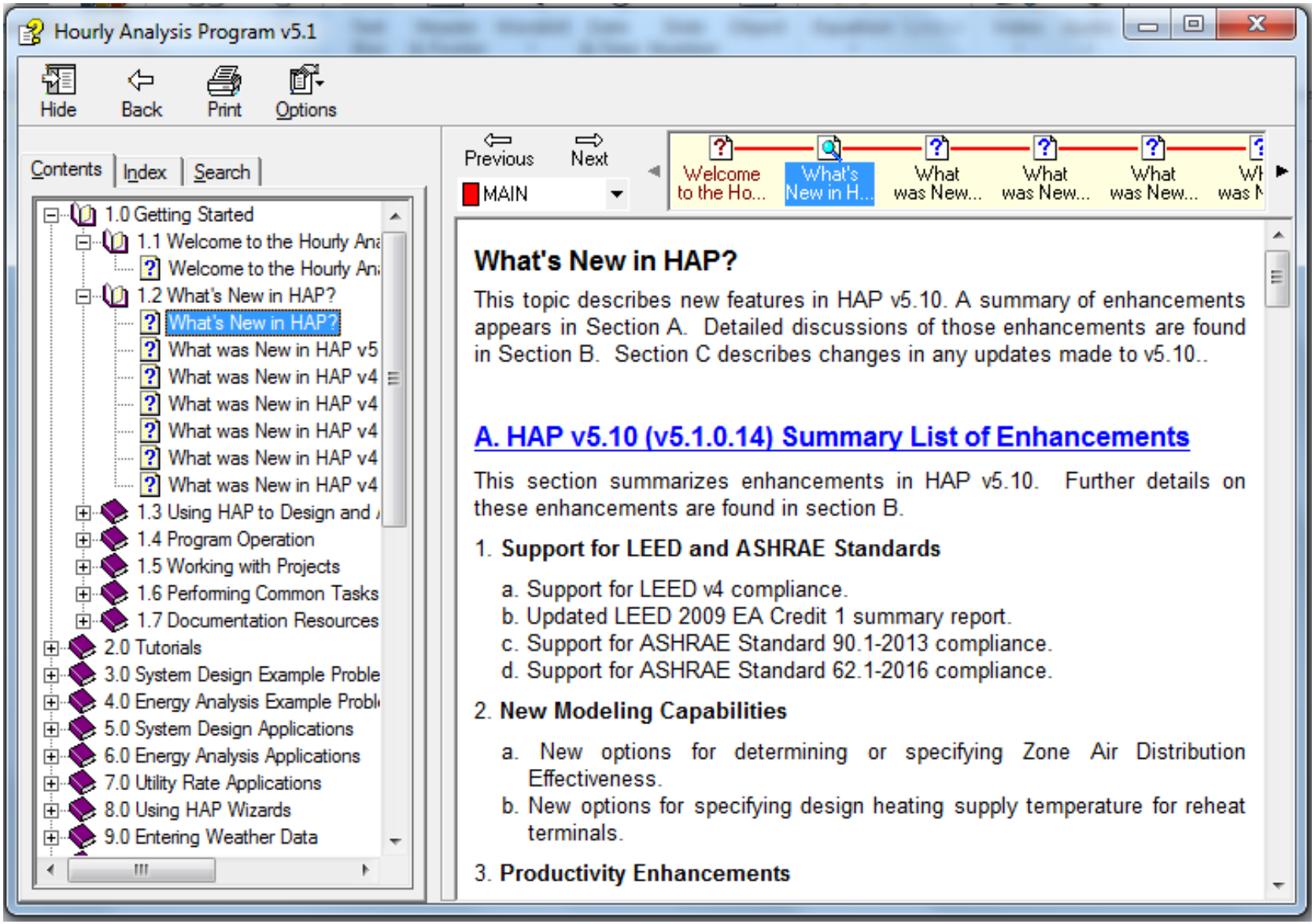
Carrier Hourly Analysis Program

- HAP is a computer tool which assists engineers in designing HVAC systems for commercial buildings. HAP is two tools in one.

- First it is a tool for estimating loads and designing systems. Second, it is a tool for simulating energy use and calculating energy costs. In this capacity it is useful for LEED®, schematic design and detailed design energy cost evaluations.

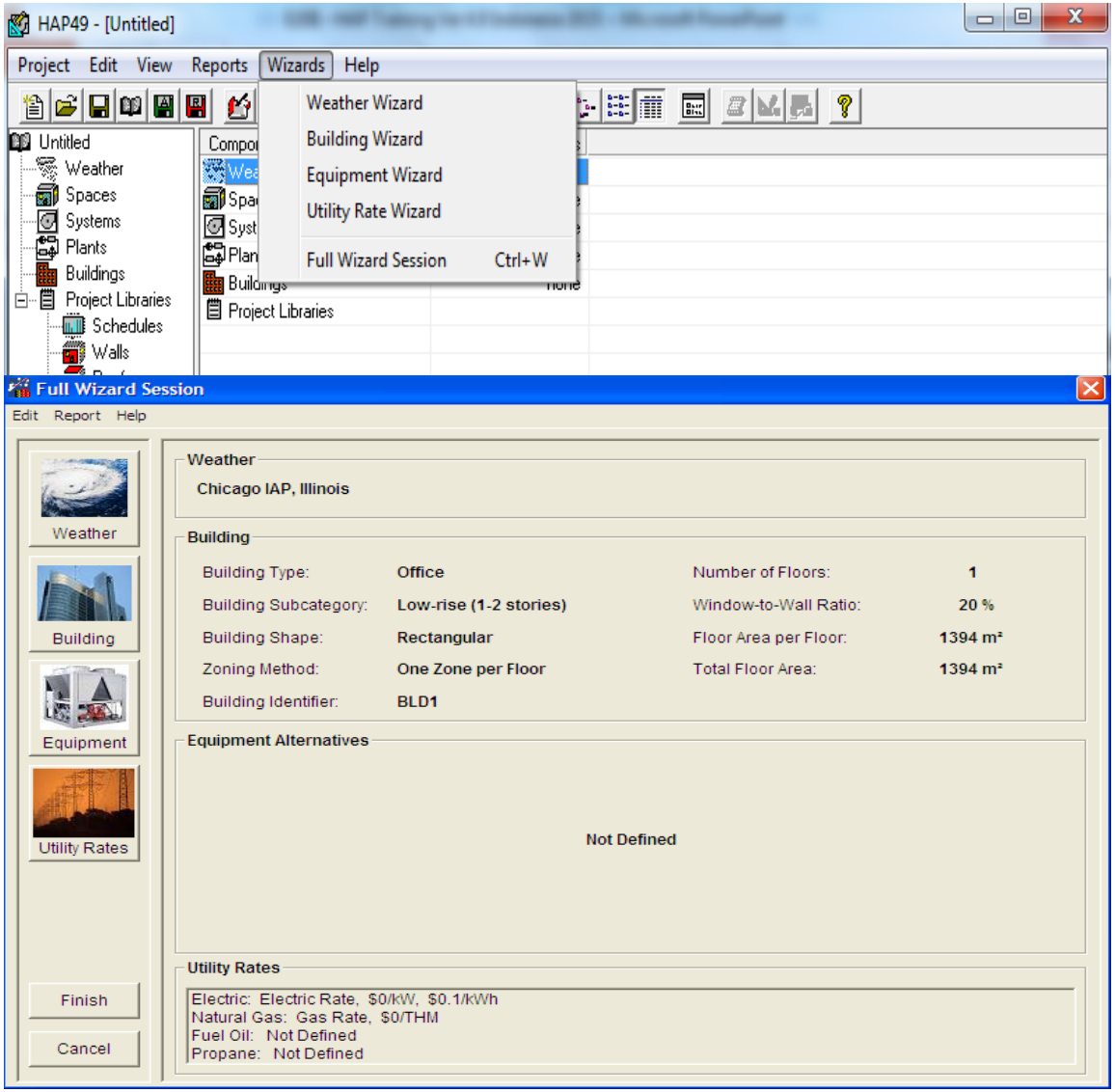
- HAP uses the ASHRAE-endorsed transfer function method for load calculations and detailed 8,760 hour-by-hour energy simulation techniques for the energy analysis.

Updated Features in HAP

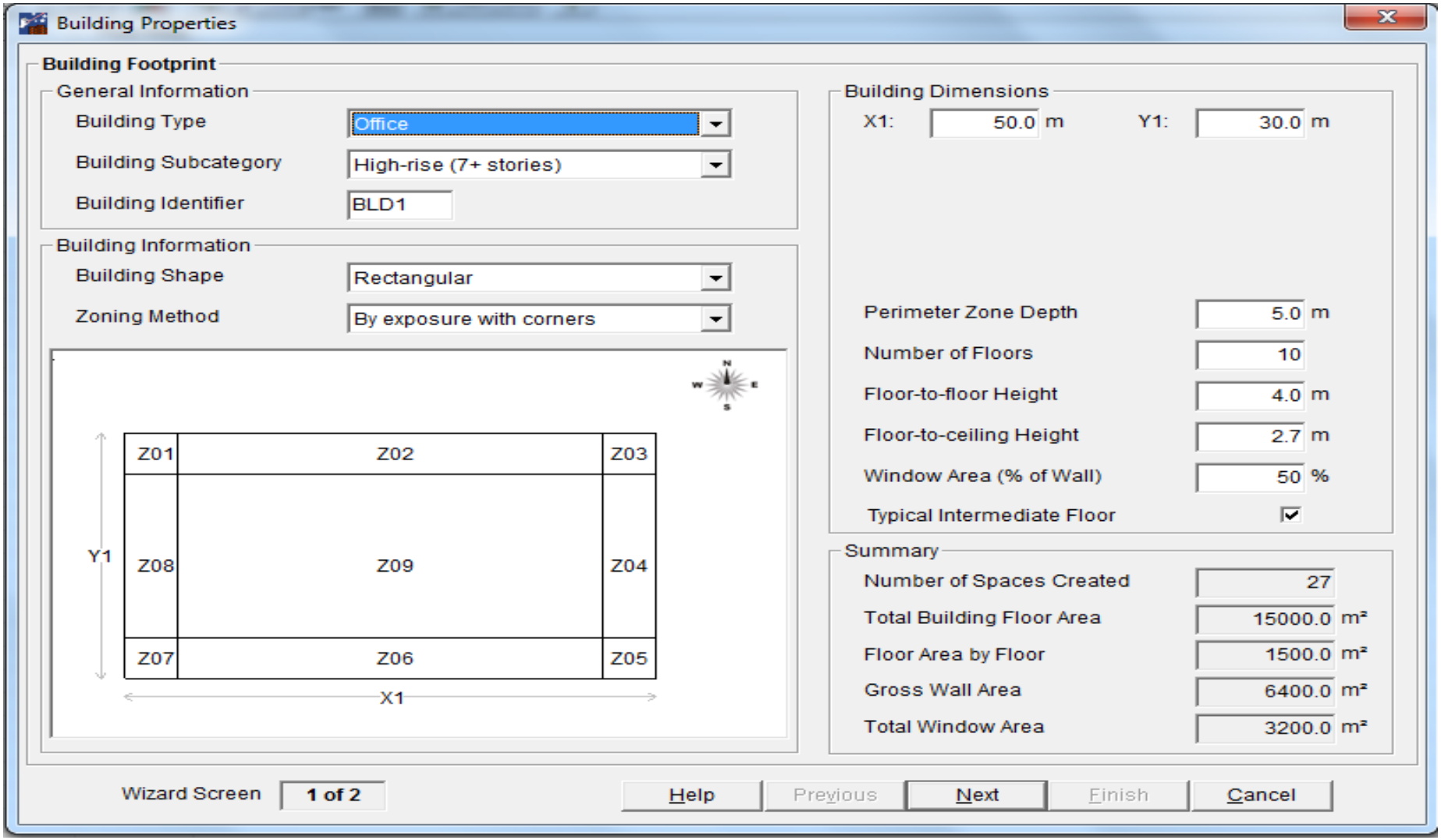


Introducing HAP Wizard Session

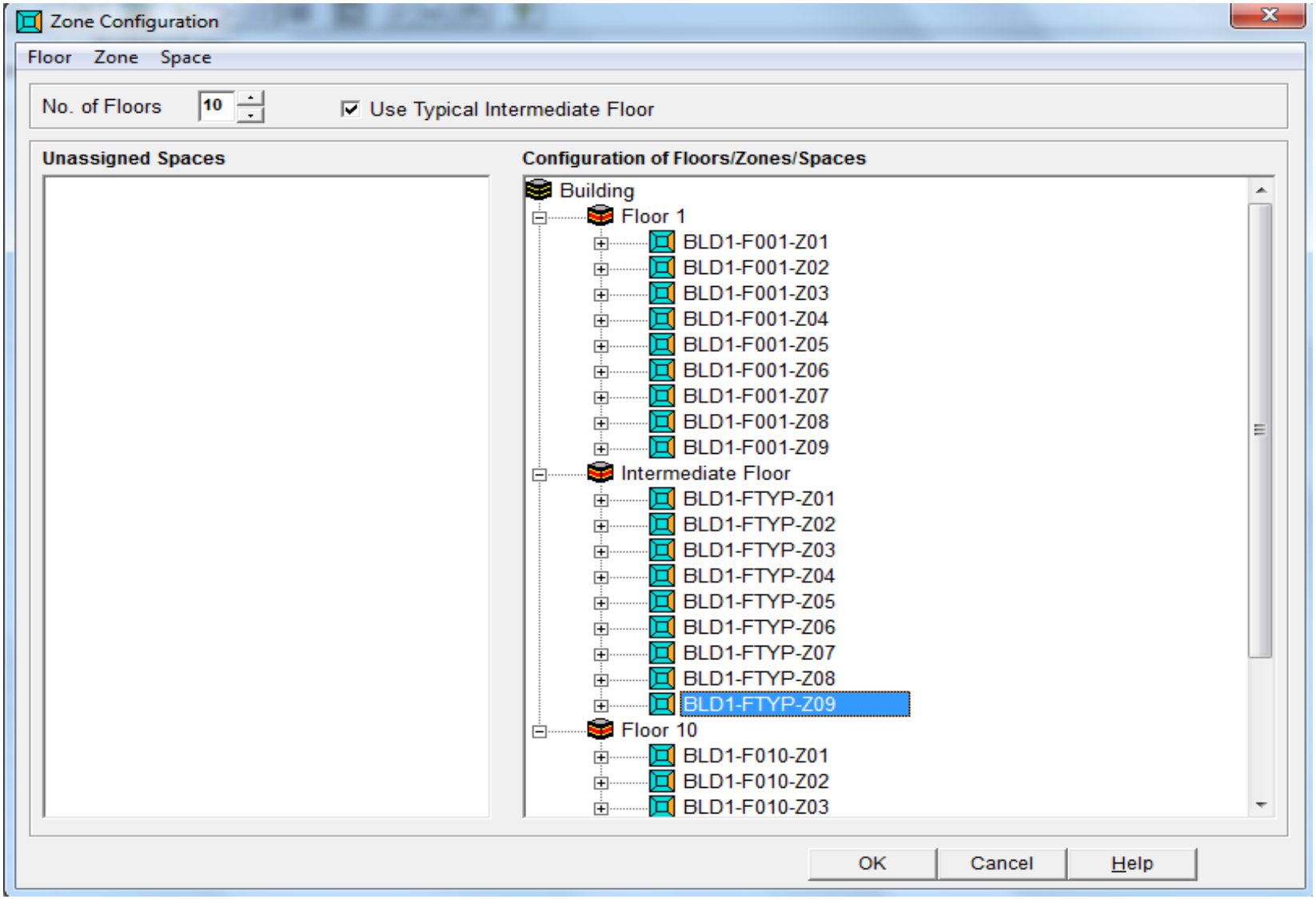
- Top Down Approach
- Well Suited for Preliminary or Schematic Design
- Bring a User through a Series of Input Screens i.e. Building Location, The Building, Type of Equipment & Utility Rates
- Applies Intelligent Assumptions to convert User Inputs to a Details Interface
- Wizard Inputs can be Edited Once Returned to Main HAP Program



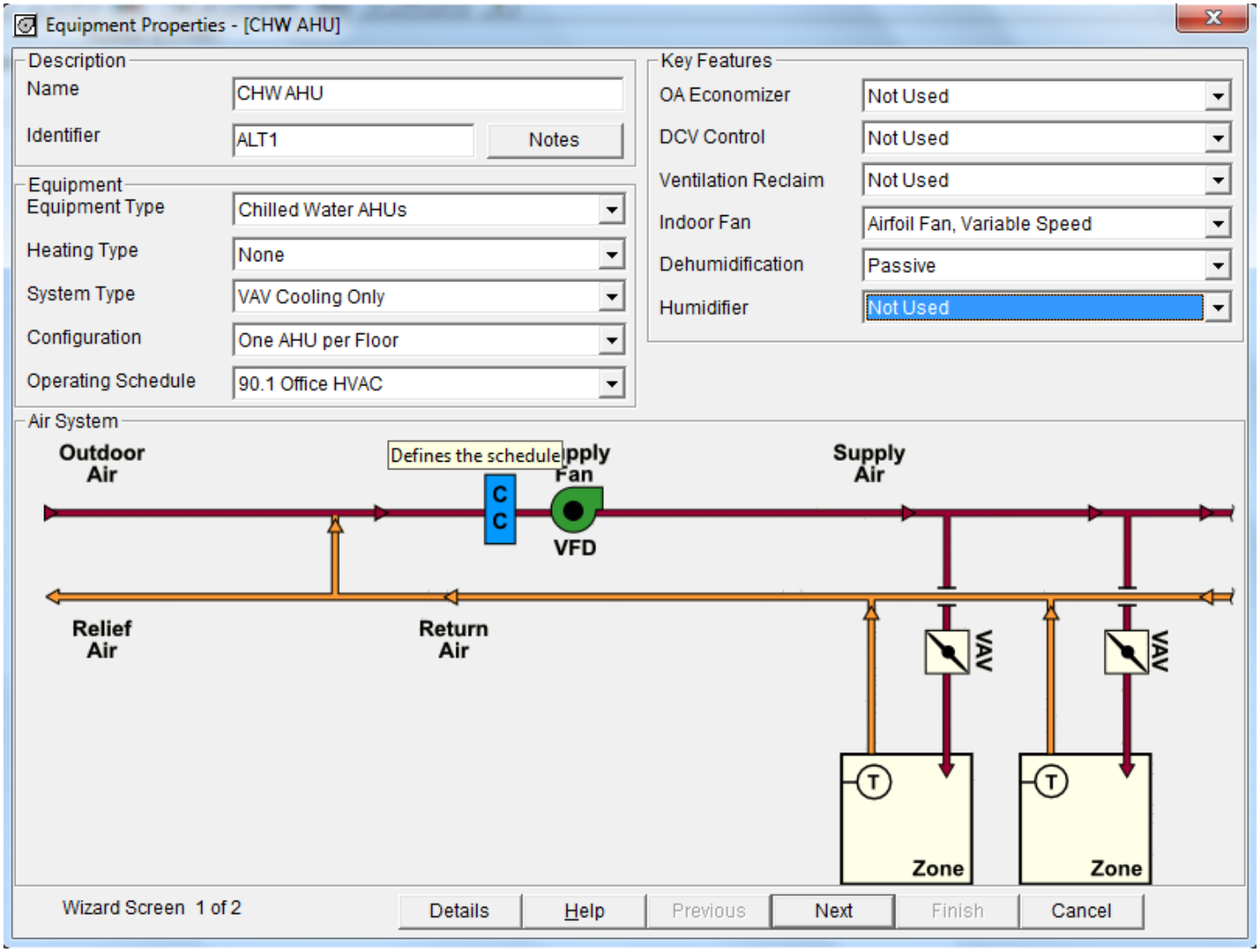
Building Wizard



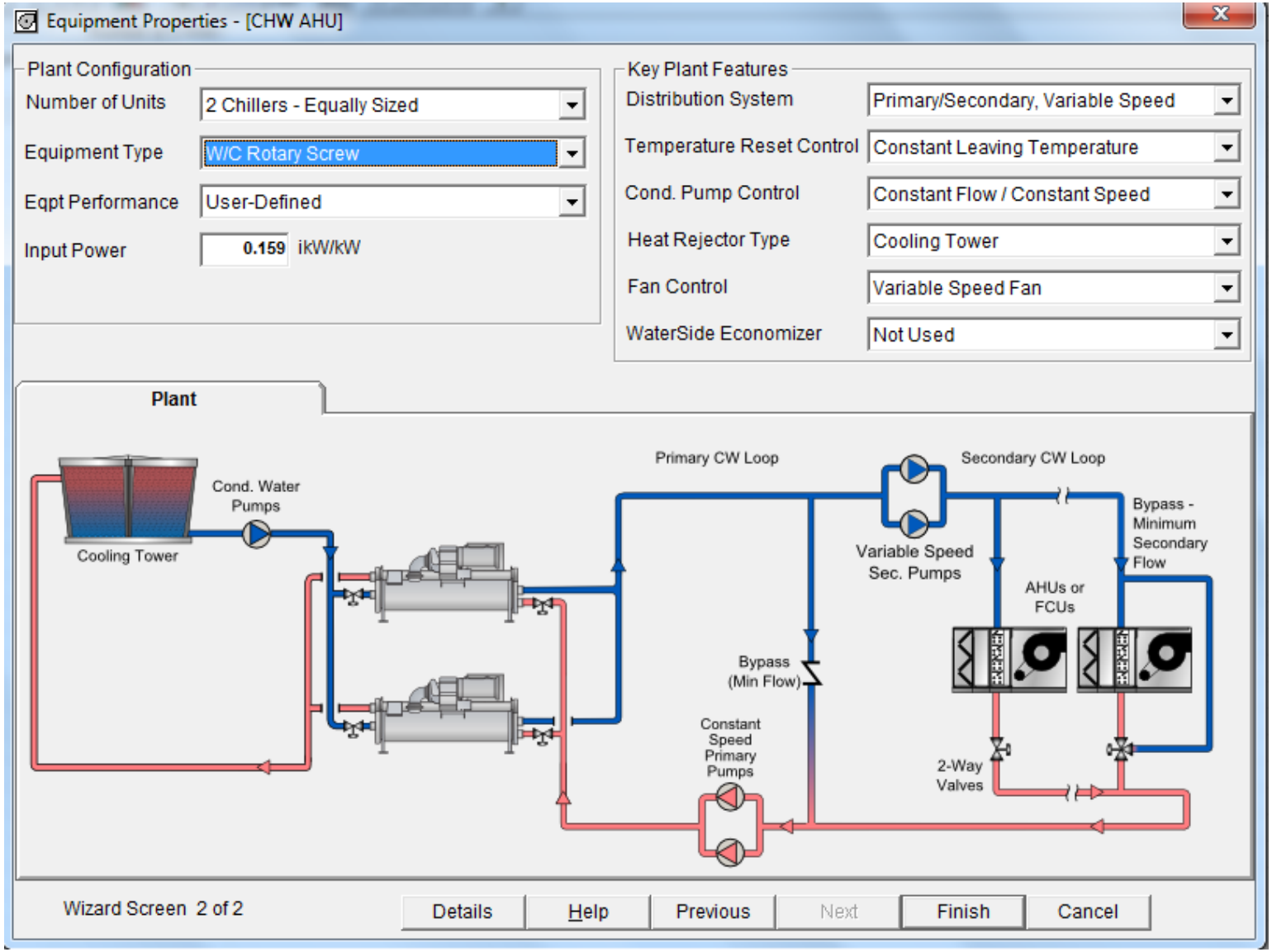
Equipment Wizard – Zone Config.



Equipment Wizard – Equipment Prop.

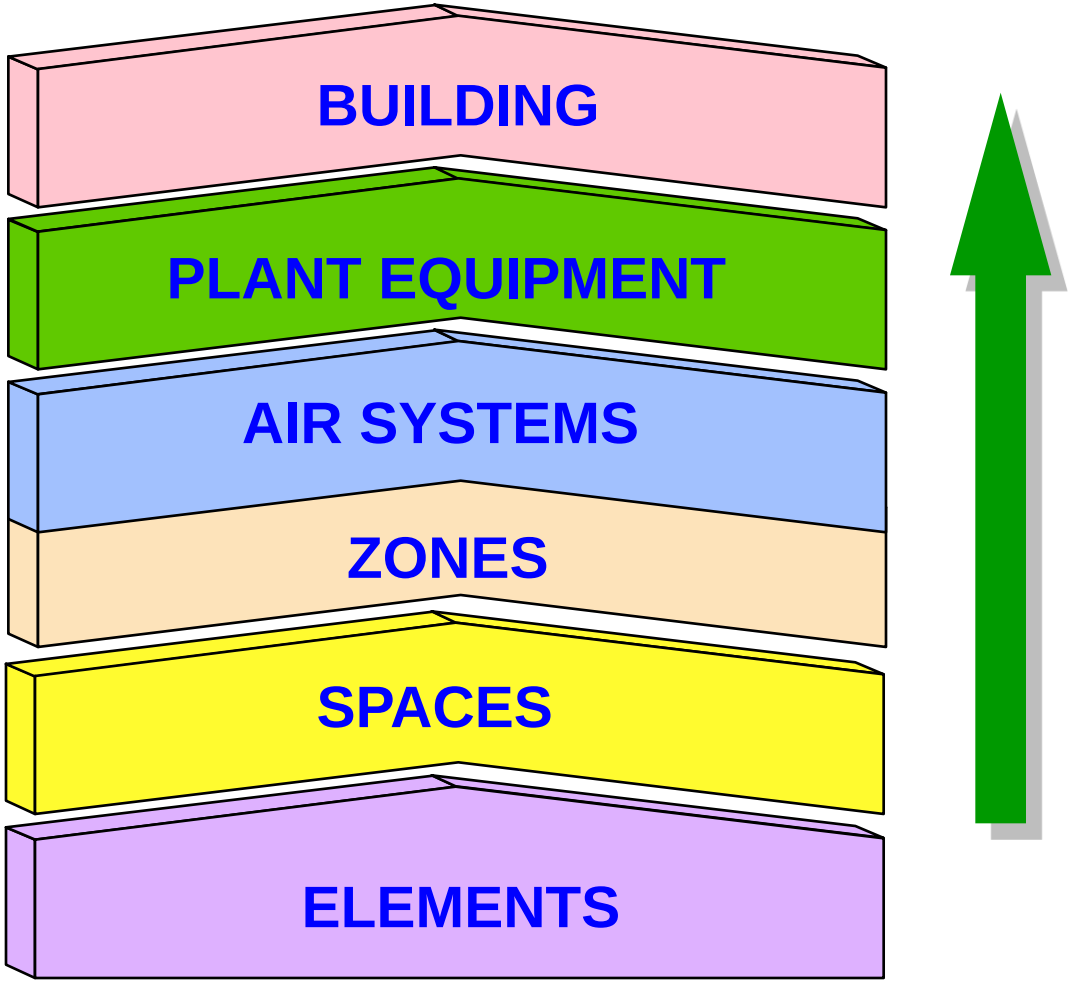


Equipment Wizard – Equipment Prop.



HAP Energy Modeling Building Block Approach

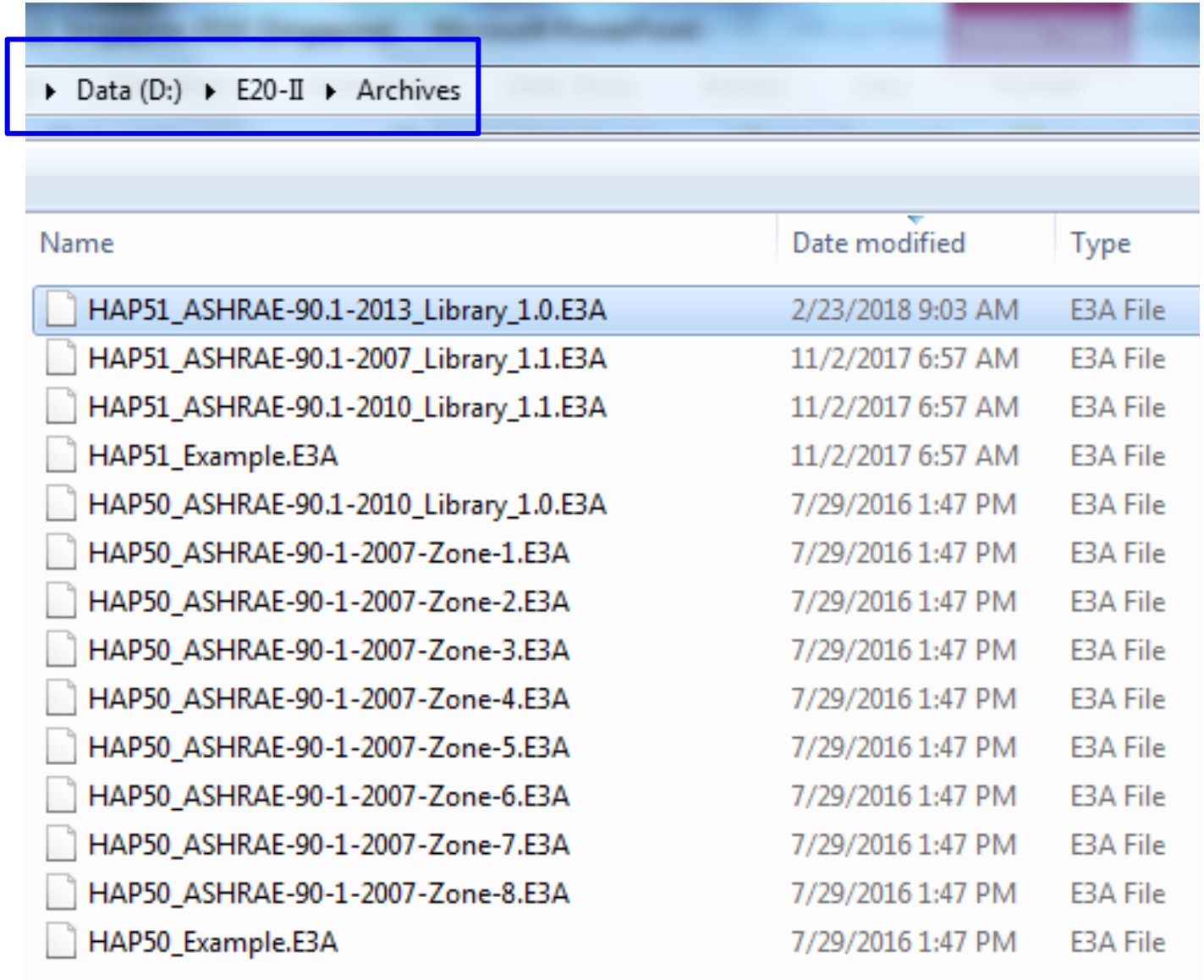
- Bottom Up Approach
- All Data is Directly Entered by the User
- A Sum of the Building to Estimate Operating Costs
- Miscellaneous Building Energy Consumption
- Utility Rate Structures Applied
- Energy Reports in Dollars
- A Way to Model Multiple Alternatives in Design



Project Data Management

- Archive project data for safe keeping using the Archive option on the Project Menu.
- Retrieve data that you earlier archived using the Retrieve option on the Project Menu.
- Convert data from a previous version of HAP using one of the Convert HAP Data options on the Project Menu.
- Import data from another project into the current project using the Import Data option on the Project Menu.
- Import data from a gbXML file using the Import gbXML option on the Project Menu. For example, a gbXML file generated by a CAD tool can be imported into HAP to speed the process of transferring data from floor plan drawings into HAP.

Retrieve ASHRAE Files



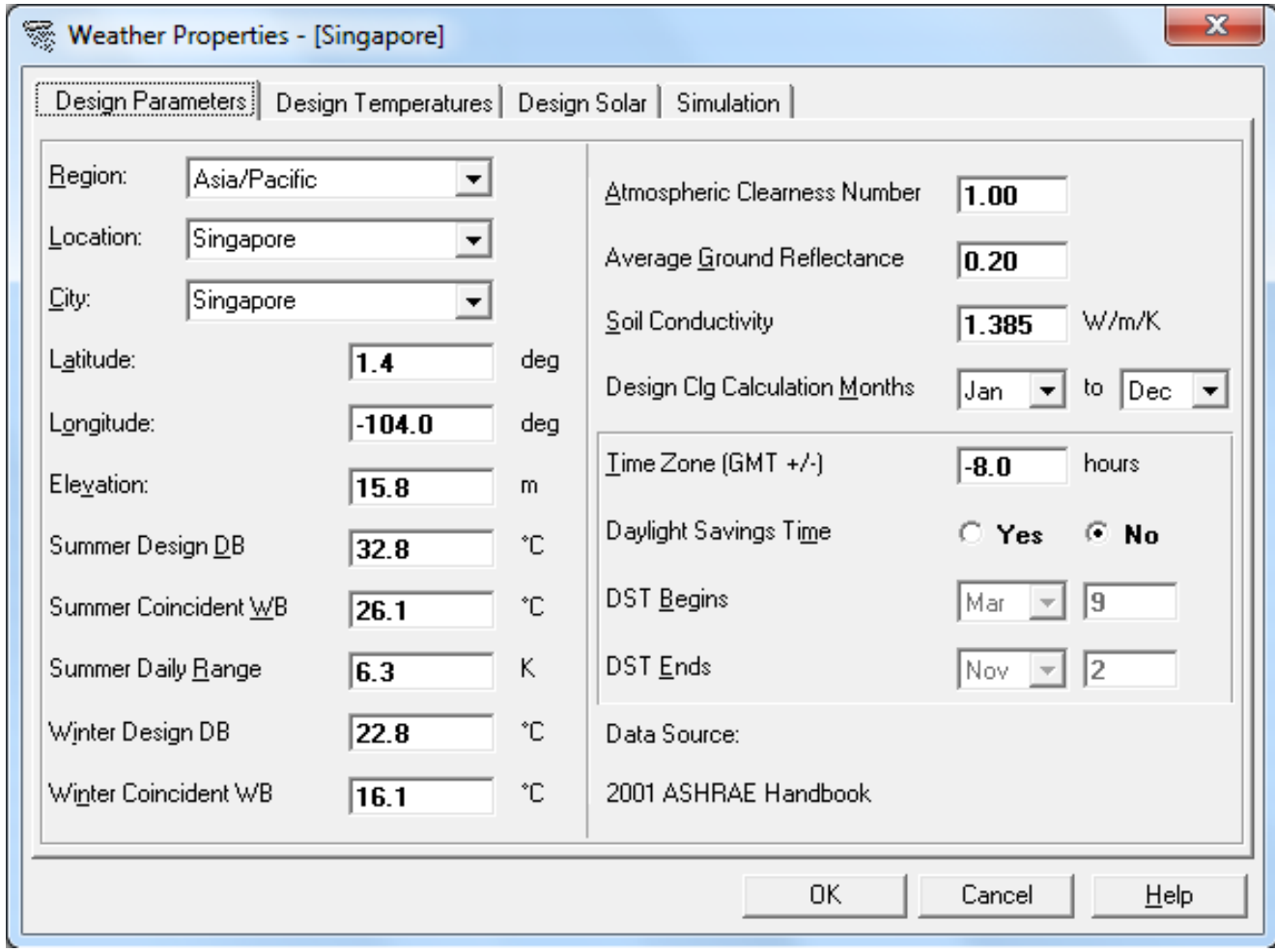
Project Data Management

Project Data Quantities. A project can contain all of the data for your analysis. This can include multiple variations of the building and its HVAC systems and equipment. Maximum limits on the quantity of data items in a project are shown below:

Data Category	Maximum Number of Items
Weather	1
Spaces	32000
Air Systems	5000
Plants	250
Buildings	100
Schedules	Unlimited
Wall, Roof, Window, Door Assemblies	Unlimited
Shade Geometries	Unlimited
Chillers, Cooling Towers, Boilers	Unlimited
Electric Rates, Fuel Rates	Unlimited

Define Weather Properties

- Weather
  - Design Parameters
  - Design Temperatures
  - Design Solar
  - Simulation



Define Weather Properties

Design Parameters

- **Summer Daily Range** represents the difference between maximum and minimum dry-bulb temperatures on an average day during the warmest month of the year.
- **Atmospheric Cleanliness No.**
  - factor used to correct sky solar radiation profiles for unusually clear or hazy conditions
  - Very clear conditions, >1.15
  - Typical conditions, ~ 1.00
  - Very Hazy conditions, <0.85
- **Average Ground Reflectance**
  - Solar Radiation reflected by Ground Surface. Typical Values shown below:

Surface Type	**Reflectance**
New Concrete	0.31 to 0.34
Old Concrete	0.22 to 0.25
Bright Green Grass	0.21 to 0.31
Crushed Rock	0.20
Bitumen and Gravel Roof	0.14
Bituminous Parking Lot	0.09 to 0.12

Notes:
1. Reflectance varies with angle of incidence.
2. Data from 2001 ASHRAE Handbook of Fundamentals, Table 10, pg 30.16.

Define Weather Properties

Design Parameters

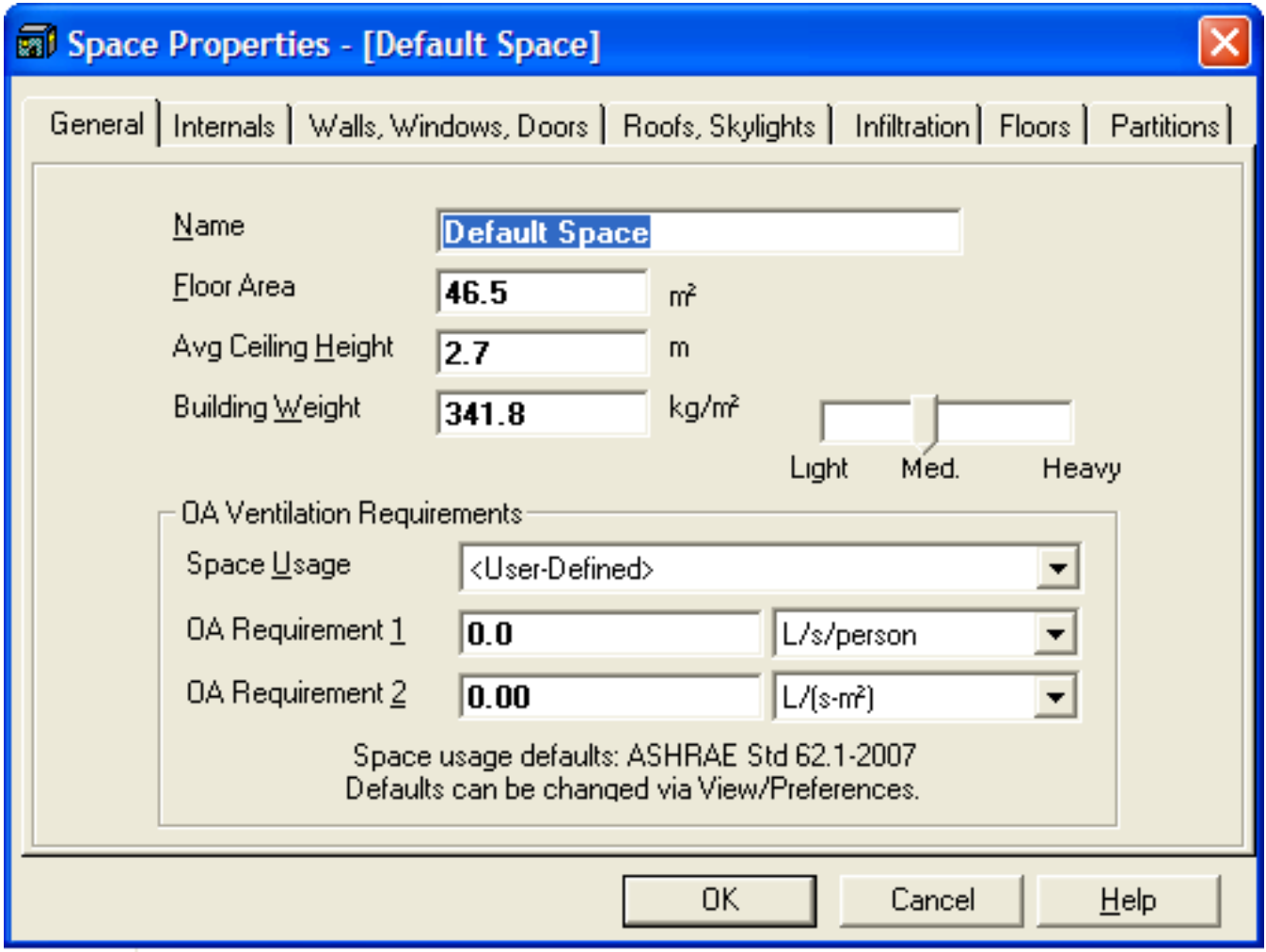
- **Soil Conductivitiy**

- refers to the thermal conductivity of soil surrounding a building. The conductivity affects calculation of heat transfer through basement walls, basement floors and slab floors. Thermal conductivity varies depending on the composition of local soil and its moisture content.
- Sample conductivities for common soil types in North America are provided in the table below:-

		Recommended Values for Design(2) (W/m/k)	
Classification	Normal Range	Low(3)	High(4)
Sands	0.61 to 2.51	0.78	2.25
Silts	0.87 to 2.51	1.64	2.25
Clays	0.87 to 1.64	1.13	1.56
Loams	0.87 to 2.51	0.95	2.25

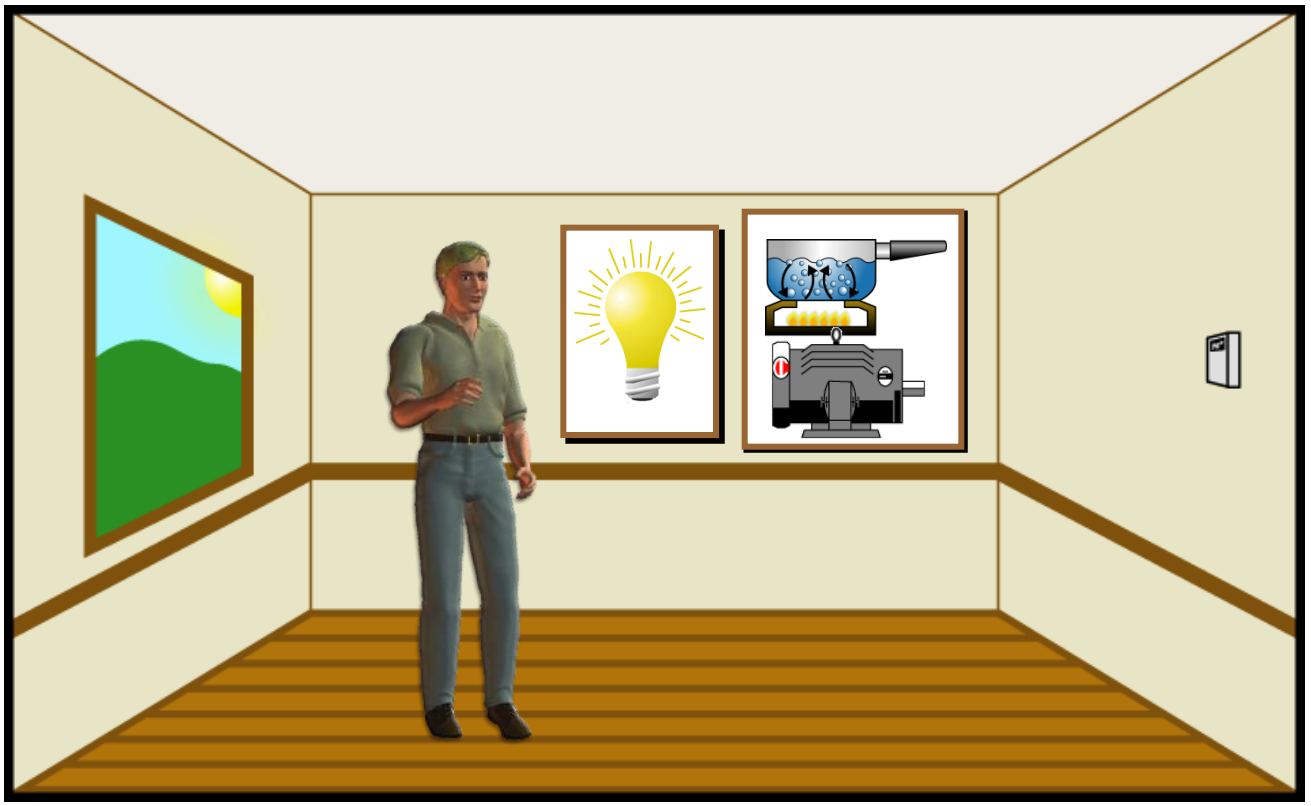
Space Sizing

- Space
  - General
  - Internals
  - Walls, Windows, Doors
  - Roof
  - Infiltration
  - Floors
  - Partitions

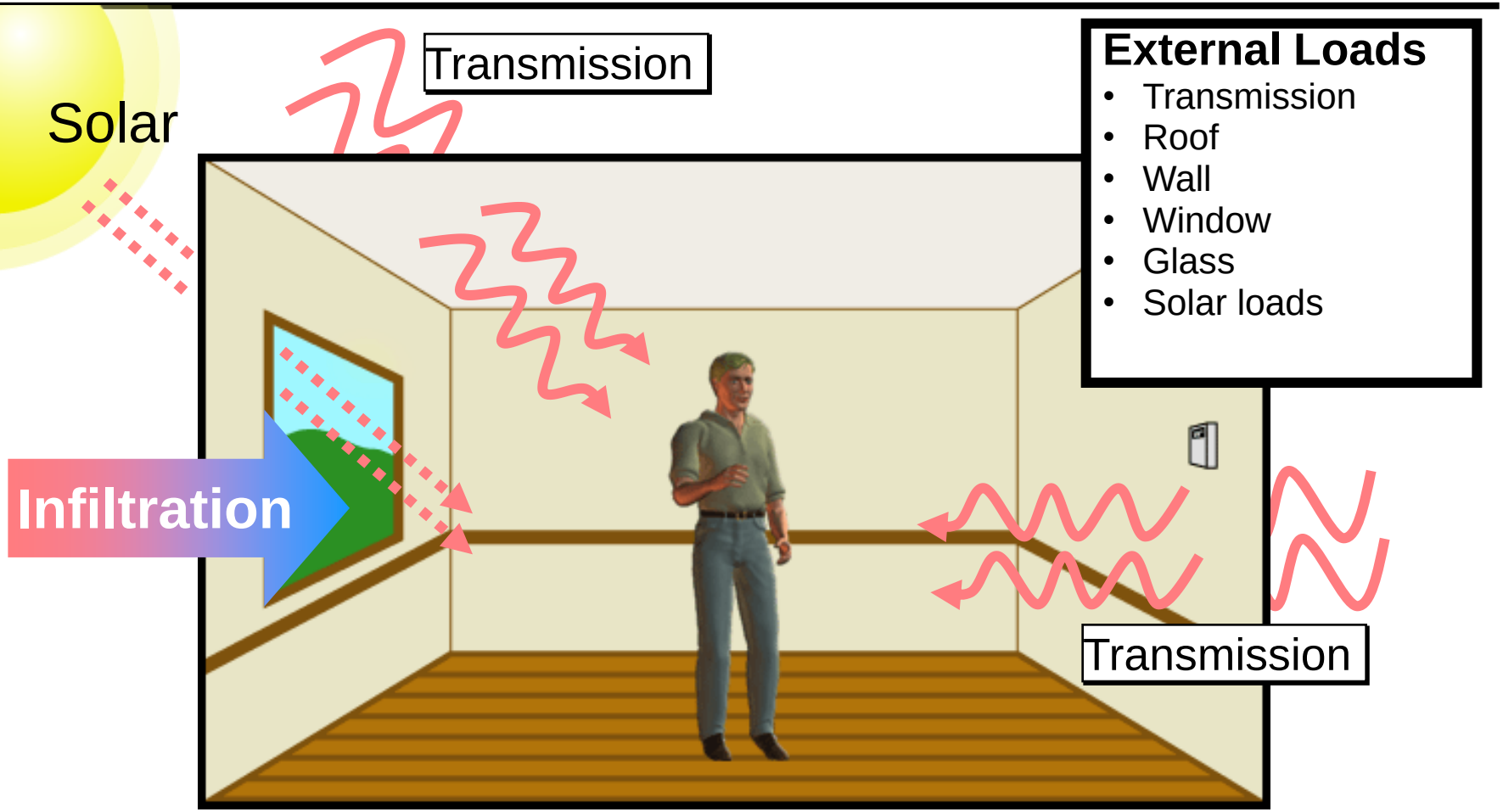


Internal Heat Load

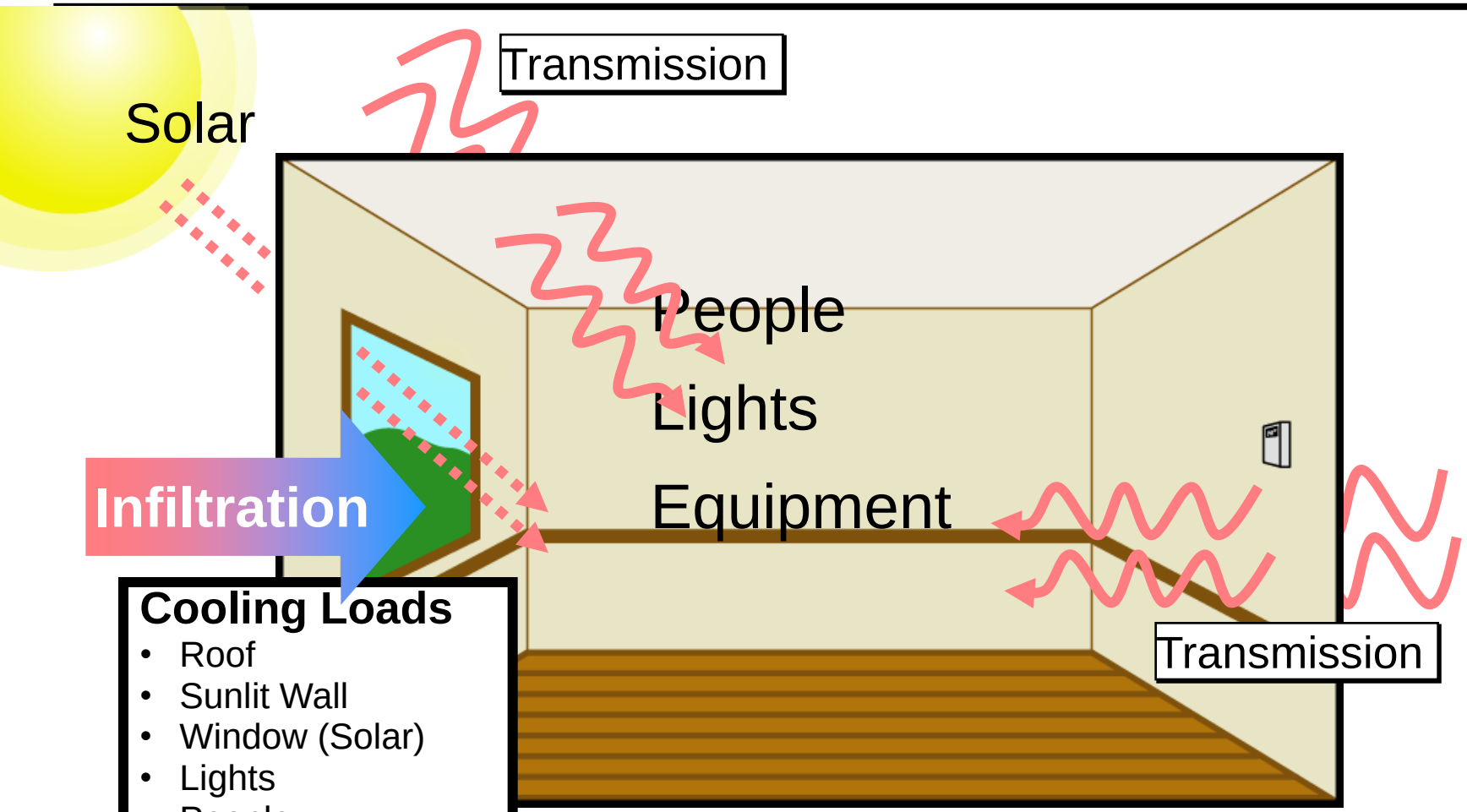
- People
- Lights
- Other Electric
- Schedules
- Miscellaneous



External Heat Load



Building Load



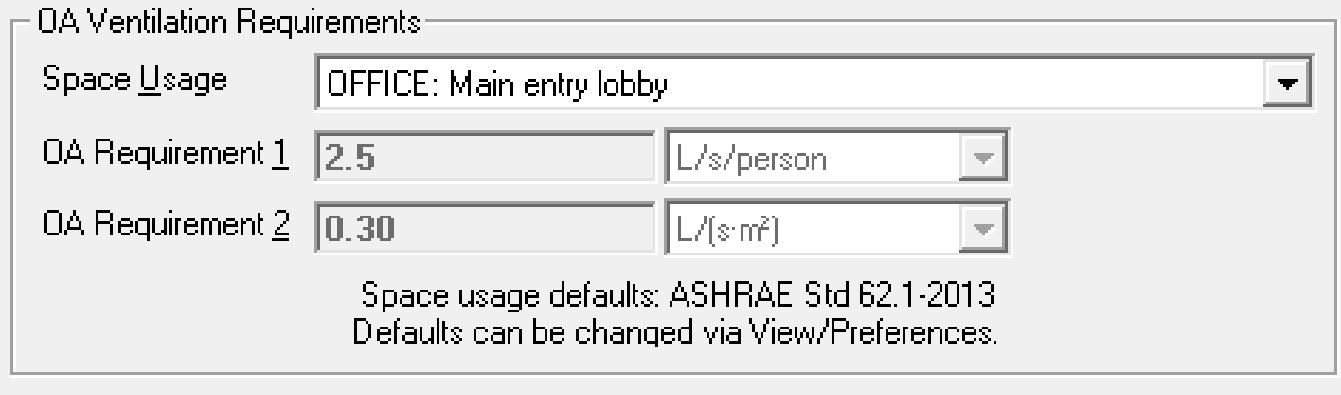
Cooling Loads

- Roof
- Sunlit Wall
- Window (Solar)
- Lights
- People
- Equipment
- Infiltration
- Ventilation

Space Properties

➢ OA Ventilation Requirements

Space usage options are taken from ASHRAE Standard according to your prior specification in the View/Preferences option. A note below the ventilation inputs indicates which source of defaults is used.



If you are instead complying with a different ventilation standard or code or entering your own values, choose the "User-Defined" usage type. When this option is selected, you will be permitted to directly enter the ventilation requirements and units of measure.

Space Properties

- General
  - OA Requirement 1 and 2
  - One or two outdoor air requirements can be defined for the space. Typically one outdoor requirement is needed.
  - When both outdoor air requirements are specified, they will be additive. 2 OA requirements maybe needed due to the space requiring 2 codes.

SS 553 : 2009

Table 1 – Outdoor air supply requirement for comfort air-conditioning

Type of building/ Occupancy	Minimum outdoor air supply			
	l/s per m^2 floor area	m^3 /h per m^2 floor area	l/s per person	Air class [1]
Restaurants	3.4	12.2	5.1	2
(i) Dance halls	7.0	25.0	10.5	1
Offices	0.6	2.0	5.5	1
(ii) Shops, supermarkets and department stores	1.1	3.8	5.5	1 or 2
Theatres and cinemas seating area	2.0	7.3	3.0	1
Lobbies and corridors	0.3	1.1	3.3	1
Concourses	1.1	4.0	3.3	1
(iii) Hotel guest rooms	15.0 l/s per room	54.0 m^3 /h per room	5.5	1
(iv) Classrooms				
Primary school children and above	2.8	10.0	4.2	1
Childcare centres	2.8	10.0	8.4	1

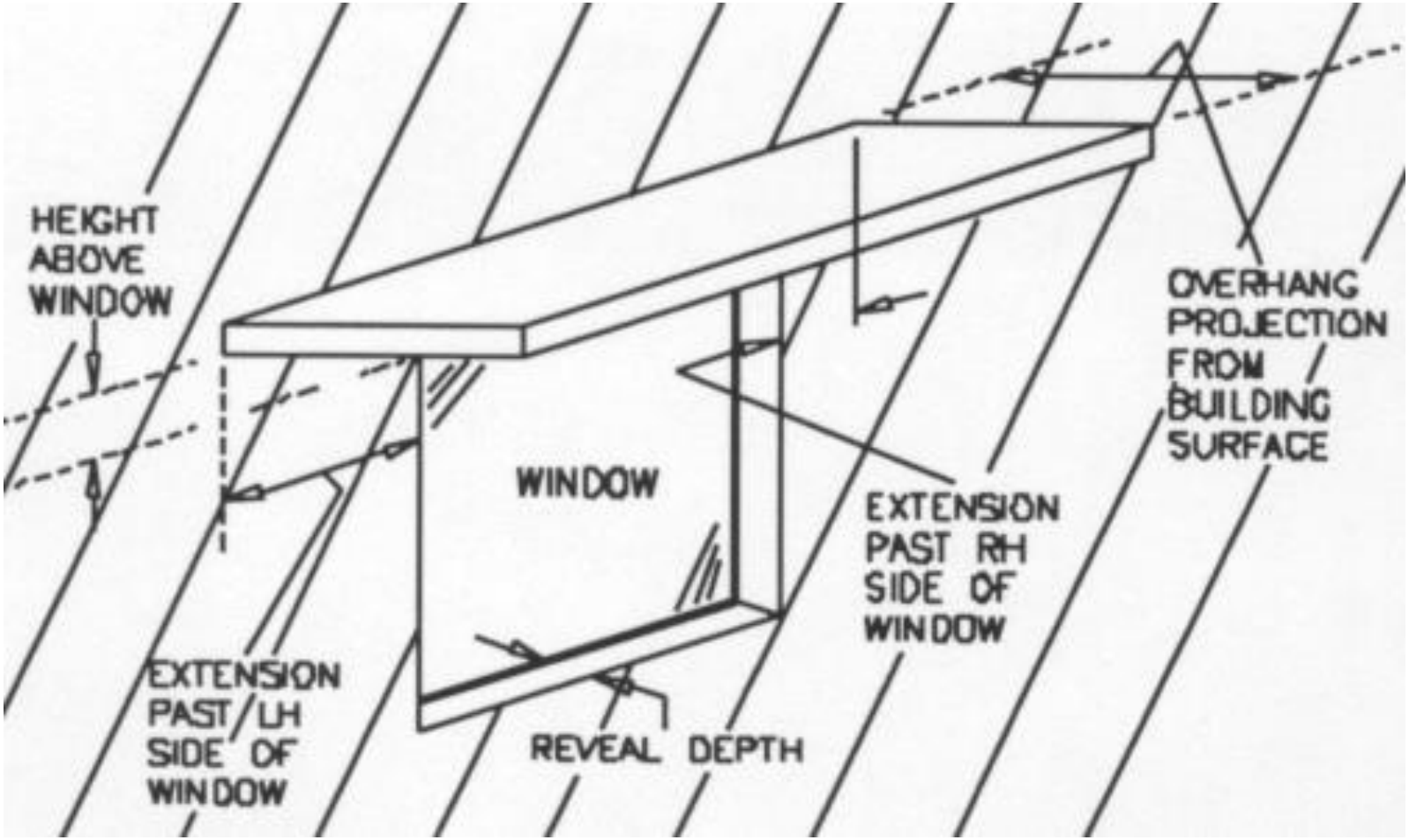
Space Properties

- Internals
  - For fluorescent lights, power is used to drive both the bulb and a ballast starter device. The program computes the total power draw for the lighting fixture by multiplying lamp wattage by the ballast multiplier. Ballast multipliers values from 0.1 to 2.00 are permitted.

  - Note that when incandescent lighting fixtures are used, the ballast multiplier should be specified as 1.00.

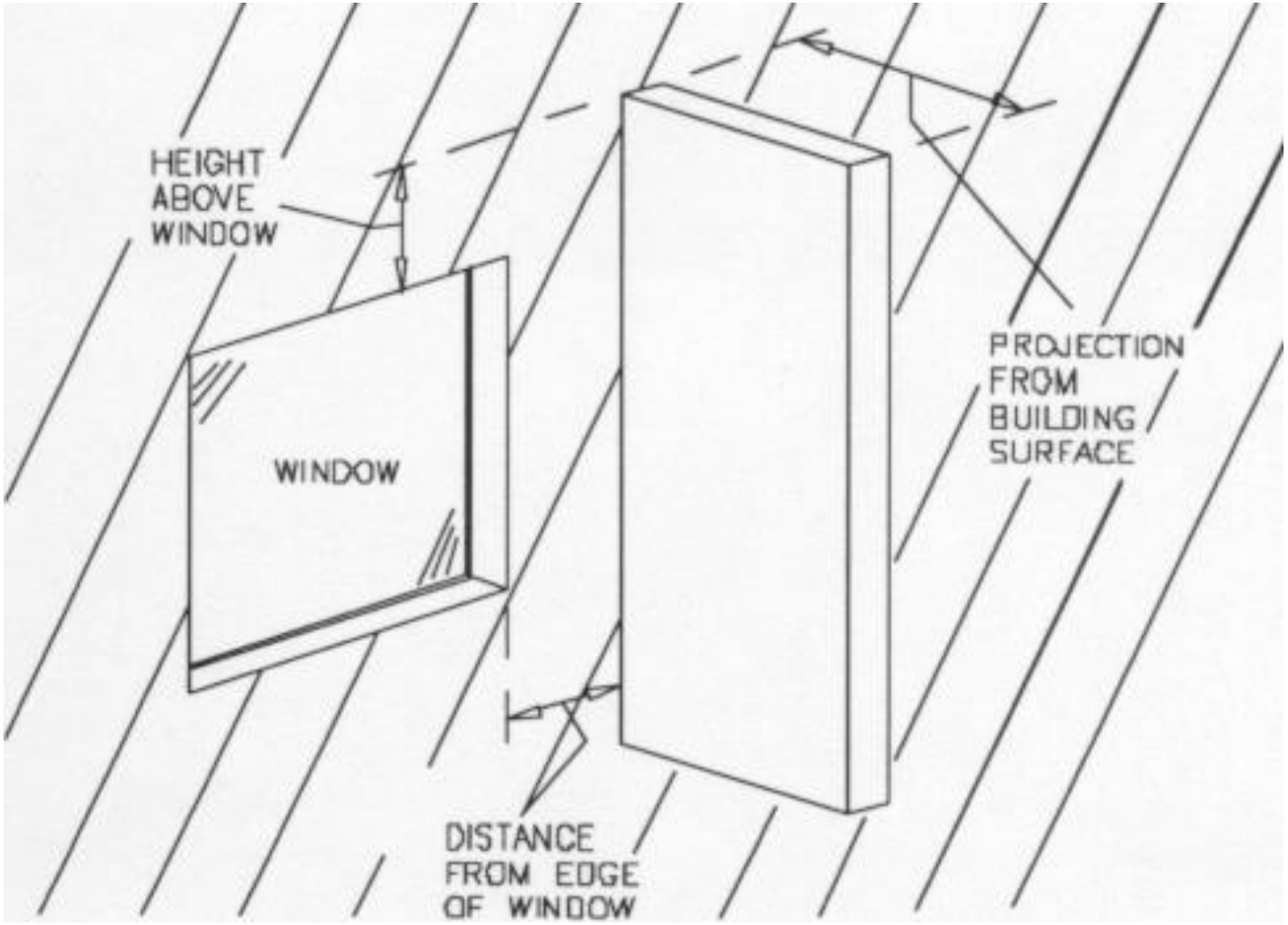
Space Properties

- Shades - Overhangs



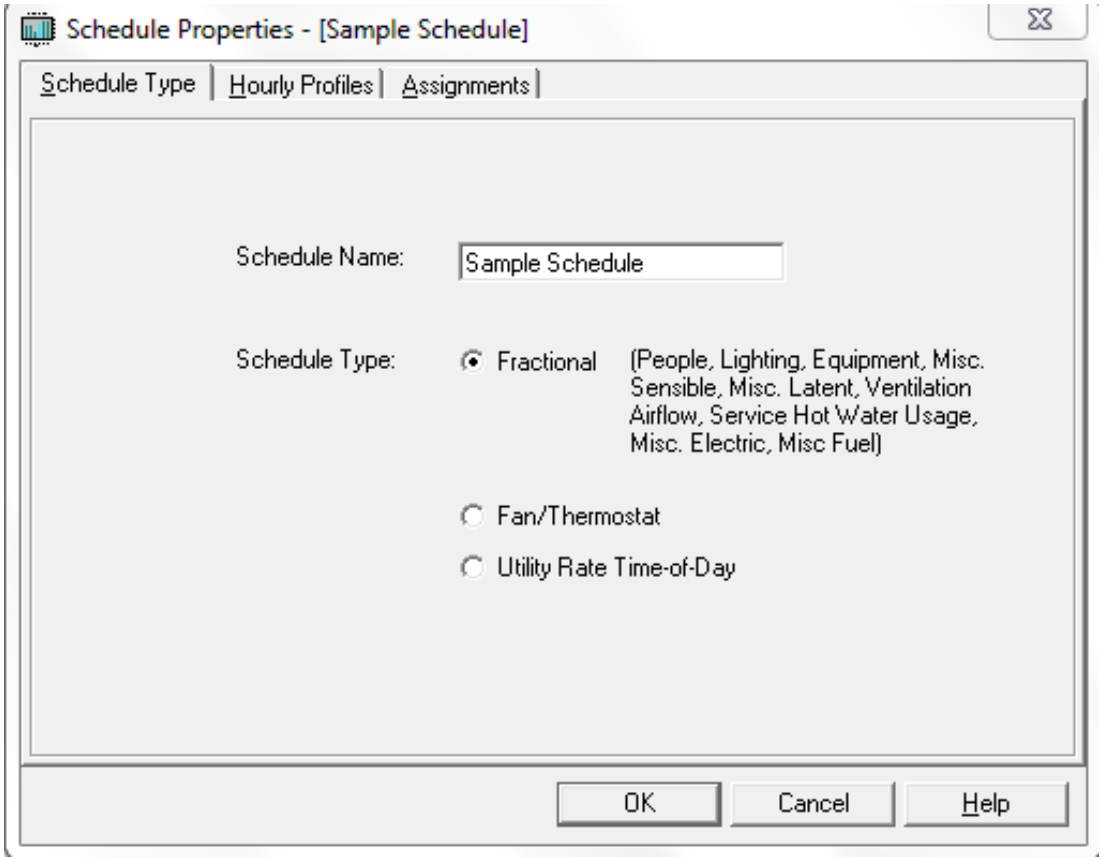
Space Properties

- Shades - Fins



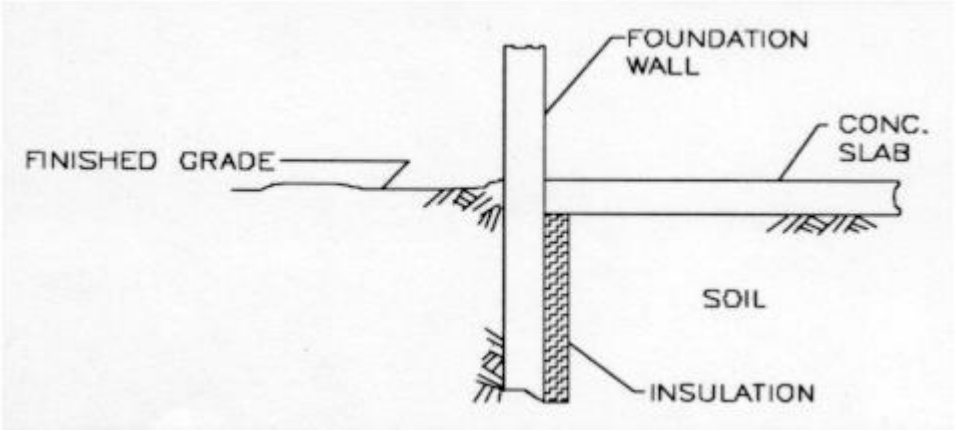
Schedules

- Schedules
  - Fractional
    - schedules define hourly and daily behavior in percentages. Fractional schedules are most often used to describe the hourly variation of internal heat gains. For example, percentages in a lighting schedule define the fraction of lights in use each hour of the day.
  - Fan / Thermostat
    - schedules define the hours in each HVAC equipment operating period. Hours of a day are designated as "occupied" or "unoccupied."
  - Utility Rate Time-of-Day
    - define on-peak and off-peak pricing periods for electricity. This option should be used when scheduling time-of-day periods for an electric rate structure.

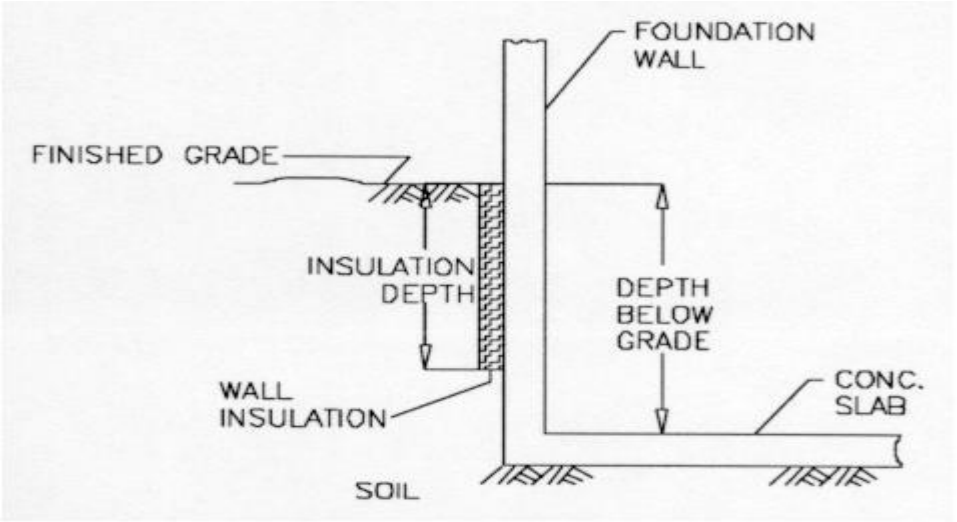


Floors & Partition

- **Slab Floor on Grade**
  - Assumes heat is transferred from the room air through the slab floor to the soil beneath . Working from the slab perimeter inward, the program calculates the total thermal resistance of the heat transfer path by considering the R-value of the slab floor, soil beneath the slab and slab footer insulation.

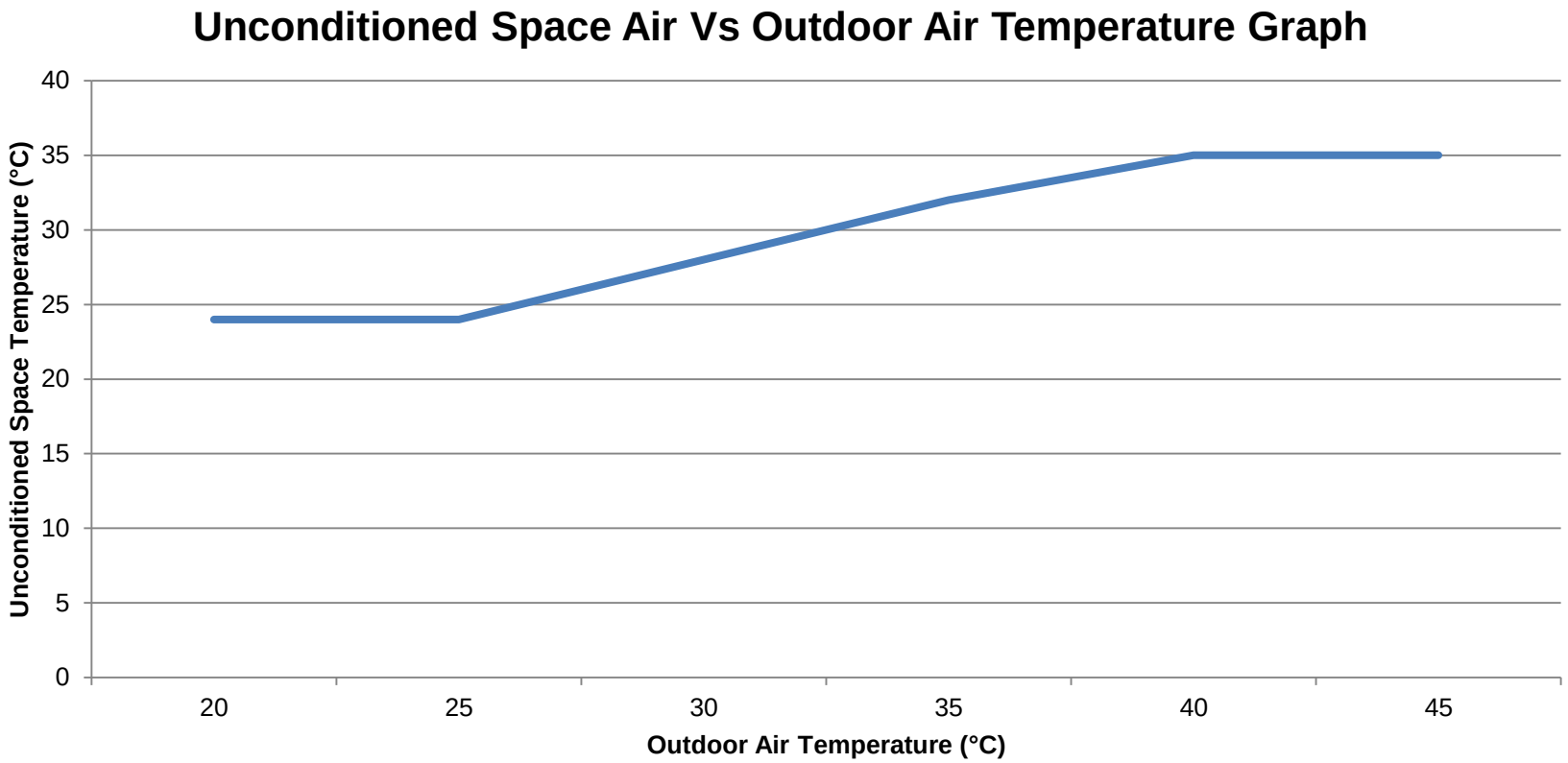


- **Slab Floor below Grade**
  - Heat transmitted through both the floor and basement walls is considered. The floor heat transmission gain is calculated using the procedures described above for slab-on-grade floors. The thermal resistance to heat flow depends on the R-value of the basement wall, wall insulation and the adjacent soil.



- **Floor, Wall & Ceiling Partitions**

Floors & Partition

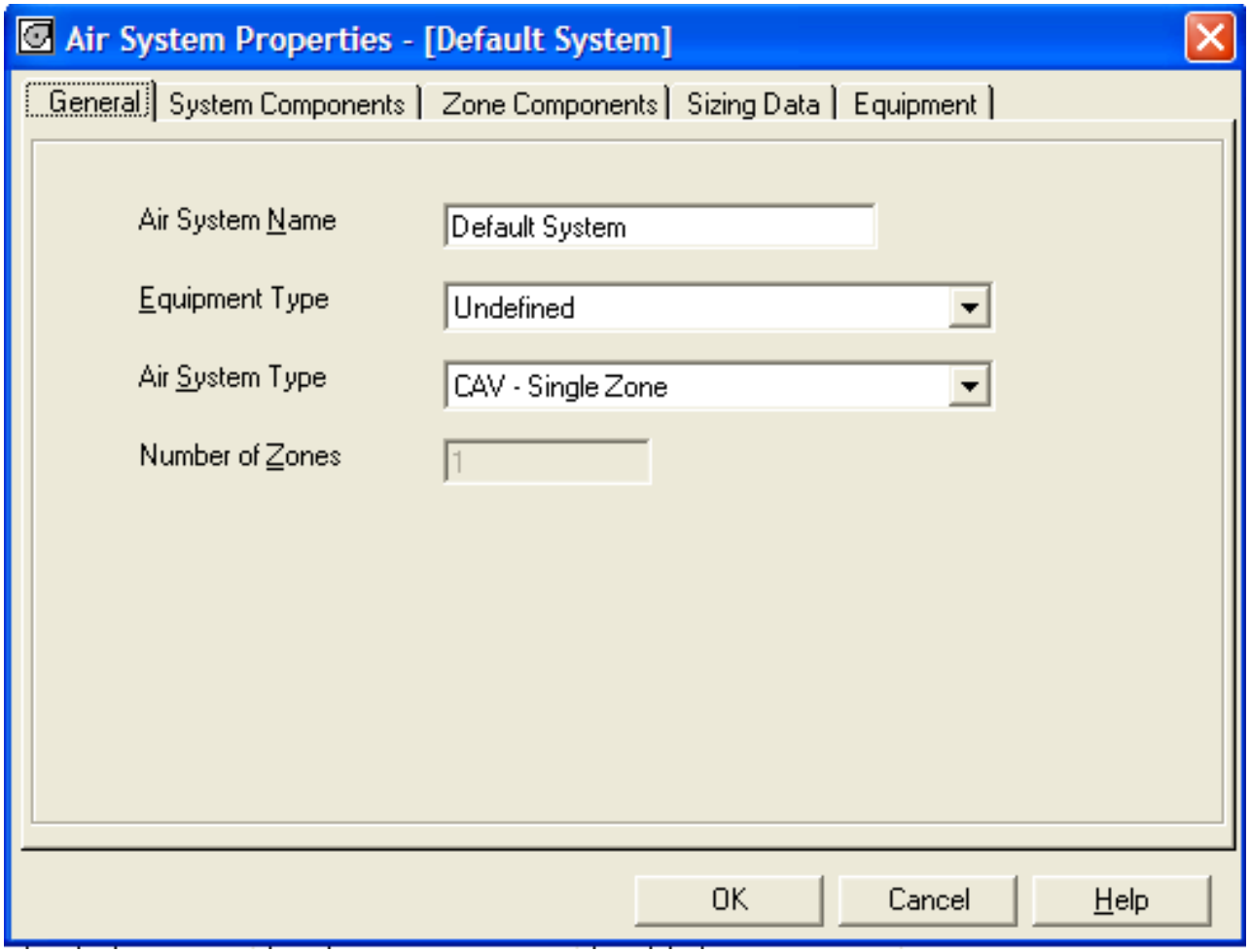


Recommended Temps to use:

Unconditioned Space Maximum Temperature = 33 deg C.
Ambient at Maximum Space Temperature = 35 deg C.
Unconditioned Space Minimum Temperature = 24 deg C.
Ambient at Minimum Space Temperature = 25 deg C

System Specification

- Systems
  - General
  - System Components
  - Zone Components
  - Sizing Data
  - Equipments



System Specification

Cooling Coil Capacity Control

1. **Constant Temperature, Fan Cycled -** The supply fan is cycled on and off to modulate cooling provided to the zone. While the supply fan is cycled on, air is delivered to zone terminal at the design supply air temperature. This option is only offered for Chilled Water AHU CAV Single Zone systems.

2. **Constant Temperature, Fan On -** Air is delivered to zone terminals at the design supply air temperature at “occupied” hours. Provides maximum cooling to zones at all times, conditioning must be modulated by varying the supply airflow. This option is offered, VAV, CAV, Dual Duct and Multizone systems.

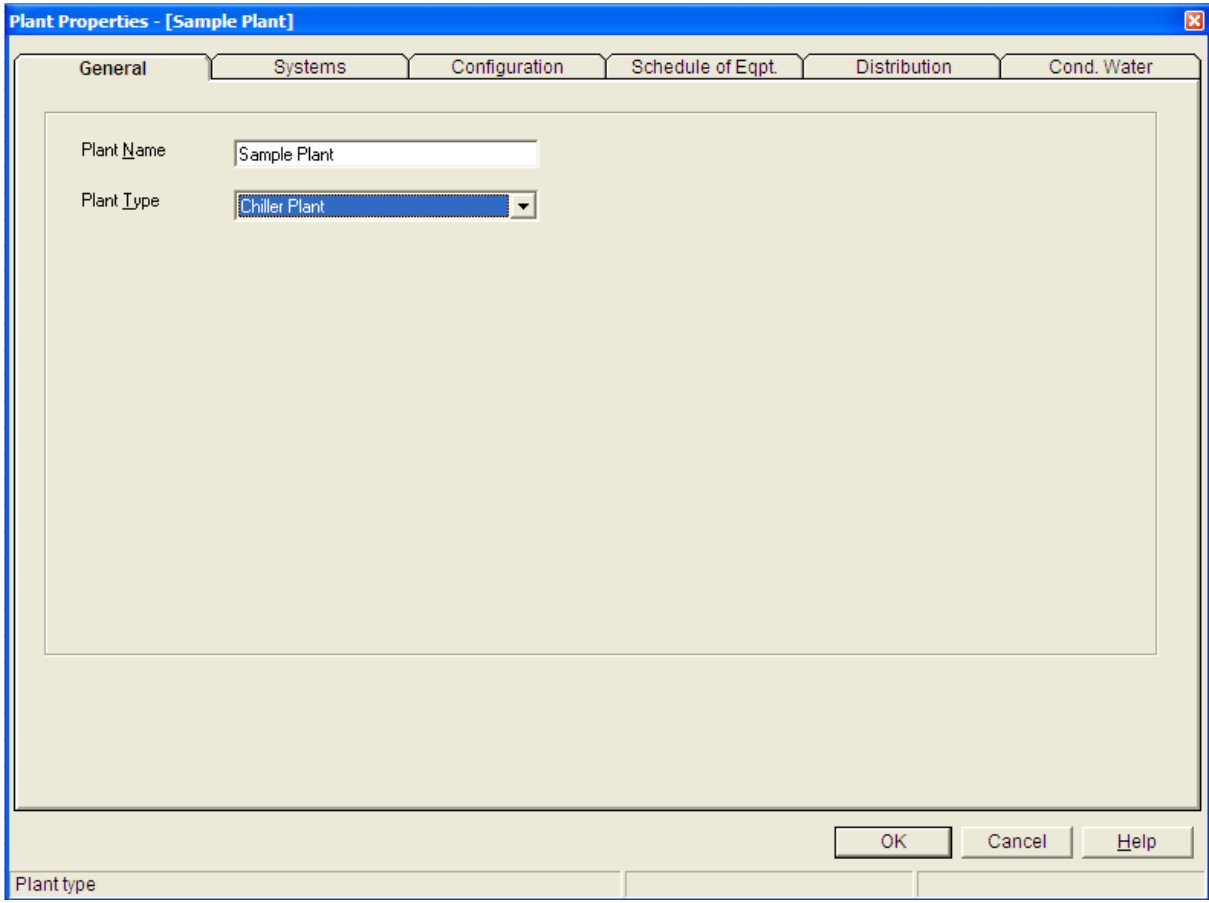
3. **Cycled or Staged Capacity, Fan On -** During "occupied" system operating hours, the supply fan runs continuously to condition and ventilate. In a DX unit, compressors cycle or unload to modulate the cooling provided to zones in the system. In a chilled water unit, water flow or water temperature is modulated to control cooling coil capacity.

4. **Temperature Reset by Greatest Zone Demand -** During "occupied" system operating hours, the supply fan runs continuously to condition and ventilate. The supply air temperature is reset according to the greatest sensible cooling load among zones served by the system. When this control is selected, you must also specify the maximum cooling supply temperature allowed. The control algorithm will not reset the supply temperature above this level. In VAV systems, supply temperature is reset such that one or more VAV boxes are fully open.

5. **Temperature Reset by Outdoor Air Schedule -** Supply air temperature (SAT) is reset according to an outdoor air temperature schedule. When this control is used, the minimum and maximum SATs are defined along with the corresponding outdoor air temperatures (OAT). The minimum SAT is always the design value. The remaining SAT and OAT values are defined by the user. This is used more in Winter Conditions-.

Plant Energy Modeling

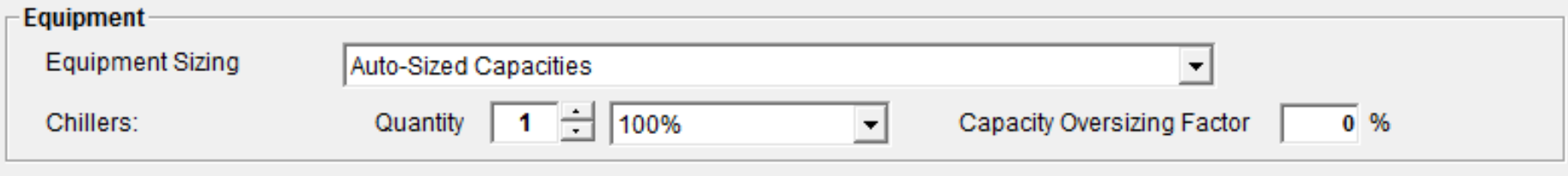
- Plants
  - General
  - System
  - Configuration
  - Schedule of Eqpt.
  - Distribution
  - Cond. Water



Generating Building Load

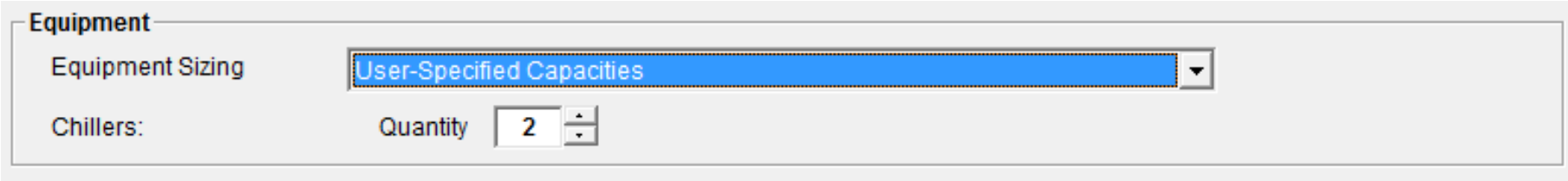
- Name The Plant a simple name like “Base Plant”
- Use Generic Chiller Plant to Determine Load
- Under “System”, Assign the Defined Systems to the Plant
- Generate the Report to Determine Load.
- Once the Load is Determined, The Type and Size of Each Chiller can be Designed
- Copy This Generate Plant and Name it Based on your Required Configuration

Configuration



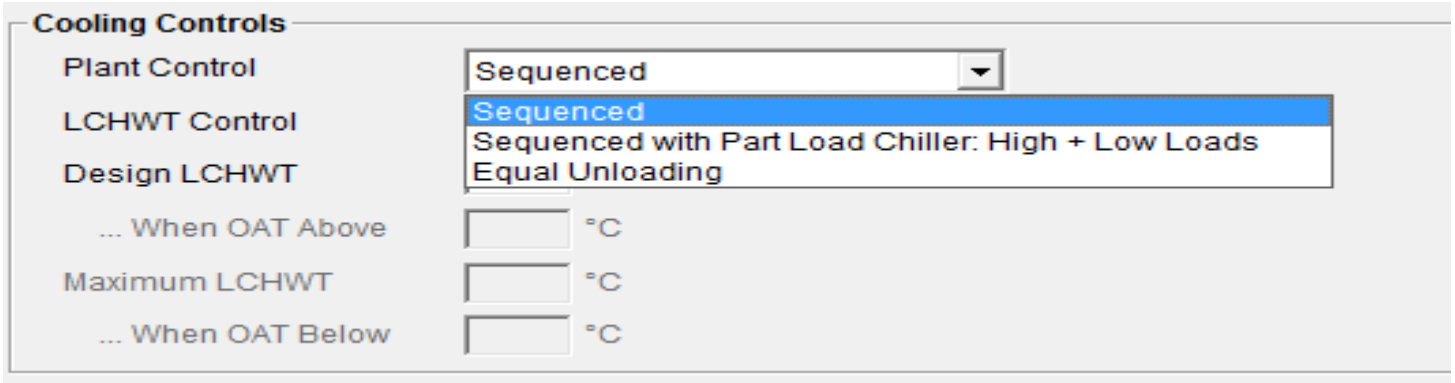
- **Chiller Sizing**. The plant and its chillers can be sized in one of two ways.

- Auto-Sized Chiller Capacities - For preliminary design. With this option the program will automatically determine the plant design capacity
  - When you specify "Auto-Sized Chiller Capacities" you must also define how the plant capacity will be divided among chillers in the plant. For example, if the plant contains two chillers, you are offered options such as "Equally Sized", "60%/40%", "75%/25%" and so on.
  - Capacity Oversizing Factor**.** When you specify "Auto-Sized Chiller Capacities" you must also define the oversizing factor for plant capacity.



- User-Defined Capacity – Recommended Option. Set the configuration when you generated the load.

Cooling Controls



Sequenced. All chillers in the system are sequenced in the order they are defined on the Schedule of Equipment tab. Chiller 1 turns on first. If its capacity is not sufficient to meet the load, chiller 2 turns on, and so forth. Chillers are turned on until the total capacity is sufficient to meet the building load. While running, chillers share the building load by running at the same part-load ratio.

Building Load	Chiller 1 Tons	Chiller 2 Tons	Chiller 3 Tons
1500	500	500	500
1250	417	417	417
1000	500	500	Off
750	375	375	Off
500	500	Off	Off
250	250	Off	Off

Cooling Controls

Part-Load Chiller: High+Low Loads. With this control, all chillers are sequenced in a conventional manner described above for "Sequenced" control, with the Part-Load chiller acting as the last chiller to turn on. However, when the capacity of the part-load chiller alone is sufficient to meet the building load, all other chillers turn off and the part-load chiller runs alone to serve the load. Therefore, the part-load chiller runs for high and low load conditions and is off for intermediate load conditions.

Building Load	Chiller 1 Tons	Chiller 2 Tons	Part Load Tons
1200	500	500	200
1000	500	500	Off
800	400	400	Off
600	300	300	Off
500	500	Off	Off
400	400	Off	Off
300	300	Off	Off
200	Off	Off	200
100	Off	Off	100

Cooling Controls

Equal Unloading. With this control, all chillers in the plant operate for all loads. There is no sequencing of chillers as occurs in the other control schemes

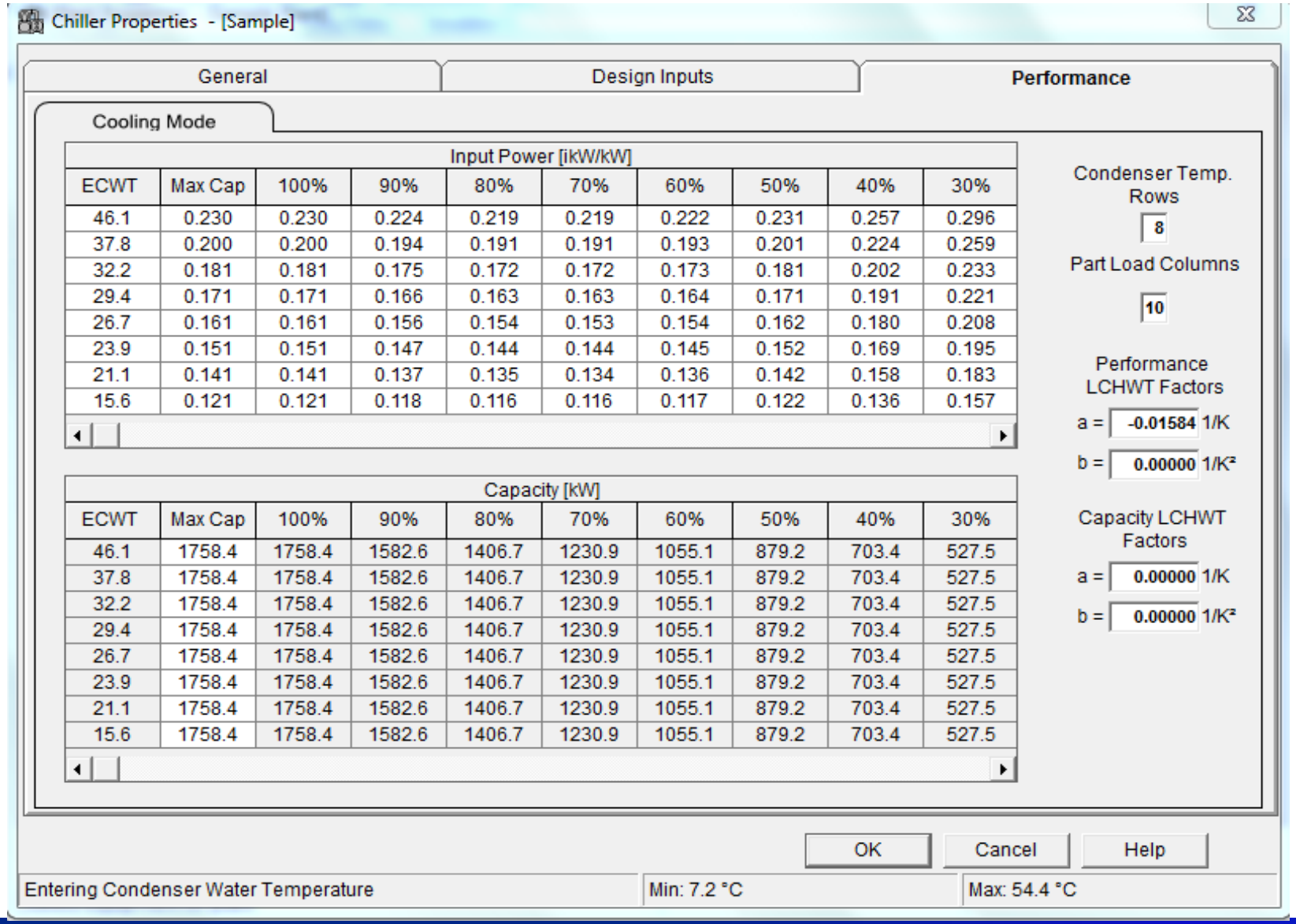
Building Load	Chiller 1 Tons	Chiller 2 Tons	Chiller 3 Tons
300	100	100	100
240	80	80	80
180	60	60	60
120	40	40	40
60	20	20	20

a. **Constant LCHWT.** With this control the design LCHWT (see below) is held constant for all plant operating hours.

b. **Reset by OAT Schedule.** With this control the plant LCHWT is adjusted according to a reset schedule based on outdoor air dry-bulb temperature. Control points for this schedule are defined by the remaining inputs in this section.

c. **Reset by Load (RWT).** With this control the plant LCHWT is adjusted based on plant load. LCHWT is adjusted to maintain the return water temperature (RWT) at a constant value.

Chiller Schedule - Performance

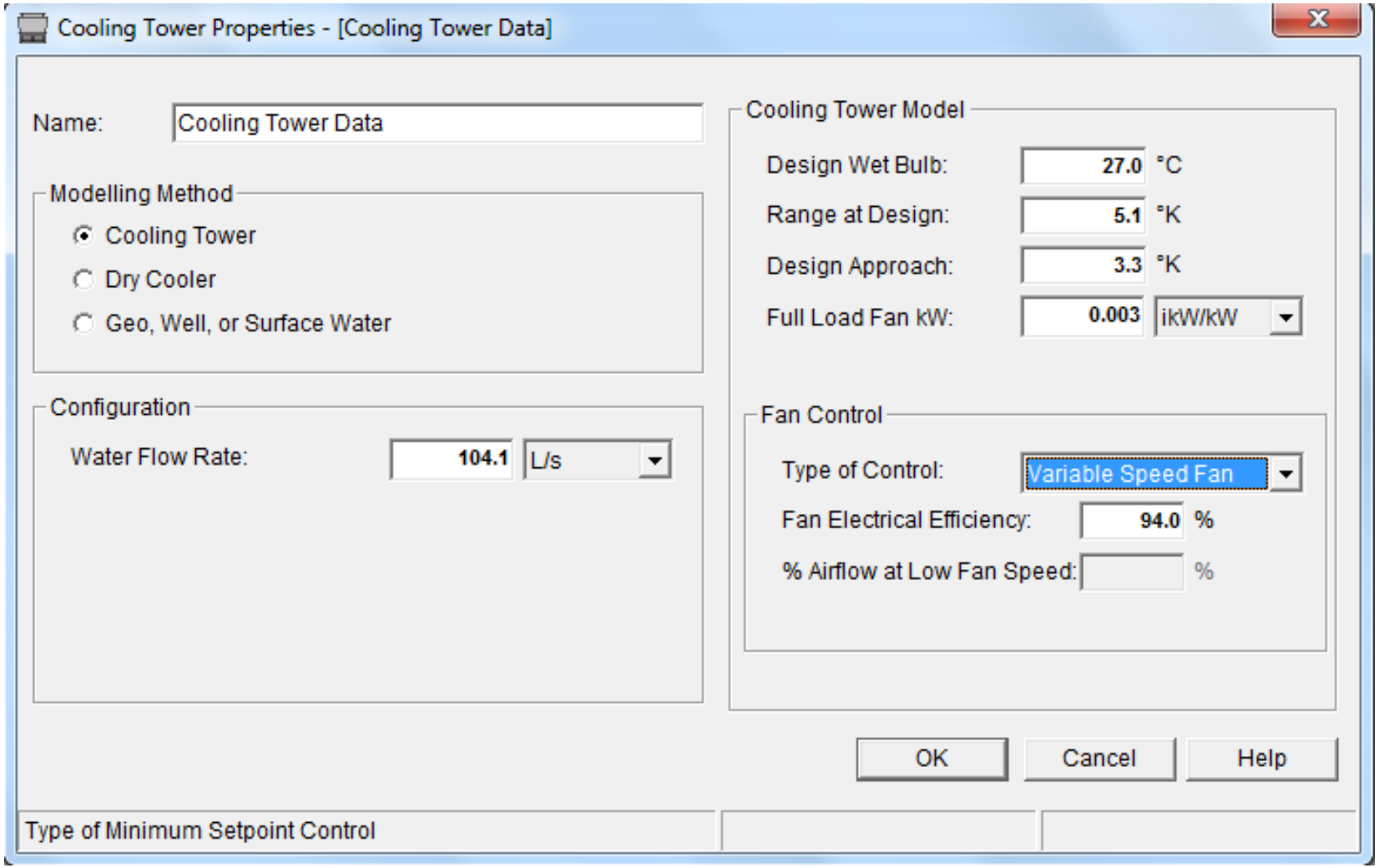


Chiller Schedule - Definitions

- **LCHWT Factors for Performance** are defined in the two input items immediately below the table dimensions on the right-hand side of the tab. The map data in the Performance and Capacity tables represent performance at the design leaving chilled water temperature for the chiller or heat pump. **These LCHWT correction factors are only relevant if the equipment will be used in a plant which uses chilled water reset, or a plant that uses a design LCHWT different from that defined for the chiller.**

- **LCHWT Factors for Capacity** are defined in the lower two input items on the right-hand side of the tab. Similar to the LCHWT Factors for Performance described above, **these factors are used to correct for capacity at leaving chilled water temperatures other than the design LCHWT**.

Cooling Tower Schedule



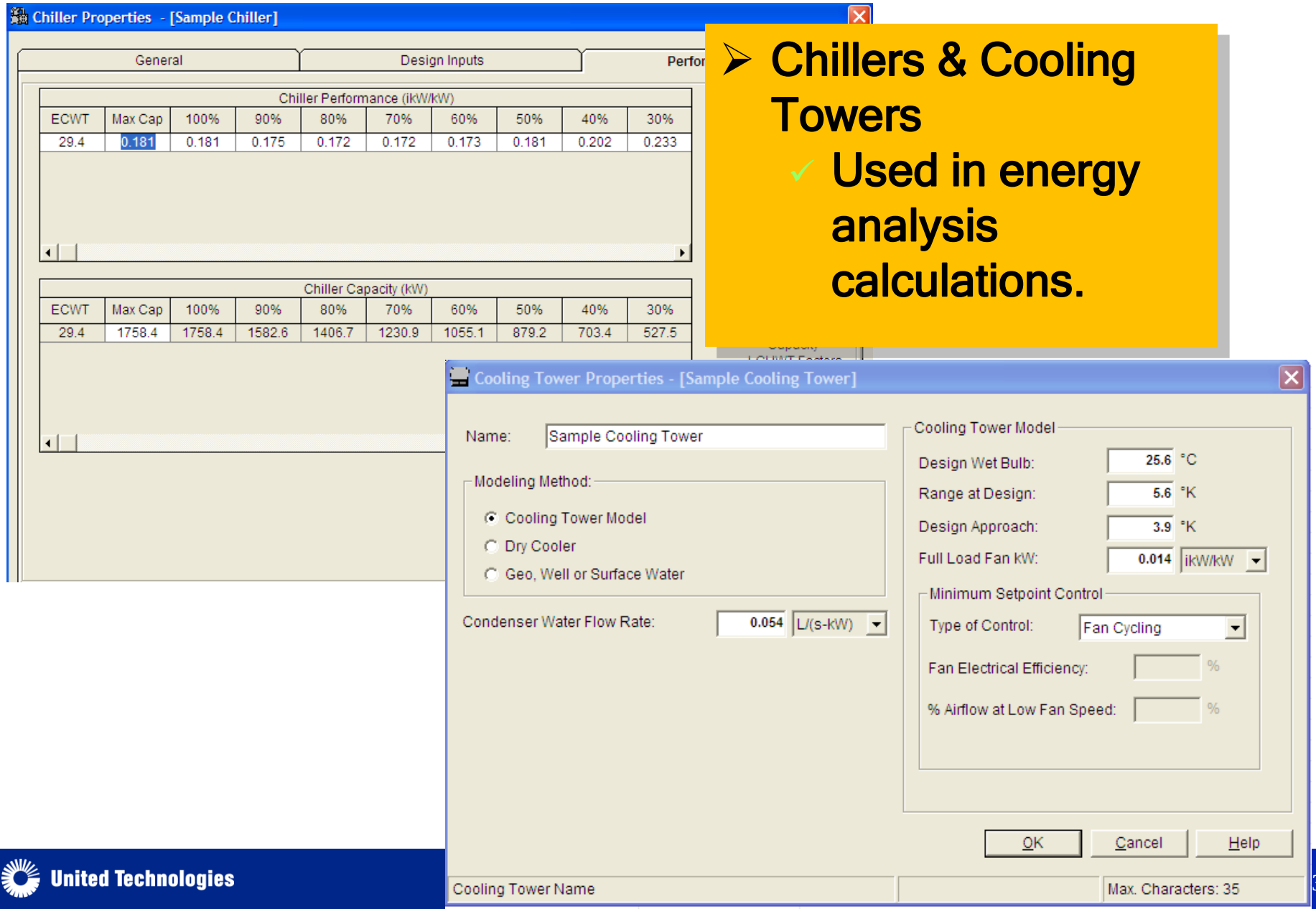
Cooling Tower Schedule - Definitions

1. **Design Wet-Bulb** defines the outdoor wet-bulb temperature for the full load design point for the cooling tower.
2. **Range at Design** defines the difference between the inlet and outlet water temperatures at the tower's full load design point.
3. **Design Approach** defines the approach between the temperature of water leaving the tower and the outdoor wet-bulb temperature for the tower's full load design point.

Together these first three inputs are used to define full load heat transfer effectiveness of the cooling tower. Once full load performance is known, performance at off-design and part-load conditions can be calculated using the thermodynamic algorithm.

4. **Full Load Fan kW** defines the fan motor input power at the tower's full load design point. This item can be entered in two ways: (1) as a motor input kW or (2) as a power ratio expressed as kW per ton of heat rejection (kW per kW of heat rejection in Metric units). To choose the units of measure for this input, use the drop down list to the right of the input item.
5. **Fan Control.** The four options listed in the drop-down list are:
    a) **Water Bypass** - Warm inlet water will be bypassed around the tower to blend with tower outlet water to produce the required temperature.
    b) **Fan Cycling -** The tower fan will cycle ON and OFF, thereby reducing the tower airflow and the heat transfer effectiveness to produce the required return water temperature.
    c) **2-Speed Fan** – The tower fan uses a two speed fan motor. For conditions where high airflows are sufficient to maintain minimum setpoint, the fan will cycle between high and low speed. For conditions where low airflows are sufficient to maintain minimum setpoint, the fan will cycle between low speed and OFF.
    d) **Variable Speed Fan** – The tower fan uses a variable speed drive. Motor speed is adjusted to produce the airflow rate necessary to maintain the minimum setpoint temperature.

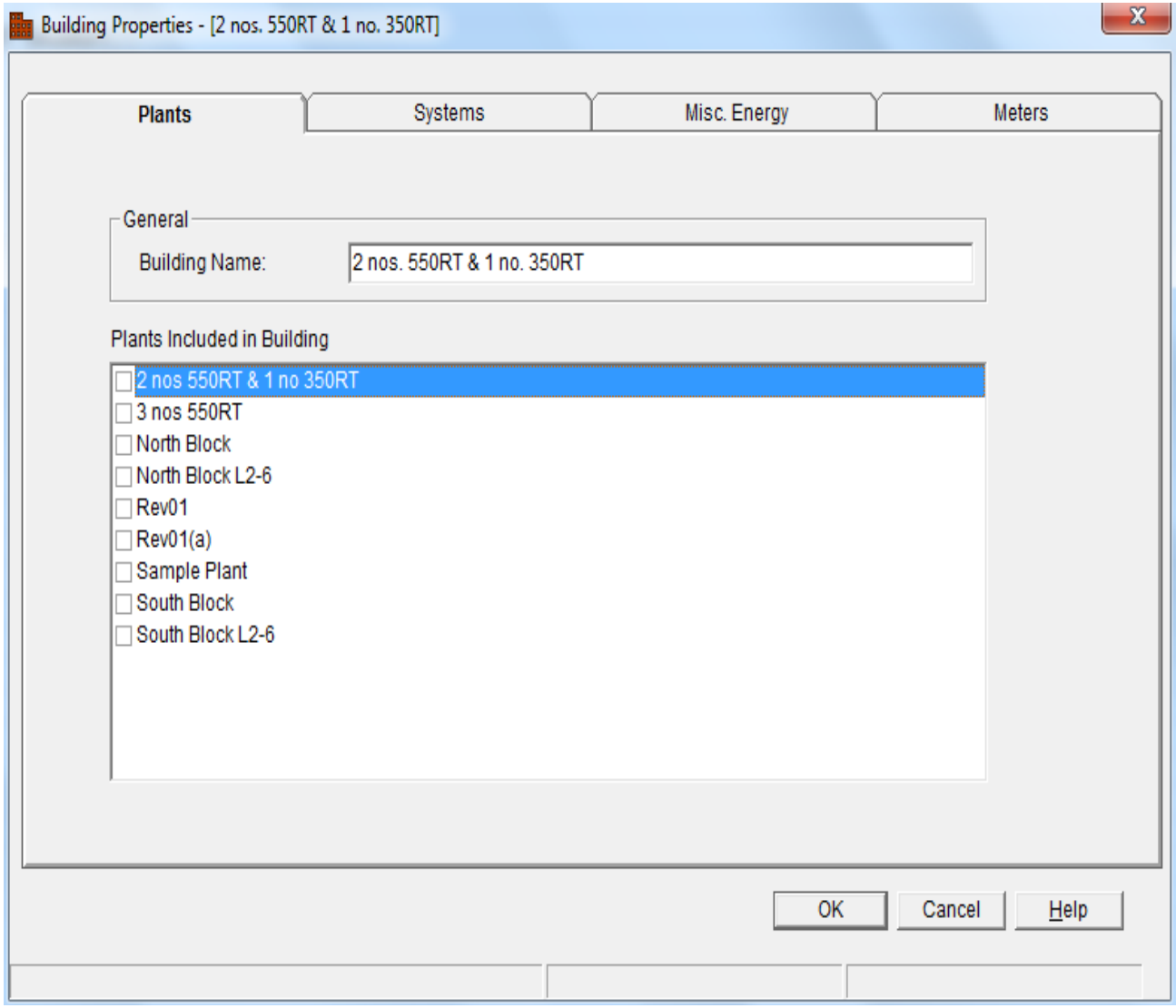
Plant Equipment Schedule



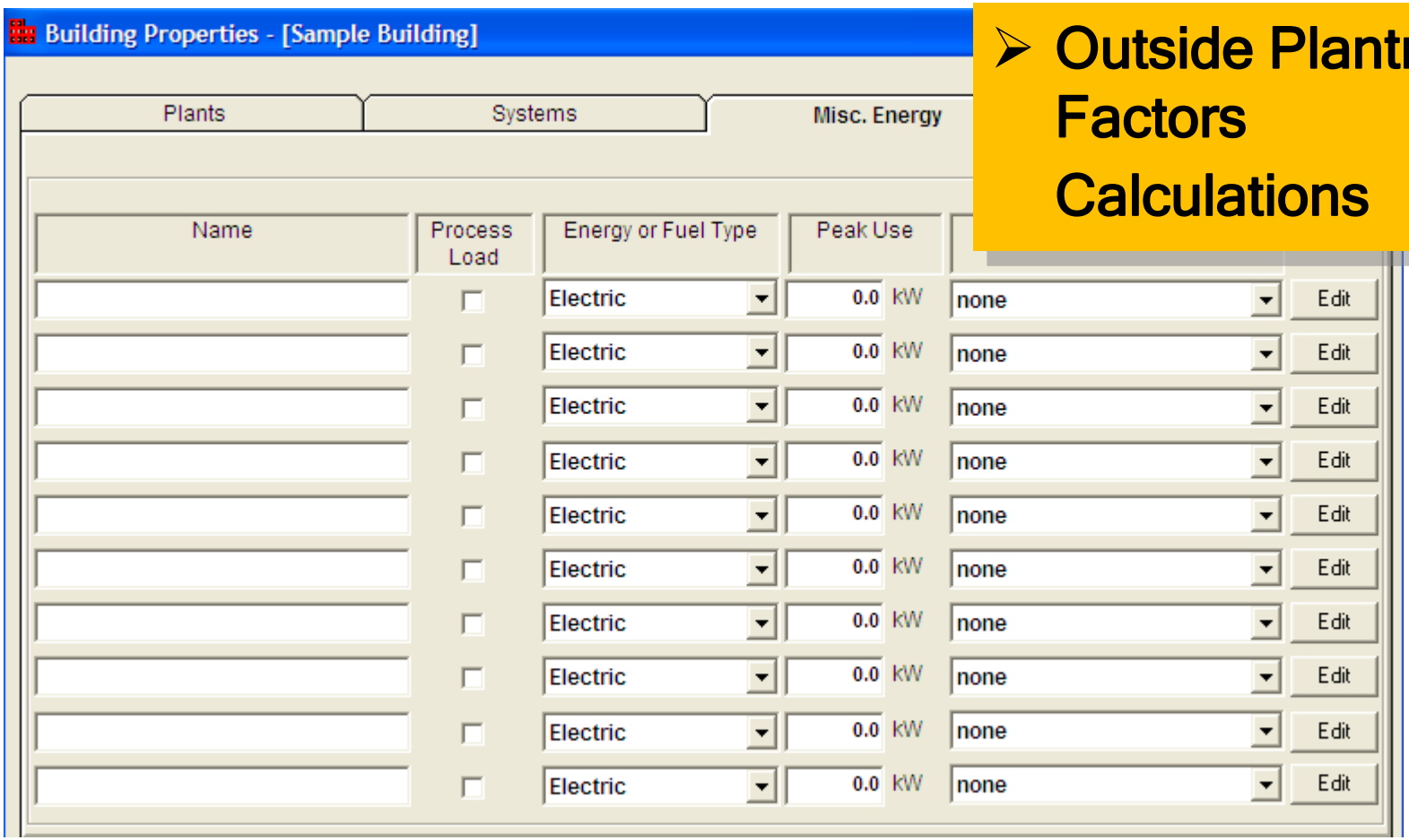
- **Chillers & Cooling Towers**
  - ✓ **Used in energy analysis calculations.**

Building Properties

- Building Properties
  - Plants
  - System
  - Misc. Energy
  - Meters



Building Properties Energy Modeling



- Outside Plantroom Factors Calculations

Building Properties

- **Process** is an optional input that defines whether the item qualifies as process energy for purposes of a LEED Energy and Atmophere Credit 1 analysis. If LEED analysis is not performed, item is not relevant and can be left blank.

- **Energy or Fuel Type** defines what energy or fuel source is used for the item.

- **Peak Use** specifies the maximum energy or fuel rate for the item. Electrical energy items are defined in units of kW.

- **Schedule** defines the fractional schedule used for this energy item. This schedule describes how energy or fuel use varies hour by hour. For example, if the 8 AM value in one of the schedule profiles is 80%, that means that 80% of the peak energy use occurs during this hour.

- **Application Information.** HAP automatically accounts for certain types of non-HVAC energy use:
  a) Lighting energy use in conditioned areas was specified in space inputs and is automatically calculated as part of system simulation calculations.
  b) Electrical equipment energy use in conditioned areas was also specified in space inputs and is automatically calculated as part of system simulation calculations.

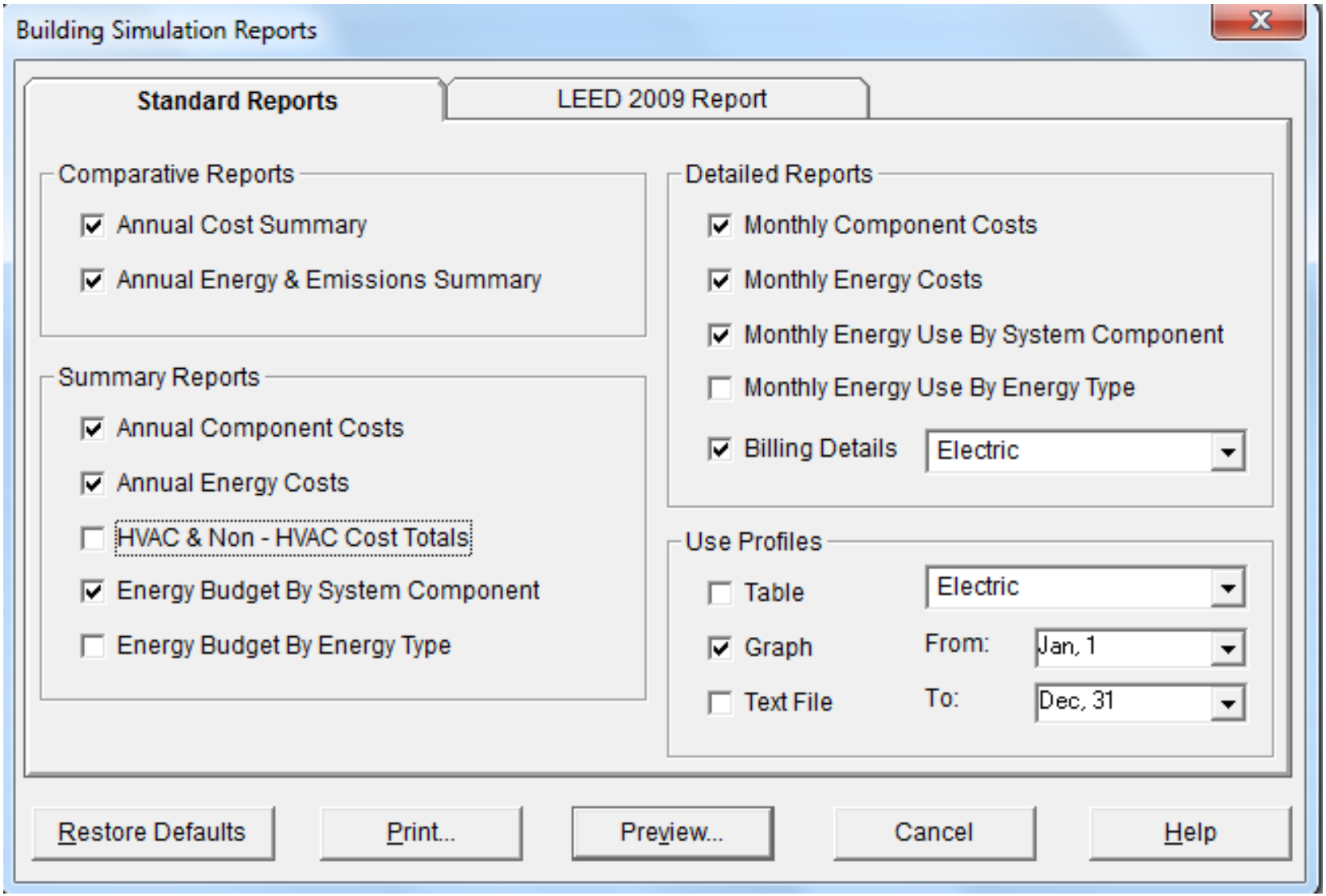
Building Properties

Average Building Power Factor
This item defines an average building power factor used to convert electric power data from units of kW to kVA. It is only applicable when the electric rate chosen for the building uses units of kVA for demand-related charges. If units of kVA are not used, the power factor is not relevant. Its value can be left at 100%.

Source Electric Generating Efficiency
This item defines the average generating efficiency for electric power plants that provide energy to the building. This value is used to calculate "source" energy totals on the two Energy Budget reports. This input is only required if the program will be used to generate the Energy Budget reports and local energy codes require that both "site" and "source" energy totals be provided. If this feature is not needed, set the efficiency to 100%.

Additional Floor Area
This item defines the non-conditioned floor area in the building, not already accounted for. This input is used together with the conditioned floor area to calculate cost per sqft (cost per sqm) or energy per sqft (energy per sqm) check figures on the building simulation reports. In certain cases local energy codes may require that these check figures be based on the gross floor area of the building rather than just the conditioned floor area. If this is not required, specify zero as the additional floor area.

Building Properties



Building Properties

1. The Annual Cost Summary report compares annual energy cost results for buildings. Costs are listed by system component categories (e.g. fans, cooling, heating, etc..).
2. The Annual Energy and Emissions Summary report compares annual energy cost results for buildings with costs listed by energy or fuel type
3. The Annual Component Costs report contains annual energy costs for a single building tabulated by system component categories such as fans, cooling, heating, etc.
4. The Annual Energy Costs report contains annual energy costs for a single building tabulated by energy or fuel type (e.g., electric, gas). The report displays the data both in pie chart and table format. Length: 1 page.
5. The HVAC & Non-HVAC Cost Totals report contains annual energy cost totals for HVAC and non-HVAC uses. The report displays the data both in pie chart and table format.
6. The Energy Budget by System Component report lists annual energy consumption itemized by system components such as fans, cooling, heating etc. This report is sometimes required for demonstrating compliance with energy efficiency codes.
7. The Energy Budget by Energy Type report lists annual energy consumption itemized by energy and fuel type categories such as electric, gas, fuel oil, etc. This report is sometimes required for demonstrating compliance with energy efficiency codes.
8. The Monthly Component Costs report contains month-by-month energy costs for system component categories such as fans, cooling, heating, etc...

Building Properties

9. The Monthly Energy Costs report lists month-by-month energy costs for separate energy and fuel types.
10. The Monthly Energy Use by System Component report provides month-by-month energy use for each system component category such as fans, cooling, heating, etc. This output is useful when investigating monthly variations in energy use for various system components.
11. The Monthly Energy Use by Energy Type report lists monthly-by-month energy use for each energy or fuel type.
12. The Billing Details report documents how the utility bill is calculated. It tabulates the month-by-month component charges for energy and demand, monthly energy use, monthly peak demand and the time of peak demands. A separate copy of the report can be generated for each energy or fuel source used in the building. Length: 2 pages.
13. The Use Profiles report contains hour-by-hour profiles of energy use for the building for one energy or fuel type. Separate reports can be generated for each energy or fuel type. This report is available in tabular, graphical and text file versions. The text file option generates a TXT disk file containing use profile data in a format suitable for import into spreadsheet programs. Lengths: Tabular – 1 page for each 18 days; Graph – 1 page for all cases.

8760 Hour by Hour Analysis

Hourly Simulation Results for A-Base-30GX 205 A/C Chillers

APO_HAP42 Advanced Handout_03_01_05 03/07/2005 07:45PM

Table 1.1 Hourly Plant Simulation Results for Friday, August 1

Hour	Cooling Coil Load (kW)	Plant Load (kW)	Chiller Output (kW)	Chiller Input (kW)	Primary Chilled Water Pump (kW)	Secondary Chilled Water Pump (kW)
0000	7.1	12.2	12.2	4.3	3.0	2.7
0100	12.6	17.7	17.7	6.3	3.0	2.7
0200	11.9	17.1	17.1	6.0	3.0	2.7
0300	12.9	18.1	18.1	6.4	3.0	2.7
0400	12.6	17.8	17.8	6.3	3.0	2.7
0500	12.8	18.0	18.0	6.4	3.0	2.7
0600	1030.4	1059.7	1059.7	300.9	6.0	3.5
0700	1070.2	1100.5	1100.5	311.3	6.0	3.8
0800	1322.5	1359.7	1359.7	381.4	6.0	5.6
0900	1374.7	1413.4	1408.9	399.0	6.0	6.1
1000	1411.7	1451.6	1408.9	405.6	6.0	6.5
1100	1446.3	1487.2	1408.9	410.8	6.0	6.8
1200	1069.9	1100.2	1100.2	329.4	6.0	3.7
1300	1284.9	1321.0	1321.0	378.4	6.0	5.3
1400	1145.3	1177.6	1177.6	327.0	[illegible]	[illegible]
1500	1147.1	1179.4	1179.4	332.6	[illegible]	[illegible]
1600	987.3	1015.5	1015.5	292.2	[illegible]	[illegible]
1700	882.3	907.8	907.8	267.4	[illegible]	[illegible]
1800	318.2	329.4	329.4	100.4	[illegible]	[illegible]
1900	352.2	364.1	364.1	107.7	[illegible]	[illegible]
2000	344.9	356.7	356.7	105.4	[illegible]	[illegible]
2100	333.8	345.4	345.4	101.8	[illegible]	[illegible]
2200	321.8	333.2	333.2	98.6	[illegible]	[illegible]
2300	11.0	16.1	16.1	5.6	[illegible]	[illegible]
Total	**15924.4**	**16419.2**	**16293.7**	**4691.2**	[illegible]	[illegible]

- True 24x7-Hour by Hour Energy Analysis
- Single Page Overview For Quick Review
- Detailed Weather Profiles - Tabular or Graphical – Any Range of Days

Hourly Simulation Results for A-Base-30GX 205 A/C Chillers

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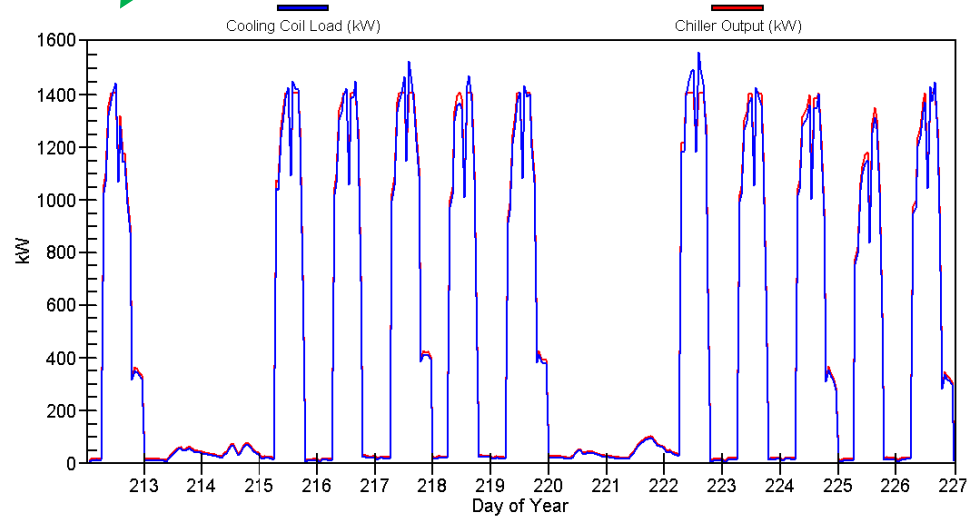
Hourly Simulation Results for Friday, August 1 (day 213) thru Friday, August 15 (day 227)



Annual Cost Summary

Annual Cost Summary

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Table 1. Annual Costs

Component	A-Base Case-PFPMXB-Complex Rate ($)	B-Alt1-PFPMXB-Complex Rate ($)	C-Alt 2-4PFCU/VSS-Complex Rate ($)	D-Alt 3-SZCV/RTU-Complex Rate ($)
Air System Fans	16,660	16,688	18,216	18,549
Cooling	164,501	139,450	60,708	133,551
Heating	22	1	0	0
Pumps	9,550	9,370	7,338	0
Cooling Tower Fans	0	0	7,933	0
HVAC Sub-Total	**190,733**	**165,509**	**94,196**	**152,100**
Lights	91,180	91,201	88,506	90,638
Electric Equipment	22,309	22,324	21,666	22,181
Misc. Electric	2,966	2,960	2,873	2,946
Misc. Fuel Use	17,184	17,185	17,185	17,185
Non-HVAC Sub-Total	**133,639**	**133,670**	**130,229**	**132,949**
Grand Total	**324,373**	**299,179**	**224,425**	**285,049**

Table 2. Annual Cost per Unit Floor Area

Component	A-Base Case-PFPMXB-Complex Rate ($/m²)	B-Alt1-PFPMXB-Complex Rate ($/m²)	C-Alt 2-4PFCU/VSS-Complex Rate ($/m²)	D-Alt 3-SZCV/RTU-Complex Rate ($/m²)
Air System Fans	2.877	2.882	3.146	3.204
Cooling	28.410	24.084	10.485	23.065
Heating	0.004	0.000	0.000	0.000
Pumps	1.649	1.618	1.267	0.000
Cooling Tower Fans	0.000	0.000	1.370	0.000
HVAC Sub-Total	**32.941**	**28.584**	**16.268**	**26.269**
Lights	15.747	15.751	15.286	15.654
Electric Equipment	3.853	3.856	3.742	3.831
Misc. Electric	0.512	0.511	0.496	0.509
Misc. Fuel Use	2.968	2.968	2.968	2.968
Non-HVAC Sub-Total	**23.080**	**23.086**	**22.491**	**22.961**
Grand Total	**56.021**	**51.670**	**38.760**	**49.230**
Gross Floor Area (m²)	5790.2	5790.2	5790.2	5790.2
Conditioned Floor Area (m²)	5790.2	5790.2	5790.2	5790.2

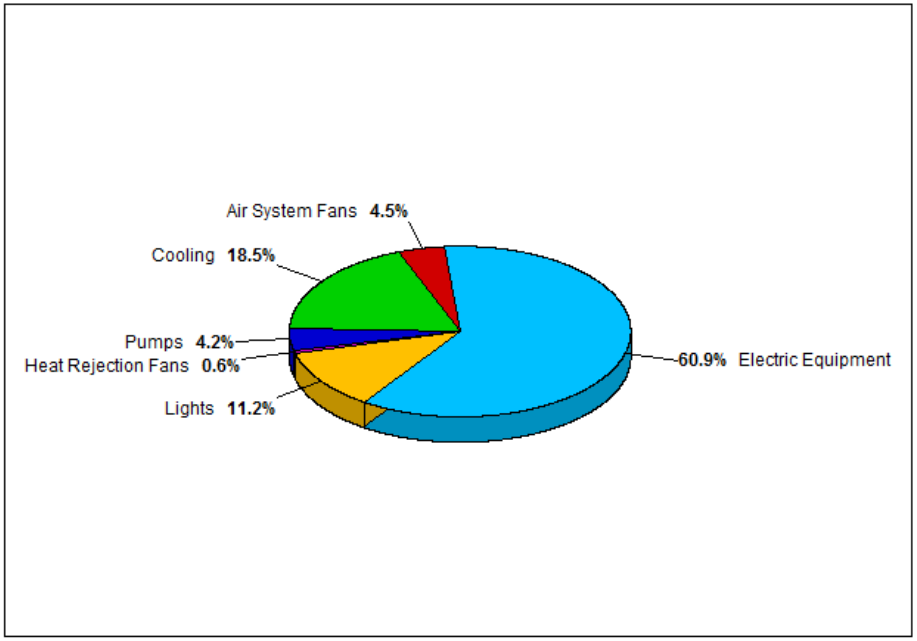
Note: Values in this table are calculated using the Gross Floor Area.

- Annual Operating Costs segregated by components ie.
  - Chiller Plant
  - Airside
  - Pumps
  - Lightings
  - Lifts
  - Miscellaneous

Detailed Report on Annual Components Cost

Annual Component Costs - 2 nos. 550RT & 1 no. 350RT

Worked Example for viewing — 10/28/2015
Carrier Singapore Ltd — 12:54AM



1. Annual Costs

Component	Annual Cost ($)	($/m²)	Percent of Total (%)
Air System Fans	130,174	5.674	4.5
Cooling	541,417	23.597	18.5
Heating	0	0.000	0.0
Pumps	123,655	5.389	4.2
Heat Rejection Fans	18,766	0.818	0.6
HVAC Sub-Total	**814,012**	**35.478**	**27.8**
Lights	327,670	14.281	11.2
Electric Equipment	1,781,786	77.657	60.9
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**2,109,456**	**91.939**	**72.2**
Grand Total	**2,923,467**	**127.417**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **22944.2** m²
Conditioned Floor Area ..... **22944.2** m²

Detailed Report on the Billing and Components Cost

Monthly Component Costs - C-Alt 2-4PFCU/VSS-Complex Rate

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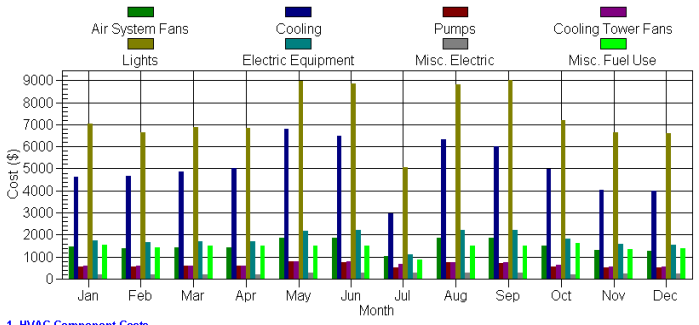

1. HVAC Component Costs

Month	Air System Fans ($)	Cooling ($)	Heating ($)	Pumps ($)	Cooling Towers ($)	HVAC Total ($)
January	1,460	4,618	0	550	603	7,231
February	1,388	4,671	0	550	592	7,201
March	1,415	4,860	0	578	612	7,465
April	1,417	5,007	0	578	595	7,597
May	1,841	6,811	0	781	797	10,230
June	1,861	6,467	0	754	791	9,873
July	1,047	2,949	0	494	675	5,165
August	1,838	6,323	0	739	766	9,666
September	1,853	6,006	0	714	770	9,343
October	1,515	4,974	0	572	621	7,682
November	1,298	4,048	0	514	543	6,403
December	1,282	3,973	0	516	570	6,341
Total	**18,216**	**60,708**	**0**	**7,338**	**7,933**	**94,196**

2. Non-HVAC Component Costs

Month	Lights ($)	Electric Equipment ($)	Misc. Electric ($)	Misc. Fuel Use ($)	Non-HVAC Total ($)	Grand Total ($)
January	7,050	1,746	213	1,560	10,570	17,801
February	6,633	1,650	200	1,418	9,902	17,103
March	6,897	1,693	216	1,512	10,317	17,782
April	6,839	1,701	210	1,497	10,247	17,844
May	8,954	2,188	279	1,512	12,934	23,164
June	8,847	2,231	276	1,497	12,851	22,724
July	5,061	1,094	260	850	7,265	12,430
August	8,805	2,201	280	1,512	12,799	22,465
September	9,000	2,229	276	1,497	13,002	22,345
October	7,176	1,800	211	1,608	10,795	18,477
November	6,650	1,581	225	1,353	9,808	16,211
December	6,593	1,552	227	1,368	9,740	16,081
Total	**88,506**	**21,666**	**2,873**	**17,185**	**130,229**	**224,425**

- Annual Operating Costs can be further analysed in monthly basis

Billing Details - Elect

APO_HAP42 Advanced Handout_03_01_05

1. Component Charges

Billing Period	Energy Charges ($)	Demand Charges ($)	Customer Charges ($)	Taxes ($)	Total Charge ($)
Jan	8,319	6,809	50	1,062	16,241
Feb	7,717	6,892	50	1,026	15,685
Mar	8,192	6,963	50	1,064	16,270
Apr	8,207	7,021	50	1,069	16,347
May	10,031	10,155	50	1,416	21,651
Jun	9,647	10,141	50	1,389	21,228
Jul	5,746	5,026	50	758	11,579
Aug	9,682	9,851	50	1,371	20,953
Sep	9,483	9,952	50	1,364	20,848
Oct	8,758	6,958	50	1,104	16,869
Nov	6,895	6,941	50	972	14,858
Dec	6,929	6,772	50	963	14,714
Totals	**99,605**	**93,480**	**600**	**13,558**	**207,243**

2. Totals

Billing Period	Total Charges ($)	Total Consumption (kWh)	Avg Price ($/kWh)
Jan	16,241	129,909	0.1250
Feb	15,685	120,636	0.1300
Mar	16,270	128,647	0.1265
Apr	16,347	128,256	0.1275
May	21,651	132,445	0.1635
Jun	21,228	126,992	0.1672
Jul	11,579	76,013	0.1523
Aug	20,953	127,450	0.1644
Sep	20,848	124,855	0.1670
Oct	16,869	136,366	0.1237
Nov	14,858	109,044	0.1363
Dec	14,714	110,339	0.1333
Totals	207,243	1,450,951	0.1428

3. Consumption Totals

Billing Period	Peak (kWh)	Mid-Peak (kWh)	Normal Peak (kWh)	Off-Peak (kWh)	Overall (kWh)
Jan	96,440	0	15,275	18,194	129,909
Feb	89,244	0	14,249	17,144	120,636
Mar	94,011	0	15,061	19,576	128,647
Apr	94,856	0	15,407	17,992	128,256
May	95,824	0	16,737	19,884	132,445
Jun	93,754	0	15,283	17,954	126,992
Jul	56,424	0	5,689	13,900	76,013
Aug	94,176	0	15,135	18,138	127,450
Sep	92,075	0	15,010	17,771	124,855
Oct	101,703	0	16,825	17,838	136,366
Nov	78,349	0	12,195	18,500	109,044
Dec	77,876	0	11,950	20,513	110,339
Totals	1,064,731	0	168,815	217,404	1,450,951