Technology and Engineering Development (TED) Building

Thomas Jefferson National Accelerator Facility

Newport News, VA

Tech Report II

Building and Plant Energy Analysis Report

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Executive Summary

Load and energy simulations allow a designer to identify areas of a building where efficiency can be improved. A block simulation is run for the TED to determine an approximation of its mechanical loads, operational costs, and impact on the environment. The results of the simulation will be used as a baseline to compare the effects of re-designs that will be completed in later parts of this thesis. Trane Trace 700 v6.2 is the software used for this simulation because it was used by the designer to run a room by room simulation. By using the same software, results of each simulation can be directly compared without considerations of intrinsic programming differences.

The results of the block simulation showed a total cooling load of 213 tons and a total heating load of 1929 MBtuh. Compared to loads calculated by the designer in a room by room analysis, errors in the block load model simulation are 13% for cooling and -13.5% for heating. These values show that the block load model serves as a good approximation of the overall mechanical loads on the building. More specific load comparisons that appear later in this report include cooling ft^2/ton, heating Btuh/ft^2, total supply air cfm/ft^2, and ventilation supply cfm/ft^2.

The results of an energy simulation that uses the same block model predict a total energy use of 6.21×10^6 kBtu/yr and a total annual energy cost of $115,175. More specific data such as monthly energy use and costs for the heating and cooling plants, fans, pumps, lighting, and miscellaneous loads are discussed later in this report. Because the building is currently under construction, a comparison of simulated energy use and costs to actual utility bills is not completed. However, an energy simulation run by the designer is compared to the energy simulation run using the block model. An environmental impact analysis in the last section of this report uses the annual energy use results to determine the production of emissions such as $C0_2$, NO_X, and SO_X in lbm/yr.

Section 1 Design Load Estimation

1.1 TED Mechanical System Overview

Two air-handling units (AHU) supply 55ºF air to variable air volume terminal boxes throughout the TED. The AHUs contain a mixing box, MERV 8/13 filter, preheat coil, and cooling coil while the terminal boxes contain a re-heat coil to condition air more specifically to each zone. Gas fired steam humidifiers are also included downstream of each AHU. AHU-1 supplies the first floor and high bay zones while AHU-2 supplies the second floor. Each AHU utilizes an economizer and is coupled with an outdoor air pre-conditioning unit (OAU) that uses building exhaust air to pre-condition outdoor air via a total energy wheel. Additional space conditioning equipment includes two cabinet unit heaters, located in two exit stairwells, and three water cooled wall mounted air conditioning units that serve each of the three data closets.

The central plant is composed of twelve water source heat pumps that create 44ºF chilled and 120ºF hot water. This water is used for the heating and cooling coils in the AHUs, terminal boxes, cabinet unit heaters, and water cooled air conditioning units. The condenser water is pumped through a vertical bore loop geothermal system and is maintained between 50ºF and 90ºF, depending on whether the system is heating or cooling. A closed circuit air cooler and gas fired condenser boiler are also included in the system to be used for close to peak design load conditions. Variable frequencies drives are used for air handling unit supply and return fans, and condenser water, chilled water, and hot water circulation pumps.

1.2 Model Construction

A block load model is used to get an approximation of mechanical system loads and overall energy use. It does not have as good accuracy as a room-by-room model, however, can be completed in less time, with less specific information, and with a smaller program file size. For the TED block load model, rooms with similar occupancy types were grouped together into zones which were, then, each assigned to appropriate systems. Two variable air volume with minimum 30% flow systems were created to represent AHU-

1 and AHU-2. For each system, supply fan data such as type, static pressure, and energy use were entered from the design schedules. Zones on the first floor and high bay were assigned to AHU-1 while zones on the second floor were assigned to AHU-2. Each AHU is equipped with an economizer and was coupled with a pre-conditioning unit as described in the mechanical system overview. An additional system was created to model the load on the three wall mounted air-conditioning units serving the data rooms. Packaged water-cooled air conditioning units were the type of system chosen. Figures 1-2-1 and 1-2-2 on the following page outline the areas that make up each zone.

Exterior wall, window, and door areas for each zone were calculated using a combination of design floor plans and elevations [1]. Roof areas for the second floor zones and the high bay were assumed to be the same as their floor area and the skylight located above the corridor on the second floor was included. Detailed spreadsheets that outline specific construction materials, properties, and wall orientations used for each zone can be found in Appendix A of this report.

Figure 1-2-1: First Floor Zones (AHU-1).

Figure 1-2-2: Second Floor Zones (AHU-2).

1.3 Design Conditions

Environmental design conditions for Norfolk, VA were used because Newport News is located approximately 20 miles NWW of Norfolk. To account for worst-case conditions, 0.4% summer design day and 99.6% winter design day values were used. Tables 1-3-1 below shows specific environmental and indoor design conditions used in the model.

Table 1-3-1: Environmental and Indoor Design Conditions.

Condition	Summer	Winter
OA DB (ºF)	91.9	22.0
OA WB (ºF)	77.1	NA
IA DB (ºF)	75.0	68.0
IA RH (%)	50.0	50.0
Mech/Elec DB (ºF)	80.0	60.0
Mech Elec RH (%)	50.0	50.0
Clearness #	0.85	0.85
Ground Reflectance	0.20	0.20
OA CO2 (ppm)	400	400

1.4 Internal Loads and Schedules

Occupancy loads come from the metabolic rate of human activity in a space. Information relating to the design population of each zone was obtained from the designer and the sensible and latent loads created by people in each zone were determined from ASHRAE Handbook – Fundementals [2]. Table 1-4-1 on page 9 details the occupancy load assumptions.

Ventilation rates for each zone were obtained from the design schedules. Terminal boxes serving the same modeled zone were grouped together and their minimum required ventilation flow rates were summed. The sum represented the ventilation rate for each zone. Table 1-4-1 on the following page details these values.

The total lighting power for each zone was determined by summing the power for each fixture in the zones. This information was made available through lighting plans and schedules. The total power was divided by the area of each zone to determine the lighting power density in W/ft^2. This power density was combined with an assumption that 80% of the power was dissipated to the space as cooling load. Table 1-4-1 on the following page details the calculated lighting power densities.

Miscellaneous loads were determined using the electrical engineering basis of design report where power densities were described for offices, labs, and utility areas (corridors, mech/elec, etc.). Singular loads resulting from data centers were obtained from the designer. Table 1-4-1 on the following page details the values assumed for all miscellaneous loads.

An occupancy schedule was developed based on the normal working hours at Jefferson Lab of 7 AM – 5 PM on Monday through Friday. After 5 PM, it is assumed most employees will leave the building and only few employees with janitorial staff will remain. The building is assumed to be unoccupied during the weekend. Lighting and miscellaneous load schedules are based on typical low-rise office building usage times. The largest deviation from full load is at midday, when people are assumed to eat lunch in either a cafeteria or out of the building and not be at their workstations. Table 1-4-2 on the following page details the occupancy, lighting, and miscellaneous load schedules for a typical weekday.

Table 1-4-1: Internal loads.

Zone	Floor Area (ft^2)	P_z (ppl)	Occupancy Load Classification	Occupancy Sensible (Btu/h/per)	Occupancy Latent (Btu/h/per)	Ventilation Min OA (cfm)	Lighting Power (W)	Lighting Density (W/ft^2)	Misc. Density (W/ft^2)
1_Workshop	6081.0	12	Light Bench Work	275	475	775	10956	1.802	3.50
1_Office	7233.0	75	Mod. Active Office Work	250	200	2600	8020	1.109	3.50
1_Computer Lab	6485.0	75	Mod. Active Office Work	250	200	3500	10752	1.658	15.00
1_Mech/Elec	1101.0	0	NA	0	0	0	336	0.305	1.50
1_Corridor	5488.0	12	Walking	250	200	1665	2000	0.364	1.50
1_High Bay	10225.0	35	Manufacturing	275	275	2940	10280	1.005	1.50
CUH-1	280.0	0	NA	0	0	0	112	0.400	1.50
CRU 1-1	101.0	0	NA	0	0	0	112	1.109	5120 W
CRU 1-2	73.0	0	NA	0	0	0	112	1.534	5165 W
Floor 1 Total	37067.0	209.0					42680.0	1.151	
2_Office	18507.0	184	Mod. Active Office Work	250	200	6975	12600	0.681	3.50
2_Conference	1103.0	76	Seated, Very Light Work	245	155	1320	1140	1.034	3.50
2_Health Club	955.0	20	Athletics/Gym	710	1090	700	280	0.293	1.50
2_Mech/Elec	2627.0	0	NA	0	0	0	1400	0.533	1.50
2_Corridor	7941.0	0	Walking	250	200	1710	5364	0.675	1.50
CUH-2	265.0	0	NA	0	0	0	280	1.057	1.50
CRU 2-1	103.0	0	NA	0	0	0	112	1.087	5125 W
Floor 2 Total	31501.0	280.0					21176.0	0.672	
Building Total	68568.0	489.0					63856.0	0.931	

Table 1-4-2: Load schedules.

Time	Occ. %	Lighting %	Misc %
Midnight - 7 AM	0	5	5
7 AM - 8 AM	100	80	80
8 AM - 9 AM	100	90	90
9 AM - 10 AM	100	90	90
10 AM - 11 AM	100	95	95
11 AM - Noon	80	95	95
Noon - 1 PM	40	80	80
1 PM - 2 PM	80	80	80
2 PM - 3 PM	100	90	90
3 PM - 4 PM	100	90	90
4 PM - 5 PM	100	95	95
5 PM - 6 PM	30	80	80
6 PM - 7 PM	10	70	70
7 PM - 8 PM	10	60	60
8 PM - 9 PM	10	40	40
9 PM - 10 PM	10	30	30
10 PM - Midnight	5	20	20

1.5 Modeled vs. Designed Load Comparison

All of the assumptions that were mentioned in the previous sections of this report were put into Trane Trace 700 v6.2 software and the block load simulation was run. Screenshots of sample input dialogues are provided in Appendix B. Table 1-5-1 below compares modeled and designed values.

Table 1-5-1: Modeled vs. Design Loads.

		Cooling ft^2/ton		Heating Btuh/ft^2		Supply Air cfm/ft^2		% OA	
	Area (ft^2)	Modeled	Designed	Modeled	Designed	Modeled	Designed	Modeled	Designed
AHU-1	36893	322.3	422.53	29.11	32.98	1.01	0.79	30.7	21
AHU-2	31398	332.5	310.78	27.23	34.01	0.9	0.93	37.8	52.6
Wall Mounted AC	277	61.61	60.45	0	0	8.66	8.66	0	0

The largest difference between the modeled and designed values can be seen in the Cooling ft^2/ton for system AHU-1. A lower modeled value is indicative of the fact that the block cooling load calculated for AHU-1 was 34% higher than that of the room by room cooling load calculated by the designer. Another significant difference is the heating load for the entire building being lower in the block results than in the designer's results. A possible source for these occurrences may be the over-estimation of plug loads in the block model. Plug loads are sources of heat generated inside the building due to (mainly) electronics plugged into receptacles. An over-estimation of this internal heat gain can increase cooling loads and decrease heating loads. A reason for the plug load estimation error is discussed further in section 2.2 of this report.

In summary, the loads resulting from the block model simulation are in relative agreement with the results calculated by the designer in a more specific room by room model. This report has shown that block models can make a good approximation of loads on the building without sacrificing time and money. This realization can be useful to engineers and building designers in determining the effectiveness of different solutions early in the design process.

Section 2 Annual Energy Consumption and Operating Costs

2.1 Utilities

Electricity is provided to the TED via a Dominion Virginia Power substation. Dominion Power has various rate schedules and each depend on the type and amount of service provided to the customer. The basis of design report mentions that the peak electricity demand is expected to be less than 500 kW. In addition, the TED is assumed to be a commercial business. These two parameters qualify the TED to be considered under the GS-2 Intermediate General Service (30 - 500 kW) Schedule [3].

Natural gas is available on the Jefferson Lab site, however, no information about the specific source and cost could be located. Instead, the average cost of natural gas ($\$/ft^3$ converted to $/therm) in Virginia for the first six months in 2010 as reported by the U.S. Energy Information Administration was used [4]. Table 2-1-1 below summarizes the utility rates for the TED.

Table 2-1-1: Utility Rates.

Electricity	Consumption ($/kWh)	Demand ($/kW)	Min Charge ($/Month)
June - September	0.06689	5.506	21.17
October - May	0.05969	4.068	21.17
Natural Gas	**Consumption ($/therm)**		
Virginia 2010 Ave.	0.977		

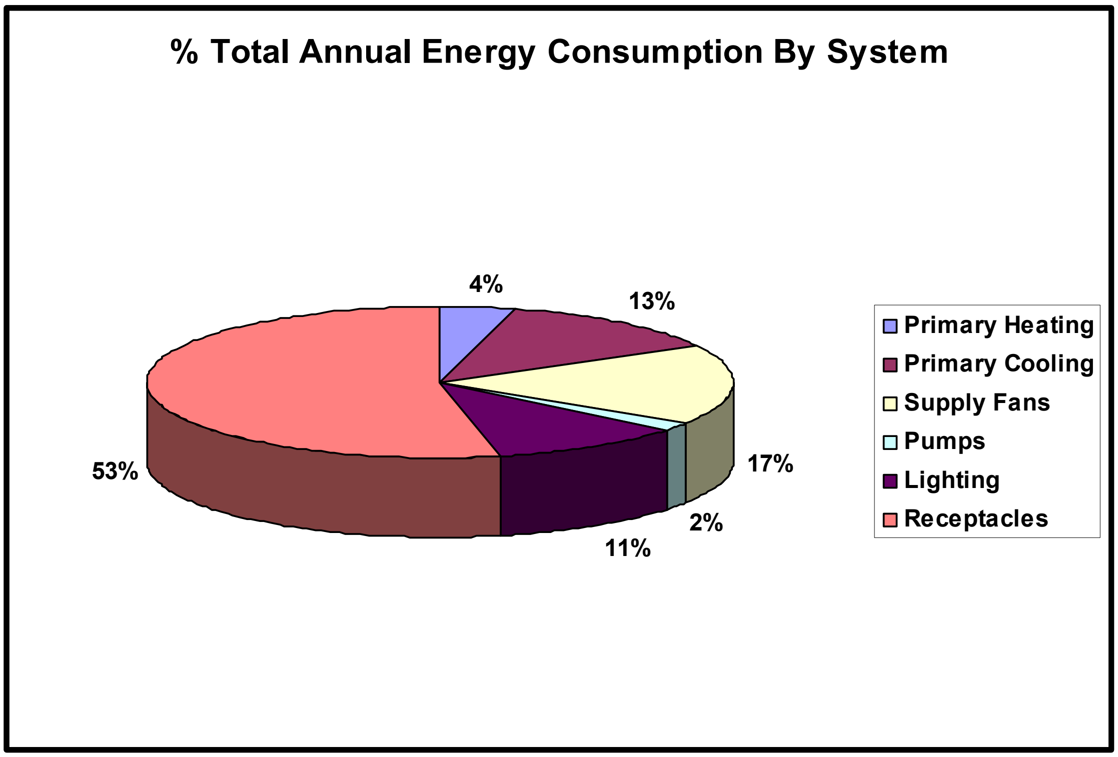
2.2 Annual Energy Consumption and Costs

The total energy consumption calculated by the block load model was broken down by building system and compared to the energy analysis prepared by the designer. Table 2-2-1 and Figure 2-2-1 on the following page summarize this breakdown. Note that the largest differences in predicted consumption appear in the heating system and in the receptacle loads.

Table 2-2-1: Annual Energy Consumption by Building System (Modeled).

	Electricity (kWh)		Gas (kBtu)	
System	Modeled	Designed	Modeled	Designed
Primary Heating	31,407	11,949	163,785	95,857
Primary Cooling	235,745	200,169	-	-
Supply Fans	323,354	205,143	-	-
Pumps	31,792	39,011	-	-
Lighting	203,843	193,442	-	-
Receptacles	993,946	418,511	-	-
Building Total	**1,820,087**	**1,068,225**	**163,785**	**95,857**

Figure 2-2-1: Annual Energy Consumption by Building System (Modeled).



The energy consumed by the modeled primary heating system is significantly more than the predicted energy consumption by the designed primary heating system. The likely source of error may be contributed to inaccuracies in creating the heating plant in the Trace block model due to a combination of user unfamiliarity with the program and the untraditional nature of the central heating and cooling plant.

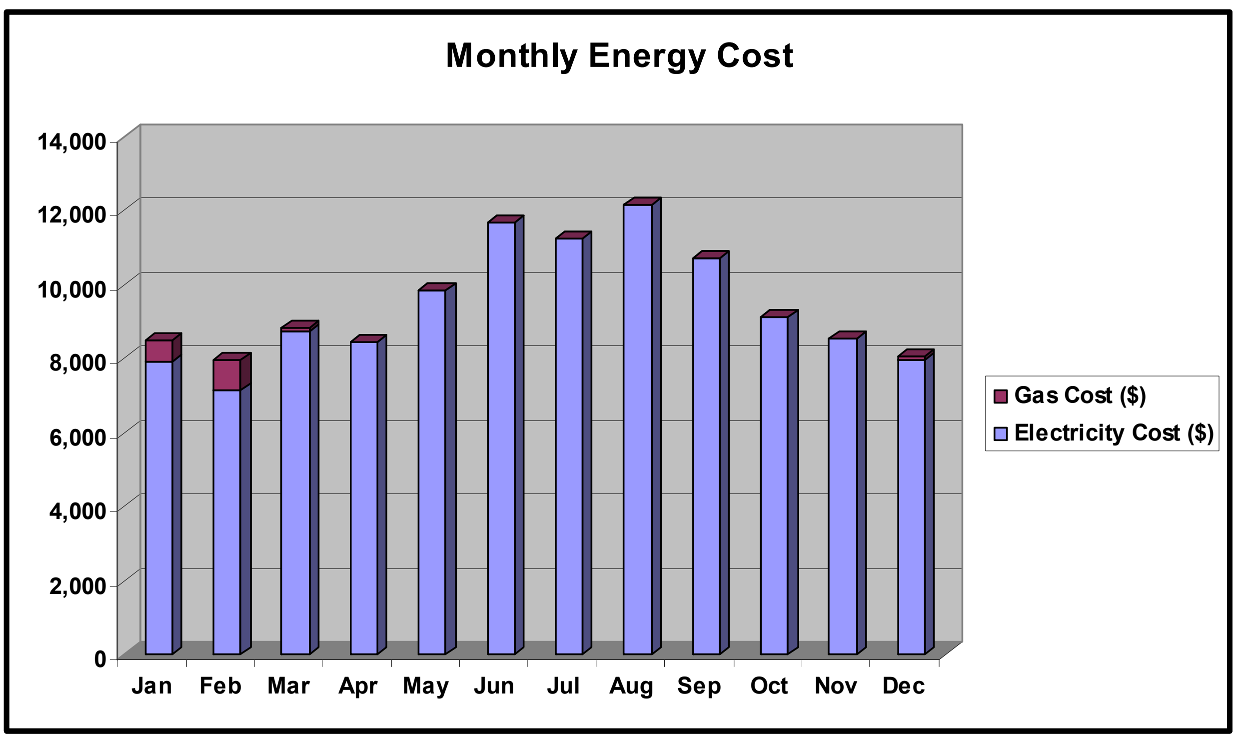
The modeled receptacle load is more than double the designed receptacle load. This could be attributed to the nature of the block load. Areas with smaller power densities (W/ft^2), such as corridors or storage rooms, may be included in areas with larger power densities. For instance, the zone called 1_Computer Labs has a specified receptacle power density of 15 W/ft^2. Any extra area included in this zone that would not necessarily be included in a room by room analysis would have a large effect on the load contributed by that zone.

Table 2-2-2 and Figure 2-2-2 below show the monthly energy consumption, monthly energy cost, total energy cost, and total cost per square foot of floor area.

Table 2-2-2: Monthly Energy Consumption and Cost (Modeled).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Electricity (kWh)	132,364	119,691	146,685	141,865	164,948	174,656	168,286	181,867	160,140	152,959	142,844	133,783	1,820,088
Electricity Cost ($)	7,901	7,144	8,756	8,468	9,846	11,683	11,257	12,165	10,712	9,130	8,526	7,986	113,574
Gas (therms)	611	838	91	0	0	0	0	0	0	0	4	94	1,638
Gas Cost ($)	597	819	89	0	0	0	0	0	0	0	4	92	1,601
Total Cost ($)	8,498	7,963	8,845	8,468	9,846	11,683	11,257	12,165	10,712	9,130	8,530	8,078	115,175
Building Area (ft^2)	**68,568**												
Total Utility Cost ($)	**115,175**												
Cost Density ($/ft^2)	**1.68**												

Figure 2-2-2: Monthly Energy Cost By System (Modeled).



From Figure 2-2-2 on the previous page, it can be seen that electricity consumption dominates the cost of energy in the TED. This is because the primary source of both hot water and chilled water is the twelve water source heat pumps connected to a vertical bore geothermal loop. Electricity is used in the heat pump compressors as well condenser water, chilled water, and hot water pumps. The gas fired boiler is only used in the cases of close to peak heating design load.

An energy density for the TED was calculated in order to establish a comparison of energy efficiency to other buildings in the United States. The total annual energy consumption was summed and divided by the building floor area, resulting in an energy density of 90.6 kBtu/ft^2. According to a United States Department of Energy's Energy Information Administration report that surveyed energy consumption in commercial buildings in 2003, typical buildings ranging in size from 50,001 ft^2 to 100,000 ft^2 in the East North Atlantic part of the US have an average energy density of 91.5 kBtu/ft^2 [5]. Typical office buildings in the same location have an energy density of 120 kBtu/ft^2 [5]. Though the TED is not fully considered an office building, it is the most similar building type surveyed. When compared to buildings of similar size and type, the TED uses below average amounts of energy per square foot of floor area.

2.3 Annual Emissions Production

The total number of pollutant emissions must be accounted for in order to consider the total impact of a building on the environment. The National Renewable Energy Laboratory (NREL) produced a report in 2007 [6] that describes how building designers can easily calculate the production of various pollutants based on total building energy use. A number of tables contain emission factors for each pollutant based on the form of the energy and whether it was derived or combusted on site. To calculate the total annual emissions of the TED, Table 3 Total Emission Factors for Delivered Electricity and Table 8 Emission Factors for On-Site Combustion in a Commercial Boiler are used [6]. Table 2-3-1 on the following page summarizes the results.

Table 2-3-1: Annual Emissions Production.

Electricity (kWh/yr) = 1,820,087			Natural Gas (kBtu/yr) = 163,785; 1000 Btu = 1 ft^3; Natural Gas (1000 ft^3/yr) = 163.785		
Pollutant	**Delivered Electricity Emissions Factor (lb/kWh)**	**Annual Emissions (lb/yr)**	**On Site Combustion Emissions Factor (lb/1000 ft^3)**	**Annual Emissions (lb/yr)**	**Total Annual Emissions (lb/yr)**
CO2e	1.74E+00	3.17E+06	1.23E+02	2.01E+04	**3.19E+06**
CO2	1.64E+00	2.98E+06	1.22E+02	2.00E+04	**3.00E+06**
CH4	3.59E-03	6.53E+03	2.50E-03	4.09E-01	**6.53E+03**
N2O	3.87E-05	7.04E+01	2.50E-03	4.09E-01	**7.08E+01**
NOX	3.00E-03	5.46E+03	1.11E-01	1.82E+01	**5.48E+03**
SOX	8.57E-03	1.56E+04	6.32E-04	1.04E-01	**1.56E+04**
CO	8.54E-04	1.55E+03	9.33E-02	1.53E+01	**1.57E+03**
TNMOC	7.26E-05	1.32E+02	-	-	**1.32E+02**
VOC	-	-	6.13E-03	1.00E+00	**1.00E+00**
Lead	1.39E-07	2.53E-01	5.00E-07	8.19E-05	**2.53E-01**
Mercury	3.36E-08	6.12E-02	2.60E-07	4.26E-05	**6.12E-02**
PM10	9.26E-05	1.69E+02	8.40E-03	1.38E+00	**1.70E+02**
Solid Waste	2.05E-01	3.73E+05	-	-	**3.73E+05**

References

1. EwingCole Construction Drawings and Specifications: Mechanical, Electrical, Plumbing, and Architectural

2. ASHRAE (1997). *Handbook – Fundamentals*. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Atlanta, GA.

3. Virginia Power Company (2010). *Schedule GS-2 Intermediate General Service*. <http://www.dom.com/dominion-virginia-power/customer-service/rates-and-tariffs/pdf/vabgs2.pdf.> (accessed October, 2010.

4. U.S. Energy Information Administration (2010). *U.S. Natural Gas Prices*. <http://www.eia.gov/dnav/ng/ng_pri_sum_dcu_nus_m.htm.> (accessed October, 2010).

5. U.S. Energy Information Administration (2003). *Table C11 Consumption and Gross Energy Intensity by Building Size for Sum of Major Fuels for Non-Mall Buildings*. <http://www.eia.doe.gov/emeu/cbecs/cbecs2003/detailed_tables_2003/2003set9/2003pdf/c11.pdf.> (accessed October, 2010).

6. Deru. M., Torcellini. P. (2007). *Source Energy and Emission Factors for Energy Use in Buildings*. National Renewable Energy Laboratory.

7. 2009 – 2010 BAE Tech 2 Reports

Appendix A

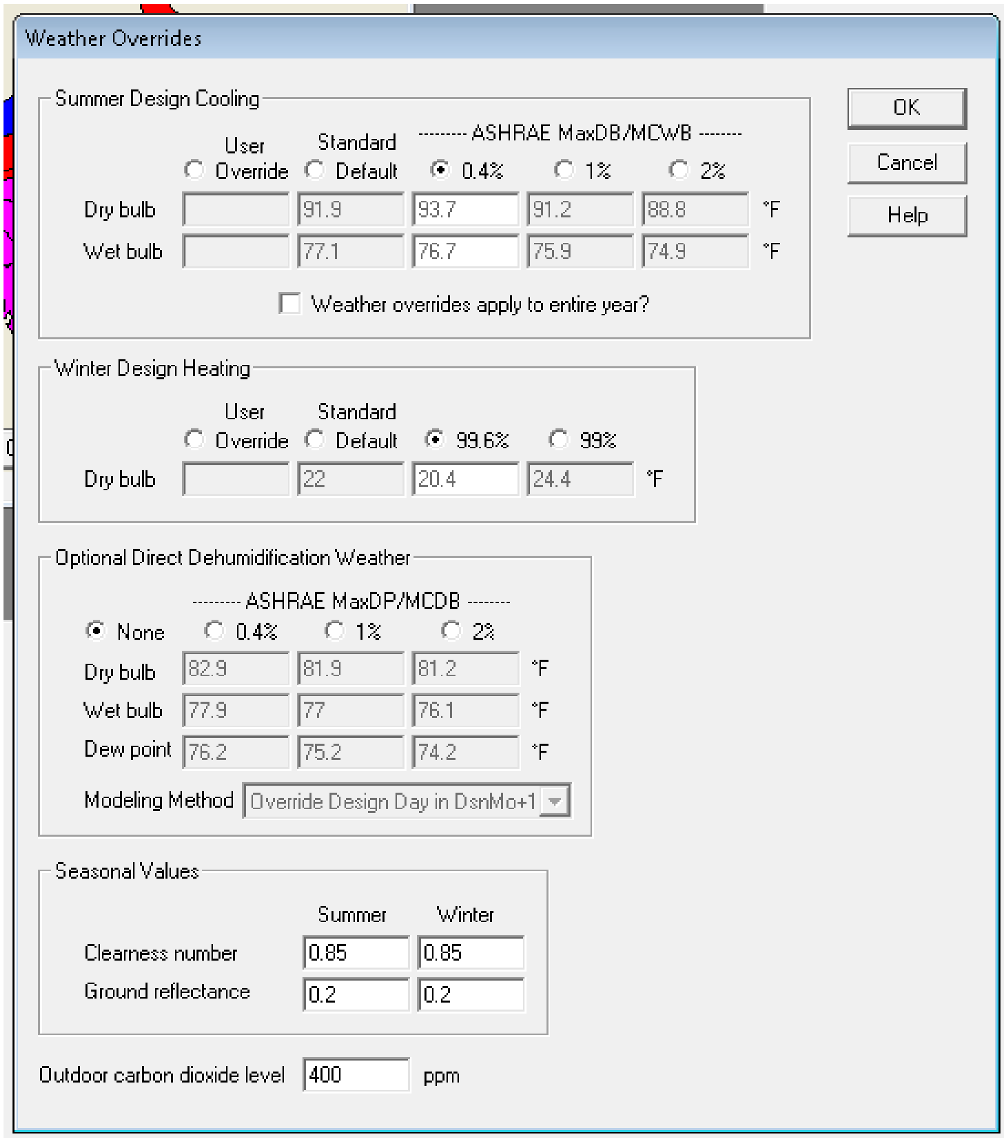
				Exterior Wall					
Zone	Floor Area (ft^2)	Floor Height (ft)	Total Facade Area (ft^2)	Construction	Area (ft^2)	Direction	U-Value BTU/(h °F ft²)	α	ε
1_Workshop	6081.0	15.3	1300.0	Brick Veneer	971.0	N	0.0667	0.9	0.9
1_Office	7233.0	15.3	756.0	Brick Veneer	634.0	N	0.0667	0.9	0.9
				Brick Veneer	136.0	N	0.0667	0.9	0.9
				Brick Veneer	1540.0	W	0.0667	0.9	0.9
				Brick Veneer	975.0	E	0.0667	0.9	0.9
1_Computer Lab	6485.0	15.3	0.0						
1_Mech/Elec	1101.0	15.3	375.3	Brick Veneer	375.3	W	0.0667	0.9	0.9
				Brick Veneer	364.0	E	0.0667	0.9	0.9
1_Corridor	5488.0	15.3	97.0	Curtain Wall (Spandrel)	32.5	N	0.0833	0.9	0.9
				Brick Veneer	120.5	N	0.0667	0.9	0.9
				Brick Veneer	351.5	N	0.0667	0.9	0.9
				Groundface CMU	1312.2	S	0.0667		
				Brick Veneer	257.3	E	0.0667	0.9	0.9
1_High Bay	10225.0	40.5	4711.0	Brick Veneer	4265.2	W	0.0667	0.9	0.9
				Groundface CMU	1403.7	S	0.0667		
				Insulated Metal Panel	2028.0	S	0.0714	0.9	0.9
				Groundface CMU	1329.7	E	0.0667		
				Insulated Metal Panel	2470.5	E	0.0714	0.9	0.9
CUH-1	280.0	36.0	218.0	Brick Veneer	179.5	W	0.0667	0.9	0.9
CRU 1-1	101.0	15.3	0.0						
CRU 1-2	73.0	15.3	0.0						
Floor 1 Total	**37067.0**		**22024.1**		**18745.9**				

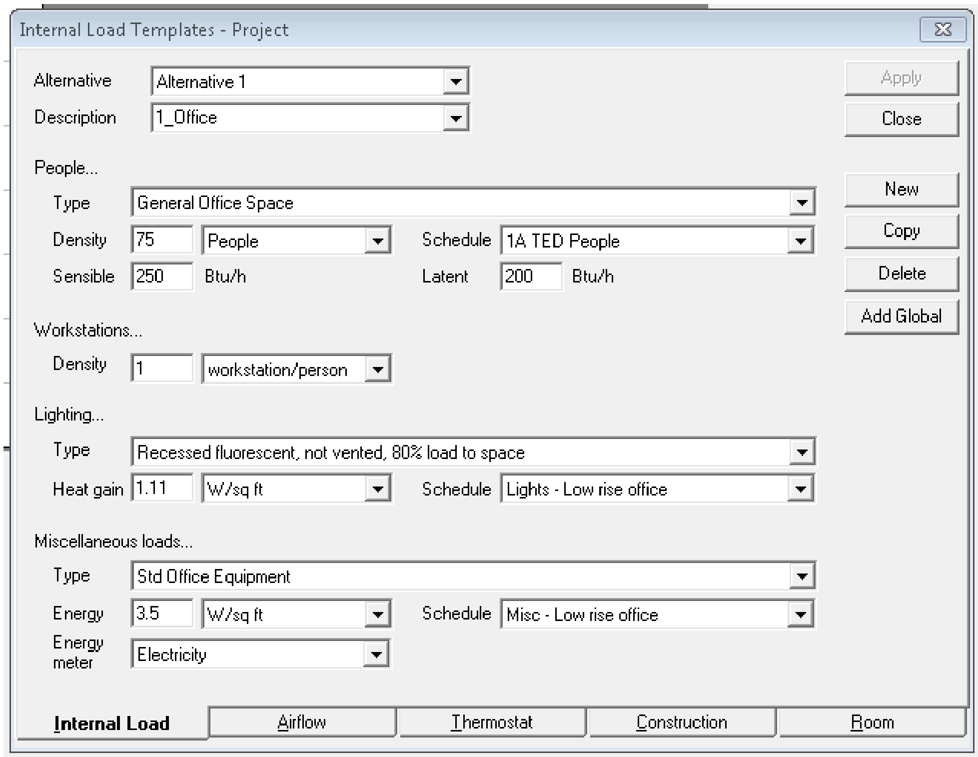
	Glazing on Wall				Door on Wall			Roof				
Zone	**Construction**	**Area (ft^2)**	**U-Value BTU/(h °F ft²)**	**SHGC**	**Construction**	**Area (ft^2)**	**U-Value**	**Contruction**	**U-Value BTU/(h °F ft²)**	**SRI**	**α**	**ε**
1_Workshop	Alum. Store Front	329.0	0.4000	0.28								
1_Office	Curtain Wall	122.0	0.4000	0.38								
	Curtain Wall	50.0	0.4000	0.38								
	Alum. Store Front	364.5	0.4000	0.28								
	Curtain Wall	115.0	0.4000	0.38								
	Alum. Store Front	44.0	0.4000	0.28								
1_Computer Lab												
1_Mech/Elec												
1_Corridor	Curtain Wall	20.5	0.4000	0.38		44.0						
	Curtain Wall	73.5	0.4000	0.38		57.0						
	Curtain Wall	84.5	0.4000	0.38								
	Alum. Store Front	48.0	0.4000	0.28	Steel Door	48.8	0.2					
					Overhead Door	384.0	0.2					
	Curtain Wall	55.5	0.4000	0.38								
1_High Bay	Curtain Wall	412.6	0.4000	0.38	Standard Door	33.2	0.2	Ethylene Interpolymer	0.0333	98.54	0.9	0.9
					Steel Door	48.8	0.2					
					Overhead Door	240.0	0.2					
	Alum. Store Front	80.0	0.4000	0.28								
					Steel Door	48.8	0.2					
					Overhead Door	456.0	0.2					
	Alum. Store Front	80.0	0.4000	0.28								
CUH-1					Standard Door	38.5	0.2					
CRU 1-1												
CRU 1-2												
Floor 1 Total		**1879.1**				**1399.1**						

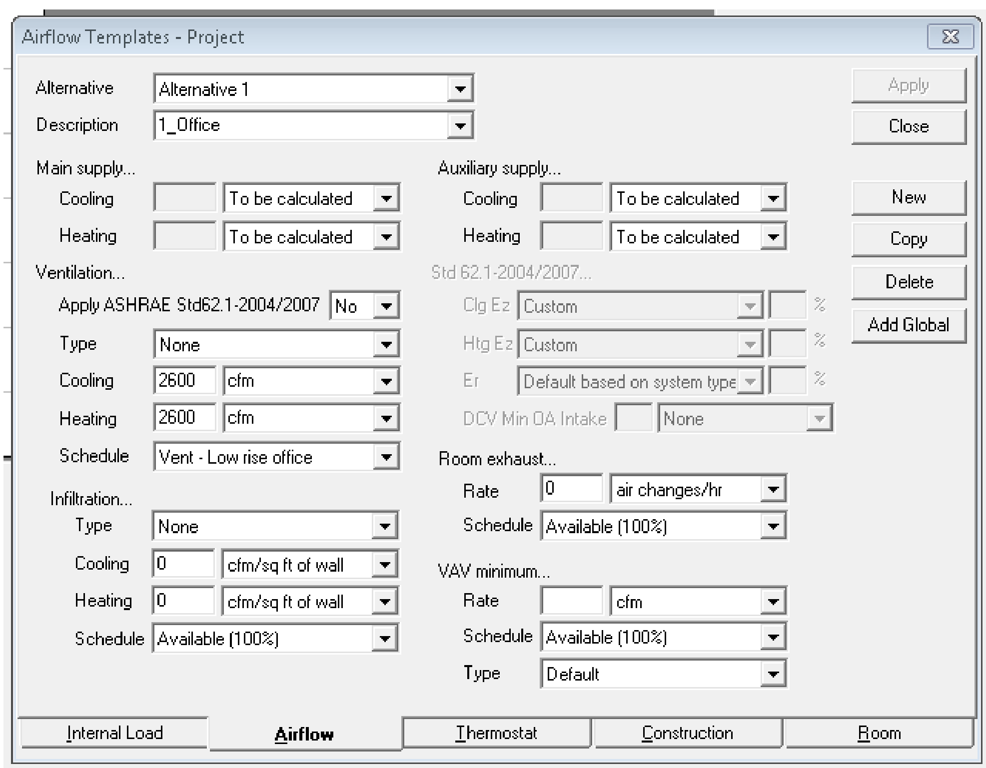
Zone	Floor Area (ft^2)	Floor Height (ft)	Total Facade Area (ft^2)	Exterior Wall					
				Construction	Area (ft^2)	Direction	U-Value BTU/(h °F ft²)	α	ε
2_Office	18507.0	20.7	2188.5	Curtain Wall (Spandrel)	1320.0	N	0.0833	0.9	0.9
				Brick Veneer	866.2	N	0.0667	0.9	0.9
				Curtain Wall (Spandrel)	1039.0	W	0.0833	0.9	0.9
				Brick Veneer	335.4	W	0.0667	0.9	0.9
				Insulated Metal Panel	871.0	S	0.0714	0.9	0.9
				Insulated Metal Panel	932.3	E	0.0714	0.9	0.9
				Brick Veneer	176.2	E	0.0667	0.9	0.9
2_Conference	1103.0	20.7	315.0	Insulated Metal Panel	252.0	S	0.0714	0.9	0.9
				Insulated Metal Panel	163.0	E	0.0714	0.9	0.9
				Insulated Metal Panel	688.0	E	0.0714	0.9	0.9
2_Health Club	955.0	20.7	836.0	Insulated Metal Panel	740.0	E	0.0714	0.9	0.9
2_Mech/Elec	2627.0	20.7	0.0						
2_Corridor	7941.0	20.7	666.5	Insulated Metal Panel	433.5	N	0.0714	0.9	0.9
				Brick Veneer	367.2	N	0.0667	0.9	0.9
				Curtain Wall (Spandrel)	1738.0	W	0.0833	0.9	0.9
				Insulated Metal Panel	165.8	S	0.0714	0.9	0.9
				Brick Veneer	410.0	E	0.0667	0.9	0.9
				Insulated Metal Panel	751.0	E	0.0714	0.9	0.9
				Insulated Metal Panel	272.3	E	0.0714	0.9	0.9
				Curtain Wall (Spandrel)	65.0	E	0.0833	0.9	0.9
CUH-2	265.0	36.0	218.0	Insulated Metal Panel	202.0	E	0.0714	0.9	0.9
CRU 2-1	103.0	20.7	0.0						
Floor 2 Total	**31501.0**		**16395.2**		**11787.9**				
Building Total	**68568.0**		**38419.3**		**30533.8**				

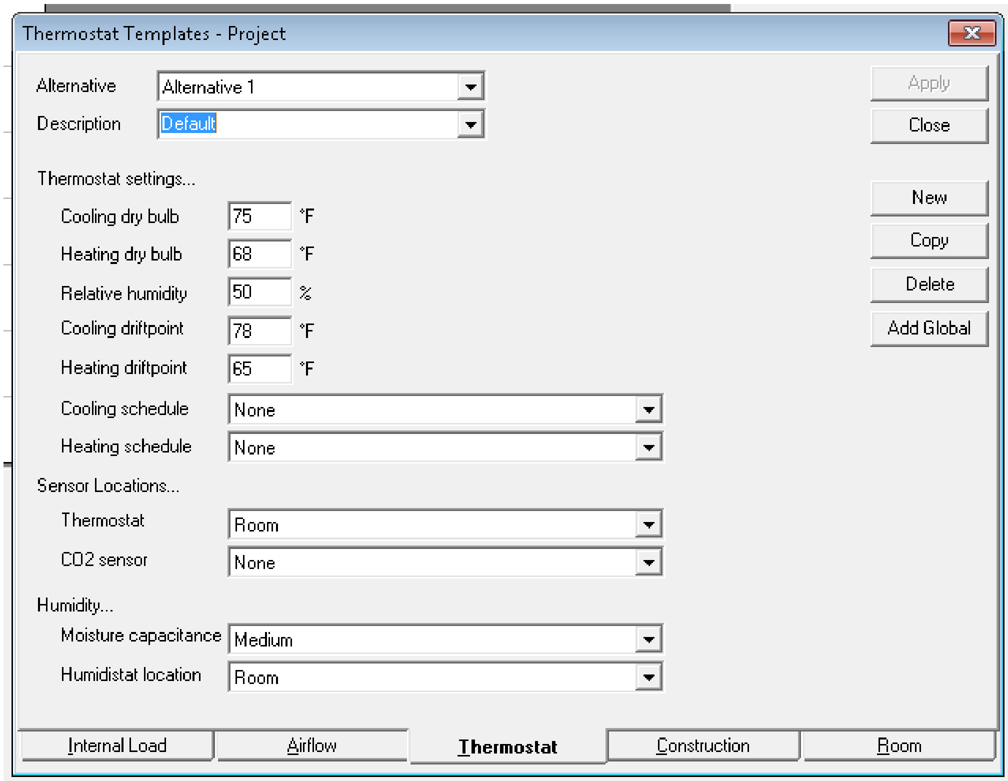
	Glazing on Wall				Door on Wall			Roof					Skylight		
Zone	**Construction**	**Area (ft²)**	**U-Value BTU/(h °F ft²)**	**SHGC**	**Construction**	**Area (ft²)**	**U-Value**	**Contruction**	**U-Value BTU/(h °F ft²)**	**SRI**	**α**	**ε**	**Area (ft²)**	**U-Value**	**SHGC**
2_Office	Curtain Wall	868.5	0.4000	0.38				Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
	Curtain Wall	208.5	0.4000	0.38											
	Curtain Wall	648.0	0.4000	0.38											
	Alum. Store Front	441.0	0.4000	0.28											
	Alum. Store Front	336.0	0.4000	0.28											
	Curtain Wall	42.8	0.4000	0.38											
2_Conference	Alum. Store Front	63.0	0.4000	0.28				Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
	Alum. Store Front	67.0	0.4000	0.28											
	Alum. Store Front	80.0	0.4000	0.28											
2_Health Club	Alum. Store Front	96.0	0.4000	0.28				Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
2_Mech/Elec								Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
2_Corridor	Curtain Wall	233.0	0.4000	0.38				Ethylene Interpolymer	0.0333	98.54	0.9	0.9	302.45	0.28	0.37
	Curtain Wall	192.5	0.4000	0.38											
	Curtain Wall	1222.0	0.4000	0.38											
	Curtain Wall	42.0	0.4000	0.38											
	Alum. Store Front	16.0	0.4000	0.28											
	Curtain Wall	35.0	0.4000	0.38											
CUH-2	Alum. Store Front	16.0	0.4000	0.28				Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
CRU 2-1								Ethylene Interpolymer	0.0333	98.54	0.9	0.9			
Floor 2 Total		**4607.3**													
Building Total		**6486.4**													

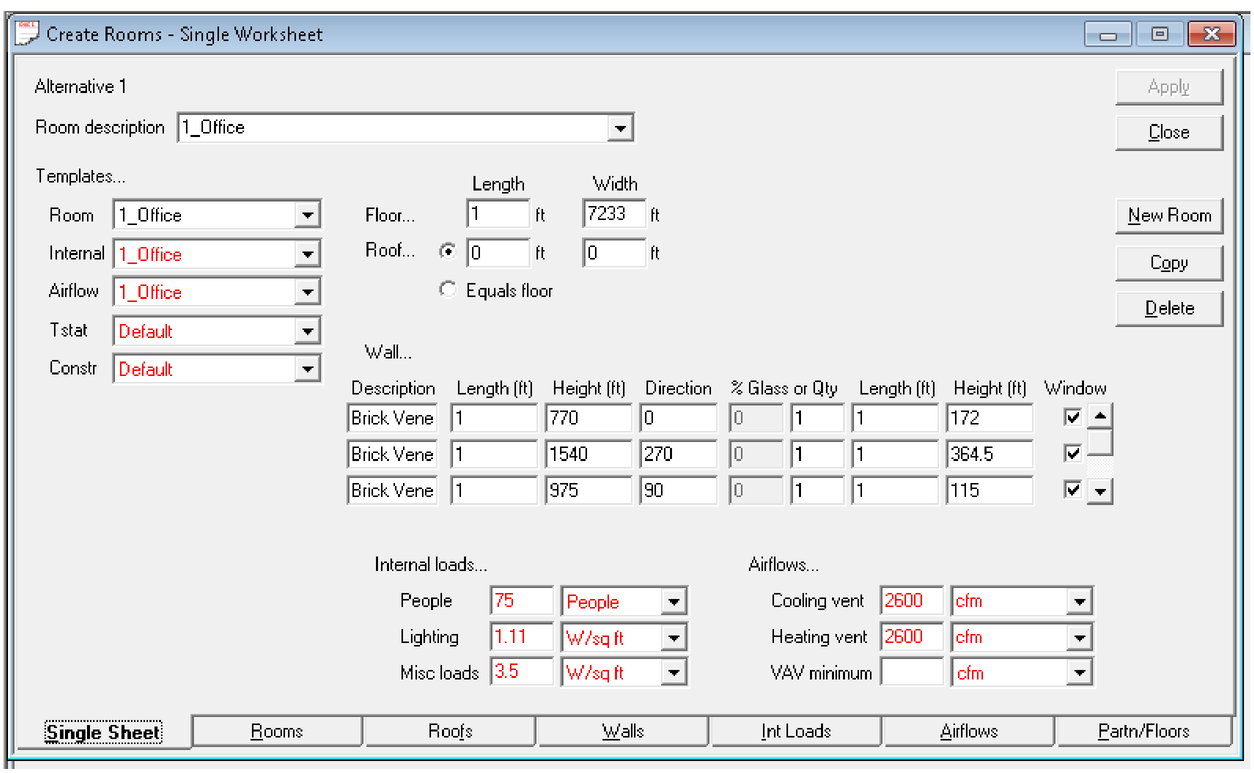
Appendix B

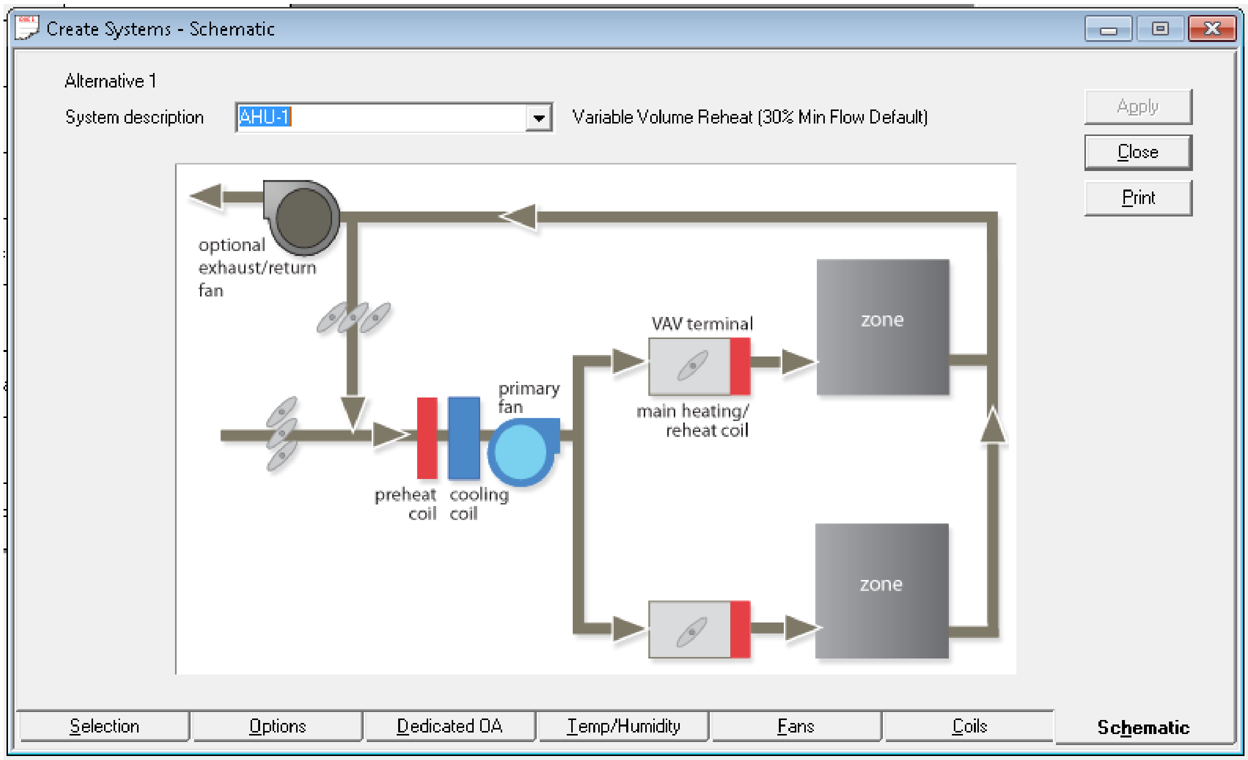

Weather Overrides
Summer Design Cooling
User Override
Standard Default
-------- ASHRAE MaxDB/MCWB --------
0.4%
1%
2%
Dry bulb
91.9
93.7
91.2
88.8
°F
Wet bulb
77.1
76.7
75.9
74.9
°F
Weather overrides apply to entire year?
Winter Design Heating
User Override
Standard Default
99.6%
99%
Dry bulb
22
20.4
24.4
°F
Optional Direct Dehumidification Weather
-------- ASHRAE MaxDP/MCDB -------
None
0.4%
1%
2%
Dry bulb
82.9
81.9
81.2
°F
Wet bulb
77.9
77
76.1
°F
Dew point
76.2
75.2
74.2
°F
Modeling Method
Override Design Day in DsnMo+1
Seasonal Values
Summer
Winter
Clearness number
0.85
0.85
Ground reflectance
0.2
0.2
Outdoor carbon dioxide level
400
ppm
OK
Cancel
Help

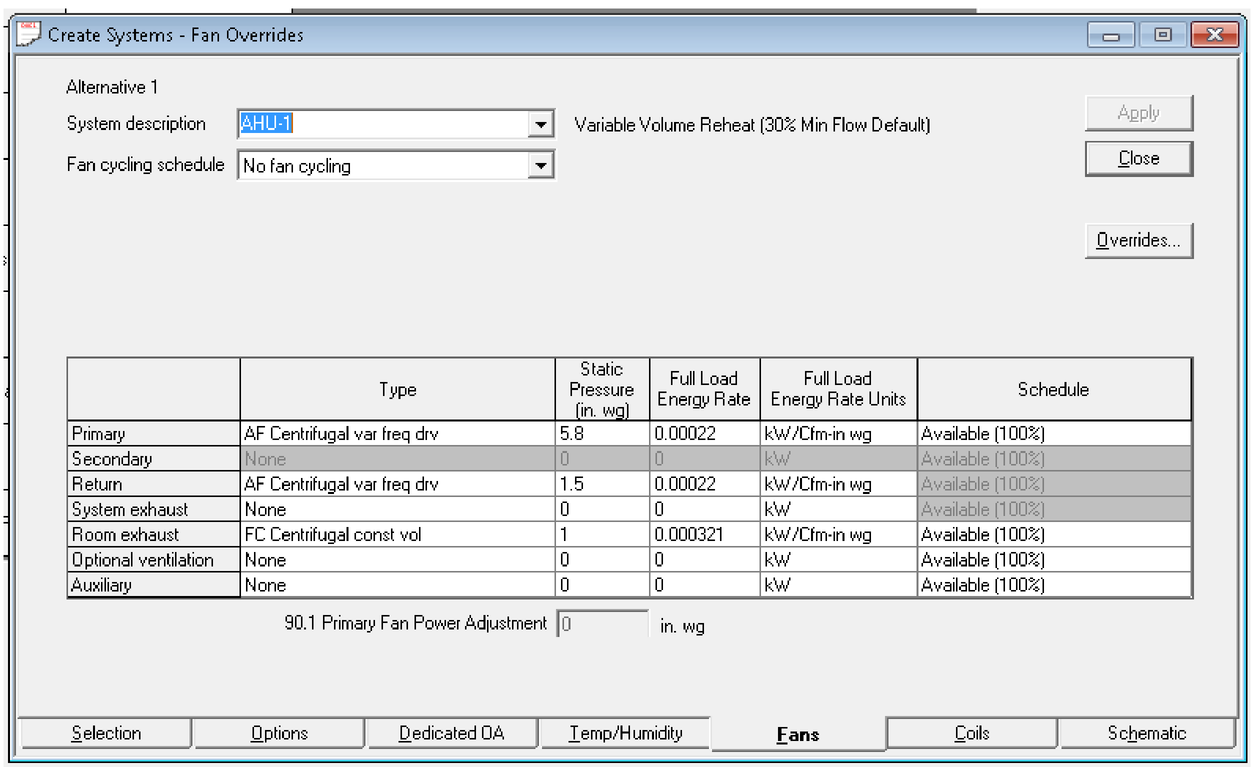

Internal Load Templates - Project
Alternative
Alternative 1
Description
1_Office
Apply
Close
People...
Type
General Office Space
Density
75
People
Schedule
1A TED People
Sensible
250
Btu/h
Latent
200
Btu/h
New
Copy
Delete
Add Global
Workstations...
Density
1
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
1.11
W/sq ft
Schedule
Lights - Low rise office
Miscellaneous loads...
Type
Std Office Equipment
Energy
3.5
W/sq ft
Schedule
Misc - Low rise office
Energy meter
Electricity
Internal Load
Airflow
Thermostat
Construction
Room


Airflow Templates - Project
Alternative
Alternative 1
Description
1_Office
Apply
Close
Main supply...
Cooling
To be calculated
Heating
To be calculated
Auxiliary supply...
Cooling
To be calculated
Heating
To be calculated
New
Copy
Delete
Add Global
Ventilation...
Apply ASHRAE Std62.1-2004/2007
No
Type
None
Cooling
2600
cfm
Heating
2600
cfm
Schedule
Vent - Low rise office
Std 62.1-2004/2007...
Clg Ez
Custom
Htg Ez
Custom
Er
Default based on system type
DCV Min OA Intake
None
Room exhaust...
Rate
0
air changes/hr
Schedule
Available (100%)
Infiltration...
Type
None
Cooling
0
cfm/sq ft of wall
Heating
0
cfm/sq ft of wall
Schedule
Available (100%)
VAV minimum...
Rate
cfm
Schedule
Available (100%)
Type
Default
Internal Load
Airflow
Thermostat
Construction
Room


Thermostat Templates - Project
Alternative
Alternative 1
Description
Default
Apply
Close
Thermostat settings...
Cooling dry bulb
75
°F
Heating dry bulb
68
°F
Relative humidity
50
%
Cooling driftpoint
78
°F
Heating driftpoint
65
°F
Cooling schedule
None
Heating schedule
None
New
Copy
Delete
Add Global
Sensor Locations...
Thermostat
Room
CO2 sensor
None
Humidity...
Moisture capacitance
Medium
Humidistat location
Room
Internal Load
Airflow
Thermostat
Construction
Room


Create Rooms - Single Worksheet
Alternative 1
Room description
1_Office
Apply
Close
Templates...
Room
1_Office
Internal
1_Office
Airflow
1_Office
Tstat
Default
Constr
Default
Length
Width
Floor...
1
ft
7233
ft
Roof...
0
ft
0
ft
Equals floor
New Room
Copy
Delete
Wall...
Description
Length (ft)
Height (ft)
Direction
% Glass or Qty
Length (ft)
Height (ft)
Window
Brick Vene
1
770
0
0
1
1
172
Brick Vene
1
1540
270
0
1
1
364.5
Brick Vene
1
975
90
0
1
1
115
Internal loads...
People
75
People
Lighting
1.11
W/sq ft
Misc loads
3.5
W/sq ft
Airflows...
Cooling vent
2600
cfm
Heating vent
2600
cfm
VAV minimum
cfm
Single Sheet
Rooms
Roofs
Walls
Int Loads
Airflows
Partn/Floors




Create Systems - Fan Overrides

Alternative 1

System description: AHU-1 — Variable Volume Reheat (30% Min Flow Default)

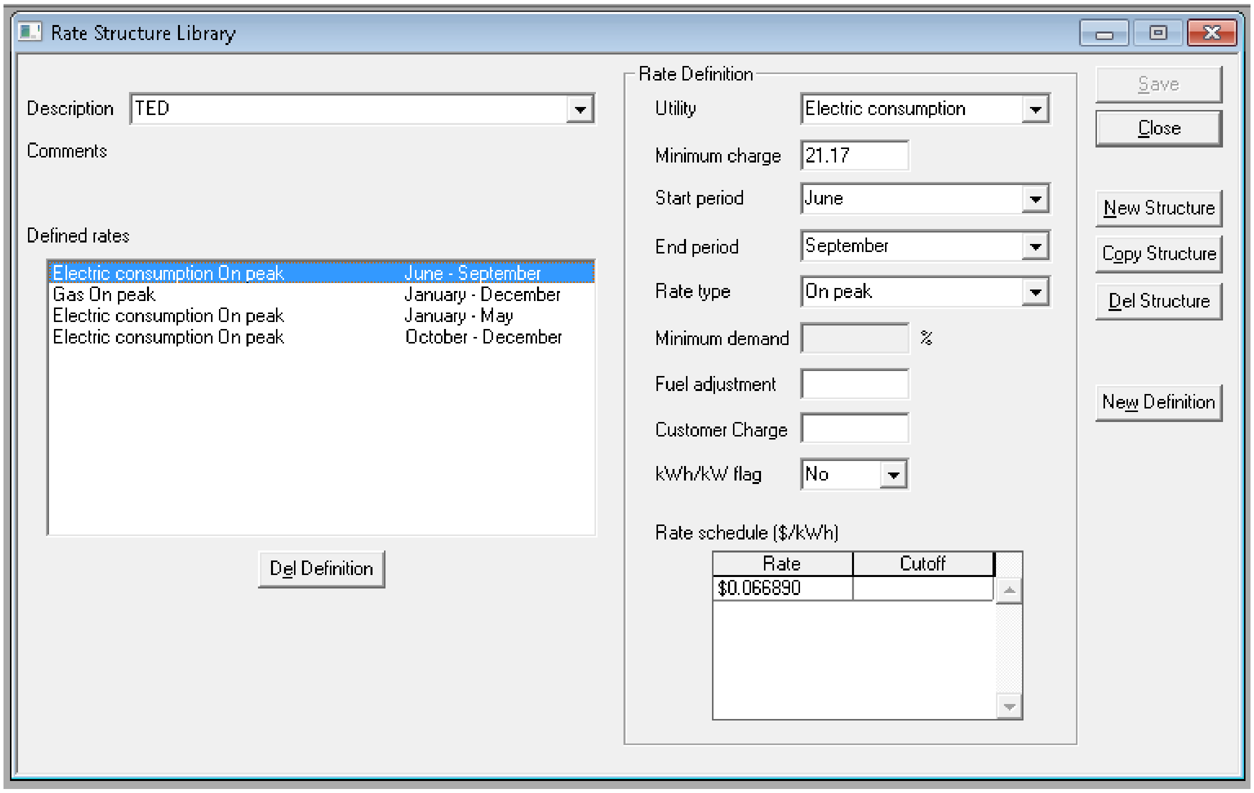
Fan cycling schedule: No fan cycling

Apply | Close | Overrides...

	Type	Static Pressure (in. wg)	Full Load Energy Rate	Full Load Energy Rate Units	Schedule
Primary	AF Centrifugal var freq drv	5.8	0.00022	kW/Cfm-in wg	Available (100%)
Secondary	None	0	0	kW	Available (100%)
Return	AF Centrifugal var freq drv	1.5	0.00022	kW/Cfm-in wg	Available (100%)
System exhaust	None	0	0	kW	Available (100%)
Room exhaust	FC Centrifugal const vol	1	0.000321	kW/Cfm-in wg	Available (100%)
Optional ventilation	None	0	0	kW	Available (100%)
Auxiliary	None	0	0	kW	Available (100%)

90.1 Primary Fan Power Adjustment: 0 in. wg

Selection | Options | Dedicated OA | Temp/Humidity | Fans | Coils | Schematic


Rate Structure Library
Description TED
Comments
Defined rates
Electric consumption On peak June - September
Gas On peak January - December
Electric consumption On peak January - May
Electric consumption On peak October - December
Del Definition
Rate Definition
Utility Electric consumption
Minimum charge 21.17
Start period June
End period September
Rate type On peak
Minimum demand %
Fuel adjustment
Customer Charge
kWh/kW flag No
Rate schedule ($/kWh)
Rate Cutoff
$0.066890
Save
Close
New Structure
Copy Structure
Del Structure
New Definition