TECHNICAL REPORT 1

CENTRAL HIGH SCHOOL

ADAM BROWN

MECHANICAL OPTION

ADVISOR LAURA MILLER

Submitted 9/18/13

Contents

Executive Summary

The objective of this report is to analyze Central High School, located in the Mid-Atlantic region, in accordance with ASHRAE 62.1-2010 and ASHRAE 90.1-2010 standards.

The analysis of ASHRAE 62.1 on the building shows that is compliant with section 5 but not with section 6. Non-compliant issues in section 5 were from the project still being in the construction phase and information is vague or waiting more information and that some sub-sections do not apply to this building. One system did not meet minimum ventilation requirements, ERU-16, and therefore the building is not compliant with section 6.

Analyzing ASHRAE 90.1 shows that the building is not compliant with the standards set down in it. Due to missing information or ambiguity of the wording in the specifications there were issues with the building being compliant. Further investigation and fact finding will reveal more information to see if these sections of the building can be compliant.

Building Overview

Building Description

Central High School is a newly renovated high school located in the Mid-Atlantic region. At roughly 320,000 square feet it is an impressive state of the art school with two levels the top one being the addition. The building has food and science labs, classrooms, offices, gyms and an auditorium to serve the learning needs of the occupants. It is expected to be completed by February 2015.

Mechanical System Overview

Twenty energy recovery units are located throughout the building that delivers outdoor air to fan coil units with recirculated air serving the zones. Along with that, two air cooled chillers and a boiler serve the fan coil units.

Occupant and Project Team

Owner: Confidential

Construction Manager: Jacobs http://jacobs.com/

Architect: SHW Group, LLP http://www.shwgroup.com/

Structural Engineer: Adtek Engineers, INC. http://www.adtekengineers.com/

Mechanical and Electrical Engineers: SHW Group, LLP http://www.shwgroup.com/

Civil Engineers: Bowman Consulting http://www.bowmanconsulting.com/

Kitchen Consultant: Nyikos Associates http://nyikosassociates.com/

Acoustical and Technology: Polysonics Corporation http://www.polysonics-corp.com/

ASHRAE Standard 62.1 - 2010 Analysis

Section 5 Systems and Equipment

5.1 Natural Ventilation

The necessary positioning of control dampers for all air-side balancing are provided to be either on site or remotely done. They will be multi-louvered type with adjacent blades and made to have a 2-poisition control to them. Ceiling space is used to recirculate air and provide ventilation to fan coil units housed in the ceiling. Minimum ventilation to each zone was calculated according to code and each zone but one receives the minimum amount. The specifications provided by the mechanical engineer states assumptions to calculate ventilation rates. Means to balance and measure airflow is required by the contractor to be performed in accordance with airflow rates calculated by the mechanical engineer.

The building complies with section 5.1

5.2 Exhaust Duct Locations

Exhaust ductwork has been negatively pressurized and insulated. Negative pressurization of all exhaust hoods in science labs and food lab areas ensure no harmful particles recirculate back into the room.

The building complies with section 5.2

5.3 Ventilation System Controls

A factory mounted ASHRAE Standard 62.1 – 2004 airflow monitoring and control station at the outdoor air opening of the mixing box will be provided. It will track variable outside air quantity for ventilation demand flow control in the spaces.

The building complies with section 5.3

5.4 Airstream Surfaces

Duct liners at least one inch thick and thermal conductivity of .26 that comply with ASTM C 1071 standards will be used to prevent erosion of glass fibers and prevent mold growth of micro-organisms in the ductwork.

The building complies with section 5.4

5.5 Outdoor Air Intakes

Location of outdoor air intakes will be in compliance with Table 5-1. To prevent rain and snow intrusion storm resistant louvers have been placed over the air intakes. Bird screens at one half inch will be utilized.

The building complies with section 5.5

5.6 Local Capture of Contaminants

Non-combustion mechanical equipment directly exhausts all contaminants outdoors.

5.7 Combustion Air

A natural gas fired boiler shall have sensors provided that will ensure enough air is provided for the combustion process. Flue-gas recirculation ducts from vent to burners and then outside will be installed.

The building complies with section 5.7

5.8 Particulate Matter Removal

Outside and exhaust airstreams will have a 2 inch think MERV 7 efficiency prefilter according to ASHRAE Test Standard 52.2-2007. Final filters for the outside airstream will be of 12 inches rigid MERV 12 material.

The building complies with section 5.8

5.9 Dehumidification Systems

Rooms with building occupants will have a relative humidity of no less than 35 percent but no more than 50 percent. Therefore it will be under the required 65 percent or less relative humidity range. Minimum outdoor air intake is set higher than the maximum exhaust rate throughout the building in each zone.

The building complies with section 5.9

5.10 Drain Pans

With a 2 percent slope the drain pan will be fabricated at a length with a leaving face to comply with ASHRAE 62.1-2004 and a minimum depth of 2 inches. It will drain to the lowest points to prevent overflow and be fitted with a moisture tight seal.

The building complies with section 5.10

5.11 Finned-Tube Coils and Heat Exchangers

All dehumidifying cooling coil assemblies will have drain pans in accordance with Section 5.10.

The building complies with section 5.11

5.12 Humidifiers and Water-Spray Systems

Water-spray systems are not used in the system.

5.13 Access for Inspection, Cleaning, and Maintenance

Currently the layout of system suggests adequate clearances for personal to inspect and maintain the equipment. Access doors have been specified on equipment. Ductwork is within easy accessible plenum space areas or areas that are exposed.

The building complies with section 5.13

5.14 Building Envelope and Interior Surfaces

Exterior walls have glass-mate gypsum wall sheathing at 1/2 inch thick and plywood roof sheathing at 3/4 inch thick for the roofs. Tests were done according to ASTM E 331 to ensure no water leakage or penetration occurs on the interior surfaces of the building.

The building complies with section 5.14

5.15 Buildings with Attached Parking Garages

There are no parking garages attached to the building.

5.16 Air Classification and Recirculation

Offices, classrooms, conference rooms shall be under the Class 1 air classification. Assembly areas such as the auditorium, theater and library will under the Class 1 air classification. Science, food, and art labs along with the cafeteria and kitchen are designed with exhaust hoods that will not have air recirculated and are under Class 2 air classification.

The building complies with section 5.16

5.17 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

This will be an ETS-Free building.

Section 6 Procedures

Section 6 of ASHRAE 62.1 outlines the procedure for calculating the minimum outdoor air rates using the Ventilation Rate Procedure method. To arrive at the minimum outdoor rates the first calculation that must be done is the breathing zone outdoor airflow.

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

The terms definitions are as follows:

Vbz – breathing zone outdoor airflow [cfm]

Rp – outdoor airflow per person from Table 6-1 of ASHRAE 62.1 [cfm/person]

Pz – expected zone population at its highest occupancy [people]

Ra – outdoor airflow per unit area from Table 6-1 of ASHRAE 62.1 [cfm/ft^2]

Az – occupiable floor area of the zone [ft^2]

After calculating the Vbz values the zone outdoor airflow, Voz, is calculated by the following equation:

$$V_{oz} = V_{bz}/E_z$$

The terms definitions are as follows:

Voz – zone outdoor airflow [cfm]

Vbz – breathing zone outdoor airflow [cfm]

Ez – zone air distribution effectiveness [Note: assumed to be 1 for all systems]

Since the building utilizes multiple-zone recirculating systems the following equation was used to find the primary outdoor air fraction, Zpz:

$$Z_{pz} = V_{oz}/V_{pz}$$

The terms definitions are as follows:

Zpz – primary outdoor air fraction [unitless]

Voz – zone outdoor airflow [cfm]

Vpz – zone primary airflow [cfm]

Appendix A shows the calculations for each energy recovery unit. A minimum ventilation rate was calculated by the mechanical engineer along with the actual amount provided to each space. Values calculated for this report were compared to both values but compliance was determined by comparing to the minimum ventilation rate according to code.

Ventilation Compliance ASHRAE 62.1 -2010				
System	OA Minimum	OA Designed Minimum	OA Provided	Compliant?
ERU-1	5700	9060	11780	Y
ERU-2A/B	1500	2010	3400	Y
ERU- 3	3400	4504	6990	Y
ERU- 4	950	1255	1655	Y
ERU- 5	3410	3070	3500	N
ERU- 6	430	495	1535	Y
ERU- 7	13235	14598	20130	Y
ERU- 8	16000	21260	28360	Y
ERU- 9	2900	3730	5570	Y
ERU- 10	3070	3531	4700	Y
ERU- 11	1900	2250	4500	Y
ERU- 12/13	7155	15000	21540	Y
ERU- 14	705	1250	2295	Y
ERU- 15	7570	7440	10660	N
ERU- 16	2235	1800	2170	N
ERU- 17	2000	3012	4050	Y
ERU- 18/19	11200	13620	18960	Y
ERU- 20	1770	2171	2925	Y

Summary

Through the analysis of ASHRAE 62.1 – 2010 Central High School has adequately designed systems and equipment. Even though there are non-compliance issues with the overall building these are due to the systems not being incorporated or lack of information at this time. As the building is still under construction these issues will be resolved by the end of the project. This report reflects that there are three systems that do not meet minimum ventilation requirements. But compared to what the actual amount of outdoor air provided for ventilation then only one system, ERU-16, does not meet this minimum. Therefore this report shows that this building is in compliance with section 5 but not section 6 of ASHRAE 62.1 – 2010.

ASHRAE Standard 90.1 – 2010 Analysis

Section 5 Building Envelope

5.1.4 Climate

Central High School is located in the Mid-Atlantic Region placing it in climate zone 4A.

5.2 Compliance Paths

For the building to comply with section 5.2 Compliance Paths it must be compliant with sections 5.1, 5.4, 5.7, 5.8.

5.4 Mandatory Provisions

Typical wall sections are given in Appendix A to show the proper sealing of all fenestrations.

5.5 Prescriptive Building Envelope Option

Typical wall, roof, and floor section are given in Appendix A to show minimum requirements for insulation. Calculations to show percentage of vertical glazing for the purpose of showing fenestration area, U-factors, and SHGC have not been done.

5.7 Submittals

Approval of submittals from the local jurisdiction are unknown at this time.

5.8 Product Information and Installation Requirements

Specifications and designs have met this section of ASHRAE 90.1 -2010.

Section 6 Heating, Ventilating, and Air Conditioning

6.1.1.2

Second floor of building is an addition and must comply with requirements in section 6.2.

6.2 Compliance Path

Compliance will be met by meeting sections 6.1, 6.4, 6.5, 6.7, 6.8.

6.4 Mandatory Provisions

For quality assurance all mechanical equipment shall be rated at least at minimum energy ratings or efficiencies and are to be verified. Provisions in the specifications call for mechanical equipment such as fuel-fired domestic hot water heaters to be labeled and comply with ASHRAE 90.1. HVAC controls for mechanical equipment such as boilers to prevent over pressurization are fitted on to them. Ventilation and damper controls are also present throughout the building. Duct insulation shall be 2 inch liner inside a double wall duct with perforated inner wall. Plenum insulation shall either be 1.5 inch thick mineral-fiber blanket or mineral-fiber board. Multiple methods and materials are listed in the specifications to prevent leakage from ductwork.

6.5 Prescriptive Path

Economizer is required according to Table 6.5.1A for comfort cooling. Economizers are not required according to Table 6.5.1B for computer rooms. High-limit shutoff controls can range from fixed enthalpy, electronic enthalpy, differential enthalpy, or dew-point and dry-bulb temperatures. Supply, return and exhaust dampers are already in compliance. Information for type of hood in kitchen not given at this time to comply with section 6.5.7. Laboratory exhaust systems do not exceed the 5000 cfm exhaust rate limit to comply with section 6.5.7.2.

6.7 Submittals

Engineer has specified in the specifications that mechanical contractor must balance the air and hydronic systems. Procedures for commissioning have been put into the specifications. Approval of submittals by the local jurisdiction is unknown at this time.

6.8 Minimum Equipment Efficiency Tables

Air cooled chiller CH-3 is approximately 110 tons and CH-4 approximately 7 tons. For performance requirements it has been stated that the chillers must comply with AHRI 550/590 test procedures. The natural gas boiler has an input of 9,805 MBH and it is stated in the specifications that the boiler must comply with 10 CFR 430.

Section 7 Service Water Heating

7.1 General

Compliance will be meet by complying with section 7.2.

7.2 Compliance Path

Compliance will be meet by complying with sections 7.1, 7.4, 7.5, 7.7, 7.8.

7.4 Mandatory Provisions

Calculations for service hot water heating and the associated equipment with efficiencies can be found on the drawings.

7.5 Prescriptive Path

The natural gas fired boiler complies with section 6.

7.7 Submittals

Drawings and specifications have been submitted to the local jurisdiction and approval unknown at this time.

7.8 Product Information

Boiler shall be fired at no less than 7872 MBTU/Hr and comply with efficiency codes.

Section 8 Power

8.1 General

Compliance will be meet through complying with the sections within this section.

8.2 Compliance Path

Compliance will be meet through complying with sections, 8.1, 8.4, 8.7.

8.4 Mandatory Provisions

Maximum voltage drop shall not exceed 5 percent for branch circuits, sub feeder and feeders. This is not in compliance with ASHRAE 90.1 voltage drop of 2 percent for feeders and 3 percent for branch circuits.

8.7 Submittals

Drawings and specifications have been sent to the local jurisdiction and approval unknown at this time.

Section 9 Lighting

9.1 General

Compliance will be meet when section 9.2 has been meet.

9.2 Compliance Path

Compliance will be meet when sections 9.1, 9.4 and either 9.5 or 9.6.

9.4 Mandatory Provisions

Occupancy sensors, day lighting sensors, emergency lighting, exterior, and zone lighting controls are to be provided.

Note:

Method of either the building area or space by space is not known at this time and will be looked into.

Section 10 Other Equipment

10.1 General

Compliance will be meet with sections 10.2.

10.2 Compliance Path

Compliance will be meet with sections 10.1, 10.4, 10.8.

10.4 Mandatory Provisions

Information on whether or not the motors used in this project were manufactured before or after 2010 was not given. Specifications require adequate lighting and ventilation along with a stand y mode.

10.8 Product Information

Motor required to be provided but no further information given about what type to be used.

Summary

Through the analysis of ASHRAE 90.1 – 2010 is has been determined that Central High School is mostly compliant with the standards. Due to ambiguity of the wording in the specifications and information not in the specifications some sections were not applicable. This gives the opportunity to further investigate and find out more information to later on make the building compliant with the standard. Therefore this report shows that Central High School is not within compliance of ASHRAE 90.1 – 2010.

References

SHW Group LLP "Final Bid Set". Reston, Virginia.

Central High School "Master Specifications".

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

ASHRAE. Standard 90.1-2010, Energy Standards for Buildings Except Low-Rise Residential Buildings. Atlanta, GA. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

Appendix A

Table 1

ASHRAE 62.1 Table 5-1 to confirm air intake minimum separation distances from contamination sources.

TABLE 5-1 Air Intake Minimum Separation Distance

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

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

Table 2

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-1	Cafeteria	7.5	604	0.18	6420	5686	11780	0.48

Table 3

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-2A/B	Stage	10	134	0.06	1910	1455	3400	0.43

Table 4

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-3	Reception	5	5	0.06	358	46.48	130	0.36
	Director's Office	5	2	0.06	152	19.12	55	0.35
	Director's Office	5	2	0.06	152	19.12	55	0.35
	Conference	5	10	0.06	623	87.38	260	0.34
	Food Lab	7.5	31	0.12	1184	374.58	620	0.60
	Office	5	1	0.06	54	8.24	30	0.27
	Food Lab	7.5	31	0.12	1184	374.58	620	0.60
	Office	5	1	0.06	54	8.24	30	0.27
	Decisions	5	16	0.06	442	106.52	320	0.33
	Decisions	5	16	0.06	442	106.52	320	0.33
	Plan	5	14	0.06	314	88.84	280	0.32
	Office	5	1	0.06	96	10.76	40	0.27
	Office	5	1	0.06	96	10.76	40	0.27
	Alt. Ed.	10	31	0.12	966	425.92	620	0.69
	Alt. Ed.	10	31	0.12	966	425.92	620	0.69
	Alt. Ed.	10	31	0.12	966	425.92	620	0.69
	Alt. Ed.	10	31	0.12	966	425.92	620	0.69
	Media Seminar	10	20	0.12	630	275.6	390	0.71
	Corridor	0	0	0.06	1620	97.2	215	0.45
	Corridor	0	0	0.06	1020	61.2	135	0.45
Total						3399	6020	

Table 5

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-4	Multipurpose Lab	7.5	26	0.06	1370	277.2	520	0.53
	Child Development Lab	7.5	26	0.06	1030	256.8	520	0.49
	Child Classroom	10	26	0.12	880	365.6	500	0.73
	Corridor	0	0	0.06	850	51	115	0.44
Total						951	1655	

Table 6

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-5	Reading Room	10	160	0.12	10410	2849.2	2615	1.09
	Publications	10	26	0.12	875	365	510	0.72
	Media Work Room	10	8	0.12	409	129.08	160	0.81
	Office	5	2	0.06	135	18.1	55	0.33
	Work Room	5	6	0.06	305	48.3	160	0.30
Total						3410	3500	

Table 7

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-6	SRO	5	1	0.06	167	15.02	40	0.38
	Attendance Office	5	1	0.06	100	11	40	0.28
	Hall	5	2	0.06	220	23.2	55	0.42
	Main Lobby	5	20	0.06	3575	314.5	400	0.79
	Corridor	0	0	0.06	1112	66.72	1000	0.07
Total						430	1535	

Table 8

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-7	Biology	10	31	0.18	1404	562.72	620	0.91
	Biology	10	31	0.18	1404	562.72	620	0.91
	Biology	10	31	0.18	1404	562.72	620	0.91
	Prep	10	4	0.12	285	74.2	180	0.41
	Chemistry Prep	10	4	0.12	256	70.72	200	0.35
	Chemistry Storage	5	2	0.12	120	24.4	100	0.24
	Chemistry	10	31	0.18	1324	548.32	620	0.88
	Student Projects	7.5	28	0.06	1465	297.9	560	0.53
	Biology	10	31	0.18	1324	548.32	620	0.88
	General Prep	10	4	0.12	256	70.72	200	0.35
	Earth Science	10	31	0.18	1494	578.92	620	0.93
	Corridor	0	0	0.06	925	55.5	125	0.44
	Corridor	0	0	0.06	1320	79.2	175	0.45
	Corridor	0	0	0.06	925	55.5	125	0.44
	Technical Lab	10	31	0.18	1520	583.6	620	0.94
	Fabrication	10	4	0.18	203	76.54	150	0.51
	Storage	5	2	0.12	277	43.24	60	0.72
	Chemistry	10	31	0.18	1324	548.32	620	0.88
	Biology	10	31	0.18	1324	548.32	620	0.88
	Corridor	0	0	0.06	509	30.54	70	0.44
	Corridor	0	0	0.06	1320	79.2	175	0.45
	Corridor	0	0	0.06	509	30.54	70	0.44
	Teacher Planning	5	31	0.06	1454	242.24	620	0.39
	Student Projects	7.5	20	0.06	648	188.88	400	0.47
	General Prep	10	4	0.12	180	61.6	200	0.31
	Physics	10	31	0.18	1470	574.6	620	0.93
	Technical Classroom	10	31	0.12	1351	472.12	620	0.76
	Corridor	0	0	0.06	1445	86.7	190	0.46
	Design	10	31	0.06	1211	382.66	620	0.62
	Earth Science	10	31	0.18	1400	562	620	0.91
	Physics	10	31	0.18	1330	549.4	620	0.89
	General Prep	10	4	0.12	402	88.24	200	0.44
	Corridor	0	0	0.06	1445	86.7	190	0.46
	Books	5	5	0.12	238	53.56	100	0.54
	Engineer	5	2	0.06	112	16.72	100	0.17
	Corridor	0	0	0.06	1320	79.2	175	0.45
	Special Education Resource	10	17	0.12	1032	293.84	340	0.86
	Special Education Resource	10	16	0.12	835	260.2	320	0.81
	Special Conference	5	18	0.06	465	117.9	470	0.25
	Special Office	5	9	0.06	274	61.44	235	0.26
	ESOL	10	17	0.12	851	272.12	340	0.80
	Special Education Classroom	10	17	0.12	712	255.44	340	0.75
	Special Education Conference	5	12	0.06	380	82.8	320	0.26
	Health Waiting	10	4	0.18	206	77.08	120	0.64
	Nurse	10	2	0.18	100	38	55	0.69
	Exam Room	10	2	0.18	109	39.62	55	0.72
	Rest Area	10	4	0.18	183	72.94	105	0.69
	Treatment	10	2	0.18	141	45.38	55	0.83
	SP Office	5	2	0.06	147	18.82	60	0.31
	Sp Conference	5	16	0.06	596	115.76	420	0.28
	In School Suspension	10	16	0.12	527	223.24	320	0.70
	Speech	10	9	0.12	378	135.36	180	0.75
	Business Classroom	10	31	0.12	1106	442.72	620	0.71
	Career	10	16	0.12	695	243.4	320	0.76
	Test Coordinator	5	2	0.06	122	17.32	60	0.29
	Pyschology	5	2	0.06	122	17.32	60	0.29
	Registrar	5	2	0.06	122	17.32	60	0.29
	Council	5	2	0.06	122	17.32	60	0.29
	SSO	5	2	0.06	122	17.32	60	0.29
	Work	5	4	0.06	122	27.32	105	0.26
	Corridor	0	0	0.06	246	14.76	35	0.42
	Test	10	12	0.12	236	148.32	240	0.62
	Guidance Reception	10	10	0.12	305	136.6	200	0.68
	Conference	10	15	0.12	352	192.24	390	0.49
	SSO	5	2	0.06	122	17.32	60	0.29
	Council	5	2	0.06	122	17.32	60	0.29
	Council	5	2	0.06	122	17.32	60	0.29
	Record	5	4	0.06	238	34.28	120	0.29
	Corridor	0	0	0.06	246	14.76	35	0.42
	Council	5	2	0.06	122	17.32	60	0.29
	Council	5	2	0.06	122	17.32	60	0.29
	Council	5	2	0.06	122	17.32	60	0.29
	SSO	5	2	0.06	122	17.32	60	0.29
	School Store	5	5	0.06	492	54.52	100	0.55
	Corridor	0	0	0.06	2190	131.4	285	0.46
Total						13235	19950	

Table 9

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-8	English	10	31	0.12	1024	432.88	620	0.70
	English	10	31	0.12	1188	452.56	620	0.73
	Math	10	31	0.12	1024	432.88	620	0.70
	Math	10	31	0.12	1188	452.56	620	0.73
	English	10	31	0.12	747	399.64	620	0.64
	Tele	0	0	0.06	250	15	175	0.09
	English	10	31	0.06	883	362.98	620	0.59
	English	10	31	0.06	883	362.98	620	0.59
	Math	10	31	0.06	883	362.98	620	0.59
	Math	10	31	0.06	883	362.98	620	0.59
	Corridor	0	0	0.06	1320	79.2	175	0.45
	Corridor	0	0	0.06	3000	180	400	0.45
	Math	10	31	0.06	953	367.18	620	0.59
	Math	10	31	0.06	756	355.36	620	0.57
	Math	10	31	0.06	756	355.36	620	0.57
	Math	10	31	0.06	883	362.98	620	0.59
	Math	10	31	0.06	883	362.98	620	0.59
	English	10	31	0.06	883	362.98	620	0.59
	English	10	31	0.06	883	362.98	620	0.59
	English	10	31	0.06	747	354.82	620	0.57
	English	10	31	0.06	747	354.82	620	0.57
	Corridor	0	0	0.06	3000	180	400	0.45
	Teacher Planning	5	42	0.06	2640	368.4	840	0.44
	English	10	31	0.06	883	362.98	620	0.59
	English	10	31	0.06	883	362.98	620	0.59
	Math	10	31	0.06	883	362.98	620	0.59
	Corridor	0	0	0.06	1320	79.2	175	0.45
	Business Computer Lab	10	36	0.12	1008	480.96	705	0.68
	Social Studies Classroom	10	31	0.06	747	354.82	620	0.57
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	PE Classroom	10	31	0.06	756	355.36	620	0.57
	Corridor	0	0	0.06	400	24	55	0.44
	Telecom	0	0	0.06	470	28.2	320	0.09
	PE Classroom	10	31	0.06	756	355.36	620	0.57
	Book Storage	5	0	0.06	622	37.32	415	0.09
	Book Storage	5	0	0.06	220	13.2	150	0.09
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	Social Studies Classroom	10	31	0.06	756	355.36	620	0.57
	General Resources	5	34	0.06	1500	260	670	0.39
	Computer Science Lab	10	34	0.12	1500	520	670	0.78
	Corridor	0	0	0.06	1450	87	245	0.36
	AP Reception	5	10	0.06	510	80.6	260	0.31
	English	10	31	0.06	747	354.82	620	0.57
	Social Studies Classroom	10	31	0.06	747	354.82	620	0.57
	Social Studies Classroom	10	31	0.06	747	354.82	620	0.57
	Business Lab	10	31	0.06	1010	370.6	620	0.60
	Business Classroom	10	31	0.06	1010	370.6	620	0.60
	Business Computer Lab	10	36	0.12	1008	480.96	705	0.68
	Corridor	0	0	0.06	400	24	55	0.44
	Telecom	0	0	0.06	365	21.9	245	0.09
Total						15914	28360	

Table 10

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-9	Reception	5	14	0.06	896	123.76	280	0.44
	Work Room	5	5	0.06	354	46.24	130	0.36
	AP Office	5	2	0.06	150	19	60	0.32
	AP Office	5	2	0.06	150	19	60	0.32
	Business Office	5	2	0.06	105	16.3	60	0.27
	Finance	5	2	0.06	116	16.96	60	0.28
	Principal Secretary	5	2	0.06	116	16.96	60	0.28
	Principal	5	3	0.06	219	28.14	80	0.35
	Administration Corridor	0	0	0.06	350	21	50	0.42
	Conference	5	10	0.06	420	75.2	260	0.29
	Corridor	0	0	0.06	815	48.9	110	0.44
	Corridor	0	0	0.06	1600	96	210	0.46
	Art Comm.	10	31	0.12	1070	438.4	620	0.71
	Art	10	31	0.12	1380	475.6	620	0.77
	AP Office	5	2	0.06	145	18.7	60	0.31
	Volunteer	5	5	0.06	366	46.96	130	0.36
	Corridor	0	0	0.06	435	26.1	60	0.44
	AP Office	5	2	0.06	145	18.7	60	0.31
	AP Office	5	2	0.06	145	18.7	60	0.31
	Corridor	0	0	0.06	890	53.4	120	0.45
	Faculty Lounge	5	30	0.06	1127	217.62	600	0.36
	World Language	10	31	0.06	1075	374.5	620	0.60
	World Language	10	31	0.06	1075	374.5	620	0.60
	Kitchen	7.5	2	0.12	169	35.28	40	0.88
	Corridor	0	0	0.06	1690	101.4	220	0.46
	Conference	5	12	0.06	400	84	320	0.26
Total						2811	5570	

Table 10

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-10	Art-Ceramic	10	31	0.18	1260	536.8	620	0.87
	Art Comm.	10	31	0.18	1334	550.12	620	0.89
	Art Planning	5	13	0.06	400	89	260	0.34
	Corridor	0	0	0.06	2100	126	275	0.46
	World Language	10	31	0.06	1075	374.5	620	0.60
	World Language	10	31	0.06	1075	374.5	620	0.60
	Kitchen	7.5	2	0.12	169	35.28	40	0.88
	Video Production	10	29	0.12	840	390.8	580	0.67
	Teacher Planning	5	13	0.06	390	88.4	260	0.34
	Black Box	10	31	0.06	1750	415	620	0.67
	Corridor	0	0	0.06	1407	84.42	185	0.46
Total						3065	4700	

Table 11

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-11	Aux. Gym	0	150	0.3	6322	1897	4500	0.42

Table 12

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU- 12/13	Gym	0	1000	0.3	11925	7155	21540	0.33

Table 13

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-14	Corridor	0	0	0.06	5624	337.44	750	0.45
	Concessions	7.5	2	0.18	203	51.54	60	0.86
	Athletic Director	5	3	0.06	186	26.16	100	0.26
	Coaches Office	5	6	0.06	602	66.12	180	0.37
	Corridor	0	0	0.06	1774	106.44	235	0.45
	Officials	5	4	0.06	158	29.48	125	0.24
	Officials	5	4	0.06	158	29.48	125	0.24
	Laundry	5	2	0.12	158	28.96	100	0.29
	Training	5	4	0.06	158	29.48	120	0.25
Total						705	1795	

Table 14

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-15	Team Room	20	100	0.06	1050	2063	2840	0.73
	Teacher's Plan	5	6	0.06	296	47.76	360	0.13
	Men's Lockers	20	80	0.06	1230	1673.8	2130	0.79
	Team Room	20	100	0.06	1050	2063	2840	0.73
	Teacher's Plan	5	6	0.06	296	47.76	360	0.13
	Women's Lockers	20	80	0.06	1230	1673.8	2130	0.79
Total						7569	10660	

Table 15

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-16	Fitness	20	100	0.06	2646	2158.76	2000	1.08
	Corridor	0	0	0.06	1275	76.5	170	0.45
Total						2235	2170	

Table 16

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-17	Corridor	0	0	0.06	1113	66.78	150	0.45
	Music	10	82	0.06	1824	929.44	1640	0.57
	Inst. Music	10	82	0.06	2150	949	1640	0.58
	Robe Storage	5	0	0.06	327	19.62	200	0.10
	Inst. Storage	5	0	0.06	633	37.98	420	0.09
Total						2003	4050	

Table 17

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-18/19	Auditorium	5	700	0.06	6530	3891.8	16320	0.24
	Lobby	5	18	0.06	715	132.9	360	0.37
	Teaching Alcove	7.5	87	0.06	1440	738.9	960	0.77
	Teaching Alcove	7.5	87	0.06	1440	738.9	960	0.77
	Stage Office	5	6	0.06	232	43.92	180	0.24
	Control	5	6	0.06	405	54.3	180	0.30
Total						11201	18960	

Table 18

Calculations for minimum outdoor air for ventilation rates.

Unit	Space	Rp (cfm/person)	Pz (people)	Ra (cfm/ft^2)	Az (ft^2)	Vbz (cfm)	Vpz (cfm)	Zpz
ERU-20	Dance	20	31	0.06	1755	725.3	620	1.17
	Costume Storage	5	0	0.06	243	14.58	165	0.09
	Practice	5	3	0.06	190	26.4	80	0.33
	Practice	5	3	0.06	190	26.4	80	0.33
	Practice	5	3	0.06	190	26.4	80	0.33
	Practice	5	3	0.06	190	26.4	80	0.33
	Practice	5	3	0.06	190	26.4	80	0.33
	Keyboard	10	31	0.12	1236	458.32	620	0.74
	Corridor	0	0	0.06	1074	64.44	150	0.43
	Planning	5	4	0.06	223	33.38	80	0.42
	Corridor	0	0	0.06	557	33.42	100	0.33
	Dressing	5	10	0.06	346	70.76	200	0.35
	Dressing	5	10	0.06	346	70.76	200	0.35
	Set Room	5	12	0.06	619	97.14	240	0.40
	Corridor	0	0	0.06	1113	66.78	150	0.45
Total						1767	2925	

Table 19

ASHRAE 62.1 – 2010 Table 6-1 to determine minimum ventilation rates in the breathing zone.

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

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft²	L/s·m²		#/1000 ft² or #/100 m²	cfm/person	L/s·person	
Correctional Facilities									
Cell	5	2.5	0.12	0.6		25	10	4.9	2
Dayroom	5	2.5	0.06	0.3		30	7	3.5	1
Guard stations	5	2.5	0.06	0.3		15	9	4.5	1
Booking/waiting	7.5	3.8	0.06	0.3		50	9	4.4	2
Educational Facilities									
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6	2
Daycare sickroom	10	5	0.18	0.9		25	17	8.6	3
Classrooms (ages 5–8)	10	5	0.12	0.6		25	15	7.4	1
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7	1
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3	1
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0	1
Art classroom	10	5	0.18	0.9		20	19	9.5	2
Science laboratories	10	5	0.18	0.9		25	17	8.6	2
University/college laboratories	10	5	0.18	0.9		25	17	8.6	2
Wood/metal shop	10	5	0.18	0.9		20	19	9.5	2
Computer lab	10	5	0.12	0.6		25	15	7.4	1
Media center	10	5	0.12	0.6	A	25	15	7.4	1
Music/theater/dance	10	5	0.06	0.3		35	12	5.9	1
Multi-use assembly	7.5	3.8	0.06	0.3		100	8	4.1	1
Food and Beverage Service									
Restaurant dining rooms	7.5	3.8	0.18	0.9		70	10	5.1	2
Cafeteria/fast-food dining	7.5	3.8	0.18	0.9		100	9	4.7	2
Bars, cocktail lounges	7.5	3.8	0.18	0.9		100	9	4.7	2
Kitchen (cooking)	7.5	3.8	0.12	0.6		20	14	7.0	2
General									
Break rooms	5	2.5	0.06	0.3		25	10	5.1	1
Coffee stations	5	2.5	0.06	0.3		20	11	5.5	1
Conference/meeting	5	2.5	0.06	0.3		50	6	3.1	1
Corridors	–	–	0.06	0.3		–			1
Occupiable storage rooms for liquids or gels	5	2.5	0.12	0.6	B	2	65	32.5	2
Hotels, Motels, Resorts, Dormitories									
Bedroom/living room	5	2.5	0.06	0.3		10	11	5.5	1
Barracks sleeping areas	5	2.5	0.06	0.3		20	8	4.0	1
Laundry rooms, central	5	2.5	0.12	0.6		10	17	8.5	2
Laundry rooms within dwelling units	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies/prefunction	7.5	3.8	0.06	0.3		30	10	4.8	1
Multipurpose assembly	5	2.5	0.06	0.3		120	6	2.8	1

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

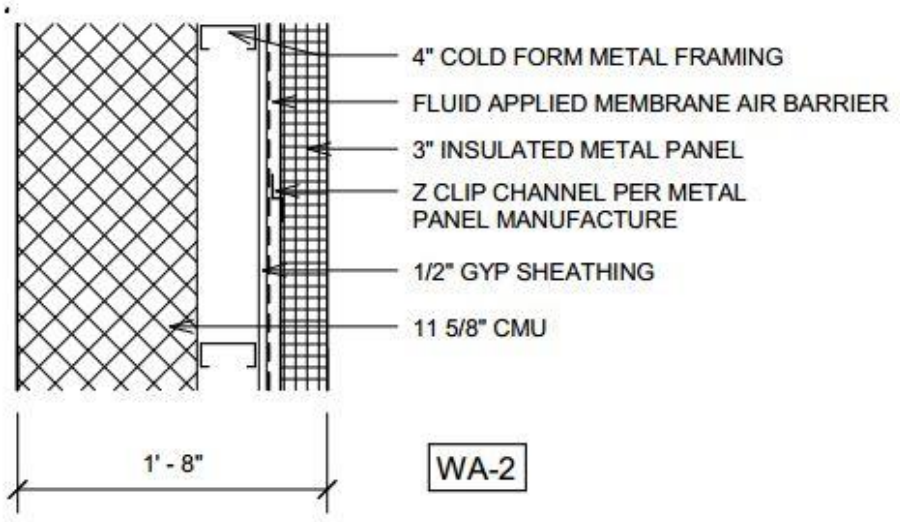
Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft²	L/s·m²		#/1000 ft² or #/100 m²	cfm/person	L/s·person	
Office Buildings									
Breakrooms	5	2.5	0.12	0.6		50	7	3.5	1
Main entry lobbies	5	2.5	0.06	0.3		10	11	5.5	1
Occupiable storage rooms for dry materials	5	2.5	0.06	0.3		2	35	17.5	1
Office space	5	2.5	0.06	0.3		5	17	8.5	1
Reception areas	5	2.5	0.06	0.3		30	7	3.5	1
Telephone/data entry	5	2.5	0.06	0.3		60	6	3.0	1
Miscellaneous Spaces									
Bank vaults/safe deposit	5	2.5	0.06	0.3		5	17	8.5	2
Banks or bank lobbies	7.5	3.8	0.06	0.3		15	12	6.0	1
Computer (not printing)	5	2.5	0.06	0.3		4	20	10.0	1
General manufacturing (excludes heavy industrial and processes using chemicals)	10	5.0	0.18	0.9		7	36	18	3
Pharmacy (prep. area)	5	2.5	0.18	0.9		10	23	11.5	2
Photo studios	5	2.5	0.12	0.6		10	17	8.5	1
Shipping/receiving	10	5	0.12	0.6	B	2	70	35	2
Sorting, packing, light assembly	7.5	3.8	0.12	0.6		7	25	12.5	2
Telephone closets	–	–	0.00	0.0		–			1
Transportation waiting	7.5	3.8	0.06	0.3		100	8	4.1	1
Warehouses	10	5	0.06	0.3	B	–			2
Public Assembly Spaces									
Auditorium seating area	5	2.5	0.06	0.3		150	5	2.7	1
Places of religious worship	5	2.5	0.06	0.3		120	6	2.8	1
Courtrooms	5	2.5	0.06	0.3		70	6	2.9	1
Legislative chambers	5	2.5	0.06	0.3		50	6	3.1	1
Libraries	5	2.5	0.12	0.6		10	17	8.5	1
Lobbies	5	2.5	0.06	0.3		150	5	2.7	1
Museums (children's)	7.5	3.8	0.12	0.6		40	11	5.3	1
Museums/galleries	7.5	3.8	0.06	0.3		40	9	4.6	1
Residential									
Dwelling unit	5	2.5	0.06	0.3	F,G	F			1
Common corridors	–	–	0.06	0.3					1
Retail									
Sales (except as below)	7.5	3.8	0.12	0.6		15	16	7.8	2
Mall common areas	7.5	3.8	0.06	0.3		40	9	4.6	1
Barbershop	7.5	3.8	0.06	0.3		25	10	5.0	2

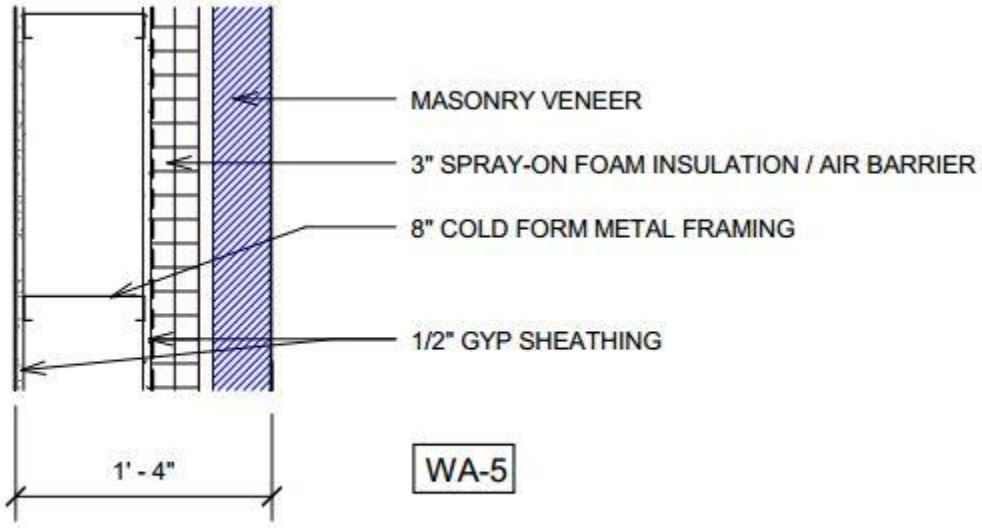
TABLE 6-1 MINIMUM VENTILATION RATES IN BREATHING ZONE *(Continued)*
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_a		Notes	Default Values			Air Class
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)		
	cfm/person	L/s·person	cfm/ft²	L/s·m²		#/1000 ft² or #/100 m²	cfm/person	L/s·person	
Beauty and nail salons	20	10	0.12	0.6		25	25	12.4	2
Pet shops (animal areas)	7.5	3.8	0.18	0.9		10	26	12.8	2
Supermarket	7.5	3.8	0.06	0.3		8	15	7.6	1
Coin-operated laundries	7.5	3.8	0.12	0.6		20	14	7.0	2
Sports and Entertainment									
Sports arena (play area)	–	–	0.30	1.5	E	–			1
Gym, stadium (play area)	–	–	0.30	1.5		30			2
Spectator areas	7.5	3.8	0.06	0.3		150	8	4.0	1
Swimming (pool & deck)	–	–	0.48	2.4	C	–			2
Disco/dance floors	20	10	0.06	0.3		100	21	10.3	2
Health club/aerobics room	20	10	0.06	0.3		40	22	10.8	2
Health club/weight rooms	20	10	0.06	0.3		10	26	13.0	2
Bowling alley (seating)	10	5	0.12	0.6		40	13	6.5	1
Gambling casinos	7.5	3.8	0.18	0.9		120	9	4.6	1
Game arcades	7.5	3.8	0.18	0.9		20	17	8.3	1
Stages, studios	10	5	0.06	0.3	D	70	11	5.4	1

Figure 1

Typical wall sections.





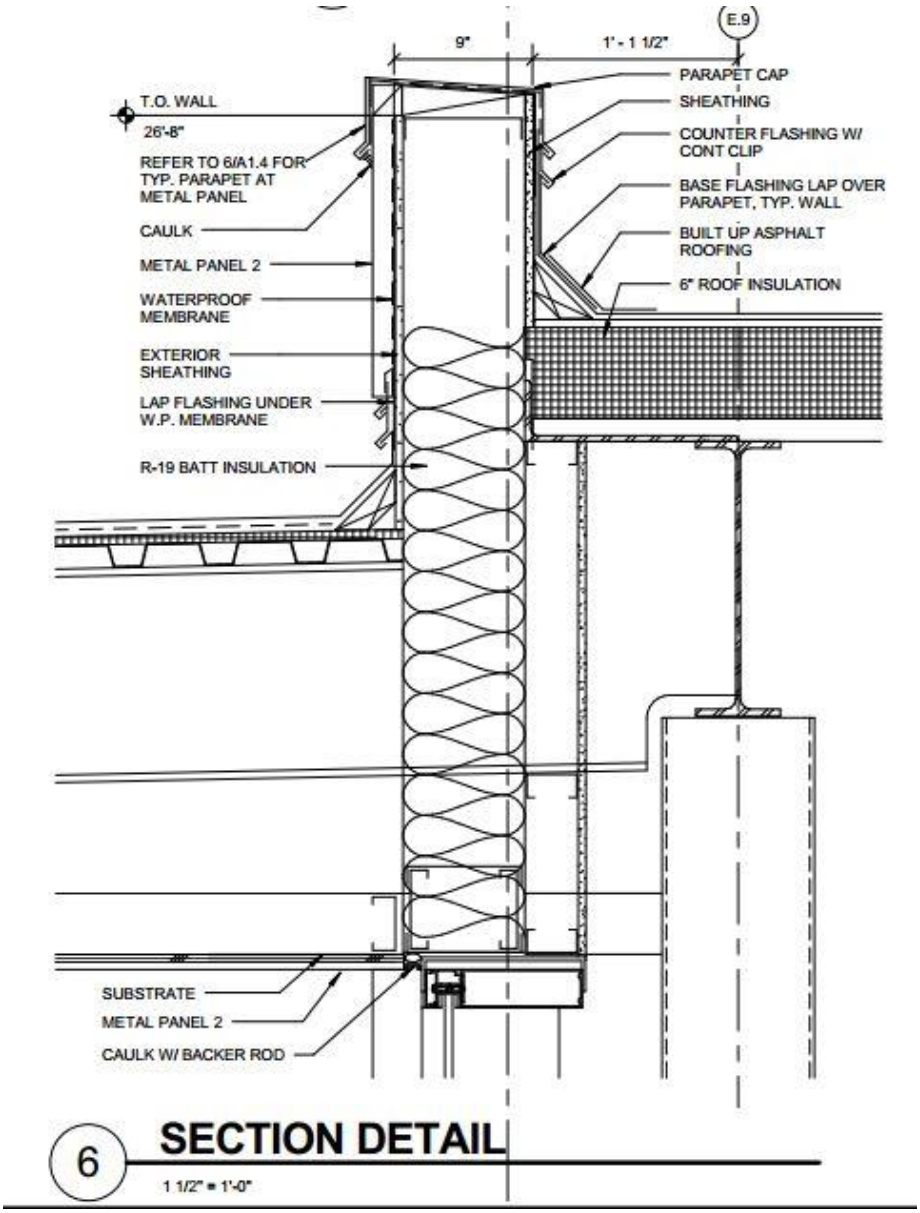

9"
1' - 1 1/2"
E.9
PARAPET CAP
SHEATHING
COUNTER FLASHING W/ CONT CLIP
BASE FLASHING LAP OVER PARAPET, TYP. WALL
BUILT UP ASPHALT ROOFING
6" ROOF INSULATION
T.O. WALL
26'-8"
REFER TO 6/A1.4 FOR TYP. PARAPET AT METAL PANEL
CAULK
METAL PANEL 2
WATERPROOF MEMBRANE
EXTERIOR SHEATHING
LAP FLASHING UNDER W.P. MEMBRANE
R-19 BATT INSULATION
SUBSTRATE
METAL PANEL 2
CAULK W/ BACKER ROD
6
SECTION DETAIL
1 1/2" = 1'-0"

Figure 2

ASHRAE baseline building envelope U-values for buildings in zone 4A.

TABLE 5.5-4 Building Envelope Requirements for Climate Zone 4 (A, B, C)*

Opaque Elements	Nonresidential		Residential		Semiheated	
	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value	Assembly Maximum	Insulation Min. R-Value
Roofs						
Insulation Entirely above Deck	U-0.048	R-20.0 c.i.	U-0.048	R-20.0 c.i.	U-0.173	R-5.0 c.i.
Metal Building[a]	U-0.055	R-13.0 + R-13.0	U-0.055	R-13.0 + R-13.0	U-0.097	R-10.0
Attic and Other	U-0.027	R-38.0	U-0.027	R-38.0	U-0.053	R-19.0
Walls, Above-Grade						
Mass	U-0.104	R-9.5 c.i.	U-0.090	R-11.4 c.i.	U-0.580	NR
Metal Building	U-0.084	R-19.0	U-0.084	R-19.0	U-0.113	R-13.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.089	R-13.0	U-0.064	R-13.0 + R-3.8 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-1.140	NR	C-0.119	R-7.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.087	R-8.3 c.i.	U-0.074	R-10.4 c.i.	U-0.137	R-4.2 c.i.
Steel-Joist	U-0.038	R-30.0	U-0.038	R-30.0	U-0.069	R-13.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.066	R-13.0
Slab-On-Grade Floors						
Unheated	F-0.730	NR	F-0.540	R-10 for 24 in.	F-0.730	NR
Heated	F-0.860	R-15 for 24 in.	F-0.860	R-15 for 24 in.	F-1.020	R-7.5 for 12 in.
Opaque Doors						
Swinging	U-0.700		U-0.700		U-0.700	
Nonswinging	U-1.500		U-0.500		U-1.450	
Fenestration	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**	**Assembly Max. U**	**Assembly Max. SHGC**
Vertical Glazing, 0%–40% of Wall						
Nonmetal framing (all)[c]	U-0.40		U-0.40		U-1.20	
Metal framing (curtainwall/storefront)[d]	U-0.50	SHGC-0.40 all	U-0.50	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (entrance door)[d]	U-0.85		U-0.85		U-1.20	
Metal framing (all other)[d]	U-0.55		U-0.55		U-1.20	
Skylight with Curb, Glass, % of Roof						
0%–2.0%	U_{all}-1.17	$SHGC_{all}$-0.49	U_{all}-0.98	$SHGC_{all}$-0.36	U_{all}-1.98	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.17	$SHGC_{all}$-0.39	U_{all}-0.98	$SHGC_{all}$-0.19	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}-1.30	$SHGC_{all}$-0.65	U_{all}-1.30	$SHGC_{all}$-0.62	U_{all}-1.90	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.30	$SHGC_{all}$-0.54	U_{all}-1.30	$SHGC_{all}$-0.27	U_{all}-1.90	$SHGC_{all}$-NR
Skylight without Curb, All, % of Roof						
0%–2.0%	U_{all}-0.69	$SHGC_{all}$-0.49	U_{all}-0.58	$SHGC_{all}$-0.36	U_{all}-1.36	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-0.69	$SHGC_{all}$-0.39	U_{all}-0.58	$SHGC_{all}$-0.19	U_{all}-1.36	$SHGC_{all}$-NR

*The following definitions apply: c.i. = *continuous* ... ion) requirement.
[a]When using R-value compliance method, a thermal spacer block is required; otherwise use the *U-factor* compliance method. See Table A2.3.
[b]Exception to Section A3.1.3.1 applies.
[c]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[d]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.