Technical Assignment 1

ASHRAE Standard 62.1 and Standard 90.1 Evaluations

Compliance Analysis

Des Places Residence Hall

Duquesne University

Pittsburgh, PA

DUQUESNE UNIVERSITY

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Executive Summary

Des Places Residence Hall, which is currently in the construction phase will be a 131,000 ft^2 dormitory building for students at Duquesne University. There has been a strong emphasis on energy conservation and green practices throughout the design process and the building must achieve a minimum of LEED certification by its completion. The building is 12 stories above grade with a mechanical penthouse above Floor 12.

The mechanical system for Des Places is fairly simple, while at the same time managing to save a great deal on energy use. The vast majority of the rooms are conditioned by individual four pipe fan coil units. These fan coil units range in size from 300 cfm to 1200 cfm based on the size and load demands of the space. Each unit is connected to a thermostat that can run on automatic controls or be set to a desired temperature by the occupant. The only spaces that are not fully conditioned in the building are the storage and mechanical rooms. These zones are heated with unit heaters. A 100% outdoor air energy recovery unit in the mechanical penthouse provides the required amount of outdoor air to all of the spaces in the building that require it. The energy recovery unit saves energy by using a desiccant wheel that picks up latent and sensible heat from the return air plenum and transfers it to the supply air plenum. The supply fan for ERU-1 is controlled by a variable frequency drive to save on energy consumption as well. The building receives its chilled water and steam from the central plants on Duquesne's campus. These main lines are fed into the building from underground piping through the south wall of Floor 1. Both the chilled water and steam for the building come from an outside source, so no chillers or boilers are needed for Des Places. The steam is converted to hot water immediately after entering the building and two pumps then circulate the hot water to all of the fan coil units, unit heaters, cabinet heaters and the energy recovery unit. The chilled water is circulated through the building by two pumps as well.

ASHRAE Standard 62.1 was the first set of requirements used to analyze Des Places. Sections 5 and 6 were examined in particular. Section 5 deals with the equipment that effects indoor air quality. An analysis of the buildings compliance with Section 5 was an overall success. As the table below shows, Des Places met the requirements of every applicable chapter.

ASHRAE Standard 62.1, Section 5 Compliance	
Section	ASHRAE 62.1 Compliance
5.1-Natural Ventilation	N.A.
5.2-Ventilation Air Distribution	YES
5.3-Exhaust Duct Location	YES
5.4-Ventilation System Controls	YES
5.5-Airstream Surfaces	YES
5.6-Outdoor Air Intakes	YES
5.7-Local Capture of Contaminants	YES
5.8-Combustion Air	YES
5.9-Particulate Matter Removal	YES
5.10-Dehumidification Systems	YES
5.11-Drain Pans	YES
5.12-Finned-Tube Coils and Heat Exchangers	YES
5.13-Humidifiers and Water-Spray Systems	N.A.
5.14-Access For Inspection, Cleaning and Maintenance	YES
5.15-Building Evelope and Interior Surfaces	YES
5.16-Building with Attached Parking Garage	N.A.
5.17-Air Classification and Recirculation	YES
5.18-Requirements for Buildings Containing ETS Areas and ETS-Free Areas	N.A.

Section 6 sets minimum outdoor air requirements for the ventilation systems in a building. For Des Places the only air handler that needed to be analyzed was ERU-1. Although a small number of rooms in the building did not receive the minimum amount of outside air needed, ERU-1 greatly exceeded the requirements of Section 6. The compliance summary of ERU-1 is shown in the table below.

Compliance Summary				
AHU	Calculated Outdoor Air	Design OA Flow Into Rooms	Design OA Flow From Schedule	ASHRAE 62.1 Compliance
ERU-1	10855 cfm	15895 cfm	20600 cfm	YES

Des Places was further analyzed in accordance with sections five through nine of ASHRAE Standard 90.1. This standard provides a prescriptive method for evaluating the energy efficiency of a building. The sections that were examined for this report deal with the building envelope, HVAC systems, service water heating, power and lighting. Des Places successfully met and usually exceeded the baseline requirements listed in this standard. A detailed summary of the buildings compliance with Standard 90.1 can be found on page 13.

Overall Des Places Residence Hall was very successful in meeting all of the requirements outlined in the applicable sections of ASHRAE Standards 62.1 and 90.1. A detailed summary of this analysis is given below.

ASHRAE Standard 62.1-2007 Compliance Analysis

Section 5

Section 5 of ASHRAE Standard 62.1 deals with the systems and equipment that effect indoor air quality in a building. The standards set forth in this section are meant to improve the air quality of a building so that it will be acceptable for human occupants and minimize any potential negative health effects.

5.1 - Natural Ventilation:

The only windows that are operable for natural ventilation are in the bedrooms. Although these windows can open and close, they are equipped with a safety feature that only allows them to slide 6" down from the top of the frame. Therefore natural ventilation is not relied on to bring in the required amount of outdoor air to each space. The building utilizes a mechanical ventilation system instead.

5.2 – Ventilation Air Distribution:

Constant volume supply registers are used to deliver the proper amount of ventilation to each space in accordance with Section 6 of Standard 62.1. The outdoor air is delivered to all of the supply registers through a 100% outdoor air energy recovery unit, located in the mechanical penthouse. In the entire building, 14 out of a total of 364 rooms do not have the required amount of outdoor air flow. A detailed analysis of the buildings compliance with Section 6 is given in this report.

5.3 – Exhaust Duct Location:

All exhaust ducts are negatively pressurized in relation to the spaces that they pass through. All of the exhaust ductwork in the building terminates at exhaust louvers which bring the contaminated air outside of the building in areas where there is no pedestrian traffic. The ductwork that connects to Exhaust Fan 3 is brought outside in the mechanical penthouse of the building, which is 12 stories above ground. Exhaust fans 1 and 4 bring their contaminated air outside on the ground level on the west side of the building, which is a sufficient distance from the loading dock area on the north side of the building.

5.4 – Ventilation System Controls:

There are occupancy sensors in each room that are connected to the supply registers and control their dampers. If the room is unoccupied, the dampers are fully closed and if the room is occupied the dampers switch to fully open and allow the required amount of outside air to be delivered to the space. The dampers for each supply register influence the pressure and air flow going through the supply ductwork which connects to the energy recovery unit in the penthouse. The supply fan in ERU-1 is controlled by a variable frequency drive which reacts to the air flow

demand from the registers in each room. The VFD controls the power of the fan, so that it can adjust to meet the required air flow while not wasting any energy by running at a speed that is higher than necessary.

5.5 – Airstream Surfaces:

In section 233113 (Metal Ducts) of the mechanical specifications it states that "surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004". The majority of the ductwork is constructed of galvanized steel with lock-type spiral seams. Compliant flexible duct is used before the registers and diffusers when necessary.

5.6 – Outdoor Air Intakes:

Des Places has outdoor intakes on the ground level and penthouse level. The images below show where the intakes are located in relation to the exhaust outlets and the loading dock.

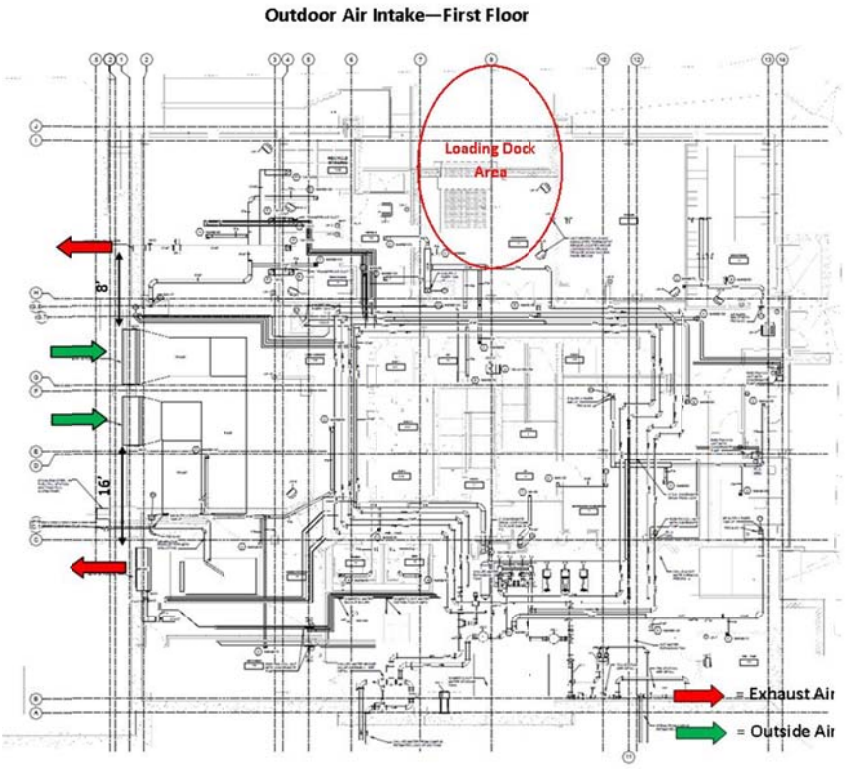

***Figure 1**: Floor plan of first floor showing OA inlet and EA outlet locations*

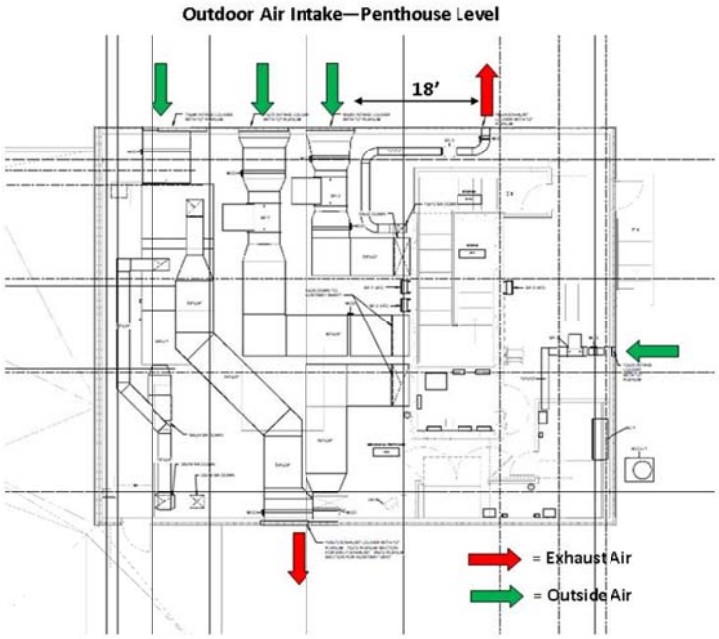

Figure 2: *Floor plan of penthouse showing OA inlet and EA outlet locations*

The images above show that the locations of the outdoor air intakes are compliant with Table 5-1 with the exception of the intake location on Floor 1. Although these two intakes are not compliant, they are an exception to this section because they only provide air to the generator room, so that it has enough oxygen to run properly. Therefore the only outdoor air intakes that serve the ventilation system are located on the Penthouse level and all of these are compliant.

According to the mechanical specifications the intakes are designed to meet the rain and snow entrainment requirements as specified in this section. They will also be equipped with compliant bird screens.

5.7 – Local Capture of Contaminants:

All of the exhaust ducts terminate to the outside through walls on the first floor or mechanical penthouse, meeting the requirements of this section.

5.8 – Combustion Air:

The only piece of equipment in Des Places that uses a combustion process is the emergency generator located in the generator room on Floor 1. The necessary amount of fresh air is introduced into the space through two outdoor air intakes located on the west wall. The generator has an exhaust vent connected directly to it which brings the majority of the combustion air outside of the building. Any remaining polluted air that the exhaust vent does not capture is taken out of the space by EF-4 and brought directly outside through an exhaust air louver.

5.9 – Particulate Matter Removal:

ERU-1 is the only piece of equipment that requires a particulate matter filter. The pre-filter, which is located right after the outside air inlet has a MERV 8 rating. The final filter, which is located in the supply air plenum after the precool and reheat coils, has a MERV 11 rating. Both of these filters exceed the requirements of this section.

5.10 – Dehumidification Systems:

The mechanical system for Des Places is designed to keep the relative humidity under 50% for every occupied space in the building. The second part of this section states that the minimum outdoor air intake must exceed the total cfm taken out of the building by the exhaust when the air-conditioning systems are dehumidifying. This is required to keep the building positively pressurized. The table below shows the total exhaust airflow coming out of the building.

Exhaust		
Tag	Serves	System Airflow
EF-1	Trash and Recycling	1533 cfm
EF-3	Trash Chute	800 cfm
EF-4	Generator Room	150 cfm
	Total:	2483 cfm

Table 1: *Total exhaust airflow leaving Des Places*

The outdoor air intake for ERU-1 can reach a maximum of 20600 cfm and the minimum outdoor air that must be brought into the building when it is occupied is 10855 cfm, as calculated using the ventilation rate procedure from Section 6. The energy recovery unit will operate within this range (10855 cfm – 20600 cfm) at all times and therefore the outdoor air intake will always be much greater than the total exhaust air leaving the building.

5.11 – Drain Pans:

All drain pans are specified to have a minimum slope of 1/8" per foot from the horizontal. The specifications call for drain pans to be a minimum of 3 inches deep with a 1 ½ inch diameter minimum drain line that connects to a field-provided P-trap. The drain pans are fabricated with stainless steel and the drains are made of copper.

5.12 – Finned Tube Coils and Heat Exchangers:

There are no heat exchangers for this building, so this section only applies to the finned-tube coils in ERU-1. In the specifications for "Packaged Air-To-Air Energy Recovery Units", it states that all coil sections will have drain pans that comply with ASHRAE 62.1 and have 18 inch spacing between coils to allow access for cleaning.

5.13 – Humidifiers and Water-Spray Systems:

There are no direct evaporation humidifiers, air washers or any other water-spray systems used for humidification in this building, so this section does not apply.

5.14 – Access For Inspection, Cleaning, and Maintenance:

Access to all mechanical equipment is sufficient to provide working space for inspection and routine maintenance. The specifications for the energy recovery unit call for all access doors to be of the same construction as the wall panels and be the full height of the ERU, up to 80 inches. Vapor tight lights with a minimum 40 watt bulb are also required inside the ERU for better visibility. Labels are required on the access doors for all of the mechanical equipment in the building to identify the equipment within.

5.15 – Building Envelope and Interior Surfaces:

The masonry wall of the building has a vapor barrier followed by a 1 7/8" airspace to limit water vapor diffusion on the inside of the wall. The roof has a TPO membrane which acts as a water-tight seal.

The insulation for the supply and return ducts in the building will have a density from 3 to 6 lb/ft^3, a minimum R-value of 4.2 at a nominal thickness of 1", and a maximum water vapor transmission rate of 0.06 perm in. The insulation for the hydronic piping in Des Places will have a polymer vapor-retardant jacket with self-sealing adhesive tape to keep condensation from forming on the exterior of the pipes. The figure below shows a typical pipe insulation sleeve through a wall. The insulation for both the ducts and the pipes should be sufficient in preventing condensation from forming on the exposed surface or within the material itself.

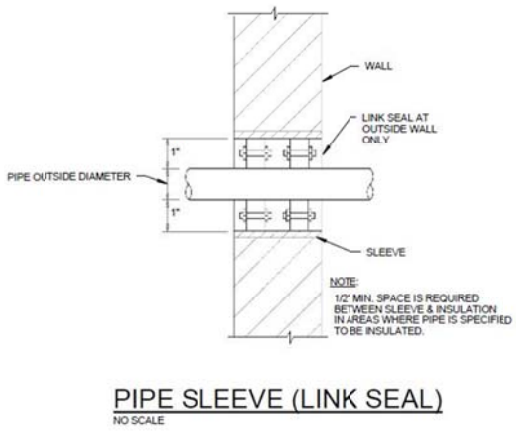

Figure 3: *Hydronic pipe sleeve detail, where pipe goes through a wall*

5.16 – Buildings With Attached Parking Garages:

Des Places does not have an attached parking garage, so this section does not apply.

5.17 – Air Classification and Recirculation:

Most of the building air in Des Places can be characterized as Class 1 and recirculated. The only air in the building that can be described as Class 3 is found in the bathrooms, generator room and trash rooms and all of this air is exhausted directly out of the building. Therefore Des Places meets the requirements of this section.

5.18 – Requirements For Buildings Containing ETS Areas and ETS-Free Areas:

Des Places Residence Hall is a smoke free building, so this section does not apply.

Section 6

Procedures

For the purpose of these calculations, ERU-1 was selected for analysis. ERU-1 is a 100% outdoor air unit that provides fresh air to all of the required zones in the building.

The Ventilation Rate Procedure was chosen over the IAQ Procedure because the building does not utilize controls that remove air contaminants. It also utilizes a single 100% Outside Air Energy Recovery Unit to deliver the required amount of fresh air to each space in the building. This method of delivering outdoor air is better suited for the Ventilation Rate Procedure.

The Ventilation Rate Procedure determines outdoor air intakes for individual rooms based on the occupancy type, occupancy level, and floor area of each space. The minimum rates given for each room type are based on typical contaminant sources and source strengths within those spaces. The formulas for this procedure are outlined and explained in the section below.

Section 6.2-Ventilation Rate Procedure:

The outdoor air for the site of Des Places was deemed acceptable in accordance with Section 4.1 of Standard 62.1 and therefore section 6.2.1, which deals with air contaminants, can be ignored.

Formula 6-1 was used to find the breathing zone outdoor airflow (V_{bz}) required for each space. This formula is shown below:

$$V_{bz} = (R_p \times P_z) + (R_a \times A_z)$$

- R_p = Outdoor airflow rate required per person. These values are given in Table 6-1 for each occupancy category.

- P_z = Zone population. This should account for the largest number of people expected to occupy the space during typical usage. These values were primarily decided by the furniture layout of each room.
- R_a = Outdoor airflow rate required per unit area. These values are given in Table 6-1 for each occupancy category.
- A_z = Zone floor area. These values were taken from the architectural floor plans.

Zone Air Distribution Effectiveness (E_z)

All of the spaces served by the Energy Recovery Unit fall into the category "ceiling supply of cool air" in Table 6-2, which decides the value of E_z for each zone. Therefore for every zone in the building,

$$E_z = 1.0$$

Zone Outdoor Airflow (V_{oz})

V_{oz} is the design outdoor airflow that must be provided to each zone by the supply air distribution system. It is given by formula 6-2,

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

Because $E_z = 1$, formula 2 simplifies to,

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

Primary Outdoor Air Fraction (Z_p)

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

V_{pz} is the total airflow to the space from the air handling unit. This includes both the outdoor air and the recirculated return air.

Outdoor Air Intake Flow (V_{ot})

One Energy Recovery Unit in the penthouse uses 100% outdoor air to supply all of the spaces in the building that require fresh air. For a scenario such as this the following equation applies:

$$V_{ot} = \sum_{\text{all zones}} V_{oz}$$

This relationship between V_{ot} and $\sum V_{oz}$ will apply for the Energy Recovery Unit and for the entire building.

Section 6.2.8 – Exhaust Ventilation:

All of the spaces in the building that require exhaust ventilation were checked in accordance with this section. The only room types in Des Places that require exhaust are the public and private

restrooms, janitor closets, trash rooms and recycling rooms. Table 6-4 was used to determine the minimum exhaust rates.

Calculations

The spreadsheets found in Appendix A show all of the calculations necessary to find the total outdoor air intake needed for the entire building and consequently for ERU-1, because it delivers outdoor air to every space. The areas for each room were measured from the architectural floor plans and the numbers for the column named "Design CFM to Space" came from the CFM labels next to all of the supply diffusers on the mechanical duct plans (H1.1 – H1.6).

The table below shows the total outdoor air required by floor and the design outdoor air delivered to each floor by the supply registers and diffusers. The value for $\sum V_{oz}$ was found by summing the V_{oz} calculated for each room. The values in the column entitled "Design OA" is the sum of the design outdoor air delivered to each room by all of the supply registers and diffusers for each room on the floor.

OA Requirements By Floor

Floor	∑Voz	Vot	Design OA
1	769 cfm	769 cfm	1425 cfm
2	868 cfm	868 cfm	1615 cfm
3	897 cfm	897 cfm	1265 cfm
4	897 cfm	897 cfm	1265 cfm
5	897 cfm	897 cfm	1265 cfm
6	897 cfm	897 cfm	1265 cfm
7	897 cfm	897 cfm	1265 cfm
8	897 cfm	897 cfm	1265 cfm
9	897 cfm	897 cfm	1265 cfm
10	897 cfm	897 cfm	1265 cfm
11	897 cfm	897 cfm	1265 cfm
12	1145 cfm	1145 cfm	1470 cfm
Total:	10855 cfm	10855 cfm	15895 cfm

Table 2: *Total outdoor air required and delivered to each floor*

The next table is a summary of the building's compliance to the ASHRAE ventilation guidelines, given in section 6.2.

Compliance Summary				
AHU	Calculated Outdoor Air	Design OA Flow Into Rooms	Design OA Flow From Schedule	ASHRAE 62.1 Compliance
ERU-1	10855 cfm	15895 cfm	20600 cfm	YES

Table 3: *ASHRAE 62.1, Section 6 Compliance Summary for ERU-1*

The exhaust calculations were completed through the use of tables as well. The exhaust calculations for Floor 1 are shown below as an example of the method used for determining the compliance of the building's exhaust system to Section 6.2.8. The values for the column entitled "Design Exhaust CFM to Space" were found by recording the cfm values next to the exhaust diffusers on the mechanical duct plans.

Floor 1 - Exhaust Calculations									
Room Name & Number	Location	Occupancy Category	Area (SF)	Number of Units	Exhaust Rate (cfm/SF)	Exhaust Rate (cfm/unit)	Exhaust Required (CFM)	Design Exhaust CFM to Space	ASHRAE 62.1 Compliance
103-Mens	1st Floor	Toilets-Private	59	1		50	50	50	YES
104-Womens	1st Floor	Toilets-Private	54	1		50	50	50	YES
107-Trash Staging	1st Floor	Janitor Closets, trash rooms, recycling	173		1.00		173	200	YES
108-Recycle Staging	1st Floor	Janitor Closets, trash rooms, recycling	173		1.00		173	200	YES

Table 4: *Exhaust calculations for required rooms on Floor 1*

Result Analysis

The calculations showed that the ventilation and exhaust systems for Des Places complied almost entirely with Section 6.2 of ASHRAE Standard 62.1. The only exception to total compliance was in one room on Floor 1, one room on Floor 2, nine rooms on Floors 3 through 11 and three rooms on Floor 12. The insufficient amount of outdoor air delivered to these rooms is somewhat made up for by the total amount of OA being delivered to each floor. Every floor has far more outdoor air being introduced through the supply diffusers than the calculated sum of V_{oz}. This excess amount of fresh air will circulate gradually from rooms that are positively pressurized with an excess amount of air to rooms that are negatively pressurized with not as much fresh air. This will allow the rooms that do not have an adequate amount of outdoor air to pick some up from rooms that have more than enough.

The Energy Recovery Unit in the penthouse is the only system that delivers outdoor air to the building, so it was therefore the only piece of equipment that was examined for ventilation compliance. According to the schedule on drawing H0.1, ERU-1 can supply a maximum of 20,600 CFM of outside air. This is almost double the required amount for the building, as calculated in accordance with the procedures given in Section 6.2. It is also 4,705 cfm more than

the total design outdoor airflow into all of the spaces from the supply diffusers. Therefore it can be concluded that ERU-1 safely meets the ventilation requirements of ASHRAE Standard 62.1.

Every room in Des Places that requires exhaust air complies with Standard 62.1 as well. The tables in Appendix A show that every space has an exhaust register that either matches or exceeds the required airflow.

ASHRAE Standard 62.1 Conclusions

The analysis of this buildings compliance to Standard 62.1 was an overall success. As the table below shows, Des Places met all of the applicable requirements in Section 5. Although every room in the building did not meet the ventilation requirements given in Section 6, the energy recovery unit that supplies all of the outdoor air to the building did exceed the total ventilation requirement by a significant margin.

ASHRAE Standard 62.1, Section 5 Compliance	
Section	ASHRAE 62.1 Compliance
5.1-Natural Ventilation	N.A.
5.2-Ventilation Air Distribution	YES
5.3-Exhaust Duct Location	YES
5.4-Ventilation System Controls	YES
5.5-Airstream Surfaces	YES
5.6-Outdoor Air Intakes	YES
5.7-Local Capture of Contaminants	YES
5.8-Combustion Air	YES
5.9-Particulate Matter Removal	YES
5.10-Dehumidification Systems	YES
5.11-Drain Pans	YES
5.12-Finned-Tube Coils and Heat Exchangers	YES
5.13-Humidifiers and Water-Spray Systems	N.A.
5.14-Access For Inspection, Cleaning and Maintenance	YES
5.15-Building Evelope and Interior Surfaces	YES
5.16-Building with Attached Parking Garage	N.A.
5.17-Air Classification and Recirculation	YES
5.18-Requirements for Buildings Containing ETS Areas and ETS-Free Areas	N.A.

Table 5: *Summary of ASHRAE Standard 62.1, Section 5 compliance*

ASHRAE Standard 90.1-2007 Compliance Analysis

The following section is an analysis of the compliance of Des Places Residence Hall to the requirements set forth in ASHRAE Standard 90.1, Energy Standard for Buildings. The buildings envelope, HVAC systems, service water heating, lighting and electric motor efficiency are all evaluated in detail for their compliance with this standard.

Section 5 – Building Envelope

Section 5 of Standard 90.1 describes the performance requirements for the building envelope. These requirements are based on the location of the building and the space conditioning category.

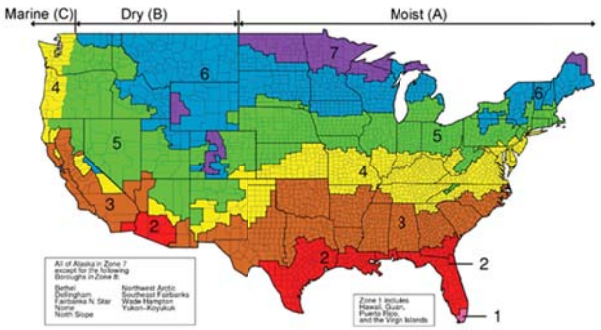

Figure 4: *ASHRAE climate zone map for the United States of America*

The first step in determining a buildings compliance with Section 5 is finding what zone it is located in according to the ASHRAE Climate Zone map shown above. Des Places is located in Pittsburgh, PA which is in Climate Zone 5.

5.5 – Prescriptive Building Envelope Option:

The Prescriptive Building Envelope Option was chosen to evaluate the building envelope for Des Places. In order for this method to be used, two prerequisites must be met. The total vertical fenestration area cannot exceed 40% of the total building wall area and the total skylight fenestration cannot exceed 5% of the total roof area. The elevations shown below were used to calculate the total window area in relation to the total area of the walls. There are no skylights on the roof, so the second requirement does not apply to this building.

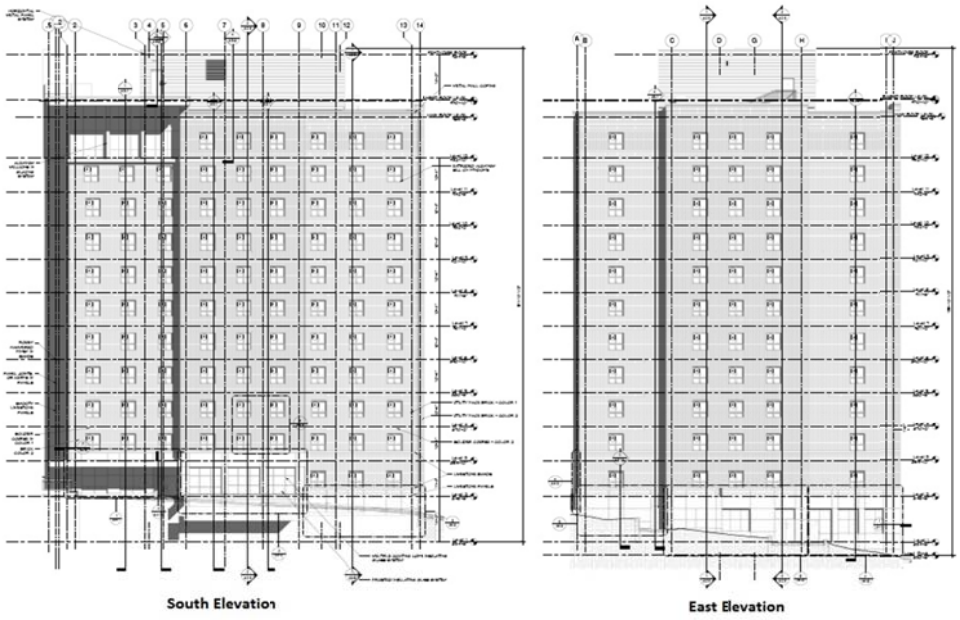

Figure 5: *South and east exterior elevations for Des Places*

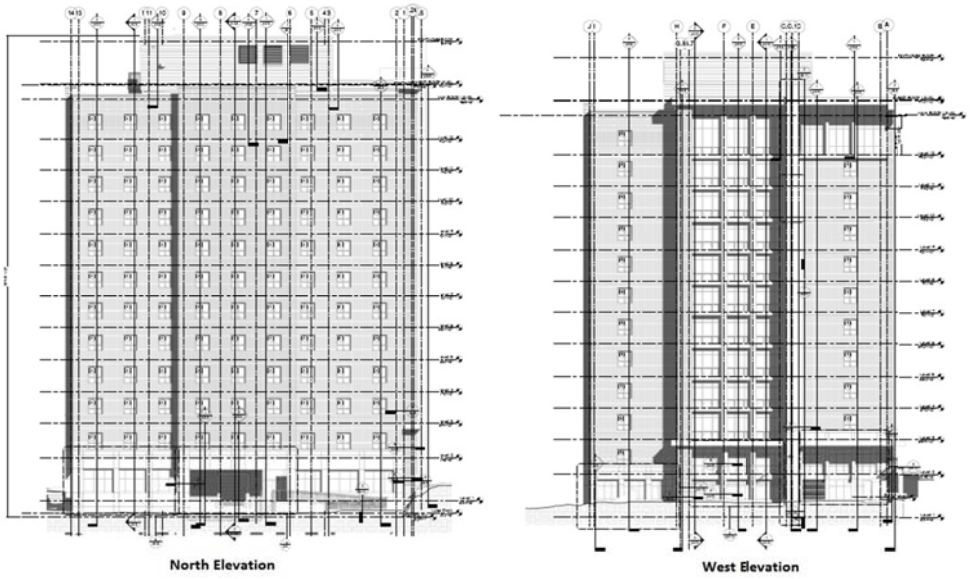

Figure 6: *North and west exterior elevations for Des Places*

The table below shows the total square footage of the vertical fenestration compared to the total wall area for each elevation. None of the elevations had more than 31% glazing. The total fenestration area was only 20% of the total wall area, which falls well below the maximum of 40% as set in Section 5.5. Therefore the building envelope can be analyzed using the Prescriptive Building Envelope Option.

Wall Window Areas			
Elevation	Fenestration Area (SF)	Wall Area (SF)	% Glazing
South	2981	13653	22
East	1424	13266	11
North	2372	15880	15
West	4084	13258	31
Total:	10861	56057	20

Table 6: *Total vertical fenestration area and percentage of total wall for Des Places*

Des Places Residence Hall fits into the occupancy classification of a "residential" building and the entire building is conditioned. All of the maximum U-Values and minimum R-Values for the floors, roofs and walls and the maximum U-Values and SHGC values for the fenestration are given in Table 5.5-5 of ASHRAE 90.1. The actual envelope construction is given below (construction materials are listed in succession from interior of wall to exterior):

- **Exterior Masonry Wall**: 5/8" gypsum board, air space for metal studs, 1/2" densglass sheathing, 3" of spray urethane insulation, 1 7/8" air cavity, 3 5/8" face brick
- **Roof**: Metal deck, 5/8" gypsum board sheathing, 5 1/2" polyisocyanurate insulation, 3/4" perlite protection board, TPO Membrane.
- **Glazing**:
  - **Windows in Masonry Wall:** PPG Double paned, Solarban 60 Solargray window followed by a clear window
  - **Glazing Used on Curtain Wall on West Elevation:** PPG double paned, Solarban R100 Solargray window followed by a clear window
  - **Storefront Glazing:** PPG double paned, Solarban 70XL window followed by a clear window

Wall and Roof Insulation Requirements			
Assembly Type	Required Min. R-Value	Designed R-Value	ASHRAE 90.1 Compliance
Wall	R-20.5	R-25.5	YES
Roof	R-20.0	R-34.5	YES

Table 7: *Wall and roof insulation compliance in accordance with ASHRAE 90.1, Section 5*

Glazing Insulation Requirements					
Glazing Type	Required Max. U-Value	Designed U-Value	Required Max. SHGC	Designed SHGC	ASHRAE 90.1 Compliance
Masonry Wall Glazing	U-0.55	U-0.29	SHGC-0.40	SHGC-0.24	YES
West Curtain Wall Glazing	U-0.45	U-0.29	SHGC-0.40	SHGC-0.17	YES
Storefront Glazing	U-0.45	U-0.28	SHGC-0.40	SHGC-0.19	YES

Table 8: *Glazing insulation compliance in accordance with ASHRAE 90.1, Section 5*

The two tables shown above prove that the exterior wall, roof and all of the glazing used in the envelope of Des Places is compliant with the insulation requirements given in Table 5.5-5. Not only is the building envelope compliant with Section 5, all of the building materials used for Des Places exceed the minimum requirements by a large margin. This should save a great deal on energy use over the life of the building.

Section 6 – Heating, Ventilating and Air Conditioning

Section 6 of Standard 90.1 prescribes the minimum efficiencies for the mechanical equipment in a newly constructed building as well as the minimum thickness for the piping insulation. There are two different methods of analysis for this standard. There is a simplified approach outlined in Section 6.3 and there is a Mandatory Provisions approach given in Section 6.4. The simplified approach can only be used if the total area of the building is less than or equal to 25,000 ft^2. The occupiable area of Des Places is roughly 131,000 ft^2, which far exceeds the limit. Therefore the compliance analysis will follow the guidelines set forth in Section 6.4-Mandatory Provisions and Section 6.5-Preventative Path.

Section 6.4 – Mandatory Provisions:

This project is just beginning the construction phase, so the verification of equipment efficiencies and labeling of mechanical equipment cannot be completed at this time.

The vast majority of rooms in Des Places are heated and cooled with a four-pipe Whalen fan coil unit. All of these units are controlled by a zone thermostat that can run automatically and keep a set temperature in the space. The occupants of each space can also override the automatic controls and set the thermostat to a temperature of their choice.

The only pieces of equipment that handle over 10,000 cfm are ERU-1, SF-1 and SF-2. The supply fan in the energy recovery unit is run by a variable frequency drive with direct digital controls. These controls ensure that the energy consumption of the unit is minimized while still meeting the required conditions of the spaces that it serves. Supply fans 1 and 2 are equipped with optimum start controls to reduce energy consumption.

Section 6.5 – Preventative Path:

This section deals primarily with the efficiency of fans and sets acceptable values for the horsepower of each fan, based on their total airflow. The mechanical system for Des Places consists mostly of constant volume fans, with the exception of the supply fan in ERU-1, which runs a variable volume system. Table 6.5.3.1.1A (shown below) sets the guidelines for fan energy compliance. Option 1 was chosen to evaluate all of the supply fans, exhaust fans, unit heater fans and the energy recovery unit fan for compliance with Section 6. The variable volume formula was used to assess the fan for ERU-1 and the constant volume formula was chosen for the remainder of the fans.

TABLE 6.5.3.1.1A Fan Power Limitation[a]

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

[a] where
CFM_S = the maximum design supply airflow rate to conditioned spaces served by the system in cubic feet per minute
hp = the maximum combined motor nameplate horsepower
bhp = the maximum combined fan brake horsepower
A = sum of $(PD \times CFM_D/4131)$
where
PD = each applicable pressure drop adjustment from Table 6.5.3.1.1B in in. w.c.
CFM_D = the design airflow through each applicable device from Table 6.5.3.1.1B in cubic feet per minute

Figure 6: *Table 6.5.3.1.1A (Fan Power Limitation) from ASHRAE 90.1, Section 6.5*

The table given below shows the calculations done to determine whether the fans in Des Places meet the requirements outlined in Table 6.5.3.1.1A.

Fan Compliance					
Fan Tag	Formula Used	CFM	Allowable HP	Motor HP	ASHRAE 90.1 Compliance
ERU-1	hp ≤ CFMs * 0.0015	20600	30.9	10	YES
SF-1	hp ≤ CFMs * 0.0011	22000	24.2	10	YES
SF-2	hp ≤ CFMs * 0.0011	15000	16.5	7.5	YES
SF-3	hp ≤ CFMs * 0.0011	400	0.4	0.5	NO
EF-1	hp ≤ CFMs * 0.0011	1533	1.7	0.5	YES
EF-3	hp ≤ CFMs * 0.0011	800	0.9	0.5	YES
EF-4	hp ≤ CFMs * 0.0011	150	0.2	0.25	NO
UH-1	hp ≤ CFMs * 0.0011	1000	1.1	0.083	YES
UH-2	hp ≤ CFMs * 0.0011	1400	1.5	0.083	YES
UH-3	hp ≤ CFMs * 0.0011	1400	1.5	0.083	YES
UH-4	hp ≤ CFMs * 0.0011	3500	3.9	0.33	YES
UH-5	hp ≤ CFMs * 0.0011	1400	1.5	0.083	YES
UH-6	hp ≤ CFMs * 0.0011	1400	1.5	0.083	YES
UH-7	hp ≤ CFMs * 0.0011	1400	1.5	0.083	YES
UH-8	hp ≤ CFMs * 0.0011	3400	3.7	0.33	YES
UH-9	hp ≤ CFMs * 0.0011	1000	1.1	0.083	YES
UH-10	hp ≤ CFMs * 0.0011	480	0.5	0.33	YES

Table 9: *Fan compliance with ASHRAE 90.1, Section 6.5*

The only fans in the table above that are not compliant fall into the exception listed in Section 6.5.3.1.2a, which states that for fans less than 6 bhp, a larger motor size may be used as long as it is within 50% of the allowable horsepower, as calculated by the formulas in Table 6.5.3.1.1A. If this exception is considered, than all of the fans in the building meet the efficiency requirements of Section 6.

Section 6.7 – Submittals:

Des Places Residence Hall is designed to achieve a minimum of LEED certification. Therefore the proper submittal of all drawings and manuals will be enforced. Proper system balancing and

commissioning will be performed as well after the building is constructed in order to achieve necessary LEED credits.

Section 7 - Service Water Heating

The heating source for Des Places is a steam line coming into the building in the southeast corner of Floor 1 from Duquesne University's central steam plant. The steam is then converted to hot water by one steam to hot water converter, sized at 195 gpm. The heat source for the hydronic system in this building comes from another location, and therefore there is no service water heating equipment needed. Because of this fact, Section 7 does not apply to this building.

Section 8 – Power

Feeder conductors have been sized for a maximum voltage drop of 2% and the branch circuit conductors have been sized for a 3% maximum voltage drop. A single line diagram of the buildings electrical distribution system (Drawing E5.0) and floor plans showing the location and areas served for all distribution systems (Drawings E2.0 – E3.4) have been provided.

Section 9 – Lighting

This section defines the maximum allowable lighting power densities by building type or by room type. The compliance analysis can be done by either the Building Area Method or the Space-By-Space Method. The Building Area Method was chosen for the evaluation of Des Places, because it defines a lighting power density value for the entire building based on the building type. These values are found in Table 9.5.1. Des Places fits into the dormitory category and therefore has a building lighting power density of 1.0 w/ft^2. To find the total lighting power density for the building, all of the lighting fixtures on each floor of the building. Floors three through eleven were assumed to use the same light fixtures. The table showing the fixture count by type for each floor of the building is given in Appendix A. Then the total watts from the lighting load could be found for each floor by multiplying the total number of fixtures by their respective wattages. The totals are given in the table below and compared to the area of the building to assess compliance with this section.

Lighting Power Density Analysis					
Floor	Total Designed Watts	Area (SF)	LPD Designed (W/SF)	Maximum LPD From Standard (W/SF)	ASHRAE 90.1 Compliance
Floor 1	7360	9771	0.75	1.00	YES
Floor 2	7912	9895	0.80	1.00	YES
Floor 3-11	6988	10148	0.69	1.00	YES
Floor 12	10514	10097	1.04	1.00	NO
Penthouse	1504	2977	0.51	1.00	YES
TOTAL:	**90182**	**121392**	**0.74**	**1.00**	**YES**

Table 10: *Compliance of Des Places with LPD requirements given in ASHRAE 90.1, Section 9*

The results above show that the lighting power density of Des Places is compliant with Section 9 of Standard 90.1. Although Floor 12 has a power density higher than 1 W/SF, the overall building power density is 0.74 W/SF. The Building Area Method analyzes the entire building for compliance, so Des Places is therefore well within the upper limit of 1 W/SF.

ASHRAE Standard 90.1 Conclusions

The calculations and analysis performed for Des Places have shown that it meets all of the requirements examined in section 5 through 9 of Standard 90.1. Some of the requirements outlined in Standard 90.1, such as those given in the Service Water Heating section do not apply to this building and were therefore overlooked. It is also possible that some mistakes were made in the calculations performed or that certain applicable requirements were overlooked.

Des Places exceeded many of the requirements of this standard by a large margin. The R-Values for the wall and roof and the U-Values for the glazing used on this building far surpass the insulation requirements given in Section 5. The overall lighting power density was also under the maximum prescribed value by about 25%. The main reason why the designers of Des Places decided to surpass the minimum requirements of this section by such a great deal, is because the building must achieve a minimum of LEED certification with a goal of earning Silver or Gold certification by the end of construction. Many of the LEED credits that are attainable in the design stage are based on how far the building can exceed the minimum requirements of Standard 90.1. Therefore in the interest of gaining more LEED credits for the project and saving on the energy consumption of the building over its lifetime, Des Places was held to a higher standard for many of the requirements outlined in Standard 90.1.

APPENDIX A

List of Tables and Figures

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APPENDIX B

Supplemental Tables

ASHRAE 62.1 Ventilation Calculations

Floor 1 - Ventilation Calculations													
Room Name & Number	Location	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Breathing Zone O.A. Flow Required Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Design CFM to Space	ASHRAE 62.1 Compliance
			Az	Rp	Ra	Pz,f	Vbz = Rp*Pz + Ra*Az		Voz = Vbz / Ez				
100A-Vestibule	1st Floor	Corridors	156	0	0.06	0	9	1.0	9	9	1.0	200	YES
100-Lobby/Corridor	1st Floor	Corridors	615	0	0.06	0	37	1.0	37	37	1.0	300	YES
101-IDF	1st Floor	Storage rooms	134	0	0.12	0	16	1.0	16	16	1.0	150	YES
102A-Fire Pump	1st Floor	Storage rooms	123	0	0.12	0	15	1.0	15	15	1.0	10	NO
102-Mechanical Room	1st Floor	Elevator machine rooms	1846	0	0.12	0	222	1.0	222	222	1.0	230	YES
106-Storage	1st Floor	Storage rooms	1571	0	0.12	0	189	1.0	189	189	1.0	195	YES
110-Loading Dock	1st Floor	Shipping/receiving	469	0	0.12	0	56	1.0	56	56	1.0	80	YES
111-Storage	1st Floor	Storage rooms	541	0	0.12	0	65	1.0	65	65	1.0	70	YES
112-Storage	1st Floor	Storage rooms	585	0	0.12	0	70	1.0	70	70	1.0	90	YES
113-House Office	1st Floor	Office spaces	118	5	0.06	2	17	1.0	17	17	1.0	20	YES
114-Grounds Office	1st Floor	Office spaces	196	5	0.06	3	27	1.0	27	27	1.0	30	YES
115-Bike Storage	1st Floor	Storage rooms	387	0	0.12	0	46	1.0	46	46	1.0	50	YES
								∑Voz =	769				
											Total Design CFM:	1425	

Floor 2 - Ventilation Calculations

Room Name & Number	Location	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Breathing Zone O.A. Flow Required Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Design CFM to Space	ASHRAE 62.1 Compliance
			Az	Rp	Ra	Pz,f	Vbz = Rp*Pz + Ra*Az		Voz = Vbz / Ez				
200B-Corridor	2nd Floor	Corridors	522	0	0.06	0	31	1.0	31	31	1.0	100	YES
200A-Main Vestibule	2nd Floor	Corridors	122	0	0.06	0	7	1.0	7	7	1.0	150	YES
200-Main Lobby	2nd Floor	Main entry lobbies	747	5	0.06	23	160	1.0	160	160	1.0	350	YES
201A-Security Desk	2nd Floor	Office spaces	134	5	0.06	1	13	1.0	13	13	1.0	50	YES
201-Security Office	2nd Floor	Office spaces	112	5	0.06	1	12	1.0	12	12	1.0	80	YES
202-F.C.C.	2nd Floor	Corridors	106	0	0.06	1	6	1.0	6	6	1.0	10	YES
203A-Office	2nd Floor	Office spaces	178	5	0.06	3	26	1.0	26	26	1.0	30	YES
203-SEC	2nd Floor	Office spaces	132	5	0.06	1	13	1.0	13	13	1.0	60	YES
204-Ministry Office	2nd Floor	Office spaces	432	5	0.06	3	41	1.0	41	41	1.0	90	YES
206-Lounge	2nd Floor	Multipurpose assembly	232	5	0.06	9	59	1.0	59	59	1.0	70	YES
207-4-6 Bed Suite ADA	2nd Floor	Corridors	192	0	0.06	0	12	1.0	12	12	1.0	35	YES
207A-Bedroom A	2nd Floor	Bedroom/Livingroom	210	5	0.06	4	33	1.0	33	33	1.0	35	YES
207B-Bedroom B	2nd Floor	Bedroom/Livingroom	199	5	0.06	2	22	1.0	22	22	1.0	25	YES
207C-Bedroom C	2nd Floor	Bedroom/Livingroom	223	5	0.06	2	23	1.0	23	23	1.0	25	YES
208-RA ADA	2nd Floor	Bedroom/Livingroom	282	5	0.06	1	22	1.0	22	22	1.0	25	YES
209-Jan	2nd Floor	Storage rooms	65	0	0.12	0	8	1.0	8	8	1.0	50	YES
210-4 Bed Suite-No Living ADA	2nd Floor	Corridors	168	0	0.06	0	10	1.0	10	10	1.0	10	YES
210A-Bedroom A	2nd Floor	Bedroom/Livingroom	210	5	0.06	2	23	1.0	23	23	1.0	25	YES
210B-Bedroom B	2nd Floor	Bedroom/Livingroom	210	5	0.06	2	23	1.0	23	23	1.0	25	YES
211-4-6 Bed Suite ADA	2nd Floor	Corridors	187	0	0.06	0	11	1.0	11	11	1.0	15	YES
211A-Bedroom A	2nd Floor	Bedroom/Livingroom	209	5	0.06	4	33	1.0	33	33	1.0	35	YES
211B-Bedroom B	2nd Floor	Bedroom/Livingroom	200	5	0.06	2	22	1.0	22	22	1.0	25	YES
211C-Bedroom C	2nd Floor	Bedroom/Livingroom	222	5	0.06	2	23	1.0	23	23	1.0	25	YES
214-4 Bed Suite No Living ADA	2nd Floor	Corridors	162	0	0.06	0	10	1.0	10	10	1.0	10	YES
214A-Bedroom A	2nd Floor	Bedroom/Livingroom	218	5	0.06	2	23	1.0	23	23	1.0	25	YES
214B-Bedroom B	2nd Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	25	YES
215-4-6 Bed Suite ADA	2nd Floor	Corridors	191	0	0.06	0	11	1.0	11	11	1.0	15	YES
215A-Bedroom A	2nd Floor	Bedroom/Livingroom	215	5	0.06	4	33	1.0	33	33	1.0	35	YES
215B-Bedroom B	2nd Floor	Bedroom/Livingroom	203	5	0.06	2	22	1.0	22	22	1.0	25	YES
215C-Bedroom C	2nd Floor	Bedroom/Livingroom	223	5	0.06	2	23	1.0	23	23	1.0	25	YES
216A-Living Area	2nd Floor	Bedroom/Livingroom	296	5	0.06	8	58	1.0	58	58	1.0	80	YES
216B-Bedroom	2nd Floor	Bedroom/Livingroom	160	5	0.06	1	15	1.0	15	15	1.0	15	YES
216C-Master Bedroom	2nd Floor	Bedroom/Livingroom	149	5	0.06	2	19	1.0	19	19	1.0	15	NO
								∑Voz =	868				
											Total Design CFM:	1615	

Floors 3-11 - Ventilation Calculations

Room Name & Number	Location	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Breathing Zone O.A. Flow Required Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Design CFM to Space	ASHRAE 62.1 Compliance
			Az	Rp	Ra	Pz,f	Vbz = Rp*Pz + Ra*Az		Voz = Vbz / Ez				
300-Corridor	3rd Floor	Corridors	1011	0	0.06	0	61	1.0	61	61	1.0	100	YES
301-4-6 Bed Suite	3rd Floor	Corridors	213	0	0.06	0	13	1.0	13	13	1.0	15	YES
301A-Bedroom A	3rd Floor	Bedroom/Livingroom	206	5	0.06	4	32	1.0	32	32	1.0	35	YES
301B-Bedroom B	3rd Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	25	YES
301C-Bedroom C	3rd Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	25	YES
302-Lounge	3rd Floor	Multipurpose assembly	644	5	0.06	23	154	1.0	154	154	1.0	185	YES
303-Laundry	3rd Floor	Laundry rooms, central	342	5	0.12	6	71	1.0	71	71	1.0	250	YES
304-4-6 Bed Suite	3rd Floor	Corridors	207	0	0.06	0	12	1.0	12	12	1.0	10	NO
304A-Bedroom A	3rd Floor	Bedroom/Livingroom	208	5	0.06	4	32	1.0	32	32	1.0	35	YES
304B-Bedroom B	3rd Floor	Bedroom/Livingroom	208	5	0.06	2	22	1.0	22	22	1.0	25	YES
304C-Bedroom C	3rd Floor	Bedroom/Livingroom	208	5	0.06	2	22	1.0	22	22	1.0	25	YES
305-2 Bed Suite	3rd Floor	Bedroom/Livingroom	281	5	0.06	2	27	1.0	27	27	1.0	30	YES
306-Trash/Jan.	3rd Floor	Storage rooms	66	0	0.12	0	8	1.0	8	8	1.0	50	YES
307-4 Bed Suite No Living	3rd Floor	Corridors	152	0	0.06	0	9	1.0	9	9	1.0	10	YES
307A-Bedroom A	3rd Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	35	YES
307B-Bedroom B	3rd Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	35	YES
308-4-6 Bed Suite	3rd Floor	Corridors	209	0	0.06	0	13	1.0	13	13	1.0	15	YES
308A-Bedroom A	3rd Floor	Bedroom/Livingroom	211	5	0.06	4	33	1.0	33	33	1.0	35	YES
308B-Bedroom B	3rd Floor	Bedroom/Livingroom	211	5	0.06	2	23	1.0	23	23	1.0	25	YES
308C-Bedroom C	3rd Floor	Bedroom/Livingroom	211	5	0.06	2	23	1.0	23	23	1.0	25	YES
309-2 Bed Suite	3rd Floor	Bedroom/Livingroom	293	5	0.06	2	28	1.0	28	28	1.0	30	YES
311-4 Bed Suite No Living	3rd Floor	Corridors	162	0	0.06	0	10	1.0	10	10	1.0	10	YES
311A-Bedroom A	3rd Floor	Bedroom/Livingroom	224	5	0.06	2	23	1.0	23	23	1.0	25	YES
311B-Bedroom B	3rd Floor	Bedroom/Livingroom	224	5	0.06	2	23	1.0	23	23	1.0	25	YES
312-4-6 Bed Suite	3rd Floor	Corridors	209	0	0.06	0	13	1.0	13	13	1.0	15	YES
312A-Bedroom A	3rd Floor	Bedroom/Livingroom	208	5	0.06	4	32	1.0	32	32	1.0	35	YES
312B-Bedroom B	3rd Floor	Bedroom/Livingroom	206	5	0.06	2	22	1.0	22	22	1.0	25	YES
312C-Bedroom C	3rd Floor	Bedroom/Livingroom	206	5	0.06	2	22	1.0	22	22	1.0	25	YES
313-4 Bed Suite Living	3rd Floor	Corridors	165	0	0.06	0	10	1.0	10	10	1.0	10	YES
313A-Bedroom A	3rd Floor	Bedroom/Livingroom	215	5	0.06	2	23	1.0	23	23	1.0	25	YES
313B-Bedroom B	3rd Floor	Bedroom/Livingroom	215	5	0.06	2	23	1.0	23	23	1.0	25	YES
314-RA Unit	3rd Floor	Bedroom/Livingroom	274	5	0.06	1	21	1.0	21	21	1.0	25	YES
								∑Voz =	897		**Total Design CFM:**	1265	

Floor 12 - Ventilation Calculations

Room Name & Number	Location	Occupancy Category	Area (SF)	People O.A. Rate (cfm/person)	Area O.A. Rate (cfm/SF)	# of Occupants Furniture	Breathing Zone O.A. Flow Required Vbz (cfm)	Ez	Voz (cfm)	Vpz (cfm)	Zp	Design CFM to Space	ASHRAE 62.1 Compliance
			Az	Rp	Ra	Pz,f	Vbz = Rp*Pz + Ra*Az		Voz = Vbz / Ez				
1200A-Corridor	12th Floor	Corridors	576	0	0.06	0	35	1.0	35	35	1.0	100	YES
1200-Lobby	12th Floor	Lobbies/prefunction	516	7.5	0.06	16	151	1.0	151	151	1.0	180	YES
1201A-Stor	12th Floor	Storage rooms	93	0	0.12	0	11	1.0	11	11	1.0	10	NO
1201B-Kit	12th Floor	Storage rooms	94	0	0.12	0	11	1.0	11	11	1.0	0	NO
1201C-Hall	12th Floor	Corridors	112	0	0.06	0	7	1.0	7	7	1.0	10	YES
1201-Conference Room	12th Floor	Conference/meeting	867	5	0.06	37	237	1.0	237	237	1.0	290	YES
1202-Lounge	12th Floor	Multipurpose assembly	648	5	0.06	23	154	1.0	154	154	1.0	185	YES
1203-Laundry	12th Floor	Laundry rooms, central	334	5	0.12	6	70	1.0	70	70	1.0	70	YES
1204-4-6 Bed Suite	12th Floor	Corridors	207	0	0.06	0	12	1.0	12	12	1.0	10	NO
1204A-Bedroom A	12th Floor	Bedroom/Livingroom	208	5	0.06	4	32	1.0	32	32	1.0	35	YES
1204B-Bedroom B	12th Floor	Bedroom/Livingroom	208	5	0.06	2	22	1.0	22	22	1.0	25	YES
1204C-Bedroom C	12th Floor	Bedroom/Livingroom	208	5	0.06	2	22	1.0	22	22	1.0	25	YES
1205-2 Bed Suite	12th Floor	Bedroom/Livingroom	281	5	0.06	2	27	1.0	27	27	1.0	30	YES
1206-Jan/Trash	12th Floor	Storage rooms	67	0	0.12	0	8	1.0	8	8	1.0	50	YES
1207-4 Bed Suite No Living	12th Floor	Corridors	152	0	0.06	0	9	1.0	9	9	1.0	10	YES
1207A-Bedroom A	12th Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	25	YES
1207B-Bedroom B	12th Floor	Bedroom/Livingroom	212	5	0.06	2	23	1.0	23	23	1.0	25	YES
1208-4-6 Bed Suite	12th Floor	Corridors	209	0	0.06	0	13	1.0	13	13	1.0	15	YES
1208A-Bedroom A	12th Floor	Bedroom/Livingroom	211	5	0.06	4	33	1.0	33	33	1.0	35	YES
1208B-Bedroom B	12th Floor	Bedroom/Livingroom	211	5	0.06	2	23	1.0	23	23	1.0	25	YES
1208C-Bedroom C	12th Floor	Bedroom/Livingroom	211	5	0.06	2	23	1.0	23	23	1.0	25	YES
1209-2 Bed Suite	12th Floor	Bedroom/Livingroom	293	5	0.06	2	28	1.0	28	28	1.0	30	YES
1211-4 Bed Suite No Living	12th Floor	Corridors	162	0	0.06	0	10	1.0	10	10	1.0	10	YES
1211A-Bedroom A	12th Floor	Bedroom/Livingroom	224	5	0.06	2	23	1.0	23	23	1.0	25	YES
1211B-Bedroom B	12th Floor	Bedroom/Livingroom	224	5	0.06	2	23	1.0	23	23	1.0	25	YES
1212-4-6 Bed Suite	12th Floor	Corridors	209	0	0.06	0	13	1.0	13	13	1.0	15	YES
1212A-Bedroom A	12th Floor	Bedroom/Livingroom	208	5	0.06	4	32	1.0	32	32	1.0	35	YES
1212B-Bedroom B	12th Floor	Bedroom/Livingroom	206	5	0.06	2	22	1.0	22	22	1.0	25	YES
1212C-Bedroom C	12th Floor	Bedroom/Livingroom	206	5	0.06	2	22	1.0	22	22	1.0	25	YES
1213-RA Unit	12th Floor	Bedroom/Livingroom	269	5	0.06	1	21	1.0	21	21	1.0	30	YES
1214-Jan/Stor	12th Floor	Storage rooms	33	0	0.12	0	4	1.0	4	4	1.0	70	YES
								∑Voz =	1145				
											Total Design CFM:	1470	

ASHRAE 62.1 Exhaust Calculations

Floor 1 - Exhaust Calculations									
Room Name & Number	Location	Occupancy Category	Area (SF)	Number of Units	Exhaust Rate (cfm/SF)	Exhaust Rate (cfm/unit)	Exhaust Required (CFM)	Design Exhaust CFM to Space	ASHRAE 62.1 Compliance
103-Mens	1st Floor	Toilets-Private	59	1		50	50	50	YES
104-Womens	1st Floor	Toilets-Private	54	1		50	50	50	YES
107-Trash Staging	1st Floor	Janitor Closets, trash rooms, recycling	173		1.00		173	200	YES
108-Recycle Staging	1st Floor	Janitor Closets, trash rooms, recycling	173		1.00		173	200	YES

Floor 2 - Exhaust Calculations									
Room Name & Number	Location	Occupancy Category	Area (SF)	Number of Units	Exhaust Rate (cfm/SF)	Exhaust Rate (cfm/unit)	Exhaust Required (CFM)	Design Exhaust CFM to Space	ASHRAE 62.1 Compliance
207D-Toilet B	2nd Floor	Toilets-Private	64	1		25	25	25	YES
207E-Toilet ADA	2nd Floor	Toilets-Private	81	1		25	25	25	YES
208A-Toilet ADA	2nd Floor	Toilets-Private	59	1		25	25	25	YES
210D-Toilet ADA	2nd Floor	Toilets-Private	61	1		25	25	60	YES
211D-Toilet B	2nd Floor	Toilets-Private	81	1		25	25	30	YES
211E-Toilet ADA	2nd Floor	Toilets-Private	61	1		25	25	40	YES
212A-Toilet ADA	2nd Floor	Toilets-Private	81	1		25	25	30	YES
214D-Toilet ADA	2nd Floor	Toilets-Private	61	1		25	25	60	YES
215D-Toilet B	2nd Floor	Toilets-Private	64	1		25	25	30	YES
215E-Toilet ADA	2nd Floor	Toilets-Private	81	1		25	25	40	YES
216D-Master Bath	2nd Floor	Toilets-Private	83	1		25	25	25	YES
216E-Bath	2nd Floor	Toilets-Private	71	1		25	25	30	YES

Floors 3-11 - Exhaust Calculations									
Room Name & Number	Location	Occupancy Category	Area (SF)	Number of Units	Exhaust Rate (cfm/SF)	Exhaust Rate (cfm/unit)	Exhaust Required (CFM)	Design Exhaust CFM to Space	ASHRAE 62.1 Compliance
301D-Toilet B	3rd Floor	Toilets-Private	62	1		25	25	25	YES
301E-Toilet A	3rd Floor	Toilets-Private	63	1		25	25	25	YES
304D-Toilet A	3rd Floor	Toilets-Private	63	1		25	25	25	YES
304E-Toilet B	3rd Floor	Toilets-Private	71	1		25	25	25	YES
305A-Toilet	3rd Floor	Toilets-Private	55	1		25	25	25	YES
307C-Toilet	3rd Floor	Toilets-Private	62	1		25	25	25	YES
308D-Toilet A	3rd Floor	Toilets-Private	62	1		25	25	25	YES
308E-Toilet B	3rd Floor	Toilets-Private	61	1		25	25	25	YES
309A-Toilet	3rd Floor	Toilets-Private	56	1		25	25	30	YES
311C-Toilet	3rd Floor	Toilets-Private	62	1		25	25	30	YES
312D-Toilet A	3rd Floor	Toilets-Private	63	1		25	25	30	YES
312E-Toilet B	3rd Floor	Toilets-Private	67	1		25	25	25	YES
313C-Toilet	3rd Floor	Toilets-Private	61	1		25	25	30	YES
314A-Toilet	3rd Floor	Toilets-Private	58	1		25	25	25	YES

Floor 12 - Exhaust Calculations									
Room Name & Number	Location	Occupancy Category	Area (SF)	Number of Units	Exhaust Rate (cfm/SF)	Exhaust Rate (cfm/unit)	Exhaust Required (CFM)	Design Exhaust CFM to Space	ASHRAE 62.1 Compliance
1204D-Toilet A	12th Floor	Toilets-Private	64	1		25	25	25	YES
1204E-Toilet B	12th Floor	Toilets-Private	63	1		25	25	25	YES
1205A-Toilet	12th Floor	Toilets-Private	55	1		25	25	30	YES
1207C-Toilet	12th Floor	Toilets-Private	62	1		25	25	30	YES
1208D-Toilet A	12th Floor	Toilets-Private	62	1		25	25	25	YES
1208E-Toilet B	12th Floor	Toilets-Private	62	1		25	25	25	YES
1209A-Toilet	12th Floor	Toilets-Private	56	1		25	25	30	YES
1211C-Toilet	12th Floor	Toilets-Private	62	1		25	25	30	YES
1212D-Toilet A	12th Floor	Toilets-Private	63	1		25	25	30	YES
1212E-Toilet B	12th Floor	Toilets-Private	67	1		25	25	30	YES
1213A- RA Toilet	12th Floor	Toilets-Private	55	1		25	25	30	YES
1215-Men	12th Floor	Toilets-Public	161	2		50	100	140	YES
1216-Women	12th Floor	Toilets-Public	167	2		50	100	140	YES

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Number of Lighting Fixtures By Floor						
Fixture Type	Watts/Fixture	Floor 1	Floor 2	Floors 3-11	Floor 12	Penthouse
ALV	50				8	
CV4	32		13		7	
DFD	32				28	
DL	32	4	23	23	25	
DLD	32			9		
DLDS	32		30	18	23	
DLG	32		9	10	13	
DLW	24		6			
DSK	42		36	42	32	
EP	32	6				
P30	168				4	
P36	336				4	
PM	50				15	
PS	50				6	
SCB	32	3	4	4	4	3
SCL	24		34	41	31	
SH	32		29	38	30	
ST	64	52	2	2	2	22
TR3	96	10				
TRA	72	12	24	10	4	
TRF	64	8				
TRG	64	20	2	2	6	