Technical Assignment 1

ASHRAE Standard 62.1 and 90.1 Evaluation

Park Place Corporate Center One

Findlay Township, PA

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Executive Summary

Park Place Corporate Center One, which will be referred to as Park Place 1 throughout the rest of this report, is a building with a lengthy history. Originally constructed by The Hillman Company in 1982, Park Place 1 is one of a matching two building set that was designed to house numerous tenants, all of them with the interest of using the building as office space.

During the rest of the building's life, it changed ownership hands several times with the most recent acquisition occurring on 28 December 2009 by DiCicco Development. Following the purchase, a renovation was immediately put into place in an attempt to improve the outdated systems that the building was constructed with. It was during this renovation that the building came under study and is now the focus of this report.

Park Place 1 appears to be a glass box from the exterior. The façade is a curtain wall design that was meant to reflect the contemporary architectural trends of the time—the modern office building. The wall is seemingly one hundred percent completely reflective glass from the outside. It is separated by steel black mullions, giving the building a distinctly dark appearance. Relatively square, the building is just under one and a half times longer than it is wide. There are five floors, each one approximately 19,488 square feet, making the building 99,281 square feet in total.

In the following report, ASHRAE (American Society of Heating, Refrigerating, and Air-Conditioning Engineers) Standard 62.1- Ventilation for Acceptable Indoor Air Quality and ASHRAE Standard 90.1- Energy Standard for Buildings Except Low-Rise Residential Buildings will be analyzed for compliance with respect to Park Place 1. That said, it is important to understand some of the elementary assumptions and influences that the building selected is going to have on the report.

First, Park Place 1 was a core and shell design to be fit out by future tenants. The design of each individual tenant is subject to variation. Because not all spaces are occupied, not all drawings possessed, and the renovation targeting of the whole building systems, standard office building assumptions will be made with respect to occupancies. This will be especially important in the analysis of 62.1 which addresses the amount of outdoor air required in individual spaces. Because individual spaces are not laid out throughout the entire building, the purpose of the study is to analyze whether or not the base building systems can support future tenant fit out that will comply with the standard. If, in some cases, there are spaces that do have diffusers laid out with specific air flow rates, those spaces will be analyzed individually.

The analysis of ASHRAE Standard 90.1 should be slightly straighter forward as it tends to address whole building issues more directly than 62.1. With that in mind however, the building is almost thirty years old and when constructed, did not have 90.1 under which to design from.

The important note about this study is that the building is a renovation of a tenant fit out. The project was selected for study because of its uniform loads and the opportunity it has for improvement. The simplicity of the existing systems lends the building to an opportunity of

analyzing a greater number of systems on a more advanced level to provide an equally or greater lesson as to which systems perform better than others. The building simply serves as a vessel through which that study can occur.

It is with this concept in mind that this study aims to clarify some of the control situations that the building will lend to further study by better understanding ASHRAE Standards 62.1 and 90.1 in that order.

Mechanical Summary

To begin, it is be important to first address what the primary design considerations were and to follow with the result of such considerations.

When speaking with the owner (DiCicco Development) and design engineer (CJL Engineering), three primary design goals were made clear. First, the base building systems would be laid out to provide the future or current occupants with the ability to have a high performance system. That said, the systems were designed with the intention that variable air volume (VAV) would be supplied to all spaces and that the tenants should not have to make substantial adjustments to the supplied air temperature from the base building systems. Second, there would be a relative uniformity in the types of loads that would be present in the building. Because the primary function of the building is to house office space, seven main occupancy types were considered: office space, open office space, conference rooms, corridors, kitchens, restrooms, and storage. Each floor would be considered the same type of occupancy and for the purposes of an accurate study, reasonable assumptions about the percentage of floor area of each type with respect to the whole have been made. To see the break down by percentage, see Table 1 below.

Occupancy Type	% of Total Floor Area
Office Space	30
Open Office Space	30
Conference	10
Corridor	15
Kitchen	5
Restroom	5
Storage	5
Total	100

Table 1- Percentage Occupancy of Total Square Footage

The third and final primary design goal was for the system to be an improvement on the energy efficiency of the building and at a reasonable cost. The owner expressed that redundancy be important but that building operation should be relatively simple and the systems should be reliable. For these reasons, the owner felt that packaged units would be both economically suitable and operationally easy to maintain.

Continuing to the results of the renovation, two packaged 115 ton rooftop units (RTU) will be placed on the roof to serve the entire building. The units will be linked together in parallel for two main considerations. One, during the renovation, current tenants still need air conditioning and two, the units are both oversized so that in the event of a failure, the building can at minimum be tempered by what would be a substantially undersized single unit.

Each RTU, named RTU-1 and RTU-2, is intended to split the building into two subdivisions—East and West. This implies that RTU-1 will serve the west side of floors one through five with the east side being handled by RTU-2. For overall performance characteristics of both RTU's, please see Table 2 below.

While the RTU's are designed with a heating element, two existing boilers, located inside the rooftop penthouse, are intended to meet the required heating load during the heating season. The RTU's are intended to be used as back up to the boilers in the event of failure. These gas-fired boilers have a total heat input of 970,000 Btu/h. The warm water that they supply will be distributed to terminal units within the occupied spaces depending on the future designs.

Air distribution is handled by two main duct shafts, duct shaft one (DS-1) and two (DS-2) which correspond to RTU-1 and 2 respectively. Both shafts run adjacent to the two staircases located in the building core and handle both supply and return air to and from the loads and RTU's.

Rooftop Unit Schedule			
Name	RTU-1	RTU-2	Units
Air Quantity	45,000	45,000	cfm
Minimum Outdoor Air	4,500	4,500	cfm
External Air Pressure (Supply Fan)	3.5	3.5	in. H2O
Supply Fan Motor	75	75	HP
Max External Air Pressure (Return/Exhaust Fan)	1.0	1.0	in. H2O
Return Exhaust Fan Motor	40	40	HP
Heat Output	1,100,000	1,100,000	Btu/Hr
Gas Input	1,380,000	1,380,000	Btu/Hr
Entering Air Temperature	63	63	°F
Leaving Air Temperature	85	85	°F
Cooling Capacity	115	115	Tons
Entering Air Temperature DB	77.5	77.5	°F
Entering Air Temperature WB	64.3	64.3	°F
Ambient Temperature	92	92	°F
Condenser Fan	8 @ 1.5 EA	8 @ 1.5 EA	HP
Compressor Full Load Amps	4 @ 44.7 EA	4 @ 44.7 EA	Amps
Compressor Locked Rotor Amps	4 @ 260 EA	4 @ 260 EA	Amps
Filter Number and Size	21-20x24x12	21-20x24x12	-
	5-12x24x12	5-12x24x12	-
Minimum Circuit Amps	365	365	Amps
Area Served	West	East	-
Electrical Characteristics	480V-3ϕ-60 Hz	480V-3ϕ-60 Hz	-
Maximum Breaker Size	400	400	Amps

Table 2- Rooftop Unit Schedule

ASHRAE Standard 62.1-2007 Ventilation for Acceptable Indoor Air Quality Compliance Analysis

Section 5: Systems and Equipment

Section 5.1- Natural Ventilation

Park Place one utilizes no natural ventilation as a means by which to provide outdoor air. Mechanical Ventilation is used exclusively.

Section 5.2- Ventilation Air Distribution

The ventilation air distribution system allows for adjustment of outdoor air quantity both in the RTU's as well as in VAV boxes that are located throughout the space. Every space in the building will be provided with adequate ventilation air. Supply air will be ducted and a return air plenum will be used for exhaust air.

Section 5.3- Exhaust Duct Location

Restroom and kitchens will be negatively pressurized so as to prevent contaminants from spreading into occupied areas.

Section 5.4- Ventilation System Controls

The ventilation system, and mechanical system for that matter, will be controlled by a building automation system that will ensure adequate control of all equipment to enable minimum or increased ventilation air.

Section 5.5- Airstream Surfaces

All supply air distribution is ducted with sheet metal until terminal boxes. From the terminal boxes, either flexible duct connections or rigid connections supply air to the space diffusers.

Section 5.6- Outdoor Intakes

All outdoor air will be supplied by the two RTU's located on the roof of the building. The RTU's stand alone on the roof of the building apart from the rooftop penthouse which houses the gas-fired boiler. The exhaust from the boiler is located on the opposite side of the penthouse that the RTU's are located on. That distance well exceeds the 15 feet requirement prescribed in Table 5-1 of Standard 62.1.

Section 5.7- Local Capture of Contaminants

All building exhaust is directed immediately to the outdoors via the distribution shafts located in the center of the building.

Section 5.8- Combustion Air

There are two generators located in the rooftop penthouse southwest corner. Both generators are vented immediately to the exterior through an exhaust fan located within five and twenty feet respectively.

Section 5.9- Particulate Matter Removal

Both rooftop units are provided with 2" thick high efficiency throw-away pleated media type pre-filters of U.L. Class 2 and minimum efficiency reporting value (MERV) of 7 per ASHRAE 52.2. Once prefiltered, air passes through a 12" thick cartridge type U.L. Class 2 MERV 13 final-filter.

Section 5.10- Dehumidification Systems

The building systems were sized to create an interior space summer condition of 75°F at 50% relative humidity. The systems should be capable of maintaining relative humidity well under the 65% requirement. Also, the building should always be bringing in more ventilation air than it is exhausting in an attempt to maintain a positive pressure relative to the outdoors so that infiltration will be minimized.

Section 5.11- Drain Pans

All drain pans are to be installed in accordance with ASHRAE Standard 62.1. In addition, drain pans will be double-sloped stainless steel to assure positive drainage of all condensate in the unit casing.

Section 5.12- Finned-Tube Coils and Heat Exchangers

The spacing between individual finned-tube coils meets the required minimum access length of 18". Drain pans are provided beneath each dehumidifying coil assembly.

Section 5.13- Humidifiers and Water Spray Systems

There is no humidification to be added to the system during the heating or cooling seasons.

Section 5.14- Access for Inspection, Cleaning, and Maintenance

The packaged RTU's are provided with industry standard access sections for the cleaning of all systems within the units. Access doors are hinged with a single, exterior mounted, height and tension adjustable handle to provide positive latching at three points. Access shall be provided for the return/exhaust fan, filters, evaporator coil, and blank sections.

Section 5.15- Building Envelope and Interior Spaces

The building envelope has been furnished with a weather barrier, vapor retarder, and has been sealed at joints to reduce infiltration and the potential for water to enter the building. All cooling equipment, piping, or other equipment that could potentially draw condensation from the interior environment has been specified to have insulation to reduce the potential for condensation.

Sections 5.16 through 5.18 do not apply to Park Place 1.

ASHRAE Standard 62.1-2007 Compliance Analysis

Section 6: Procedures

RTU-1 and RTU-2 are identical units that serve identical spaces and therefore only calculations for one of the units will be shown under the assumption that both units will be the same and calculation of both would be redundant. In conjunction, because the spaces have not been individually laid out in some cases as explained above, assumptions of space occupancy type will be used to demonstrate a common tenant fit out for an average office space.

Section 6.2- Ventilation Rate Procedure

The outdoor air at the site is compliant with Section 4.1 – Regional Air Quality and therefore the outdoor airflow required in the breathing zone can be calculated with Equation 6-1.

$$V_{bz} = R_p \times P_z + R_a \times A_z \qquad \textbf{(6-1)}$$

A_z = zone floor area: the net occupiable floor area of the zone (ft^2)

P_z = zone population: the largest number of people expected to occupy the zone during typical usage.

R_p = outdoor airflow rate required per person as determined from Table 6-1 (cfm/person)

R_a = outdoor airflow rate required per unit area as determined from Table 6-1 (cfm/ft^2)

Zone Air Distribution Effectiveness (E_z)

The spaces served by RTU-1 will have "ceiling supply of cool air" defined in Table 6-2 Zone Air Distribution Effectiveness and will therefore have a value for E_z = 1.

Zone Outdoor Airflow (Voz)

The zone outdoor airflow is calculated using Equation 6-2 from the ASHRAE Standard and is shown below.

$$V_{oz} = V_{bz}/E_z \qquad \textbf{(6-2)}$$

Because E_z = 1,

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

Primary Outdoor Air Fraction

$$Z_p = V_{oz}/V_{pz} \qquad \textbf{(6-5)}$$

Uncorrected Outdoor Air Intake

$$V_{ou} = D\Sigma_{\text{all zones}}(R_p \text{ x } P_z) + \Sigma_{\text{all zones}}(R_a \text{ x } A_z) \qquad \textbf{(6-6)}$$

$$\text{Here, } D = P_s/\Sigma_{\text{all zones}} P_z \qquad \textbf{(6-7)}$$

Outdoor Air Intake

$$V_{ot} = V_{ou}/E_v \qquad \textbf{(6-8)}$$

As previously stated, there are seven occupancy types for Park Place 1 with corresponding outdoor air (OA) rates that can be seen in the Table 3 below.

Occupancy Type	% of Total Floor Area	cfm/person	cfm/ft^2
Office Space	30	5	0.06
Open Office Space	30	5	0.06
Conference	10	5	0.06
Corridor	15	0	0.06
Break Room	5	5	0.06
Restroom	5	-	-
Storage	5	0	0.12
Total	100	-	-

Table 3- Outdoor Air Requirements for Occupied Areas

It is important to note that restrooms are generally not supplied with fresh air and should be exhausted only. This is due to the desire for the restrooms to be negatively pressurized relative to adjacent spaces to prevent the spread of contaminants. For these reasons, restrooms will not be considered in this calculation.

The results of the above calculations can be seen below in Table 4. One half of the second floor was selected for analysis as the same calculation will hold true for the rest of the occupied floors, two through five, in the building. The entire first floor is also selected for analysis.

Park Place Corporate Center 1 Outdoor Air Calculation
ASHRAE 62.1 2007 Minimum Ventilation Calculation Compliance

Room Name & Number	Location	Occupancy Category	Area (SF) Az	People O.A. Rate (cfm/person) Rp	Area O.A. Rate (cfm/SF) Ra	# of Occupants 62.1 Pz,f	Breathing Zone O.A. Flow Required Vbz (cfm) Vbz = Rp*Pz + Ra*Az	Adjustment for Diversity Vou (cfm) Vou=D(Rp*Pz)+Ra*Az	Outdoor Air Intake Vot=Vou/Ev
Seating 1	1st Floor	Lobbies/prefunction	288	7.5	0.06	3	38.9	38.9	43
Seating 2	1st Floor	Lobbies/prefunction	288	7.5	0.06	3	38.9	38.9	43
Elevator Lobby	1st Floor	Lobbies/prefunction	288	7.5	0.06	3	38.9	38.9	43
West Corridor	1st Floor	Corridors	240	0	0.06	0	14.4	14.4	16
East Corridor	1st Floor	Corridors	240	0	0.06	0	14.4	14.4	16
North Corridor	1st Floor	Corridors	240	0	0.06	0	14.4	14.4	16
Electrical Closet Central	1st Floor	Electric equipment rooms	100	0	0.06	0	6.0	6.0	7
Janitor's Closet Central	1st Floor	Storage rooms	100	0	0.12	0	12.0	12.0	13
Rear Vestible	1st Floor	Lobbies/prefunction	360	7.5	0.06	4	48.6	48.6	54
Electrical Closet North	1st Floor	Electric equipment rooms	100	0	0.06	0	6.0	6.0	7
Loading Dock	1st Floor	Shipping/receiving	250	0	0.12	0	30.0	30.0	33
Paper Closet	1st Floor	Storage rooms	75	0	0.12	0	9.0	9.0	10
Phone Closet	1st Floor	Storage rooms	75	0	0.12	0	9.0	9.0	10
Building Storage	1st Floor	Storage rooms	75	0	0.12	0	9.0	9.0	10
Janitor's Closet North	1st Floor	Storage rooms	100	0	0.12	0	12.0	12.0	13
North East Office	1st Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
North East Open Office	1st Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
North East Corridor	1st Floor	Corridors	1148	0	0.06	0	68.9	68.9	77
North East Storage	1st Floor	Storage rooms	383	0	0.12	0	46.0	46.0	51
North East Kitchen	1st Floor	Break rooms	383	5	0.06	10	70.9	70.9	79
North East Conference	1st Floor	Conference/meeting	766	5	0.06	38	237.5	137.0	152
South East Office	1st Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
South East Open Office	1st Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
South East Corridor	1st Floor	Corridors	1148	0	0.06	0	68.9	68.9	77
South East Storage	1st Floor	Storage rooms	383	0	0.12	0	46.0	46.0	51
South East Kitchen	1st Floor	Break rooms	383	5	0.06	10	70.9	70.9	79
South East Conference	1st Floor	Conference/meeting	766	5	0.06	38	237.5	137.0	152
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South West Storage	1st Floor	Storage rooms	383	0	0.12	0	46.0	46.0	51
South West Kitchen	1st Floor	Break rooms	383	5	0.06	10	70.9	70.9	79
South West Conference	1st Floor	Conference/meeting	766	5	0.06	38	237.5	137.0	152
South East Office	2nd Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
South East Open Office	2nd Floor	Office spaces	2297	5	0.06	11	195.2	195.2	217
South East Corridor	2nd Floor	Corridors	1148	0	0.06	0	68.9	68.9	77
South East Storage	2nd Floor	Storage rooms	383	0	0.12	0	46.0	46.0	51
South East Kitchen	2nd Floor	Break rooms	383	5	0.06	10	70.9	70.9	79
South East Conference	2nd Floor	Conference/meeting	766	5	0.06	38	237.5	137.0	152
	Vbz=Voz	Zp=Voz/Vpz		cfm of OA required- 1st Floor			3154		
	Zp=.16	Ev=.9		cfm of OA required- 2nd through 5th Floor			11411		
				Total Buildng OA Requirement (cfm)			14565		

Table 4- Total Building OA Required

Because the building is a tenant fit out and there are no diffusers laid out in the occupied spaces it is impossible whether or not to say if individual spaces comply with the standard. What is more important in the analysis of the building is whether or not the base building systems can provide the amount of OA required so that upon future design of specific spaces, the designer will have ample OA to ensure that the spaces do comply. This is in fact the case.

The two rooftop units are capable of delivering up to 90,000 cfm of supply air (SA) and can modulate the return air (RA) and OA to meet the ventilation needs of the building. Both RTU's are equipped with variable speed drives that allow for variable air volume supply. The RTU's have economizers that are capable of providing 100% OA.

ASHRAE Standard 62.1 Conclusion

After studying the capacities of the ventilation supply systems and the requirements of the spaces for ventilation air, it is clear that the building is capable of complying with Standard 62.1. Of course, this is dependent on the future design of individual tenant fit outs, but the base building system will provide adequate OA to each floor of the building to ensure that the standard can be met. Beyond the supply of ventilation air, the systems will provide clean, contaminant free air as prescribed by Section 5 of the standard.

ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings

Compliance Analysis

The following report is an investigation into the compliance of Park Place 1 with ASHRAE Standard 90.1 Energy Standard for Buildings Except Low-Rise Residential Buildings. The building envelope, HVAC systems, service water heating, power, lighting, and electric motor efficiency will all be studied in detail sufficient enough to determine compliance with the Standard.

Section 5: Building Envelope

Figure 1- Exterior Picture of the Curtain Wall

Park Place 1 is located in Findlay Township, Pennsylvania which is a suburb of Pittsburgh. Located in zone 5A, Table 5.5-5 will be used to evaluate roofs, walls (all walls are above grade), Slab-on-grade Floors, doors, and fenestration.

As seen above in Figure 1, the building envelope appears to be completely glass with steel mullions when in reality this is not the case. From the interior of the building, it is quite clear that the glass actually covers a hidden interior wall that is broken three feet above the floor to allow for natural light until six inches underneath the ceiling where the wall resumes.

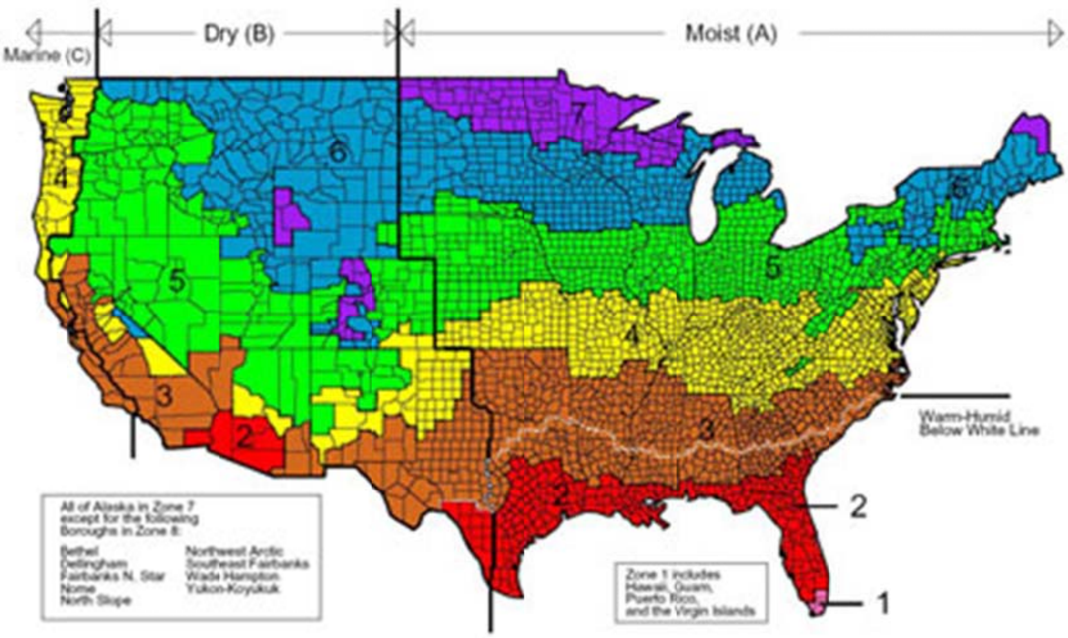

Figure 2- ASHRAE Climate Zone Map

Section 5.5- Prescriptive Building Envelope Option

The entire building with the exception of the rooftop penthouse, which houses the mechanical system equipment, is conditioned and will therefore be taken into consideration in the analysis. This includes floors one through five.

Fenestration Area Analysis				
Level	Glass Area (ft^2)	Gross Wall Area (ft^2)	% Glass	Compliance?
1	5,112	8,804	58.1	No
2	4,828	8,520	56.7	No
3	3,124	6,816	45.8	No
4	4,828	8,520	56.7	No
5	3,124	6,816	45.8	No
Total	21,016	39,476	53.2	No

Table 5- Fenestration Area Compliance Chart

As indicated above in Table 5, the building does not comply on any level as the maximum allowable fenestration area may not exceed 40%. Every single floor and the building as a hole exceed 40% fenestration area.

Building Envelope Mass Requirements For Climate Zone 5A				
Required		Built		Compliance?
Assembly Max	Insulation Min. R-Value	Assembly Max	Insulation Min. R-Value	
U-0.090	R-11 c.i.	U-0.110	R-9	No

Table 6- Curtain Wall Mass Thermal Compliance

Building Envelope Metal Framing Requirements For Climate Zone 5A				
Required		Built		Compliance?
Assembly Max	Assembly Max SHGC	Assembly Max	Assembly Max SHGC	
U-0.45	0.4	U-0.50	0.50	No

Table 7- Curtain Wall Metal Framing Thermal Compliance

From Table 6 above, it is clear that Park Place 1 does not comply with ASHRAE Standard 90.1 in the thermal performance of opaque mass. While it is close, the assembly underperforms the levels required by the standard.

Table 7 shows that, again, Park Place 1 does not meet the standard for thermal performance of metal framing within the curtain wall system.

Because Park Place 1 was built in 1982, the standards under which buildings were constructed do not match those of today. Today's standards are more stringent. For the time, Park Place 1 would have been considered an environmentally friendly building. It has seen some envelope improvements over the course of its life however, the building is still not performing as well as it could be. This is a possible consideration for an improvement to the building systems.

Section 6: Heating, Ventilation, and Air Conditioning

Section 6.2- Compliance Paths

Under Standard 90.1 there are two compliance paths that may be used. The simplified approach mandates that buildings must be under 25,000 ft^2. Because of the square footage restriction of the simplified approach, Park Place 1, which is just shy of 100,000 ft^2, must pursue the Mandatory Provisions Approach presented in Section 6.4.

Section 6.4- Mandatory Provisions

As specified in Table 6.8.1A on Standard 90.1, packaged air-cooled air conditioners that operate above 760,000 Btu/h must have an EER of 9.5 or above and an IPLV of 9.2 or above. Though the systems are not yet installed or even purchased, the owner has made it a point that he would like for the systems to comply with all modern standards. He indicated that any installed system would meet or surpass the required minimum efficiency rates stated in this section.

Again, because the building mechanical systems have not been purchased, it is not possible to verify equipment efficiencies. All equipment will be labeled.

Thermostatic controls will be provided in every occupied zone as a minimum with the opportunity for demand controlled ventilation (DCV) in spaces with modulating occupancy. Zones for analysis have been broken into four quadrants, each of which has two perimeter envelop zones and a single interior zone. By dividing up the zones this way and providing thermostatic controls to each zone, it will ensure that environmental temperature conditions are met.

All controls will be linked to a central building automation system capable of maintaining a prescribed deadband range and schedule to ensure optimum building energy performance. Coupled with the RTU's that provide over 10,000 cfm of supply air, the system will be capable of optimum start in compliance with Section 6.4.3.3.3.

Located in the vertical duct shafts in the center of the building, motorized fire and smoke dampers have been added to all ventilation ducts so as to prevent the spread of smoke in the event of a fire. All dampers are controlled by the building automation system and are capable of 100% open and 100% closed.

All newly added equipment will comply with leakage rates as prescribed by manufactures literature under AMCA Standard 500. All existing dampers are to be removed during the renovation with the exception of those located in the rooftop penthouse that are tied into the existing-to-remain boilers.

There will not be any humidification or snow melting systems in any part of the building.

All new duct work and system piping will be installed with insulation. Existing conditions of visible piping and duct work suggests that originally installed equipment was done so with insulation though it is uncertain at this point in time. Further investigation is to take place.

Section 6.5- Prescriptive Path

Both RTU's have been equipped with 100% OA comparative dry bulb economizers that will be integrated into the central building automation system.

Because both RTU's are variable volume, fan power limitation was checked using Option 1: Fan System Motor Nameplate hp and the equation:

$$hp \leq CFM_s \cdot 0.0015$$

The resulting calculations can be seen in the Table 8 shown below.

Supply Fan Compliance				
Unit	hp	CFM	Allowable hp	Compliance?
RTU-1	75	45,000	67.5	No
RTU-2	75	45,000	67.5	No
FPCV-A	1/6	200	0.3	Yes
FPCV-B	1/6	350	0.525	Yes
FPCV-C	1/4	750	1.125	Yes
FPCV-D	1/2	1,000	1.5	Yes
FPCV-E	3/4	1,400	2.1	Yes
FPCV-F	1	1,800	2.7	Yes
FPCV-G	1	2,300	3.45	Yes
FPVV-A	1/6	200	0.3	Yes
FPVV-B	1/6	350	0.525	Yes
FPVV-C	1/4	750	1.125	Yes
FPVV-D	1/2	1,000	1.5	Yes
FPVV-E	3/4	1,400	2.1	Yes
FPVV-F	1	1,800	2.7	Yes
FPVV-G	1	2,400	3.6	Yes

Table 8- Supply Fan Compliance

Note: FPCV: Fan Powered Constant Volume Air Valve
FPVV: Fan Powered Variable Volume Air Valve

From Table 8 above it is clear to see that the two RTU's do not comply with ASHRAE standard 90.1. This in all likelihood has to do with the system being slightly oversized in a measure of being conservative by the design engineer. In the case above, where the supply fans do not comply, the exception in Section 6.5.3.1.2 part b. has been taken into effect according to the design engineer.

The building exhaust, with the exception of the restrooms is handled by return fans located in the RTU's on the roof. From the space, the plenum above the ceiling serves as the means through which air is exhausted from the space to the RTU and then outside. The restroom exhaust air is handled by two identical fans, one for each side of the building, located in the rooftop penthouse. Because of this, there are very few exhaust fans in the system. Table 9 below shows compliance with Standard 90.1 for the exhaust fans. In the event of a tenant requiring a kitchen or other exhaust hood, space has been left in the air supply shaft located in the center of the building.

Exhaust Fan Compliance				
Unit	hp	CFM	Allowable hp	Compliance?
EF-1	1	3,500	5.25	Yes
RTU-1	40	40,500	60.75	Yes
RTU-2	40	40,500	60.75	Yes

Table 9- Exhaust Fan Compliance

There are currently no energy recovery systems in the building; however, the owner has expressed interest that this study further researches the potential feasibility of such systems.

The fan powered constant and variable volume air valves (FPCV, FPVV) have hydronic reheat coils. These coils are provided with water from the boilers and two 5 hp pumps located in the rooftop penthouse. Because the pumps do not exceed 10 hp, the system meets the criteria listed under Section 6.5.4.

Section 6.7- Submittals

Because of the age of the building, only the newest renovations of the building will be analyzed for compliance under ASHRAE Standard 90.1. All existing systems will not be considered in a professional sense. This report does, however, account for all systems that lie within the realm of the standard.

Section 7: Service Water Heating

Building service water heating is not being adjusted as part of the scope of the building renovation. All existing systems are to remain and function as continuous. That said, for the purposes of study, the system will be analyzed for compliance with Standard 90.1.

Section 7.2- Compliance Paths

The Energy Cost Budget Method will not be used for this project.

Section 7.4- Mandatory Provisions

Service hot water piping insulation has been provided on all piping located in the rooftop penthouse. As part of the renovation, new insulation will be provided to the piping to increase the overall efficiency of the system, at which point in time, the building will comply with Standard 90.1.

All controlling of the existing boilers will be handled by the building automation system that is to be installed as a part of the renovation. This includes temperature, temperature maintenance, and circulating pump control.

The gas-fired boilers have an input value of 970,000 Btu/hr of input energy which implies that Section 7.5.1 bullet a. must be used to demonstrate compliance. Because the building is not fully occupied, the design was not a part of the renovation, and the original design was almost 30 years ago, it is impossible to say what the maximum demand for gal/h is going to be for the year and whether or not the boilers can comply with Standard 90.1.

Section 8- Power

Section 8.4- Mandatory Provisions

ASHRAE Standard 90.1 specifies that feeders be sized at a voltage drop of 2% of the design load and branch circuits 3% respectively. Park Place 1 complies with this section of the standard.

Section 9- Lighting

The lighting systems of Park Place 1 are very elementary with the exception of the main lobby area. Because the building is designed as office space, 2x4 feet recessed fluorescent luminaires with T8 lamps have been installed. The luminaires have been placed on a grid gapped by six feet on center along the north-south column line and twelve feet on center along the east-west column line. To demonstrate compliance with Section 9, the Building Area Method Compliance Path described under Section 9.5 will be used.

Section 9.4- Mandatory Provisions

Automatic lighting shutoff has been incorporated into the building automation system so that during unoccupied hours, lighting will be reduced to a minimum. This provision includes exterior lighting as well as interior. The program will function based on a time-of-day schedule.

Space control will be handled on a tenant by tenant basis. Because many of the floors do not have occupants, the spaces do not have walls and therefore cannot be analyzed for compliance with space control.

Section 9.5- Building Area Method Compliance Path

As prescribed in Table 9.6.1, the maximum allowable lighting power density for an office building is 1 W/ft^2. Park Place 1 has a lighting power density of roughly 1.2 W/ ft^2 which exceeds the allowance set forth by Standard 90.1.

Conclusion

Following the investigations undertaken to analyze Park Place 1 for compliance with ASHRAE Standard 90.1, it was clear to see that the age of the building severely hampered it from meeting criteria for an energy efficient building by today's standards. Generally the problems of complying fell on the construction methods and quality of materials that the building envelope was comprised of. This is very reasonable given the fact that energy was not as expensive or considered as precious of a resource during the early 1980's as it is today.

Because of the building's energy shortcomings by today's standards, efforts have been made to improve the mechanical systems as a first attempt, lowest cost, quickest payback measure. Replacing or upgrading the building curtain wall system would be immensely expensive and is probably unreasonable to expect of a building of such age.

In conclusion, while the building does not comply with Standard 90.1, it comes very close and can be considered a successful building due to its age consideration. All efforts have been made by ownership to come as close as reasonably possible to decrease the impact that the building has on the environment.

APPENDIX A

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