



Energy Analysis Report

Project:

1601 Fairfax Drive

Prepared by:

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Submitted for:

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Project Location:

**1601 Fairfax Drive
Arlington, VA 22209**

Engineer:

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Executive Summary



Figure 1: 1601 Fairfax Drive, Perspective View

The project in consideration is the construction of a multifamily building at 1601 Fairfax Drive in Arlington, VA. The building will consist of eight (8) stories with approximately 144 living units along with (2) levels of underground parking garage. The sizes of the living units range from 506 sq.ft. to 1,157 sq.ft. The purpose of this report is to provide an energy analysis comparing four HVAC alternatives:

- Manifold Variable Refrigerant Flow (VRF) System with Heat Recovery
- One-to-one VRF Heat Pump System
- Split System Heat Pumps
- ASHRAE 90.1-2010 Baseline System – Packaged Rooftop Heat Pumps (PTHPs)

For the first three alternatives, dedicated outdoor air system (DOAS) units will provide the building with room-neutral air to the living units.

The manifold VRF system with heat recovery is estimated to save 455,179 kWh in annual energy consumption over the ASHRAE 90.1-2010 Baseline System.

The one-to-one VRF heat pump system is estimated to save 419,893 kWh in annual energy consumption over the ASHRAE 90.1-2010 Baseline System.

The split system heat pump system is estimated to save 312,665 kWh in annual energy consumption over the ASHRAE 90.1-2010 Baseline System.

Scope of Work

The 1601 Fairfax Drive is a new construction of a multifamily building. The purpose of this report is to provide an energy analysis comparing four HVAC alternatives:

- Manifold Variable Refrigerant Flow (VRF) System with Heat Recovery
- One-to-one VRF Heat Pump System
- Split System Heat Pumps
- ASHRAE 90.1-2010 Baseline System – Packaged Rooftop Heat Pumps (PTHPs)

For the first three alternatives, dedicated outdoor air system (DOAS) units will provide the building with room-neutral air directly to the living units.

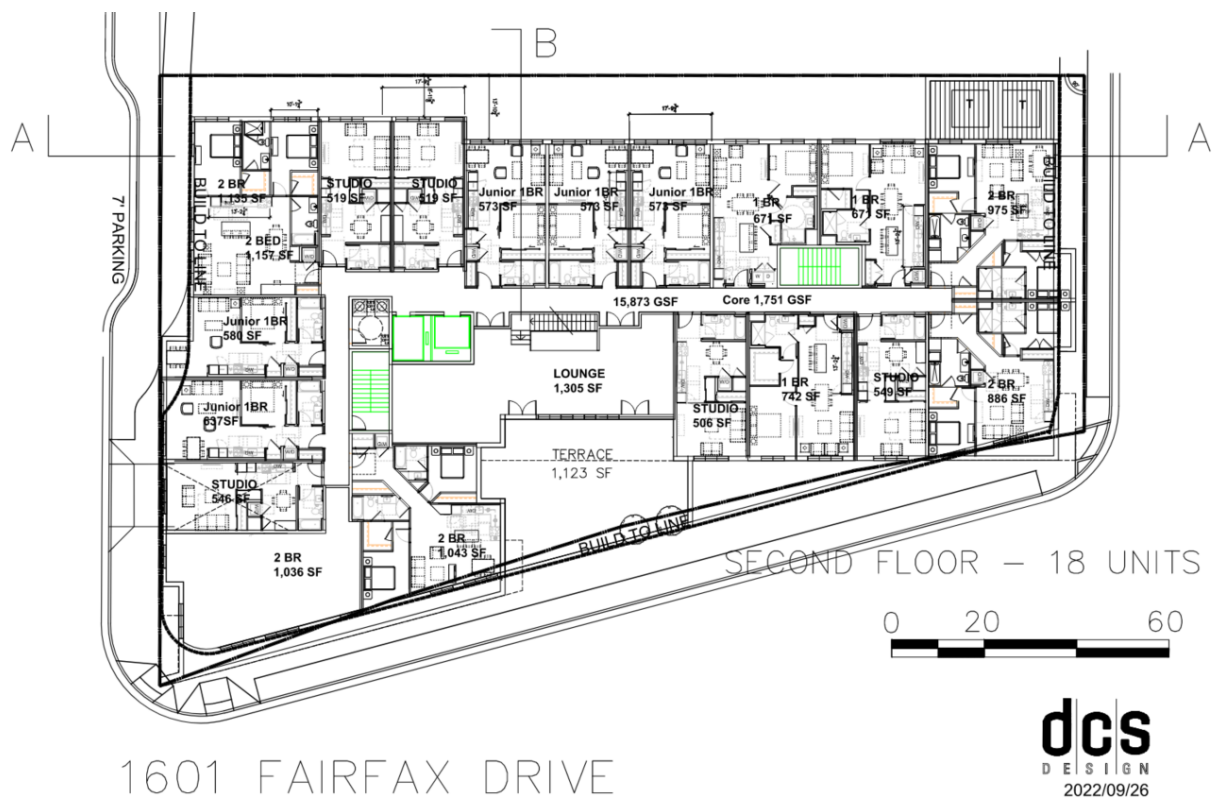


Figure 2: 1601 Fairfax Drive, Preliminary Drawings

The energy analysis will be conducted using TRACE 700, an ASHRAE Std. 140 approved energy modelling software. Weather data derived from Reagan National AP, VA was entered into the model. The rooms and HVAC systems were created in the model based on the preliminary building drawings provided (see Figure 2). Equipment efficiencies were derived from Engineering Data documents published by Daikin, LG, Trane, and Lync.

Variable Refrigerant Flow Systems

Each of the proposed alternatives being observed are variable refrigerant flow (VRF) systems. VRF systems are split direct expansion systems. The manifold VRF system consists of one condensing unit that is piped into several indoor units. This design includes heat recovery, with branch selector boxes. Heat recovery allows for rejection heat from one indoor unit in cooling mode to be used to heat another indoor unit. This function increases energy efficiency. The one-to-one VRF system consists of heat pumps with one condensing unit for every indoor unit. The indoor units that are piped in must all be either in heating or cooling mode.

Model Details

Building Details

The rooms created in the energy model are based on the floor plans provided (see figure 2). Weather data from Reagan National Airport was used to model ambient conditions over the 8760 hours of the year.

The HVAC equipment efficiencies are based on a combination of preliminary cut sheets provided for each of the proposed equipment and typical observed equipment efficiency values.

1601 Fairfax Drive: HVAC Systems

For the manifold VRF system the indoor units on each floor are all piped into a single condensing unit. This provides the maximum potential for heat recovery as rooms on each side of the building will have varying load profiles throughout the day. For the one-to-one VRF heat pump system and the regular split system heat pumps each indoor unit is piped to a single condensing unit.

The dedicated outdoor air systems consist of rooftop heat pumps that will condition outdoor air via direct expansion (DX) cooling, hot gas reheat, and heat pump heating. This dedicated outdoor air unit does not contain an energy recovery wheel. A separate rooftop air conditioning unit will serve the corridors. This unit provides conditioned air via DX cooling and electric heating. This unit includes an economizer and is responsible for bringing outside air into the corridors.

Model Summary

Item	Baseline-ASHRAE 90.1-2010 App G	VRF Heat Recovery (Manifold) w/ DOAS	VRF Heat Pump (1:1) w/ DOAS	SSHP w/ DOAS
Weather Data	Full-year weather. Washington DC	Identical with Baseline	Identical with Baseline	Identical with Baseline
Interior Lighting	Whole Building Method 90.1-2010 Multifamily 0.6 W/sqft Parking 0.25 W/sqft	LPD Reduction Multifamily 0.6 W/sqft Common Areas 0.3 W/sqft Parking 0.125 W/sqft	LPD Reduction Multifamily 0.6 W/sqft Common Areas 0.3 W/sqft Parking 0.125 W/sqft	LPD Reduction Multifamily 0.6 W/sqft Common Areas 0.3 W/sqft Parking 0.125 W/sqft
Roof	90.1-10 Roof Zone 4. Assembly U-0.048	R-30 above deck; Assembly U-0.032	Assembly U-0.032	Assembly U-0.032
Wall	90.1-10 Wall Zone 4. Residential Assembly U-0.064.	R-13 + R-7.5c.i.; Assembly U-0.064	Assembly U-0.064	Assembly U-0.064
Window	Floors 1-2, 90.1-10 metal Framing, Zone 4, U-0.5, SHGC 0.4 Floors 3-8, 90.1-10 nonmetal Framing, Zone 4, U-0.4, SHGC 0.4	Floors 1-2 (Aluminum) Assembly U-0.36, SHGC - 0.32 Floors 3-8 (Vinyl) Assembly U-0.29, SHGC - 0.23	Floors 1-2 Assembly U-0.36, SHGC - 0.32 Floors 3-8 Assembly U-0.29, SHGC - 0.23	Floors 1-2 Assembly U-0.36, SHGC - 0.32 Floors 3-8 Assembly U-0.29, SHGC - 0.23
Window-Wall Ratio	34.00%	34.00%	34.00%	34.00%
Air Side System	ASHRAE Baseline Sys 2 (PTHP)	VRF Heat Recovery System w/ DOAS RTU serving Corridors	VRF Heat Pump System w/ DOAS RTU serving Corridors	Split System Heat Pump w/ DOAS RTU serving Corridors
Fans	Sys 2 CV; Fan Power: 0.0003 kW/cfm Garage Ventilation VV: 2 kW	VRF VV; Fan Power: 0.000413 kW/cfm DOAS VV; Fan Power: 2.8 kW RTU (corridors) VV; Fan Power: 1.05 kW Garage Ventilation VV: 2 kW	VRF VV; Fan Power: 0.000413 kW/cfm DOAS VV; Fan Power: 2.8 kW RTU (corridors) VV; Fan Power: 1.05 kW Garage Ventilation VV: 2 kW	SSHP fan w/ ECM; Fan Power: 0.000413 kW/cfm DOAS VV; Fan Power: 2.8 kW RTU (corridors) VV; Fan Power: 1.05 kW Garage Ventilation VV: 2 kW
Cooling/ Heating Plant	Sys 2 (12MBH) 10.4 EER and 3.1 COP	VRF HR 11.5 EER and 3.5 COP DOAS ACHP 584 MBH 10.2 EER, 3.6 COP RTU (corridor) 88.6 MBH 11.2 EER, Elec Heat	VRF HP 12 EER and 3.2 COP DOAS ACHP 584 MBH 10.2 EER, 3.6 COP RTU (corridor) 88.6 MBH 11.2 EER, Elec Heat	SSHP 15 SEER and 8.5 HSPF DOAS ACHP 584 MBH 10.2 EER, 3.6 COP RTU (corridor) 88.6 MBH 11.2 EER, Elec Heat
Hot Water	Elec Res Water Heater: 1 COP 3.16 GPM Pump CV: 2 HP	HP Water Heater: 3 COP 2.42 GPM Pump CV: 2 HP	HP Water Heater: 3 COP 2.42 GPM Pump CV: 2 HP	Elec Res Water Heater: 1 COP 2.42 GPM Pump CV: 2 HP
Plug Loads	1.32 W/sf	1.21 W/sf	1.21 W/sf	1.21 W/sf
Utility Rate	June 2022 EIA VA Rates Electricity: \$0.089/kWh Natural Gas: \$1.16/therm	Identical with Baseline	Identical with Baseline	Identical with Baseline

- 1) All systems are auto sized based on the energy model
- 2) VRF Fan Power is based on average data
- 3) Note: Alternative 4 (Regular SSHPs) includes electric resistance DHW w/ COP of 1

Energy Savings

Modeled energy savings compared to the baseline ASHRAE 90.1-2010 Appendix G alternative are based on the following measures:

- Lower building lighting power density (parking garage and common spaces only)
- Improved building envelope and glazing
- Variable Volume Fans (EC motors)
- Higher cooling and heating equipment efficiencies
- Higher DHW efficiency
- Hot water usage reduction from low flow fixtures
- Plug load reduction from energy star appliances

Solar

Assumptions:

- Roof Area of 16,382 (Based on drawings provided)
- Power output of 2 W/sq.ft.
- Energy output of 1300 kWh/kW (Estimated using PV sol based on project location)

Based on the assumptions above the estimated energy output from installing PV solar panels on the rooftop would be approximately 42,593 kWh.

Conclusion

Based on the results from the energy model, all 3 alternatives (manifold VRF, one-to-one VRF, and SSHP) will provide greater than 28% energy consumptions savings when compared to the baseline ASHRAE 90.1-2010 system. This conclusion includes solar and is based on the following:

The manifold VRF system with heat recovery is estimated to save 36.40% in annual energy consumption (39.80% including solar) over the ASHRAE 90.1-2010 Baseline System.

The one-to-one VRF heat pump system is estimated to save 33.58% in annual energy consumption (36.98% including solar) over the ASHRAE 90.1-2010 Baseline System.

The regular SSHPs are estimated to save 25.00% in annual energy consumption (28.41% including solar) over the ASHRAE 90.1-2010 Baseline System.

Trace Reports

Energy Cost Budget / PRM Summary

By Spectrum Energy, LLC

Project Name:	Date: January 10, 2023
City:	Weather Data: Reagan_AP_VA_TMY3

Note: The percentage displayed for the "Proposed/ Base %" column of the base case is actually the percentage of the total energy consumption.

* Denotes the base alternative for the ECB study.

		* Alt-1 Proposed - Manifold VRF			Alt-2 Proposed - VRF Heat Pump			Alt-3 Baseline ASHRAE 90_1 201			Alt-4 Proposed - SSHP and Elec		
		Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW	Energy 10 ³ kWh/yr	Proposed / Base %	Peak kW
Lighting - Conditioned	Electricity	90.4	11.4	21	90.4	100.0	21	126.9	140.4	29	90.4	100.0	21
Lighting - Unconditioned	Electricity	17.9	2.3	4	17.9	100.0	4	35.8	200.0	7	17.9	100.0	4
Space Heating	Electricity	125.7	15.8	202	130.6	103.9	216	178.1	141.7	446	171.2	136.2	386
Space Cooling	Electricity	130.9	16.5	94	161.3	123.2	104	223.4	170.7	189	192.9	147.3	122
Pumps	Electricity	17.4	2.2	2	17.4	100.0	2	17.4	100.0	2	17.4	100.0	2
Heat Rejection	Electricity	8.3	1.0	4	8.3	100.1	4	21.9	263.3	16	21.9	262.8	13
Fans - Conditioned	Electricity	39.1	4.9	16	39.1	100.0	16	256.9	657.2	31	60.6	155.1	13
Receptacles - Conditioned	Electricity	320.9	40.3	74	320.9	100.0	74	345.4	107.6	80	320.9	100.0	74
Stand-alone Base Utilities	Electricity	44.7	5.6	8	44.7	100.0	8	44.7	100.0	8	44.7	100.0	8
Total Building Consumption		795.4			830.7			1,250.6			937.9		

		* Alt-1 Proposed - Manifold VRF			Alt-2 Proposed - VRF Heat Pum			Alt-3 Baseline ASHRAE 90_1 201			Alt-4 Proposed - SSHP and Elec		
Total	Number of hours heating load not met	3			3			0			3		
	Number of hours cooling load not met	6			6			16			5		

		* Alt-1 Proposed - Manifold VRF		Alt-2 Proposed - VRF Heat Pum		Alt-3 Baseline ASHRAE 90_1 201		Alt-4 Proposed - SSHP and Elec	
		Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr	Energy 10 ³ kWh/yr	Cost/yr \$/yr
Electricity		795.4	80,975	830.7	84,698	1,250.6	127,965	937.9	95,869
Total		795	80,975	831	84,698	1,251	127,965	938	95,869

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 1 Proposed - Manifold VRF HR

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	9,205.0	8,314.0	9,190.6	8,910.4	9,197.8	8,896.0	9,212.2	9,190.6	8,910.4	9,197.8	8,903.2	9,212.2	108,340.2
Peak (kW)	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
Misc. Ld													
Electric (kWh)	27,260.3	24,622.0	27,246.7	26,383.1	27,253.5	26,369.5	27,267.1	27,246.7	26,383.1	27,253.5	26,376.3	27,267.0	320,928.7
Peak (kW)	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.8	0.6	0.8	2.5	7.3	15.8	19.6	16.9	13.0	5.7	1.5	1.1	85.6
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Bsu 1: Exterior Lighting													
Electric (kWh)	208.3	188.2	208.3	201.6	208.3	201.6	208.3	208.3	201.6	208.3	201.6	208.3	2,452.8
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bsu 2: Elevator													
Electric (kWh)	2,999.3	2,709.0	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	35,313.8
Peak (kW)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Bsu 3: Parking Garage EF													
Electric (kWh)	589.0	532.0	589.0	570.0	589.0	570.0	589.0	589.0	570.0	589.0	570.0	589.0	6,935.0
Peak (kW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Bsu 4: DHW Load (GPM)													
Proc. Hot Water (therms)	176.1	159.0	176.1	170.4	176.1	170.4	176.1	176.1	170.4	176.1	170.4	176.1	2,073.0
Peak (therms/Hr)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cpl 1: Cooling plant - VRV [Sum of dsn coil capacities=100.5 tons]													
VRV HR [Clg Nominal Capacity/F.L.Rate=100.5 tons / 76.01 kW] [**Orig F.L.Rate=104.9 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	1,649.1	1,404.3	1,714.3	3,172.2	4,850.1	8,783.6	12,139.8	10,460.9	5,226.5	3,514.3	1,520.7	1,467.2	55,902.9
Peak (kW)	19.1	19.1	12.5	28.1	41.4	38.0	45.3	45.3	25.9	22.5	13.2	12.4	45.3
VRV HR [Htg Nominal Capacity/F.L.Rate=1,356 mbh / 84.72 kW] [**Orig F.L.Rate=113.6 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	7,747.6	7,353.3	4,355.5	620.8	77.8	0.0	0.0	0.0	77.8	445.3	2,854.1	4,278.0	27,810.1
Peak (kW)	33.0	37.8	29.0	16.5	13.9	0.0	0.0	0.0	12.2	15.1	22.5	22.5	37.8

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 1 Proposed - Manifold VRF HR

Equipment - Utility	----- Monthly Consumption -----												Total
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Cpl 1: Cooling plant - VRV [Sum of dsn coil capacities=100.5 tons]													
VRV HR (Cooling Equipment - Heat Recovered From Condenser Loop)													
Energy Recovered (therms)	93.4	75.2	30.2	0.9	0.0	0.0	0.0	0.0	0.6	0.7	28.6	46.1	275.7
Peak (therms/Hr)	0.8	0.9	0.8	0.2	0.0	0.0	0.0	0.0	0.1	0.1	0.8	0.8	0.9
Heat pump defrost cycle [F.L.Rate=32.16 kW] (Misc Accessory Equipment)													
Electric (kWh)	827.7	784.0	545.9	41.8	0.0	0.0	0.0	0.0	0.0	22.5	278.2	529.1	3,029.2
Peak (kW)	1.6	1.6	1.6	1.6	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6
Cpl 2: Cooling plant - DOAS [Sum of dsn coil capacities=39.62 tons]													
DOAS [Clg Nominal Capacity/F.L.Rate=48.71 tons / 50.95 kW] [**Orig F.L.Rate=57.31 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	51.8	0.0	84.5	1,543.3	5,484.2	12,934.3	17,389.2	15,112.6	8,837.8	3,461.1	546.5	214.9	65,660.1
Peak (kW)	21.9	0.0	21.9	25.7	38.3	38.1	41.8	40.6	35.5	30.3	21.9	21.9	41.8
DOAS [Htg Nominal Capacity/F.L.Rate=411.5 mbh / 27.14 kW] [**Orig F.L.Rate=33.50 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	8,891.0	8,477.5	7,782.7	3,427.6	1,620.9	100.4	10.6	23.5	960.0	2,467.7	6,926.0	8,567.0	49,254.9
Peak (kW)	20.8	20.8	20.8	14.9	9.8	3.9	1.7	2.5	9.2	14.9	20.8	20.8	20.8
DOAS (Cooling Equipment - Heat Recovered From Condenser Loop)													
Energy Recovered (therms)	12.1	0.0	19.2	272.7	812.2	1,432.5	1,582.4	1,569.1	1,136.1	666.6	104.8	47.9	7,655.7
Peak (therms/Hr)	2.6	0.0	2.5	2.7	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=64.21 tons / 3.55 kW]													
Electric (kWh)	1,034.2	980.9	945.6	481.9	339.6	381.4	628.1	455.6	380.4	377.9	880.8	1,048.6	7,935.0
Peak (kW)	2.3	2.3	2.3	1.8	3.6	1.4	3.6	3.6	1.9	1.8	2.3	2.3	3.6
Cntl panel & interlocks - 0.1 kW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	70.4	65.1	73.7	68.9	71.5	67.2	72.3	70.7	69.8	71.4	72.0	74.4	847.4
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cpl 3: Cooling plant - RTU corridor [Sum of dsn coil capacities=5.76 tons]													
RTU cool [Clg Nominal Capacity/F.L.Rate=7.38 tons / 6.34 kW] [**Orig F.L.Rate=7.91 kW] (Cooling Equipment)													
Electric (kWh)	13.7	0.7	23.4	202.6	435.1	1,020.9	1,398.9	1,199.7	637.9	291.9	32.3	20.2	5,277.2
Peak (kW)	1.9	1.5	1.9	2.9	4.1	3.9	5.4	5.3	4.0	2.7	1.9	1.8	5.4
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=9.33 tons / 0.52 kW]													
Electric (kWh)	1.1	0.1	1.9	14.5	31.8	71.6	100.4	83.5	47.9	21.9	2.6	1.7	378.8
Peak (kW)	0.1	0.0	0.1	0.2	0.5	0.3	0.5	0.5	0.3	0.2	0.1	0.1	0.5

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 1 Proposed - Manifold VRF HR

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cpl 3: Cooling plant - RTU corridor [Sum of dsn coil capacities=5.76 tons]													
Cntl panel & interlocks - 0.05 KW [F.L.Rate=0.05 kW] (Misc Accessory Equipment)													
Electric (kWh)	2.5	0.3	5.8	16.7	23.4	26.5	27.3	27.4	23.6	21.5	3.9	3.5	182.1
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hpl 1: Heating plant - VRV [Sum of dsn coil capacities=1,412 mbh]													
Hpl 2: Heating plant - DHW [Sum of dsn coil capacities=84.77 mbh]													
HP Water Heater [Nominal Capacity/F.L.Rate=84.77 mbh / 8.28 kW] (Heating Equipment)													
Electric (kWh)	1,719.5	1,553.1	1,719.5	1,664.1	1,719.5	1,664.1	1,719.5	1,719.5	1,664.1	1,719.5	1,664.1	1,719.5	20,246.0
Peak (kW)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Heating water circ pump [F.L.Rate=1.99 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,479.5	1,336.3	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	17,419.5
Peak (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Hpl 3: Heating plant - No heat [Sum of dsn coil capacities=0 mbh]													
Hpl 4: Heating plant - DOAS [Sum of dsn coil capacities=400.4 mbh]													
DOAS Heat [Nominal Capacity/F.L.Rate=400.4 mbh / 117.3 kW] (Heating Equipment)													
Electric (kWh)	11,566.2	11,670.7	4,419.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.3	176.8	27,947.7
Peak (kW)	117.3	117.3	96.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.6	22.2	117.3
Hpl 5: Heating plant - RTU corridor [Sum of dsn coil capacities=76.69 mbh]													
RTU heat [Nominal Capacity/F.L.Rate=76.69 mbh / 22.47 kW] (Heating Equipment)													
Electric (kWh)	185.8	169.8	59.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	31.6	456.8
Peak (kW)	21.5	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	21.5
Sys 1: VRF													
Daikin VRV IV ECM Motor [DsnAirflow/F.L.Rate=62,872 cfm / 28.86 kW] (Main Clg Fan)													
Electric (kWh)	778.3	711.8	802.6	1,188.5	1,370.4	2,116.1	2,562.1	2,447.0	1,596.4	1,330.3	707.3	726.0	16,336.8
Peak (kW)	4.3	3.5	4.7	11.4	11.2	10.2	12.0	12.0	11.8	10.0	5.7	3.2	12.0
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=6,594 cfm / 2.80 kW] (Opt. Ventilation Fan)													
Electric (kWh)	1,794.0	1,620.5	1,797.1	1,735.7	1,795.6	1,738.7	1,792.5	1,797.1	1,735.7	1,795.6	1,737.2	1,792.5	21,132.1
Peak (kW)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8

Sys 3: RTU Corridor

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 1 Proposed - Manifold VRF HR

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Sys 3: RTU Corridor													
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=924.4 cfm / 1.05 kW] (Main Clg Fan)													
Electric (kWh)	100.1	89.8	93.8	126.0	139.9	175.3	208.4	191.4	146.1	134.3	103.7	106.6	1,615.2
Peak (kW)	0.9	0.3	0.3	0.5	0.6	0.6	1.1	1.1	0.6	0.5	0.3	0.3	1.1

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 2 Proposed - VRF Heat Pump 1:1

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	9,205.0	8,314.0	9,190.6	8,910.4	9,197.8	8,896.0	9,212.2	9,190.6	8,910.4	9,197.8	8,903.2	9,212.2	108,340.2
Peak (kW)	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
Misc. Ld													
Electric (kWh)	27,260.3	24,622.0	27,246.7	26,383.1	27,253.5	26,369.5	27,267.1	27,246.7	26,383.1	27,253.5	26,376.3	27,267.0	320,928.7
Peak (kW)	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.8	0.6	0.8	2.5	7.3	15.8	19.6	16.9	13.0	5.7	1.5	1.1	85.6
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Bsu 1: Exterior Lighting													
Electric (kWh)	208.3	188.2	208.3	201.6	208.3	201.6	208.3	208.3	201.6	208.3	201.6	208.3	2,452.8
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bsu 2: Elevator													
Electric (kWh)	2,999.3	2,709.0	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	35,313.8
Peak (kW)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Bsu 3: Parking Garage EF													
Electric (kWh)	589.0	532.0	589.0	570.0	589.0	570.0	589.0	589.0	570.0	589.0	570.0	589.0	6,935.0
Peak (kW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Bsu 4: DHW Load (GPM)													
Proc. Hot Water (therms)	176.1	159.0	176.1	170.4	176.1	170.4	176.1	176.1	170.4	176.1	170.4	176.1	2,073.0
Peak (therms/Hr)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cpl 1: Cooling plant - VRV [Sum of dsn coil capacities=100.5 tons]													
VRV HR [Clg Nominal Capacity/F.L.Rate=100.5 tons / 71.64 kW] [**Orig F.L.Rate=100.5 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	1,476.6	1,247.6	2,279.5	5,616.6	7,858.8	14,178.1	17,033.0	15,664.4	9,613.2	6,760.5	2,203.1	1,871.4	85,802.8
Peak (kW)	27.3	19.7	23.1	45.4	52.1	49.0	55.0	53.9	45.1	43.4	32.8	20.5	55.0
VRV HR [Htg Nominal Capacity/F.L.Rate=1,356 mbh / 124.2 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	9,169.1	8,537.5	4,957.5	716.9	92.9	0.0	0.0	0.0	101.0	515.1	3,458.9	5,117.6	32,666.3
Peak (kW)	43.6	52.1	36.5	18.5	15.3	0.0	0.0	0.0	15.3	17.2	26.6	26.7	52.1

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 2 Proposed - VRF Heat Pump 1:1

Equipment - Utility	----- Monthly Consumption -----												Total
	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Cpl 1: Cooling plant - VRV [Sum of dsn coil capacities=100.5 tons]													
Heat pump defrost cycle [F.L.Rate=32.16 kW] (Misc Accessory Equipment)													
Electric (kWh)	827.7	784.0	545.9	41.8	0.0	0.0	0.0	0.0	0.0	22.5	278.2	529.1	3,029.2
Peak (kW)	1.6	1.6	1.6	1.6	0.0	0.0	0.0	0.0	0.0	1.6	1.6	1.6	1.6
Cpl 2: Cooling plant - DOAS [Sum of dsn coil capacities=39.62 tons]													
DOAS [Clg Nominal Capacity/F.L.Rate=48.71 tons / 50.95 kW] [**Orig F.L.Rate=57.31 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	51.8	0.0	84.5	1,543.3	5,484.2	12,934.3	17,389.2	15,112.6	8,837.8	3,461.1	546.5	214.9	65,660.1
Peak (kW)	21.9	0.0	21.9	25.7	38.3	38.1	41.8	40.6	35.5	30.3	21.9	21.9	41.8
DOAS [Htg Nominal Capacity/F.L.Rate=411.5 mbh / 27.14 kW] [**Orig F.L.Rate=33.50 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	8,891.0	8,477.5	7,782.7	3,427.6	1,620.9	100.4	10.6	23.5	960.0	2,467.7	6,926.0	8,567.0	49,254.9
Peak (kW)	20.8	20.8	20.8	14.9	9.8	3.9	1.7	2.5	9.2	14.9	20.8	20.8	20.8
DOAS (Cooling Equipment - Heat Recovered From Condenser Loop)													
Energy Recovered (therms)	12.1	0.0	19.2	272.7	812.2	1,432.5	1,582.4	1,569.1	1,136.1	666.6	104.8	47.9	7,655.7
Peak (therms/Hr)	2.6	0.0	2.5	2.7	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=64.21 tons / 3.55 kW]													
Electric (kWh)	1,034.2	980.9	945.6	481.9	339.6	381.4	628.1	455.6	380.4	377.9	880.8	1,048.6	7,935.0
Peak (kW)	2.3	2.3	2.3	1.8	3.6	1.4	3.6	3.6	1.9	1.8	2.3	2.3	3.6
Cntl panel & interlocks - 0.1 KW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	70.4	65.1	73.7	68.9	71.5	67.2	72.3	70.7	69.8	71.4	72.0	74.4	847.4
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cpl 3: Cooling plant - RTU corridor [Sum of dsn coil capacities=5.76 tons]													
RTU cool [Clg Nominal Capacity/F.L.Rate=7.38 tons / 6.34 kW] [**Orig F.L.Rate=7.91 kW] (Cooling Equipment)													
Electric (kWh)	17.4	0.9	30.2	236.4	494.3	1,112.4	1,476.7	1,287.1	727.4	349.6	40.5	25.8	5,798.6
Peak (kW)	2.2	1.9	2.2	3.0	4.1	4.0	5.3	5.3	4.2	2.9	2.2	2.2	5.3
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=9.33 tons / 0.52 kW]													
Electric (kWh)	1.2	0.1	2.1	15.1	32.7	73.0	101.6	84.9	49.3	22.8	2.7	1.7	387.0
Peak (kW)	0.1	0.0	0.1	0.2	0.5	0.3	0.5	0.5	0.3	0.2	0.1	0.1	0.5
Cntl panel & interlocks - 0.05 KW [F.L.Rate=0.05 kW] (Misc Accessory Equipment)													
Electric (kWh)	2.5	0.3	5.8	16.7	23.4	26.5	27.3	27.4	23.6	21.5	3.9	3.5	182.1
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 2 Proposed - VRF Heat Pump 1:1

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<u>Hpl 1: Heating plant - VRV [Sum of dsn coil capacities=1,412 mbh]</u>													
<u>Hpl 2: Heating plant - DHW [Sum of dsn coil capacities=84.77 mbh]</u>													
HP Water Heater [Nominal Capacity/F.L.Rate=84.77 mbh / 8.28 kW] (Heating Equipment)													
Electric (kWh)	1,719.5	1,553.1	1,719.5	1,664.1	1,719.5	1,664.1	1,719.5	1,719.5	1,664.1	1,719.5	1,664.1	1,719.5	20,246.0
Peak (kW)	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1	4.1
Heating water circ pump [F.L.Rate=1.99 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,479.5	1,336.3	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	17,419.5
Peak (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
<u>Hpl 3: Heating plant - No heat [Sum of dsn coil capacities=0 mbh]</u>													
<u>Hpl 4: Heating plant - DOAS [Sum of dsn coil capacities=400.4 mbh]</u>													
DOAS Heat [Nominal Capacity/F.L.Rate=400.4 mbh / 117.3 kW] (Heating Equipment)													
Electric (kWh)	11,566.2	11,670.7	4,419.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.3	176.8	27,947.7
Peak (kW)	117.3	117.3	96.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.6	22.2	117.3
<u>Hpl 5: Heating plant - RTU corridor [Sum of dsn coil capacities=76.69 mbh]</u>													
RTU heat [Nominal Capacity/F.L.Rate=76.69 mbh / 22.47 kW] (Heating Equipment)													
Electric (kWh)	185.8	169.8	59.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	31.6	456.8
Peak (kW)	21.5	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	21.5
<u>Sys 1: VRF</u>													
Daikin VRV IV ECM Motor [DsnAirflow/F.L.Rate=62,872 cfm / 28.86 kW] (Main Clg Fan)													
Electric (kWh)	778.3	711.8	802.6	1,188.5	1,370.4	2,116.1	2,562.1	2,447.0	1,596.4	1,330.3	707.3	726.0	16,336.8
Peak (kW)	4.3	3.5	4.7	11.4	11.2	10.2	12.0	12.0	11.8	10.0	5.7	3.2	12.0
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=6,594 cfm / 2.80 kW] (Opt. Ventilation Fan)													
Electric (kWh)	1,794.0	1,620.5	1,797.1	1,735.7	1,795.6	1,738.7	1,792.5	1,797.1	1,735.7	1,795.6	1,737.2	1,792.5	21,132.1
Peak (kW)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
<u>Sys 3: RTU Corridor</u>													
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=924.4 cfm / 1.05 kW] (Main Clg Fan)													
Electric (kWh)	100.1	89.8	93.8	126.0	139.9	175.3	208.4	191.4	146.1	134.3	103.7	106.6	1,615.2
Peak (kW)	0.9	0.3	0.3	0.5	0.6	0.6	1.1	1.1	0.6	0.5	0.3	0.3	1.1

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 3 Baseline ASHRAE 90_1 2010

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	13,830.4	12,491.5	13,801.7	13,388.9	13,816.0	13,360.1	13,844.7	13,801.7	13,388.9	13,816.0	13,374.5	13,844.7	162,759.0
Peak (kW)	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8	35.8
Misc. Ld													
Electric (kWh)	29,341.4	26,501.7	29,327.8	28,397.1	29,334.6	28,383.5	29,348.2	29,327.8	28,397.1	29,334.6	28,390.3	29,348.2	345,432.0
Peak (kW)	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.7	0.6	0.7	1.4	3.8	9.9	13.3	11.1	7.5	2.7	0.8	0.8	53.2
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Bsu 1: Exterior Lighting													
Electric (kWh)	208.3	188.2	208.3	201.6	208.3	201.6	208.3	208.3	201.6	208.3	201.6	208.3	2,452.8
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bsu 2: Elevator													
Electric (kWh)	2,999.3	2,709.0	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	35,313.8
Peak (kW)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Bsu 3: Parking Garage EF													
Electric (kWh)	589.0	532.0	589.0	570.0	589.0	570.0	589.0	589.0	570.0	589.0	570.0	589.0	6,935.0
Peak (kW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Bsu 4: DHW Load (GPM)													
Proc. Hot Water (therms)	229.9	207.7	229.9	222.5	229.9	222.5	229.9	229.9	222.5	229.9	222.5	229.9	2,706.9
Peak (therms/Hr)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Cpl 1: Cooling plant - PTHP [Sum of dsn coil capacities=227.8 tons]													
PTHP cool [Clg Nominal Capacity/F.L.Rate=227.8 tons / 215.7 kW] [**Orig F.L.Rate=262.9 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	3,256.5	3,017.3	6,245.6	14,336.6	19,314.5	36,956.4	46,496.0	41,956.2	24,906.8	16,278.4	5,200.7	4,604.3	222,569.2
Peak (kW)	70.1	55.6	70.4	128.6	165.4	152.1	188.4	176.9	162.4	129.3	79.8	52.8	188.4
PTHP cool [Htg Nominal Capacity/F.L.Rate=3,280 mbh / 262.9 kW] [**Orig F.L.Rate=310.1 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	17,304.1	16,142.8	11,814.1	2,499.4	586.9	0.0	0.0	0.0	443.5	1,871.0	9,122.5	12,907.4	72,691.7
Peak (kW)	81.7	85.8	81.0	43.3	22.7	0.0	0.0	0.0	18.8	39.8	69.9	66.9	85.8

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 3 Baseline ASHRAE 90_1 2010

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cpl 1: Cooling plant - PTHP [Sum of dsn coil capacities=227.8 tons]													
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=293.8 tons / 16.25 kW]													
Electric (kWh)	1,095.9	1,015.7	1,114.3	1,368.7	1,653.2	2,950.9	3,743.8	3,340.9	2,094.8	1,507.6	945.3	1,060.0	21,891.0
Peak (kW)	6.0	5.0	6.0	9.9	16.3	12.0	16.3	16.3	12.9	10.5	6.7	4.6	16.3
Cntl panel & interlocks - 0.1 kW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	71.2	65.2	71.4	62.8	63.4	65.2	73.3	72.3	62.6	63.1	69.7	73.2	813.4
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Hpl 1: Heating plant - PTHP [Sum of dsn coil capacities=3,278 mbh]													
PTHP Heat [Nominal Capacity/F.L.Rate=3,278 mbh / 960.7 kW] (Heating Equipment)													
Electric (kWh)	12,015.4	11,825.4	2,276.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26,117.4
Peak (kW)	313.0	343.7	203.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	343.7
Hpl 2: Heating plant - DHW [Sum of dsn coil capacities=110.7 mbh]													
DHW elec [Nominal Capacity/F.L.Rate=110.7 mbh / 32.43 kW] (Heating Equipment)													
Electric (kWh)	6,736.0	6,084.2	6,736.0	6,518.8	6,736.0	6,518.8	6,736.0	6,736.0	6,518.8	6,736.0	6,518.8	6,736.0	79,311.4
Peak (kW)	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2	16.2
Heating water circ pump [F.L.Rate=1.99 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,479.5	1,336.3	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	17,419.5
Peak (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Hpl 3: Heating plant - No heat [Sum of dsn coil capacities=0 mbh]													
Sys 1: System 2													
FC Centrifugal Const Vol [DsnAirflow/F.L.Rate=89,986 cfm / 30.00 kW] (Main Clg Fan)													
Electric (kWh)	21,605.9	19,492.2	21,637.3	21,075.3	21,856.9	21,092.9	21,760.5	21,763.1	21,127.7	21,846.2	20,949.5	21,621.9	255,829.4
Peak (kW)	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0	30.0
Sys 3: System 2 - Corridor													
FC Centrifugal Const Vol [DsnAirflow/F.L.Rate=2,807 cfm / 0.94 kW] (Main Clg Fan)													
Electric (kWh)	29.3	27.7	17.0	57.4	100.0	179.6	225.0	206.2	114.5	73.0	8.4	9.1	1,047.1
Peak (kW)	0.5	0.6	0.5	0.6	0.7	0.6	0.7	0.7	0.5	0.5	0.3	0.2	0.7

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 4 Proposed - SSHP and Elec DHW

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Lights													
Electric (kWh)	9,205.0	8,314.0	9,190.6	8,910.4	9,197.8	8,896.0	9,212.2	9,190.6	8,910.4	9,197.8	8,903.2	9,212.2	108,340.2
Peak (kW)	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7	24.7
Misc. Ld													
Electric (kWh)	27,260.3	24,622.0	27,246.7	26,383.1	27,253.5	26,369.5	27,267.1	27,246.7	26,383.1	27,253.5	26,376.3	27,267.0	320,928.7
Peak (kW)	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1	74.1
Cooling Coil Condensate													
Recoverable Water (1000gal)	0.8	0.6	0.8	2.2	6.4	14.8	18.5	15.9	12.1	5.1	1.3	1.0	79.5
Peak (1000gal/Hr)	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1
Bsu 1: Exterior Lighting													
Electric (kWh)	208.3	188.2	208.3	201.6	208.3	201.6	208.3	208.3	201.6	208.3	201.6	208.3	2,452.8
Peak (kW)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Bsu 2: Elevator													
Electric (kWh)	2,999.3	2,709.0	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	2,999.3	2,902.5	2,999.3	2,902.5	2,999.3	35,313.8
Peak (kW)	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Bsu 3: Parking Garage EF													
Electric (kWh)	589.0	532.0	589.0	570.0	589.0	570.0	589.0	589.0	570.0	589.0	570.0	589.0	6,935.0
Peak (kW)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Bsu 4: DHW Load (GPM)													
Proc. Hot Water (therms)	176.1	159.0	176.1	170.4	176.1	170.4	176.1	176.1	170.4	176.1	170.4	176.1	2,073.0
Peak (therms/Hr)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Cpl 1: Cooling plant - SSHP [Sum of dsn coil capacities=130.4 tons]													
SSHP cool [Clg Nominal Capacity/F.L.Rate=130.4 tons / 87.63 kW] [**Orig F.L.Rate=125.2 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	2,136.4	1,841.0	3,434.7	7,882.3	11,012.5	19,465.4	24,435.5	22,255.6	12,886.5	8,958.0	3,059.8	2,713.6	120,081.3
Peak (kW)	33.1	24.2	33.0	61.5	70.9	64.1	74.2	71.3	58.2	54.0	36.9	28.2	74.2
SSHP cool [Htg Nominal Capacity/F.L.Rate=1,760 mbh / 136.7 kW] [**Orig F.L.Rate=174.3 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	5,718.1	5,270.5	3,539.3	474.7	61.5	0.0	0.0	0.0	67.6	340.2	2,452.1	3,765.9	21,689.9
Peak (kW)	37.5	37.8	37.7	14.9	5.1	0.0	0.0	0.0	4.7	12.7	27.0	26.8	37.8

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 4 Proposed - SSHP and Elec DHW

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Cpl 1: Cooling plant - SSHP [Sum of dsn coil capacities=130.4 tons]													
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=157.8 tons / 8.73 kW]													
Electric (kWh)	488.6	437.8	577.6	957.0	1,212.3	1,923.8	2,268.7	2,130.6	1,428.4	1,099.6	504.4	507.9	13,536.7
Peak (kW)	4.1	3.6	4.0	6.1	8.7	6.1	8.7	8.7	6.3	5.9	4.6	3.5	8.7
Cntl panel & interlocks - 0.1 kW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	71.1	65.7	71.2	62.6	63.7	69.4	74.3	73.8	65.0	63.9	69.6	72.6	822.9
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cpl 2: Cooling plant - DOAS [Sum of dsn coil capacities=39.62 tons]													
DOAS [Clg Nominal Capacity/F.L.Rate=48.71 tons / 50.95 kW] [**Orig F.L.Rate=57.31 kW] (Cooling Equipment - Cooling Mode)													
Electric (kWh)	51.8	0.0	84.5	1,543.3	5,484.2	12,934.3	17,389.2	15,112.6	8,837.8	3,461.1	546.5	214.9	65,660.1
Peak (kW)	21.9	0.0	21.9	25.7	38.3	38.1	41.8	40.6	35.5	30.3	21.9	21.9	41.8
DOAS [Htg Nominal Capacity/F.L.Rate=411.5 mbh / 27.14 kW] [**Orig F.L.Rate=33.50 kW] (Cooling Equipment - Heating Mode)													
Electric (kWh)	8,891.0	8,477.5	7,782.7	3,427.6	1,620.9	100.4	10.6	23.5	960.0	2,467.7	6,926.0	8,567.0	49,254.9
Peak (kW)	20.8	20.8	20.8	14.9	9.8	3.9	1.7	2.5	9.2	14.9	20.8	20.8	20.8
DOAS (Cooling Equipment - Heat Recovered From Condenser Loop)													
Energy Recovered (therms)	12.1	0.0	19.2	272.7	812.2	1,432.5	1,582.4	1,569.1	1,136.1	666.6	104.8	47.9	7,655.7
Peak (therms/Hr)	2.6	0.0	2.5	2.7	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=64.21 tons / 3.55 kW]													
Electric (kWh)	1,034.2	980.9	945.6	481.9	339.6	381.4	628.1	455.6	380.4	377.9	880.8	1,048.6	7,935.0
Peak (kW)	2.3	2.3	2.3	1.8	3.6	1.4	3.6	3.6	1.9	1.8	2.3	2.3	3.6
Cntl panel & interlocks - 0.1 kW [F.L.Rate=0.10 kW] (Misc Accessory Equipment)													
Electric (kWh)	70.4	65.1	73.7	68.9	71.5	67.2	72.3	70.7	69.8	71.4	72.0	74.4	847.4
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Cpl 3: Cooling plant - RTU corridor [Sum of dsn coil capacities=5.76 tons]													
RTU cool [Clg Nominal Capacity/F.L.Rate=7.38 tons / 6.34 kW] [**Orig F.L.Rate=7.91 kW] (Cooling Equipment)													
Electric (kWh)	13.7	0.7	23.4	202.6	435.1	1,020.9	1,398.9	1,199.7	637.9	291.9	32.3	20.2	5,277.2
Peak (kW)	1.9	1.5	1.9	2.9	4.1	3.9	5.4	5.3	4.0	2.7	1.9	1.8	5.4
90.1 Min Air Cooled Condenser [Design Heat Rejection/F.L.Rate=9.33 tons / 0.52 kW]													
Electric (kWh)	1.1	0.1	1.9	14.5	31.8	71.6	100.4	83.5	47.9	21.9	2.6	1.7	378.8
Peak (kW)	0.1	0.0	0.1	0.2	0.5	0.3	0.5	0.5	0.3	0.2	0.1	0.1	0.5

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 4 Proposed - SSHP and Elec DHW

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
<u>Cpl 3: Cooling plant - RTU corridor [Sum of dsn coil capacities=5.76 tons]</u>													
Cntl panel & interlocks - 0.05 KW [F.L.Rate=0.05 kW] (Misc Accessory Equipment)													
Electric (kWh)	2.5	0.3	5.8	16.7	23.4	26.5	27.3	27.4	23.6	21.5	3.9	3.5	182.1
Peak (kW)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
<u>Hpl 1: Heating plant - SSHP [Sum of dsn coil capacities=1,412 mbh]</u>													
SSHP Heat [Nominal Capacity/F.L.Rate=1,412 mbh / 413.9 kW] (Heating Equipment)													
Electric (kWh)	5,191.4	4,985.9	913.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11,091.1
Peak (kW)	149.1	176.5	100.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	176.5
<u>Hpl 2: Heating plant - DHW [Sum of dsn coil capacities=84.77 mbh]</u>													
Elec Water Heater [Nominal Capacity/F.L.Rate=84.77 mbh / 24.84 kW] (Heating Equipment)													
Electric (kWh)	5,158.6	4,659.4	5,158.6	4,992.2	5,158.6	4,992.2	5,158.6	5,158.6	4,992.2	5,158.6	4,992.2	5,158.6	60,738.3
Peak (kW)	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4	12.4
Heating water circ pump [F.L.Rate=1.99 kW] (Misc Accessory Equipment)													
Electric (kWh)	1,479.5	1,336.3	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	1,479.5	1,431.7	1,479.5	1,431.7	1,479.5	17,419.5
Peak (kW)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
<u>Hpl 3: Heating plant - No heat [Sum of dsn coil capacities=0 mbh]</u>													
<u>Hpl 4: Heating plant - DOAS [Sum of dsn coil capacities=400.4 mbh]</u>													
DOAS Heat [Nominal Capacity/F.L.Rate=400.4 mbh / 117.3 kW] (Heating Equipment)													
Electric (kWh)	11,566.2	11,670.7	4,419.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	114.3	176.8	27,947.7
Peak (kW)	117.3	117.3	96.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.6	22.2	117.3
<u>Hpl 5: Heating plant - RTU corridor [Sum of dsn coil capacities=76.69 mbh]</u>													
RTU heat [Nominal Capacity/F.L.Rate=76.69 mbh / 22.47 kW] (Heating Equipment)													
Electric (kWh)	185.8	169.8	59.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9.9	31.6	456.8
Peak (kW)	21.5	3.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1	3.1	21.5
<u>Sys 1: SSHP</u>													
DC Fan with ECM Motor [DsnAirflow/F.L.Rate=62,872 cfm / 28.85 kW] (Main Clg Fan)													
Electric (kWh)	2,770.7	2,507.0	2,860.8	3,085.8	3,221.3	3,600.5	3,846.9	3,815.8	3,336.0	3,266.3	2,750.0	2,818.2	37,879.1
Peak (kW)	6.9	6.3	7.0	9.0	9.0	9.0	9.0	9.0	9.0	8.6	7.1	6.7	9.0

EQUIPMENT ENERGY CONSUMPTION

By Spectrum Energy, LLC

Alternative: 4 Proposed - SSHP and Elec DHW

----- Monthly Consumption -----

Equipment - Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Sys 1: SSHP													
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=6,594 cfm / 2.80 kW] (Opt. Ventilation Fan)													
Electric (kWh)	1,794.0	1,620.5	1,797.1	1,735.7	1,795.6	1,738.7	1,792.5	1,797.1	1,735.7	1,795.6	1,737.2	1,792.5	21,132.1
Peak (kW)	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8	2.8
Sys 3: RTU Corridor													
AF Centrifugal var freq drv [DsnAirflow/F.L.Rate=924.4 cfm / 1.05 kW] (Main Clg Fan)													
Electric (kWh)	100.1	89.8	93.8	126.0	139.9	175.3	208.4	191.4	146.1	134.3	103.7	106.6	1,615.2
Peak (kW)	0.9	0.3	0.3	0.5	0.6	0.6	1.1	1.1	0.6	0.5	0.3	0.3	1.1

MONTHLY ENERGY CONSUMPTION

By Spectrum Energy, LLC

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1 Proposed - Manifold VRF HR													
Electric													
On-Pk Cons. (kWh)	78,174	72,583	66,139	54,704	59,687	69,451	79,804	75,302	61,803	57,402	57,839	62,513	795,402
On-Pk Demand (kW)	251	245	218	170	203	188	211	207	177	162	149	155	251

Energy Consumption	Environmental Impact Analysis
Building Source	CO2
17,073 Btu/(ft2-year)	No Data Available
51,225 Btu/(ft2-year)	No Data Available
Floor Area	NOX
159,004 ft2	No Data Available

Alternative: 2 Proposed - VRF Heat Pump 1:1													
Electric													
On-Pk Cons. (kWh)	79,427	73,611	67,313	57,279	62,771	74,939	84,777	80,594	66,304	60,777	59,134	63,762	830,688
On-Pk Demand (kW)	254	246	222	188	214	204	224	219	199	184	159	155	254

Energy Consumption	Environmental Impact Analysis
Building Source	CO2
17,831 Btu/(ft2-year)	No Data Available
53,497 Btu/(ft2-year)	No Data Available
Floor Area	NOX
159,004 ft2	No Data Available

MONTHLY ENERGY CONSUMPTION

By Spectrum Energy, LLC

----- Monthly Energy Consumption -----

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 3 Baseline ASHRAE 90_1 2010													
Electric													
On-Pk Cons. (kWh)	110,562	101,429	98,318	92,811	98,737	114,613	127,503	122,480	102,160	96,802	89,685	95,481	1,250,581
On-Pk Demand (kW)	394	402	279	296	336	323	364	351	335	293	237	213	402

Energy Consumption		Environmental Impact Analysis	
Building	26,844 Btu/(ft2-year)	CO2	No Data Available
Source	80,539 Btu/(ft2-year)	SO2	No Data Available
		NOX	No Data Available
Floor Area	159,004 ft2		

Alternative: 4 Proposed - SSHP and Elec DHW													
Electric													
On-Pk Cons. (kWh)	86,987	80,544	73,557	65,471	72,399	86,939	99,167	94,109	76,014	69,257	64,643	68,830	937,916
On-Pk Demand (kW)	324	330	230	213	243	226	254	250	221	207	175	169	330

Energy Consumption		Environmental Impact Analysis	
Building	20,132 Btu/(ft2-year)	CO2	No Data Available
Source	60,403 Btu/(ft2-year)	SO2	No Data Available
		NOX	No Data Available
Floor Area	159,004 ft2		



DAVIS
CARTER
SCOTT Ltd

LEED MF MIDRISE v4 CHECKLIST

1601 Fairfax Drive

322122.00

1/13/2023 - County 4.1 Submission

ADDRESS: 1601 Fairfax Drive, Arlington, VA 22209

LEED for Homes: Multifamily Midrise v4

Yes	Targeted	?	No			
				INTEGRATIVE PROCESS		2 Points
	1		1	Credit 1	Integrative Process	2
0	1	0	1			
				LOCATION AND TRANSPORTATION (8 pts req'd w/ EA)		15 Points
Y				Pre 1	Floodplain Avoidance	Req'd
			0	Credit 1	LEED for Neighborhood Development Location	15 -OR-
	8			Credit 2	Site Selection	8
3				Credit 3	Compact Development	3
2				Credit 4	Community Resources	2
1.5				Credit 5	Access to Quality Transit	2
6.5	8	0	0			
				SUSTAINABLE SITES		7 Points
Y				Pre 1	Construction Activity Pollution Prevention	Req'd
Y				Pre 2	No Invasive Plants	Req'd
	1		1	Credit 1	Heat Island Reduction	2
			3	Credit 2	Rainwater Management	3
	2			Credit 3	Nontoxic Pest Control	2
0	2.5	0	4			
				WATER EFFICIENCY (3 pts required)		12 Points
Y				Pre 1	Water Metering	Req'd
	6		6	Credit 1	Total Water Use	12 -OR-
			0	Credit 2	Indoor Water Use	6
			0	Credit 3	Outdoor Water Use	4
0	6	0	6			
				ENERGY & ATMOSPHERE (8 pts required w/ LT)		37 Points
Y				Pre 1	Minimum Energy Performance	Req'd
Y				Pre 2	Energy Metering	Req'd
Y				Pre 3	Education of Homeowner, Tenant, or Building Manager	Req'd
	23		7	Credit 1	Annual Energy Use	30
			5	Credit 2	Efficient Hot Water Distribution System	5
	1		1	Credit 3	Advanced Utility Tracking	2
0	24	0	13			
				MATERIALS & RESOURCES		9 Points
Y				Pre 1	Certified Tropical Wood	Req'd
Y				Pre 2	Durability Management	Req'd
	1			Credit 1	Durability Management Verification	1
			5	Credit 2	Environmentally Preferable Products	5
	2		1	Credit 3	Construction Waste Management	3
0	3	0	6			

Yes	Targeted	?	No	INDOOR ENVIRONMENTAL QUALITY (3 pts required)		18 Points
Y				Pre 1	Ventilation	Req'd
Y				Pre 2	Combustion Venting	Req'd
Y				Pre 3	Garage Pollutant Protection	Req'd
Y				Pre 4	Radon Resistant Construction	Req'd
Y				Pre 5	Air Filtering	Req'd
Y				Pre 6	Environmental Tobacco Smoke	Req'd
Y				Pre 7	Compartmentalization	Req'd
	1		2	Credit 1	Enhanced Ventilation	3
			2	Credit 2	Contaminant Control	2
	1		2	Credit 3	Balancing of Heating and Cooling Distribution Systems	3
			3	Credit 4	Enhanced Compartmentalization	3
	2			Credit 5	Enhanced Combustion Venting	2
	1			Credit 6	Enhanced Garage Pollutant Protection	1
			3	Credit 7	Low-Emitting Products	3
	1			Credit 8	No Environmental Tobacco Smoke	1
0	6	0	12			

Yes	Targeted	?	No	INNOVATION IN DESIGN		6 Points
Y				Pre 1	Preliminary Rating	TBD
			1	Credit 1.1	Innovation in Design	LT Credit 4 - Community Resources Exemplary
	1			Credit 1.2	Innovation in Design	Install EV charging stations for 2% of parking spaces
			1	Credit 1.3	Innovation in Design	EPDs, Specify 20+ products with EPDs.
			1	Credit 1.4	Innovation in Design	HPDs, Specify 20+ products with HPDs.
			1	Credit 1.5	Innovation in Design	TBD
1				Credit 2	LEED Accredited Professional	
1	1	0	4			

Yes	Targeted	?	No	REGIONAL PRIORITY		4 Points
	1			Credit 1.1	Regional Priority	Site Selection (8 pts min)
	1			Credit 1.2	Regional Priority	Community Resources (2 pts min)
			1	Credit 1.3	Regional Priority	Access to Transit (2 pts min)
			1	Credit 1.4	Regional Priority	Rainwater Management (3 pts min)
0	2	0	2			

Yes	Targeted	?	No	PROJECT TOTALS		110 Points Possible
7.5	54	0	48	Certified 40 to 49 Points Silver 50 to 59 Points Gold 60 to 79 Points Platinum 80+ Points		
61				= Total Points Estimated		

IMPORTANT: LEED points shown represent our professional opinion of credit achievability. Credits are awarded by USGBC/GBCI only and are the result of collaborative effort and decisions by all team members. DCS cannot guarantee any LEED points or specific level of certification.