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TECHNICAL REPORT THREE: MECHANICAL SYSTEMS EXISTING CONDITIONS EVALUATION

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Executive Summary

This report is an examination of the currently existing mechanical system in the NEOMED Research and Graduate Education building and the Comparative Medical Unit expansion. It includes initial design conversation and discussion, load and other calculations, basic system breakdown, and evaluation of cost, space, and LEED certification potential.

Based on the analyses that follow, the top priority of the owner appear to be maintaining a top-notch research and education facility with flexibility and accessibility for students and staff. Considerations for energy efficiency and cost are absolutely made, but do not interfere with established operations and programming.

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.

Early Design Criteria

Objectives and requirements

The new Research and Graduate Education Building was built to help the university address the biomedical research and education needs of the region. It provides a working space for 30+ scientists focused on research involving better diagnosis and treatment of arthritis, cardiovascular disease, Alzheimer's disease, and innovative ways to design and deliver new medicines. The facility provides full support for teams with offices for faculty, write-up areas for researchers, small group teaching rooms, and open lab and support spaces. The top floor is shelled out for future program expansion.

The existing Comparative Medical Unit provides animal care services for research and teaching programs at the university. It is staffed by 8 personnel under a qualified vet specializing in lab animal medicine. The addition to the existing building was meant to expand animal care capabilities by adding to the vivarium and providing additional mechanical space.

Due to the sensitive nature of the activities in the lab and vivarium spaces, 100% outdoor air is required for these areas. As a result of this requirement, serious thought was given to the different energy recovery measures that could be taken to minimize the energy use of airside systems. HVAC System design was intended to have following characteristics: modular approach, energy responsiveness, flexibility for future changes, durability and ease of maintenance, reliability, and redundancy of critical components.

Code requirements that were followed include:

- Ohio State Building and Mechanical Codes.
- NEOUCOM Design and Engineering Guidelines
- Recommendations of the National Fire Protection Association (NFPA), in general, and, in particular:
    - HVAC: NFPA 90A, 90B, 96
    - HVAC: NFPA 45
- Recommendations of ASHRAE including ASHRAE 62-1999, Indoor Air Quality and ASHRAE/ANSI 15, Chiller Mechanical Rooms.
- National Electrical Code (NEC)
- Energy Conservation Act 222
- ANSI Z 9.5
- USGBC LEED Criteria
- NIH Design Requirements Manual
- Recommendations of AAALAC (animal areas)

Outdoor design conditions

The project is located in Rootstown, Ohio, which ASHRAE places in region 5A-cool and moist. The project mechanical system was designed with a winter exterior design temperature of 0 degrees F and a summer exterior design temperature of 89 degrees dry bulb/73 degrees wet bulb +- 2 degrees.

Indoor design Conditions

Indoor design temperature and humidity varies based on space type. Labs and support spaces are set to 72 degrees F year-round. Mechanical and electrical rooms are conditioned to 65 degrees during the winter and ventilated with no conditioning in the summer. Animal holding rooms in the CMU have a selectable range from 68-85 degrees to provide species-appropriate conditioning, with the exception of rabbit holding areas set to exactly 65 degrees.

Humidity in the lab and associated support spaces is set to 35%(±5) in the winter and 50% (±5%) in the summer. Vivarium spaces in the CMU are set to 30-40%(±5) during winter and 50% (±5%) during summer.

Available utilities and rates

Campus utilities include electric, natural gas, cold water and sanitary/storm sewer. Electrical service consists of a high voltage loop stepped down to 480/277 and 208/120 at each building. Site natural gas piping is a mix of low pressure and medium pressure.

With regards to heating, roughly 6 or 8 boiler plants are located at various points on the existing campus. Typically one “heating” location is present for a heating water loop for each building project. The largest of these is the existing boiler and chiller plant in the M building, just to the east of existing CMU. This main plant feeds all of the original 1974 part of campus. The chillers at M Building feed nearly all of the entire campus as well. There are some smaller DX cooling units scattered throughout the campus, but they are not a significant percentage of the campus cooling capacity.

In addition to chillers and boilers, Building M also contains a high pressure steam boiler plant that makes 80 psig steam. Originally a coal fired plant in 1974 with two large coal boilers, it was switched to four natural-gas fired Ohio-Special steam boilers in 1991. The steam plant once served heat exchangers in the M building boiler room, AHU heating coils throughout campus, the DHW tank in the M building, numerous humidifiers throughout campus, and many lab steam outlets, plus steam sterilizers. The NEOMED campus has since downsized their use of steam, and now only hi-pressure steam is distributed to the CMU vivarium equipment, humidifiers in the CMU, and steam sterilizers.

Design influences

Operability was a major influence in initial design, and is one of the factors that drove the decision to provide stand-alone utilities for the RGE Building. The RGE is intended to be available 24/7 to the scientists and their teams, and also the CMU must be able to provide 24/7 HVAC for the animals in the vivarium.

Distance to existing utilities also drove the decision to include stand-alone utilities. Originally, the design team considered extending the hi-pressure steam from the existing M building boiler room to the new RGE building, but that was cut due to budgetary concerns. Space was reserved in the RGE lab AHUs for humidifiers to be installed later, along with space for a medium pressure steam boiler in RGE basement. Also, the design team looked at extending piping from the central M building boiler and chiller plant; however, there was still going to be a need for additional chilled water and heating capacity so the cost to just include a new plant was very similar. Direct burial was considered as well as an indoor route, but that was complicated by the fact that the bridge connectors were alternate bids. The CMU addition is however connected to the M building boiler and chiller plant as well as the steam plant, seeing as the existing utilities were already located in the original building.

A variable air volume was deemed the safest and most obvious choice for airside systems. Due to the very stringent air change per hour requirements and variety of unique spaces, plus the need for 100% outdoor air, custom air handling units were created for the RGE labs and Vivarium expansion. The office side of the RGE does include a custom 30% outdoor air unit with a mixing plenum and economizer for some energy recovery.

Heat and energy recovery was a critical design point due to the large air turnover rate; a number of options were weighed. Desiccant dehumidification was ruled out, primarily due to the chemicals and contaminants that would be present. The design team did not know how those would have reacted with the desiccants, so they erred on the safer side. Also, the additional efficiency would primarily occur during cooling season and in a cool wet climate it was not “where the money was” with savings. Air-to-air, wheel, and heat-pipe systems were all eliminated as energy recovery systems due to their potential cross-over for contamination. A heat-pipe recovery was briefly considered, but would have needed to be a two coil design which is a more complex and expensive variety. The only options left were either simple run-around glycol coils or a heat pump between the outside air and exhaust air streams. The design team elected to use glycol coils in the end.

With concern to controls, the team did not consider CO2 monitoring since most spaces were going to have occupancy sensors; some of the sensors unfortunately did get value-engineered out. The new addition has an automatic temperature control system consisting of an independent direct digital control circuit. This circuit is connected and interfaced with the existing campus front ends to allow the campus-wide system to trend recording of the major equipment operation and alarms. This data is used to develop a point schedule for the RGE, as well as to trend recording of environmental conditions and lighting in the CMU to maintain AAALAC accreditation.

A RO/DI water system was provided for the labs and vivarium spaces, sized to supply the feed for the animal watering equipment. A separate laboratory waste collection system was provided to drain all laboratory fixtures. The waste is piped through a duplex limestone chip tank neutralization system.

With regards to fire protection, the new RGE includes a combination wet sprinkler and standpipe system with sprinkler drain risers extended to spill to the exterior. It was important to specify non-ferrous piping and components to be used in areas subject to magnetic fields or equipment. In addition, a new fire pump room was provided in the RGE basement. The existing CMU building was non fire suppressed, so the new addition was designed to remain non fire suppressed with the inclusion of fire separation walls between the existing building and new addition.

Engineering calculations

Ventilation Rates

Designer ventilation rates were only necessary for the RGE office AHU, given it is the only one that does not rely on 100% outdoor air. Designer calculation could not be located.

Heating and Cooling Loads

Designer calculation are summarized in Appendix A

Annual Energy Consumption

At this point in time, energy meter readings and utility bills are not available

System Breakdown

Air

To achieve proper ventilation and space conditioning, there are five total air handling units for the project, broken down in the table below. AHU-1 and AHU-2 are located on the rooftop of the RGE and serve the Lab and Support areas, while AHU-3 is located on the roof as well and serves the RGE offices. AHU-4 is located in the Basement of the RGE and serves to simply provide constant volume ventilation and space conditioning to the mechanical plant.

Air Handling Units																	
				Fans									Coils			
				Supply			Return			Exhaust			Heating		Cooling	
NO.	Type	Area	Min. OA. CFM	NO.	CFM/fan	ESP	NO.	CFM/fan	ESP	NO.	CFM/fan	ESP	GPM	Tot. MBH	GPM	Tot. MBH
AHU-1	Custom VAV	RGE Labs	50,000	4	12,500	4.0"	-	-	-	2	50,000	4.75"	140	2085	470	3584
AHU-2	Custom VAV	RGE Labs	50,000	4	12,500	4.0"	-	-	-	2	50,000	4.75"	140	2085	470	3584
AHU-3	Custom VAV	RGE Offices	8,400	2	14,000	3.0"	1	28,000	2.0"	-	-	-	51	820	150	1294
AHU-4	Constant	RGE Basm.	450	1	4,500	1.0"	-	-	-	-	-	-	13	194.4	47	187
AHU-5	Custom VAV	CMU exp.	85,000	4	21,250	4.0"	-	-	-	3	42,500	4.0"	270	3420	625	6135

Hot water

Boilers							
NO.	Type	Medium	MBH In	MBH out	GPM	Steam PSIG	Min. Gas input pressure
B-1	Condensing	HW	3,000	2,883	225	-	3.5"
B-2	Condensing	HW	3,000	2,883	225	-	3.5"
B-3	Condensing	HW	3,000	2,883	225	-	3.5"
B-5	Firetube	Steam	1,969	1,697	-	80	9.5"
B-6	Modulating, Condensing	HW	3,000	2,664	133	-	3.5"
B-7	Modulating, Condensing	HW	3,000	2,664	133	-	3.5"

Hydronic Pumps						
	NO.	Type	Service	GPM	Head Pressure (FT H20)	MHP
RGE	HWP-1	End Suction	Primary Heating Water	450	72	15
	HWP-2	End Suction	Primary Heating Water	450	72	15
	CWP-1	End Suction	Chilled Water Pump	680	65	20
	CWP-2	End Suction	Chilled Water Pump	680	65	20
	TWP-1	Horiz. Split Case	Tower Water Pump	1275	65	30
	TWP-2	Horiz. Split Case	Tower Water Pump	1275	65	30
	HGRP-1	End Suction	AHU-1 Heat Recovery Coil	480	65	15
	HGRP-2	End Suction	AHU-2 Heat Recovery Coil	480	65	15
	HCP-1	In-line	AHU-1 Heating Coil	140	15	1
	HCP-2	In-line	AHU-2 Heating Coil	140	15	1
	HCP-3	In-line	AHU-3 Heating Coil	50	12	0.5
	HCP-4	In-line	AHU-4 Heating Coil	12	12	0.125
	CWP-3	In-line	AHU-4 Cooling Coil	47	25	0.75
CMU	HWP-1	End Suction	Heating Water	500	50	15
	HWP-2	End Suction	Heating Water	500	50	15
	HCP-1	In-line	AHU-5 Heating Coil	270	12	1.5
	HGRP-1	End Suction	Heat Recovery	540	65	15

Steam

Chiller water

Chillers					
NO.	Type	Tons Output	Min. Turndown Tons	Evap. GPM	Cond. GPM
CH-1	Centrifugal	425	45	680	1275
CH-2	Centrifugal	425	45	680	1275

Cooling Towers						
					Motors	
NO.	Type	Tons	No. Cells	Total GPM	HP	RPM
CT-1	Crossflow	425	1	1275	25	1800
CT-2	Crossflow	425	1	1275	25	1800

Energy Recovery

System Assessment

Initial cost

The rough estimate for the up-front costs of the mechanical system are tabulated below in Table __. The total budget for all mechanical work wound up at roughly $6.6 million out of a total project cost of roughly $40 million.

DESCRIPTION	QUANTITY	UNIT	UNIT PRICE	ESTIMATE	TOTAL
FIRE PROTECTION		$/SF	$3.44		$217,000
PLUMBING		$/SF	$21.00		$1,323,000
HVAC		$/SF	$80.94		$5,099,000

Space utilization

Due to the inclusion of a rooftop penthouse and utility basement, interference with the plan of the RGE was kept to a minimum. Roughly 6000 square feet of basement was used for the Mechanical plant. With the addition of roughly 1090 square feet lost to mechanical shaft space, the project only lost about 7100 square feet to the mechanical system. It is important to note however, that a large ceiling space was included due to big ductwork- a 3 foot plenum that results in a 14’8” floor-to-floor height. Negligible space was lost in CMU addition due to the inclusion of a penthouse, use of existing utilities, and the absence of shafts.

LEED Analysis

The project schematic design outline states that the team sought for a basic LEED Certification level. What follows is a quick breakdown of the RGE and CMU’s adherence to the Energy and Atmosphere and Indoor Environmental Air Quality sections of the USGBC LEED 2013 Standard for New Construction.

Energy and Atmosphere Credits

EA Prerequisite 1: Fundamental Commissioning and verification- pass

> Commissioning performed by PSI, INC

EA Prerequisite 2: Minimum Energy Performance- pass

> Option 2- follows ASHRAE Standard 90.1

EA PREREQUISITE: BUILDING-LEVEL ENERGY METERING-pass

> New meters installed for natural gas, HW, DCW, CW, Electric at CMU; meters for NG, Electric, and DCW at RGE

EA PREREQUISITE: FUNDAMENTAL REFRIGERANT MANAGEMENT-pass

No CFC's in any of new construction

EA CREDIT: ENHANCED COMMISSIONING-0 pts

No follow-up commissioning after building opened

EA CREDIT: OPTIMIZE ENERGY PERFORMANCE-0 pts

No energy modeling/simulation performed

EA CREDIT: ADVANCED ENERGY METERING-1 pt

Meters are interfaced with campus network. ATC stores data and trends and develops point schedule

EA CREDIT: DEMAND RESPONSE-0 pts

No demand response program used

EA CREDIT: RENEWABLE ENERGY PRODUCTION-0 pts

No renewable energy sources on campus utilized

EA CREDIT: ENHANCED REFRIGERANT MANAGEMENT- 0 pts

No analysis performed on refrigerants used

EA CREDIT: GREEN POWER AND CARBON OFFSETS-0 pts

No contract engaged

Indoor Environmental Quality Credits

EQ PREREQUISITE: MINIMUM INDOOR AIR QUALITY PERFORMANCE-pass

Project meets ASHRAE STD 62.1

EQ PREREQUISITE: ENVIRONMENTAL TOBACCO SMOKE CONTROL-pass

Due to the nature of the activities inside of both the RGE and CMU, smoking is prohibited in or around

EQ CREDIT: ENHANCED INDOOR AIR QUALITY STRATEGIES- 1 pt

Pressurized Vestibules are used at all entryways, areas with potentially hazardous chemicals are kept at negative pressure and sufficiently exhausted, and all AHU's have MERV-14 after filters

EQ CREDIT: LOW-EMITTING MATERIALS- 0pts

EQ CREDIT: CONSTRUCTION INDOOR AIR QUALITY MANAGEMENT PLAN- 0 pts

EQ CREDIT: INDOOR AIR QUALITY ASSESSMENT- 0 pts

EQ CREDIT: THERMAL COMFORT- 0 pts

All temperature and humidity controlled by ddc system to exact design specifications

EQ CREDIT: INTERIOR LIGHTING- 0 pts

Mostly fluorescents used, mostly automatic controls

EQ CREDIT: DAYLIGHT- 0 pts

No daylighting analyses performed

EQ CREDIT: QUALITY VIEWS- 1 pt

Layout and glazing is such that at least 75% of all regularly occupied spaces in RGE have unobstructed outdoor visibility.

EQ CREDIT: ACOUSTIC PERFORMANCE- 0 pts

No acoustical analysis performed

As evidenced by the previous analysis, the design did not truly aim for any sort of serious LEED certification, despite what the schematic outline states or what the original intent may have been.

Overall System Evaluation

Overall, the system functions very well towards meeting the priorities of the owner, which are running an excellent facility conducive to top-notch biomedical research, while maintaining some level of efficiency and affordability. Given the stringent design conditions, viable system options, and existing conditions, the mechanical design is very reasonable and functions well.

There do however exist potential opportunities for energy savings and cost cuts. If an alternative system for space conditioning were to be used, such as a chilled beam system, it could potentially result in reduced floor-to-floor height, less equipment, and less energy lost to air turnover. Further research will definitely be needed to evaluate whether this strategy can in fact meet air change and other requirements. In addition, given the general lack of energy and equipment analyses, potential exists for improvement in controls and equipment selection.

References

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Appendix

Air Handler #1 - RGE-AHU-3 - Total Load Summary

Air Handler Description:	RGE-AHU-3 Variable Air Volume
Supply Air Fan:	Draw-Thru with program estimated horsepower of 2.38 HP
Fan Input:	0% motor and fan efficiency with 0 in. water across the fan
Sensible Heat Ratio:	0.87 --- This system occurs 1 time(s) in the building. ---
Air System Peak Time:	1pm in August.
Outdoor Conditions:	Clg: 89° DB, 71° WB, 90.88 grains, Htg: 0° DB
Indoor Conditions:	Clg: 72° DB, 50% RH, Htg: 75° DB

Summer: Exhaust controls outside air, ----- Winter: Exhaust controls outside air.

Zone Space sensible loss:	240,061 Btuh			
Infiltration sensible loss:	0 Btuh	0 CFM		
Outside Air sensible loss:	0 Btuh	0 CFM		
Supply Duct sensible loss:	0 Btuh			
Return Duct sensible loss:	0 Btuh			
Return Plenum sensible loss:	0 Btuh			
Total System sensible loss:			240,061	Btuh
Heating Supply Air: 240,061 / (.957 X 1.08 X 20) =		11,612 CFM		
Winter Vent Outside Air (0.0% of supply) =		0 CFM		
Zone space sensible gain:	446,398 Btuh			
Infiltration sensible gain:	0 Btuh			
Draw-thru fan sensible gain:	5,793 Btuh			
Supply duct sensible gain:	0 Btuh			
Reheat sensible gain:	0 Btuh			
Total sensible gain on supply side of coil:			452,191	Btuh
Cooling Supply Air: 452,191 / (.957 X 1.1 X 17) =		25,265 CFM		
Summer Vent Outside Air (0.0% of supply) =		0 CFM		
Return duct sensible gain:	0 Btuh			
Return plenum sensible gain:	0 Btuh			
Outside air sensible gain:	0 Btuh	0 CFM		
Blow-thru fan sensible gain:	0 Btuh			
Total sensible gain on return side of coil:			0	Btuh
Total sensible gain on air handling system:			452,191	Btuh
Zone space latent gain:	67,650 Btuh			
Infiltration latent gain:	0 Btuh			
Outside air latent gain:	0 Btuh			
Total latent gain on air handling system:			67,650	Btuh
Total system sensible and latent gain:			519,841	Btuh

Check Figures

Total Air Handler Supply Air (based on a 17° TD):	25,265	CFM
Total Air Handler Vent. Air (0.00% of Supply):	0	CFM
Total Conditioned Air Space:	20,043	Sq.ft
Supply Air Per Unit Area:	1.2605	CFM/Sq.ft
Area Per Cooling Capacity:	462.7	Sq.ft/Ton
Cooling Capacity Per Area:	0.0022	Tons/Sq.ft
Heating Capacity Per Area:	11.98	Btuh/Sq.ft
Total Heating Required With Outside Air:	240,061	Btuh
Total Cooling Required With Outside Air:	43.32	Tons

Air Handler #1 - RGE-AHU-LAB - Total Load Summary

Air Handler Description:	RGE-AHU-LAB Variable Air Volume
Supply Air Fan:	Blow-Thru with program estimated horsepower of 5.46 HP
Fan Input:	0% motor and fan efficiency with 0 in. water across the fan
Sensible Heat Ratio:	0.92 --- This system occurs 1 time(s) in the building. ---
Air System Peak Time:	3pm in August.
Outdoor Conditions:	Clg: 91° DB, 71° WB, 86.97 grains, Htg: 0° DB
Indoor Conditions:	Clg: 72° DB, 50% RH, Htg: 75° DB

Summer: Exhaust controls outside air, ----- Winter: Exhaust controls outside air.

Zone Space sensible loss:	207,430 Btuh		
Infiltration sensible loss:	0 Btuh	0 CFM	
Outside Air sensible loss:	0 Btuh	0 CFM	
Supply Duct sensible loss:	0 Btuh		
Return Duct sensible loss:	0 Btuh		
Return Plenum sensible loss:	0 Btuh		
Total System sensible loss:			207,430 Btuh
Heating Supply Air: 207,430 / (.957 X 1.08 X 20) =		10,034 CFM	
Winter Vent Outside Air (0.0% of supply) =		0 CFM	
Zone space sensible gain:	1,219,004 Btuh		
Infiltration sensible gain:	0 Btuh		
Draw-thru fan sensible gain:	0 Btuh		
Supply duct sensible gain:	0 Btuh		
Reheat sensible gain:	0 Btuh		
Total sensible gain on supply side of coil:			1,219,004 Btuh
Cooling Supply Air: 1,219,004 / (.957 X 1.1 X 20) =		57,892 CFM	
Summer Vent Outside Air (0.0% of supply) =		0 CFM	
Return duct sensible gain:	0 Btuh		
Return plenum sensible gain:	0 Btuh		
Outside air sensible gain:	0 Btuh	0 CFM	
Blow-thru fan sensible gain:	13,275 Btuh		
Total sensible gain on return side of coil:			13,275 Btuh
Total sensible gain on air handling system:			1,232,279 Btuh
Zone space latent gain:	107,888 Btuh		
Infiltration latent gain:	0 Btuh		
Outside air latent gain:	0 Btuh		
Total latent gain on air handling system:			107,888 Btuh
Total system sensible and latent gain:			1,340,166 Btuh

Check Figures

Total Air Handler Supply Air (based on a 20° TD):	57,892 CFM
Total Air Handler Vent. Air (0.00% of Supply):	0 CFM
Total Conditioned Air Space:	33,050 Sq.ft
Supply Air Per Unit Area:	1.7516 CFM/Sq.ft
Area Per Cooling Capacity:	295.9 Sq.ft/Ton
Cooling Capacity Per Area:	0.0034 Tons/Sq.ft
Heating Capacity Per Area:	6.28 Btuh/Sq.ft
Total Heating Required With Outside Air:	207,430 Btuh
Total Cooling Required With Outside Air:	111.68 Tons

Air Handler #1 - CMU-AHU-1 - Total Load Summary

Air Handler Description:	CMU-AHU-1 Variable Air Volume
Supply Air Fan:	Draw-Thru with program estimated horsepower of 1.39 HP
Fan Input:	0% motor and fan efficiency with 0 in. water across the fan
Sensible Heat Ratio:	0.89 --- This system occurs 1 time(s) in the building. ---
Air System Peak Time:	4pm in June.
Outdoor Conditions:	Clg: 88° DB, 72° WB, 97.09 grains, Htg: 0° DB
Indoor Conditions:	Clg: 71° DB (avg.), 50% RH, Htg: 74° DB (avg.)

Summer: Ventilation controls outside air, ----- Winter: Ventilation controls outside air.

Zone Space sensible loss:	110,832	Btuh				
Infiltration sensible loss:	0	Btuh	0	CFM		
Outside Air sensible loss:	759,475	Btuh	9,948	CFM		
Supply Duct sensible loss:	0	Btuh				
Return Duct sensible loss:	0	Btuh				
Return Plenum sensible loss:	0	Btuh				
Total System sensible loss:					870,307	Btuh
Heating Supply Air: 110,832 / (.957 X 1.08 X 11) =			9,621	CFM		
Winter Vent Outside Air (103.4% of supply) =			9,948	CFM		
Zone space sensible gain:	261,537	Btuh				
Infiltration sensible gain:	0	Btuh				
Draw-thru fan sensible gain:	3,389	Btuh				
Supply duct sensible gain:	0	Btuh				
Reserve sensible gain:	0	Btuh				
Total sensible gain on supply side of coil:					264,926	Btuh
Cooling Supply Air: 264,926 / (.957 X 1.1 X 17) =			14,781	CFM		
Summer Vent Outside Air (100.0% of supply) =			14,781	CFM		
Return duct sensible gain:	0	Btuh				
Return plenum sensible gain:	0	Btuh				
Outside air sensible gain:	264,166	Btuh	14,781	CFM		
Blow-thru fan sensible gain:	0	Btuh				
Total sensible gain on return side of coil:					264,166	Btuh
Total sensible gain on air handling system:					529,093	Btuh
Zone space latent gain:	31,193	Btuh				
Infiltration latent gain:	0	Btuh				
Outside air latent gain:	372,252	Btuh				
Total latent gain on air handling system:					403,445	Btuh
Total system sensible and latent gain:					932,538	Btuh

Check Figures

Total Air Handler Supply Air (based on a 17° TD):	14,781	CFM
Total Air Handler Vent. Air (100.00% of Supply):	14,781	CFM
Total Conditioned Air Space:	14,704	Sq.ft
Supply Air Per Unit Area:	1.0052	CFM/Sq.ft
Area Per Cooling Capacity:	189.2	Sq.ft/Ton
Cooling Capacity Per Area:	0.0053	Tons/Sq.ft
Heating Capacity Per Area:	59.19	Btuh/Sq.ft
Total Heating Required With Outside Air:	870,307	Btuh
Total Cooling Required With Outside Air:	77.71	Tons