



---

## Technical Report 2

*Building and Plant Energy Analysis Report*

*October 4, 2013*

## Table of Contents

Executive Summary .....	4
Building Overview.....	5
Mechanical Systems Overview.....	5
Building Load Estimation .....	7
Design Conditions .....	7
Location .....	7
Building Construction .....	7
Load Assumptions.....	7
Occupancy & Ventilation .....	7
Lighting & Miscellaneous Loads .....	7
Schedules .....	8
System Equipment .....	8
Heating & Cooling .....	8
Air-Side Equipment.....	8
Conclusion.....	9
Annual Energy Consumption .....	9
Fuel consumption.....	9
Water Consumption .....	10
Annual Consumption Results .....	11
Annual Operating Cost .....	11
Overview.....	11
Equipment Operating Cost .....	11
Annual Cost Results .....	12
Emissions.....	12
References.....	12
Appendix A.....	14
Appendix B.....	20

## List of Figures

<b>Figure 1</b> First Floor Level (Source: Architect of Record) .....	5
<b>Figure 2</b> Monthly Electrical Energy Consumption .....	10
<b>Figure 3</b> Electricity Use .....	10
<b>Figure 4</b> Monthly Natural Gas Consumption .....	10
<b>Figure 5</b> Monthly Water Consumption .....	11
<b>Figure 6</b> Annual Fuel Cost by Fuel Type .....	12
<b>Figure 7</b> Monthly Fuel Cost .....	12
<b>Figure 8</b> Annual Building Emissions Data .....	13

## List of Tables

<b>Table 1</b> Design Conditions (Source: ASHRAE 2005 Handbook of Fundamentals) .....	7
<b>Table 2</b> Building Construction U-Values (Source: Engineer of Record) .....	7
<b>Table 3</b> Occupancy Schedule (Source: Trane® Trace Library) .....	8
<b>Table 4</b> Air Handling Unit Modeling Information (Source: Engineer of Record) .....	9
<b>Table 5</b> System Level Load Comparison .....	9
<b>Table 6</b> Annual & Monthly Equipment Energy Cost .....	13

## Executive Summary

Technical Report 2 examines the mechanical design of the Auditorium, through load modeling software and analysis of annual operating costs and fuel consumption. Using final construction documentation, a model was prepared using Trane Trace 700 software. Further analysis of the load calculation software results, were performed to determine the breakdown of annual operation cost by equipment type. A final emissions study was also performed to determine the environmental impact of the mechanical systems.

The assumptions and input data into the Trace software can be found listed in the [Building Load Estimation](#) section and related appendices of this report. Standardized values reference from ASHRAE Standards 62.1-2010 and 90.1-2010 were used when values could not be directly obtained from the construction documents. The overall result of the load calculation performed was generally acceptable. The energy consumption of the building from the Trace model developed for this report compared to the cooling and heating coil schedules do not agree. It appears that the initial design engineers used the Trace software to gather airflow information for the spaces in the building but relied on previous engineering experience to size the heating system.

The following sections on annual fuel consumption and annual operating cost are based on the output data from the Trace model developed for this report. The largest differing condition, is that the central steam and chilled water plants were not able to be modeling as they exist. Instead a natural gas boiler and water cooled chiller were substituted as the equipment in the model. However, the findings still follow the typical annual trends for a heating dominated climate and were used gather a general idea of energy use. The results yielded an annual operating cost of \$ 698,683 (\$4.07/SF). The electrical consumption for the year totaled 5,438 MWh and annual natural gas consumption was 199,413 therms (19,941 MBtu) or 85.6 therms/hr.

The final area of analysis is the Auditorium's environmental impact on its surroundings. Once again, based on the Trace energy consumption output, the CO<sub>2</sub> emissions total approximately 8.5 million pounds of carbon per year. The high percentage of electricity consumed on site, contribute to the large amount of CO<sub>2</sub> released from off-site generation. Additionally, further information is being gathered on the chilled water plant's refrigerant composition and will be evaluated for environmental and legislative compliance.

## 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 Lemna, Minnesota.

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

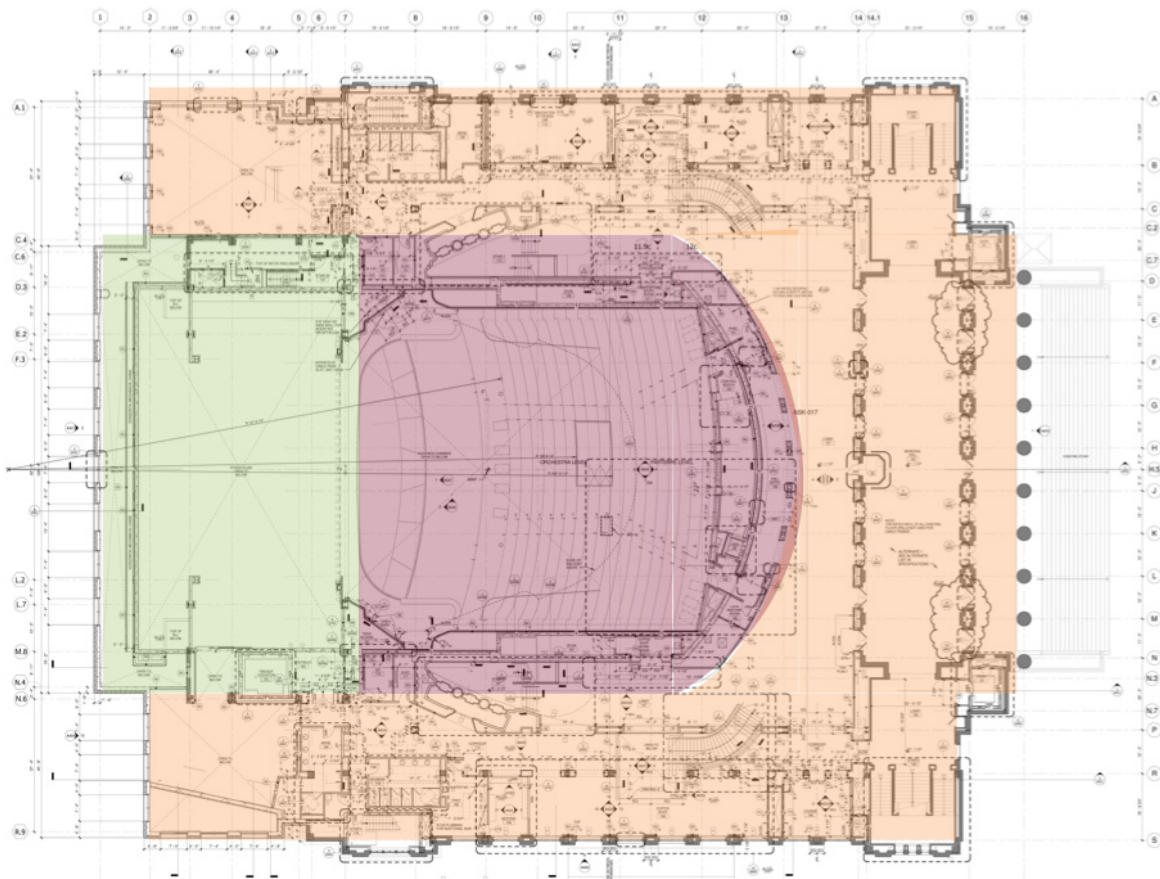


Figure 1 First Floor Level (Source: Architect of Record)

## 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 the [System Equipment](#) section the breakdown and calculations of airflow values for each of air handling units.

# Building Load Estimation

## Design Conditions

### Location

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. The following Table 1 details the design temperature used in building heating a cooling calculations.

COLDEST MONTH	HEATING DB (99.6%)	HUMIDIFICATION (99.6%)		
		DP	HR	MCWB
JANUARY	-14.9	-25.7	1.4	-14.0

WARMEST MONTH	COOLING (0.4%)		DEHUMIDIFICATION (0.4%)		
	DB	MCWB	DP	HR	MCWB
JULY	91.0 F	73.2	73.3	127.8	83.4

Table 1 Design Conditions (Source: ASHRAE 2005 Handbook of Fundamentals)

### Building Construction

Table 2, below, lists the U-values and description of the how the exterior walls and windows were modeled using Trane Trace 700 software. Being a historic building from the late 1920s, the envelope of the building is primarily brick construction with limited insulation. The infiltration of the building was modeled with average leakage and neutral pressurization (0.3 air changes/hour)

BUILDING CONSTRUCTION				
TYPE	DESCRIPTION	U-VALUE		SHADING COEFFICIENT
Wall	Face brick, 12" HW Conc, 1" Insul	0.168	btu/h-ft <sup>2</sup> -F	--
Below-Grade Wall	12" HW Conc 6" Insul	0.045	btu/h-ft <sup>2</sup> -F	--
Roof	Steel Sheet. 4" Insul	0.068	btu/h-ft <sup>2</sup> -F	--
Slab	4" LW Concrete	0.213	btu/h-ft <sup>2</sup> -F	--
Window	Double Clear 1/4"	0.600	btu/h-ft <sup>2</sup> -F	0.82

Table 2 Building Construction U-Values

## Load Assumptions

### Occupancy & Ventilation

The occupancy for the spaces was either determined from the architectural plans or the standardized SF/person values from Table 6-1 in ASHRAE 62.1-2010 were used. This table was also the basis for minimum outdoor airflow into the spaces to achieve proper ventilation.



See Appendix B for Table 6-1. Additionally, exhaust air requirements were also taken from Table 6-4 in ASHRAE 62.1-2010 (Appendix B) to incorporate accurate airflow into the model.

### Lighting & Miscellaneous Loads

Table 9.6.1 in ASHRAE 90.1-2010 defines the maximum lighting power density values and were the basis of the heat gain and energy consumption due to lighting. For office spaces, an additional 1.5 W/SF of miscellaneous load was added to account for computers and other office equipment located in these spaces. Furthermore, the performance support spaces were also modeled with an additional 2.0 W/SF heat load to account for additional equipment and/or people coming with the traveling performance acts.

START TIME	END TIME	PERCENTAGE [%]
------------	----------	----------------

SCHEDULE - OFFICE (WEEKDAY)		
12:00 AM	6:00 AM	0
6:00 AM	7:00 AM	10
7:00 AM	8:00 AM	30
8:00 AM	11:00 AM	100
11:00 AM	1:00 PM	80
1:00 PM	5:00 PM	100
5:00 PM	6:00 PM	10
6:00 PM	12:00 AM	0

SCHEDULE - OFFICE (WEEKEND)		
12:00 AM	12:00 AM	0

SCHEDULE - OTHER (ALL DAYS)		
12:00 AM	12:00 AM	100

### Schedules

The typical office spaces' air distribution equipment is modeled with a standard office occupancy schedule shown in Table 3 on the left. Zones without regular occupancy are modeled with a worst case scenario of 100% available cooling. Rooms that follow under this category are the performance support spaces, stage, rehearsal spaces and the audience chamber.

Table 3 Occupancy Schedule (Trane Trace® Library)

## System Equipment

### Heating & Cooling

Since the Auditorium is supplied with steam and has no heating plant on-site, a generic boiler was used in the model to evaluate the heating requirement for the building. On the cooling side, even though the chiller plant is located in the basement of the building, it serves a larger grouping of buildings than just the Auditorium. A water cooled chiller was used to model the cooling plant for the building. Additionally, only the distribution pumps were modeled to get an accurate energy consumption model for the building itself. Including the other equipment would not reflect the current conditions accurately. Further analysis will be required to determine the energy consumption of the steam and chiller plant.

### Air-Side Equipment

AHU-5 used a dual energy recovery wheel. One wheel was for heat recovery (HRW) to preheat the incoming outdoor air. The other was a passive dehumidification wheel (PDW) to control humidity. Note, AHU-4 was not used and does not exist in the final construction



documentation. The four air handling units were modeled as follows in Table 4:

SYTEM NO.	AREA SERVED	SYSTEM TYPE	DISTRIBUTION METHOD	STATIC PRESSURE		ENERGY RECOVERY
				SUPPLY FAN	RETURN FAN	
AHU 1	PUBLIC SPACES	VAV	FAN POWERED BOXES	4.5	2.0	--
AHU 2	AUDITORIUM	VAV	UNDERFLOOR AIR DISTRIBUTION	4.0	2.0	--
AHU 3	PERFORMANCE SPACES	VAV	FAN POWERED BOXES	4.5	1.75	--
AHU 5	PERFORMANCE SUPPORT (CHILLED BEAMS)	VAV 100% OA	CHILLED BEAM	5.75	3.5	DUAL WHEEL HRW/PDW

Table 4 Air Handling Unit Modeling Information

### Conclusion

After analysis of the building using Trane Trace 700 load calculation software, there are significant areas of differing results from the initial engineer’s design model. Even though the airflows are similar and reflect the design conditions, the cooling and heating energy consumption are significantly different in some respects. This error could be due to additional design factors or loads not provided on the drawings or inaccurate modeling of the systems. Additionally, due to the historic nature of the renovation the design engineer may have used the Trace 700 software to determine the airflows for the spaces, then relied on previous expertise to determine correct heating and cooling requirements for the building. Modeling the steam and chiller plant are beyond the level of detail for this report, but could have helped in determining better system level energy consumption results. Below is a comparison of the results from the initial engineers design model and the model used for this report (Table 5).

	System Name	Total Supply [CFM]	Total OA [CFM]	AHU Ventilation Efficiency	AHU OA Required [CFM]	Exhaust [CFM]	Total OA/Makeup Air Required [CFM]	AHU OA [%]	HEATING [MBh]	COOLING [Ton]	FINAL SIZE [CFM]
MODEL	AHU-1 : Public Spaces	74,370	15,475	0.80	19,343	3,359	19,343	26%	6,465	412.0	--
	AHU-2 : Audience Chamber	60,545	11,649	0.90	12,943	0	12,943	21%	5,083	327.5	--
	AHU-3 : Performance Spaces	26,990	7,083	0.80	8,854	0	8,854	33%	3,233	174.5	--
	AHU-5: Performance Support Spaces	5,360	3,123	0.80	3,904	2,738	3,904	73%	777	49.9	--
	<b>TOTALS</b>		<b>167,265</b>	<b>37,330</b>		<b>45,044</b>	<b>6,097</b>	<b>45,044</b>		<b>15,558</b>	<b>176</b>
DESIGN	AHU-1 : Public Spaces	69,909	15,839	0.80	18,455	11,341	18,455	26%	2,964	195.3	70,000
	AHU-2 : Audience Chamber	61,500	12,371	0.90	13,745	0	13,745	22%	5,140	135.3	61,000
	AHU-3 : Performance Spaces	28,655	7,771	0.80	6,957	0	6,957	24%	2,744	36.7	31,000
	AHU-5: Performance Support Spaces	7,990	3,010	0.80	3,763	5,509	5,509	69%	803	99.4	10,000
	<b>TOTALS</b>		<b>168,054</b>	<b>38,991</b>		<b>42,920</b>	<b>16,850</b>	<b>44,666</b>		<b>11,651</b>	<b>364</b>

Table 5 System Level Load Comparison

# Annual Energy Consumption

## Fuel consumption

Based on the modeled information, the resultant fuel consumption can be characterized monthly in Figure 2, below. The electricity consumption is broken down by equipment use and displayed in Figure 3 as a percentage compared to the annual total consumption of 5,438 MWh.

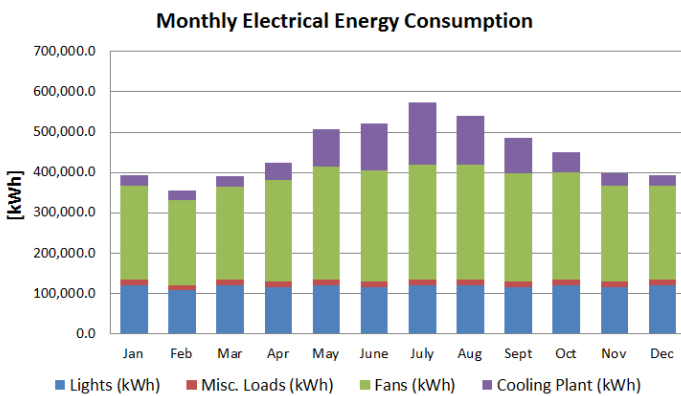


Figure 2 Monthly Electrical Energy Consumption

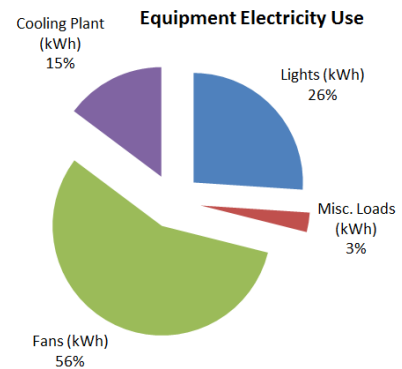


Figure 3 Electricity Use

It can be seen that the dominant consumer of electricity is the use of fans throughout the year, with increased consumption during the summer months. The next largest contributor to electricity use is the lighting requirements. The high allowable lighting power densities in theater spaces increase this value even though they will not be utilized daily. The miscellaneous loads account for a small part of electrical consumption. Additionally the cooling plant consumes more in the summer months, as to be expected, and hardly any kWh in the winter months.

Lemma, Minnesota is a heating dominated climate and the modeled use of a gas-fired boiler consumes significant levels during the winter months. The heating requirement peaks in the design condition's coldest month, January, and the demand falls just short of 45,000 therms (4500 MBtu) which equates to 85 therms/hr.

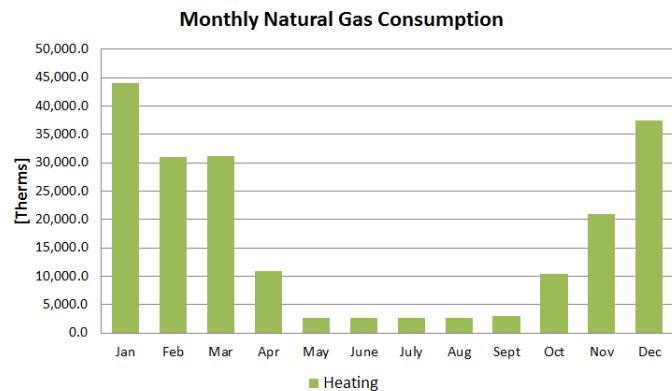


Figure 4 Monthly Natural Gas Consumption

## Water Consumption

As seen in Figure 5, right, the water consumption in the Auditorium increases during the late spring through summer months (May - September). This can be characterized due to the increased demand for cold air and water. As the chilled water plant output increases the consumption of the working fluid (municipal water) also increases. The peak water demand occurs during the design condition's warmest month, July, where the month's consumption exceeds 800,000 gallons.

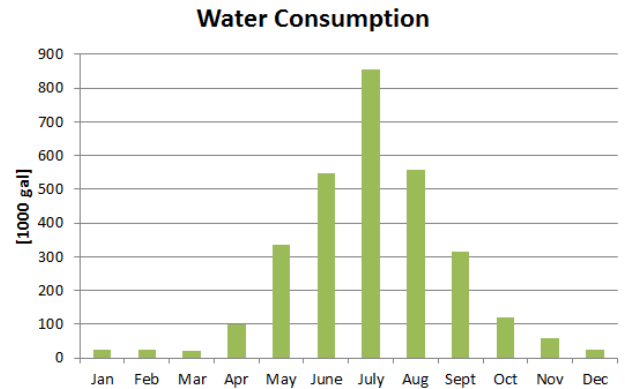


Figure 5 Monthly Water Consumption

## Annual Consumption Results

The Auditorium's use demand for electricity, water, cooling, and heating as expressed in the previous figures, show a standard trend for a heating dominated climate zone that has increased levels of lighting requirements above the typical office building on an annual cycle. When analyzing the design and construction documentation, an outside consultant evaluated the energy control strategies implemented to increase energy savings. They determined that the design for the Auditorium performed 12% better than a baseline building of similar type and occupancy. The key difference between the outside consultant's analysis and the model created for this report is level of detail. The outside energy consultant delved into far greater detail with a program more sophisticated than Trane Trace 700. They also have previous modeling experience and historical precedence to compare their findings with. The consultant was able to provide the owner with a greater certainty of energy consumption and savings.

# Annual Operating Cost

## Overview

The annual operating cost for the Auditorium, based on a Trane Trace 700 model is \$698,686, which can be expressed as \$4.07/SF of floor area. This is based on a simplified cost estimate of \$0.09/kWh and \$1.05/therm. Based on the findings, the electric portion of the annual cost is higher by approximately \$300,000/year, as seen in Figure 6. The monthly cost data (Figure 7) show that electricity accounts for the majority of cost per month over the calendar year.

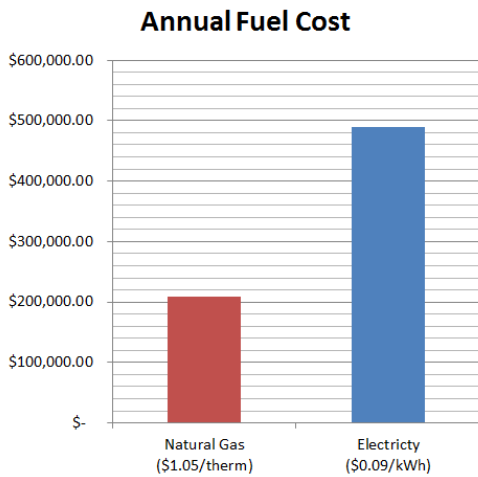


Figure 6 Annual Fuel Cost by Fuel Type

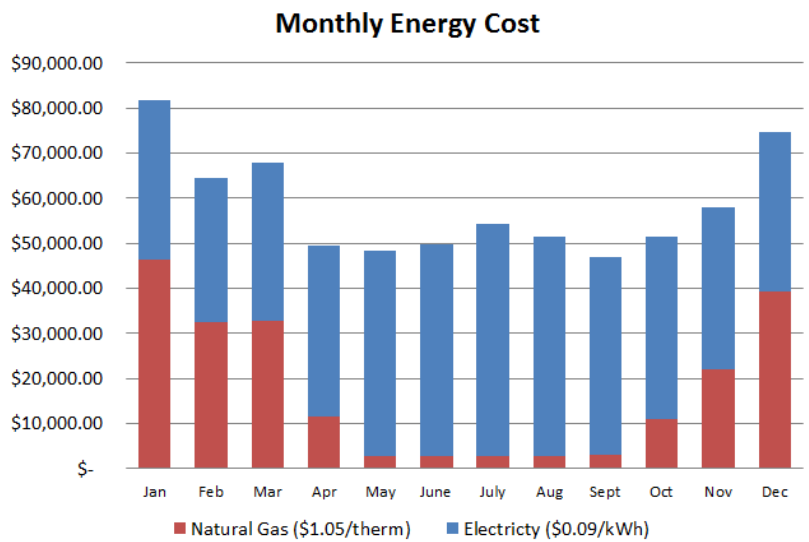


Figure 7 Monthly Fuel Cost

## Equipment Operating Cost

In Table 6, on the next page, the breakdown of cost by end-use shows that the systems' fans and the heating plant cost the most per year. A reduction in electricity use would significantly save the owner on its operating cost per year. One thing to note, is that the fans were all modeled with variable speed drives, which tend to reduce the energy consumption of fans overall compared to constant speed fans.

Cost Breakdown by Use Type					
	Lights	Misc. Loads	Fans	Cooling Plant	Heating Plant
Jan	\$ 10,821.15	\$ 1,192.63	\$ 21,036.05	\$ 2,385.92	\$ 46,262.22
Feb	\$ 9,773.94	\$ 1,077.22	\$ 19,010.47	\$ 2,164.06	\$ 32,534.46
Mar	\$ 10,821.13	\$ 1,192.63	\$ 20,902.43	\$ 2,362.31	\$ 32,681.67
Apr	\$ 10,472.08	\$ 1,154.16	\$ 22,625.83	\$ 3,890.66	\$ 11,397.33
May	\$ 10,821.14	\$ 1,192.63	\$ 25,355.11	\$ 8,290.72	\$ 2,728.99
Jun	\$ 10,472.06	\$ 1,154.16	\$ 24,781.97	\$ 10,553.92	\$ 2,751.71
Jul	\$ 10,821.16	\$ 1,192.63	\$ 25,745.78	\$ 13,857.23	\$ 2,791.47
Aug	\$ 10,821.13	\$ 1,192.63	\$ 25,656.23	\$ 10,875.90	\$ 2,859.50
Sep	\$ 10,472.09	\$ 1,154.16	\$ 24,120.95	\$ 8,038.70	\$ 3,117.29
Oct	\$ 10,821.15	\$ 1,192.63	\$ 24,047.27	\$ 4,536.08	\$ 10,921.65
Nov	\$ 10,472.07	\$ 1,154.16	\$ 21,311.12	\$ 2,977.48	\$ 21,993.77
Dec	\$ 10,821.16	\$ 1,192.63	\$ 20,947.43	\$ 2,374.84	\$ 39,344.62
<b>Total</b>	<b>\$ 127,410.26</b>	<b>\$ 14,042.27</b>	<b>\$ 275,540.61</b>	<b>\$ 72,307.82</b>	<b>\$ 209,384.68</b>

<b>Annual Total</b>	<b>\$ 698,685.64</b>
---------------------	----------------------

Table 6 Annual & Monthly Equipment Energy Cost  
Annual Cost \$4.07/SF

### Annual Cost Results

Further reduction in annual cost can be realized through the modeling of a more accurate electricity and fuel rate structures. The simplified cost data modeled for this report is not a realistic view of actual building operating cost, however it provides a basis for the initial view of what systems cost the most to operate. Area’s for further evaluation include efficiency of variable speed drive fans, campus steam and chilled water plant efficiency, output and consumption.

### Emissions

The environmental impact of the building on its surroundings is due mainly to the consumption of electricity. Approximately 8.5 million pounds of CO<sub>2</sub> are released per year to maintain occupant comfort and accommodate the electrical needs of the Auditorium. Additionally 19,860 grams/year (44 lbm/yr) of SO<sub>2</sub> is released along with 16,973 grams/yr (37 lbm/yr) of NOX compounds. (Figure 8, right) The impact of these greenhouse gas emission should be considered along with the type of refrigerant being used in the chilled water plant. Unfortunately, the specifications of the chiller plant is not included in the design documents for this renovation. However the information is being gathered for further environmental impact analysis.

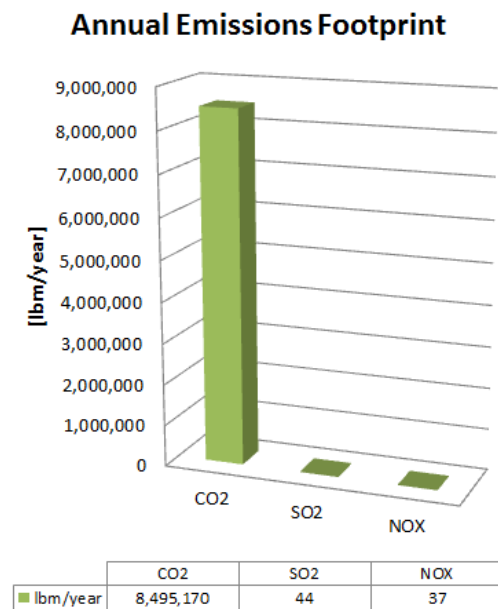


Figure 8 Annual Building Emissions Data

## 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.

ASHRAE (2012). *2012 ASHRAE Handbook - Fundamentals*. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

Trane Trace<sup>®</sup> 700 Version 6.2.10.0.

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](mailto:erin.c.miller@psu.edu).*



## Appendix A

<i>Table 1 - Ventilation Calculations</i> .....	16
<i>Table 2 - Load Template Data</i> .....	19

## Appendix B

<i>Figure 1 - ASHRAE 2005 Handbook of Fundamentals - Weather Data</i> .....	20
<i>Figure 2 - ASHRAE 62.1-2010 Table 6-1 - Minimum Ventilation Rates</i> .....	21
<i>Figure 3 - ASHRAE 62.1-2010 Table 6-4 - Minimum Exhaust Rates</i> .....	24
<i>Figure 4 - ASHRAE 90.1-2010 Tables 9.6.1 - Lighting Power Densities</i> .....	25

Room Number and Description	ASHRAE 62 Space Type (Pulldown Menu)	Manual Inputs					ASHRAE 62 Zone Distribution System (Pulldown Menu)	Heating Min cfm	Exhaust cfm	Calculations					Engineering Checks				Lookups							
		Area ft²	Height ft	People	Load Calc Peak cfm	People Diversity				Peak cfm	OA cfm	Z Crit	People #	Heating cfm	Exhaust cfm	Peak ACHR	Peak CFM/ft²	OA CFM/ft²	OA CFM/ft² Provided	ASHRAE cfm/person	ASHRAE CFM/ft²	ASHRAE People Density	Zone Dist. Effectiveness	People OA cfm	Area OA cfm	
<b>The Auditorium</b>	<b>Building Totals</b>	<b>130,856</b>		<b>6,327</b>				<b>6,038</b>		<b>167,265</b>	<b>37,330</b>	<b>49</b>	<b>6,177</b>	<b>50,180</b>	<b>6,152</b>		<b>1.28</b>								<b>28,245</b>	<b>9085</b>
<b>AHU-1 : Public Spaces</b>	<b>System Totals</b>	<b>72,530</b>		<b>2,578</b>				<b>3359</b>		<b>74,370</b>	<b>15,475</b>	<b>47</b>	<b>2,578</b>	<b>22,311</b>	<b>3,359</b>		<b>1.03</b>							<b>9,905</b>	<b>5570</b>	
B08 MECH/STOR	Storage rooms	2,803	9	5	422	100%	A-Ceiling supply, cooling	30%	0	425	336	0.79	5	128	0	1.0	0.15	0.12	0.05	0	0.12	0	1.0	0	336	
B08.1 MECH/STOR	Storage rooms	1,027	9	12	154	100%	A-Ceiling supply, cooling	30%	0	155	123	0.79	12	47	0	1.0	0.15	0.12	0.05	0	0.12	0	1.0	0	123	
B09 FIRE STATION	Storage rooms	172	9	1	26	100%	A-Ceiling supply, cooling	30%	0	30	21	0.69	1	9	0	1.2	0.17	0.12	0.06	0	0.12	0	1.0	0	21	
B10 MECH	Storage rooms	1,748	9	5	263	100%	A-Ceiling supply, cooling	30%	0	265	210	0.79	5	80	0	1.0	0.15	0.12	0.05	0	0.12	0	1.0	0	210	
003 Lobby	Lobbies	572	9	50	281	100%	A-Ceiling supply, cooling	30%	0	285	284	1.00	50	86	0	3.3	0.50	0.50	0.17	5	0.06	150	1.0	250	34	
003.1 Unisex	Restrooms	58	9	1	36	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	333	100%	A-Ceiling supply, cooling	30%	149	335	76	0.23	3	101	149	7.5	1.12	0.26	0.39	7.5	0.18	70	1.0	23	54	
008 First Aid	Office space	99	9	1	68	100%	A-Ceiling supply, cooling	30%	0	70	11	0.16	1	21	0	4.7	0.71	0.11	0.25	5	0.06	5	1.0	5	6	
009 Fire Command	Storage rooms	152	9	1	23	100%	A-Ceiling supply, cooling	30%	0	25	18	0.73	1	8	0	1.1	0.16	0.12	0.06	0	0.12	0	1.0	0	18	
010 Womens	Restrooms	591	9	5	889	100%	A-Ceiling supply, cooling	30%	296	890	144	0.16	5	267	296	10.0	1.51	0.24	0.53	7.5	0.18	70	1.0	38	106	
011 Coat Check	Office space	169	9	1	99	100%	A-Ceiling supply, cooling	30%	0	100	15	0.15	1	30	0	3.9	0.59	0.09	0.21	5	0.06	5	1.0	5	10	
013 Box office	Office space	420	9	4	205	100%	A-Ceiling supply, cooling	30%	0	210	45	0.22	4	63	0	3.3	0.50	0.11	0.18	5	0.06	5	1.0	20	25	
017 Call Center	Office space	219	9	2	120	100%	A-Ceiling supply, cooling	30%	0	120	23	0.19	2	36	0	3.7	0.55	0.11	0.19	5	0.06	5	1.0	10	13	
074 Corridor	Corridors	294	9	8	45	100%	A-Ceiling supply, cooling	30%	0	50	18	0.35	8	15	0	1.1	0.17	0.06	0.06	0	0.06	0	1.0	0	18	
088 West Entry	Lobbies	565	9	36	297	100%	A-Ceiling supply, cooling	30%	0	300	214	0.71	36	90	0	3.5	0.53	0.38	0.19	5	0.06	150	1.0	180	34	
089 Will Call	Office space	288	9	3	149	100%	A-Ceiling supply, cooling	30%	0	150	32	0.22	3	45	0	3.5	0.52	0.11	0.18	5	0.06	5	1.0	15	17	
090 Open Office	Office space	439	9	4	213	100%	A-Ceiling supply, cooling	30%	0	215	46	0.22	4	65	0	3.3	0.49	0.11	0.17	5	0.06	5	1.0	20	26	
090.2 Admin Office	Office space	112	9	1	318	100%	A-Ceiling supply, cooling	30%	0	320	12	0.04	1	96	0	19.1	2.86	1.0	1.00	5	0.06	5	1.0	5	7	
090.4 IT Support	Office space	112	9	1	335	100%	A-Ceiling supply, cooling	30%	0	335	12	0.03	1	101	0	20.0	3.00	1.0	1.05	5	0.06	5	1.0	5	7	
090.6 Bldg Mngr	Office space	146	9	2	368	100%	A-Ceiling supply, cooling	30%	0	370	19	0.05	2	111	0	16.8	2.53	0.13	0.88	5	0.06	5	1.0	10	9	
091 Coat Check	Office space	448	9	2	217	100%	A-Ceiling supply, cooling	30%	0	220	37	0.17	2	66	0	3.3	0.49	0.08	0.17	5	0.06	5	1.0	10	27	
093 Womens	Restrooms	473	9	4	290	100%	A-Ceiling supply, cooling	30%	236	290	115	0.40	4	87	236	4.1	0.61	0.24	0.21	7.5	0.18	70	1.0	30	85	
097 Lobby	Lobbies	706	9	35	355	100%	A-Ceiling supply, cooling	30%	0	355	217	0.61	35	107	0	3.4	0.50	0.31	0.18	5	0.06	150	1.0	175	42	
097 Unisex	Restrooms	61	8	1	38	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	57	100%	A-Ceiling supply, cooling	30%	21	60	24	0.40	4	18	21	5.8	0.86	0.35	0.30	5	0.06	25	1.0	20	4	
098 Mens	Restrooms	330	9	3	359	100%	A-Ceiling supply, cooling	30%	165	360	82	0.23	3	108	165	7.3	1.09	0.25	0.38	7.5	0.18	70	1.0	23	59	
100 MEM HALL	Corridors	2,878	10	190	2,470	100%	A-Ceiling supply, cooling	30%	0	2,475	173	0.07	190	743	0	5.2	0.86	0.06	0.30	0	0.06	0	1.0	0	173	
101 LOBBY	Lobbies	616	10	50	600	100%	A-Ceiling supply, cooling	30%	0	605	287	0.47	50	182	0	5.9	0.98	0.47	0.34	5	0.06	150	1.0	250	37	
104 LOUNGE	Lobbies	298	10	10	1,210	100%	A-Ceiling supply, cooling	30%	0	1,210	68	0.06	10	363	0	24.4	4.07	0.23	1.42	5	0.06	150	1.0	50	18	
105 CORRIDOR	Corridors	491	10	25	76	100%	A-Ceiling supply, cooling	30%	0	80	29	0.37	25	24	0	1.0	0.16	0.06	0.06	0	0.06	0	1.0	0	29	
106 CONF	Conference / meeting	388	10	15	1,441	100%	A-Ceiling supply, cooling	30%	0	1,445	98	0.07	15	434	0	22.3	3.72	0.25	1.30	5	0.06	50	1.0	75	23	
107 CONCESSION	Breakrooms	255	10	4	210	100%	A-Ceiling supply, cooling	30%	77	210	35	0.17	4	63	77	4.9	0.82	0.14	0.29	5	0.06	25	1.0	20	15	
109 STOR	Storage rooms	156	10	1	23	100%	A-Ceiling supply, cooling	30%	0	25	19	0.75	1	8	0	1.0	0.16	0.12	0.06	0	0.12	0	1.0	0	19	
110 INNO LAB	Conference / meeting	591	10	5	2,172	100%	A-Ceiling supply, cooling	30%	0	2,175	60	0.03	5	653	0	22.1	3.68	0.10	1.29	5	0.06	50	1.0	25	35	
110.1 CONF	Conference / meeting	201	10	2	1,210	100%	A-Ceiling supply, cooling	30%	0	1,215	22	0.02	2	365	0	36.2	6.03	0.11	2.11	5	0.06	50	1.0	10	12	
125 CORRIDOR	Corridors	2,032	10	101	306	100%	A-Ceiling supply, cooling	30%	0	310	122	0.39	101	93	0	0.9	0.15	0.06	0.05	0	0.06	0	1.0	0	122	
128 MENS	Restrooms	220	10	3	578	100%	A-Ceiling supply, cooling	30%	110	580	62	0.11	3	174	110	15.9	2.64	0.28	0.92	7.5	0.18	70	1.0	23	40	
131 ELEC	Storage rooms	74	10	1	11	100%	A-Ceiling supply, cooling	30%	0	15	9	0.59	1	5	0	1.2	0.20	0.12	0.07	0	0.12	0	1.0	0	9	
134 WOMENS	Restrooms	266	10	2	163	100%	A-Ceiling supply, cooling	30%	133	165	63	0.38	2	50	133	3.7	0.62	0.24	0.22	7.5	0.18	70	1.0	15	48	
137 CORRIDOR	Corridors	398	10	19	62	100%	A-Ceiling supply, cooling	30%	0	65	24	0.37	19	20	0	1.0	0.16	0.06	0.06	0	0.06	0	1.0	0	24	
155 HALL ENTRY	Lobbies	761	10	38	374	100%	A-Ceiling supply, cooling	30%	0	375	236	0.63	38	113	0	3.0	0.49	0.31	0.17	5	0.06	150	1.0	190	46	
157 LOBBY	Lobbies	4,190	10	209	2,058	100%	A-Ceiling supply, cooling	30%	0	2,060	1,296	0.63	209	618	0	3.0	0.49	0.31	0.17	5	0.06	150	1.0	1045	251	
163 VEST	Lobbies	162	10	8	79	100%	A-Ceiling supply, cooling	30%	0	80	50	0.62	8	24	0	3.0	0.49	0.31	0.17	5	0.06	150	1.0	40	10	
168 MENS	Restrooms	233	10	2	142	100%	A-Ceiling supply, cooling	30%	116	145	57	0.39	2	44	116	3.7	0.62	0.24	0.22	7.5	0.18	70	1.0	15	42	
175 CORRIDOR	Corridors	2,316	10	115	359	100%	A-Ceiling supply, cooling	30%	0	360	139	0.39	115	108	0	0.9	0.16	0.06	0.05	0	0.06	0	1.0	0	139	
178 WOMENS	Restrooms	265	10	2	163	100%	A-Ceiling supply, cooling	30%	133	165	63	0.38	2	50	133	3.7	0.62	0.24	0.22	7.5	0.18	70	1.0	15	48	
182 PREP	Breakrooms	250	10	14	725	100%	A-Ceiling supply, cooling	30%	75	730	85	0.12	14	219	75	17.5	2.92	0.34	1.02	5	0.06	25	1.0	70	15	
184 SERVING	Coffee Stations	185	10	10	709	100%	A-Ceiling supply, cooling	30%	55	710	122	0.17	10	213	55	23.1	3.85	0.66	1.35	10	0.12	25	1.0	100	22	

Room Number and Description	ASHRAE 62 Space Type (Pull-down Menu)	Manual Inputs						Calculations						Engineering Checks				Lookups							
		Area ft²	Height ft	People	Load Calc Peak cfm	People Diversity	ASHRAE 62 Zone Distribution System (Pull-down Menu)	Heating Min cfm	Exhaust cfm	Peak cfm	OA cfm	Z Crit	People #	Heating cfm	Exhaust cfm	Peak ACHR	Peak CFM/ft²	OA CFM/ft²	OA CFM/ft² Provided	ASHRAE cfm/person	ASHRAE CFM/ft²	ASHRAE People Density	Zone Dist. Effectiveness	People OA cfm	Area OA cfm
290.14 GRANTS CNSLT	Office space	88	10	1	581	100%	A-Ceiling supply, cooling	30%	0	585	10	0.02	1	176	0	39.8	6.64	0.12	2.32	5	0.06	5	1.0	5	5
295 CORRIDOR	Corridors	304	10	10	47	100%	A-Ceiling supply, cooling	30%	0	50	18	0.36	10	15	0	1.0	0.16	0.06	0.06	0	0.06	0	1.0	0	18
296 LOUNGE	Lobbies	300	10	10	1,261	100%	A-Ceiling supply, cooling	30%	0	1,265	68	0.05	10	380	0	25.3	4.21	0.23	1.48	5	0.06	150	1.0	50	18
297 LOBBY	Lobbies	1,296	10	44	637	100%	A-Ceiling supply, cooling	30%	0	640	298	0.47	44	192	0	3.0	0.49	0.23	0.17	5	0.06	150	1.0	220	78
298 LOBBY	Lobbies	574	10	20	583	100%	A-Ceiling supply, cooling	30%	0	585	134	0.23	20	176	0	6.1	1.02	0.23	0.36	5	0.06	150	1.0	100	34
301 LOBBY	Lobbies	652	10	32	615	100%	A-Ceiling supply, cooling	30%	0	615	199	0.32	32	185	0	5.7	0.94	0.31	0.33	5	0.06	150	1.0	160	39
303 LOBBY	Lobbies	1,211	10	60	595	100%	A-Ceiling supply, cooling	30%	0	595	373	0.63	60	179	0	2.9	0.49	0.31	0.17	5	0.06	150	1.0	300	73
304 LOUNGE	Lobbies	342	10	17	1,230	100%	A-Ceiling supply, cooling	30%	0	1,230	106	0.09	17	369	0	21.6	3.60	0.31	1.26	5	0.06	150	1.0	85	21
305 CORRIDOR	Corridors	233	10	11	36	100%	A-Ceiling supply, cooling	30%	0	40	14	0.35	11	12	0	1.0	0.17	0.06	0.06	0	0.06	0	1.0	0	14
307 CORRIDOR	Corridors	127	10	6	20	100%	A-Ceiling supply, cooling	30%	0	20	8	0.38	6	6	0	0.9	0.16	0.06	0.06	0	0.06	0	1.0	0	8
310 HONORS	Office space	904	10	8	880	100%	A-Ceiling supply, cooling	30%	0	880	94	0.11	8	264	0	5.8	0.97	0.10	0.34	5	0.06	5	1.0	40	54
310.02 PRO ADVR	Office space	85	10	1	570	100%	A-Ceiling supply, cooling	30%	0	575	10	0.02	1	173	0	40.4	6.73	0.12	2.36	5	0.06	5	1.0	5	5
310.04 PRO ADVR	Office space	106	10	1	535	100%	A-Ceiling supply, cooling	30%	0	535	11	0.02	1	161	0	30.4	5.06	0.11	1.77	5	0.06	5	1.0	5	6
310.06 PRO ADVR	Office space	105	10	1	535	100%	A-Ceiling supply, cooling	30%	0	535	11	0.02	1	161	0	30.5	5.08	0.11	1.78	5	0.06	5	1.0	5	6
310.08 PRO ADVR	Office space	106	10	1	535	100%	A-Ceiling supply, cooling	30%	0	540	11	0.02	1	162	0	30.7	5.11	0.11	1.79	5	0.06	5	1.0	5	6
310.10 PRO ADVR	Office space	106	10	1	67	100%	A-Ceiling supply, cooling	30%	0	70	11	0.16	1	21	0	4.0	0.66	0.11	0.23	5	0.06	5	1.0	5	6
310.11 PRO ADVR	Office space	95	10	1	535	100%	A-Ceiling supply, cooling	30%	0	535	11	0.02	1	161	0	33.7	5.62	0.11	1.97	5	0.06	5	1.0	5	6
310.12 PRO ADVR	Office space	106	10	1	63	100%	A-Ceiling supply, cooling	30%	0	65	11	0.17	1	20	0	3.7	0.61	0.11	0.22	5	0.06	5	1.0	5	6
310.13 PRO ADVR	Office space	86	10	1	538	100%	A-Ceiling supply, cooling	30%	0	540	10	0.02	1	162	0	37.8	6.30	0.12	2.21	5	0.06	5	1.0	5	5
310.14 PRO ADVR	Office space	114	10	1	65	100%	A-Ceiling supply, cooling	30%	0	65	12	0.18	1	20	0	3.4	0.57	0.10	0.20	5	0.06	5	1.0	5	7
310.15 PRO ADVR	Office space	90	10	1	543	100%	A-Ceiling supply, cooling	30%	0	545	10	0.02	1	164	0	36.2	6.03	0.12	2.11	5	0.06	5	1.0	5	5
310.16 PRO ADVR	Office space	124	10	1	15	100%	A-Ceiling supply, cooling	30%	0	20	12	0.62	1	6	0	1.0	0.16	0.10	0.06	5	0.06	5	1.0	5	7
310.17 CORRIDOR	Corridors	158	10	1	535	100%	A-Ceiling supply, cooling	30%	0	535	9	0.02	1	161	0	20.3	3.38	0.06	1.18	0	0.06	0	1.0	0	9
318 WKRM	Conference / meeting	134	10	2	130	100%	A-Ceiling supply, cooling	30%	0	130	18	0.14	2	39	0	5.8	0.97	0.13	0.34	5	0.06	50	1.0	10	8
327 CORRIDOR	Corridors	1,226	10	61	190	100%	A-Ceiling supply, cooling	30%	0	190	74	0.39	61	57	0	0.9	0.16	0.06	0.05	0	0.06	0	1.0	0	74
334 WOMENS	Restrooms	233	10	2	143	100%	A-Ceiling supply, cooling	30%	116	145	57	0.39	2	44	116	3.7	0.62	0.24	0.22	7.5	0.18	70	1.0	15	42
335 CUST	Storage rooms	32	10	1	6	100%	A-Ceiling supply, cooling	30%	0	10	4	0.38	1	3	0	1.9	0.32	0.12	0.11	0	0.12	0	1.0	0	4
341 MENS	Restrooms	162	10	2	99	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	43	100%	A-Ceiling supply, cooling	30%	0	45	17	0.37	14	14	0	1.0	0.16	0.06	0.06	0	0.06	0	1.0	0	17
368 MENS	Restrooms	166	10	2	102	100%	A-Ceiling supply, cooling	30%	83	105	45	0.43	2	32	83	3.8	0.63	0.27	0.22	7.5	0.18	70	1.0	15	30
375 CORRIDOR	Corridors	1,284	10	64	199	100%	A-Ceiling supply, cooling	30%	0	200	77	0.39	64	60	0	0.9	0.16	0.06	0.05	0	0.06	0	1.0	0	77
377 ELEC	Storage rooms	78	10	1	12	100%	A-Ceiling supply, cooling	30%	0	15	9	0.62	1	5	0	1.2	0.19	0.12	0.07	0	0.12	0	1.0	0	9
378 WOMENS	Restrooms	230	10	2	141	100%	A-Ceiling supply, cooling	30%	115	145	56	0.39	2	44	115	3.8	0.63	0.25	0.22	7.5	0.18	70	1.0	15	41
382 CONFERENCE	Conference / meeting	297	10	13	850	100%	A-Ceiling supply, cooling	30%	0	855	83	0.10	13	257	0	17.3	2.88	0.28	1.01	5	0.06	50	1.0	65	18
385 CORRIDOR	Corridors	1,527	10	76	236	100%	A-Ceiling supply, cooling	30%	0	240	92	0.38	76	72	0	0.9	0.16	0.06	0.06	0	0.06	0	1.0	0	92
390 HONORS	Office space	1,301	10	11	3,489	100%	A-Ceiling supply, cooling	30%	0	3,490	133	0.04	11	1,047	0	16.1	2.68	0.10	0.94	5	0.06	5	1.0	55	78
390.1 ASC DIR	Office space	93	10	1	66	100%	A-Ceiling supply, cooling	30%	0	70	11	0.15	1	21	0	4.5	0.76	0.11	0.26	5	0.06	5	1.0	5	6
390.2 ASC DIR	Office space	130	10	1	564	100%	A-Ceiling supply, cooling	30%	0	565	13	0.02	1	170	0	26.0	4.33	0.10	1.52	5	0.06	5	1.0	5	8
390.3 HNR STD ASSC	Office space	89	10	1	64	100%	A-Ceiling supply, cooling	30%	0	65	10	0.16	1	20	0	4.4	0.73	0.12	0.26	5	0.06	5	1.0	5	5
390.4 HNR DIR	Office space	195	10	1	1,144	100%	A-Ceiling supply, cooling	30%	0	1,145	17	0.01	1	344	0	35.2	5.87	0.09	2.05	5	0.06	5	1.0	5	12
390.5 WKRM	Conference / meeting	121	10	1	118	100%	A-Ceiling supply, cooling	30%	0	120	12	0.10	1	36	0	6.0	0.99	0.10	0.35	5	0.06	50	1.0	5	7
396 LOUNGE	Lobbies	337	10	17	1,278	100%	A-Ceiling supply, cooling	30%	0	1,280	105	0.08	17	384	0	22.8	3.79	0.31	1.33	5	0.06	150	1.0	85	20
397 LOBBY	Lobbies	1,174	10	58	577	100%	A-Ceiling supply, cooling	30%	0	580	360	0.62	58	174	0	3.0	0.49	0.31	0.17	5	0.06	150	1.0	290	70
398 LOBBY	Lobbies	619	10	31	601	100%	A-Ceiling supply, cooling	30%	0	605	192	0.32	31	182	0	5.9	0.98	0.31	0.34	5	0.06	150	1.0	155	37
400 LEC GALLERY	Lecture Classroom	1,483	10	90	5,527	100%	A-Ceiling supply, cooling	30%	0	5,530	764	0.14	90	1,659	0	22.4	3.73	0.52	1.31	7.5	0.06	65	1.0	675	89
403 LOBBY	Lobbies	1,389	10	100	682	100%	A-Ceiling supply, cooling	30%	0	685	583	0.85	100	206	0	3.0	0.49	0.42	0.17	5	0.06	150	1.0	500	83
404 CORRIDOR	Corridors	152	10	5	42	100%	A-Ceiling supply, cooling	30%	0	45	9	0.20	5	14	0	1.8	0.30	0.06	0.10	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	172	100%	A-Ceiling supply, cooling	30%	140	175	73	0.42	3	53	140	3.7	0.62	0.26	0.22	7.5	0.18	70	1.0	23	51
420 LOBBY	Lobbies	1,230	10	9	745	100%	A-Ceiling supply, cooling	30%	0	750	119	0.16	9	225	0	3.7	0.61	0.10	0.21	5	0.06	150	1.0	45	74
422 CONCESSIONS	Breakrooms	162	9	1	133	100%	A-Ceiling supply, cooling	30%	49	135	15	0.11	1	41	49	5.5	0.83	0.09	0.29	5	0.06	25	1.0	5	10
436 PIPE ORGAN LOFT E	Storage rooms	619	10	2	93	100%	A-Ceiling supply, cooling	30%	0	95	74	0.78	2	29	0	0.9	0.15	0.12	0.05	0	0.12	0	1.0	0	74
460 RECITAL HALL	Stages, studios	1,960	10	250	2,774	100%	A-Ceiling supply, cooling	30%	0	2,775	2,618	0.94	250	833	0	8.5	1.42	1.34	0.50	10	0.06	70	1.0	2500	118
462 STOR	Storage rooms	417	10	1	63	100%	A-Ceiling supply, cooling	30%	0	65	50	0.77	1	20	0	0.9	0.16	0.12	0.05	0	0.12	0	1.0	0	50
463 CORRIDOR	Corridors	145	10	1	22	100%	A-Ceiling supply, cooling	30%	0	25	9	0.35	1	8	0	1.0	0.17	0.06	0.06	0	0.06	0	1.0	0	9
467 CORRIDOR	Corridors	230	10	1	36	100%	A-Ceiling supply, cooling	30%	0	40	14	0.35	1	12	0	1.0	0.17	0.06	0.06	0	0.06	0	1.0	0	14
470 ELEC	Storage rooms	287	10	1	43	100%	A-Ceiling supply, cooling	30%	0	45	34	0.77	1	14	0	0.9	0.16	0.12	0.05	0	0.12	0	1.0	0	34
478.1 STOR	Storage rooms	54	1																						



Room Number and Description	ASHRAE 62 Space Type (Pulldown Menu)	Manual Inputs					Calculations									Engineering Checks				Lookups					
		Area ft²	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 ACHR	Peak CFM/ft²	OA CFM/ft²	OA CFM/ft² Provided	ASHRAE cfm/person	ASHRAE CFM/ft²	ASHRAE People Density	Zone Dist. Effectiveness	People OA cfm	Area OA cfm
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	84	100%	A-Ceiling supply, cooling	30%	70	85	38	0.45	6	26	70	4.6	0.61	0.28	0.21	5	0.06	50	1.0	30	8
B49 BRK RM	Breakrooms	206	8	9	100	100%	A-Ceiling supply, cooling	30%	62	100	57	0.57	9	30	62	3.6	0.49	0.28	0.17	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	23	100%	A-Ceiling supply, cooling	30%	0	25	12	0.48	1	8	0	1.6	0.21	0.10	0.07	5	0.06	5	1.0	5	7
B52 DRESSING	Dressing Room/Locker Room	131	8	6	79	100%	A-Ceiling supply, cooling	30%	66	80	38	0.47	6	24	66	4.6	0.61	0.29	0.21	5	0.06	50	1.0	30	8
B53 TECH OFFICE/WKRM	Conference / meeting	148	8	2	20	100%	A-Ceiling supply, cooling	30%	0	20	19	0.94	2	6	0	1.0	0.13	0.13	0.05	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	129	100%	A-Ceiling supply, cooling	30%	107	130	58	0.45	9	39	107	4.6	0.61	0.27	0.21	5	0.06	50	1.0	45	13
B57 HOUSE SOUND/ELEC	Office space	208	8	3	27	100%	A-Ceiling supply, cooling	30%	0	30	27	0.92	3	9	0	1.1	0.14	0.13	0.05	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	23	100%	A-Ceiling supply, cooling	30%	0	25	17	0.69	2	8	0	1.5	0.20	0.14	0.07	5	0.06	5	1.0	10	7
B60 DRESSING	Dressing Room/Locker Room	525	8	21	315	100%	A-Ceiling supply, cooling	30%	262	315	136	0.43	21	95	262	4.5	0.60	0.26	0.21	5	0.06	50	1.0	105	31
B61 WKRM/STOR	Storage rooms	173	8	2	54	100%	A-Ceiling supply, cooling	30%	0	55	21	0.38	2	17	0	2.4	0.32	0.12	0.11	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	20	100%	A-Ceiling supply, cooling	30%	0	25	19	0.77	2	8	0	1.2	0.16	0.12	0.06	5	0.06	5	1.0	10	9
B64 DRESSING	Dressing Room/Locker Room	519	8	21	311	100%	A-Ceiling supply, cooling	30%	259	315	136	0.43	21	95	259	4.6	0.61	0.26	0.21	5	0.06	50	1.0	105	31
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	50	100%	A-Ceiling supply, cooling	30%	0	50	27	0.55	3	15	0	1.8	0.24	0.13	0.09	5	0.06	5	1.0	15	12
B80 CUST MAIN	Janitorial	202	8	2	24	100%	A-Ceiling supply, cooling	30%	202	25	0	0.00	2	8	202	0.9	0.12	0.00	0.04	0	0	0	1.0	0	0
B82 SOUND WKRM	Office space	201	8	2	26	100%	A-Ceiling supply, cooling	30%	0	30	22	0.74	2	9	0	1.1	0.15	0.11	0.05	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	200	100%	A-Ceiling supply, cooling	30%	0	200	200	1.00	19	60	0	0.5	0.06	0.06	0.02	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	19	100%	A-Ceiling supply, cooling	30%	0	20	0	0.00	1	6	0	1.2	0.16	0.00	0.05	0	0	0	1.0	0	0
B92 BOH STOR	Storage rooms	1,128	8	5	135	100%	A-Ceiling supply, cooling	30%	0	140	135	0.97	5	42	0	0.9	0.12	0.12	0.04	0	0.12	0	1.0	0	135
020 Reception	Lobbies	172	9	2	29	100%	A-Ceiling supply, cooling	30%	0	30	20	0.68	2	9	0	1.2	0.17	0.12	0.06	5	0.06	150	1.0	10	10
020.1 Ticketing Dir	Office space	126	8	2	24	100%	A-Ceiling supply, cooling	30%	0	25	18	0.70	2	8	0	1.5	0.20	0.14	0.07	5	0.06	5	1.0	10	8
020.2 Open Office	Office space	631	9	6	183	100%	A-Ceiling supply, cooling	30%	0	185	68	0.37	6	56	114	2.0	0.29	0.11	0.10	5	0.06	5	1.0	30	38
020.4 Ex Relations Dir	Office space	112	8	2	39	100%	A-Ceiling supply, cooling	30%	0	40	17	0.42	2	12	0	2.7	0.36	0.15	0.12	5	0.06	5	1.0	10	7
020.6 Exec Art Dir	Office space	134	9	2	96	100%	A-Ceiling supply, cooling	30%	0	100	18	0.18	2	30	0	5.0	0.74	0.13	0.26	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	309	100%	A-Ceiling supply, cooling	30%	0	310	273	0.88	24	93	0	4.2	0.56	0.49	0.20	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	20	100%	A-Ceiling supply, cooling	30%	0	20	20	0.99	1	6	0	0.4	0.06	0.06	0.02	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	7	0.29	1	8	20	4.8	0.63	0.19	0.22	5	0.06	50	1.0	5	2
045 Corridor	Corridors	2,894	39.2	5	174	100%	A-Ceiling supply, cooling	30%	0	175	174	0.99	5	53	0	0.1	0.06	0.06	0.02	0	0.06	0	1.0	0	174
055 Crossover	Storage rooms	1,496	39.2	1	200	100%	A-Ceiling supply, cooling	30%	0	200	179	0.90	1	60	0	0.2	0.13	0.12	0.05	0	0.12	0	1.0	0	179
060 Loading	Storage rooms	1,298	39.2	3	156	100%	A-Ceiling supply, cooling	30%	0	160	156	0.97	3	48	0	0.2	0.12	0.12	0.04	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
062 Loading	Storage rooms	317	8	3	38	100%	A-Ceiling supply, cooling	30%	0	40	38	0.95	3	12	0	0.9	0.13	0.12	0.04	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	6	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	120	100%	A-Ceiling supply, cooling	30%	0	125	120	0.96	2	38	0	0.5	0.06	0.06	0.02	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	5	100%	A-Ceiling supply, cooling	30%	0	5	5	0.95	1	2	0	0.5	0.06	0.06	0.02	0	0.06	0	1.0	0	5
070 Dressing Star	Dressing Room/Locker Room	139	8	6	83	100%	A-Ceiling supply, cooling	30%	69	85	38	0.45	6	26	69	4.6	0.61	0.28	0.21	5	0.06	50	1.0	30	8
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	94	100%	A-Ceiling supply, cooling	30%	78	95	44	0.47	7	29	78	4.5	0.61	0.28	0.21	5	0.06	50	1.0	35	9
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	102	100%	A-Ceiling supply, cooling	30%	0	105	71	0.67	5	32	0	1.0	0.14	0.09	0.05	5	0.06	5	1.0	25	46
080.2 Mktg Dir	Office space	166	8	2	26	100%	A-Ceiling supply, cooling	30%	0	30	20	0.66	2	9	0	1.4	0.18	0.12	0.06	5	0.06	5	1.0	10	10
080.4 Opp Dir/Bus Mngr	Office space	145	8	2	23	100%	A-Ceiling supply, cooling	30%	0	25	19	0.75	2	8	0	1.3	0.17	0.13	0.06	5	0.06	5	1.0	10	9
082 Security	Office space	203	8	4	50	100%	A-Ceiling supply, cooling	30%	0	50	32	0.64	4	15	0	1.8	0.25	0.16	0.09	5	0.06	5	1.0	20	12
084 House Mngr	Office space	102	8	1	21	100%	A-Ceiling supply, cooling	30%	0	25	11	0.44	1	8	0	1.8	0.25	0.11	0.09	5	0.06	5	1.0	5	6
087 Ushers	Office space	279	8	3	37	100%	A-Ceiling supply, cooling	30%	0	40	32	0.79	3	12	0	1.1	0.14	0.11	0.05	5	0.06	5	1.0	15	17

Template	People		Lighting		Misc		AIRFLOW			CONSTRUCTION	
	TYPE	DENSITY SF/PERSON	TYPE	HEAT GAIN W/SF	TYPE	ENERGY W/SF	VENTILATION TYPE 62.1	VAV CONTROL	EXHAUST CFM/SF	FLR-FLR HEIGHT	ABOVE/BELOW GRADE
Auditorium Seating Area	Auditorium	6.7	Flourescent, hung below ceiling, 100% load to space	2.43	--	0.50	Auditorium seating area	30% Min Clg Airflow	0.0	100	ABOVE
Balcony Seating Area	Auditorium	6.7	Flourescent, hung below ceiling, 100% load to space	2.43	--	1.50	Auditorium seating area	30% Min Clg Airflow	0.0	24	ABOVE
Breakrooms	General Office Space	143	Recessed flourescent, not vented, 80% load to space	0.89	Appliances	3.00	Breakrooms	30% Min Clg Airflow	0.5	10	ABOVE
Coffee Stations	General Office Space	143	Recessed flourescent, not vented, 80% load to space	0.89	Appliances	1.00	Coffee Stations	30% Min Clg Airflow	0.5	10	ABOVE
Conference/Meeting	Conference Room	20	Recessed flourescent, not vented, 80% load to space	1.23	Office Equipment	0.50	Conference / meeting	30% Min Clg Airflow	0.0	10	ABOVE
Corridor	None	0	Recessed flourescent, not vented, 80% load to space	0.66	--	0.00	Corridors	0.5 cfm/SF	0.0	10	ABOVE
Dressing Room/Locker Room (Below Grade)	Conference Room	20	Flourescent, hung below ceiling, 100% load to space	1.50	--	2.50	Default Std62	30% Min Clg Airflow	0.5	10	BELOW
Dressing Room/Locker Room (Above Grade)	Conference Room	20	Flourescent, hung below ceiling, 100% load to space	1.50	--	3.50	Default Std63	30% Min Clg Airflow	0.5	10	ABOVE
Janitorial (Below Grade)	None	0	Recessed flourescent, not vented, 80% load to space	0.95	--	0.00	Storage rooms	0.5 cfm/SF	1.0	10	BELOW
Janitorial (Above Grade)	None	0	Recessed flourescent, not vented, 80% load to space	0.95	--	0.00	Storage rooms	0.5 cfm/SF	0.0	10	ABOVE
Laundry	None	0	Recessed flourescent, not vented, 80% load to space	0.60	Equipment	2.00	Laundries	30% Min Clg Airflow	0.0	10	ABOVE
Lecture Classroom	Classroom	20	Recessed flourescent, not vented, 80% load to space	1.24	Office Equipment	0.50	Lecture Classroom	30% Min Clg Airflow	0.0	10	ABOVE
Lobbies	Reception Area	45	Recessed flourescent, not vented, 80% load to space	1.00	--	0.00	Lobbies	30% Min Clg Airflow	0.0	10	ABOVE
Music/Dance/Theater	Classroom	20	Recessed flourescent, not vented, 80% load to space	2.43	--	0.00	Music/theater/dance	30% Min Clg Airflow	0.0	10	ABOVE
Office Space	General Office Space	143	Recessed flourescent, not vented, 80% load to space	0.98	Office Equipment	1.25	Office space	30% Min Clg Airflow	0.0	10	ABOVE
Restrooms	None	0	Recessed flourescent, not vented, 80% load to space	0.98	--	0.00	Default Std62	30% Min Clg Airflow	0.5	10	ABOVE
Stages/Studios	Classroom	20	Recessed flourescent, not vented, 80% load to space	1.25	--	0.00	Stages, studios	30% Min Clg Airflow	0.0	10	ABOVE
Storage Room	None	0	Recessed flourescent, not vented, 80% load to space	0.63	--	0.00	Storage rooms	0.5 cfm/SF	0.0	100	ABOVE

# Appendix B: Figure 1 - Handbook of Fundamentals - Weather Data

2005 ASHRAE Handbook - Fundamentals (IP)

© 2005 ASHRAE, Inc.

## Design conditions for [redacted] MN, USA

### Station Information

Station name	WMO#	Lat	Long	Elev	StdP	Hours +/- UTC	Time zone code	Period
1a	1b	1c	1d	1e	1f	1g	1h	1i
[redacted]	726580	44.87N	93.22W	837	14.257	-6.00	NAC	7201

### Annual Heating and Humidification Design Conditions

Coldest month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
	99.6%	99%	99.6%		99%		0.4%		1%		MCWS	PCWD			
	3a	3b	DP	HR	DP	HR	WS	MCDB	WS	MCDB			5a	5b	5c
2			4a	4b	4c	4d	4e	4f	5a	5b	5c	5d	6a	6b	
1	-14.9	-9.4	-25.7	1.4	-14.0	-19.7	1.9	-8.2	27.9	13.6	25.2	12.3	8.7	310	

### Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest month	Hottest month DB range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB					
		0.4%		1%		2%		0.4%		1%		2%		MCWS	PCWD				
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB			10a	10b	10c	10d
7	8	9a	9b	9c	9d	9e	9f	10a	10b	10c	10d	10e	10f	11a	11b				
7	18.6	91.0	73.2	87.8	71.8	85.0	70.1	76.7	87.2	74.7	84.2	72.7	81.9	13.9	180				

Dehumidification DP/MCDB and HR									Enthalpy/MCDB					
0.4%			1%			2%			0.4%		1%		2%	
DP	HR	MCDB	DP	HR	MCDB	DP	HR	MCDB	Enth	MCDB	Enth	MCDB	Enth	MCDB
12a	12b	12c	12d	12e	12f	12g	12h	12i	13a	13b	13c	13d	13e	13f
73.3	127.8	83.4	71.3	119.3	81.1	69.4	111.3	79.0	33.0	87.6	31.0	84.2	29.2	81.9

### Extreme Annual Design Conditions

Extreme Annual WS			Extreme Max WB	Extreme Annual DB				n-Year Return Period Values of Extreme DB							
1%	2.5%	5%		Mean	Standard deviation		n=5 years		n=10 years		n=20 years		n=50 years		
14a	14b	14c	15	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
24.8	21.6	19.5	83.5	96.5	-20.8	3.6	5.7	99.1	-24.9	101.2	-28.2	103.2	-31.4	105.8	-35.6

### Monthly Design Dry Bulb and Mean Coincident Wet Bulb Temperatures

%	Jan		Feb		Mar		Apr		May		Jun	
	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB
	18a	18b	18c	18d	18e	18f	18g	18h	18i	18j	18k	18l
0.4%	42.6	37.2	51.9	44.8	66.3	55.9	81.2	61.2	88.4	66.3	93.2	72.3
1%	39.7	35.1	47.4	41.2	61.8	52.3	77.0	59.3	85.9	65.4	90.9	71.8
2%	37.6	33.7	44.2	39.5	57.9	48.9	73.6	57.4	83.3	64.5	88.7	70.7

%	Jul		Aug		Sep		Oct		Nov		Dec	
	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB	DB	MCWB
	18m	18n	18o	18p	18q	18r	18s	18t	18u	18v	18w	18x
0.4%	96.6	75.4	94.1	75.9	89.3	72.5	79.6	62.5	66.4	54.9	49.4	44.2
1%	94.0	75.1	90.8	74.5	86.3	70.8	75.7	61.0	62.1	54.2	44.9	39.8
2%	91.8	74.1	88.7	74.0	83.7	69.7	72.3	60.1	59.0	51.9	42.0	37.3

### Monthly Design Wet Bulb and Mean Coincident Dry Bulb Temperatures

%	Jan		Feb		Mar		Apr		May		Jun	
	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB
	19a	19b	19c	19d	19e	19f	19g	19h	19i	19j	19k	19l
0.4%	37.6	42.0	44.7	50.3	57.3	63.6	63.9	76.1	70.9	82.2	76.9	88.2
1%	35.7	38.8	42.6	47.1	54.1	60.6	62.0	73.3	69.1	79.6	75.4	85.3
2%	34.3	36.7	39.8	43.7	51.0	55.6	59.9	69.7	67.7	78.0	74.1	83.9

%	Jul		Aug		Sep		Oct		Nov		Dec	
	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB	WB	MCDB
	19m	19n	19o	19p	19q	19r	19s	19t	19u	19v	19w	19x
0.4%	79.7	90.1	78.8	89.2	75.0	85.9	66.7	74.0	58.2	63.1	46.2	48.5
1%	78.2	89.3	77.4	87.8	73.3	83.1	64.2	71.5	55.5	60.5	40.7	44.5
2%	77.2	88.3	76.2	85.7	71.7	80.3	62.2	69.9	53.0	57.8	37.6	40.9

### Monthly Mean Daily Temperature Range

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20a	20b	20c	20d	20e	20f	20g	20h	20i	20j	20k	20l
15.9	15.3	15.7	19.1	19.8	19.5	18.6	17.9	18.6	18.0	14.0	14.2

WMO#	World Meteorological Organization number	Lat	Latitude, °	Long	Longitude, °
Elev	Elevation, ft	StdP	Standard pressure at station elevation, psi		
DB	Dry bulb temperature, °F	DP	Dew point temperature, °F	WB	Wet bulb temperature, °F
WS	Wind speed, mph	Enth	Enthalpy, Btu/lb	HR	Humidity ratio, grains of moisture per lb of dry air
MCDB	Mean coincident dry bulb temperature, °F	MCDP	Mean coincident dew point temperature, °F	MCWB	Mean coincident wet bulb temperature, °F
MCWS	Mean coincident wind speed, mph	PCWD	Prevailing coincident wind direction, °, 0 = North, 90 = East		



Appendix B: Figure 2 - 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	
	cfm/person	L/s-person	cfm/ft <sup>2</sup>	L/s-m <sup>2</sup>		Occupant Density	Combined Outdoor Air Rate (see Note 5)		
						(see Note 4) #/1000 ft <sup>2</sup> or #/100 m <sup>2</sup>	cfm/person L/s-person		
<b>Correctional Facilities</b>									
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
<b>Educational Facilities</b>									
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
<b>Food and Beverage Service</b>									
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
<b>General</b>									
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
<b>Hotels, Motels, Resorts, Dormitories</b>									
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 2 - 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		Area Outdoor Air Rate		Notes	Default Values		Air Class	
	$R_p$		$R_a$			Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s-person	cfm/ft <sup>2</sup>	L/s-m <sup>2</sup>			#/1000 ft <sup>2</sup> or #/100 m <sup>2</sup>		cfm/person
<b>Office Buildings</b>									
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
<b>Miscellaneous Spaces</b>									
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
<b>Public Assembly Spaces</b>									
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
<b>Residential</b>									
Dwelling unit	5	2.5	0.06	0.3	F,G	F			1
Common corridors	–	–	0.06	0.3					1
<b>Retail</b>									
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 2 - 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	
	cfm/person	L/s-person	cfm/ft <sup>2</sup>	L/s-m <sup>2</sup>		Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
						#/1000 ft <sup>2</sup> or #/100 m <sup>2</sup>	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
<b>Sports and Entertainment</b>									
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<sub>m</sub>/ft<sup>3</sup> (1.2 kg<sub>m</sub>/m<sup>3</sup>), 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 3 - 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 <sup>2</sup>	Notes	Exhaust Rate, L/s-unit	Exhaust Rate, L/s-m <sup>2</sup>	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 4 - ASHRAE 90.1-2010 Tables 9.6.1 - Lighting Power Densities

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method

Common Space Types <sup>a</sup>	LPD, W/ft <sup>2</sup>	RCR Threshold
Atrium		
First 40 ft in height	0.03 per ft (height)	NA
Height above 40 ft	0.02 per ft (height)	NA
Audience/Seating Area—Permanent		
For auditorium	0.79	6
For Performing Arts Theater	2.43	8
For Motion Picture Theater	1.14	4
Classroom/Lecture/Training	1.24	4
Conference/Meeting/Multipurpose	1.23	6
Corridor/Transition	0.66	Width < 8 ft
Dining Area	0.65	4
For Bar Lounge/Leisure Dining	1.31	4
For Family Dining	0.89	4
Dressing/Fitting Room for Performing Arts Theater	0.40	6
Electrical/Mechanical	0.95	6
Food Preparation	0.99	6
Laboratory		
For Classrooms	1.28	6
For Medical/Industrial/Research	1.81	6
Lobby	0.90	4
For Elevator	0.64	6
For Performing Arts Theater	2.00	6
For Motion Picture Theater	0.52	4
Locker Room	0.75	6
Lounge/Recreation	0.73	4
Office		
Enclosed	1.11	8
Open Plan	0.98	4
Restrooms	0.98	8
Sales Area (for accent lighting, see Section 9.6.2(b))	1.68	6
Stairway	0.69	10
Storage	0.63	6
Workshop	1.59	6
Building-Specific Space Types	LPD, W/ft <sup>2</sup>	RCR Threshold
Automotive		
Service/Repair	0.67	4
Bank/Office		
Banking Activity Area	1.38	6
Convention Center		

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method (continued)

Building-Specific Space Types	LPD, W/ft <sup>2</sup>	RCR Threshold
Audience Seating	0.82	4
Exhibit Space	1.45	4
Courthouse/Police Station/Penitentiary		
Courtroom	1.72	6
Confinement Cells	1.10	6
Judges' Chambers	1.17	8
Penitentiary Audience Seating	0.43	4
Penitentiary Classroom	1.34	4
Penitentiary Dining	1.07	6
Dormitory		
Living Quarters	0.38	8
Fire Stations		
Engine Room	0.56	4
Sleeping Quarters	0.25	6
Gymnasium/Fitness Center		
Fitness Area	0.72	4
Gymnasium Audience Seating	0.43	6
Playing Area	1.20	4
Hospital		
Corridor/Transition	0.89	Width < 8 ft
Emergency	2.26	6
Exam/Treatment	1.66	8
Laundry/Washing	0.60	4
Lounge/Recreation	1.07	6
Medical Supply	1.27	6
Nursery	0.88	6
Nurses' Station	0.87	6
Operating Room	1.89	6
Patient Room	0.62	6
Pharmacy	1.14	6
Physical Therapy	0.91	6
Radiology/Imaging	1.32	6
Recovery	1.15	6
Hotel/Highway Lodging		
Hotel Dining	0.82	4
Hotel Guest Rooms	1.11	6
Hotel Lobby	1.06	4
Highway Lodging Dining	0.88	4
Highway Lodging Guest Rooms	0.75	6
Library		
Card File and Cataloging	0.72	4
Reading Area	0.93	4
Stacks	1.71	4

Appendix B: Figure 4 - ASHRAE 90.1-2010 Tables 9.6.1 - Lighting Power Densities (con't)

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method (continued)

Building-Specific Space Types	LPD, W/ft <sup>2</sup>	RCR Threshold
<b>Manufacturing</b>		
Corridor/Transition	0.41	Width < 8 ft
Detailed Manufacturing	1.29	4
Equipment Room	0.95	6
Extra High Bay (>50 ft Floor to Ceiling Height)	1.05	4
High Bay (25–50 ft Floor to Ceiling Height)	1.23	4
Low Bay (<25 ft Floor to Ceiling Height)	1.19	4
<b>Museum</b>		
General Exhibition	1.05	6
Restoration	1.02	6
<b>Parking Garage</b>		
Garage Area	0.19	4
<b>Post Office</b>		
Sorting Area	0.94	4
<b>Religious Buildings</b>		
Audience Seating	1.53	4
Fellowship Hall	0.64	4
Worship Pulpit, Choir	1.53	4
<b>Retail</b>		

TABLE 9.6.1 Lighting Power Densities Using the Space-by-Space Method (continued)

Building-Specific Space Types	LPD, W/ft <sup>2</sup>	RCR Threshold
Dressing/Fitting Room	0.87	8
Mall Concourse	1.10	4
Sales Area (for accent lighting, see Section 9.6.3(c))	1.68	6
<b>Sports Arena</b>		
Audience Seating	0.43	4
Court Sports Arena—Class 4	0.72	4
Court Sports Arena—Class 3	1.20	4
Court Sports Arena—Class 2	1.92	4
Court Sports Arena—Class 1	3.01	4
Ring Sports Arena	2.68	4
<b>Transportation</b>		
Air/Train/Bus—Baggage Area	0.76	4
Airport—Concourse	0.36	4
Audience Seating	0.54	4
Terminal—Ticket Counter	1.08	4
<b>Warehouse</b>		
Fine Material Storage	0.95	6
Medium/Bulky Material Storage	0.58	4

<sup>a</sup>In cases where both a common space type and a building-specific type are listed, the building specific space type shall apply.