The State Institute of Rehabilitation

Technical Investigation, Part Three

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Executive Summary

The following report is an in depth investigation into the existing system conditions and operation of the Institute of Rehabilitation. The Institute of Rehabilitation is an approximately 120,000 gsf addition to an existing building. The three-story addition operates on a stand-alone mechanical system which is entirely separate from the existing building's equipment.

In this report, each piece of mechanical equipment is examined. The operation and controls of the three hot-water boilers, the eighteen unit heaters, the nine variable air volume air handling units, and the five split system air conditioners were all examined in comparison with building design conditions.

The load and ventilation calculations from Technical Report II and Technical Report I, respectively, were combined for a comprehensive study of building operation. Load calculations were completed using Trace 700. Similar room conditions, including level, use, and exposure, were combined into nine separate groupings and analyzed as block loads and compared to existing design conditions. Ventilation calculations utilized ASHRAE Standard 62.1. The spaces ventilated were defined using a combination of ASHRAE 62.1 and ASHRAE 170 spaces, so as to accurate represent office and healthcare spaces.

Resultant from the block load analysis is an energy consumption and energy expenditure summary. The actual operating history of the building, including natural gas and electricity consumption, was not available. The predicted consumption is compared only to design conditions and therefore is theoretical in nature.

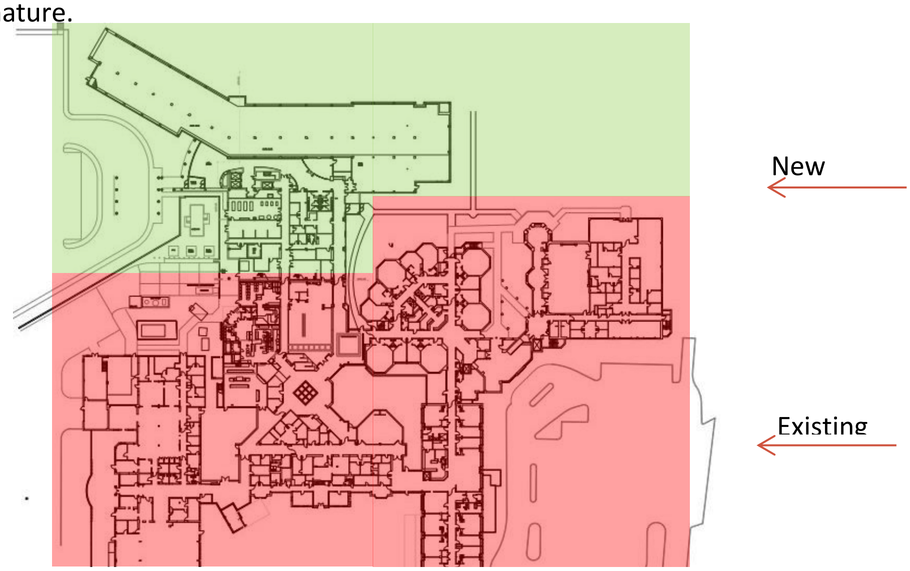


Figure 1: A color diagram depicting the interface between the existing Rehabilitation Center and the new wing

Mechanical Summary

The addition abutting the existing structure is, mechanically, stand-alone. Cooling, heating, and ventilation systems in the new structure are entirely separate from the mechanical plant located in the basement of the existing facility.

The majority of the buildings cooling loads are handled by the nine (9) packaged, variable air volume rooftop air handling units (RTU) located on the roof. Direct refrigerant expansion coils handle cooling within the RTU's. Split-system air conditioning units, where needed, handle supplemental cooling.

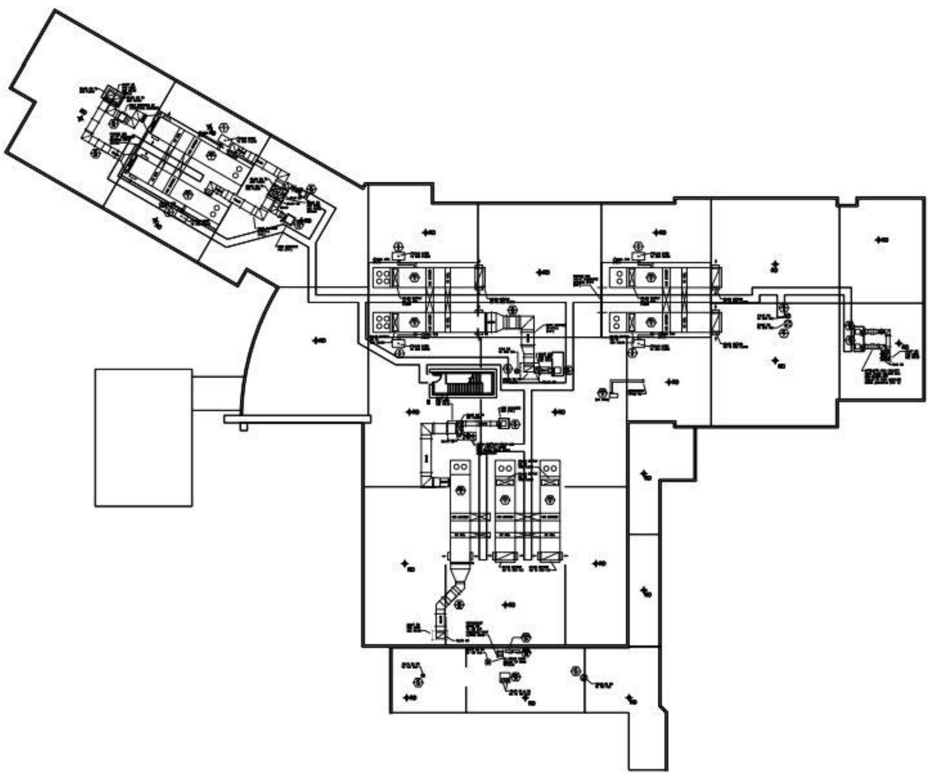


Figure 2: Roof Plan showing RTUs

Natural-gas fired hot water coils handle the building's heating loads. Supplemental heating is provided, where needed, by hot-water unit heaters and cabinet unit heaters. The hot water feeding the units is produced in the ground-floor mechanical room by three (3) natural-gas fired, 1600 MBH hot-

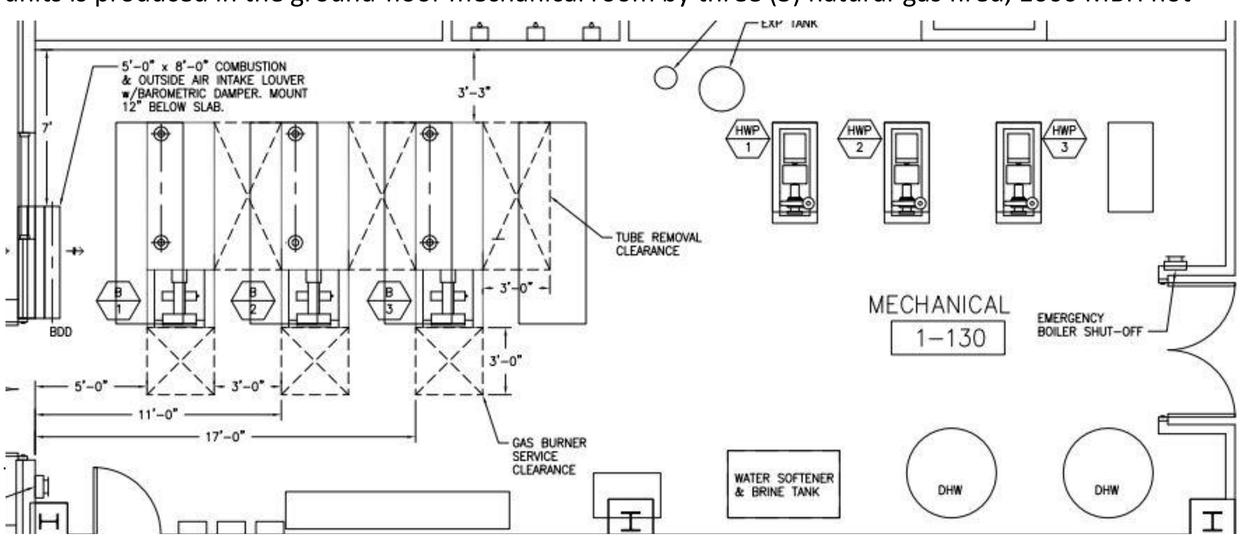


Figure 3: Mechanical Room

water boilers. In addition to unit heaters, the boilers also supply hot water to zone reheat coils in a total of 137 terminal VAV units.

For the sake of simplicity, the unit heaters have been individually neglected and their design capacities blanketed under the “heating plant” in the Trane 700 model.

Mechanical System

Outdoor and Indoor Design Conditions

The building is closest in location to the Newark International Airport, and so the temperature data retrieved from the 2009 ASHRAE Handbook of Fundamentals, Appendix A, and used in the load and energy model is that of Newark. The summary of the temperatures used is shown below. A more extensive view of the weather data is available in Appendix A.

It is important to note that because the Institute of Rehabilitation is a healthcare building, moreover one which serves a medically compromised in-patient population, all effort was made to design the building to operate under more severe conditions. The heating and cooling design temperatures were retrieved from the 99.6% (winter) and 0.4% (cooling) weather scenarios.

The indoor environment was designed at a relative humidity (RH) of 50%, for 72^{o}F and 75^{o}F for the winter and summer, respectively.

	Summer: Design Cooling (0.4%)	**Winter: Design Heating**(99.6%)
Outdoor Air Dry Bulb (^{o}F)	95	11
Outdoor Air Wet Bulb (^{o}F)	74	-
Indoor Air Dry Bulb(^{o}F)	75	72
Indoor Air Wet Bulb (^{o}F)	62	60

Figure 4: Weather data for Newark, NJ and indoor design setpoints

Ventilation

Ventilation requirements were calculated using ASHRAE 62.1 and ASHRAE 170 standards. The building is comprised of an assortment of different spaces, both typical office and retail spaces listed in 62.1 and healthcare and healthcare-related spaces listed by 170. A full analysis of the ventilation provided in the building can be found in Technical Report 1, while a brief summary of design vs. actual RTU operation can be found in the following table:

Zone/ System	System Capacity	Outdoor Air Supplied	Outdoor Air Required
RTU-1	11500	3450	1741.00
RTU-2	11500	3450	1742.00
RTU-3	12000	3600	2857.00
RTU-4	12000	3600	2220.00
RTU-5	14000	4200	2005.00
RTU-6	14000	4200	1146.00
RTU-7	12500	3750	3541.00
RTU-8	12500	3750	3460.00
RTU-9	12500	3750	728.00
Total	**112500**	**33750**	**19440**

Table 1:RTU system capacities and ventilation

The amount of outdoor air supplied by each rooftop air handling unit, at a minimum of 30% of total air supplied, is significantly more than the amount of outdoor air required. In some cases, the amount of outdoor air supplied is more than three times greater than that required. The discrepancy between actual and calculated values is most likely the culmination of design assumptions for room occupancies.

Heating and Cooling

The results following would indicate that the amount of cooling supplied to the building is approximately 14% less than what is required. Concerning upon first glance, the disparity is easily explained. The disparity between design and calculated supply air volumes owes largely to the neglect of a diversity factor in the Trace 700 model. In the load model, no diversity factor was applied to building occupancy. All spaces were assumed to be 100% occupied at all times. This assumption calculates the worst-case load scenario but is inaccurate. None of the spaces will be 100% occupied at all times. In reality, therefore, the cooling system as it was designed is more than capable of supplying the building's required cooling.

Similarly, the disparity between design and calculated heating is explained by the operation of individual VAV reheat coils. Less air is required from the rooftop units in heating mode than in cooling mode to achieve the desired space conditioning. In theory, once a space has reached the design temperature setpoint, less air volume is required from the RTUs. Rather than continually cycle the VAV RTUs on and off, they are throttled down to their minimum supply position and the remaining conditioning is provided by the hot-water reheat coils inside individual Variable Air Volume boxes and the 18 cabinet unit heaters and unit heaters.

	System		Designed			Calculated		
	Zone/ System	System Capacity	$A_{floor}(ft^2)$	Supply Air Flow (cooling)	cfm/ft2	$A_{floor}(ft^2)$	Supply Air Flow	cfm/ft2
Cooling	RTU-1	11500	4930	10385	2.11	5895	8755	1.49
	RTU-2	11500	4930	10835	2.20	5907	11260	1.91
	RTU-3	12000	8366	11310	1.35	10139	19966	1.97
	RTU-4	12000	8466	11480	1.36	9874	19379	1.96
	RTU-5	14000	7277	12000	1.65	6830	11993	1.76
	RTU-6	14000	7189	12723	1.77	4745	7811	1.65
	RTU-7	12500	8229	10250	1.25	10069	12510	1.24
	RTU-8	12500	7490	11600	1.55	9920	10911	1.10
	RTU-9	12500	11025	11510	1.04	11090	14454	1.30
	Total	**112500**	**67902**	**102093**	**1.50**	**74469**	**117039**	**1.57**
	Zone/ System	System Capacity	$A_{floor}(ft^2)$	Supply Air Flow (heating)	cfm/ft2	$A_{floor}(ft^2)$	Supply Air Flow	cfm/ft2
Heating	RTU-1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	RTU-2	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	RTU-3	12000	8366	9060	1.08	10139	6949	0.69
	RTU-4	12000	8466	9230	1.09	9874	7271	0.74
	RTU-5	14000	7277	8865	1.22	6830	4263	0.62
	RTU-6	14000	7189	9090	1.26	4745	2464	0.52
	RTU-7	12500	8229	8610	1.05	10069	3774	0.37
	RTU-8	12500	7490	9250	1.23	9920	3502	0.35
	RTU-9	12500	11025	5120	0.46	11090	5141	0.46
	Total	**112500**	**67902**	**72425**	**1.07**	**74469**	**41176**	**0.55**

Table 2: Design vs. Calculated Heating and Cooling Air Supplies

Existing Mechanical and Plumbing Equipment and Operations

Equipment

RTU

The nine (9) Variable Air Volume (VAV) rooftop units and one (1) constant air volume unit provide, between them, approximately 114,000 cfm of air. Approximately 30% of the air supplied to the building is outdoor air, the other 70% is accounted for in return air. The air quantities delivered are tabulated below, and are separated by area and exposure in the following array.

Figure 4: Floor 1

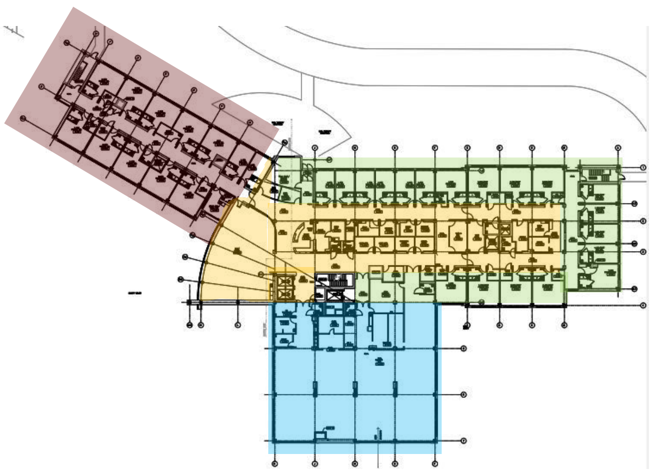


Figure 5: Floor 2

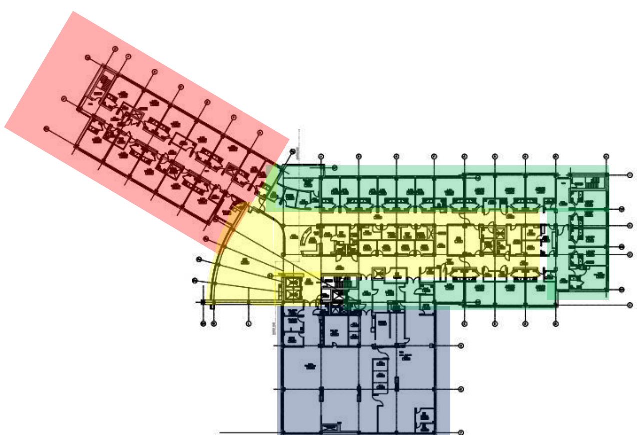


Figure 6: Floor 3

RTU-Block Assignment;

Key Plan

RTU-1; block 1

RTU-2; block 2

RTU-3; block 3

RTU-4; block 4

RTU-5; block 5

RTU-6; block 6

RTU-7; block 7

RTU-8; block 8

RTU-9; block 9

Table 3: RTU return vs. OA supply and MBH load capacities

Zone/ System	System Capacity (cfm)	Outdoor Air (cfm)	Return Air (cfm)	Total Cooling MBH	Total Heating MBH
RTU-1	11500	3450	8050	466.00	470
RTU-2	11500	3450	8050	466.00	470
RTU-3	12000	3600	8400	540.00	740
RTU-4	12000	3600	8400	540.00	740
RTU-5	14000	4200	9800	567.00	570
RTU-6	14000	4200	9800	567.00	570
RTU-7	12500	3750	8750	473.00	510
RTU-8	12500	3750	8750	473.00	510
RTU-9	12500	3750	8750	49.00	476
Total	**112500**	**33750**	**78750**	**4141**	**5056**

The RTUs operate on 20 MHP variable frequency drive (VFD) supply fans at 460V/3Ø power.

Each RTU uses direct expansion (DX) refrigeration cooling and natural-gas heating. Each packaged RTU is supplied with filter banks, one 30% and one 95%. These equate in recent classification to, roughly, MERV 5 and MERV 16 pre and final filters, respectively.

For flow sequence, please refer to Figure 7.

Air Terminal Units

The Insititute of Rehabilitation contains, in total, 137 single-duct Variable Air Volume (VAV) units. The VAVs distribute air to individual spaces and are responsible for the reheat of air through hot-water coils. The largest reheat coil installed circulates at 4.5 GPM with an entering water temperature of 180oF. Each VAV is manufactured with a flow sensor. The hot water supplied to the VAVs is supplied by the three natural-gas boilers and the flow controlled by three hot water pumps and, individually, by a three-way bypass valve for when heating is not required (ie. Summer).

Boilers

System	CFH Natural Gas	Flow Rate(GPM)	EWT (°F)	LWT (°F)	Input (MBH)	Output (MBH)
B-1	2000	110	150	180	2000.00	1600
B-2	2000	110	150	180	2000.00	1600
B-3	2000	110	150	180	2000.00	1600
Total	**6000**	**330**	**150**	**180**	**6000**	**4800**

Table 4: Boiler Operation

The three hot water boilers, located in the mechanical room on the ground floor, supply hot water to the 18 unit and cabinet unit heaters, as well as the 137 VAV units. The boiler itself, comprised of heavy steel, is jacketed by 1-1/2” fiberglass insulation and finished with zinc and enamel. Boiler tube and furnace access panels are encased with 2” ceramic fiber insulation.

Hydronic Pumps
There are three centrifugal, hydronic hot water pumps operating with net positive suction head of 5.1 in. H_2O. Located directly next to the three hot water boilers, they are headered with a hot-water bypass system which allows hot water to return to the boilers when lesser volumes of heating hot water are called for by the building. For flow sequencing, please refer to Figure 9, following.

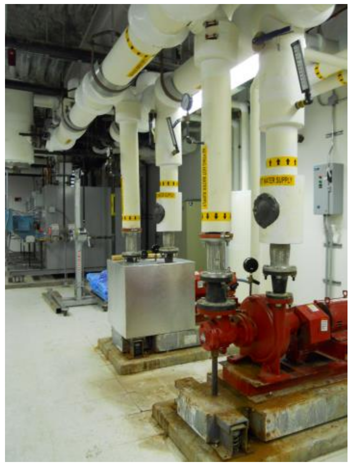


Figure 8: Hydronic mechanical-hot water pumps

Cabinet Unit Heaters
The cabinet unit heaters (CUH), of which there are eight, operate at 115V/1 Ø power. The largest CUH is capable of providing 32 MBH to 850 CFM using 2.5 GPM, while the smallest can provide a maximum of 4MBH to 105 CFM at 0.5 GPM.

Unit Heaters
The hot water unit heaters run at a maximum of 1.5 GPM and 575 GPM. The smallest unit heater runs at 0.5 GPM and 250 CFM. They are equipped with integral thermostats and operate at 115V/1 Ø power.

Split-System Air conditioning units
Excess sensible load in the two elevator machine rooms, the electrical room, the data room, and the vending room, respectively, is mitigated by the operation of a split-system air conditioning unit. Their capacities are summarized in the following table.

Table 5: Split System Air Conditioning locations and capacities

Name	Location	CFM	Total Load (MBH)
AC-1	Electrical Room	1300	42
AC-2A	Elevator Machine Room	750	34.2
AC-2B	Elevator Machine Room	750	34.2
AC-3	Data Room	750	18.4
AC-4	Vending	850	18.4

Operations

Air Side

The rooftop air handling units combine and condition return and outdoor air. Return air enters the air handling unit by duct through normally open dampers which. The return air is moved by a VFD-controlled centrifugal fan modulated by an airflow sensor. It is pushed through normally-open dampers to combine with incoming outdoor air in the mixing box/economizer. The minimum volume of outdoor air incorporated is 30% of the total supply air. The ratio of outdoor air to return air is modulated by the dampers on the return duct and outdoor air intake, respectively.

Mixed air next moves through the pre-filter bank. Flow through the filter bank is monitored by a differential pressure transducer which senses and reports changes in pressure, and thus flow, across the bank. This ensures that velocity does not exceed the maximum of 500 fpm.

The mixed air now passes over the DX-coil. The refrigerant, with a very low heat of vaporization, is evaporated when it absorbs heat from the mixed air. The refrigerant is then cooled by an attached condenser and once again flows through the evaporator coils. Cooled air is then pulled through the VFD-controlled centrifugal supply fan. A natural-gas heating unit, located immediately downstream of the supply fan, further conditions the air during periods of heating.

Air subsequently flows over the last bank of 95% filters, equivalent to MERV 16. Humidification needs are met by a natural-gas fed steam generator located exteriorly to the air handling unit. Air is then distributed via the discharge plenum and its flow is monitored by smoke-detector, static pressure transducer, temperature transducer, and humidity transducer. Insufficient fluid and flow characteristics are fed back through the RTU and flow and conditioning settings modified.

Water Side

The mechanical heating hot-water system is comprised of three natural-gas fed boilers capable of providing a combined total of 4800 MBH of sensible heat. The hot water produced in the boilers passes first through an air-separator and is then distributed to the building by three centrifugal pumps.

Building heating requirements are monitored by temperature sensors located in individual spaces and flow from the pumps is subsequently modulated by a series of ball and plug valves. A hot-water bypass flow allows for the return of un-needed hot water to the boilers.

The facility does not use chilled water and is unconnected to the existing buildings chilled water plant. While future upgrades to the existing chiller plant and the connection of the new facility to the existing plant would be recommended, it currently utilizes only direct expansion cooling.

A detailed flow diagram can be found below.

Mechanical Space Requirements

System Energy

Energy use in the State Institute of Rehabilitation was analyzed using Trace 700. Because current utility usage and cost figures for the actual building were unavailable, however, the analysis is limited to those loads identified in Trace 700 and does not provide an accurate comparison between the existing and theoretical building.

The State Institute of Rehabilitation consumes approximately 2,307,550 kwh/yr or 7873676 kBtu/yr. Energy used is subdivided into the categories outlined in the following table.. The greatest system energy consumption is attributed to the lights. Because the building operates 24/7, the amount of energy used in lighting the facility is expected.

The second largest contributor to energy usage is mechanical cooling. This is largely due to the use of dx cooling in each RTU.

A more detailed view of building and system energy use can be found in Appendix D.

Equipment Energy Consumption		
Equipment	Energy Used (kBtu/yr)	%
Lights	4451834	56.54%
Cooling	2528690	32.12%
Heating	575249	7.31%
Heat Rejection	301014	3.82%
Receptacles	16888	0.21%
Total	7873676	100.00%

Table 6: Detail of building energy usage

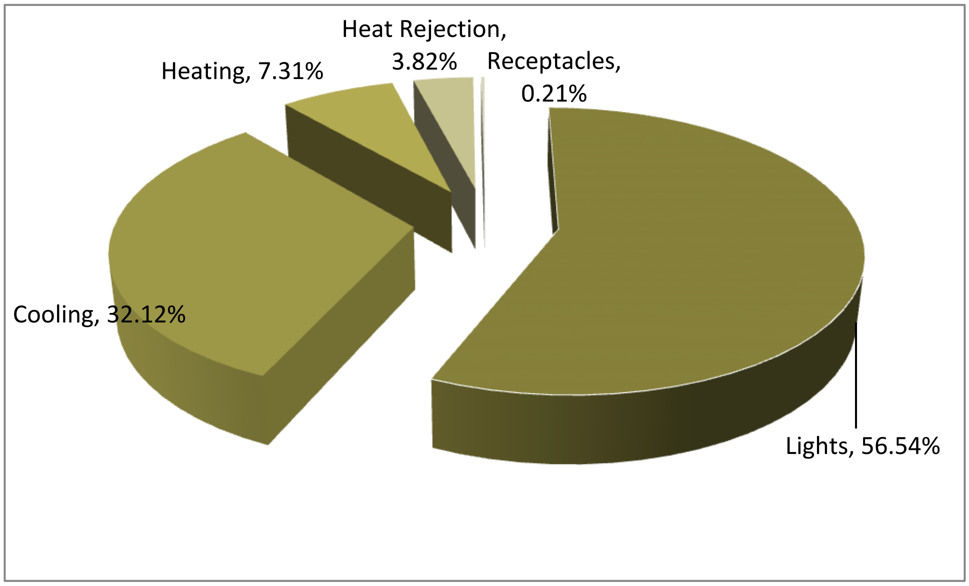


Figure 10: Visual comparison of energy used by different building systems

LEED Analysis

The State Institute of Rehabilitation, having been built before the popularization of the Leadership in Energy and Environmental Design rating system, did not adhere to any LEED standards.

Energy and Atmosphere

EA Prerequisite 1: Fundamental Commissioning of the Building Energy Systems

The commissioning of the building, post construct, ensures that all installed systems operated as specified by design. A commissioning authority analyzes system operation post-installation and would adhere to the methods outlined by LEED V2.2.

Commissioning was specified by the designers and so this credit, though not done explicitly through LEED standards, is achieved.

EA Prerequisite 2: Minimum Energy Performance

The building does not meet minimum energy performance standards, as outlined in Technical Report 1 through a comparison of the facility with ASHRAE 90.1 Standards.

EA Prerequisite 3: Fundamental Refrigerant Management

The building uses, almost exclusively, direct expansion cooling. None of the refrigerants used in the cooling system are chlorofluorocarbon-based, as the building complies with the Montreal Protocol of 1987, and so the building meets and achieves this credit.

EA Credit 1: Optimize Energy Performance

Because the State Institute of Rehabilitation does not comply with the minimum energy performance prerequisite, it is not eligible for this credit.

EA Credit 2: On-Site Renewable Energy

The site does not utilize any renewable energy resources. In subsequent redesign, the building could incorporate solar photo-voltaic or solar-thermal energy uses. Wind and geothermal are not advisable.

EA Credit 3: Enhanced Commissioning

The building is slated to be commissioned by

EA Credit 4: Enhanced Refrigerant Management

The building uses refrigerants extensively. It does not exceed those provisions laid out by EA Prerequisite 3, however, and so is not eligible to receive this credit.

Indoor Environmental Quality (IEQ)

IEQ Prerequisite 1: Minimum Indoor Air Quality Performance

The building complies with all ventilation requirements outlined by ASHRAE 62.1 and so, additionally, complies with this LEED requirement.

IEQ Prerequisite 2: Environmental Tobacco Smoke (ETS) Control

The interior of the building is smoke-free, as outlined in Technical Report 1. Additionally, smoking is prohibited within 25 feet of the building. This credit may be earned.

IEQ Credit 1: Outdoor Air Delivery Monitoring

Ventilation requirements are monitored by CO_2 sensors located throughout the building.

IEQ Credit 2: Increased Ventilation

The building may operate on more than 30% Outdoor air, but only when called through for by the economizer and outdoor air conditions. An increase in ventilation is not planned for and so this credit is not met.

IEQ Credit 3.1: Construction Indoor Air Quality Management Plan - During Construction

To reduce indoor air quality problems inherent from construction, all HVAC components were protected during construction. Additionally, on-site materials were shielded from moisture so as to prevent mold and mildew growth. The filters used in the building, in an effort to meet healthcare building requirements, are MERV 5 and 16 and so, without attention paid to LEED, already meet this credit.

IEQ Credit 4.1: Low-Emitting Materials Adhesives and Sealants

Because the building is, as previously addressed, a healthcare facility, all effort was made to protect occupants from odorous, irritating, and hazardous materials. The building meets and complies with all VOC standards.

IEQ Credit 6.2: Controllability of Systems- Thermal Comfort

As a healthcare building with a medically-compromised in-patient population, windows were designed to be inoperable. Thermostat control, however, is inherent in all of the patient rooms. Larger group spaces, like nurses' stations, gymnasiums, and dining areas, are operated on automatic temperature sensors.

IEQ Credit 7.1: Thermal Comfort-Design

In order to provide a comfortable environment for occupants, the building must comply with those standards set forth by ASHRAE Standard 55.

IEQ Credit 7.2: Thermal Comfort-Verification

No thermal comfort survey was completed and so the building does not meet this requirement.

IQ Credit 8.1: Daylight and Views

Daylight is provided for almost all of the spaces. Some spaces, like interior offices, are not provided with daylighting. 75% are daylit and so the building meets this standard.

Summary

The building, overall, does not currently meet enough credits to be

Overall System Evaluation

Assumptions

The mechanical system currently in use in the State Institute of Rehabilitation adequately meets all occupant and space cooling and heating requirements. It is perfectly able to meet humidity, temperature, and ventilation requirements required by a healthcare facility.

The mechanical system, though able to meet all building load requirements, is unable to meet them efficiently. Despite the availability of an existing mechanical plant, located in the basement of the existing structure, the new facility uses DX refrigeration and individual RTU heating and humidification.

Improvements could be made to the operational efficiency of the site by connecting the facility to the fully operational mechanical plant in the existing building. To do so would require a potentially expensive upgrade to existing equipment, most notably the steam boilers and chillers.

Much of the existing equipment, however, is nearing the end of its useful operational life and so installation of new equipment is imminent regardless. Because equipment replacement is necessary, an upgrade to the equipment would be prudent. Overall, if the steam boilers and chiller were upgraded in size, the facility as a whole would decrease its operational costs.

Because the steam produced in the steam boilers is low pressure, the transport of steam heat to the third floor of the new facility may pose a problem. This may be mitigated through the installation of a steam booster pump, which would help circulate steam to areas located too far from the mechanical plant.

Renewable energy resources may be investigated in subsequent reports but, overall, the most cost-effective and energy-efficient methods of upgrading the building are related to an update of the mechanical plant. Solar photo-voltaic and solar-thermal systems might be explored. Additionally, as the building is constructed on a large site and backs up to a large hill, they might investigate thermal storage systems which would reduce the price of producing chilled water by doing so at night.

Because the current system is basic in nature, there are a multitude of improvements which could be made to increase energy efficiency and even occupant comfort. Options for improvement will be explored in the final Thesis Proposal.

References

ASHRAE (2010), Standard 62.1-2010, Ventilation for Acceptable Indoor Air Quality. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta,GA, 2009.

ASHRAE (2010), Standard 90.1-2010, Energy Standard for Buildings Except Low-Rise Residential Buildings. American Society ofHeating, Refrigerating, and Air Conditioning Engineers, Inc., Atlanta,GA, 2009

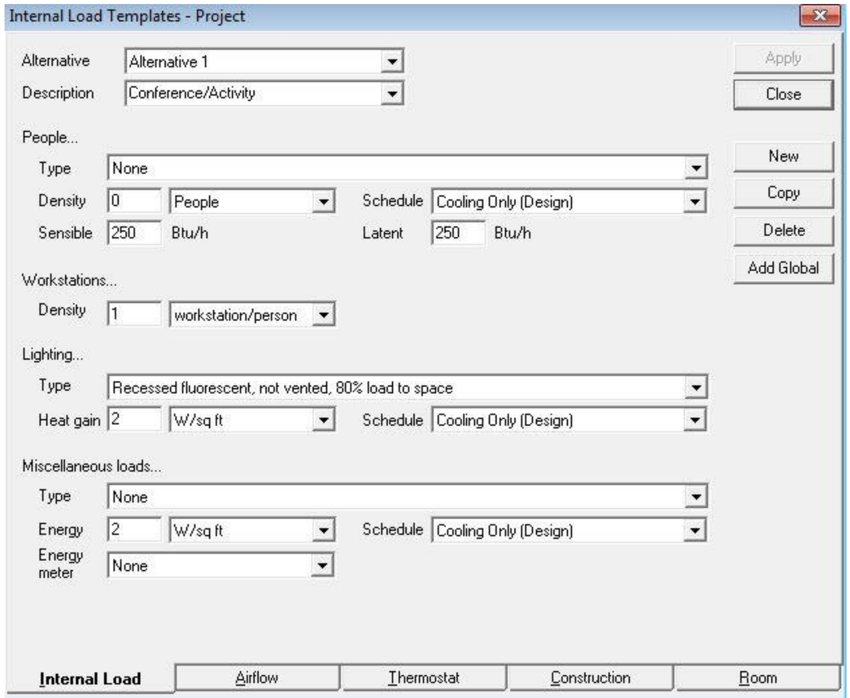
ASHRAE (2009). 2009 ASHRAE Handbook - Fundamentals. Atlanta, GA: American Society of Heating Refrigeration and Air Conditioning Engineers, Inc.

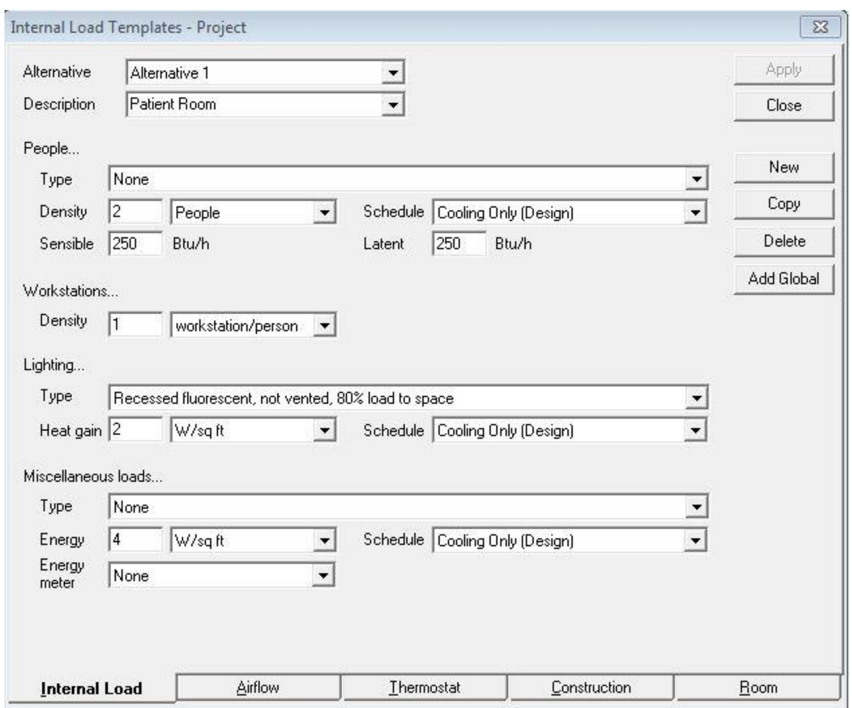
APPENDIX A-Weather

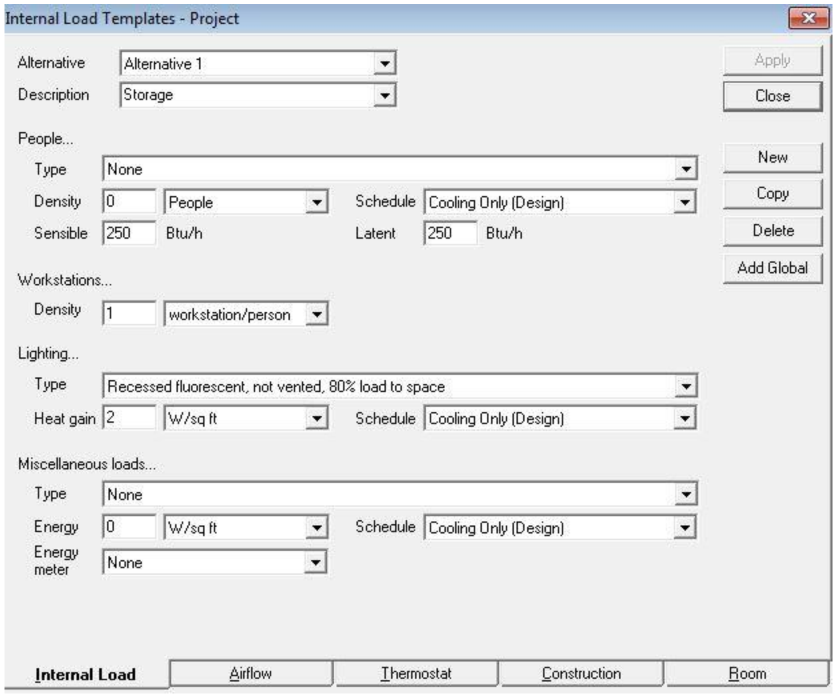
Meaning of acronyms:
DB: Dry bulb temperature, °F *WB: Wet bulb temperature, °F* *Lat: Latitude, °* *Long: Longitude, °* *Elev: Elevation, ft*
MCWB: Mean coincident wet bulb temperature, °F *DP: Dew point temperature, °F* *HR: Humidity ratio, grains of moisture per lb of dry air* *WS: Wind speed, mph*
MCDB: Mean coincident dry bulb temperature, °F *HDD and CDD 65: Annual heating and cooling degree-days, base 65°F, °F-day*

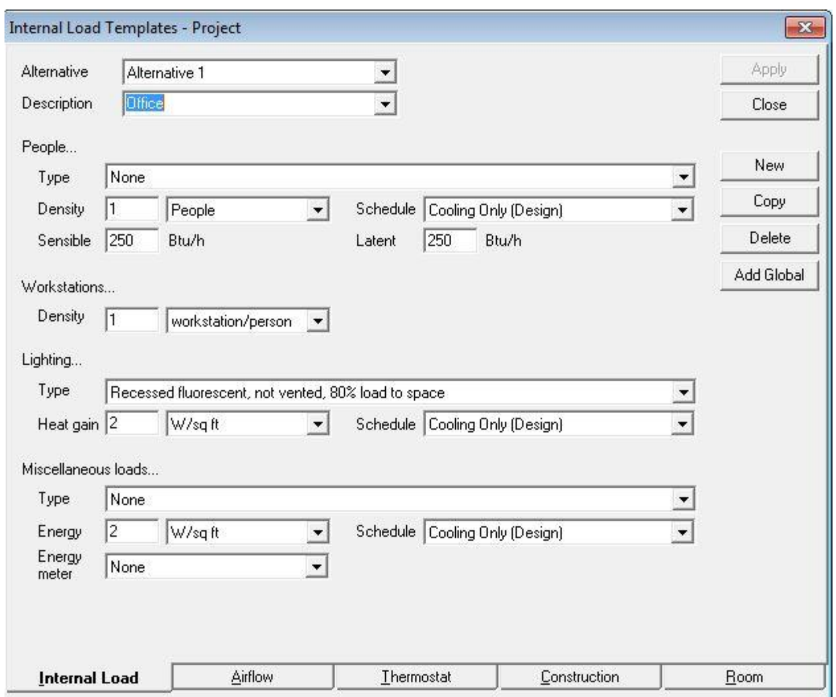
Station	Lat	Long	Elev	Heating DB		Cooling DB/MCWB						Evaporation WB/MCDB				Dehumidification DP/HR/MCDB						Extreme Annual WS			Heat./Cool. Degree-Days	
						0.4%		1%		2%		0.4%		1%		0.4%			1%							
				99.6%	99%	DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	DP	HR	MCDB	DP	HR	MCDB	1%	2.5%	5%	HDD	CDD 65
MANCHESTER AIRPORT	42.93N	71.44W	233	1.0	6.7	91.2	72.1	88.6	70.8	85.8	69.7	75.8	86.4	74.1	83.4	72.5	121.4	80.6	71.5	117.3	79.1	19.0	17.7	15.5	6212	739
PEASE INTL TRADEPOR	43.08N	70.82W	102	2.6	7.7	89.3	72.7	85.9	71.1	82.4	69.5	75.5	84.5	73.5	82.0	72.5	120.8	80.4	71.0	114.7	78.3	22.6	19.4	17.2	6442	534
New Jersey																										*7 sites, 1 more on CD-ROM*
ATLANTIC CITY INTL AP	39.46N	74.46W	66	9.9	14.9	92.3	75.0	89.4	74.0	86.4	72.8	77.9	87.5	76.6	85.0	75.2	132.4	81.8	74.1	127.8	80.6	24.8	21.1	18.8	4950	995
BELMAR-FARMINGDALE	40.18N	74.13W	85	10.7	15.7	90.7	73.6	88.1	72.5	84.3	71.0	76.4	86.5	74.8	83.8	73.1	123.3	80.9	72.2	119.4	80.1	25.4	22.1	19.4	5118	867
MCGUIRE AFB	40.02N	74.60W	148	10.3	15.1	92.9	75.7	90.3	74.7	87.8	73.4	78.8	87.8	77.2	86.3	76.5	139.1	83.3	74.6	130.1	81.8	23.3	19.8	17.6	4897	1074
MILLVILLE MUNICIPAL AP	39.37N	75.08W	75	10.3	15.3	91.9	74.9	89.5	74.1	86.9	73.0	78.0	87.1	76.7	85.0	75.4	133.3	81.4	74.3	128.7	80.4	19.8	18.2	16.6	4860	1052
NEWARK INTERNATIONAL ARPT	40.72N	74.17W	30	11.0	15.5	94.0	74.9	91.0	73.5	88.2	72.2	77.7	88.8	76.3	85.9	74.7	130.1	82.0	73.5	124.7	80.8	25.0	21.9	19.4	4710	1242
TETERBORO AIRPORT	40.85N	74.06W	7	9.9	14.5	92.4	75.1	89.7	74.0	86.8	72.4	78.0	88.0	76.3	85.5	75.1	131.8	82.8	73.4	124.2	80.5	20.6	18.7	17.3	5055	1002
TRENTON MERCER COUNTY AP	40.28N	74.81W	213	9.8	14.1	92.6	74.4	89.9	73.7	87.2	72.6	77.5	88.9	76.0	85.7	73.7	126.6	81.9	72.9	123.0	81.1	23.5	20.0	18.4	5144	987

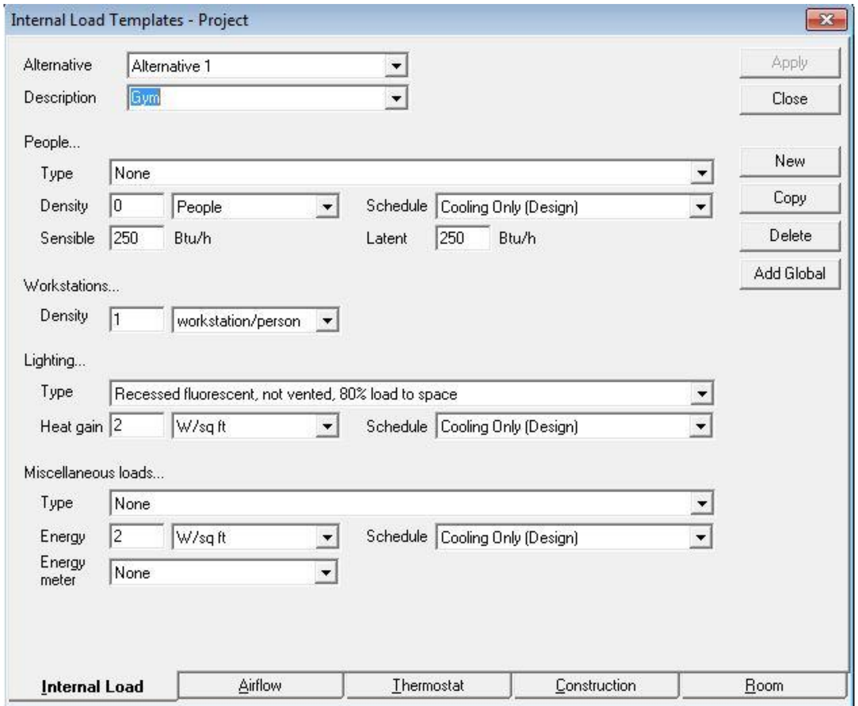
Appendix B- Trace Templates

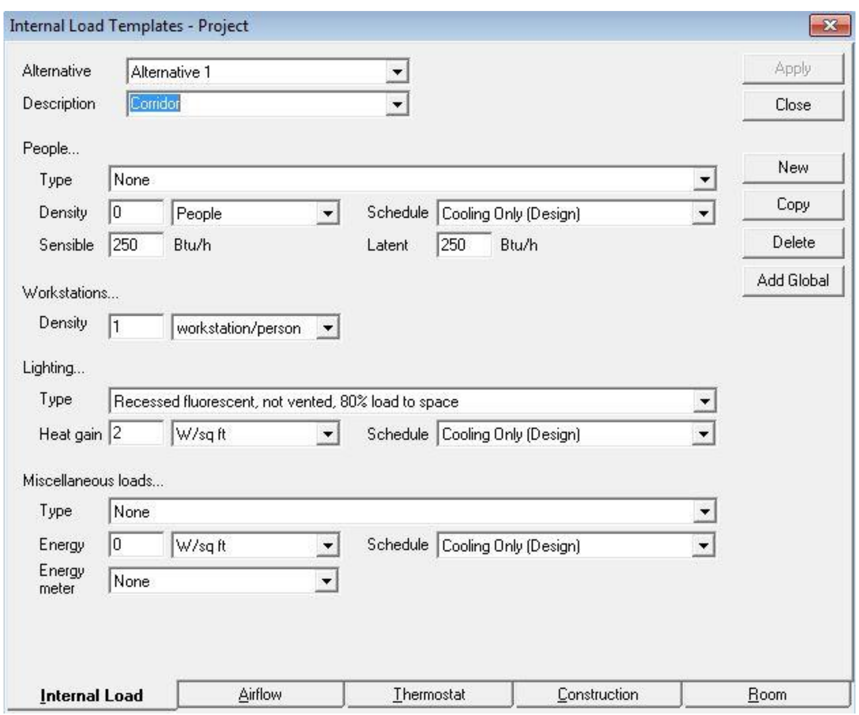


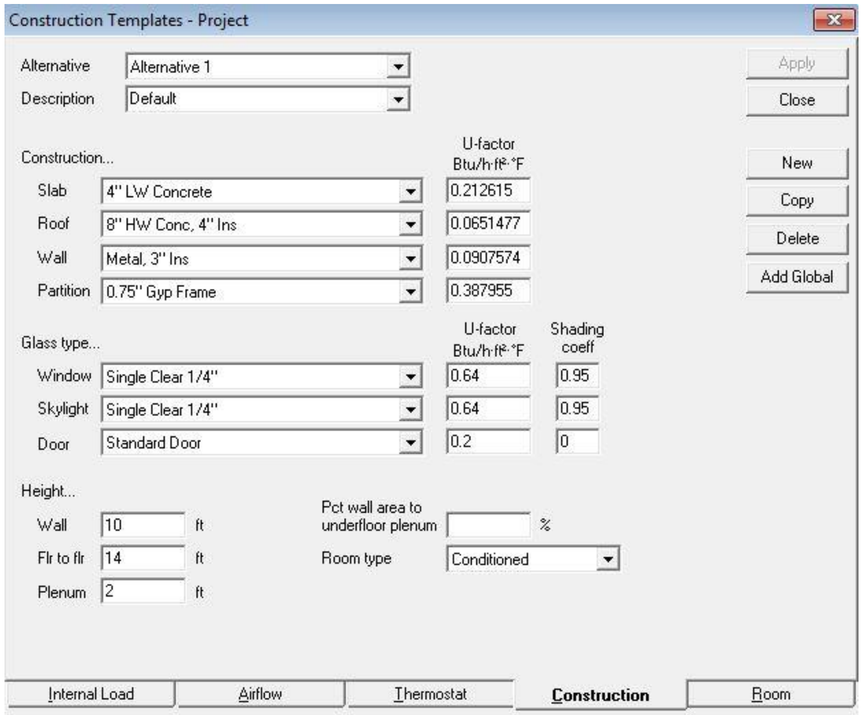



Internal Load Templates - Project
Alternative
Alternative 1
Description
Storage
Apply
Close
People...
Type
None
New
Density
0
People
Schedule
Cooling Only (Design)
Copy
Sensible
250
Btu/h
Latent
250
Btu/h
Delete
Add Global
Workstations...
Density
1
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
2
W/sq ft
Schedule
Cooling Only (Design)
Miscellaneous loads...
Type
None
Energy
0
W/sq ft
Schedule
Cooling Only (Design)
Energy meter
None
Internal Load
Airflow
Thermostat
Construction
Room


Internal Load Templates - Project
Alternative
Alternative 1
Description
Office
Apply
Close
People...
Type
None
New
Density
1
People
Schedule
Cooling Only (Design)
Copy
Sensible
250
Btu/h
Latent
250
Btu/h
Delete
Add Global
Workstations...
Density
1
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
2
W/sq ft
Schedule
Cooling Only (Design)
Miscellaneous loads...
Type
None
Energy
2
W/sq ft
Schedule
Cooling Only (Design)
Energy meter
None
Internal Load
Airflow
Thermostat
Construction
Room


Internal Load Templates - Project
Alternative
Alternative 1
Description
Gym
Apply
Close
People...
Type
None
New
Density
0
People
Schedule
Cooling Only (Design)
Copy
Sensible
250
Btu/h
Latent
250
Btu/h
Delete
Add Global
Workstations...
Density
1
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
2
W/sq ft
Schedule
Cooling Only (Design)
Miscellaneous loads...
Type
None
Energy
2
W/sq ft
Schedule
Cooling Only (Design)
Energy meter
None
Internal Load
Airflow
Thermostat
Construction
Room


Internal Load Templates - Project
Alternative
Alternative 1
Description
Corridor
Apply
Close
People...
Type
None
New
Density
0
People
Schedule
Cooling Only (Design)
Copy
Sensible
250
Btu/h
Latent
250
Btu/h
Delete
Add Global
Workstations...
Density
1
workstation/person
Lighting...
Type
Recessed fluorescent, not vented, 80% load to space
Heat gain
2
W/sq ft
Schedule
Cooling Only (Design)
Miscellaneous loads...
Type
None
Energy
0
W/sq ft
Schedule
Cooling Only (Design)
Energy meter
None
Internal Load
Airflow
Thermostat
Construction
Room


Construction Templates - Project
Alternative
Alternative 1
Description
Default
Apply
Close
Construction...
U-factor
Btu/h·ft²·°F
Slab
4" LW Concrete
0.212615
Roof
8" HW Conc, 4" Ins
0.0651477
Wall
Metal, 3" Ins
0.0907574
Partition
0.75" Gyp Frame
0.387955
New
Copy
Delete
Add Global
Glass type...
U-factor
Btu/h·ft²·°F
Shading
coeff
Window
Single Clear 1/4"
0.64
0.95
Skylight
Single Clear 1/4"
0.64
0.95
Door
Standard Door
0.2
0
Height...
Wall
10
ft
Flr to flr
14
ft
Plenum
2
ft
Pct wall area to
underfloor plenum
%
Room type
Conditioned
Internal Load
Airflow
Thermostat
Construction
Room

Appendix C- Zone Checksums

Appendix D- Mechanical Equipment Operations