 1,128 | 8 | 5 | 200 | 100% | A-Ceiling supply, cooling | 30% | 0 | **200** | 135 | 0.68 | 5 | 60 | 0 | 1.3 | 0.18 | 0.12 | 0.06 | 0 | 0.12 | 0 | 1.0 | 0 | 135 |
| 020 Reception | Lobbies | 172 | 9 | 2 | 163 | 100% | A-Ceiling supply, cooling | 30% | 0 | **165** | 20 | 0.12 | 2 | 50 | 0 | 6.4 | 0.96 | 0.12 | 0.34 | 5 | 0.06 | 150 | 1.0 | 10 | 10 |
| 020.1 Ticketing Dir | Office space | 126 | 8 | 2 | 38 | 100% | A-Ceiling supply, cooling | 30% | 0 | **40** | 18 | 0.44 | 2 | 12 | 0 | 2.4 | 0.32 | 0.14 | 0.11 | 5 | 0.06 | 5 | 1.0 | 10 | 8 |
| 020.2 Open Office | Office space | 631 | 9 | 6 | 447 | 100% | A-Ceiling supply, cooling | 30% | 0 | **450** | 68 | 0.15 | 6 | 135 | 114 | 4.8 | 0.71 | 0.11 | 0.25 | 5 | 0.06 | 5 | 1.0 | 30 | 38 |
| 020.4 Ex Relations Dir | Office space | 112 | 8 | 2 | 111 | 100% | A-Ceiling supply, cooling | 30% | 0 | **115** | 17 | 0.15 | 2 | 35 | 0 | 7.7 | 1.03 | 0.15 | 0.36 | 5 | 0.06 | 5 | 1.0 | 10 | 7 |
| 020.6 Exec Art Dir | Office space | 134 | 9 | 2 | 255 | 100% | A-Ceiling supply, cooling | 30% | 0 | **255** | 18 | 0.07 | 2 | 77 | 0 | 12.6 | 1.90 | 0.13 | 0.66 | 5 | 0.06 | 5 | 1.0 | 10 | 8 |
| 029 Unisex | Restrooms | 38 | 9 | 1 | 23 | 100% | A-Ceiling supply, cooling | 30% | 19 | **25** | 14 | 0.57 | 1 | 8 | 19 | 4.4 | 0.66 | 0.38 | 0.23 | 7.5 | 0.18 | 70 | 1.0 | 8 | 7 |
| 030 Green Room | Music/theater/dance | 552 | 8 | 24 | 500 | 100% | A-Ceiling supply, cooling | 30% | 0 | **500** | 273 | 0.55 | 24 | 150 | 0 | 6.8 | 0.91 | 0.49 | 0.32 | 10 | 0.06 | 35 | 1.0 | 240 | 33 |
| 031 Elec | Storage rooms | 79 | 8 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.95 | 1 | 3 | 0 | 0.9 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 036 Corridor | Corridors | 331 | 9 | 1 | 50 | 100% | A-Ceiling supply, cooling | 30% | 0 | **50** | 20 | 0.40 | 1 | 15 | 0 | 1.0 | 0.15 | 0.06 | 0.05 | 0 | 0.06 | 0 | 1.0 | 0 | 20 |
| 041 Quick Change | Dressing Room/Locker Room | 39 | 8 | 1 | 24 | 100% | A-Ceiling supply, cooling | 30% | 20 | **25** | 0 | 0.00 | 1 | 8 | 20 | 4.8 | 0.63 | 0.00 | 0.22 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| 045 Corridor | Corridors | 2,894 | 39.2 | 5 | 522 | 100% | A-Ceiling supply, cooling | 30% | 0 | **525** | 174 | 0.33 | 5 | 158 | 0 | 0.3 | 0.18 | 0.06 | 0.06 | 0 | 0.06 | 0 | 1.0 | 0 | 174 |
| 055 Crossover | Storage rooms | 1,496 | 39.2 | 1 | 1,734 | 100% | A-Ceiling supply, cooling | 30% | 0 | **1,735** | 179 | 0.10 | 1 | 521 | 0 | 1.8 | 1.16 | 0.12 | 0.41 | 0 | 0.12 | 0 | 1.0 | 0 | 179 |
| 060 Loading | Storage rooms | 1,298 | 39.2 | 3 | 372 | 100% | A-Ceiling supply, cooling | 30% | 0 | **375** | 156 | 0.42 | 3 | 113 | 0 | 0.4 | 0.29 | 0.12 | 0.10 | 0 | 0.12 | 0 | 1.0 | 0 | 156 |
| 061 Tool Stor | Storage rooms | 131 | 8 | 7 | 16 | 100% | A-Ceiling supply, cooling | 30% | 0 | **20** | 16 | 0.79 | 7 | 6 | 0 | 1.1 | 0.15 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 16 |

**The Auditorium**
Francis Michael Performing Arts Academy
Lemma, MN
Revised: 09.17.2013

**Printed 9/17/2013**

| Manual Inputs | | | | | | | | | | Calculations | | | | | | Engineering Checks | | | | Lookups | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Room Number and Description | ASHRAE 62 Space Type (Pulldown Menu) | Area $ft^2$ | Height ft | People | Load Calc Peak cfm | People Diversity | ASHRAE 62 Zone Distribution System (Pulldown Menu) | Heating Min cfm | Exhaust cfm | **Peak cfm** | **OA cfm** | **Z Crit** | **People #** | **Heating cfm** | **Exhaust cfm** | Peak AC/HR | Peak $CFM/ft^2$ | OA $CFM/ft^2$ | OA CFM/ft2 Provided | ASHRAE cfm/person | ASHRAE $CFM/ft^2$ | ASHRAE People Density | Zone Dist. Effectiveness | People OA cfm | Area OA cfm |
| 062 Loading | Storage rooms | 317 | 8 | 3 | 175 | 100% | A-Ceiling supply, cooling | 30% | 0 | **175** | 38 | 0.22 | 3 | 53 | 0 | 4.1 | 0.55 | 0.12 | 0.19 | 0 | 0.12 | 0 | 1.0 | 0 | 38 |
| 063 Quick Change | Restrooms | 42 | 8 | 1 | 25 | 100% | A-Ceiling supply, cooling | 30% | 21 | **30** | 15 | 0.50 | 1 | 9 | 21 | 5.4 | 0.72 | 0.36 | 0.25 | 7.5 | 0.18 | 70 | 1.0 | 8 | 8 |
| 064 CUST | Janitorial | 49 | 8 | 1 | 7 | 100% | A-Ceiling supply, cooling | 30% | 49 | **10** | 0 | 0.00 | 1 | 3 | 49 | 1.5 | 0.20 | 0.00 | 0.07 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| 065 Corridor | Corridors | 2,001 | 8 | 2 | 204 | 100% | A-Ceiling supply, cooling | 30% | 0 | **205** | 120 | 0.59 | 2 | 62 | 0 | 0.8 | 0.10 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 120 |
| 066 Unisex | Restrooms | 48 | 9 | 1 | 29 | 100% | A-Ceiling supply, cooling | 30% | 24 | **30** | 16 | 0.54 | 1 | 9 | 24 | 4.2 | 0.63 | 0.34 | 0.22 | 7.5 | 0.18 | 70 | 1.0 | 8 | 9 |
| 069 Corridor | Corridors | 79 | 8 | 1 | 8 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 5 | 0.48 | 1 | 3 | 0 | 0.9 | 0.13 | 0.06 | 0.04 | 0 | 0.06 | 0 | 1.0 | 0 | 5 |
| 070 Dressing Star | Dressing Room/Locker Room | 139 | 8 | 6 | 94 | 100% | A-Ceiling supply, cooling | 30% | 69 | **95** | 0 | 0.00 | 6 | 29 | 69 | 5.1 | 0.69 | 0.00 | 0.24 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| 070.1 TLT | Restrooms | 73 | 8 | 1 | 44 | 100% | A-Ceiling supply, cooling | 30% | 36 | **45** | 21 | 0.46 | 1 | 14 | 36 | 4.6 | 0.62 | 0.28 | 0.22 | 7.5 | 0.18 | 70 | 1.0 | 8 | 13 |
| 072 Visiting Comp | Dressing Room/Locker Room | 157 | 8 | 7 | 157 | 100% | A-Ceiling supply, cooling | 30% | 78 | **160** | 0 | 0.00 | 7 | 48 | 78 | 7.7 | 1.02 | 0.00 | 0.36 | 0 | 0 | 0 | 1.0 | 0 | 0 |
| 077 Elec | Storage rooms | 78 | 8 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.94 | 1 | 3 | 0 | 1.0 | 0.13 | 0.12 | 0.04 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 077.1 Stor | Storage rooms | 72 | 8 | 1 | 9 | 100% | A-Ceiling supply, cooling | 30% | 0 | **10** | 9 | 0.86 | 1 | 3 | 0 | 1.0 | 0.14 | 0.12 | 0.05 | 0 | 0.12 | 0 | 1.0 | 0 | 9 |
| 080 Open Office | Office space | 762 | 8 | 5 | 257 | 100% | A-Ceiling supply, cooling | 30% | 0 | **260** | 71 | 0.27 | 5 | 78 | 0 | 2.6 | 0.34 | 0.09 | 0.12 | 5 | 0.06 | 5 | 1.0 | 25 | 46 |
| 080.2 Mktg Dir | Office space | 166 | 8 | 2 | 82 | 100% | A-Ceiling supply, cooling | 30% | 0 | **85** | 20 | 0.23 | 2 | 26 | 0 | 3.8 | 0.51 | 0.12 | 0.18 | 5 | 0.06 | 5 | 1.0 | 10 | 10 |
| 080.4 Opp Dir/Bus Mngr | Office space | 145 | 8 | 2 | 73 | 100% | A-Ceiling supply, cooling | 30% | 0 | **75** | 19 | 0.25 | 2 | 23 | 0 | 3.9 | 0.52 | 0.13 | 0.18 | 5 | 0.06 | 5 | 1.0 | 10 | 9 |
| 082 Security | Office space | 203 | 8 | 4 | 61 | 100% | A-Ceiling supply, cooling | 30% | 0 | **65** | 32 | 0.50 | 4 | 20 | 0 | 2.4 | 0.32 | 0.16 | 0.11 | 5 | 0.06 | 5 | 1.0 | 20 | 12 |
| 084 House Mngr | Office space | 102 | 8 | 1 | 31 | 100% | A-Ceiling supply, cooling | 30% | 0 | **35** | 11 | 0.32 | 1 | 11 | 0 | 2.6 | 0.34 | 0.11 | 0.12 | 5 | 0.06 | 5 | 1.0 | 5 | 6 |
| 087 Ushers | Office space | 279 | 8 | 3 | 84 | 100% | A-Ceiling supply, cooling | 30% | 0 | **85** | 32 | 0.37 | 3 | 26 | 0 | 2.3 | 0.30 | 0.11 | 0.11 | 5 | 0.06 | 5 | 1.0 | 15 | 17 |

# Lighting Power Density Analysis

| SPACE NAME | Area [SF] | LPD [W/SF] | Allowable [Watts] |
|---|---|---|---|
| 003 Lobby | 572 | 2.00 | 1144 |
| 003.1 Unisex | 58 | 1.31 | 77 |
| 004 Mens | 298 | 1.31 | 390 |
| 008 First Aid | 99 | 1.00 | 99 |
| 009 Fire Command | 152 | 0.63 | 96 |
| 010 Womens | 591 | 1.31 | 775 |
| 011 Coat Check | 169 | 1.00 | 169 |
| 013 Box office | 420 | 1.00 | 420 |
| 017 Call Center | 219 | 1.00 | 219 |
| 020 Reception | 172 | 2.00 | 343 |
| 020.1 Ticketing Dir | 126 | 1.00 | 126 |
| 020.2 Open Office | 631 | 1.00 | 631 |
| 020.4 Ex Relations Dir | 112 | 1.00 | 112 |
| 020.6 Exec Art Dir | 134 | 1.00 | 134 |
| 029 Unisex | 38 | 1.31 | 49 |
| 030 Green Room | 552 | 2.43 | 1342 |
| 031 Elec | 79 | 0.63 | 50 |
| 036 Corridor | 331 | 0.66 | 219 |
| 040 REHERSAL | 1707 | 2.43 | 4148 |
| 041 Quick Change | 39 | 0.75 | 30 |
| 045 Corridor | 2894 | 0.66 | 1910 |
| 051 STAGE | 5655 | 2.43 | 13742 |
| 055 Crossover | 1496 | 0.63 | 942 |
| 059 STAGE STORAGE | 165 | 0.63 | 104 |
| 060 Loading | 1298 | 0.63 | 818 |
| 061 Tool Stor | 131 | 0.63 | 83 |
| 062 Loading | 317 | 0.63 | 200 |
| 063 Quick Change | 42 | 1.31 | 55 |
| 064 CUST | 49 | 0.95 | 47 |
| 065 Corridor | 2001 | 0.66 | 1320 |
| 066 Unisex | 48 | 1.31 | 63 |
| 069 Corridor | 79 | 0.66 | 52 |
| 070 Dressing Star | 139 | 0.75 | 104 |
| 070.1 TLT | 73 | 1.31 | 95 |
| 072 Visiting Comp | 157 | 0.75 | 118 |
| 074 Corridor | 294 | 0.66 | 194 |
| 077 Elec | 78 | 0.63 | 49 |
| 077.1 Stor | 72 | 0.63 | 45 |
| 080 Open Office | 762 | 1.00 | 762 |
| 080.2 Mktg Dir | 166 | 1.00 | 166 |
| 080.4 Opp Dir/Bus Mngr | 145 | 1.00 | 145 |
| 082 Security | 203 | 1.00 | 203 |
| 084 House Mngr | 102 | 1.00 | 102 |
| 087 Ushers | 279 | 1.00 | 279 |
| 088 West Entry | 565 | 2.00 | 1130 |
| 089 Will Call | 288 | 1.00 | 288 |
| 090 Open Office | 439 | 1.00 | 439 |
| 090.2 Admin Office | 112 | 1.00 | 112 |
| 090.4 IT Support | 112 | 1.00 | 112 |
| 090.6 Bldg Mngr | 146 | 1.00 | 146 |

# Lighting Power Density Analysis

| SPACE NAME | Area [SF] | LPD [W/SF] | Allowable [Watts] |
|---|---|---|---|
| 091 Coat Check | 448 | 1.00 | 448 |
| 093 Womens | 473 | 1.31 | 619 |
| 097 Lobby | 706 | 2.00 | 1412 |
| 097 Unisex | 61 | 1.31 | 80 |
| 097.2 Vending | 69 | 0.89 | 62 |
| 098 Mens | 330 | 1.31 | 432 |
| 100 MEM HALL | 2878 | 0.66 | 1900 |
| 101 LOBBY | 616 | 2.00 | 1232 |
| 104 LOUNGE | 298 | 2.00 | 595 |
| 105 CORRIDOR | 491 | 0.66 | 324 |
| 106 CONF | 388 | 1.23 | 478 |
| 107 CONCESSION | 255 | 0.89 | 227 |
| 109 STOR | 156 | 0.63 | 98 |
| 110 INNO LAB | 591 | 1.23 | 727 |
| 110.1 CONF | 201 | 1.23 | 248 |
| 125 CORRIDOR | 2032 | 0.66 | 1341 |
| 128 MENS | 220 | 1.31 | 288 |
| 131 ELEC | 74 | 0.63 | 47 |
| 134 WOMENS | 266 | 1.31 | 349 |
| 137 CORRIDOR | 398 | 0.66 | 263 |
| 150 GROUND LEVEL SEATING | 9311 | 0.79 | 7356 |
| 155 HALL ENTRY | 761 | 2.00 | 1523 |
| 157 LOBBY | 4190 | 2.00 | 8379 |
| 163 VEST | 162 | 2.00 | 323 |
| 168 MENS | 233 | 1.31 | 305 |
| 175 CORRIDOR | 2316 | 0.66 | 1528 |
| 178 WOMENS | 265 | 1.31 | 348 |
| 182 PREP | 250 | 0.89 | 222 |
| 184 SERVING | 185 | 1.24 | 229 |
| 190 COFFEE SHOP | 1067 | 1.24 | 1323 |
| 195 CORRIDOR | 503 | 0.66 | 332 |
| 196 LOUNGE | 300 | 2.00 | 601 |
| 198 LOBBY | 614 | 2.00 | 1229 |
| 201 LOBBY | 556 | 2.00 | 1111 |
| 203 LOBBY | 1320 | 2.00 | 2639 |
| 204 LOUNGE | 338 | 2.00 | 676 |
| 205 CORRIDOR | 258 | 0.66 | 170 |
| 210 INST ADV STD | 597 | 1.23 | 735 |
| 210.02 VST FELLOW | 85 | 1.00 | 85 |
| 210.04 VST FELLOW | 109 | 1.00 | 109 |
| 210.06 VST FELLOW | 106 | 1.00 | 106 |
| 210.08 VST FELLOW | 106 | 1.00 | 106 |
| 210.10 VST FELLOW | 106 | 1.00 | 106 |
| 210.11 VST FELLOW | 90 | 1.00 | 90 |
| 210.12 VST FELLOW | 106 | 1.00 | 106 |
| 210.13 VST FELLOW | 86 | 1.00 | 86 |
| 210.14 VST FELLOW | 97 | 1.00 | 97 |
| 215 CORRIDOR | 105 | 0.66 | 69 |
| 217 WKRM | 125 | 1.23 | 153 |
| 225 CORRIDOR | 1303 | 0.66 | 860 |

# Lighting Power Density Analysis

| SPACE NAME | Area [SF] | LPD [W/SF] | Allowable [Watts] |
|---|---|---|---|
| 228 MENS | 274 | 1.31 | 358 |
| 231 ELEC | 74 | 0.63 | 46 |
| 234 WOMENS | 266 | 1.31 | 348 |
| 240 LG CONFERENCE | 1528 | 1.23 | 1879 |
| 241 UNISEX | 49 | 1.31 | 64 |
| 242 CUST | 186 | 0.63 | 117 |
| 244 STOR | 61 | 0.63 | 38 |
| 250 1ST BALCONY | 3909 | 0.79 | 3088 |
| 255 CORRIDOR | 962 | 0.66 | 635 |
| 260 FOUNDERS ROOM | 1332 | 1.23 | 1638 |
| 268 CATERING | 145 | 0.89 | 129 |
| 275 CORRIDOR | 1562 | 0.66 | 1031 |
| 277 ELEC | 79 | 0.63 | 50 |
| 278 WOMENS | 266 | 1.31 | 349 |
| 282 MENS | 266 | 1.31 | 348 |
| 283 WKRM | 106 | 1.23 | 130 |
| 285 CORRIDOR | 114 | 0.66 | 75 |
| 290 INST ADV STD | 957 | 1.23 | 1177 |
| 290.10 DIR | 128 | 1.00 | 128 |
| 290.11 VST FELLOW | 90 | 1.00 | 90 |
| 290.12 MNG DIR | 105 | 1.00 | 105 |
| 290.13 VST FELLOW | 95 | 1.00 | 95 |
| 290.14 GRANTS CNSLT | 88 | 1.00 | 88 |
| 295 CORRIDOR | 304 | 0.66 | 200 |
| 296 LOUNGE | 300 | 2.00 | 600 |
| 297 LOBBY | 1296 | 2.00 | 2592 |
| 298 LOBBY | 574 | 2.00 | 1148 |
| 301 LOBBY | 652 | 2.00 | 1303 |
| 303 LOBBY | 1211 | 2.00 | 2422 |
| 304 LOUNGE | 342 | 2.00 | 684 |
| 305 CORRIDOR | 233 | 0.66 | 154 |
| 307 CORRIDOR | 127 | 0.66 | 84 |
| 310 HONORS | 904 | 1.00 | 904 |
| 310.02 PRO ADVR | 85 | 1.00 | 85 |
| 310.04 PRO ADVR | 106 | 1.00 | 106 |
| 310.06 PRO ADVR | 105 | 1.00 | 105 |
| 310.08 PRO ADVR | 106 | 1.00 | 106 |
| 310.10 PRO ADVR | 106 | 1.00 | 106 |
| 310.11 PRO ADVR | 95 | 1.00 | 95 |
| 310.12 PRO ADVR | 106 | 1.00 | 106 |
| 310.13 PRO ADVR | 86 | 1.00 | 86 |
| 310.14 PRO ADVR | 114 | 1.00 | 114 |
| 310.15 PRO ADVR | 90 | 1.00 | 90 |
| 310.16 PRO ADVR | 124 | 1.00 | 124 |
| 310.17 CORRIDOR | 158 | 0.66 | 104 |
| 318 WKRM | 134 | 1.23 | 164 |
| 327 CORRIDOR | 1226 | 0.66 | 809 |
| 334 WOMENS | 233 | 1.31 | 305 |
| 335 CUST | 32 | 0.63 | 20 |
| 341 MENS | 162 | 1.31 | 212 |

# Lighting Power Density Analysis

| SPACE NAME | Area [SF] | LPD [W/SF] | Allowable [Watts] |
|---|---|---|---|
| 350 2ND BALCONY | 3909 | 0.79 | 3088 |
| 356 CORRIDOR | 278 | 0.66 | 184 |
| 368 MENS | 166 | 1.31 | 218 |
| 375 CORRIDOR | 1284 | 0.66 | 848 |
| 377 ELEC | 78 | 0.63 | 49 |
| 378 WOMENS | 230 | 1.31 | 301 |
| 382 CONFERENCE | 297 | 1.23 | 366 |
| 385 CORRIDOR | 1527 | 0.66 | 1008 |
| 390 HONORS | 1301 | 1.00 | 1301 |
| 390.1 ASC DIR | 93 | 1.00 | 93 |
| 390.2 ASC DIR | 130 | 1.00 | 130 |
| 390.3 HNR STD ASSC | 89 | 1.00 | 89 |
| 390.4 HNR DIR | 195 | 1.00 | 195 |
| 390.5 WKRM | 121 | 1.23 | 149 |
| 396 LOUNGE | 337 | 2.00 | 675 |
| 397 LOBBY | 1174 | 2.00 | 2349 |
| 398 LOBBY | 619 | 2.00 | 1238 |
| 400 LEC GALLERY | 1483 | 1.24 | 1839 |
| 403 LOBBY | 1389 | 2.00 | 2779 |
| 404 CORRIDOR | 152 | 0.66 | 100 |
| 416 UNISEX | 54 | 1.31 | 71 |
| 418 MENS | 281 | 1.31 | 368 |
| 420 LOBBY | 1230 | 2.00 | 2461 |
| 422 CONCESSIONS | 162 | 0.89 | 145 |
| 436 PIPE ORGAN LOFT E | 619 | 0.63 | 390 |
| 450 3RD BALCONY | 3342 | 0.79 | 2640 |
| 460 RECITAL HALL | 1960 | 2.43 | 4762 |
| 462 STOR | 417 | 0.63 | 263 |
| 463 CORRIDOR | 145 | 0.66 | 96 |
| 467 CORRIDOR | 230 | 0.66 | 152 |
| 470 ELEC | 287 | 0.63 | 181 |
| 478.1 STOR | 54 | 0.63 | 34 |
| 478.2 STOR | 65 | 0.63 | 41 |
| 482 MISC | 86 | 0.63 | 54 |
| 485 CORRIDOR | 1283 | 0.66 | 847 |
| 485 WOMENS | 397 | 1.31 | 520 |
| 491 VEST | 182 | 0.66 | 120 |
| 493 VEST | 249 | 0.66 | 165 |
| 496 CORRIDOR | 93 | 0.66 | 62 |
| 497 LOBBY | 1340 | 2.00 | 2679 |
| B08 MECH/STOR | 2803 | 0.63 | 1766 |
| B08.1 MECH/STOR | 1027 | 0.63 | 647 |
| B09 FIRE STATION | 172 | 0.63 | 108 |
| B10 MECH | 1748 | 0.63 | 1101 |
| B22 CHAIR WAGON SEATING/ORCH PIT | 2944 | 0.79 | 2326 |
| B23 TLT | 228 | 1.31 | 299 |
| B27 DRESSING | 439 | 0.75 | 329 |
| B34 DRESSING | 174 | 0.75 | 131 |
| B36 TLT | 75 | 1.31 | 99 |
| B40 DRESSING | 175 | 0.75 | 131 |

# Lighting Power Density Analysis

| SPACE NAME | Area [SF] | LPD [W/SF] | Allowable [Watts] |
|---|---|---|---|
| B42 TLT | 76 | 1.31 | 100 |
| B43 LKR RM | 326 | 0.75 | 245 |
| B44 DRESSING | 131 | 0.75 | 98 |
| B46 TLT | 86 | 1.31 | 112 |
| B47 UNISEX | 44 | 1.31 | 58 |
| B48 DRESSING | 139 | 0.75 | 105 |
| B49 BRK RM | 206 | 0.89 | 183 |
| B50 TLT | 93 | 1.31 | 122 |
| B51 TECH DIR | 118 | 1.00 | 118 |
| B52 DRESSING | 131 | 0.75 | 98 |
| B53 TECH OFFICE/WKRM | 148 | 1.23 | 182 |
| B54 TLT | 90 | 1.31 | 118 |
| B56 DRESSING | 214 | 0.75 | 161 |
| B57 HOUSE SOUND/ELEC | 208 | 1.00 | 208 |
| B58 TLT | 100 | 1.31 | 131 |
| B59 STG MNGR | 123 | 1.00 | 123 |
| B60 DRESSING | 525 | 0.75 | 393 |
| B61 WKRM/STOR | 173 | 0.63 | 109 |
| B62 TLT | 241 | 1.31 | 316 |
| B63 PROP REPAIR | 154 | 1.00 | 154 |
| B64 DRESSING | 519 | 0.75 | 389 |
| B66 TLT | 233 | 1.31 | 305 |
| B69 MUSICIAN | 206 | 1.00 | 206 |
| B80 CUST MAIN | 202 | 0.95 | 192 |
| B82 SOUND WKRM | 201 | 1.00 | 201 |
| B83 PIANO STOR | 200 | 0.63 | 126 |
| B84 CORR | 3330 | 0.66 | 2198 |
| B88 UNISEX | 46 | 1.31 | 61 |
| B90 LAUNDRY | 129 | 0.60 | 77 |
| B92 BOH STOR | 1128 | 0.63 | 711 |

# Appendix B

*Appendix B: Figure 1 - ASHRAE 62.1-2010 Table 6-1 - Minimum Ventilation Rates*

**TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE**
**(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)**

| Occupancy Category | People Outdoor Air Rate $R_p$ | | Area Outdoor Air Rate $R_a$ | | Notes | Default Values | | | Air Class |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Occupant Density (see Note 4) | Combined Outdoor Air Rate (see Note 5) | | |
| | cfm/person | L/s·person | cfm/ft$^2$ | L/s·m$^2$ | | #/1000 ft$^2$ or #/100 m$^2$ | cfm/person | L/s·person | |
| **Correctional Facilities** | | | | | | | | | |
| Cell | 5 | 2.5 | 0.12 | 0.6 | | 25 | 10 | 4.9 | 2 |
| Dayroom | 5 | 2.5 | 0.06 | 0.3 | | 30 | 7 | 3.5 | 1 |
| Guard stations | 5 | 2.5 | 0.06 | 0.3 | | 15 | 9 | 4.5 | 1 |
| Booking/waiting | 7.5 | 3.8 | 0.06 | 0.3 | | 50 | 9 | 4.4 | 2 |
| **Educational Facilities** | | | | | | | | | |
| Daycare (through age 4) | 10 | 5 | 0.18 | 0.9 | | 25 | 17 | 8.6 | 2 |
| Daycare sickroom | 10 | 5 | 0.18 | 0.9 | | 25 | 17 | 8.6 | 3 |
| Classrooms (ages 5–8) | 10 | 5 | 0.12 | 0.6 | | 25 | 15 | 7.4 | 1 |
| Classrooms (age 9 plus) | 10 | 5 | 0.12 | 0.6 | | 35 | 13 | 6.7 | 1 |
| Lecture classroom | 7.5 | 3.8 | 0.06 | 0.3 | | 65 | 8 | 4.3 | 1 |
| Lecture hall (fixed seats) | 7.5 | 3.8 | 0.06 | 0.3 | | 150 | 8 | 4.0 | 1 |
| Art classroom | 10 | 5 | 0.18 | 0.9 | | 20 | 19 | 9.5 | 2 |
| Science laboratories | 10 | 5 | 0.18 | 0.9 | | 25 | 17 | 8.6 | 2 |
| University/college laboratories | 10 | 5 | 0.18 | 0.9 | | 25 | 17 | 8.6 | 2 |
| Wood/metal shop | 10 | 5 | 0.18 | 0.9 | | 20 | 19 | 9.5 | 2 |
| Computer lab | 10 | 5 | 0.12 | 0.6 | | 25 | 15 | 7.4 | 1 |
| Media center | 10 | 5 | 0.12 | 0.6 | A | 25 | 15 | 7.4 | 1 |
| Music/theater/dance | 10 | 5 | 0.06 | 0.3 | | 35 | 12 | 5.9 | 1 |
| Multi-use assembly | 7.5 | 3.8 | 0.06 | 0.3 | | 100 | 8 | 4.1 | 1 |
| **Food and Beverage Service** | | | | | | | | | |
| Restaurant dining rooms | 7.5 | 3.8 | 0.18 | 0.9 | | 70 | 10 | 5.1 | 2 |
| Cafeteria/fast-food dining | 7.5 | 3.8 | 0.18 | 0.9 | | 100 | 9 | 4.7 | 2 |
| Bars, cocktail lounges | 7.5 | 3.8 | 0.18 | 0.9 | | 100 | 9 | 4.7 | 2 |
| Kitchen (cooking) | 7.5 | 3.8 | 0.12 | 0.6 | | 20 | 14 | 7.0 | 2 |
| **General** | | | | | | | | | |
| Break rooms | 5 | 2.5 | 0.06 | 0.3 | | 25 | 10 | 5.1 | 1 |
| Coffee stations | 5 | 2.5 | 0.06 | 0.3 | | 20 | 11 | 5.5 | 1 |
| Conference/meeting | 5 | 2.5 | 0.06 | 0.3 | | 50 | 6 | 3.1 | 1 |
| Corridors | – | – | 0.06 | 0.3 | | – | | | 1 |
| Occupiable storage rooms for liquids or gels | 5 | 2.5 | 0.12 | 0.6 | B | 2 | 65 | 32.5 | 2 |
| **Hotels, Motels, Resorts, Dormitories** | | | | | | | | | |
| Bedroom/living room | 5 | 2.5 | 0.06 | 0.3 | | 10 | 11 | 5.5 | 1 |
| Barracks sleeping areas | 5 | 2.5 | 0.06 | 0.3 | | 20 | 8 | 4.0 | 1 |
| Laundry rooms, central | 5 | 2.5 | 0.12 | 0.6 | | 10 | 17 | 8.5 | 2 |
| Laundry rooms within dwelling units | 5 | 2.5 | 0.12 | 0.6 | | 10 | 17 | 8.5 | 1 |
| Lobbies/prefunction | 7.5 | 3.8 | 0.06 | 0.3 | | 30 | 10 | 4.8 | 1 |
| Multipurpose assembly | 5 | 2.5 | 0.06 | 0.3 | | 120 | 6 | 2.8 | 1 |

*Appendix B: Figure 1 - ASHRAE 62.1-2010 Table 6-1 - Minimum Ventilation Rates (con't)*

**TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE** *(Continued)*
**(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)**

| Occupancy Category | People Outdoor Air Rate $R_p$ | | Area Outdoor Air Rate $R_a$ | | Notes | Default Values | | | Air Class |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Occupant Density (see Note 4) | Combined Outdoor Air Rate (see Note 5) | | |
| | cfm/person | L/s·person | cfm/ft$^2$ | L/s·m$^2$ | | #/1000 ft$^2$ or #/100 m$^2$ | cfm/person | L/s·person | |
| **Office Buildings** | | | | | | | | | |
| Breakrooms | 5 | 2.5 | 0.12 | 0.6 | | 50 | 7 | 3.5 | 1 |
| Main entry lobbies | 5 | 2.5 | 0.06 | 0.3 | | 10 | 11 | 5.5 | 1 |
| Occupiable storage rooms for dry materials | 5 | 2.5 | 0.06 | 0.3 | | 2 | 35 | 17.5 | 1 |
| Office space | 5 | 2.5 | 0.06 | 0.3 | | 5 | 17 | 8.5 | 1 |
| Reception areas | 5 | 2.5 | 0.06 | 0.3 | | 30 | 7 | 3.5 | 1 |
| Telephone/data entry | 5 | 2.5 | 0.06 | 0.3 | | 60 | 6 | 3.0 | 1 |
| **Miscellaneous Spaces** | | | | | | | | | |
| Bank vaults/safe deposit | 5 | 2.5 | 0.06 | 0.3 | | 5 | 17 | 8.5 | 2 |
| Banks or bank lobbies | 7.5 | 3.8 | 0.06 | 0.3 | | 15 | 12 | 6.0 | 1 |
| Computer (not printing) | 5 | 2.5 | 0.06 | 0.3 | | 4 | 20 | 10.0 | 1 |
| General manufacturing (excludes heavy industrial and processes using chemicals) | 10 | 5.0 | 0.18 | 0.9 | | 7 | 36 | 18 | 3 |
| Pharmacy (prep. area) | 5 | 2.5 | 0.18 | 0.9 | | 10 | 23 | 11.5 | 2 |
| Photo studios | 5 | 2.5 | 0.12 | 0.6 | | 10 | 17 | 8.5 | 1 |
| Shipping/receiving | 10 | 5 | 0.12 | 0.6 | B | 2 | 70 | 35 | 2 |
| Sorting, packing, light assembly | 7.5 | 3.8 | 0.12 | 0.6 | | 7 | 25 | 12.5 | 2 |
| Telephone closets | – | – | 0.00 | 0.0 | | – | | | 1 |
| Transportation waiting | 7.5 | 3.8 | 0.06 | 0.3 | | 100 | 8 | 4.1 | 1 |
| Warehouses | 10 | 5 | 0.06 | 0.3 | B | – | | | 2 |
| **Public Assembly Spaces** | | | | | | | | | |
| Auditorium seating area | 5 | 2.5 | 0.06 | 0.3 | | 150 | 5 | 2.7 | 1 |
| Places of religious worship | 5 | 2.5 | 0.06 | 0.3 | | 120 | 6 | 2.8 | 1 |
| Courtrooms | 5 | 2.5 | 0.06 | 0.3 | | 70 | 6 | 2.9 | 1 |
| Legislative chambers | 5 | 2.5 | 0.06 | 0.3 | | 50 | 6 | 3.1 | 1 |
| Libraries | 5 | 2.5 | 0.12 | 0.6 | | 10 | 17 | 8.5 | 1 |
| Lobbies | 5 | 2.5 | 0.06 | 0.3 | | 150 | 5 | 2.7 | 1 |
| Museums (children's) | 7.5 | 3.8 | 0.12 | 0.6 | | 40 | 11 | 5.3 | 1 |
| Museums/galleries | 7.5 | 3.8 | 0.06 | 0.3 | | 40 | 9 | 4.6 | 1 |
| **Residential** | | | | | | | | | |
| Dwelling unit | 5 | 2.5 | 0.06 | 0.3 | F,G | F | | | 1 |
| Common corridors | – | – | 0.06 | 0.3 | | | | | 1 |
| **Retail** | | | | | | | | | |
| Sales (except as below) | 7.5 | 3.8 | 0.12 | 0.6 | | 15 | 16 | 7.8 | 2 |
| Mall common areas | 7.5 | 3.8 | 0.06 | 0.3 | | 40 | 9 | 4.6 | 1 |
| Barbershop | 7.5 | 3.8 | 0.06 | 0.3 | | 25 | 10 | 5.0 | 2 |

*Appendix B: Figure 1 - ASHRAE 62.1-2010 Table 6-1 - Minimum Ventilation Rates (con't)*

**TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE** *(Continued)*
**(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)**

| Occupancy Category | People Outdoor Air Rate $R_p$ | | Area Outdoor Air Rate $R_a$ | | Notes | Default Values | | | Air Class |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Occupant Density (see Note 4) | Combined Outdoor Air Rate (see Note 5) | | |
| | cfm/person | L/s-person | cfm/ft$^2$ | L/s·m$^2$ | | #/1000 ft$^2$ or #/100 m$^2$ | cfm/person | L/s-person | |
| Beauty and nail salons | 20 | 10 | 0.12 | 0.6 | | 25 | 25 | 12.4 | 2 |
| Pet shops (animal areas) | 7.5 | 3.8 | 0.18 | 0.9 | | 10 | 26 | 12.8 | 2 |
| Supermarket | 7.5 | 3.8 | 0.06 | 0.3 | | 8 | 15 | 7.6 | 1 |
| Coin-operated laundries | 7.5 | 3.8 | 0.12 | 0.6 | | 20 | 14 | 7.0 | 2 |
| **Sports and Entertainment** | | | | | | | | | |
| Sports arena (play area) | – | – | 0.30 | 1.5 | E | – | | | 1 |
| Gym, stadium (play area) | – | – | 0.30 | 1.5 | | 30 | | | 2 |
| Spectator areas | 7.5 | 3.8 | 0.06 | 0.3 | | 150 | 8 | 4.0 | 1 |
| Swimming (pool & deck) | – | – | 0.48 | 2.4 | C | – | | | 2 |
| Disco/dance floors | 20 | 10 | 0.06 | 0.3 | | 100 | 21 | 10.3 | 2 |
| Health club/aerobics room | 20 | 10 | 0.06 | 0.3 | | 40 | 22 | 10.8 | 2 |
| Health club/weight rooms | 20 | 10 | 0.06 | 0.3 | | 10 | 26 | 13.0 | 2 |
| Bowling alley (seating) | 10 | 5 | 0.12 | 0.6 | | 40 | 13 | 6.5 | 1 |
| Gambling casinos | 7.5 | 3.8 | 0.18 | 0.9 | | 120 | 9 | 4.6 | 1 |
| Game arcades | 7.5 | 3.8 | 0.18 | 0.9 | | 20 | 17 | 8.3 | 1 |
| Stages, studios | 10 | 5 | 0.06 | 0.3 | D | 70 | 11 | 5.4 | 1 |

GENERAL NOTES FOR TABLE 6-1

1 **Related requirements:** The rates in this table are based on all other applicable requirements of this standard being met.
2 **Environmental Tobacco Smoke:** This table applies to ETS-free areas. Refer to Section 5.17 for requirements for buildings containing ETS areas and ETS-free areas.
3 **Air density:** Volumetric airflow rates are based on an air density of 0.075 $lb_{da}/ft^3$ (1.2 $kg_{da}/m^3$), which corresponds to dry air at a barometric pressure of 1 atm (101.3 kPa) and an air temperature of 70°F (21°C). Rates may be adjusted for actual density but such adjustment is not required for compliance with this standard.
4 **Default occupant density:** The default occupant density shall be used when actual occupant density is not known.
5 **Default combined outdoor air rate (per person):** This rate is based on the default occupant density.
6 **Unlisted occupancies:** If the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities and building construction shall be used.

ITEM-SPECIFIC NOTES FOR TABLE 6-1

A For high school and college libraries, use values shown for Public Assembly Spaces—Libraries.
B Rate may not be sufficient when stored materials include those having potentially harmful emissions.
C Rate does not allow for humidity control. Additional ventilation or dehumidification may be required to remove moisture. "Deck area" refers to the area surrounding the pool that would be expected to be wetted during normal pool use, i.e., when the pool is occupied. Deck area that is not expected to be wetted shall be designated as a space type (for example, "spectator area").
D Rate does not include special exhaust for stage effects, e.g., dry ice vapors, smoke.
E When combustion equipment is intended to be used on the playing surface, additional dilution ventilation and/or source control shall be provided.
F Default occupancy for dwelling units shall be two persons for studio and one-bedroom units, with one additional person for each additional bedroom.
G Air from one residential dwelling shall not be recirculated or transferred to any other space outside of that dwelling.

*Appendix B: Figure 2 - ASHRAE 62.1-2010 Table 6-4 - Minimum Exhaust Rates*

**TABLE 6-4 Minimum Exhaust Rates**

| Occupancy Category | Exhaust Rate, cfm/unit | Exhaust Rate, cfm/ft$^2$ | Notes | Exhaust Rate, L/s·unit | Exhaust Rate, L/s·m$^2$ | Air Class |
|---|---|---|---|---|---|---|
| Arenas | – | 0.50 | B | – | – | 1 |
| Art classrooms | – | 0.70 | | – | 3.5 | 2 |
| Auto repair rooms | – | 1.50 | A | – | 7.5 | 2 |
| Barber shops | – | 0.50 | | – | 2.5 | 2 |
| Beauty and nail salons | – | 0.60 | | – | 3.0 | 2 |
| Cells with toilet | – | 1.00 | | – | 5.0 | 2 |
| Copy, printing rooms | – | 0.50 | | – | 2.5 | 2 |
| Darkrooms | – | 1.00 | | – | 5.0 | 2 |
| Educational science laboratories | – | 1.00 | | – | 5.0 | 2 |
| Janitor closets, trash rooms, recycling | – | 1.00 | | – | 5.0 | 3 |
| Kitchenettes | – | 0.30 | | – | 1.5 | 2 |
| Kitchens—commercial | – | 0.70 | | – | 3.5 | 2 |
| Locker/dressing rooms | – | 0.25 | | – | 1.25 | 2 |
| Locker rooms | – | 0.50 | | – | 2.5 | 2 |
| Paint spray booths | – | – | F | – | – | 4 |
| Parking garages | – | 0.75 | C | – | 3.7 | 2 |
| Pet shops (animal areas) | – | 0.90 | | – | 4.5 | 2 |
| Refrigerating machinery rooms | – | – | F | – | – | 3 |
| Residential kitchens | 50/100 | – | G | 25/50 | – | 2 |
| Soiled laundry storage rooms | – | 1.00 | F | – | 5.0 | 3 |
| Storage rooms, chemical | – | 1.50 | F | – | 7.5 | 4 |
| Toilets—private | 25/50 | – | E | 12.5/25 | – | 2 |
| Toilets—public | 50/70 | – | D | 25/35 | – | 2 |
| Woodwork shop/classrooms | – | 0.50 | | – | 2.5 | 2 |

A Stands where engines are run shall have exhaust systems that directly connect to the engine exhaust and prevent escape of fumes.
B When combustion equipment is intended to be used on the playing surface additional dilution ventilation and/or source control shall be provided.
C Exhaust not required if two or more sides comprise walls that are at least 50% open to the outside.
D Rate is per water closet and/or urinal. Provide the higher rate where periods of heavy use are expected to occur, e.g., toilets in theatres, schools, and sports facilities. The lower rate may be used otherwise.
E Rate is for a toilet room intended to be occupied by one person at a time. For continuous system operation during normal hours of use, the lower rate may be used. Otherwise use the higher rate.
F See other applicable standards for exhaust rate.
G For continuous system operation, the lower rate may be used. Otherwise use the higher rate.

*Appendix B: Figure 3 - ASHRAE 90.1-2010 Tables 6.5.3.1.1A/B - Fan Power Limitations*

**TABLE 6.5.3.1.1A Fan Power Limitation[a]**

| | Limit | Constant Volume | Variable Volume |
|---|---|---|---|
| Option 1: Fan System Motor Nameplate hp | Allowable Nameplate Motor hp | $hp \leq CFM_S \cdot 0.0011$ | $hp \leq CFM_S \cdot 0.0015$ |
| Option 2: Fan System bhp | Allowable Fan System bhp | $bhp \leq CFM_S \cdot 0.00094 + A$ | $bhp \leq CFM_S \cdot 0.0013 + A$ |

[a] where

$CFM_S$ = the maximum design supply airflow rate to *conditioned spaces* served by the *system* in cubic feet per minute

hp = the maximum combined motor *nameplate horsepower*

bhp = the maximum combined *fan brake horsepower*

$A$ = sum of $(PD \times CFM_D/4131)$

where

$PD$ = each applicable pressure drop adjustment from Table 6.5.3.1.1B in in. w.c.

$CFM_D$ = the design airflow through each applicable device from Table 6.5.3.1.1B in cubic feet per minute

**TABLE 6.5.3.1.1B Fan Power Limitation Pressure Drop Adjustment**

| Device | Adjustment |
|---|---|
| **Credits** | |
| Fully ducted return and/or exhaust air systems | 0.5 in. w.c. (2.15 in. w.c. for laboratory and vivarium systems) |
| Return and/or exhaust airflow *control devices* | 0.5 in. w.c. |
| Exhaust filters, scrubbers, or other exhaust treatment | The pressure drop of device calculated at fan system design condition |
| Particulate Filtration Credit: MERV 9 through 12 | 0.5 in. w.c. |
| Particulate Filtration Credit: MERV 13 through 15 | 0.9 in. w.c. |
| Particulate Filtration Credit: MERV 16 and greater and electronically enhanced filters | Pressure drop calculated at 2× clean filter pressure drop at fan system design condition |
| Carbon and other gas-phase air cleaners | Clean filter pressure drop at fan system design condition |
| Biosafety cabinet | Pressure drop of device at fan system design condition |
| Energy Recovery Device, other than Coil Runaround Loop | (2.2 × Energy Recovery Effectiveness)—0.5 in w.c. for each airstream |
| Coil Runaround Loop | 0.6 in. w.c. for each airstream |
| Evaporative humidifier/cooler in series with another cooling coil | Pressure drop of device at fan system design condition |
| Sound Attenuation Section | 0.15 in. w.c. |
| Exhaust system serving fume hoods | 0.35 in. w.c. |
| Laboratory and vivarium exhaust systems in high-rise buildings | 0.25 in. w.c./100 ft of vertical duct exceeding 75 ft |