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TECHNICAL REPORT TWO: BUILDING AND PLANT ENERGY ANALYSIS

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DR. JAMES FREIJHAUT NEOMED Research and Graduate Education Building

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Executive Summary

This Report is an evaluation of the NEOMED Research and Graduate Education and Comparable Medical Unit with respect to building and plant energy analysis. Contained herein are building loads calculated from current design criteria, annual energy consumption, utility costs, and yearly emissions. It is important to note that for time constraints, only an analysis of the new RGE building was performed.

To calculate values for loads, energy consumption, and utilities, a Trane Trace 700 model was constructed, based on information from current design documents. Emissions were calculated based on information from several 2009 documents. Also, the calculated Trace values are compared and contrasted to the Elite CHVAC 7 model constructed by the designer Scheeser Buckley Mayfield.

After running the initial Trane Trace 700 file, it is clear that further work needs to be done to the model in order for it to be of any valuable insight. Calculated loads wildly differ from design loads and data on utility finances and building operation schedule need to be obtained.

Building Overview

The project is comprised of three additions to the NEOMED campus. The main addition is the Research and Graduate Education Center, a four-story 63,000 square foot biomedical research building. The first three floors are fully built out with laboratories, support rooms, and offices, while the top floor is shelled in and will be built out as the research program grows. There is a 6,000 square foot basement to house stand-alone utilities.

The second component is a 14,500 square foot addition to the Comparable Medical Unit, which provides animal care services. Lastly, several existing laboratories in Building D were renovated.

Mechanical Systems Overview

Campus Utilities will not be utilized for this project; there is a stand-alone system of chillers, medium pressure steam generators, and hot water boilers located in the basement area of the addition. The RGE Building has two 100% outside air handling units each sized at 50,000 CFM respectively and a smaller 28,000 CFM office unit with return air. In addition, the basement mechanical plant has its own constant-volume 8500 CFM unit. The CMU has its own 35,000 CFM 100% outdoor air unit as well.

Design Load Estimation

System Design Assumptions

The following sections detail the assumptions, data and inputs that were used in the construction of the Trane Trace 700 model. Much of this information was taken directly from an MEP Schematic Narrative written by BR+A Consulting Engineers in early design. Other information was obtained from various construction drawings and specifications provided by Scheeser Buckley Mayfield.

Design Condition Assumptions

The RGE Building has a variety of laboratory and office spaces, many of which had stringent space thermostat set points. All Occupied spaces were set according to the temperature and humidity settings in Table 1, taken from Division 23 Section 3 of the BR+A Schematic Narrative.

	<u>Winter °F</u>	<u>Summer °F (±2°F)</u>
<u>Exterior Design Temp.</u>	0	89°db /73°wb
<u>Interior Design Temp.</u>		
Laboratories / support spaces	72	72
Mechanical/Electrical Rooms	65	Vent Only
<u>Supply Air Temperature</u> (at discharge of chilled water coil)	52°F db	51°F db /51.5° wb
<u>Humidity</u>		
Lab / Support spaces	35%±5	50% (±5%)

Table 1: HVAC Design Criteria

Occupancy Assumptions

Documents provided did not specify any particular occupation densities. Therefore, when calculating internal loads and ventilation requirements, ASHRAE standard values for occupancy per 1000 square foot were internally referenced by the Trace model.

Ventilation Assumptions

The majority of the RGE building is configured on a 100% OA system to control contaminants; labs, tissue culture rooms, operating rooms, etc. These rooms, however, have very stringent air circulation requirements. These requirements, given in minimum air changes per hour, ensure that enough uncontaminated fresh air is utilized and that delicate pressure relationships are maintained between rooms so as to avoid contaminant travel. These requirements are outlined below in Figure 1, from Division 23 Section 4a of the Schematic Narrative.

- 1) Laboratories and support spaces
 - Exhaust: 100% Exhaust.
 - Air Circulation: As required by air conditioning load or equipment ventilation load. Min. 6 ACH/HR.
 - Pressure: Negative in relation to corridors and office spaces
 - Electrical Loads: 10 w/sf power, 2 w/sf lighting
- 2) Toilets/Janitors Closets
 - Exhaust: 100% Exhaust
 - Air Circulation: 10 ACH exhaust (min.), constant volume
 - Pressure: Negative to adjacent spaces
 - Electrical Loads: 1.5 w/sf lighting, convenience outlets
- 3) Procedure Rooms
 - Exhaust: 100% Exhaust
 - Air Circulation: 15 ACH minimum, as required for equipment makeup ventilation Load, constant volume
 - Pressure: Negative to adjacent spaces
 - Electrical Loads: 15 w/sf power, 2 w/sf lighting
- 4) Tissue Culture Rooms
 - Exhaust: 100% Exhaust
 - Air Circulation: 15 ACH minimum, as required for cooling
 - Pressure: Positive
 - Electrical Load: 15 w/sf power; 2 w/sf lighting
- 5) Corridors
 - Exhaust: 100% Exhaust
 - Air Circulation: Minimum 6 ACH or requirement for make-up due to labs being at ~~negative~~ pressure.
 - Pressure: Positive to Laboratories
 - Electrical Loads: 1.5 w/sf lighting
- 6) Environmental Rooms
 - Exhaust: 100% Exhaust
 - Air Circulation: 20 CFM ventilation only
 - Pressure: Neutral

Figure 1: Ventilation Rates, Pressure Relationships, Electric Load Allowances

The remaining office spaces configured on the smaller AHU were ventilated based on preloaded ASHRAE Std. 62.1 values, as design ventilation rates were unable to be obtained from available design documents.

Building Infiltration Assumptions

Given the research and laboratory programming of the building, the research function areas are required to maintain delicate pressure relationships. While perhaps not entirely realistic, all areas were modeled in the Trace file as having pressurized tight construction with 0 cooling and heating infiltration.

Lighting and Equipment Assumptions

Very specific lighting and power loads are given by Figure 1, referenced earlier in the report. Additional values are given in Division 26 Section 4a, listed below in Figure 2.

4. Normal Power

a. The electrical system loads will be designed as follows:

- 1) 1.5 watts/sq. ft. for lighting.
- 2) 8 to 10 watts/sq. ft. for Laboratories
- 3) 10 to 30 watts/sq. ft. for Lab Support Spaces
- 4) 2.0 watts/sq. ft. for power-All Other Areas.
- 5) 10 to 15 watts/sq. ft. for Plumbing and HVAC air handling equipment.



Figure 2: Normal Power Loads

Construction Type Assumptions

In the Trace model average values were used for the construction data for building elements. A library entry for the RGE wall was created, based off of section provided in construction drawings. The “RGE Wall” template consists of 5/8” gypsum board, followed by 6” insulation between metal studs, 2.73” hi-density stiff insulation, air space, and 4” face brick. Floor slabs were all entered as 4” heavyweight concrete and roof was calculated as 4” lightweight concrete. Interior partitions were all taken as .75” gypsum frame from the preloaded library. All glass was entered as a percentage of wall area, in most areas 38%. The default single clear ¼” window type was utilized.

Weather Information Assumptions

Trane Trace has a preloaded library of several hundred American cities across the country. Weather data for Akron, Ohio was specified as this was the closest city to the project’s Rootstown, Ohio location.

Schedule Assumptions

At the time of model construction, no data for typical occupancy schedule was available. While not the most realistic measure, all schedules were specified as 100% available and will need to be modified as more information is obtained.

Comparison of Load Calculations to Designer Calculations

The first observation taken when the Trace model finished generating reports was that the calculated airflows for most of the air handlers were significantly larger than the design CFM respective to each AHU. The only value that was realistic was the 26,000 CFM cooling airflow calculated for AHU-3, which serves the office spaces. Each of the lab AHU’s were designed at 50,000 CFM; AHU-1 was twice that at 98,000 cooling CFM and AHU-2 was a whopping six times design value at 300,000 cooling CFM. The constant volume AHU-4 for the basement was twice

design value at 19,000 cooling CFM. Further refinement of the Trace model is required in order to yield any real insight on the building; perhaps some assumptions should be modified and more information gathered.

Annual Energy Consumption and Cost

System Energy Consumption

Utility and plant info was taken directly from the RGE Schematic Design Narrative. Default rates and financial information were used in the Trace model as utility bills are currently unavailable.

Energy Consumption Comparison

According to the Trace 700 model, yearly electric consumption is on the order of 4,200,000 kWh. Yearly gas consumption is on the order of 200,000 therms and yearly water consumption is 7 million gallons.

Site vs. Source Energy Consumption

Building energy consumption comes in at roughly 350 kBtu/SF-year. Source energy consumption comes in at about 655 kBtu/SF-year.

Annual Energy Costs

Based on Trace default financial values, total annual utility cost is \$221,799 per year.

Total Annual Emission Rates

Based on Trane Trace calculations, 7.7 million lbm/year of CO₂ is emitted. 53,200 gm/year of SO₂ is emitted and 13,300 gm/year of NO_x is emitted.

References

Scheeser Buckley Mayfield LLC. Mechanical, Electrical, Plumbing, and Fire Protection Construction Documents. Scheeser Buckley Mayfield, Uniontown, Ohio

Bard, Rao + Athanas Consulting Engineers, LLC. MEP Schematic Narratives. BR+A, Boston, MA

Ellenzweig Architects. Architectural Construction Documents. Ellenzweig, Boston, MA

TC Architects Inc. Architectural Construction Documents. TC Architects, Akron, Ohio

Appendix

SYSTEM SUMMARY
DESIGN AIRFLOW QUANTITIES
 By ACADEMIC

System Description	System Type	MAIN SYSTEM					Auxiliary System	Room
		Outside Airflow cfm	Cooling Airflow cfm	Heating Airflow cfm	Return Airflow cfm	Exhaust Airflow cfm	Supply Airflow cfm	Exhaust Airflow cfm
Alternative 1								
RGE AHU-1	Variable Volume Reheat (30% Min Flow Default)	68,749	98,914	29,914	98,914	68,749	0	96,704
RGE AHU-2	Variable Volume Reheat (30% Min Flow Default)	297,689	299,921	91,650	299,921	297,689	0	311,391
RGE AHU-3	Variable Volume Reheat (30% Min Flow Default)	3,245	26,354	8,001	26,354	3,245	0	10,572
RGE AHU-4	Bypass Multizone	450	18,956	18,956	18,956	450	0	18,753
Totals		370,133	444,145	148,521	444,145	370,133	0	437,420

Note: Airflows on this report are not additive because they are each taken at the time of their respective peaks. To view the balanced system design airflows, see the appropriate Checksums report (Airflows section).

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SYSTEM SUMMARY

DESIGN COOLING CAPACITIES

By ACADEMIC

Alternative 1

Building Airside Systems and Plant Capacities

Plant	System	Peak Plant Loads							Block Plant Loads									
		Main Coil ton	Aux Coil ton	Opt Vent Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Peak Total ton	Time	Main Coil ton	Aux Coil ton	Opt Vent Coil ton	Misc Load ton	Stg 1	Stg 2	Base Utility ton	Block Total ton
						Desic Cond ton	Desic Cond ton			Of Peak mo/hr					Desic Cond ton	Desic Cond ton		
Cooling plant - 001		1,958.9	0.0	0.0	0.0	0.0	0.0	0.0	1,958.9	7/16	1,749.0	0.0	0.0	0.0	0.0	0.0	0.0	1,749.0
	RGE AHU-1	386.6	0.0	0.0	0.0	0.0	0.0	0.0	386.6	7/16	353.8	0.0	0.0	0.0	0.0	0.0	0.0	353.8
	RGE AHU-2	1,486.9	0.0	0.0	0.0	0.0	0.0	0.0	1,486.9	7/16	1,312.4	0.0	0.0	0.0	0.0	0.0	0.0	1,312.4
	RGE AHU-3	54.5	0.0	0.0	0.0	0.0	0.0	0.0	54.5	7/16	53.1	0.0	0.0	0.0	0.0	0.0	0.0	53.1
	RGE AHU-4	30.9	0.0	0.0	0.0	0.0	0.0	0.0	30.9	7/16	29.7	0.0	0.0	0.0	0.0	0.0	0.0	29.7
Building totals		1,958.9	0.0	0.0	0.0	0.0	0.0	0.0	1,958.9		1,749.0	0.0	0.0	0.0	0.0	0.0	0.0	1,749.0

Building peak load is 1,958.9 tons.

Building maximum block load of 1,749.0 tons occurs in July at hour 16 based on system simulation.

SYSTEM SUMMARY
DESIGN HEATING CAPACITIES
 By ACADEMIC

Alternative 1

System Coil Capacities

System Description	System Type	Main System Btu/h	Aux System Btu/h	Preheat Btu/h	Reheat Btu/h	Humid. Btu/h	Optional Vent Btu/h	Stg 1	Stg 2	Stg 1	Stg 2	Heating Totals Btu/h
								Desic Regen Btu/h	Desic Regen Btu/h	Frost Prevention Btu/h	Frost Prevention Btu/h	
RGE AHU-1	Variable Volume Reheat (30% Min Flow Default)	-3,279,402	0	-3,504,387	-576,530	0	0	0	0	0	0	-6,783,789
RGE AHU-2	Variable Volume Reheat (30% Min Flow Default)	-4,792,309	0	-14,572,320	-1,951,715	0	0	0	0	0	0	-19,364,628
RGE AHU-3	Variable Volume Reheat (30% Min Flow Default)	-1,271,535	0	-170,008	-141,833	0	0	0	0	0	0	-1,441,542
RGE AHU-4	Bypass Multizone	-66,281	0	0	0	0	0	0	0	0	0	-66,281
Totals		-9,409,526	0	-18,246,715	-2,670,078	0	0	0	0	0	0	-27,656,240

Building Plant Capacities

Plant	System	Peak Loads											Absorption Load MBh	
		Main Coil MBh	Preheat Coil MBh	Reheat Coil MBh	Humid. Coil MBh	Aux Coil MBh	Opt Vent Coil MBh	Misc Load MBh	Stg 1 Desic. Regen. MBh	Stg 2 Desic. Regen. MBh	Stg 1 Frost Prev. MBh	Stg 2 Frost Prev. MBh		Base Utility MBh
Heating plant - 002		9,410	18,247	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-1	3,279	3,504	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-2	4,792	14,572	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-3	1,272	170	0	0	0	0	0	0	0	0	0	0	0
	RGE AHU-4	66	0	0	0	0	0	0	0	0	0	0	0	0

Building peak load is 27,656.2 MBh.

Economic Summary

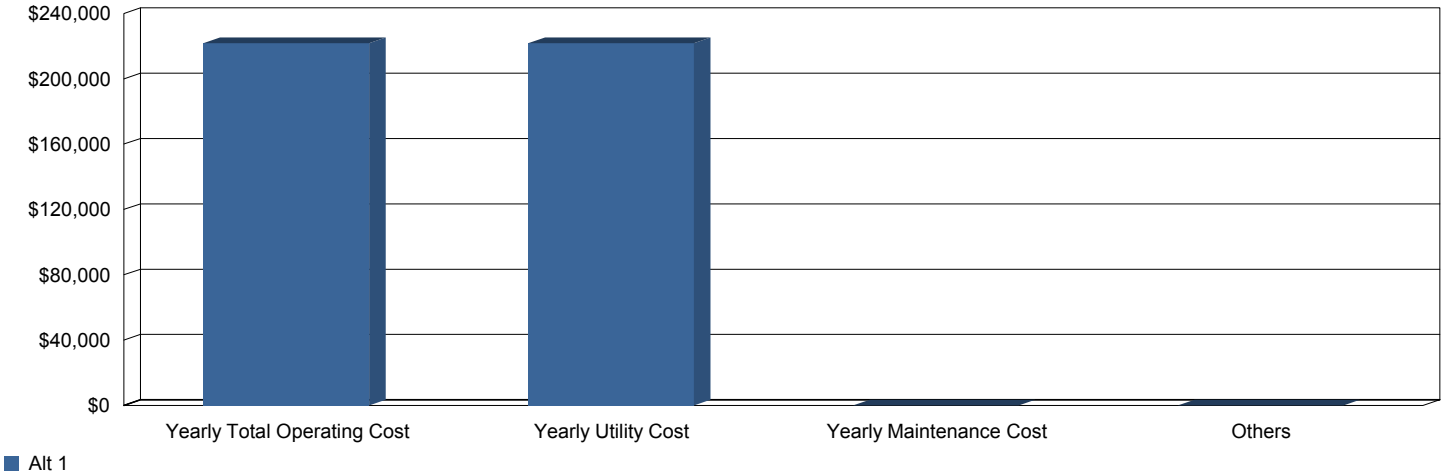
Project Information

Location	Rootstown, Ohio	Study Life:	20 years
Project Name	Neomed Research and Graduate Education	Cost of Capital:	10 %
User	Samuel T Bridwell	Alternative 1:	
Company	The Pennsylvania State University		
Comments			

Economic Comparison of Alternatives

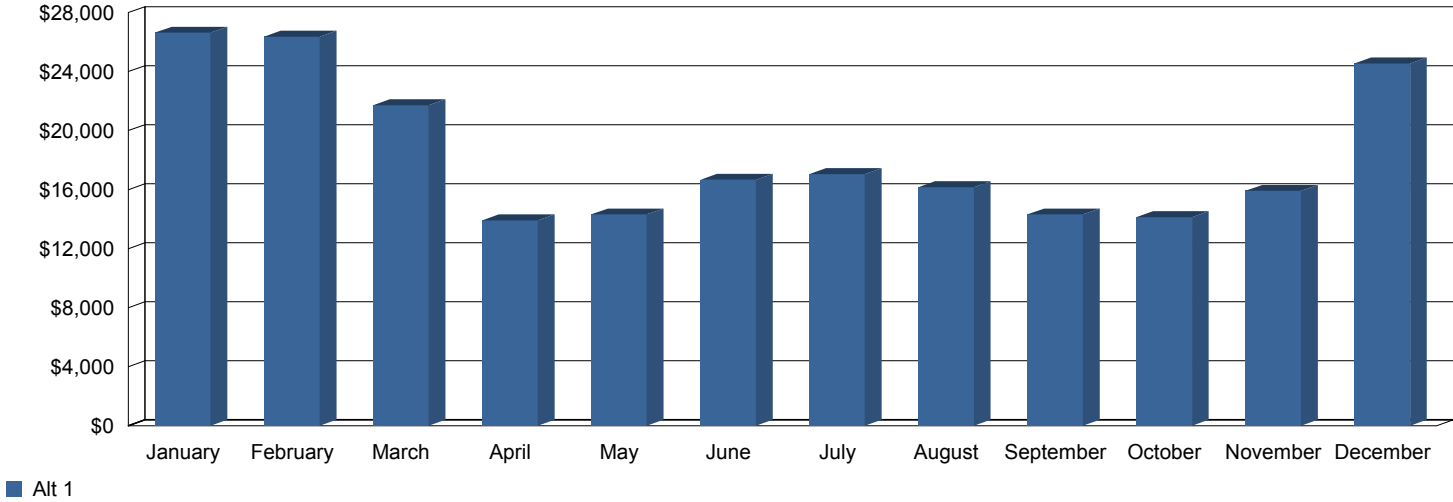
Yearly Savings (\$)	First Cost Difference (\$)	Cumulative Cash Flow Difference (\$)	Simple Payback (yrs.)	Net Present Value (\$)	Life Cycle Payback (yrs.)	Internal Rate of Return (%)	Life Cycle Cost

Annual Operating Costs



Yearly Total Operating Cost (\$)	Yearly Utility Cost (\$)	Yearly Maintenance Cost (\$)	Plant kWh/ton-hr

Monthly Utility Costs



ENERGY CONSUMPTION SUMMARY

By ACADEMIC

	Elect Cons. (kWh)	Gas Cons. (kBtu)	Water Cons. (1000 gals)	% of Total Building Energy	Total Building Energy (kBtu/yr)	Total Source Energy* (kBtu/yr)
Alternative 1						
Primary heating						
Primary heating		19,913,922		57.9 %	19,913,922	20,962,024
Other Htg Accessories	43,022			0.4 %	146,834	440,546
Heating Subtotal	43,022	19,913,922		58.3 %	20,060,756	21,402,570
Primary cooling						
Cooling Compressor	950,519			9.4 %	3,244,121	9,733,337
Tower/Cond Fans	272,359		7,413	2.7 %	929,562	2,788,966
Condenser Pump				0.0 %	0	0
Other Clg Accessories	10,814			0.1 %	36,908	110,736
Cooling Subtotal....	1,233,692		7,413	12.2 %	4,210,592	12,633,038
Auxiliary						
Supply Fans	1,512,810			15.0 %	5,163,221	15,491,213
Pumps	90,001			0.9 %	307,174	921,613
Stand-alone Base Utilities				0.0 %	0	0
Aux Subtotal....	1,602,811			15.9 %	5,470,395	16,412,826
Lighting						
Lighting	1,355,949			13.5 %	4,627,855	13,884,954
Receptacle						
Receptacles	6,078			0.1 %	20,743	62,235
Cogeneration						
Cogeneration				0.0 %	0	0
Totals						
Totals**	4,241,553	19,913,922	7,413	100.0 %	34,390,341	64,395,620

* Note: Resource Utilization factors are included in the Total Source Energy value .

** Note: This report can display a maximum of 7 utilities. If additional utilities are used, they will be included in the total.

Energy Cost Budget / PRM Summary

By ACADEMIC

Project Name: Neomed Research and Graduate Education	Date: October 06, 2014
City: Rootstown, Ohio	Weather Data: Akron, Ohio

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		
		Energy 10 ⁶ Btu/yr	Proposed / Base %	Peak kBtu/h
Lighting - Conditioned	Electricity	4,627.9	13	528
Space Heating	Electricity	146.8	0	36
	Gas	19,913.9	58	6,994
Space Cooling	Electricity	3,281.0	10	1,666
Pumps	Electricity	307.2	1	111
Heat Rejection	Electricity	929.6	3	224
Fans - Conditioned	Electricity	5,163.2	15	1,620
Receptacles - Conditioned	Electricity	20.7	0	2
Total Building Consumption		34,390.3		

		* Alt-1	
Total	Number of hours heating load not met	0	
	Number of hours cooling load not met	0	

		* Alt-1	
		Energy 10 ⁶ Btu/yr	Cost/yr \$/yr
Electricity		14,476.4	122,229
Gas		19,913.9	99,570
Total		34,390	221,799

MONTHLY ENERGY CONSUMPTION

By ACADEMIC

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

Utility	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
Alternative: 1													
Electric													
On-Pk Cons. (kWh)	232,362	209,454	241,360	266,940	382,432	542,511	673,198	562,125	391,157	263,034	241,512	235,466	4,241,551
On-Pk Demand (kW)	394	392	411	558	968	1,134	1,148	1,094	958	510	452	398	1,148
Off-Pk Demand (kW)	390	392	412	474	735	1,018	1,103	988	818	466	423	395	1,103
Mid-Pk Demand (kW)	404	405	424	475	777	1,122	1,174	1,072	818	455	427	409	1,174
Gas													
On-Pk Cons. (therms)	41,507	40,987	31,096	11,945	1,924	486	118	581	1,294	13,422	18,570	37,209	199,139
On-Pk Demand (therms/hr)	65	70	57	37	9	3	1	3	5	40	45	60	70
Water													
Cons. (1000gal)	57	51	59	179	741	1,525	2,043	1,640	802	190	67	58	7,413
Energy Consumption						Environmental Impact Analysis							
Building	349,705 Btu/(ft2-year)					CO2	7,666,942 lbm/year						
Source	654,819 Btu/(ft2-year)					SO2	53,207 gm/year						
						NOX	13,296 gm/year						
Floor Area	98,341 ft2												

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System Checksums

By ACADEMIC

RGE AHU-1

Variable Volume Reheat (30% Min Flow Default)

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 16		Mo/Hr: 7 / 18		Mo/Hr: Heating Design						Cooling	Heating		
Outside Air:		OADB/WB/HR: 85 / 71 / 95		OADB: 82		OADB: 6						SADB	56.5	156.9	
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Return	79.1	61.0	
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Ret/OA	83.5	21.1	
Envelope Loads				Envelope Loads				Envelope Loads				Fn MtrTD	0.3	0.0	
Skylite Solar	0	0	0	0	0	0	0	0.00	Skylite Solar	0	0	0.00	Fn BldTD	0.6	0.0
Skylite Cond	0	0	0	0	0	0	0	0.00	Skylite Cond	0	0	0.00	Fn Frict	1.8	0.0
Roof Cond	0	264,576	6	0	0	0	-211,284	3.11	Roof Cond	0	0	0.00	AIRFLOWS		
Glass Solar	150,037	0	3	132,426	8	0	0	0.00	Glass Solar	0	0	0.00	Diffuser	98,914	29,914
Glass/Door Cond	51,487	0	1	44,315	3	-280,815	-280,815	4.14	Glass/Door Cond	-280,815	-280,815	4.14	Terminal	98,914	29,914
Wall Cond	3,123	535	0	4,209	0	-11,548	-14,271	0.21	Wall Cond	-11,548	-14,271	0.21	Main Fan	98,914	29,914
Partition/Door	117,208	117,208	3	127,211	8	-690,824	-690,824	10.18	Partition/Door	-690,824	-690,824	10.18	Sec Fan	0	0
Floor	209,649	209,649	5	263,918	16	-1,602,238	-1,602,238	23.61	Floor	-1,602,238	-1,602,238	23.61	Nom Vent	68,749	21,689
Adjacent Floor	0	0	0	0	0	0	0	0.00	Adjacent Floor	0	0	0.00	AHU Vent	68,749	21,689
Infiltration	0	0	0	0	0	0	0	0.00	Infiltration	0	0	0.00	Infil	0	0
Sub Total ==>	531,504	265,112	796,616	17	572,080	35	-2,585,425	41.25	Sub Total ==>	-2,585,425	-2,799,432	41.25	MinStop/Rh	29,914	29,914
Internal Loads				Internal Loads				Internal Loads				Return	30,165	8,225	
Lights	165,663	18,378	184,041	4	165,663	10	0	0.00	Lights	0	0	0.00	Exhaust	0	0
People	152,831	0	152,831	3	76,867	5	0	0.00	People	0	0	0.00	Rm Exh	68,749	21,689
Misc	740,932	0	740,932	16	740,932	45	0	0.00	Misc	0	0	0.00	Auxiliary	0	0
Sub Total ==>	1,059,426	18,378	1,077,804	23	983,462	60	0	0.00	Sub Total ==>	0	0	0.00	Leakage Dwn	0	0
Ceiling Load	75,106	-75,106	0	0	74,730	5	-117,452	0.00	Ceiling Load	-117,452	0	0.00	Leakage Ups	0	0
Ventilation Load	0	0	2,513,883	54	0	0	-1,523,604	22.45	Ventilation Load	0	-1,523,604	22.45	ENGINEERING CKS		
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	Adj Air Trans Heat	0	0	0.00	% OA	69.5	72.5
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	Ov/Undr Sizing	0	0	0.00	cfm/ft²	2.94	0.89
Ov/Undr Sizing	0	0	0	0	0	0	1	0.00	Exhaust Heat	0	1	0.00	cfm/ton	255.87	
Exhaust Heat	0	-18,654	-18,654	0	0	0	-2,401,955	35.39	OA Preheat Diff.	0	-2,401,955	35.39	ft²/ton	86.93	
Sup. Fan Heat	0	0	269,272	6	0	0	-61,957	0.91	RA Preheat Diff.	0	-61,957	0.91	Btu/hr-ft²	138.04	-201.86
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	Additional Reheat	0	0	0.00	No. People	307	
Duct Heat Pkup	0	0	0	0	0	0	0	0.00	Underflr Sup Ht Pkup	0	0	0.00			
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	Supply Air Leakage	0	0	0.00			
Supply Air Leakage	0	0	0	0	0	0	0	0.00	Grand Total ==>	-2,702,876	-6,786,948	100.00			
Grand Total ==>	1,666,036	189,730	4,638,920	100.00	1,630,271	100.00	-2,702,876	100.00							

COOLING COIL SELECTION										
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	386.6	4,638.9	3,020.7	96,474	83.5	68.5	85.5	53.9	52.9	61.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	386.6	4,638.9								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	33,606		
Part	26,980		
Int Door	0		
ExFlr	32,887		
Roof	18,000	0	0
Wall	11,619	4,427	38
Ext Door	21	0	0

HEATING COIL SELECTION				
	Capacity	Coil Airflow	Ent	Lvg
	MBh	cfm	°F	°F
Main Htg	-3,279.4	29,914	53.9	156.9
Aux Htg	0.0	0	0.0	0.0
Preheat	-3,504.4	68,749	6.0	53.9
Reheat	-576.5	29,914	53.9	72.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-6,783.8			

System Checksums

By ACADEMIC

RGE AHU-2

Variable Volume Reheat (30% Min Flow Default)

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES				
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 16		Mo/Hr: Heating Design						Cooling	Heating			
Outside Air:		OADB/WB/HR: 86 / 71 / 95		OADB: 85		OADB: 6						SADB	54.6	101.1		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total				Ra Plenum	75.2	71.6		
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens					Return	75.2	71.6		
											Ret/OA	86.0	7.5			
Envelope Loads				Envelope Loads							Fn MtrTD	0.3	0.0			
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn BldTD	0.6	0.0		
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn Frict	1.8	0.0		
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00				AIRFLOWS				
Glass Solar	739,156	0	739,156	4	13	Glass Solar	0	0.00	Cooling	Heating		Diffuser	299,921	91,650		
Glass/Door Cond	257,642	0	257,642	1	5	Glass/Door Cond	-1,429,329	-1,429,329	7.38	299,921	91,650	Terminal	299,921	91,650		
Wall Cond	792	1,330	2,122	0	0	Wall Cond	-3,492	-10,921	0.06	Main Fan	299,921	91,650	Sec Fan	0	0	
Partition/Door	151,508	0	151,508	1	3	Partition/Door	-986,818	-986,818	5.10	Nom Vent	297,689	89,579	AHU Vent	297,689	89,579	
Floor	44,162	0	44,162	0	1	Floor	-414,462	-414,462	2.14	Infil	0	0	MinStop/Rh	91,650	91,650	
Adjacent Floor	0	0	0	0	0	Adjacent Floor	0	0	0	Return	2,233	2,072	Exhaust	1	0	
Infiltration	0	0	0	0	0	Infiltration	0	0	0.00	Rm Exh	297,688	89,579	Auxiliary	0	0	
Sub Total ==>	1,193,261	1,330	1,194,591	7	22	Sub Total ==>	-2,834,101	-2,841,530	14.67	Leakage Dwn	0	0	Leakage Ups	0	0	
Internal Loads				Internal Loads							ENGINEERING CKS					
Lights	207,368	51,842	259,211	1	4	Lights	0	0	0.00	% OA	99.3	97.7				
People	626,126	0	626,126	4	6	People	0	0	0.00	cfm/ft²	6.23	1.90				
Misc	3,765,905	0	3,765,905	21	68	Misc	0	0	0.00	cfm/ton	201.71	52.0	72.0			
Sub Total ==>	4,599,399	51,842	4,651,241	26	77	Sub Total ==>	0	0	0.00	ft²/ton	32.40					
Ceiling Load	49,257	-49,257	0	0	1	Ceiling Load	-6,492	0	0.00	Btu/hr-ft²	370.40	-401.99				
Ventilation Load	0	0	11,166,002	63	0	Ventilation Load	0	-6,292,600	32.50	No. People	1,252					
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0	0							
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0	0.00							
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0	0.00							
Exhaust Heat	0	-2,688	-2,688	0	0	OA Preheat Diff.	0	-10,187,318	52.61							
Sup. Fan Heat	0	0	833,958	5	0	RA Preheat Diff.	0	-43,179	0.22							
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0	0.00							
Duct Heat Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00							
Underflr Sup Ht Pkup	0	0	0	0	0	Supply Air Leakage	0	0	0.00							
Supply Air Leakage	0	0	0	0	0	Grand Total ==>	-2,840,592	-19,364,627	100.00							
Grand Total ==>	5,841,916	1,228	17,843,104	100.00	100.00	Grand Total ==>	-2,840,592	-19,364,627	100.00							

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	1,486.9	17,843.1	10,795.1	298,790	86.0	70.9	95.1	52.0	51.9	60.3
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	1,486.9	17,843.1								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	48,172		
Part	38,540		
Int Door	0		
ExFlr	8,486		
Roof	0	0	0
Wall	26,620	21,296	80
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-4,792.3	91,650	52.0	101.1
Aux Htg	0.0	0	0.0	0.0
Preheat	-14,572.3	297,689	6.0	52.0
Reheat	-1,951.7	91,650	52.0	72.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-19,364.6			

System Checksums

By ACADEMIC

RGE AHU-3

Variable Volume Reheat (30% Min Flow Default)

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 17		Mo/Hr: 7 / 17		Mo/Hr: Heating Design							
Outside Air:		OADB/WB/HR: 84 / 70 / 95		OADB: 84		OADB: 6							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Cooling	Heating			
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens						
Envelope Loads				Envelope Loads							AIRFLOWS		
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00			Diffuser	Cooling	Heating
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00			Terminal	26,354	8,001
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00			Main Fan	26,354	8,001
Glass Solar	52,823	0	52,823	8	52,823	Glass Solar	0	0.00			Sec Fan	0	0
Glass/Door Cond	18,130	0	18,130	3	18,130	Glass/Door Cond	-103,391	-103,391	7.17		Nom Vent	3,245	2,449
Wall Cond	1,395	382	1,777	0	1,395	Wall Cond	-4,473	-5,717	0.40		AHU Vent	3,245	2,449
Partition/Door	133,403		133,403	20	133,403	Partition/Door	-728,199	-728,199	50.53		Infil	0	0
Floor	43,375		43,375	7	43,375	Floor	-293,193	-293,193	20.34		MinStop/Rh	8,001	8,001
Adjacent Floor	0	0	0	0	0	Adjacent Floor	0	0	0		Return	23,109	5,552
Infiltration	0	0	0	0	0	Infiltration	0	0.00			Exhaust	0	0
Sub Total ==>	249,126	382	249,509	38	249,126	Sub Total ==>	-1,129,257	-1,130,500	78.44		Rm Exh	3,245	2,449
Internal Loads				Internal Loads							ENGINEERING CKS		
Lights	43,460	10,865	54,325	8	43,460	Lights	0	0.00			% OA	12.3	30.6
People	94,135	0	94,135	14	58,755	People	0	0.00			cfm/ft²	2.49	0.76
Misc	55,536	0	55,536	8	55,536	Misc	0	0.00			cfm/ton	483.32	
Sub Total ==>	193,131	10,865	203,996	31	157,751	Sub Total ==>	0	0	0.00		ft²/ton	193.72	
Ceiling Load	1,347	-1,347	0	0	1,347	Ceiling Load	-450	0	0.00		Btu/hr-ft²	61.95	-136.47
Ventilation Load	0	0	111,018	17	0	Ventilation Load	0	-171,895	11.93		No. People	248	
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0	0				
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0	0.00				
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0	0.00				
Exhaust Heat	0	-206	-206	0	0	OA Preheat Diff.	0	-41,713	2.89				
Sup. Fan Heat	0	0	62,470	10	0	RA Preheat Diff.	0	-94,617	6.56				
Ret. Fan Heat	0	27,540	27,540	4	0	Additional Reheat	0	-2,523	0.18				
Duct Heat Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00				
Underflr Sup Ht Pkup	0	0	0	0	0	Supply Air Leakage	0	0	0.00				
Supply Air Leakage	0	0	0	0	0	Grand Total ==>	-1,129,706	-1,441,249	100.00				
Grand Total ==>	443,605	37,234	654,326	100.00	408,224	Grand Total ==>	-1,129,706	-1,441,249	100.00				

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	54.5	654.3	548.3	26,354	74.8	61.7	65.4	55.2	53.0	59.4
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	54.5	654.3								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	10,563		
Part	28,550		
Int Door	0		
ExFlr	6,318		
Roof	0	0	0
Wall	4,408	1,630	37
Ext Door	42	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	-170.0	3,245	6.0	55.2
Reheat	-141.8	8,001	55.2	71.9
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1,441.5			

System Checksums

By ACADEMIC

RGE AHU-4

Bypass Multizone

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 16		Mo/Hr: 7 / 24		Mo/Hr: Heating Design							
Outside Air:		OADB/WB/HR: 85 / 71 / 95		OADB: 69		OADB: 6							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Cooling	Heating			
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Space Sens	Tot Sens	(%)					
Envelope Loads				Envelope Loads							AIRFLOWS		
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00			Diffuser	Cooling	Heating
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00			18,956	18,956	18,956
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00			Terminal	18,956	18,956
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00			Main Fan	18,956	18,956
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00			Sec Fan	0	0
Wall Cond	1,571	248	1,819	0	2,587	1	Wall Cond	-5,090	-5,894	8.89	Nom Vent	450	450
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0	0.00	AHU Vent	450	450
Floor	-172	0	-172	0	2,473	1	Floor	-32,129	-32,129	48.47	Infil	0	0
Adjacent Floor	0	0	0	0	0	0	Adjacent Floor	0	0	0.00	MinStop/Rh	0	0
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00	Return	18,506	18,506
Sub Total ==>	1,399	248	1,647	0	5,061	1	Sub Total ==>	-37,220	-38,023	57.37	Exhaust	0	0
Internal Loads				Internal Loads							ENGINEERING CKS		
Lights	30,717	0	30,717	8	30,717	9	Lights	0	0	0.00	% OA	2.4	2.4
People	0	0	0	0	0	0	People	0	0	0.00	cfm/ft²	3.16	3.16
Misc	307,170	0	307,170	83	307,170	90	Misc	0	0	0.00	cfm/ton	614.54	
Sub Total ==>	337,887	0	337,887	91	337,887	99	Sub Total ==>	0	0	0.00	ft²/ton	194.52	
Ceiling Load	22	-22	0	0	36	0	Ceiling Load	-71	0	0.00	Btu/hr-ft²	61.69	-11.05
Ventilation Load	0	0	19,310	5	0	0	Ventilation Load	0	-28,258	42.63	No. People	0	
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0			
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	0	0	0.00			
Ov/Undr Sizing	183	0	183	0	0	0	Exhaust Heat	0	0	0.00			
Exhaust Heat	0	0	0	0	0	0	OA Preheat Diff.	0	0	0.00			
Sup. Fan Heat	0	0	11,119	3	0	0	RA Preheat Diff.	0	0	0.00			
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00			
Duct Heat Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00			
Underflr Sup Ht Pkup	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00			
Supply Air Leakage	0	0	0	0	0	0	Grand Total ==>	-37,290	-66,281	100.00			
Grand Total ==>	339,491	226	370,146	100.00	342,983	100.00	Grand Total ==>	-37,290	-66,281	100.00			

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION					
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh	MBh	°F	°F	gr/lb	°F	°F	gr/lb		ft² (%)	MBh	cfm	°F	°F			
Main Clg	30.9	370.2	357.3	18,763	72.3	58.2	53.4	54.4	50.9	52.3	Floor	6,000		Main Htg	-66.3	18,956	63.6	66.9
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	0		Preheat	0.0	0	0.0	0.0
											ExFlr	6,000		Humidif	0.0	0	0.0	0.0
Total	30.9	370.2									Roof	0	0	Opt Vent	0.0	0	0.0	0.0
											Wall	3,200	0	Total	-66.3			
											Ext Door	0	0					