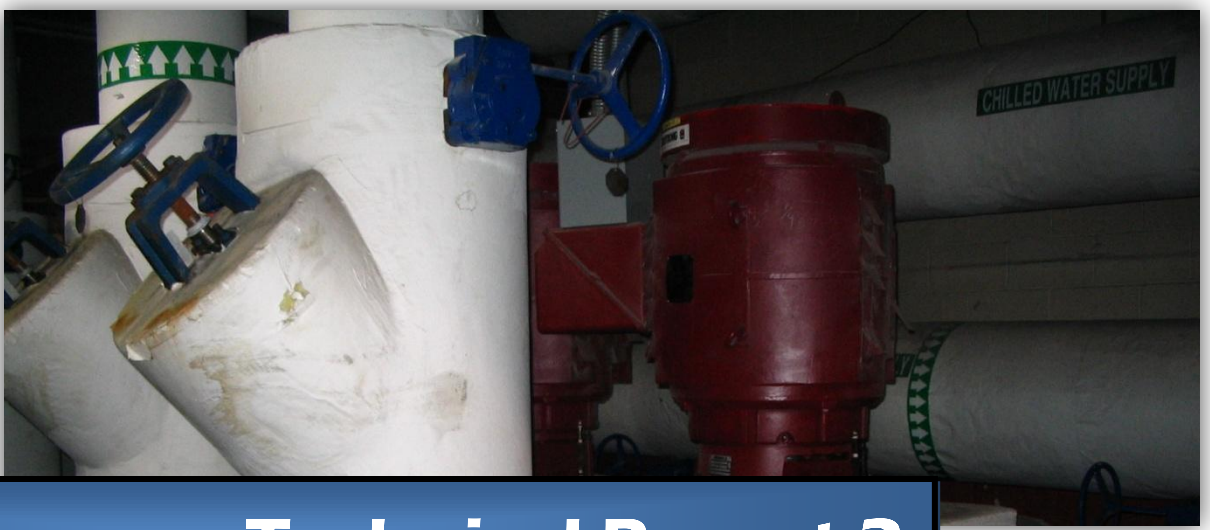

Technical Report 2

Building and Plant Energy Analysis

Bellevue Ambulatory Care Pavilion
New York, NY

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I. Executive Summary

In order to better understand the Bellevue Ambulatory Care Pavilion's performance, an energy model simulation run by Trane Air Conditioning Economics (TRACE) 700 software was performed. This simulation helped calculate cooling loads, energy consumption and various costs to run the building.

In conclusion, the simulation yielded mixed results; some values seemed reasonable while others represented unusual trends. Calculated cooling loads and cfm/ft^2 values fell within a logical range, as did percentage of energy consumption for each component of the building. However, after looking at a monthly profile of energy consumption and yearly energy cost, values appeared to be a bit off target. In terms of monthly energy consumption, the summer months had a much lower energy profile than a typical large project building in New York City. Also, the cost per square foot of building area seemed quite high. This could either be a mistake in the energy modeling or it could reveal a potential area for improvement in terms of building energy consumption.

II. Mechanical System Revisited

The 207,000 ft^2 Bellevue Ambulatory Care Pavilion serves as an addition to the Bellevue Medical Center, America's oldest public hospital, which originally opened in 1736 and last had renovations in 1973. Since it shares functions with the older parts of the Medical Center, some of its energy systems and sources root themselves in the systems of the older building. Instead of having a local chiller plant, the Pavilion has 1920 gpm of 41ºF chilled water transported to eleven on-site air handling units via 2 chilled water booster pumps. The older 9000-ton chiller plant consists of one steam powered and three electric powered chillers which supply chilled water to all parts of the Bellevue Medical Center, old and new. For heating purposes, high pressure steam is tapped from the main New York City line (supplied by Con Edison) and flows through the air handling unit heating coils at 5 psig. Also, the condenser water supply comes from a module of 8 rooftop cooling towers at the older medical center. Eleven air handling units, which supply anywhere from 3,500 to 40,000 CFM of 51.6ºF to 95.8ºF conditioned air, serve all spaces of the Ambulatory Care Pavilion. Figure 1, below, represents a general schematic of the mechanical systems.

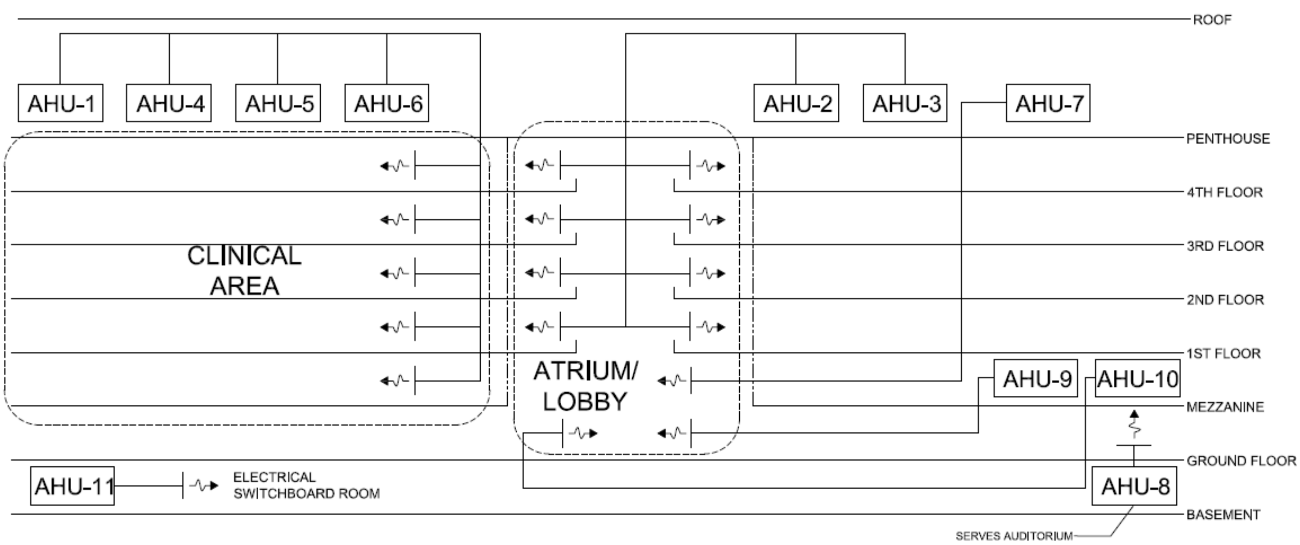


Figure 1: General Mechanical System Schematic

III. Design Load Analysis

To estimate design loads, annual energy consumption, and operating costs for the Bellevue Ambulatory Care Pavilion, Trane Air Conditioning Economics (TRACE) 700 software was used as the building energy simulation program. In order to ensure correct data and computer inputs, information in several building categories were obtained from design documents, printed and electronic. Information obtained from these documents included the following:

- Occupancy per Room (taken from Life Safety Plans)
- Room Areas (determined by "Area" commands on AutoCAD)
- Room and Floor Heights (taken from room finish plans and sections)
- Glazing Percentage (taken from plans and elevations)
- Lighting Loads in W/ft^2 (taken from lighting plans and fixture schedules)
- Equipment Loads (taken from electrical power plans)
- Building Construction (taken from partition and detail drawings)
- Mechanical Equipment Components and Operations (taken from plans, schedules, specifications and shop drawings)

For the most part, indoor spaces of the Ambulatory Care Pavilion used preset inputs from the *Lights – Extended Care Patient* schedule (see Appendix A for an example). This schedule includes a reduced required load before and after normal occupancy hours, which fits well into this building's profile. Other space types which did not fall under the *People – Extended Care Patient* schedule, such as *General Office* and *Main Entrance Lobbies*, were used as inputs in the TRACE 700 analysis.

Certain values (flow rate, demand charges, etc.) needed to be inputted into TRACE 700 in order to obtain accurate simulation results. The following values represent a few preset parameters for the building:

- **1920 GPM** of chilled water, chiller COP of **4.433**, total supply air flow of **140,020** cfm
- KW Demand Charge = **$15.58** and **$12.04** (June-Sept and Oct-May, respectively)
- **$1.39/kwh** Consumption Rate and **$2.08/therm** steam rate

Assumptions:

Several assumptions were implemented into this analysis to account for missing information, limitations with TRACE 700, and simplification of design. They include the following:

- Toilet Rooms, Storage Rooms, Electrical Closets and Janitor Closets were not included in the analysis. Most of these spaces had undercut doors which allowed in minimal supply air from corridors for ventilation and did not have separate supply air, as per design. This will cut down on the total analyzed square feet.
- Exterior walls along parts of the building's north and west façade included 12" concrete shear walls with 4" polystyrene insulation and face brick. TRACE 700 did not have this wall type in its menu; the most similar wall type used had 8" LW concrete with 5" polystyrene insulation and face brick.
- Even though the building uses several air handling units to supply conditioned air to its spaces, many of these units have typical characteristics. Therefore, all typical units were combined to create three separate air systems used in the TRACE 700 analysis.
- The building does not have a local cooling tower module or chiller plant. Condenser water and chilled water taps from the plants in the adjacent medical building. A local cooling plant was used in this analysis with the same EER but reduced flow rate.
- Instead of inputting a universal W/ft^2 for equipment loads in each room, total watts was used instead for individual spaces; most spaces had typical layouts but equipment types varied frequently. Equipment loads included wattage outputs from televisions, computers, copiers, medical exam equipment, etc.
- Ventilation rates and percentages, pressure drops, fan locations and motor horsepower values were all determined from mechanical schedules and cut sheets.

Computed Cooling Load:

An energy analysis was not performed by the engineer of this project, for it was not in the scope of work. No values will be available for comparison and accuracy purposes. After accounting for all assumptions and requirements for a sufficient building model, an energy analysis reported data as shown in the following figures and tables.

Table 1: Computed Cooling Load, Supply Air and Ventilation

	Cooling Load	Supply Air	Ventilation Air
Computed	530 ft^2/ton	0.81 cfm/ft^2	0.28 cfm/ft^2

The TRACE 700 simulation yielded annual energy consumption percentages for different components of the building. As expected, receptacle and room equipment loads accounted for the largest percentage of energy consumption. Figure 2 below represents the fractions of energy which certain building components consume.

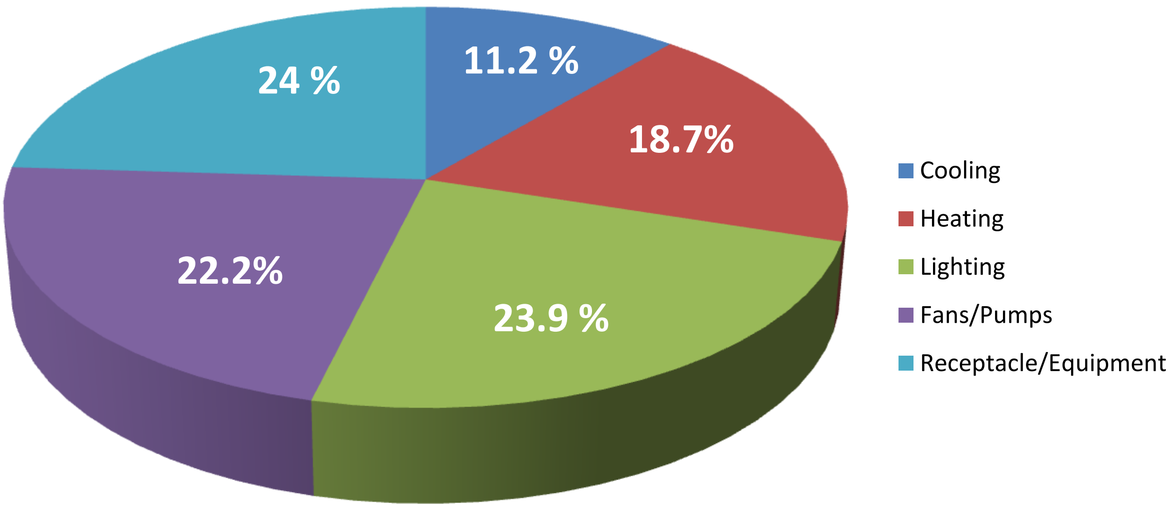


Figure 2: Energy Consumption Pie Chart

Relating to the previous figure, Table 2 shows the energy consumption percentages and kwh amount of each component.

Table 2: Energy Consumption Distribution

	Percentage of kwh	Amount in kwh
Cooling	11.2%	181325
Heating	18.7%	303629
Lighting	23.9%	387247
Fans/Pumps	22.2%	360203
Receptacle/Eqpm	24.0%	387658

In order to understand the building's energy consumption pattern based on a month to month study, the TRACE 700 analysis reported a *Monthly Energy Consumption* profile, as shown in Figure 3. The most energy consumed falls within the winter months. This observation makes sense when relating to energy consumption in Figure 1, for heating consumes more energy than heating in this building. However, it seems peculiar as to why the summer months do not consume more energy. Further research and more in-depth simulations may yield more reasonable results and explanations.

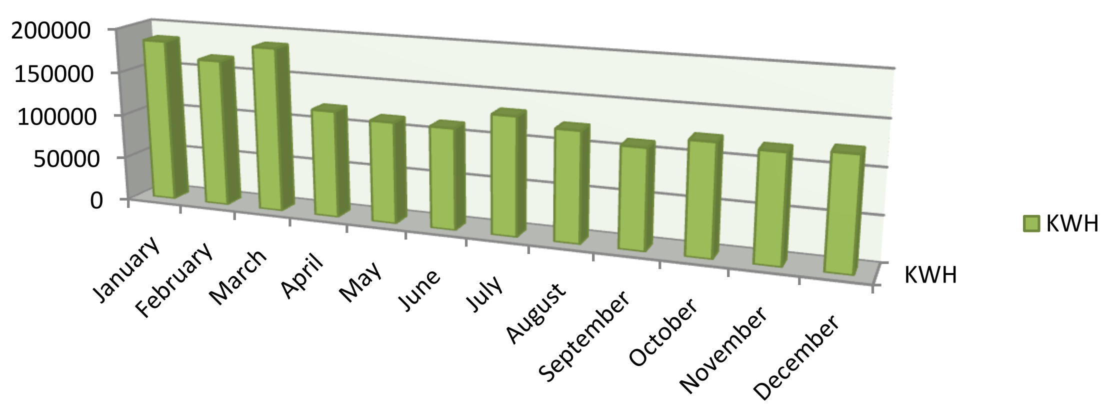


Figure 3: Monthly Energy Consumption

Once monthly energy consumption data was determined, demand charges and consumption rates yielded a monthly and annual cost to run all equipment within the scope of Figure 2.

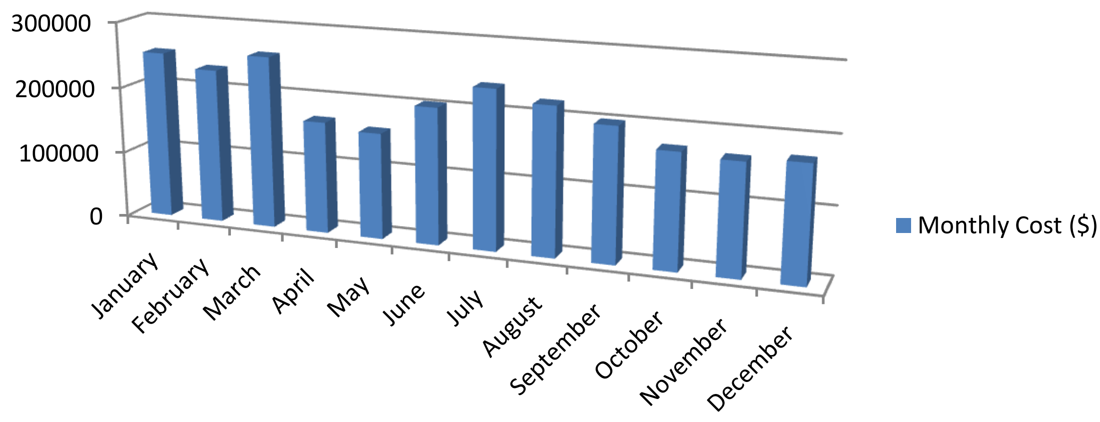


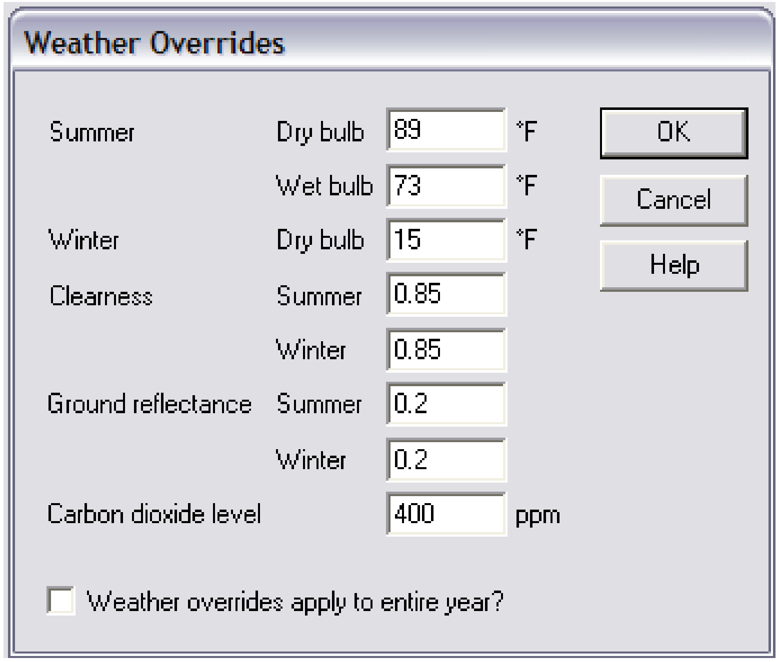
Figure 4: Monthly Cost of Total Operation

Summing up the monthly costs from Figure 4 yields an annual energy cost of **$2,189,857.27**. The months of April and May seem to consume the least amount of energy and cost the least. This may be due to the economizer features on the air handling units of the building. Temperatures in April and May fall within the economizer set temperature of 55 degrees F, which calls for less heating capacity and no cooling capacity; this would result in less energy consumed by the chillers and pumps.

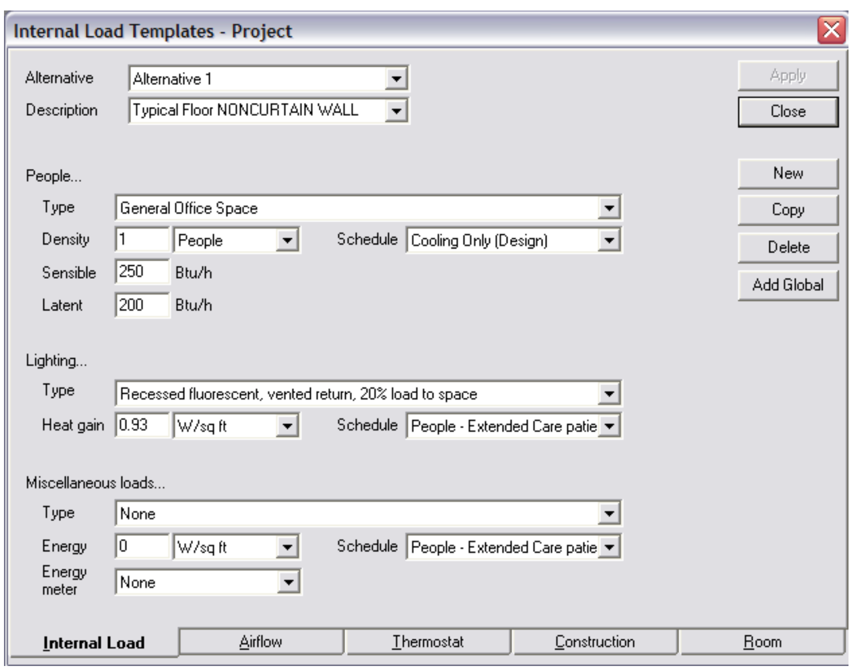
To sum up the cost analysis, using the annual energy cost based on square footage would yield a cost of **$10.58/ft^2**. This seems like a relatively high cost per square foot. A likely consideration for improvement would involve energy monitoring, reduction and efficiency.

IV. Appendix A: TRACE 700 Templates

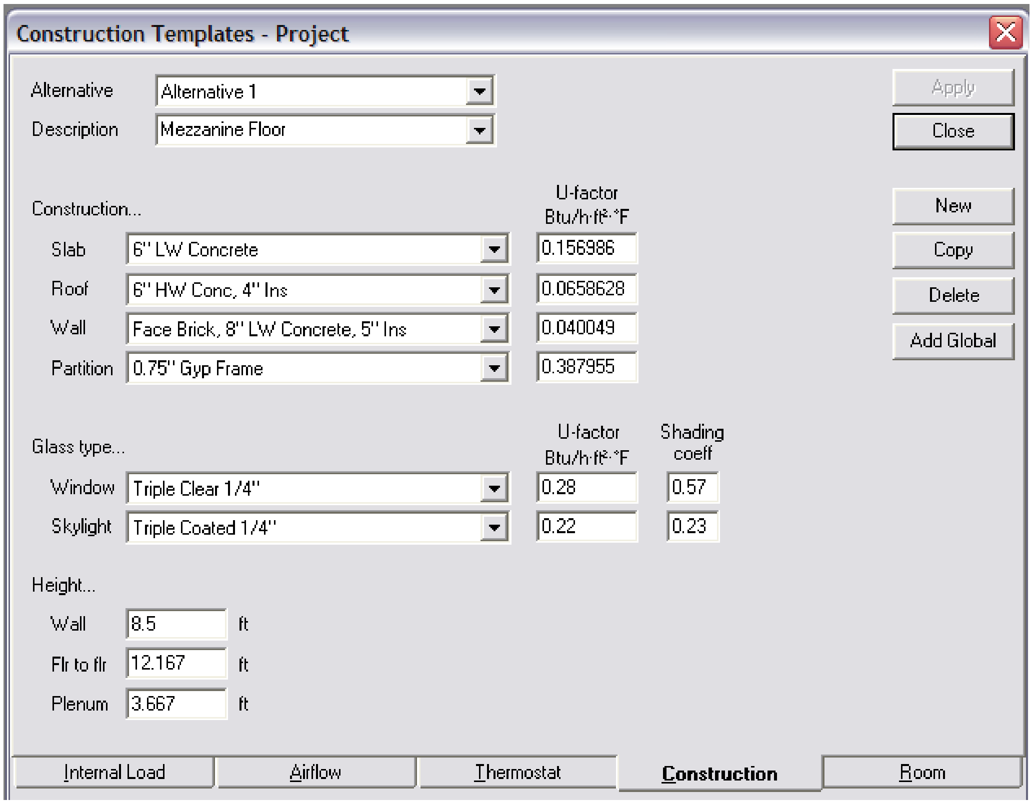
Weather Inputs for New York City



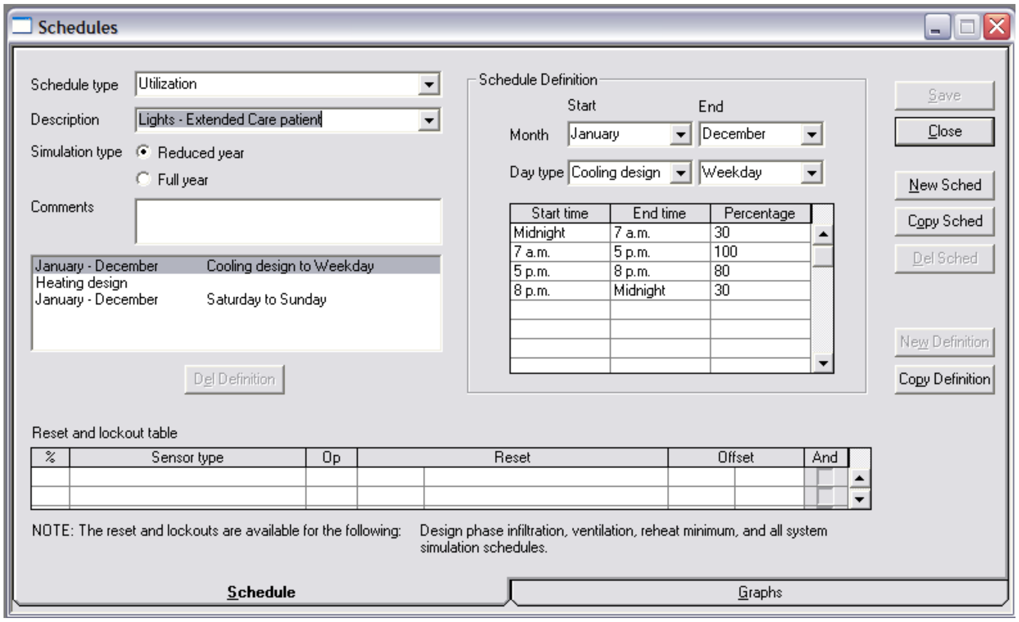
Sample Room Template



Sample Construction Template



Sample Preset Schedule



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