Technical Report 1

ASHRAE Standards 62.1 and 90.1 Design Evaluations

RIVER VUE APARTMENTS, PITTSBURGH, PA

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Figure 1: Exterior Photo of River Vue Apartments

Executive Summary

Throughout the research period for this report it was noted that several components studied, including natural ventilation intake quantity, façade fenestration, and lighting power densities do not meet current design standards and can be further investigated to develop re-design proposals at a later date. The mechanical equipment, insulation, envelope materials and control systems being installed in the current renovation project do meet ASHRAE standards however, and achieve LEED points for their sustainability. Analyses that follow proved to be very educational and helped to develop a greater understanding of River Vue Apartments as a whole.

Study of the single air handling unit proved that the outdoor air provided for ventilation just barely exceeds what is prescribed by ASHRAE Standard 62.1 Section 5 to meet code. When this analysis was completed, rough estimates for room areas were found from contract drawings and airflow rates for occupancy and square footage were chosen from ASHRAE tables in this section. It can be speculated that the mechanical engineer considers operable windows throughout the façade as a reliable source for natural ventilation and that this will supplement what the air handling unit supplies. Some of these windows proved to be in too close proximity to sources of air contaminants, however; and could pose a risk for poor indoor air quality.

Many of River Vue Apartment's building elements, such as insulation, façade materials, and the digital control system satisfy Standard 90.1 for energy conscious design and envelope standards. The building's fenestration easily exceeds 40% on each floor level, making it unable to comply with the Prescriptive method. Since this method for design proves to be an acceptable guideline, however, it was used to assess the façade's components and showed that if there was less fenestration, the building would easily meet Standard 90.1 guidelines.

Electric and lighting plans were studied to examine the lighting power densities throughout each typical space, including apartment units, main lobbies, parking garages, and corridors. According to simple calculations, the 120/208 V system feeding the building provides sufficient lighting to most spaces except some residential areas.

Introduction

The following report is an evaluation of minimum ventilation rates and other measures of indoor air quality as well as energy efficient design strategies. Portions of these analyses will suffice as supplemental material for a mechanical systems proposal for River View Apartments at a later date. Two important ASHRAE standards were considered throughout this analysis; Standard 62.1, as a guide for specifying ventilation rates for new and existing buildings with the help of the ventilation Rate Calculation procedure, and ASHRAE standard 90.1, a benchmark used to evaluate building envelope design as well as other energy conscious design applications.

Figure 2: Exterior View of River Vue Apartments

River Vue Apartments, located in Pittsburgh, Pennsylvania, is a renovation project to convert the Old State Office Building into downtown apartment living. During the summer of 2011 the building's interior will be completely stripped to allow for new mechanical, electrical, fire protection and other systems to be installed in following months, with an expected substantial completion date in the spring of 2012. It has repetitive residential units on all floors, retail and café area on the first floor, two levels of valet parking for future residents, and bi-level apartment units with balconies on the 15th and 16th floors.

Mechanical System Overview

Due to the simplicity of the complex, River Vue Apartments is served by only one 26,300 CFM air handling unit with an energy recovery wheel located on the roof serving two supply risers and two exhaust risers located in the north-east corner of the building. Two 200 GPM boilers and a 1024 GPM plate heat exchanger are located in the basement mechanical space and a 350 ton cooling tower located behind stainless steel curved panels on the roof serve the plumbing system's risers. The building can be divided into several simple zones requiring ventilation and conditioned air from the air handling unit, including residential apartment units, corridors, lobby/retail space, and the parking garage. Much of the building's ventilation will be provided by operable windows in the façade. Fire protection will

be supplied through sprinklers on each floor, which will be new to the building in the current renovation project.

Standard 62.1 - Section 5Compliance

Section 5.1 Natural Ventilation

Although River Vue Apartments does not have an engineered natural ventilation system, the building's façade incorporates operable windows in accordance with ASHRAE section 5.1.2. The aluminum window frames satisfy a project's sustainability EQ credit 6.2 for controllability of systems.

Section 5.2 Ventilation Air Distribution

See Ventilation Rate Calculation Procedure (Standard 62.1 – Section 6) below for design details. Contract specification section 023 – 0593 lists requirements for the testing, adjusting and balancing of all HVAC equipment for this project, with sub section 3.7 specifically identifying procedures for the air system. Ventilation documentation will follow this specification section's requirements.

Section 5.3 Exhaust Duct Location

Ductwork is to be constructed according to SMACNA HVAC Duct Construction Standards and therefore meets the design exception in section 5.3. Ductwork shall have the following pressure classes:

- Supply: 2 inches
- Return & Relief: 1 inch
- General exhaust duct: 1 inch

Section 5.4 Ventilation System Controls

There is a direct-digital control system with 48 hour battery backup prescribed for River Vue Apartments which will act to automatically control temperature, control valves, dampers and their operators, interface equipment and accessories for the make-up air unit, ventilation systems, unit heaters, and plumbing equipment. This system has a sequence of operation described in the contract documents and fulfills section 5.4 requirements.

Section 5.5 Airstream Surfaces

The duct liner is a rigid board of incombustible glass fiber, coated with an acrylic polymer. This material is specified by the manufacturer to be fungus and bacterial resistant by ASTM G 21 testing, however, resistance to mold growth cannot be completely guaranteed, as noted by ASHRAE Standard 62.1. All duct for the air system is built from hot-dipped, galvanized steel sheets (ASTM A 653/A 653 M FS Type B) with a G60/Z180 coating, and therefore it meets requirements of section 5.5.2 for resistance to erosion.

Section 5.6 Outdoor Air Intakes

Building windows in the facade act as part of the outdoor air ventilation system, as described above under section 5.1. Many of the windows do not meet minimum separation distances specified in ASHRAE Table 5-1, as seen below in Figure 3. Windows on the ground floor are at a distace of approximately 15 feet above the loading area and ramp for the underground parking garage, which is less than the minimum distance of 25 feet. Another violation of the ASHRAE Standard is the vestibule area on the first floor, which leads to the main lobby area. It is only six feet from the garbage storage area outside the building; less than the minimum of 15 required feet of distance.

TABLE 5-1 Air Intake Minimum Separation Distance

Object	Minimum Distance, ft (m)
Significantly contaminated exhaust (Note 1)	15 (5)
Noxious or dangerous exhaust (Notes 2 and 3)	30 (10)
Vents, chimneys, and flues from combustion appliances and equipment (Note 4)	15 (5)
Garage entry, automobile loading area, or drive-in queue (Note 5)	15 (5)
Truck loading area or dock, bus parking/idling area (Note 5)	25 (7.5)
Driveway, street, or parking place (Note 5)	5 (1.5)
Thoroughfare with high traffic volume	25 (7.5)
Roof, landscaped grade, or other surface directly below intake (Notes 6 and 7)	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: Significantly contaminated exhaust is exhaust air with significant contaminant concentration, significant sensory-irritation intensity, or offensive odor.
Note 2: Laboratory fume hood exhaust air outlets shall be in compliance with NFPA 45-1991[3] and ANSI/AIHA Z9.5-1992.[4]
Note 3: Noxious or dangerous exhaust is exhaust air with highly objectionable fumes or gases and/or exhaust air with potentially dangerous particles, bioaerosols, or gases at concentrations high enough to be considered harmful. Information on separation criteria for industrial environments can be found in the ACGIH Industrial Ventilation Manual [5] and in the *ASHRAE Handbook—HVAC Applications*.[6]
Note 4: Shorter separation distances are permitted when determined in accordance with (a) Chapter 7 of ANSI Z223.1/NFPA 54-2002[7] for fuel gas burning appliances and equipment, (b) Chapter 6 of NFPA 31-2001[8] for oil burning appliances and equipment, or (c) Chapter 7 of NFPA 211-2003[9] for other combustion appliances and equipment.
Note 5: Distance measured to closest place that vehicle exhaust is likely to be located.
Note 6: No minimum separation distance applies to surfaces that are sloped more than 45 degrees from horizontal or that are less than 1 in. (3 cm) wide.
Note 7: Where snow accumulation is expected, distance listed shall be increased by the expected average snow depth.

Figure 3: ASHRAE Standard 62.1 Table 5-1

Six inch deep louvers sloped at 45 degrees are installed on the roof top makeup air handling unit with ½" square mesh screens over the intake to comply with section 5.6.2.

Section 5.7 Local Capture of Contaminants

All exhaust fans are ducted directly outside and contain gravity actuated backdraft dampers to prevent contaminants from re-entering the building. Fans are sized to provide 100% relief air and will eliminate many contaminants from the spaces in the building.

Section 5.8 Combustion Air

Combustion air from the basement boilers is exhausted through secure flues as specified by the manufacturer. The existing fuel oil generator in the basement is to be re-used for the renovated building and, by specification section 026-3213, requires exhaust gases to be directly vented outdoors and sufficient cooling airflow for operation. Combustion air will be completely exhausted to prevent recirculation.

Section 5.9 Particulate Matter Removal

Filters shall be four inches thick and pleated with an ASHRAE efficiency of 30 % and rating of 8. They will be placed upstream of the cooling coil and therefore meet section 5.9 requirements.

Section 5.10 Dehumidification Systems

Using a psychrometric chart provided by ASHRAE (see Appendix B) and intake design air dry bulb and wet bulb temperatures from the air handling unit schedule, the relative humidity in winter operation was found to be approximately 17% and 82% in summer months. This proves that the building design does not meet section 5.10.1 requirements for a maximum of 65% humidity in the summer months of operation. Throughout both the winter and summer months, outdoor air intake is almost twice that of the exhaust air amount, thus satisfying section 5.10.2 for exfiltration.

Section 5.11 Drain Pans

Drain pans for coils are all double-sloped 304 stainless steel, as specified by the manufacturer and meet section 5.11 requirements.

Section 5.12 Finned-Tube Coils and Heat Exchangers

The finned water tube boiler does not specify a drip pan because it is not a condensing unit and the heat exchanger is a water-to-water unit, which also does not require a drip pan.

Section 5.13 Humidifiers and Water-Spray Systems

No information was specified for the mechanical system regarding humidification or water spray systems.

Section 5.14 Access for Inspection, Cleaning, and Maintenance

As mentioned in specification section 023-7433 of the contract documents, access is provided to all HVAC and electrical equipment through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges are included on the doors. The equipment units are placed on 4 inch concrete pads to maintain a clean environment. Ducts and duct accessories are located on plans with sufficient space to allow for normal operation and maintenance activities.

Section 5.15 Building Envelope and Interior Surfaces

Current roofing materials are being replaced in the proposed renovation plans to include a sealant, flashing, ½" cementitous back board and a latex plaster finish along the vertical edges. The horizontal plane of the roof is comprised of several layers, including a Dex-o-Tex traffic surface, single-ply sheet membrane, slip sheet, 6 ½" light weight concrete layer (3500 psi) with fiber reinforcement and a 1 ½" extruded insulation board. The roof deck is galvanized 20 gauge, 1 ½" thick steel with wide rib configurations. The exterior façade is comprised of sealed aluminum windows and aluminum panels with bronze glazing.

All necessary piping shall be insulated in accordance with specification section 023-0719 to include insulation, a vapor barrier jacket of 0.02 perm-inches, and a vapor barrier lap adhesive for glass fiber insulation applications. Flexible elastomeric cellular insulation will require stainless steel jackets.

Section 5.16 Buildings with Attached Parking Garages

The ground and first floors of the existing structure are being converted into valet parking areas with electric powered lifts to store two cars in one space. Particular attention has been paid to these spaces to minimize the migration of exhaust air from vehicles into the rest of the building's occupiable spaces by adding large louvers on the east and west exterior walls as well as two exhaust fans on the west wall of the first floor.

Section 5.17 Air Classification and Recirculation

Each space within the building has designated supply and return air, controlled by the makeup air handling unit. Air in the residential units can be classified as Class 1, since it contains little odor or contaminants, however, air in the parking garage levels will be classified as Class 2 and is inappropriate for transfer to other areas. Airflow values are determined in the next section with the Ventilation Rate Calculation Procedure from section 6 of ASHRAE Standard 62.1.

Section 5.18 Requirements for Buildings Containing ETS Areas and ETS-Free Areas

River Vue Apartments is considered an ETS-Free area as a whole and has a positive interior pressurization which meets all requirements for this section.

Summary of ASHRAE Standard 62.1 Section 5 Evaluation

All components of the building's mechanical system comply to the ASHRAE standard except for the façade's operable windows used natural ventilation, which, in some cases, are too close to contaminated exhaust air outlets. Although there are vestibule areas provided, sufficient ventilation in the parking garage levels may still be a concern due to the fact that lifts will allow for double parking capacity. Also, humidity levels may exceed design standards during the summer months of operation due to the mechanical system's current design.

Ventilation Rate Calculation Procedure (Standard 62.1 - Section 6)

Annual reports from the Environmental Protection Agency's (EPA) website state that air contaminant levels in the Pittsburgh area are good to moderate, which allows River Vue Apartments to not require outdoor air treatment other than the filters recommended by the manufacturer for the air handling unit. See appendix B for detailed data from the EPA.

Breathing Zone Outdoor Airflow Calculation

Required outdoor airflow can be computed using the following equation from ASHRAE Standard 62.1:

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

A_z = zone floor area

P_z = zone population

R_p = outdoor air rate required per person

R_a = outdoor airflow rate required per unit area

A summary of calculations is provided in the table below. See Appendix C for full calculation details.

Space	Outdoor Airflow
Common Corridor	933
Stairwells	346
Main Entry Lobby	42
Stair Lobby	81
Elect Equip Room	48
Bsmt Machine Room	96
Elevator Machine Room	150
Boiler Room	96
Fire Pump Room	96
Generator Room	96
Dwelling Units 2nd Floor	1641
Dwelling Units 3-14 Floors	17504
Dwelling Units 15-16	2217
Fitness Center	516
Retail Sales	365
Parking Garage	2070
Total	**26293**

Table 1: Outdoor Airflow Calculation Summary

Many of the building's spaces are repetitive in size and orientation since the floors are similar, making calculations simplistic for outdoor airflow. For detailed calculations of outdoor air rates, refer to Appendix A.

Zone Air Distribution Effectiveness

Using Table 6.2 in ASHRAE Standard 62.1 Section 6, it is obvious that River Vue Apartments has a zone air distribution effectiveness E_z= 1.0 because of its ceiling supply and floor return design.

TABLE 6-2 Zone Air Distribution Effectiveness

Air Distribution Configuration	E_z
Ceiling supply of cool air.	1.0
Ceiling supply of warm air and floor return.	1.0
Ceiling supply of warm air 15°F (8°C) or more above space temperature and ceiling return.	0.8
Ceiling supply of warm air less than 15°F (8°C) above space temperature and ceiling return provided that the 150 fpm (0.8 m/s) supply air jet reaches to within 4.5 ft (1.4 m) of floor level. ***Note:*** For lower velocity supply air, $E_z = 0.8$.	1.0
Floor supply of cool air and ceiling return provided that the 150 fpm (0.8 m/s) supply jet reaches 4.5 ft (1.4 m) or more above the floor. ***Note:*** Most underfloor air distribution systems comply with this proviso.	1.0
Floor supply of cool air and ceiling return, provided low-velocity displacement ventilation achieves unidirectional flow and thermal stratification.	1.2
Floor supply of warm air and floor return.	1.0
Floor supply of warm air and ceiling return.	0.7
Makeup supply drawn in on the opposite side of the room from the exhaust and/or return.	0.8
Makeup supply drawn in near to the exhaust and/or return location.	0.5

Figure 4: Table 6-2 from ASHRAE Standard 62.1

Zone Outdoor Airflow

Using the breathing zone outdoor airflow, zone outdoor airflow can be simply calculated using the relationship $V_{oz} = V_{bz}/E_z$, yielding a zone outdoor airflow of 26,293 cfm.

Single Zone System

River Vue Apartment's single make up air unit serves the entire building alone and therefore the building can be considered a single zone system. Using equation 6-3 in ASHRAE Standard 62.1 it can be seen that the outdoor air intake flow$V_{ot} = V_{oz}$ = 26,293 cfm.

Summary of Standard 62.1 Section 6

After review of River Vue Apartment's mechanical system with ASHRAE Standard 62.1 Section 6 requirements for indoor air quality, it is evident that the single make up air handling unit will provide just enough of the required amount of proper ventilation air for the spaces inside the building. The mechanical schedule says that the unit will supply 17,000 cfm during winter operation and 17,800 cfm during summer operation, with 9,300 cfm exhaust for a total of 26,300 cfm. The outdoor air intake flow prescribed by section 6.3 is nearly that amount, at 26,293cfm.

This building was originally constructed in 1955 and went through its first renovation project in the mid 1980's. It makes sense that the ventilation rates prescribed by today's ASHRAE standards nearly exceed those produced by the building because of its old design since the space itself has not changed in over 50 years. Discrepancies in the project and what ASHRAE calls for can be considered for further review during a future design proposal or technical report.

Standard 90.1 Compliance

Section 5.1.3 Space Conditioning Categories

The building envelope will remain completely intact with the exception of new operable windows which have a lower U factor than the previous glazing. No new framing cavities will be created in the renovation and hence, River Vue Apartments satisfies requirements for Space Conditioning.

Section 5.1.4 Climate

Pittsburgh, Pennsylvania is located in ASHRAE climate zone 5A, as seen in the figure below, and has cool conditions with periods of high humidity.

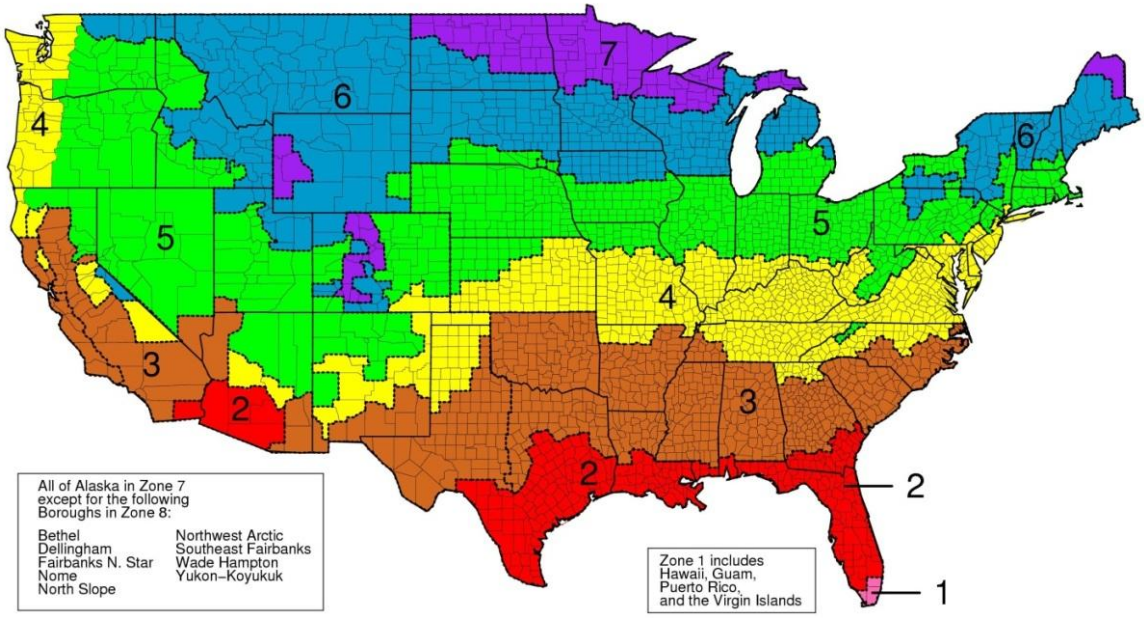


Figure 5: ASHRAE Climate Zone Map. Image courtesy: www.resourcecenter.pnl.gov

Section 5.2.1 Compliance

Although there are no skylights within the building, the fenestration including doors, windows, and storefront space exceeds 40% of the gross wall area on each floor as seen in the table below. Therefore, it cannot comply with the Prescriptive Building Envelope option listed in ASHRAE Section 5 and must implement the Building Envelope Trade-Off Option. For simplicity, however, the Prescriptive Building Envelope method will be used as a “best case” scenario for comparison.

Figure 6: Exterior View of River Vue Apartments

Level	Glass	Wall	%	Compliance
G	3992	6336	63.01	No
1	3600	6336	56.82	No
2	3600	6336	56.82	No
3	3600	6336	56.82	No
4	3600	6336	56.82	No
5	3600	6336	56.82	No
6	3600	6336	56.82	No
7	3600	6336	56.82	No
8	3600	6336	56.82	No
9	3600	6336	56.82	No
10	3600	6336	56.82	No
11	3600	6336	56.82	No
12	3600	6336	56.82	No
13	3600	6336	56.82	No
14	3600	6336	56.82	No
15	3600	6336	56.82	No
16	3000	6336	47.35	No
TOTAL	60992	107712	56.63	No

Table 2: Table for Fenestration Analysis

Section 5.4 Mandatory Provisions

Building envelope openings are specified to be sealed, caulked as required by ASHRAE Standard 90.1 Section 5.4.3 with a combination of foam-plastic board, glass-fiber blanket, sprayed fiber insulations. Interior doors are specified to allow a maximum 0.3 cfm/square foot infiltration level whereas aluminum-framed entrance doors are to allow no more than 0.6cfm/square foot infiltration into the building; both of these levels meet fenestration requirements. A 10' x 10' vestibule with two sets of swinging doors is planned for the building's first floor entrance to protect the conditioned space from the exterior environment and potential contaminants.

Section 5.5 - Prescriptive Building Envelope Option

As stated earlier, the Prescriptive Building Envelope Option described in ASHRAE Standard 90.1 will be used as a method of comparison for this building's envelope materials and construction. River Vue Apartments is classified as a residential facility and has a building envelope with the following properties:

Opaque Element	As-Built U Value	Assembly Max U (ASHRAE)	Specified R Value	Min R Value (ASHRAE)	Comply?
Roof Insulation Above Deck	0.048	0.048	20	20.0 c.i.	YES
Above Grade Walls, Steel Framed	0.064	0.064	13.0	13.0 + 7.5 c.i.	YES
Below Grade Walls	0.119	C-0.119	7.5	7.5 c.i.	YES
Steel Joist Floors	0.038	0.038	30.0	30.0	YES
Unheated Slab-On-Grade Floors	0.45	F-0.540	10	10	YES
Swinging Doors	0.49	0.5	N/A	N/A	YES
Metal Framed Entrance Door	0.49	0.8	N/A	N/A	YES
Metal Framed Vertical Glazing	0.49	0.55	N/A	N/A	YES
Metal Framed Storefront	0.36	0.45	N/A	N/A	YES

Table 3: Summary of Building Envelope properties

It is evident that the building's envelope materials would comply with specified minimum values from ASHRAE Tables 5.5-1 through 5.5-8 if the façade's fenestration did not exceed 40% of the gross wall area. Most of the components listed in Figure 9 above are locally made and achieve LEED points through their compliance with ASHRAE specified minimums. In combination with other sustainable methods, these will help achieve the project goal of LEED Certification.

Section 6.2 Compliance Path

Renovation of River Vue Apartments will incorporate all new plumbing and HVAC equipment, piping, and ductwork to meet specified project standards and efficiencies. The Prescriptive path will be implemented to evaluate the compliance of the mechanical system since the building is more than two stories and has a gross floor area close to 300,000 square feet.

Section 6.4 Mandatory Provisions

Standard 90.1 lists minimum performance requirements in terms of efficiencies for mechanical equipment. An analysis was completed to compare ASHRAE required efficiencies to the efficiencies specified by the project's air handling unit, heat pumps,

electric unit heaters, boilers and cooling tower. All equipment investigated passed ASHRAE 90.1 efficiency standards (see Figure 10 for results).

NOTE: Data for some pieces of equipment could not be identified in the contract documents, specifications, or available submittals so efficiencies and performance data was obtained on manufacturer's websites as follows:

- Anex Air product catalogs were used for the packaged outdoor energy recovery unit
- Heat pump COP values were obtained from Trane Incorporated
- Electric Unit Heater data was given by QMark

Equipment	Size	Specified Equipment Efficiency	ASHRAE 90.1 Table Referenced	Min. Efficiency Req'd by ASHRAE 90.1-	Test Procedure Recommended by ASHRAE	Compliance
Make Up Air Handling Unit	864,000 BTU/h	10 EER	6.8.1.A	9.5 EER, 9.2IPLV	ARI 340/360	YES
Heat Pump A/C-100	73,000 BTU/h	13.5 EER, 4.7 COP	6.8.1.B	4.2 COP	ARI 340/360	YES
Heat Pump A/C-103	5,000 BTU/h					
Heat Pump A/C-223	12,900 BTU/h					
Heat Pump A/C-227	11,600 BTU/h					
Heat Pump A/C-1	8,800 BTU/h					
Heat Pump A/C-2	1,900 BTU/h					
Heat Pump A/C-3	18,100 BTU/h					
Heat Pump A/C-4	23,600 BTU/h					
Heat Pump A/C-5	34,700 BTU/h					
Electric Unit Heaters	375-18,700 W	3.5	6.8.1.D	3.2 COP	ARI 310/380	YES
Boilers	2,000,000 BTU input	91%	6.8.1.F	75%	10 CFR Part 431	YES
Axial Propeller Cooling Towe	350 tons	51.2	6.8.1.G	38.2 gpm/hp	CTI ATC-105 &CTI STD-201	YES

Table 4: Summary of Mechanical Equipment Efficiencies

Section 6.4.3 Controls

Direct-Digital controls have been specified by the project engineer and approved by a Professional Engineer for the following building components:

- Control valves
- Dampers
- Damper Operators
- Humidistats
- Thermostats
- Adjustable Frequency Drives (AFD)
- Heat Pumps
- Emergency Generator
- Stairwell & Elevator Shaft Pressurization Fans
- Parking Garage Ventilation

A complete sequence of operation is provided in the Contract Document Specification Section 23-0993. These control systems meet ASHRAE 90.1 standards.

Section 6.5 - Energy Recovery

The single make up air handling unit on the roof of River Vue Apartments utilizes an enthalpy wheel mounted in a rigid frame to exchange heat and humidity from outgoing air to incoming air. This reduces the building load because less cooling is needed in summer months and less heating is required in winter months when energy is conserved. The wheel runs continuously but does not disturb laminar air flow and minimum pressure drop ratios. The building's structure does not contain high concentrations of mass and may have difficulties retaining and conserving energy naturally with the idea of thermal mass.

Section 7 -Service Water Heating Scope

ASHRAE Standard 90.1 Section 7 describes hot water heating systems for buildings and provides recommendations for equipment. As identified earlier, the two boilers serving the apartment complex have an efficiency of 91%, which is greater than the minimum performance requirement of 80% given by Table 7.8 in section 7.7.1 for hot water supply boilers, fired by natural gas. Service water will therefore be heated by an efficient source.

Section 8 - Power

Electric power is provided by seven sets of 4-500 kcmil wire in 4" conduit on the north-west side of the ground floor to a 3000A draw-out circuit breaker. From this location, 208/120 V, three phase power is supplied by four wires to 5 separate switch boards and then individual panel boards throughout the building. Feeder conductors have been sized to meet the National Electric Code by the electrical engineer and can be assumed to not exceed a 2% voltage drop at the design load. Likewise, branch circuits can be assumed to not exceed a voltage drop of 3%. Contract drawings include a complete single line diagram, floor plans indicating areas served by electrical distribution as well as electrical demolition work to be completed in the first phase of the renovation process.

Section 9 –Lighting

As mentioned in Building Statistics 2, existing gray stationary window glazing and associated gaskets are to be removed during the renovation and replaced with new, operable bronze colored panels to allow for additional day lighting. Apartments on upper levels 15 and 16 will incorporate new balcony areas to allow additional natural light and outdoor living space for the tenants.

Wall sconces and pendant fixtures, provided by Lithonia and Lumetta, hung from acoustic tile ceilings will be installed in interior corridors for guided lighting to each unit. Apartments will incorporate decorative surface-mount luminaires with Energy Star certification as well as under-cabinet lighting for bathroom and kitchen cabinets. The façade will be lit with white LED flood and spot lights as well as several metal halides. LED bollards and up-lights will be used for pathway lighting and to accent the landscape.

Automatic lighting shutoff is required due to the building's size of nearly 300,000 square feet. Contract documents specify occupancy sensors which view (+/-) 9" of horizontal view and have optional daylight override. Large spaces within the building will have wall switch occupancy sensors for manual control.

The Building area method compliance path was used to determine if interior lighting power allowances meet ASHRAE specifications. Using Table 9.5.1 "Lighting Power Densities Using the Building Area Method," lighting power densities for typical spaces were identified as shown in the table below. Apartment units are repetitive in design on certain floors and can be grouped together for simplicity.

	Area (sqft)	Wattage	LPD - As Designed	LPD - As Required	Compliance
Parking Garage	34500	15012	0.44	0.3	YES
Apartment Units Second Floor	994.5	322	0.32	0.7	NO
Apartment Units 3-14 Floors	1020	334	0.33	0.7	NO
Apartment Units 15-16 Floors	1550	1121	0.72	0.7	YES
Common Corridor	1110	2552	2.30	1	YES
Main Entry Lobby	375	1320	3.52	1	YES

Table 5: Lighting Power Density Calculations

It is evident that the lighting power density is not sufficient by ASHRAE 90.1 standards for typical apartments throughout the building, excluding the two-level units on the 15th and 16th floors. This information could be used for the development of a future design proposal or technical investigation.

Summary of Standard 90.1

Analysis of ASHRAE Standard 90.1 reveals that certain components of the building, such as interior lighting and exterior fenestration, do not meet current standards. As mentioned in the summary of Standard 62.1, the existing building is over 50 years old and therefore was constructed during a period of different code regulations. Despite these findings, there are significant improvements being made in the current renovation of River Vue Apartments including the installation of new mechanical equipment with proper efficiencies, a digital control system as well as envelope materials which meet updated standards. All of these new elements add to the sustainability of the project and help to achieve LEED Certification.

Appendix A - Calculations

Make Up Air Handling Unit Schedule used for Dehumidification System calculations in ASHRAE Standard 62.1 Section 5 Analysis

	Winter Months	Summer Months
Dry Bulb Temperature (degrees)	78	58
Wet Bulb Temperature (degrees)	54	55
Relative Humidity (percent)	17	82

	Zones																TOTAL
	Common Corridor	Stair wells	Main Entry Lobby	Stair Lobby	Elect Equip Room	Bsmt Mech Room	Elevator Machine Room	Boiler Room	Fire Pump Room	Generator Room	Dwelling Units 2nd floor	Dwelling Units 3-14 floors	Dwelling Units 15-16 floors	Fitness Center	Retail Sales	Parking Garage	
Zone floor Area (Az)	15540	5760	375	260	800	800	1250	800	800	800	14917.5	159120	20150	600	1568	34500	258040.5
Zone Population (Pz)	0	0	3.75	13	0	0	0	0	0	0	149.175	1591.2	201.5	24	23.52		
Outdoor Airflow rate required per Person (Rp) (cfm/person)	N/A	N/A	5	5	N/A	N/A	N/A	N/A	N/A	N/A	5	5	5	20	7.5	7.5	
Outdoor Airflow Rate Required per Unit Area (Ra) (cfm/sqft)	0.06	0.06	0.06	0.06	0.06	0.12	0.12	0.12	0.12	0.12	0.06	0.06	0.06	0.06	0.12	0.06	
Occupant Density (#/1000 sqft)	N/A	N/A	10	50	N/A	N/A	N/A	N/A	N/A	N/A	10	10	10	40	15	100	
OA Rate (cfm per person)	N/A	N/A	11	6	N/A	N/A	N/A	N/A	N/A	N/A	11	11	11	22	16	8	
Class	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2	1	
(Rp)*(Pz)=	0	0	18.75	65	0	0	0	0	0	0	745.875	7956	1007.5	480	176.4	0	10450
(Ra)*(Az)=	932.4	345.6	22.5	15.6	48	96	150	96	96	96	895.05	9547.2	1209	36	188.16	2070	15844
breathing zone outdoor airflow (Vbz)	932.4	345.6	41.25	80.6	48	96	150	96	96	96	1640.925	17503.2	2216.5	516	364.56	2070	26293

Lighting Power Density Calculations

Summary

	Area (sqft)	Wattage	LPD - As Designed	LPD - As Required	Compliance
Parking Garage	34500	15012	0.44	0.3	YES
Apartment Units Second Floor	994.5	322	0.32	0.7	NO
Apartment Units 3-14 Floors	1020	334	0.33	0.7	NO
Apartment Units 15-16 Floors	1550	1121	0.72	0.7	YES
Common Corridor	1110	2552	2.30	1	YES
Main Entry Lobby	375	1320	3.52	1	YES

Detailed Calculations

Parking Garage Level 1

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
F10	73	2	54	7884	17250	0.46

Parking Garage Level 2

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
F10	66	2	54	7128	17250	0.41

Apartment Units Second Floor

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
A	1	2	26	52	994.5	0.32
B	1	3	13	39		
D	2	1	26	52		
E	2	2	26	104		

F	3			0		
J	1	1	75	75		

Apartment Units 3-14 Floors

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
A	1	2	26	52	1020	0.33
B	1	3	13	39		
C	1	2	32	64		
D	3	1	26	26		
E	1	2	26	52		
F	2			0		
I	1	2	13	26		
J	1	1	75	75		

Apartment Units 15-16 Floors

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
A	6	2	26	312	1550	0.72
B	4	3	13	156		
C	1	2	32	64		
D	6	1	26	156		
E	1	2	26	52		
F	3			0		
G	4	1	13	52		
H	1	4	13	52		
I	2	2	13	52		
J	3	1	75	225		

Common Corridor

Fixture Type	Number of fixtures	Number of lamps per fixture	Watts per Lamp	Watts	Area	LPD
F11	52	1	28	1456	1110	2.30
F6	26	2	13	676		
F7DE	10	1	42	420		

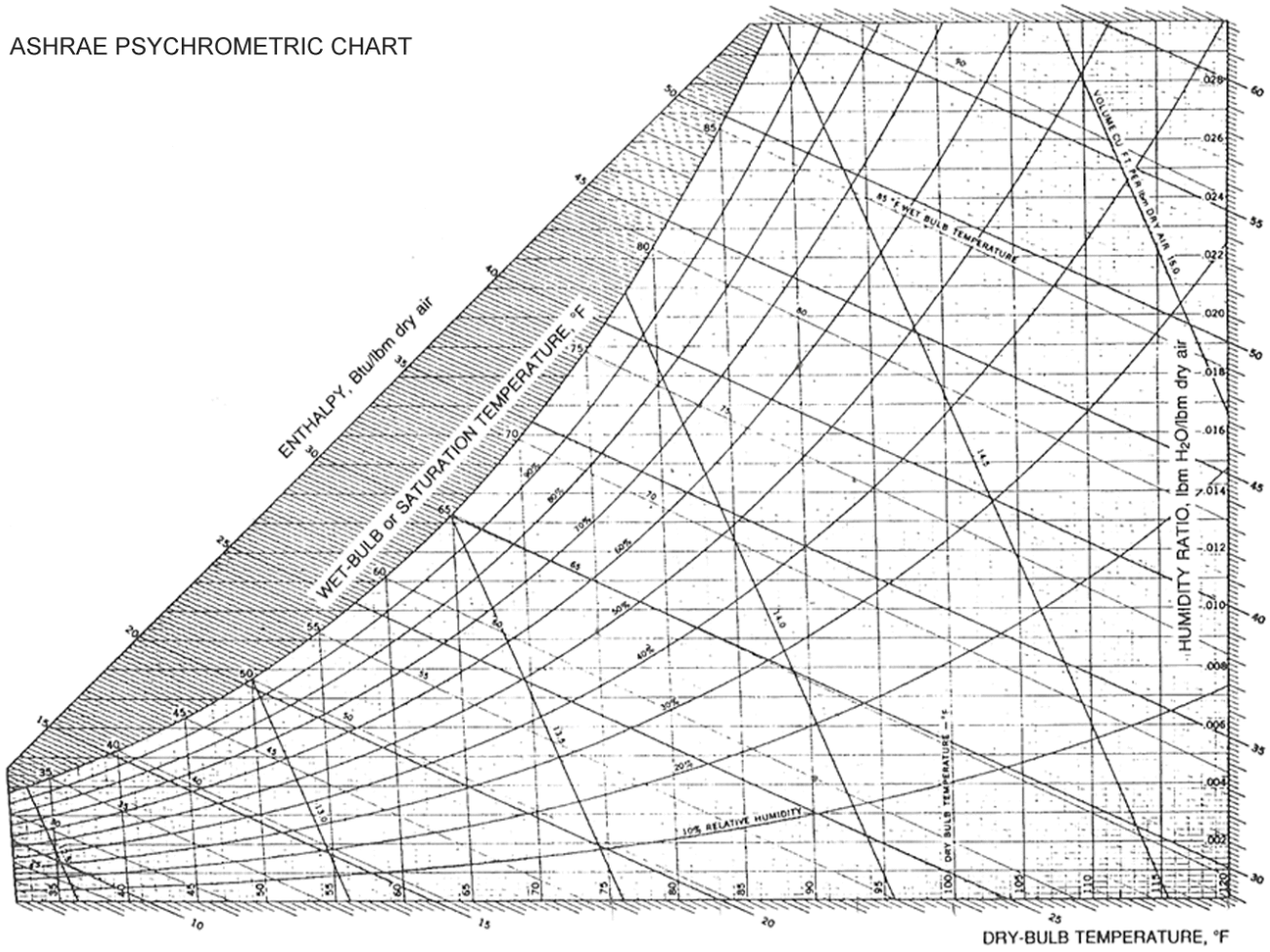
Main Entry Lobby

Fixture Type	Number of	Number of lamps per	Watts per Lamp	Watts	Area	LPD

	fixtures	fixture				
F4	22	1	32	704	375	3.52
F5	2	2	32	128		
F6	8	2	13	208		
F7	1	4	42	168		
F11	4	1	28	112		

Appendix B- References

ASHRAE PSYCHROMETRIC CHART



Air Quality Index (AQI) - A Guide to Air Quality and Your Health

The AQI is an index for reporting daily air quality. It tells you how clean or polluted your air is, and what associated health effects might be a concern for you. The AQI focuses on health effects you may experience within a few hours or days after breathing polluted air. EPA calculates the AQI for five major air pollutants regulated by the Clean Air Act: ground-level ozone, particle pollution (also known as particulate matter), carbon monoxide, sulfur dioxide, and nitrogen dioxide. For each of these pollutants, EPA has established national air quality standards to protect public health. Ground-level ozone and airborne particles are the two pollutants that pose the greatest threat to human health in this country.

How Does the AQI Work?

Think of the AQI as a yardstick that runs from 0 to 500. The higher the AQI value, the greater the level of air pollution and the greater the health concern. For example, an AQI value of 50 represents good air quality with little potential to affect public health, while an AQI value over 300 represents hazardous air quality.

An AQI value of 100 generally corresponds to the national air quality standard for the pollutant, which is the level EPA has set to protect public health. AQI values below 100 are generally thought of as satisfactory. When AQI values are above 100, air quality is considered to be unhealthy-at first for certain sensitive groups of people, then for everyone as AQI values get higher.

Publications

- Air Quality Index - A Guide to Air Quality and Your Health (PDF, 12pp., 539KB, about PDF)
- Air Quality Guide for Ozone
- Air Quality Guide for Particle Pollution
- Other AIRNow Publications
- Other AIRNow Publications - En Español
- AQI Calculator: AQI to Concentration
- AQI Calculator: Concentration to AQI
- Order any of our AIRNow publications from EPA's NSCEP

Understanding the AQI

The purpose of the AQI is to help you understand what local air quality means to your health. To make it easier to understand, the AQI is divided into six categories:

Air Quality Index (AQI) Values	Levels of Health Concern	Colors
When the AQI is in this range:	*...air quality conditions are:*	*..as symbolized by this color:*
0-50	Good	Green
51-100	Moderate	Yellow
101-150	Unhealthy for Sensitive Groups	Orange
151 to 200	Unhealthy	Red
201 to 300	Very Unhealthy	Purple
301 to 500	Hazardous	Maroon

Each category corresponds to a different level of health concern. The six levels of health concern and what they mean are:

- "Good" AQI is 0 - 50. Air quality is considered satisfactory, and air pollution poses little or no risk.
- "Moderate" AQI is 51 - 100. Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people. For example, people who are unusually sensitive to ozone may experience respiratory symptoms.
- "Unhealthy for Sensitive Groups" AQI is 101 - 150. Although general public is not likely to be affected at this AQI range, people with lung disease, older adults and children are at a greater risk from exposure to ozone, whereas persons with heart and lung disease, older adults and children are at greater risk from the presence of particles in the air. .
- "Unhealthy" AQI is 151 - 200. Everyone may begin to experience some adverse health effects, and members of the sensitive groups may experience more serious effects. .
- "Very Unhealthy" AQI is 201 - 300. This would trigger a health alert signifying that everyone may experience more serious health effects.
- "Hazardous" AQI greater than 300. This would trigger a health warnings of emergency conditions. The entire population is more likely to be affected.

AQI colors

EPA has assigned a specific color to each AQI category to make it easier for people to understand quickly whether air pollution is reaching unhealthy levels in their communities. For example, the color orange means that conditions are "unhealthy for sensitive groups," while red means that conditions may be "unhealthy for everyone," and so on.

Air Quality Index Levels of Health Concern	Numerical Value	Meaning
Good	0 to 50	Air quality is considered satisfactory, and air pollution poses little or no risk
Moderate	51 to 100	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.
Unhealthy for Sensitive Groups	101 to 150	Members of sensitive groups may experience health effects. The general public is not likely to be affected.
Unhealthy	151 to 200	Everyone may begin to experience health effects; members of sensitive groups may experience more serious health effects.
Very Unhealthy	201 to 300	Health alert: everyone may experience more serious health effects
Hazardous	301 to 500	Health warnings of emergency conditions. The entire population is more likely to be affected.

This page was last updated on Friday, September 03, 2010

QUICK LINKS

ASHRAE Table 5.5-5

TABLE 5.5-5 Building Envelope Requirements For Climate Zone 5 (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-0.119	R-7.6 c.i.
Metal Building	U-0.065	R-19.0	U-0.065	R-19.0	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-0.090	R-11.4 c.i.	U-0.080	R-13.3 c.i.	U-0.151[a]	R-5.7 c.i.[a]
Metal Building	U-0.113	R-13.0	U-0.057	R-13.0 + R-13.0	U-0.123	R-11.0
Steel-Framed	U-0.064	R-13.0 + R-7.5 c.i.	U-0.064	R-13.0 + R-7.5 c.i.	U-0.124	R-13.0
Wood-Framed and Other	U-0.064	R-13.0 + R-3.8 c.i.	U-0.051	R-13.0 + R-7.5 c.i.	U-0.089	R-13.0
Walls, Below-Grade						
Below-Grade Wall	C-0.119	R-7.5 c.i.	C-0.119	R-7.5 c.i.	C-1.140	NR
Floors						
Mass	U-0.074	R-10.4 c.i.	U-0.064	R-12.5 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-0.052	R-19.0
Wood-Framed and Other	U-0.033	R-30.0	U-0.033	R-30.0	U-0.051	R-19.0
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-0.500		U-0.700	
Nonswinging	U-0.500		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, % of Wall						
Nonmetal framing (all)[b]	U-0.35	SHGC-0.40 all	U-0.35	SHGC-0.40 all	U-1.20	SHGC-NR all
Metal framing (curtainwall/storefront)[c]	U-0.45		U-0.45		U-1.20	
Metal framing (entrance door)[c]	U-0.80		U-0.80		U-1.20	
Metal framing (all other)[c]	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}-1.17	$SHGC_{all}$-0.49	U_{all}-1.98	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.17	$SHGC_{all}$-0.39	U_{all}-1.17	$SHGC_{all}$-0.39	U_{all}-1.98	$SHGC_{all}$-NR
Skylight with Curb, Plastic, % of Roof						
0%–2.0%	U_{all}-1.10	$SHGC_{all}$-0.77	U_{all}-1.10	$SHGC_{all}$-0.77	U_{all}-1.90	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-1.10	$SHGC_{all}$-0.62	U_{all}-1.10	$SHGC_{all}$-0.62	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}-0.69	$SHGC_{all}$-0.49	U_{all}-1.36	$SHGC_{all}$-NR
2.1%–5.0%	U_{all}-0.69	$SHGC_{all}$-0.39	U_{all}-0.69	$SHGC_{all}$-0.39	U_{all}-1.36	$SHGC_{all}$-NR

*The following definitions apply: c.i. = continuous insulation (see Section 3.2), NR = no (insulation) requirement.
[a]Exception to Section A3.1.3.1 applies.
[b]Nonmetal framing includes framing materials other than metal with or without metal reinforcing or cladding.
[c]Metal framing includes metal framing with or without thermal break. The "all other" subcategory includes operable windows, fixed windows, and non-entrance doors.

Appendix C – Schedules

Lighting Fixture Schedule

Mark	Description	# Lamps per Fixture	Manufacturer	Watts/Lamp
F1	industrial fluorescent	2	Lithonia	32
F2	cfl	1	Guth	32
F3	acrylic wraparound	1	Lithonia	32
F4	recessed downlight	1	Spectrum	32
F5	2' x 4' decorative troffer	2	Finelite	32
F6	decorative wall sconce	2	Lumetta	13
F7	decorative pendant	4	Lumetta	42
F8	decorative lensed strip	1	Prudential	32
F9	lensed troffer	2	Lithonia	32
F10	parking garage fixture	2	Lithonia	54
F11	cove light	1	Lithonia	28
A	decorative surface mount	2	Lithonia	26
B	vanity light	3	Lithonia	13
C	surface fluorescent	2	Lithonia	32
D	decorative surface mount 13"	1	Lithonia	26
E	decorative surface mount 16"	2	Lithonia	26
F	under cabinet light		Lithonia	LED
G	decorative pendant	1	Lithonia	13
H	decorative pendant	4	Lithonia	13
I	decorative surface mount	2	Lithonia	13
J	exhaust fan light	1	others	75

Mechanical Equipment Schedule

Mark	Equipment	Capacity	CFM	RPM
ERU-1	Make Up Air Handling Unit	864,000 BTU/h	26,300	
A/C-100	Heat Pump	73,000 BTU/h		
A/C-103	Heat Pump	5,000 BTU/h		
A/C-223	Heat Pump	12,900 BTU/h		
A/C-227	Heat Pump	11,600 BTU/h		
A/C-1	Heat Pump	8,800 BTU/h		
A/C-2	Heat Pump	1,900 BTU/h		
A/C-3	Heat Pump	18,100 BTU/h		
A/C-4	Heat Pump	23,600 BTU/h		

A/C-5	Heat Pump	34,700 BTU/h		
HE-1	Heat Exchanger	1024 GPM		
BOILER-1	Boiler	2,000,000 BTU input		1750
BOILER-2	Boiler	2,000,000 BTU input		1750
CT	Axial Propeller Cooling Tower	350 tons		
SF-A	Supply Fan		13800	832
SF-B	Supply Fan		11,000	776
EF-B19-A	Exhaust Fan		15000	481
EF-B19-B	Exhaust Fan		15000	481
EF-114-A	Exhaust Fan		15000	481
EF-114-B	Exhaust Fan		15000	481
EF-1700-A	Exhaust Fan		4600	887
EF-1700-B	Exhaust Fan		3000	1150
EF-B20	Exhaust Fan		10000	792
EF-B21	Exhaust Fan		30000	713
EF-1600-A	Exhaust Fan		150	1300
EF-1600-B	Exhaust Fan		200	1400
SF-1600-A	Supply Fan		16000	1160
SF-1600-B	Supply Fan		31000	1170
A	Electric Heater	4800 W		
B	Electric Heater	375 W		
C	Electric Heater	4800 W		
D	Electric Heater	5000 W		
E	Electric Heater	15, 000 W		
F	Electric Heater	18,700 W		
G	Electric Heater	2,500 W		
H	Electric Heater	5,000 W		
CWP-1	Condesing Water Pump	1024 GPM		1750
CWP-2	Condesing Water Pump	1024 GPM		1750
LWP-1	Loop Water Pump	1030 GPM		1750
LWP-2	Loop Water Pump	1030 GPM		1750
AS-1	Air Separator	1030 GPM		

References

- ASHRAE, 2007, ANSI/ASHRAE, Standard 62.1-2007, Ventilation for Acceptable Indoor Air Quality. American Society of Heating Refrigeration and Air Conditioning Engineers, Inc. Atlanta, GA.
- ASHRAE 2007, ANSI/ASHRAE, Standard 90.1-2007, Energy Standard for Building Except Low Rise Residential Buildings. American Society of Heating Refrigeration and Air-Conditioning Engineers, Inc. Atlanta, GA.
- River Vue Apartments Contract Drawings and Specifications
- Environmental Protection Agency's website www.epa.gov.

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