

TECHNICAL REPORT ONE

COMPLIANCE EVALUATION OF ASHRAE STANDARDS 62.1 AND 90.1

UNIFIED SCIENCE CENTER

THE UNIVERSITY OF SCRANTON

SCRANTON, PA



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PENN STATE UNIVERSITY ARCHITECTURAL ENGINEERING

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EXECUTIVE SUMMARY

This report contains an analysis of the mechanical systems and equipment of the Unified Science Center, a 200,000 ft² teaching, research, and classroom building at The University of Scranton in Scranton, PA. Research, analysis, and calculations were performed to determine compliance with ASHRAE Standards 62.1 – *Ventilation* and 90.1 – *Energy Standard for Buildings*. Results show that the Unified Science Center is fully compliant with Standard 62.1 and almost entirely compliant with Standard 90.1.

The Unified Science Center is seeking LEED Silver certification, which helped guide the design and specification of the building, equipment, and energy use. Its mechanical systems serve a wide variety of loads in the science center including classrooms, laboratories, research facilities, surgery rooms, offices, and mechanical spaces. 100% outside air is supplied to all spaces of the building for ideal indoor air quality. (4) 52,150 CFM and (1) 5,150 CFM AHUs with desiccant energy recovery wheels and variable frequency drives are located on the penthouse level.

ASHRAE Standard 62.1 specifies minimum ventilation rates and indoor air quality for acceptable conditions. In this report compliance with Section 5 – *Systems and Equipment* was determined using project documentation. All of the requirements of Section 5 are met or exceeded by the designed systems and equipment. Compliance with Section 6 – *Ventilation Rate Procedure* was checked through the calculations found in the Appendix. The 100% outdoor supply air results in the requirements of Section 6 being significantly exceeded.

The Ventilation Rate Procedure was performed only on AHUs 1, 2, and 5. AHUs 1 and 2 serve space types and loads similar to those of AHUs 3 and 4, so results are assumed to be indicative of both sets of air handlers. AHU 5 is dedicated to a 2,700 ft² animal research facility with specific airflow requirements and infiltration concerns.

Standard 90.1 provides minimum requirements for energy efficient design for buildings. Performance of the building envelope, fenestration, and electrical systems was compared with ASHRAE recommended values, and analysis of select building systems shows that the most significant systems are compliant, while some secondary equipment falls short. To achieve LEED certification, significant emphasis is put on energy efficient design in the Unified Science Center.

SUMMARY OF COMPLIANCE WITH ASHRAE STANDARD 62.1

ASHRAE Standard 62.1 specifies the minimum ventilation rates and indoor air quality that will be acceptable to human occupants and are intended to minimize the potential for adverse health effects. It applies to all indoor or enclosed spaces that people may occupy.

The Unified Science Center is seeking Leed Silver Certification, and accordingly its HVAC systems are of a particularly high quality to achieve sophistication of operation with the use of energy efficient systems. It features 5 AHUs with variable frequency drives, desiccant energy recovery wheels, and atomizing fog humidifiers to economically serve a wide variety of spaces including offices, classrooms, laboratories, and computer/server rooms with 100% outside air.

Analysis of Sections 5 and 6 show that **the systems as designed will fully comply with ASHRAE Standard 62.1**, and in many cases greatly exceed the requirements.

Section 5 – Systems and Equipment

Section 5 specifies the systems and equipment recommended under Standard 62. It covers a number of important issues including the prevention of mold growth, measures to prevent re-entry of contaminated air, and particulate filtration. Analysis of this building relative to each of the recommendations of Section 5 shows that **compliance is entirely met**, and in many cases exceeds the minimum requirements.

Compliance

5.1: Natural Ventilation

Yes

None of the windows in the building are operable, so natural ventilation is not a consideration.

5.2: Ventilation Air Distribution

Yes

Assuming that the Variable Air Volume terminal boxes are correctly calibrated, all spaces in the Unified Science Center are designed to meet ventilation requirements.

5.3: Exhaust Duct Location

Yes

Exhaust ducts conveying potentially harmful contaminants, such as toilets, kitchens, and laboratories, are negatively pressurized relative to the spaces through which they pass and/or properly sealed from leakage; they exhaust directly to the rooftop, away from occupied spaces and air intakes.

5.4: Ventilation System Controls

Yes

Direct Digital Control (DDC) controls and field panels operate as a fully integrated extension of the existing campus Building Automation System (BAS). Input devices include temperature sensors, carbon dioxide sensors, airflow measurement devices, differential pressure transmitters, power monitoring devices, and status and safety switches. Output devices include relays, actuators, and control dampers and valves.

5.5: Airstream Surfaces

Yes

The building primarily uses sheet metal ducts and fasteners, which are exempt from this section. Airstream surfaces in non-sheet metal ducts are specified with fibrous-glass duct liner to comply with NFPA 90A – *Standard for the Installation of Air Conditioning and Ventilating Systems* and NAIMA AH124 – *Fibrous Glass Duct Liner Standard*. These standards require the prevention of erosion and mold/bacteria growth inside the ducts.

5.6: Outdoor Air Intakes

Yes

The location of outdoor air intakes relative to exhaust fans was compared with recommendations in ASHRAE Standard 62.1 Table 5.1: *Air Intake Minimum Separation Distance*. All the air handling units and air intakes are located on the penthouse level, while exhaust fans are located on the roof level above, maintaining or exceeding the recommended separation distance from air intakes. All air handling units are designed with drain systems to manage rain and snow entrainment. Bird screens are included to prevent nesting.

5.7: Local Capture of Contaminants

Yes

All potential contaminants are exhausted directly to the roof, satisfying this requirement.

5.8: Combustion Air

Yes

Boilers, laboratories, kitchens, and generators requiring combustion air are supplied with sufficient air for combustion; all products of combustion are exhausted directly outdoors, thus complying with the requirements of this section.

5.9: Particulate Matter Removal

Yes

All air handling units contain filters ranging in efficiency from MERV 8 to MERV 14, thus exceeding the minimum requirements of this section.

5.10: Dehumidification Systems

Yes

There are no systems beyond the AHUs to provide dehumidification in the building; the setpoints for various spaces range from 50% to 60% RH, below the 65% maximum in this section. All spaces meet the exfiltration requirements.

5.11: Drain Pans**Yes**

All the water coils are specified to have drain pans that comply with this Standard; they are typically double wall, continuously welded, 12 – 18 gage 304 stainless steel.

5.12: Finned-Tube Coils and Heat Exchangers**Yes**

All finned-tube heat exchangers are used for heating only, so this requirement does not apply.

5.13: Humidifiers and Water-Spray Systems**Yes**

High-pressure atomizing fog humidifiers are contained within the air handling units, and utilize water of a quality comparable to that of potable water.

5.14: Access for Inspection, Cleaning, and Maintenance**Yes**

All ventilation equipment is to be built with adequate space for inspection, cleaning, and maintenance. Convenient access is provided for each component of the air distribution system, with access doors ranging in size from 8"x5" to 25"x17".

5.15: Building Envelope**Yes**

Wall construction features a fluid-applied air and vapor barrier membrane allowing 0.20 perm, which is reinforced with a flexible membrane consisting of rubberized asphalt bonded with high density polyethylene film to allow a maximum permeance rating of 0.05 perm. Interior pipes and ducts are insulated to prevent condensation, and all exterior joints, seams, and penetrations are properly sealed to limit infiltration.

5.16: Buildings with Attached Parking Garages**Yes**

There is no parking structure attached to the Unified Science Center.

5.17: Air Classification and Recirculation**Yes**

Classification of exhaust air varies by space, but the 100% outside air system avoids issues that might arise with recirculation.

5.18: Requirements for Buildings Containing ETS Areas & ETS-Free Areas

Smoking is not permitted within the Unified Science Center; outdoor tobacco smoke should not affect the indoor air quality given that the air intakes are located on the roof.

Yes

Section 6 – Ventilation Rate Procedure

Section 6 prescribes the rate at which ventilation air must be delivered to a space and recommends various means to condition that air based on outdoor air quality criteria for acceptable ventilation. The Ventilation Rate Procedure determines acceptable outdoor air intake rates based on space type/application, occupancy level, and floor area. Analysis of the Unified Science Center shows that **the ventilation system as designed is fully compliant** with Section 6.

The ventilation system in the Unified Science Center consists of (4) 52,150 CFM and (1) 5,150 CFM AHUs with desiccant energy recovery wheels, variable frequency drives, and 100% outside air. AHUs 1 and 2 are housed together and work in tandem; their configuration is depicted in Figures 1 and 2. AHUs 3 and 4 work similarly, while AHU 5 is dedicated to a specific laboratory area. All of the AHUs are located on the penthouse level and scheduled to operate 24 hours a day.

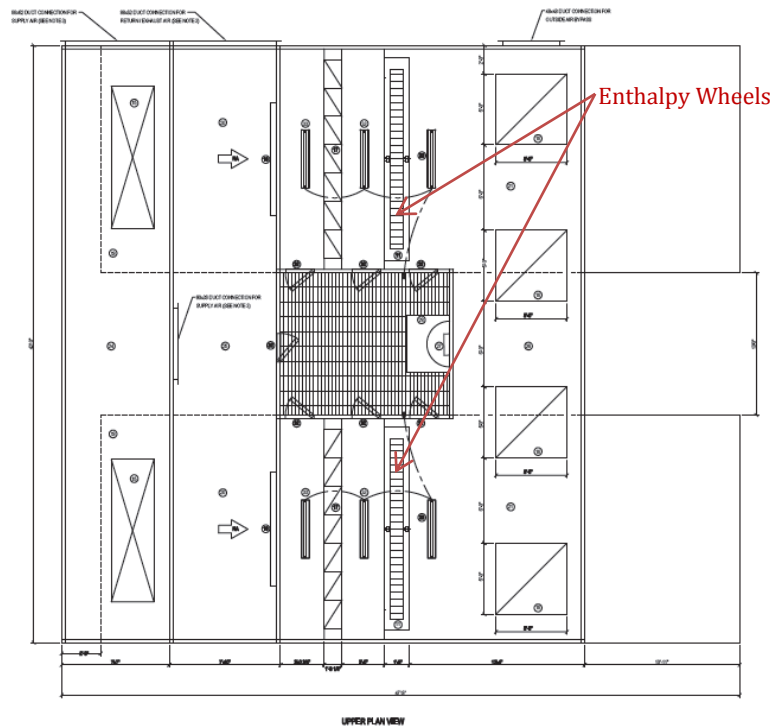


Fig. 1 Upper plan view (return/exhaust air) of dual AHU configuration

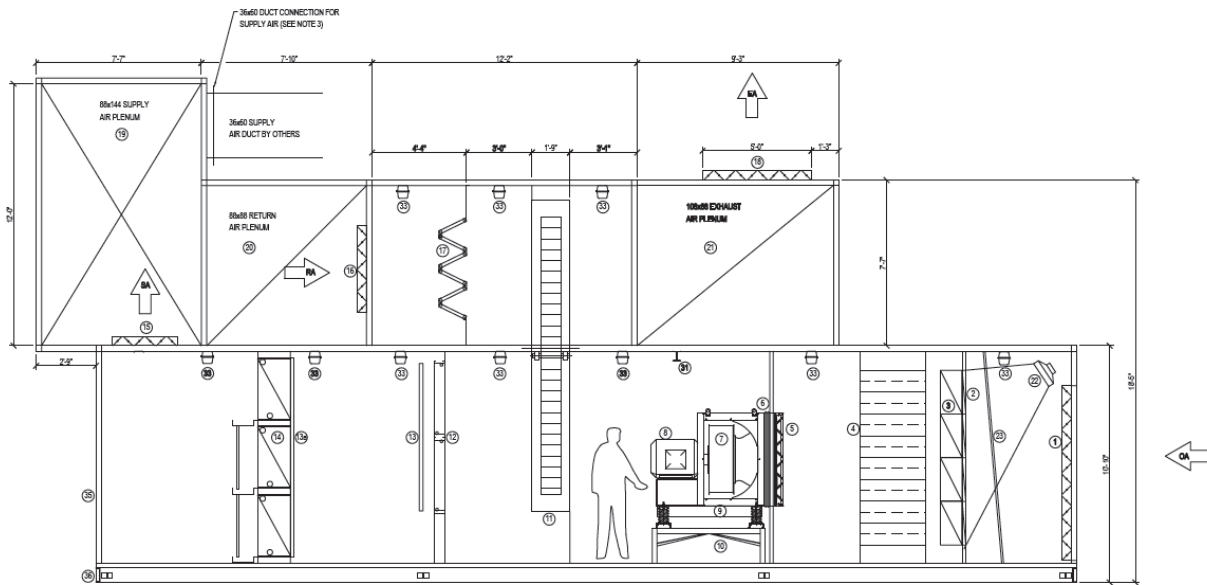


Fig. 2 Section of typical AHU with energy recovery wheel and 100% outdoor supply air

AHUs 1 and 2 serve approximately 84,333 ft² on the west side of the building, which includes office, laboratory, classroom, and mechanical room spaces. AHUs 3 and 4 serve similar spaces on the east side of the building. Because the space types and loads of AHUs 1 and 2 are comparable to those of AHUs 3 and 4, this report includes an analysis of AHUs 1 and 2 to represent the performance of both sets, and a separate analysis of AHU 5.

AHU 5 serves a 2,711 ft² ground floor vivarium dedicated to animal research. Spaces include animal holding rooms, observation areas, surgery rooms, and a bat aviary with independent temperature and humidity control.

The following ASHRAE Std. 62.1 Section 6 Ventilation Rate Procedure prescribes outdoor airflow and ventilation criteria for acceptable indoor air quality. Occupancy data was estimated using Table 6-1 when not specified in the project documentation. Outdoor air rate values were also taken from Table 6-1. Areas and design ventilation rate values were read from the drawings provided by the architectural engineers.

The Ventilation Rate Procedure

The design outdoor air flow rate required for compliance is defined as:

$$(Eq\ 6-1) \quad V_{bz} = R_p * P_z + R_a * A_z$$

where:

V_{bz} =Breathing Zone outdoor air flow (CFM)

R_p =Outdoor airflow rate per person (CFM/person)

P_z =Zone population

R_a =Outdoor airflow rate per unit area (CFM/ft²)

A_z =Zone floor area (ft²)

The outdoor airflow that must be provided by supply air systems is defined as:

$$(Eq\ 6-2) \quad V_{oz} = V_{bz} / E_z$$

where:

V_{oz} =Zone outdoor airflow, as prescribed by Standard 62.1

E_z =Zone air distribution effectiveness

E_z values are prescribed in Table 6-2; based on typical air distribution configurations according to the drawings and specifications provided by the architectural engineers, it is assumed that $E_z=1$ for all calculations, so:

$$V_{oz} = V_{bz}$$

For 100% outdoor air systems, the design outdoor air intake flow required for compliance is:

$$(Eq\ 6-4) \quad V_{ot} = \sum_{\text{all zones}} (V_{oz})$$

where:

V_{ot} =Outdoor air intake flow

The Primary Outdoor Air Fraction is defined as:

$$(Eq\ 6-5) \quad Z_p = V_{oz} / V_{pz}$$

where:

V_{pz} =Zone primary airflow

The System Ventilation Efficiency E_v is determined using Table 6-3 and is based on the maximum Z_p value.

Analysis of Results

Table 1 provides a concise summary of the overall results of the calculation procedure; detailed calculations can be found in the Appendix:

	Capacity (CFM)	Required OA (CFM) V_{ot}	Design OA (CFM) V_{pz}	Oversupply (CFM)	Max Z_p	Ev	Compliance
AHU-5	5,150	870	5050	4180	0.247	0.8	YES
AHUs 1 and 2	105,252	21,506	102,475	80969	0.446	0.7	YES

Table 1 Results of Ventilation Rate Procedure

As 100% outdoor air units, all the AHUs easily satisfy the requirements set forth by Standard 62.1. Assumptions made during analysis about space types and occupancy using default ASHRAE data may have underestimated the production of contaminants, especially in the cases of advanced laboratories and other unique spaces. For all three AHUs analyzed, the (outdoor) supply air as designed is approximately 5 times the required outdoor air.

The Unified Science Center’s ventilation system as designed will **fully comply** with Section 6.

SUMMARY OF COMPLIANCE WITH ASHRAE STANDARD 90.1

ASHRAE Standard 90.1 provides minimum requirements for the energy-efficient design of buildings except low-rise buildings. This Standard focuses on the effects of the building envelope, HVAC systems, and electrical design on energy efficiency.

The Unified Science Center utilizes a number of state of the art design features, systems, and equipment to curb energy use and achieve LEED Silver certification. Daylighting, High performance materials, and efficient equipment contribute to **significant compliance** with Standard 90.1. The majority of critical systems exceed the minimum requirements.

Section 5 – Building Envelope

Section 5 specifies requirements for the building envelope. It covers a number of important factors including climate, insulation, and fenestration, and prescribes performance criteria for energy efficiency.

The Unified Science Center’s building envelope is distinctive, with large curtain walls and local stone. In accordance with LEED criteria, the building envelope as a whole is of a superior quality in terms of thermal transfer and energy efficiency.

5.1.3: Envelope Alterations

This project includes approximately 50,000 ft² of renovation and a connection with the new structure. The alterations being performed are largely exempt from this requirement and otherwise comply fully.

5.1.4: Climate

ASHRAE classifies Scranton, PA as in Climate Zone 5, Subtype A – Cool/Humid:

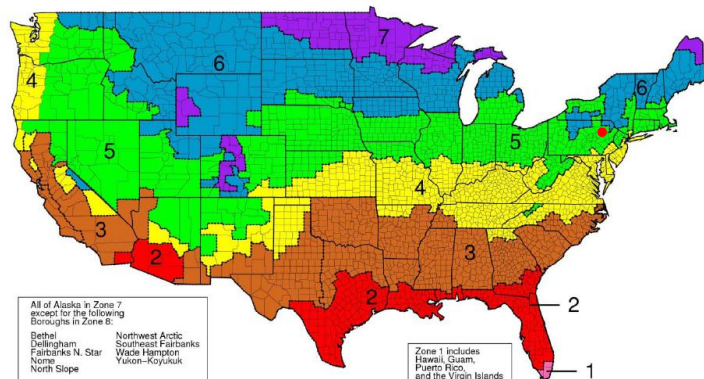


Fig. B-1, ASHRAE Standard 90.1 Appendix B

5.2.1: Compliance

The large curtain walls of the Unified Science Center make up about 30% of the gross wall area, thus complying with the requirements. With the use of double paned low-E fritted spandrel glass and architectural louvers, the curtain wall system has excellent thermal performance.

	Area of Glass (SF)	Gross Wall Area	% of Glass	Compliance
North Façade	600	4256	12	YES
East Façade	1,176	2,800	30	YES
West Façade	1280	3424	27	YES
South Façade	3285	5205	39	YES
Total	6341	15685	29	YES

5.4: Mandatory Provisions

All joints in the fenestration, doors, and structure will be sealed to limit infiltration. All building entrances are protected by vestibules or otherwise exempt from this provision.

The roofing system for the Unified Science Center consists of fully adhered single-ply PVC membrane, water-resistant gypsum substrate, tapered rigid isocyanurate foam insulation, and a laminate polyethylene vapor retarder on Type B metal deck. The PVC membrane is white in color to comply with solar reflectance values determined by LEED performance criteria.

The stone veneers are insulated by rigid polystyrene insulation.

Specific U-values and Solar Heat Gain Coefficients for glazing and roofing were not given in the documentation, but given the nature of this project it is assumed they are high performance. The roof insulation is estimated to be approximately R-30 based on the typical thickness of insulation.

Section 6: Heating, Ventilating and Air Conditioning

All of the heating, ventilation, and air conditioning equipment in the Unified Science Center is oriented toward energy efficiency and quality of operation. LEED Silver performance criteria influences much of the design and equipment typically meets or exceeds the requirements of Standard 90.1. Using Variable Frequency Drives, Variable Air Volume terminal boxes, and energy recovery, the HVAC systems are designed to comply with Standard 90.1.

There are (2) 550 ton chillers, (2) 550 ton cooling towers, (3) primary chilled water pumps, several gas fired condensing boilers. Energy performance in most areas satisfy the requirements of Section 6. The condensing boilers run at 87% efficiency, well above the ASHRAE minimum of 80%.

In addition to the high performance of each individual component of the HVAC systems, Direct Digital Controls are integrated into an existing campus Building Automation System to provide optimal air quality and thermal comfort.

REFERENCES

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

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

Project documentation provided by Einhorn Yaffee Prescott Architecture and Engineering.

APPENDIX

AHU-5										
Room No.	Room Name	Occupancy Type	Occupant Density per 1000 SF	Az	Ra	Pz	Rp	Voz=Vbz	Vpz	Zp
080A	Office	Office Space	5	125	0.06	0.625	5	10.625	150	0.070833
080C	Toilet/Shower	Storage Room	0	146	0.12	0	5	17.52	175	0.100114
080D	Holding Room #2	Science Laboratory	25	108	0.18	2.7	10	46.44	200	0.2322
080E	Vestibule	Science Laboratory	25	46	0.18	1.15	10	19.78	150	0.131867
080F	Waste	Storage Room	0	126	0.12	0	0	15.12	200	0.0756
080G	Holding Room #6	Science Laboratory	25	112	0.18	2.8	10	48.16	200	0.2408
080H	Aviary	Science Laboratory	25	175	0.18	4.375	10	75.25	350	0.215
080I	Holding Room #5	Science Laboratory	25	108	0.18	2.7	10	46.44	200	0.2322
080J	Holding Room #4	Science Laboratory	25	108	0.18	2.7	10	46.44	200	0.2322
080K	Holding Room #3	Science Laboratory	25	105	0.18	2.625	10	45.15	200	0.22575
080L	Behavioral Observation #2	Science Laboratory	25	130	0.18	3.25	10	55.9	250	0.2236
080M	Control Room	Science Laboratory	25	115	0.18	2.875	10	49.45	200	0.24725
080N	Behavioral Observation #1	Science Laboratory	25	130	0.18	3.25	10	55.9	250	0.2236
080P	Holding Room #1	Science Laboratory	25	87	0.18	2.175	10	37.41	200	0.18705
080Q	Surgery/Procedure	Science Laboratory	25	93	0.18	2.325	10	39.99	300	0.1333
080R	Surgery Prep	Science Laboratory	25	100	0.18	2.5	10	43	325	0.132308
080U	Cage Wash	Science Laboratory	25	341	0.18	8.525	10	146.63	1000	0.14663
080V	Vestibule	Corridor	0	74	0.06	0	0	4.44	150	0.0296
080W	Corridor	Corridor	0	380	0.06	0	0	22.8	150	0.152
080W	Quarantine	Science Laboratory	25	102	0.18	2.55	10	43.86	200	0.2193

AHU-1 and AHU-2									
Room Name	Occupancy Type	Occupant Density per 1000 SF	Az	Ra	Pz	Rp	Voz=Vbz	Vpz	Zp
16 Seat Classroom	Classroom	31	513	0.12	16	10	221.56	600	0.369266667
31 Seat Classroom	Classroom	44	705	0.12	31	10	394.6	1000	0.3946
Advanced Bio & Neuro Prep	Science Laboratories	25	607	0.18	15.175	10	261.01	630	0.414301587
Advanced Lab Prep Room	Science Laboratories	25	692	0.18	17.3	10	297.56	730	0.407616438
Advanced Lab Storage	Storage Rooms	0	266	0.12	0	0	31.92	200	0.1596
Advanced Teaching Lab	Science Laboratories	25	1107	0.18	27.675	10	476.01	7500	0.063468
Autoclave	Science Laboratories	25	148	0.18	3.7	10	63.64	500	0.12728
Autoclave	Science Laboratories	25	208	0.18	5.2	10	89.44	1400	0.063885714
Bio Hazard	Storage Rooms	0	59	0.06	0	0	3.54	0	Negatively Pressurized
BioChem/Molecular Teaching Lab	Science Laboratories	25	910	0.18	22.75	10	391.3	1250	0.31304
Break Room	Break Rooms	25	145	0.06	3.625	5	26.825	200	0.134125
Break Room	Break Rooms	25	145	0.06	3.625	5	26.825	200	0.134125
Cell Culture Room	Science Laboratories	25	212	0.18	5.3	10	91.16	350	0.260457143
Cell/Imm/Viro Teaching Lab	Science Laboratories	25	925	0.18	23.125	10	397.75	1200	0.331458333
Chem Teaching	Science Laboratories	25	645	0.18	16.125	10	277.35	1250	0.22188
Chemical Storage	Storage Rooms	0	315	0.06	0	0	18.9	300	0.063
Cleaning/Glass Wash	Break Rooms	25	145	0.06	3.625	5	26.825	100	0.26825
Cold Room	Storage Rooms	0	120	0.06	0	0	7.2	50	0.144
Corridor	Corridor	0	739	0.06	0	0	44.34	375	0.11824
Corridor	Corridor	0	561	0.06	0	0	33.66	300	0.1122
Corridor	Corridor	0	585	0.06	0	0	35.1	325	0.108
Corridor	Corridor	0	453	0.06	0	0	27.18	300	0.0906
Corridor	Corridor	0	458	0.06	0	0	27.48	325	0.08453846
Corridor	Corridor	0	420	0.06	0	0	25.2	300	0.084
Corridor	Corridor	0	417	0.06	0	0	25.02	300	0.0834
Corridor	Corridor	0	417	0.06	0	0	25.02	300	0.0834
Corridor	Corridor	0	402	0.06	0	0	24.12	350	0.068914286
Corridor	Corridor	0	323	0.06	0	0	19.38	300	0.0646
Corridor	Corridor	0	319	0.06	0	0	19.14	300	0.0638
Corridor	Corridor	0	318	0.06	0	0	19.08	300	0.0636
Corridor	Corridor	0	312	0.06	0	0	18.72	300	0.0624
Corridor	Corridor	0	323	0.06	0	0	19.38	350	0.055371429
Corridor	Corridor	0	323	0.06	0	0	19.38	350	0.055371429
Corridor	Corridor	0	318	0.06	0	0	19.08	350	0.054514286
Corridor	Corridor	0	314	0.06	0	0	18.84	350	0.053828571
Corridor	Corridor	0	312	0.06	0	0	18.72	350	0.053485714
CS Office	Office Space	5	127	0.06	0.635	5	10.795	100	0.10795
CS Print Room & Thesis Storage	Computer Lab	25	96	0.12	2.4	10	35.52	125	0.28416
CS Research Lab	Science Laboratories	25	207	0.18	5.175	10	89.01	400	0.222525
CS Server/Storage Room	Electrical Equipment	0	219	0.06	0	0	13.14	100	0.1314
Cylinder Room	College Laboratory	25	311	0.18	7.775	10	133.73	300	0.445766667
Dark Room	Photo Studios	10	85	0.12	0.85	5	14.45	50	0.289
Dark Room	Photo Studios	10	87	0.12	0.87	5	14.79	100	0.1479
Dispensing	Shipping/Receiving	0	132	0.12	0	0	15.84	525	0.030171429
Dry Specimen Storage	Storage Rooms	0	162	0.12	0	0	19.44	200	0.0972
Elec Room	Electrical Equipment	0	92	0.06	0	0	5.52	350	0.015771429
Elec Room	Electrical Equipment	0	91	0.06	0	0	5.46	350	0.0156
Elec. Room	Electrical Equipment	0	131	0.06	0	0	7.86	350	0.022457143
Electrical	Electrical Equipment	0	753	0.06	0	0	45.18	500	0.09036
Electrical Room	Electrical Equipment	0	99	0.06	0	0	5.94	350	0.016971429
Electronics Lab	Electrical Equipment	0	557	0.06	0	0	33.42	970	0.034453608

Faculty/Student Research Lab	College Laboratory	25	2025	0.18	50.625	10	870.75	2400	0.3628125
Faculty/Student Research Lab	College Laboratory	25	906	0.18	22.65	10	389.58	1095	0.355780822
Faculty/Student Research Lab	College Laboratory	25	1974	0.18	49.35	10	848.82	2400	0.353675
Faculty/Student Research Lab	College Laboratory	25	2043	0.18	51.075	10	878.49	2610	0.336586207
Faculty/Student Research Lab	College Laboratory	25	1948	0.18	48.7	10	837.64	2500	0.335056
Faculty/Student Research Lab	College Laboratory	25	871	0.18	21.775	10	374.53	1200	0.312108333
Faculty/Student Research Lab	College Laboratory	25	645	0.18	16.125	10	277.35	1000	0.27735
Faculty/Student Research Lab	College Laboratory	25	803	0.18	20.075	10	345.29	1500	0.230193333
Faculty/Student Research Lab	College Laboratory	25	2000	0.18	50	10	860	4725	0.182010582
Faculty/Student Research Lab	College Laboratory	25	1093	0.18	27.325	10	469.99	2700	0.17407037
Faculty/Student Space	Conference Room	50	495	0.06	24.75	5	153.45	400	0.383625
Faculty/Student Space	Conference Room	50	495	0.06	24.75	5	153.45	400	0.383625
Faculty/Student Space	Conference Room	50	494	0.06	24.7	5	153.14	400	0.38285
Faculty/Student Space	Conference Room	50	493	0.06	24.65	5	152.83	400	0.382075
Faculty/Student Space	Conference Room	50	491	0.06	24.55	5	152.21	400	0.380525
Faculty/Student Space	Conference Room	50	491	0.06	24.55	5	152.21	400	0.380525
Faculty/Student Space	Conference Room	50	490	0.06	24.5	5	151.9	400	0.37975
Faculty/Student Space	Conference Room	50	490	0.06	24.5	5	151.9	400	0.37975
Faculty/Student Space	Conference Room	50	484	0.06	24.2	5	150.04	400	0.3751
Faculty/Student Space	Conference Room	50	483	0.06	24.15	5	149.73	400	0.374325
Faculty/Student Space	Conference Room	50	482	0.06	24.1	5	149.42	400	0.37355
Faculty/Student Space	Conference Room	50	480	0.06	24	5	148.8	400	0.372
Family Toilet	Storage Rooms	0	58	0.12	0	0	6.96	75	0.0928
Field Suite	Office Space	5	540	0.06	2.7	5	45.9	500	0.0918
Fire Pump Room	Elevator Machine Rm	0	226	0.12	0	0	27.12	150	0.1808
Flammable	Storage Rooms	0	116	0.12	0	0	13.92	50	0.2784
Graduate Research Lab	College Laboratory	25	95	0.18	2.375	10	40.85	125	0.3268
Graduate Research Lab	College Laboratory	25	93	0.18	2.325	10	39.99	125	0.31992
Graduate Research Lab	College Laboratory	25	90	0.18	2.25	10	38.7	125	0.3096
Graduate Research Lab	College Laboratory	25	90	0.18	2.25	10	38.7	125	0.3096
Graduate Space	Office Space	5	157	0.06	0.785	5	13.345	200	0.066725
Graduate Space	Office Space	5	154	0.06	0.77	5	13.09	200	0.06545
Graduate Space	Office Space	5	144	0.06	0.72	5	12.24	200	0.0612
Graduate Space	Office Space	5	141	0.06	0.705	5	11.985	200	0.059925
Graduate Space	Office Space	5	133	0.06	0.665	5	11.305	200	0.056525
Graduate Space	Office Space	5	131	0.06	0.655	5	11.135	200	0.055675
Graduate W/Up Space	Office Space	5	141	0.06	0.705	5	11.985	200	0.059925
Graduate W/Up Space	Office Space	5	117	0.06	0.585	5	9.945	200	0.049725
Hazardous Waste	Storage Rooms	0	97	0.06	0	0	5.82	0	Negatively Pressurized
Headhouse	Science Laboratories	25	444	0.18	11.1	10	190.92	1400	0.136371429
Histology Teaching Lab	Science Laboratories	25	890	0.18	22.25	10	382.7	1200	0.318916667
Hot Lab	Science Laboratories	25	136	0.18	3.4	10	58.48	525	0.111390476
Individual Research Lab	Office Space	5	139	0.06	0.695	5	11.815	200	0.059075
Individual Research Lab	Office Space	5	139	0.06	0.695	5	11.815	200	0.059075
Individual Research Lab	Office Space	5	138	0.06	0.69	5	11.73	200	0.05865
Individual Research Lab	Office Space	5	135	0.06	0.675	5	11.475	200	0.057375
Individual Research Lab	Office Space	5	143	0.06	0.715	5	12.155	400	0.0303875
Isotope Storage	Storage Rooms	0	122	0.12	0	0	14.64	0	Negatively Pressurized
Lab Discussion	Conference Room	50	707	0.06	35.35	5	219.17	1000	0.21917
Lab Prep	Science Laboratories	25	981	0.18	24.525	10	421.83	1200	0.351525
Laser Support	Science Laboratories	25	161	0.18	4.025	10	69.23	400	0.173075
Machine Shop	Wood/Metal Shop	20	461	0.18	9.22	10	175.18	500	0.35036
Manager Office	Office Space	5	111	0.06	0.555	5	9.435	100	0.09435
Mechanical	Elevator Machine Rm	0	3688	0.12	0	0	442.56	0	Negatively Pressurized
Mechanical	Elevator Machine Rm	0	865	0.12	0	0	103.8	0	Negatively Pressurized
Men's Toilets	Storage Rooms	0	210	0.12	0	0	25.2	200	0.126
Men's Toilets	Storage Rooms	0	170	0.12	0	0	20.4	200	0.102
Microbiology	Science Laboratories	25	926	0.18	23.15	10	398.18	1100	0.361981818
Microscope Room	Science Laboratories	25	201	0.18	5.025	10	86.43	350	0.246942857
Microscope Room	Science Laboratories	25	138	0.18	3.45	10	59.34	300	0.1978
Modern Physics Lab	Science Laboratories	25	589	0.18	14.725	10	253.27	870	0.291114943

Networking Lab	Science Laboratories	25	558	0.18	13.95	10	239.94	1100	0.218127273
NMR Room	Science Laboratories	25	192	0.18	4.8	10	82.56	600	0.1376
Non-Majors Biology Teaching Lab	Science Laboratories	22	1100	0.18	24.2	10	440	1000	0.44
Non-Majors Prep	Science Laboratories	25	161	0.18	4.025	10	69.23	400	0.173075
Office	Office Space	5	115	0.06	0.575	5	9.775	100	0.09775
Open Computer Lab	College Laboratory	25	706	0.18	17.65	10	303.58	1000	0.30358
Physics Isotopes Lab	College Laboratory	25	126	0.18	3.15	10	54.18	300	0.1806
Physiology Teaching Lab	College Laboratory	25	921	0.18	23.025	10	396.03	940	0.421308511
Pick Up/Student	Office Space	5	101	0.06	0.505	5	8.585	100	0.08585
Pump Room	Elevator Machine Rm	0	54	0.12	0	0	6.48	500	0.01296
Recycling	Storage Rooms	0	96	0.12	0	0	11.52	0	Negatively Pressurized
Research Module	College Laboratory	25	129	0.18	3.225	10	55.47	0	Negatively Pressurized
Research Module	College Laboratory	25	129	0.18	3.225	10	55.47	0	Negatively Pressurized
Robotics Lab	College Laboratory	25	554	0.18	13.85	10	238.22	1100	0.216563636
Robotics Lab	College Laboratory	25	530	0.18	13.25	10	227.9	1100	0.207181818
Scanning Tunnel Microscope	College Laboratory	25	209	0.18	5.225	10	89.87	450	0.199711111
Seminar Room	Classroom	35	531	0.12	18.585	10	249.57	800	0.3119625
Seminar Room	Classroom	35	207	0.12	7.245	10	97.29	350	0.277971429
Seminar Room	Classroom	35	208	0.12	7.28	10	97.76	600	0.162933333
Shared Instrumentation	College Laboratory	25	155	0.18	3.875	10	66.65	250	0.2666
Shared Instrumentation	College Laboratory	25	211	0.18	5.275	10	90.73	400	0.226825
Shared Instrumentation	College Laboratory	25	152	0.18	3.8	10	65.36	600	0.108933333
Soil Sample Storage	Storage Rooms	0	194	0.12	0	0	23.28	300	0.0776
Stockroom	Storage Rooms	0	679	0.12	0	0	81.48	800	0.10185
Student Project Lab	College Laboratory	25	572	0.18	14.3	10	245.96	750	0.327946667
Student W/Up Space	Office Space	5	97	0.06	0.485	5	8.245	150	0.054966667
Student/Faculty Research	College Laboratory	25	813	0.18	20.325	10	349.59	1500	0.23306
Support	Office Space	5	212	0.06	1.06	5	18.02	300	0.060066667
Support	Office Space	5	208	0.06	1.04	5	17.68	300	0.058933333
Support	Office Space	5	202	0.06	1.01	5	17.17	300	0.057233333
Support	Office Space	5	160	0.06	0.8	5	13.6	300	0.045333333
Support Room	Office Space	5	206	0.06	1.03	5	17.51	350	0.050028571
Supporting Room	Office Space	5	203	0.06	1.015	5	17.255	300	0.057516667
Teledata	Electrical Equipment	0	115	0.06	0	0	6.9	300	0.023
Teledata	Electrical Equipment	0	113	0.06	0	0	6.78	300	0.0226
Teledata	Electrical Equipment	0	105	0.06	0	0	6.3	300	0.021
Teledata	Electrical Equipment	0	103	0.06	0	0	6.18	300	0.0206
Teledata	Electrical Equipment	0	111	0.06	0	0	6.66	500	0.01332
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	47	0.12	0	0	5.64	100	0.0564
Toilet	Storage Rooms	0	46	0.12	0	0	5.52	100	0.0552
Toilet	Storage Rooms	0	46	0.12	0	0	5.52	100	0.0552
Undergraduate Space	Conference Room	50	314	0.06	15.7	5	97.34	400	0.24335
Undergraduate Space	Conference Room	50	306	0.06	15.3	5	94.86	400	0.23715
Undergraduate W/Up Space	Conference Room	50	290	0.06	14.5	5	89.9	250	0.3596
Undergraduate W/Up Space	Conference Room	50	298	0.06	14.9	5	92.38	350	0.263942857
Undergraduate W/Up Space	Conference Room	50	315	0.06	15.75	5	97.65	400	0.244125
Undergraduate W/Up Space	Conference Room	50	251	0.06	12.55	5	77.81	350	0.222314286
Vert/Anat/Dissec Teaching Lab	College Laboratory	25	909	0.18	22.725	10	390.87	1200	0.325725
Wet Specimen Storage	Storage Rooms	0	125	0.12	0	0	15	200	0.075
Women's Toilets	Storage Rooms	0	212	0.12	0	0	25.44	200	0.1272
Women's Toilets	Storage Rooms	0	161	0.12	0	0	19.32	200	0.0966
Wood & Plastic Shop	Wood/Metal Shop	20	123	0.18	2.46	10	46.74	250	0.18696