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User's Guide to the

# **Building Design Advisor**

Version 3.0

*Building Technologies Department  
Environmental Energy Technologies Division  
Ernest Orlando Lawrence Berkeley National Laboratory*

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# Introduction

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## Overview

The Building Design Advisor (BDA) software is the result of research and development efforts by the Building Technologies Department of the Environmental Energy Technologies Division at Ernest Orlando Lawrence Berkeley National Laboratory. The objective of these efforts is to provide means for quick and easy consideration of energy-efficient and environmentally sustainable strategies and technologies from the initial, schematic phases of building design to the detailed specification of building components and systems.

The BDA is a software environment that supports the integrated use of multiple simulation tools and databases, through a single building model and a single graphical user interface. Acting as a data manager and process controller, the BDA allows editing of the values of all parameters serving as input to simulation tools, supporting comparison of multiple alternative design solutions with respect to multiple descriptive and performance parameters.

The development of the BDA concept and software has been supported by the U.S. Department of Energy (DOE) and the California Institute for Energy Efficiency (CIEE). CIEE funds have been provided by Pacific Gas and Electric (PG&E), Southern California Edison (SCE) and the California Energy Commission (CEC).

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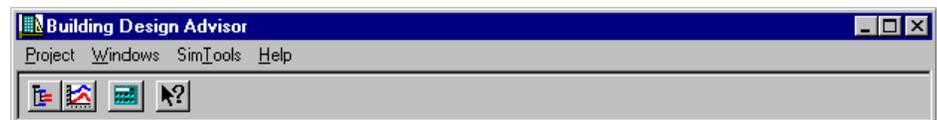
## User interface windows

The user interface of BDA has four main windows:

- BDA Main Window
- Schematic Graphic Editor (SGE)
- Building Browser
- Decision Desktop

### BDA Main Window

The main BDA window opens automatically when the program is started. It is used to manage projects and other BDA windows. From here you may also retrieve online help.

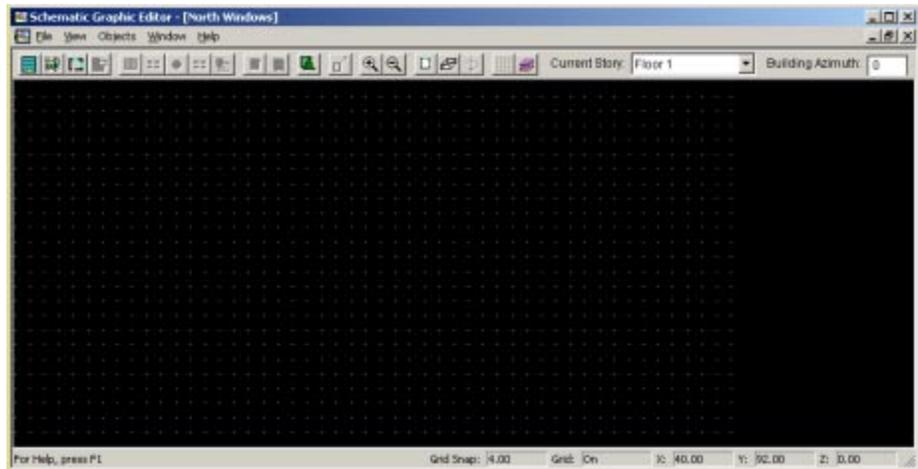


*BDA Main Window*

### Schematic Graphic Editor (SGE)

The SGE provides a graphical interface for drawing spaces, windows, luminaires, external obstructions (building shades), etc. It opens automatically when a project is opened.

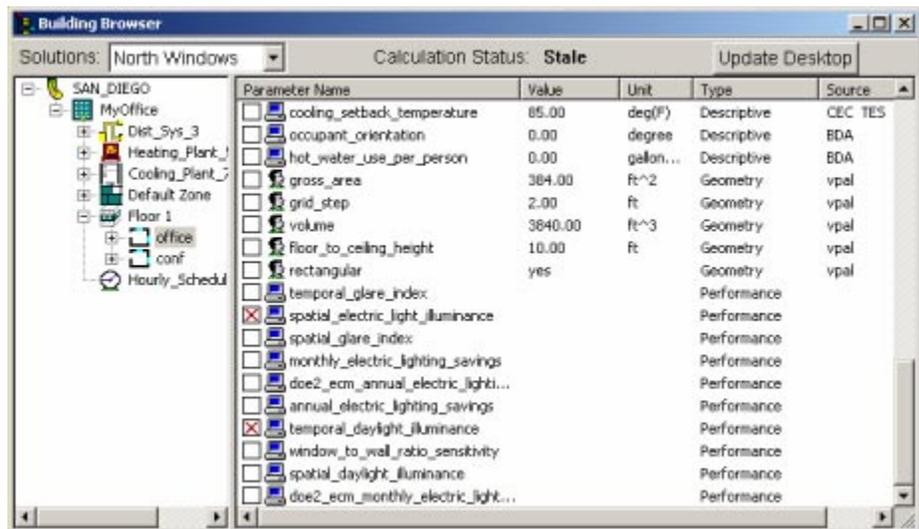
Although it appears as an integral part of BDA's graphical user interface, the Schematic Graphic Editor is actually a separate Windows® application, which is launched by BDA when a new project is created or an existing project is loaded.



*Schematic Graphic Editor (SGE).*

## Building Browser

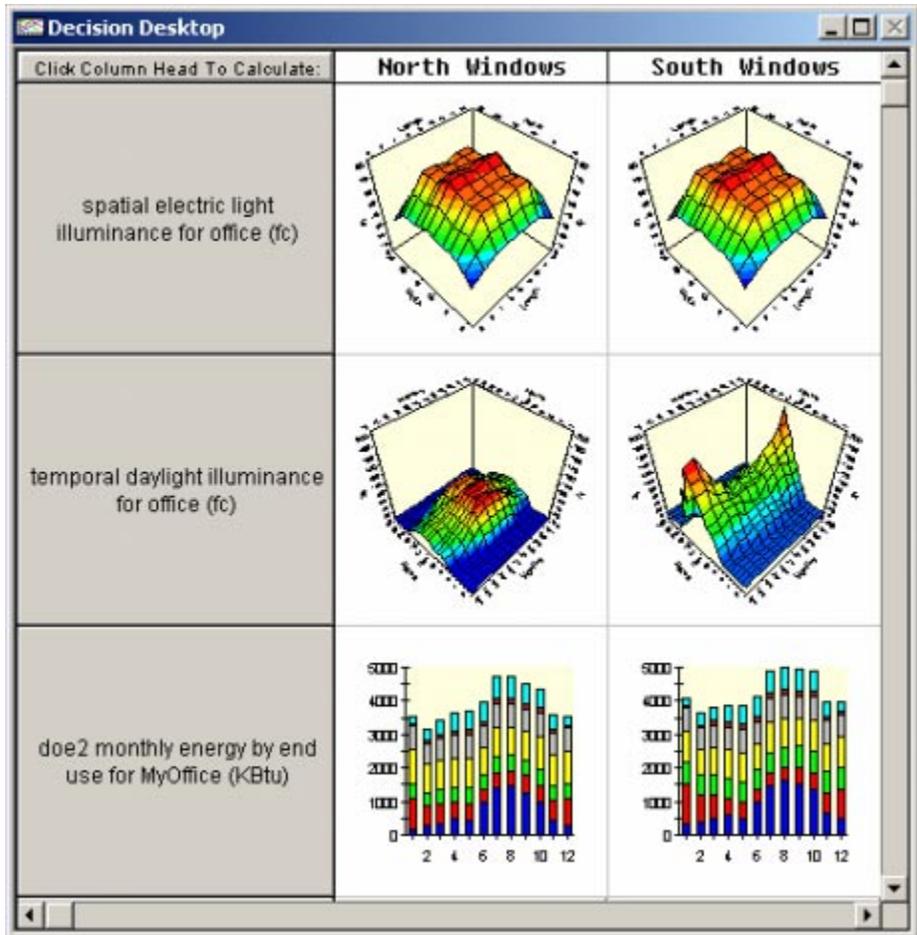
The Building Browser is a navigational tool, which displays all of the building model objects in a hierarchical fashion and displays the parameters that characterize each object, as well as their values, units, and value source (database, user input, etc). Navigation is done in an environment similar to Windows Explorer™. Object and parameter values are edited using information dialog boxes that are activated through the Building Browser.



*Building Browser*

## Decision Desktop

The Decision Desktop displays the values of selected parameters for one or more Solutions. The displayed parameters (Spatial Daylight Illuminance, Total Energy Use, etc.) are selected in the Building Browser.



*Decision Desktop*

## Supported simulation tools

The current release of BDA is linked to three simulation tools, DELight, ECM and DOE1.2E. The available outputs from these tools are listed below and defined in the Glossary.

- **DELight**
  - Spatial\_Daylight\_Illuminance
  - Temporal\_Daylight\_Illuminance
  - Temporal\_Glare\_Index
  - Monthly\_Electric\_Lighting\_Savings
  - Annual\_Electric\_Lighting\_Savings
- **ECM**
  - Spatial\_Electric\_Light\_Illuminance
  - Electric\_Light\_Illuminance for a reference point
- **DOE-2.1E**
  - Total\_Energy\_Use
  - Total\_Energy\_by\_Fuel\_Type
  - Total\_Energy\_by\_End\_Use
  - Monthly\_Energy\_by\_Fuel\_Type

Monthly\_Energy\_by\_End\_Use  
DOE2\_Annual\_Electric\_Lighting\_Savings  
DOE2\_Monthly\_Electric\_Lighting\_Savings

- **DOE-2.1E + ECM**

DOE2\_ECM\_Annual\_Electric\_Lighting\_Savings  
DOE2\_ECM\_Monthly\_Electric\_Lighting\_Savings

## BDA files

The BDA installation directory contains all the executables, databases, and other files associated with the BDA software.

**WARNING:** Do **NOT** rename, delete or move any file from the BDA home directory or any of its sub-directories unless expressly directed to do so by your BDA support person.

---

## What's covered in this manual

This manual is organized into the following chapters:

1. "Object Oriented Environment" on page 9 describes the object-oriented representation for buildings used by the Building Design Advisor. You should read this chapter first to familiarize yourself with the object environment terminology.
2. "Getting Started" on page 13 describes how to open BDA, and describes the functions of the main BDA window, including creating new projects, opening existing ones, and saving your work.
3. "Schematic Graphic Editor" on page 19 describes the Schematic Graphic Editor (SGE), a graphical interface for drawing spaces, windows and obstructions. It opens automatically when a project is opened.
4. "Building Browser" on page 35 explains the Browser's hierarchical navigation, and describes its functions, including editing and viewing object properties and parameter values.
5. "Design Decision Desktop" on page 41 describes how to use the Decision Desktop and control the appearance of the output.
6. "Tutorial" on page 49 provides a quick way to get started with using BDA.
7. "BDA Building Model" on page 61 defines all the objects, parameters, and relationships used in the BDA Building Model.

# Object-Oriented Environment

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## Overview

This chapter describes the object-oriented representation for buildings used in the Building Design Advisor. You should read this chapter first to familiarize yourself with the object environment terminology.

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## Object-oriented representation

### BDA Schema

To facilitate the extendibility of the BDA building model, we have based its representation on a generic data schema, which consists of:

- **Building Objects** (e.g. building, story, space, boundary, boundary\_segment, aperture, etc.) represent building components and systems as “containers” for parameters. Building objects are linked to each other through *relationships*.
- **Parameters** (e.g. total energy use, floor-to-floor height, hot water use per person, surface area, etc.) represent the state of *building objects* with respect to the data input and output needs of the *simulation tools* that are linked to the BDA.
- **Relationships** (e.g. composed of, part of, contains, contained in, etc.) represent links between the *building object* instances and provide a navigational framework for accessing those instances.
- **Values**. Six different data types are supported for the values of parameters:
  - Integer
  - Real number
  - Text string
  - One-dimensional array of real numbers
  - Two-dimensional array of real numbers
  - Bitmap or image
  - Video and/or audio

- **Units** (e.g., ft, KBTU, fc, etc.) qualify the values of parameters.
- **Simulation Tools** (DOE 2.1E, DELight, ECM, etc.) or processes, in general, use the values of certain parameters as input and produce the values of other parameters as output.

## Default value selection

Every time a new object is created in the Schematic Graphic Editor (SGE), default values for each parameter and children objects are selected based on building location, building type, and space type. BDA selects these values from a database, which has prototype information for different building objects. Default values in the database come from respected sources such as ASHRAE, BOCA, CEC, and IESNA and are representative of standard and/or recommended practice.

This feature allows activation of simulation tools with minimal input, saving a great deal of time that would ordinarily be required to determine and enter these values into a simulation tool. Where desired, default values may be changed in the Building Browser.

## Object naming conventions

When a project is created, the user must specify a name for it. Building objects within the project that are created by the user are also to be named by the user. Objects created by the BDA through the default value mechanism are named according to BDA's object naming conventions.

**Building** (BDA supports only one building per project at this time) is given the name of the project.

**Plenums** are named by combining the name of the story to which they belong with the word "plenum" (e.g. Ground Floor Plenum).

**Boundaries, boundary segments** and **apertures** are named by combining their object type with a unique object ID. (e.g. Wall 12, Floor 35, Ext Wall Seg 107, Int Wall Seg 149, or Window 77).

**Distribution systems, heating plants,** and **cooling plants** are named by combining their object type with a unique object ID.

NOTE: At this time, BDA supports one distribution system, one heating plant and one cooling plant per building.

Objects for which only one of their object type can exist under the parent design object are named by their object type name, e.g. *Construction, Frame, Glazing, Ground\_Surface, Hourly\_Schedule* and *Monthly\_Schedule*.

## Parameter types

*Descriptive Parameters* have values that are either default values selected by BDA when the parent object was created, or values entered by the user. Parameters with default values are identified in the Browser by a computer icon to the left of their name. Parameters with user-defined values are identified in the browser by a human face icon to the left of their name.

*Derived Parameters* occur at the *site* level only. Values are taken from a BDA database, such as TMY2 weather data, and are always identified with computer icons in the building Browser.

**Geometry Parameters** have values that are derived from the drawing in SGE and are always identified with human icons and are linked to user names.

**Performance Parameters** have no values until they are placed on the Desktop, i.e., selected as *output parameters*, and their values are calculated by the simulation tools that are linked to the BDA. They are always identified by a computer icon. If a performance parameter has a value, its *Source* field contains the name of the simulation tool that calculated the value.

**NOTE:** If a value is not an integer, a real number, or a string, then the *Value* field in the Browser may contain the name of a file where the value (real array or table, bitmap, audio or video clip) actually resides.



# Getting Started

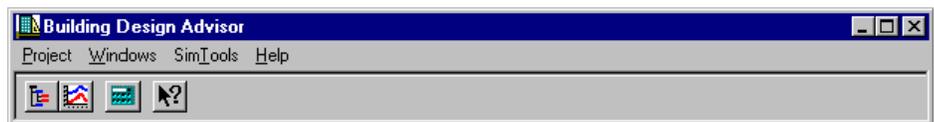
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## Overview

This chapter describes how to start BDA and use the functions of the main BDA window, including creating new projects, opening existing ones, and saving your work.

### ***Launching BDA***

Select **Building Design Advisor** from the **Programs** section of the **Start Menu** on your desktop. The main BDA window will open.



*Main BDA window*

This window is used to manage projects and open other windows. From this window you may also access the online help files. This chapter addresses the **Project** menu functions. For information on the **Simulation Tools** menu, see the Decision Desktop chapter.

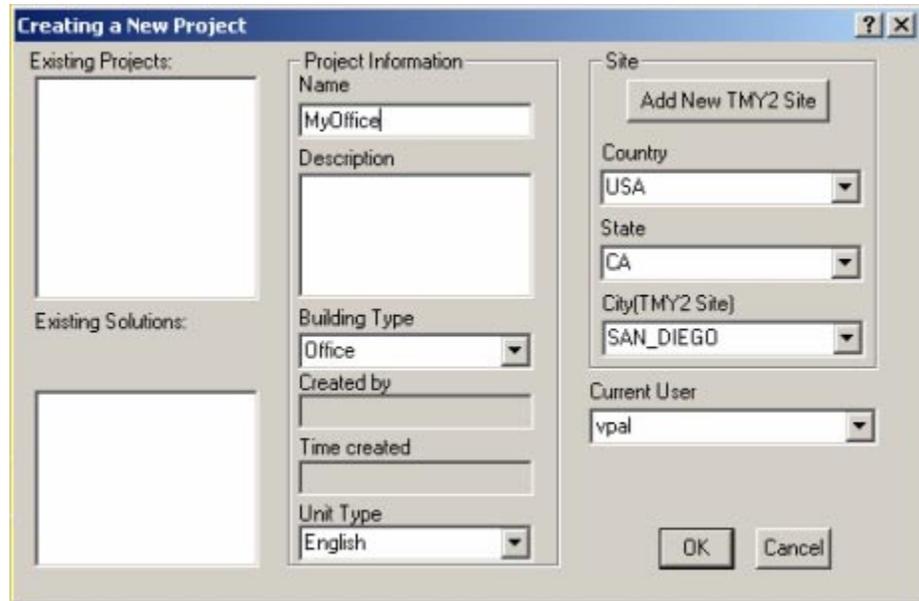
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## Managing projects

A BDA Project must be created for each building analyzed. A project consists of a site description and one or more design alternatives, or *Solutions*. Currently BDA does not support multiple buildings on one site.

### ***Create a new project***

To create a BDA Project, select **New** from the **Project** menu. The Creating a New Project dialog box will open.



Create New Project Dialog Box

You must enter a unique name for the project in the *Name* field. Other required fields include *Building Type*, *Country*, *State*, and *City*. Default values are entered in these fields; however, you should change them if they are different for your project. The *Description* field is the only optional field. The remaining fields are not user-changeable.

To complete the creation of your new project:

1. Enter a unique name in the *Name* field. The existing names appear on the left-hand side of the dialog box. You may enter a short description of the project if desired.
2. Select a *Building Type* from the pull-down list. The current selections are Lodging, Restaurant, and Office. The building type is used for the selection of default values. If the building type that you want is not represented, choose one of the available types and change the default values using the Building Browser.
3. Select a *Unit Type* from the pull-down list. The choice is between the English unit system and the Metric unit system. All the numerical parameters in the project will have their values displayed in the selected unit system.
4. Select an option from those available on the *Country*, *State* and *City* (TMY2 Site) pull-down menus. If your city is not available, select one that is similar in climate to the one you are designing for. You may also add a new TMY2 file to the database as described in the section "Add a new TMY2 file" on page 15.
5. Click **OK** when you have finished specifying values for your project.

**CAUTION:** Once you click **OK**, the information entered here cannot be changed because these values are used to select default values for building object parameters. If you want to change this information later, you must create a new project. See also "Import a project" on page 17.

**Note:** The *Current User* field is not changeable and is same as the current Windows user. BDA keeps track of the user associated with each change to the project from beginning to end. Using a different login name for each user who edits the project will be useful in managing the project.

### **Add a new TMY2 file**

Adding TMY2 files can only be done from the Creating a New Project dialog box. You will first need to see that the appropriate file is on your computer. Only a selection of cities are included with the BDA software, so you may need to download the data from another location, such as the website [http://rredc.nrel.gov/solar/old\\_data/nsrdb/tmy2/](http://rredc.nrel.gov/solar/old_data/nsrdb/tmy2/). Note that BDA does currently support non-U.S. cities as long as you can provide a TMY2 formatted file for your city.

To add a new TMY2 file:

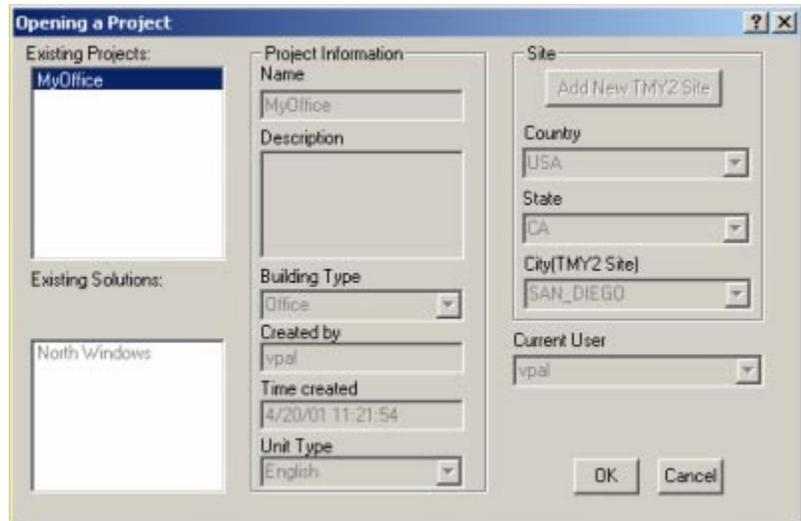
1. Open the file "Countrymap.txt" located in the "BDADData" folder within the directory where BDA is installed. If your city is not included in this file, add a line to the file specifying the city (exactly as it is specified in the TMY2 file) and the country.
2. Open the file "BDADesDay.txt" located in the "BDADData" folder within the directory where BDA is installed. If your city is not included in this file, add a line to the file specifying the city (exactly as it is specified in the TMY2 file), its WBAN, and its Design Day information. (The Design Day information is used by BDA for display purposes only. It is not used in any of the calculations.)
3. Open the Creating a New Project dialog box.
4. Click on the **Add New TMY2 File** button.
5. Browse to the directory containing the appropriate TMY2 file. Select the file and click **OK**. TMY2 files have the suffix .tm2.
6. If the file was imported correctly, the new city name will appear on the *City* pull-down list when you select the country and state.

### **Open an existing project**

The **Open Project** option will only be available if previously-saved projects exist. Only one project may be open at a time, so if a project is already open, it will be closed, and you will be prompted to save any changes.

To open a project:

1. Select **Open** from the **Project** menu. The Open Project dialog box will appear.



*Open Project dialog box*

2. Select the project you wish to open from the Existing Projects list. Information associated with that project will be displayed but cannot be changed.
3. Click **OK** or double click on the selected project name.

### ***Close project***

To close a project, select the **Close** option on the **Project** menu. If your project has not been saved, BDA will ask you whether you want to save your final version.

### ***Save project***

To save your work without closing, select **Save** from the **Project** menu. When you close a project or exit BDA, you will be prompted to save your work. Click **Yes** to save your changes in the project database.

### ***Rename a project***

Before you rename a project, you must close the project you want to rename. To rename a project:

1. Select the **Rename** option from the **Project** menu. The Rename Project dialog box will open.
2. Select the project you want to rename and enter a new name for the project.
3. Click **OK**.

### ***Save a project under a different name***

To save the current project under a different name:

1. Select **Save As** from the **Project** menu. The **Save As** dialog box will open.
2. Select the location where you want to save the project and enter a new name for the project.
3. Click **OK**.

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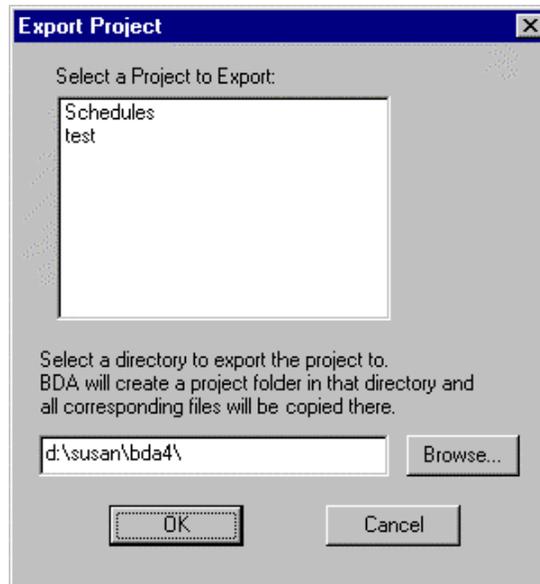
## Sharing projects

BDA does not allow copying of projects for use as templates or sharing with others. To work around this, you may use the Import Project and Export Project functions described below.

### **Export a project**

To export a project:

1. Select the **Export** option on the **Project** menu. The Export Project dialog box will appear.



*Export Project dialog box*

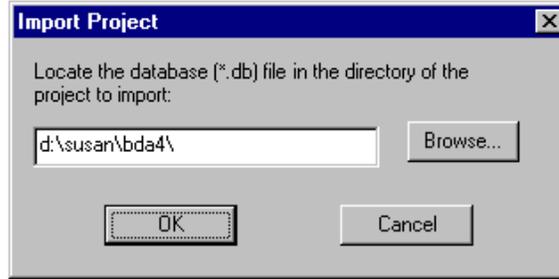
2. Select the project to be exported and type in the directory of the export destination, or click on the **Browse** button in the dialog box and select the desired destination folder.
3. Click **OK**.

The exported BDA project will consist of several files which will be placed in the directory specified in the Export Project dialog box. None of these files should be renamed.

### **Import a project**

To import a project:

1. Select the **Import** option on the **Project** menu. The Import Project dialog box will open.



*Import Project dialog box*

2. Click on **Browse** and navigate to the directory of the exported project you wish to import. Select the project file ending in *.db*.
3. Click **OK** to import the project.

You can only import files exported from BDA, which will have the format *projectname.db*, where *projectname* is the name of the project to be imported. BDA will not allow you to import a project with a name identical to that of an existing project.

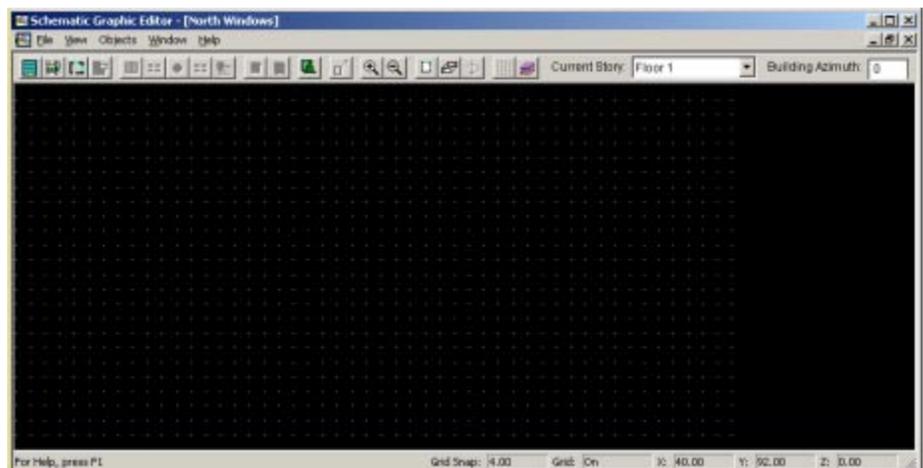
# Schematic Graphic Editor

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## Overview

The Schematic Graphic Editor (SGE) provides a graphical interface for drawing spaces, windows, and external obstructions (building shades), etc. It starts automatically when a project is opened.

This chapter describes how to create a geometric representation of your building using the Schematic Graphic Editor.



*Schematic Graphic Editor (SGE)*

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## Design Solutions

### Creating new design solutions

When you create a new project, the SGE opens, but no drawing screen is visible. The first step is to create a new *solution*. Then you will be able to create stories, then spaces and external obstructions, then apertures (windows) and other building objects.

The BDA supports multiple design solutions for a single project. Selecting **New Solution** from the SGE toolbar or menu will create an exact copy of the current solution. You may continue with changes to any of the existing solutions.

**CAUTION:** At this time, there is **NO undo** in BDA. All changes are final for the current solution. You may still delete objects and change values.

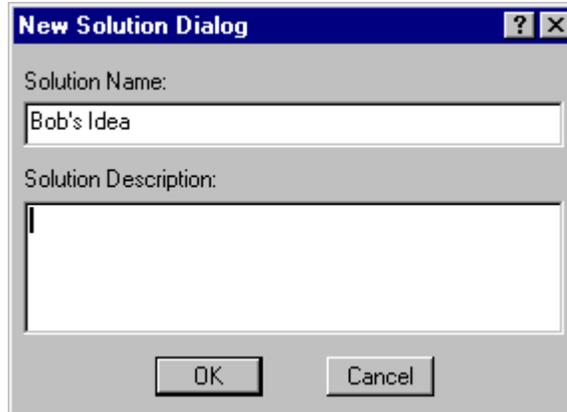
### **Create a new solution**

To create a new solution:



*Click to create a new solution.*

1. Click on the **New Solution** button or select **New Solution** from the **File** menu in SGE. The New Solution dialog box will open.



*New Solution dialog box*

2. Specify a name for the new solution, and optionally, a brief description.
3. Click **OK**.

If no previous solution exists, a new story will automatically be created, and you will be prompted to give it a name. This will be the ground story, and a new drawing grid will appear in the SGE window.

If one or more solutions already exist, a new drawing window will open, and the current solution will be copied into the new solution.

To copy a particular solution, make sure that solution is active when you create the new solution.

---

## **Drawing in SGE**

Before you begin drawing, you may want to change the grid settings so that your entire project will fit on the screen. The default grid setting is a 200 foot by 100 foot grid with a four-foot grid interval. For details on how to change these settings, see "View/Change the drawing settings" on page 25.



Click to create a new story

## Create a new story

Before you can create a space, you will need to create a story. To open the New Story dialog box:

1. Click on the **Story** button on the SGE tool bar, or select the menu item **Object → Create → Story** in SGE. The New Story dialog box will open.

New Story Dialog

Story Name: Floor 1

Story Level: 1  Story has a Plenum

Floor to Ceiling Height: 10 ft. Plenum Height: 0 ft.

OK Cancel

New Story dialog box

2. Specify a name for the new story, its height, optional plenum and plenum height. The level is displayed but is not editable.
3. Click **OK**.

**Note:** By default, roofs are created with each space. If a space is drawn on top of another space (at the story above) then the BDA will remove the roof from the space below. One of the limitations of the current version of the BDA is that even if there is a partial overlap, the BDA will remove the whole roof, meaning that it will consider it as an adiabatic surface (no heat transfer).

## Draw a space

Once you have created a story, you may add one or more spaces to it. You may add windows, luminaires, overhangs, and fins to spaces. You may also create external objects of specified dimensions.



Click to create a space

To draw a space in the current story:

1. Click on the **Space** button on the SGE tool bar, or select the menu item **Object → Create → Space**.
2. Select a space type from the drop down list of available space types. The cursor will change to the drawing mode cross-wire shape.

Press the **Esc** button to cancel the space creation.



Select a space type from this list.

3. Once you have selected a space type, the cursor will turn into a cross-wire. To draw, click and release the left mouse button once to specify the beginning point of the wall segment that will define the new space. Move the mouse to draw a wall. Click and release again to end a wall segment and continue with another.

If you want to backtrack your steps, press the **Esc** button to take you back one step at a time.

4. Double click to close the resulting polygon and define the space.
5. When you finish drawing a space, the Space Name dialog box will open. Type in a name and click **OK**.
6. The name of the new space appears on the screen as a floating graphic object attached to the cursor. Do not click yet!
7. Before anchoring the name to the space, you should move the name to the location you wish it to appear by moving the mouse. You can increase or decrease the font size using the “+”, or “-” keypad keys and you can rotate the orientation of the name 45° at a time by pressing the **r** key.
8. When you are satisfied with the name’s position, font size and orientation, anchor the name to the space by clicking the left mouse button.

**CAUTION:** Once you have positioned the name, changing the size and orientation is no longer possible.

**Note 1:** The co-ordinate system display system at the bottom of the SGE window shows *relative* values of co-ordinates of the *current* segment *while* a space is being drawn. Once a space is closed, SGE switches back to the *absolute* co-ordinate display.

**Note 2:** The DELight simulation tool which performs the daylighting calculations can only model **rectangular spaces**. Similarly, ECM, the simulation tool that performs the electric lighting calculations can only model rectangular spaces. If non-rectangular spaces are drawn, daylight and electric light output parameters do not appear in the Browser.

### ***Draw an external obstruction***

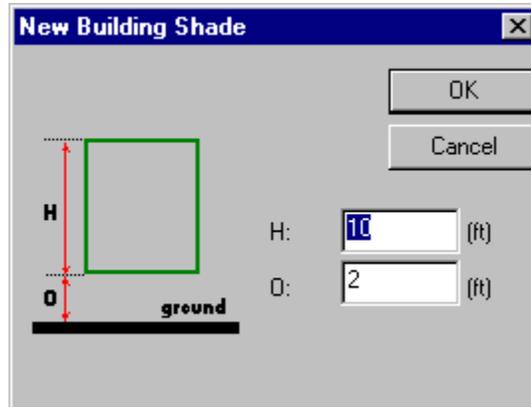
External obstructions may only be drawn at the first level of a building. Building shades are generally trees or neighboring buildings, and are also referred to as *building shades*. The only properties assigned to an external obstruction in the SGE are its geometric shape and dimensions. The values of other parameters, such as surface properties, are assigned default values which may be changed in the Building Browser.



Click to draw an external obstruction.

To draw an external obstruction:

1. Click the **Building Shade** button on the SGE toolbar or select the menu option **Object → Create → External Obstruction**. The External Obstruction dialog box will open.



External Obstruction dialog box

2. Enter the dimensions in the dimension fields. The diagram on the left side of the dialog box indicates the dimensions graphically.  $H$  is the height of the object and  $O$  is the distance between the object and the ground. The default values are roughly the dimensions of a small tree.
3. Click OK.
4. The cursor will turn to a cross-wire shape. Draw the external obstruction as you would a space. Refer to "Draw a space" on page 21 for details.

### Draw a window



Click to draw a window

To draw a window in SGE:

1. Select a space to contain the window by clicking on it. The easiest way to select a space is to click on its name.
2. Click on the **Window** button of the SGE tool bar, or select the menu item **Object → Create → Window**.
3. Click and release the left mouse button on the point in a wall from where you want to start drawing the window. Move the cursor up to the desired endpoint of the window
4. Click and release the left mouse button once again. A turquoise line representing the window will appear on the wall.

### Add an overhang to a window

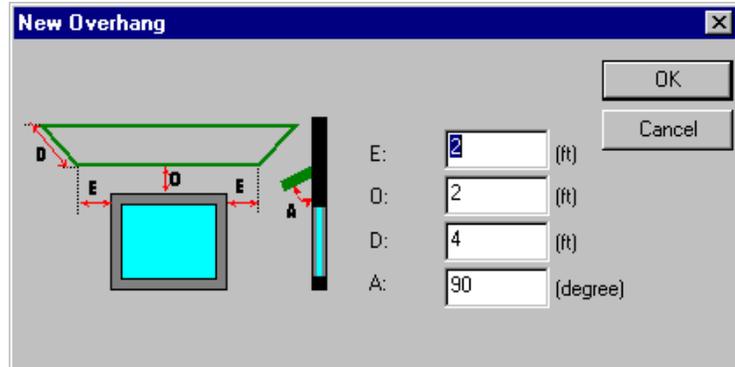
To add an overhang to a window:

1. Click on a window to contain the overhang. When a window is selected, the **Overhang** and **Fins** buttons on the SGE toolbar will become active.



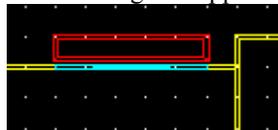
Click to insert overhang

2. Click the **Overhang** button on the SGE toolbar, or select the menu item **Object → Create → Overhang**. The Create Overhang dialog box will appear.



Insert Overhang dialog box

3. Enter the desired dimensions in the dimension fields. The diagram on the dialog box indicates the dimensions graphically. The dimensions specified are length, horizontal and vertical offsets from the window, and angle of inclination from the wall (measured from the window plane upwards). The overhang is assumed to be centered horizontally above the window.
4. Click **OK** when done to create the overhang. A red icon representing the overhang will appear next to the window. It is NOT drawn to scale.



Window with overhang icon

### **Add vertical fins to window**

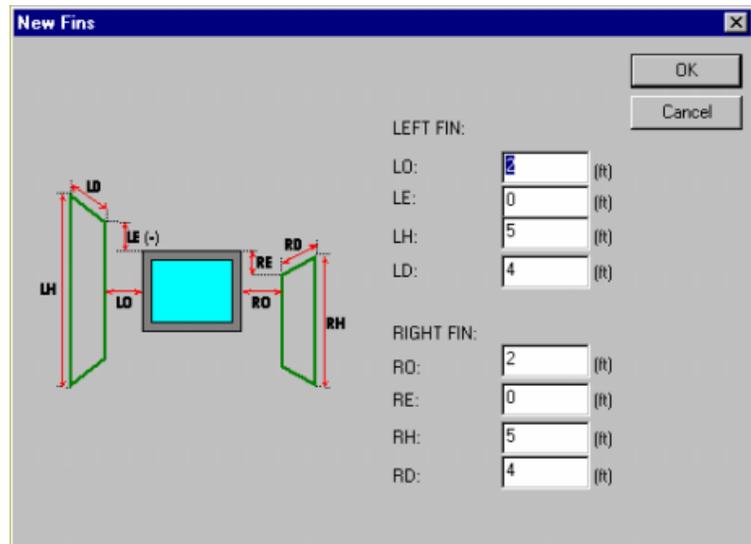
Fins may only be added as a pair, one pair per window. If you wish to add only one fin, set the values of the dimensions of the other fin to zeros.

To add a pair of vertical fins to a window:



Click to add fins to a window

1. Click on the window to contain the fins.
2. Click the **Fins** button on the SGE toolbar, or select the menu item **Object → Create → Fins**. The Create Fins dialog box will open.



Add Fins to a Window dialog box

3. Enter the desired dimensions in the dimension fields. The diagram on the dialog box indicates the dimensions graphically. The left and right fins are specified separately. For each fin, you may specify the height, width, and vertical and horizontal offsets from the window.
4. Click OK when done. A pair of green lines representing the fins will be added to the window. They are NOT drawn to scale.



Window with fins icon

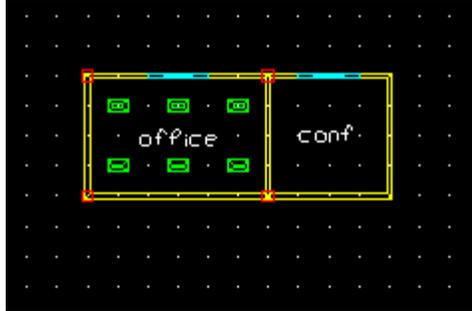
### **Add luminaires to a space**

To add luminaires to a space:



Click to add a luminaire to a space

1. Select a space to contain the luminaire by clicking on it. The easiest way to select a space is to click on its name.
2. Click on the **Luminaire** button of the SGE tool bar, or select the menu item **Object → Create → Luminaire**.
3. Click and release the left mouse button on the point inside the space where the luminaire is to be located. A green icon representing the luminaire will appear at the insertion point. It is NOT drawn to scale.



Space with luminaire icons

4. Repeat steps 2 and 3 to add more luminaires.

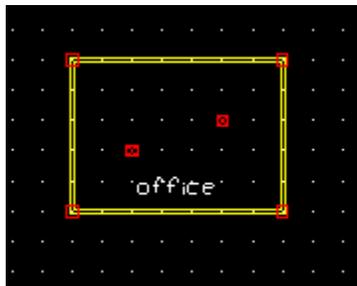
### Add reference point to space

To add a reference point to a space:

1. Select a space to contain the reference point by clicking on it. The easiest way to select a space is to click on its name.
2. Click on the **Reference Point** button of the SGE tool bar.
3. Click and release the left mouse button on the point inside the space where the reference point is to be located. A red icon representing the reference point will appear at the insertion point.



Click to add reference point to space



Space with reference point icons

4. Repeat steps 2 and 3 to add more reference points.

### View/Change the drawing settings

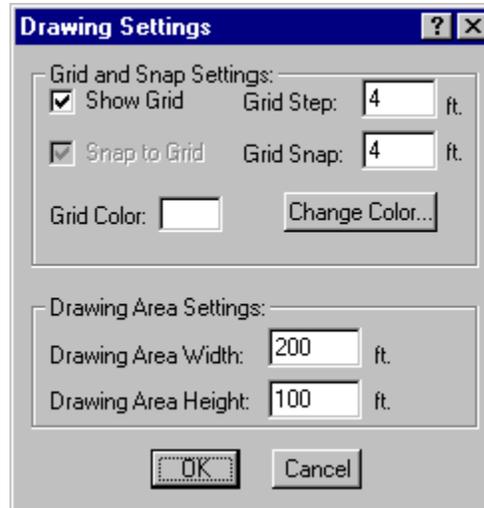
The information bar at the bottom of the SGE window displays the Grid Snap interval, the Grid Snap state (On/Off) and the x-y-z coordinates of the cursor. The grid settings, including drawing area and grid color, may be changed using the Drawing Settings tool.



Click to adjust the Drawing Settings

To change the drawing settings:

1. Click on the **Drawing Settings** tool in the SGE tool bar, or select the menu item **View → Drawing Settings**. The Drawing Settings dialog box will open.



Drawing Settings dialog box

2. You can select or deselect the *Show Grid*. The *Snap to Grid* checkbox is always checked to make sure that the BDA understands when walls coincide. This is necessary for the automatic computation of interior and exterior walls for the assignment of proper default values for wall construction. You may also change the *Grid Step* and *Grid Snap* intervals, as well as the *Drawing Area Width* and *Drawing Area Height* by typing in the appropriate text entry field; or change the *Grid Color* by clicking the **Change Color** button.
3. Click **OK** to apply changes or **Cancel** to leave settings unchanged.

### Change the building azimuth

The **Building Azimuth** is displayed in a text field on the top right hand corner of the SGE. It may be changed by typing any number between 0 and 360 in this text field. The Building Azimuth is given as the clockwise angle (in degrees) between true north and the building Y-axis. By default it is 0 degrees.

---

## Basic SGE functions

This section describes basic SGE operations that are meant to facilitate schematic design by allowing you to move spaces around, while BDA takes care of recomputing interior and exterior wall segments.

## Select object

To select an object, click on the object. The easiest way to select a space or external object is to click on its name. When an object is selected, red selection marks appear at its corners.



*Selected space*

## Move object

To move an object to another position on the SGE drawing grid:

1. Select the object to be moved.
2. Click on the **Move Object** button on the SGE tool bar or select **Move** under the **Object** menu. The mouse cursor will appear as a thick cross on the solution grid. Click the mouse anywhere on the grid to "pick up" the object. Use the mouse to move the object to its new location.
3. Click the mouse again when you have positioned the object at the desired location.

**NOTE:** If you try to move an object to a position not allowed by BDA, the object will return to its original position. For example, spaces may not overlap, so if you move a space to a position overlapping another space, the SGE will move the space back to its original location.

## Resize window

To resize a window:

1. Select the window.
2. Click once on the edge of the window you wish to move.
3. Use the mouse to reposition the window edge.
4. Click again to fix the window size.

## Zoom in

To zoom in on any particular point of the drawing, click on the **Zoom In** button on the SGE tool bar or select **Zoom In** from the **View** menu. Click to select one corner of the area you want to zoom in to. Move the mouse cursor to draw a box around an area to zoom in. Click the mouse again and the screen will zoom in on the selected area. You can repeat **Zoom In** many times as needed.

## Zoom-to-fit (zoom out)

To view the entire drawing, click on the **Zoom-To-Fit** button on the SGE tool bar or select **Zoom-To-Fit** from the **View** menu. There is no incremental zoom out. Use this function if you have zoomed in on a particular object and wish to return to the normal view.



*Move Object Tool*



*Zoom In Tool*



*Zoom Out Tool*



Click to use Plan View

### ***Plan view (2D)***

SGE by default sets the drawing to the *Plan View*, a 2-dimensional view. If you used a different view and need to return to the Plan View, select the **Plan View** button from the SGE tool bar or select menu option **View → Change View → Plan View**.

You must be in Plan View to use most of the SGE functions.

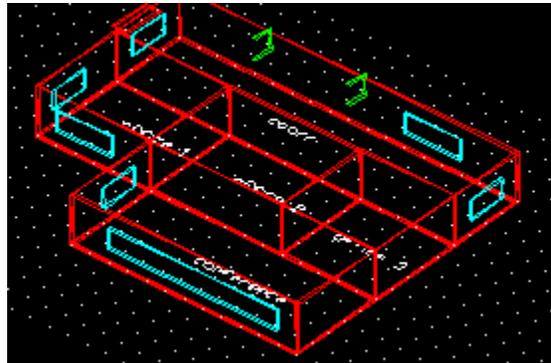
### ***Isometric view (3D)***

To switch your view to the *Isometric View*, or 3-dimensional view, select the **Isometric View tool** from the tool bar, or select the menu option **View → Change View → Isometric View**.

It is often useful to switch to the Isometric View to view your structure in 3 dimensions. Most SGE functions, however, cannot be used in this view.



Click to use Isometric View



*3D isometric view*

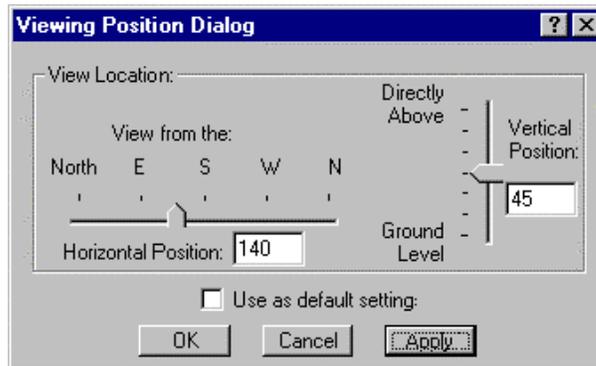
### ***Change viewer position settings***

While in the Isometric View, you can change the Viewer Position Settings. To change the Viewer Position Settings:



3-D Viewer Position Tool

1. Click on the **Viewer Position Settings** button or select **Set Viewing Position** from the **View** menu. The Viewing Position dialog box will open.



Viewing Position dialog box

2. Select the desired horizontal, vertical, and angular direction for view. You may also select the *Use as default setting* checkbox to make the specified viewer position the default view.
3. Click **Apply** to apply your changes.

### **Modify layer settings**

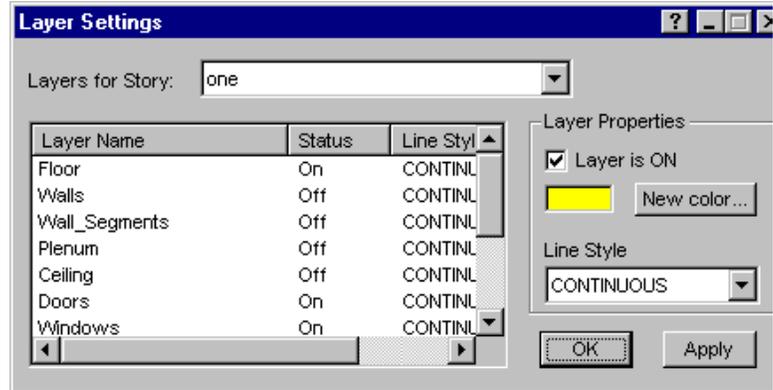
The Layer Settings function controls the appearance of objects in SGE. For each story, each object type is grouped into a *layer*. Using the Layer Settings function, you can decide whether the layer should be shown, and decide its color and line type.



Layer Settings Tool

To modify layer settings:

1. Select the **Layer Settings** button from the SGE tool bar or select **Layer Settings** from the **View** menu. The Layer Settings dialog box will open.



Layer Settings dialog box

2. To change the settings, select the desired layer and change its properties in the Layer Properties box on the right, including *Name*, *Status* (On/Off), and *Line Style*.
3. Click **Apply** to save your changes. Select another layer to edit if desired. Note your changes are only applied to the current layer and story.
4. When you are done editing layers, click **OK** to exit the dialog box.

### **Edit thermal zones**

DOE 2.1E models spaces as thermal zones. The thermal zone options have been disabled in this version of BDA.

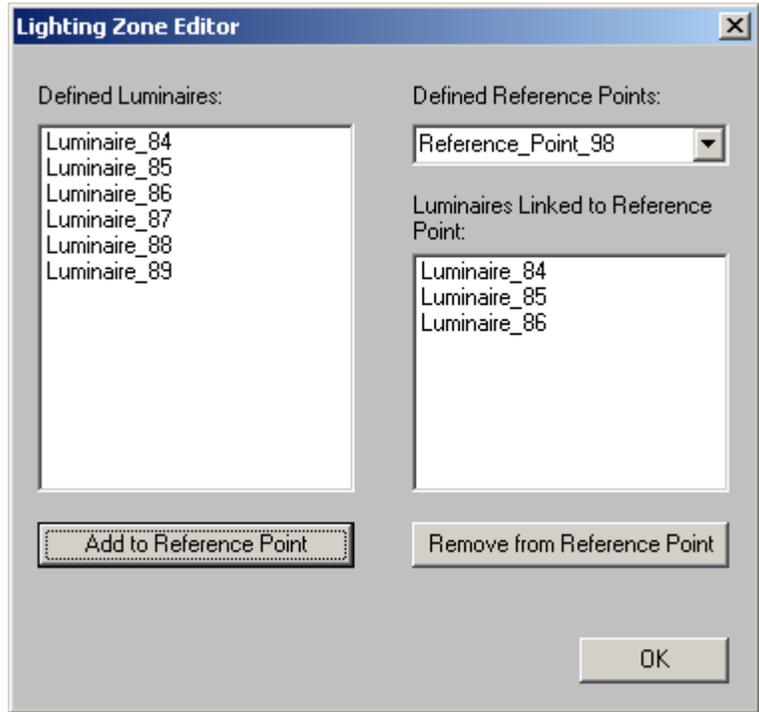
### **Edit lighting zones**

Lighting zones can be defined by associating luminaires with a reference point. The luminaire(s) and reference point(s) need to be added to the space before lighting zones can be created. To make this association:



Light Zoning Tool

1. Select the space that will contain the lighting zone.
2. Click on the **Light Zoning** button on the SGE tool bar. The **Light Zoning** dialog box will appear. A drop-down list of reference points will be filled if there are reference points in the space. A list of luminaires existing in the space is also shown in the list box on the left. If the reference point has had luminaires associated with it previously, these will appear in the list box on the right.



Lighting zone editor

3. Select a reference point from the drop-down list.
4. To add luminaires to the selected reference point, select luminaires from the list box on the left and click on the "Add to Reference Point" button.
5. To remove luminaires from the selected reference point, select luminaires from the list box on the right and click on the "Remove from Reference Point" button.
6. Click **OK** when done.

**NOTE:** You can create multiple lighting zones, but at this time BDA can model only one lighting zone per space. To specify the lighting zone for BDA to consider, see "Edit lighting controls".

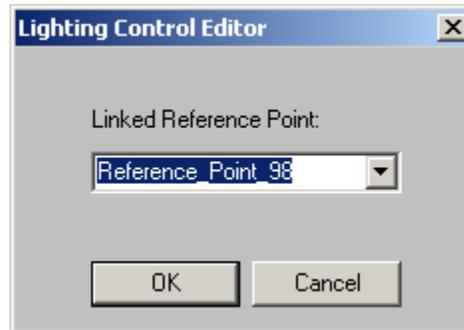
### **Edit lighting controls**

A reference point can be associated with the lighting control system for the space. The associated reference point will then act as a sensor for controlling the lighting levels. To make this association:



*Lighting Controls Tool*

1. Select the space for which the lighting controls need to be defined.
2. Click on the **Lighting Controls** button on the SGE tool bar. The **Lighting Controls** dialog box will appear. A drop-down list of reference points will be filled if there are reference points in the space.



*Lighting controls editor*

3. Select a reference point from the drop-down list.
4. Click **OK** when done.

---

## View/Edit object properties

When you create an object in SGE, it is automatically added to the BDA building model and is visible in the Building Browser. The *Object Properties* in SGE will only allow you to view and edit properties that are relevant to the SGE.

You can locate the corresponding Building Browser object for a given SGE object using the *Highlight Object in Building Browser* function.

### **View/Edit SGE properties**

SGE properties are specified by the user who creates the object. These properties may be viewed or changed at any time. To view or edit SGE properties of an object:

- Select **Properties** from the SGE **Objects** menu.
- or
- Right-click above the object and select **Properties** from the pop-up menu.

An object properties dialog box will open. Click **OK** when done.

### **Highlight object in Building Browser**

To highlight an object in the Building Browser:

1. Right click above the object.
2. Select **Highlight Object in Building Browser** from the pop-up menu.

The Building Browser window will open, and the selected SGE object will be selected in the Building Browser window.

See the Building Browser chapter for more information.

### ***Edit Solution Properties***

The **Name** and **Description** of the Solution can be changed through the SGE.

1. Right click on the drawing screen of the SGE in an area which is empty and does not have any objects drawn.
2. Select **Solution Properties** from the pop-up menu. The Solution properties dialog box will appear.
3. Make the necessary changes and click **OK**.

### ***Edit Story Name***

The Story **Name** can be changed through the SGE.

1. Right click on the drawing screen of the SGE in an area which is empty and does not have any objects drawn.
2. Select **Change Story Name** from the pop-up menu. The *Object Name* dialog box will appear.
3. Make the necessary change and click **OK**.

# Building Browser

---

## Overview

The Building Browser organizes all the building objects in a hierarchical manner and gives the user a simple and familiar means of navigating through the BDA building model and editing the values of objects and parameters. The Building Browser also allows the selection of input and output parameters for display in the Decision Desktop.

While parameter values may be edited using the Building Browser, new objects must be added using the Schematic Graphic Editor.

### **Open the Building Browser**



*Click to open the Building Browser*

To open the Building Browser window, select the **Building Browser** option on the BDA **Windows** menu or click on the **Building Browser** button on the BDA tool bar.

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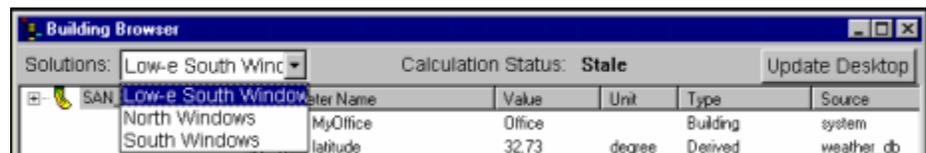
## Navigating in the Building Browser

The Building Browser follows the paradigm of the Microsoft Explorer/File Manager utility. When the Browser opens, the current solution is displayed.

### **Change the current solution**

If you have created more than one solution, the Building Browser will default to the current solution.

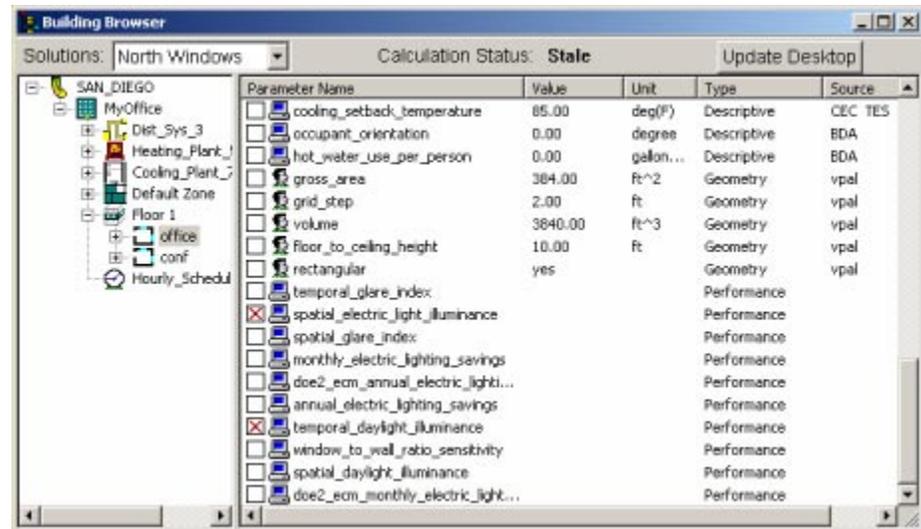
To change the solution displayed in the Building Browser, select the desired solution from the **Solutions** drop down list, located at the top of the Building Browser window.



## Browser layout

The Building Browser has two main panes. The **left** pane displays the object instances and their relationships. The **right** pane displays related object Instances and the parameters associated with object selected in the left pane.

The figure below shows a hierarchical list of objects, for the project "MyOffice" in San Diego, California, in the left panel of the Building Browser window. Each object type is identified by a specific icon. Clicking on the plus sign to the left of an object icon expands that object instance and displays its related object instances below and slightly right-indented from the icon. Clicking on the minus sign collapses the expanded object.



*The Building Browser window*

The right pane of the Building Browser window displays the parameters associated with the object selected in the left pane. Clicking on a column header will sort the displayed parameters by the values in that column.

The first column contains the names of the parameters associated with the object selected in the left pane. Parameters with default values are indicated by a computer icon to the left of the parameter name. Parameters with user-defined values are indicated by a human icon to the left of the parameter name. When the default value of a parameter is changed by the user, the computer icon is converted into the icon of a human face and the user's name is displayed in the Source column.

The other columns display the parameter values, units, and type. The last column contains the source of the parameter value.

## Relationships

As you explore the Building Browser, you will notice the obvious hierarchical relationships (parent-child) between buildings and stories, stories and spaces, spaces and boundaries, boundary segments and apertures (windows), windows and glazing, etc. The plus sign to the left of the object icon indicates that it has children objects. Childless objects have no plus sign. When an object is deleted, all of its children objects are deleted. All of the relationships between objects are defined in the BDA Building Model.

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# Using the Building Browser

This section describes how to use the functions of the Building Browser.

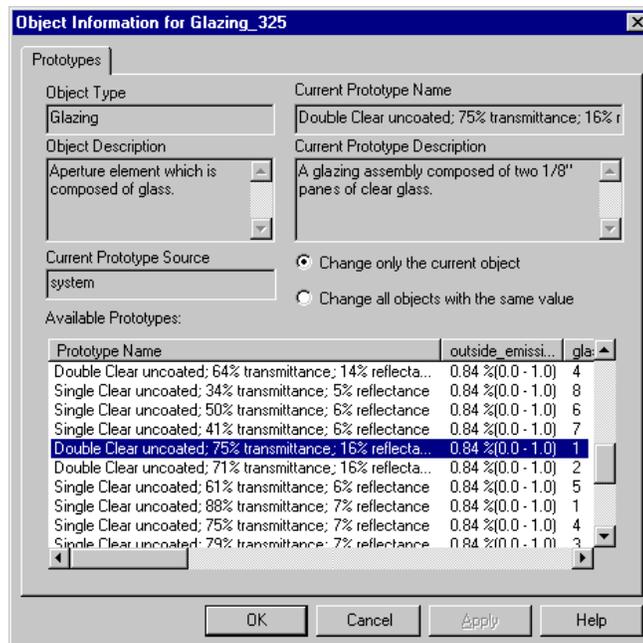
## View/Change object properties

Object value information is available in the Building Browser. You may change the value for an object with the Object Properties dialog box.

To open the Object Properties dialog box:

1. Double click on the object in the right pane of the window. The Object Information dialog box will open. Information about the object and current value will be displayed but not user-changeable. A list of available value options is displayed in the lower part of the Object Properties dialog box.

Some objects have geometric properties, which are displayed on a different tab in the same dialog box. This includes *Object Type*, *Object ID*, *Object Instance Name*, *Azimuth*, *Tilt*, *Area*, *Volume*, and *Vertices*. These values can only be changed in the SGE, so the information is read-only.



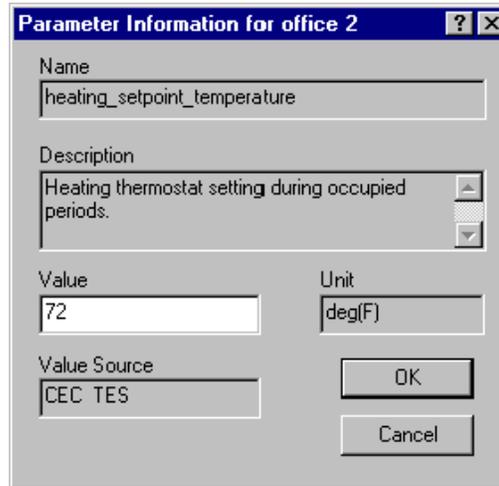
Object Information dialog box

2. To change the value of an object, select a new value option from the list of available options, by clicking on its name. Clicking on a column header sorts the available options according to the column header clicked.
3. Select either the *Change only the current object* radio button or the *Change all objects with the same value* radio button.
4. Click **OK** to change the object, or **Cancel** to abort the change.

## View/Change parameter values

To change the value of a parameter:

1. Right-click on the parameter icon in the Building Browser and select **Properties** from the pop-up menu. Alternatively, you can double click on the parameter name. The **Parameter Information Dialog Box** will open.

The image shows a dialog box titled "Parameter Information for office 2". It contains several fields: "Name" with the value "heating\_setpoint\_temperature", "Description" with the value "Heating thermostat setting during occupied periods.", "Value" with the value "72", "Unit" with the value "deg(F)", and "Value Source" with the value "CEC TES". There are "OK" and "Cancel" buttons at the bottom right.

*Parameter Information dialog box*

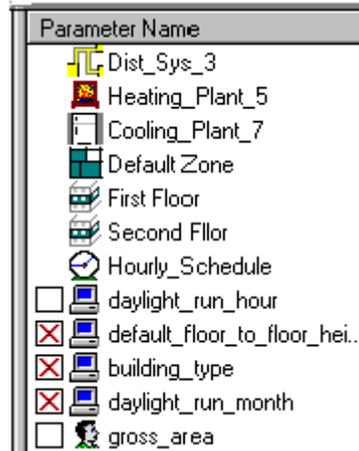
2. Enter the new value and click **OK**.

**NOTE:** In this version of the BDA, you can change the value of most *Descriptive Parameters* in the parameter list. Changing values should be done carefully, to avoid impossible combinations, e.g., a glazing whose transmittance, reflectance and absorption add up to more than 100%.

## Select parameters for display in the Desktop

To select a parameter for display in the Decision Desktop:

1. Click in the checkbox to the left of the parameter's icon. A red "X" should appear indicating that the parameter has been selected.
2. Select one or more desired parameters from any object and click the **Update Desktop** button on the Building Browser window. The selected parameters will appear as row headers on the Decision Desktop. See also "Design Decision Desktop" on page 41.



*Selecting output parameters*

To remove parameters from the Desktop, click the checkbox containing a red "X" to deselect the parameter. Clicking **Update Desktop** will remove the parameter from the Decision Desktop

### ***Highlight object in SGE***

To locate an object in the SGE, right-click on the object icon in the left pane of the Building Browser, and select **Highlight Object in SGE** from the pop-up menu.

A red asterix will appear next to the object in the Building Browser and the object will take on a purple color in the SGE. You can highlight a whole space, or just a window or wall segment.

To remove the highlighting of an object, right-click on the object icon in the Browser and select **Unhighlight Object in SGE** from the pop-up menu.



# Design Decision Desktop

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## Overview

This chapter describes how to use the Decision Desktop and control the appearance of the graphical display of parameter values.

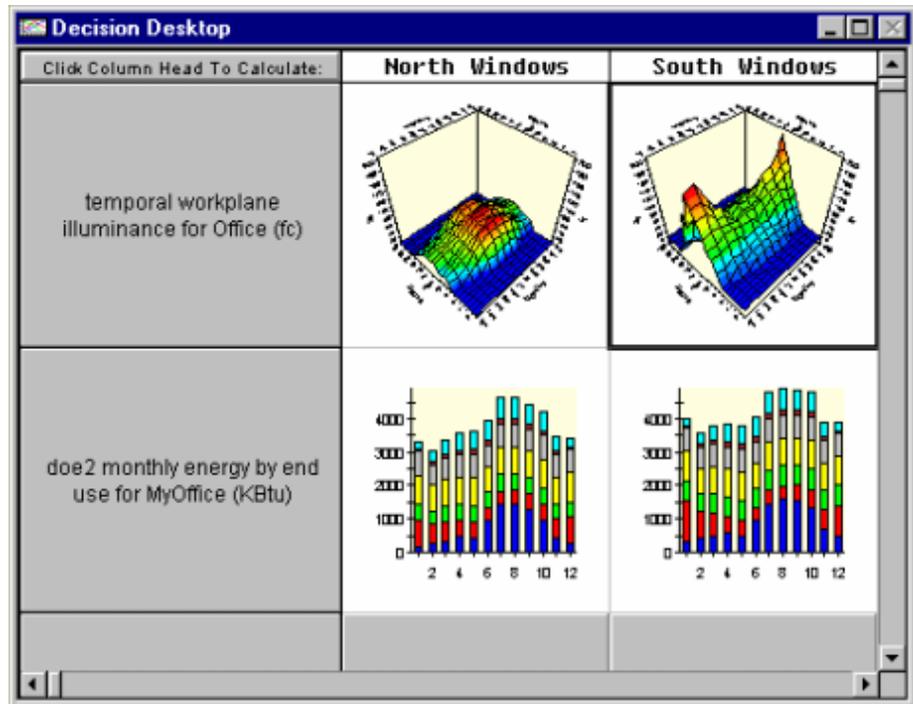
The Design Decision Desktop, or simply Desktop is the Graphical User Interface (GUI) element that helps you compare the performance of multiple design alternatives with respect to multiple parameters. The concept is very simple – the **columns** represent design Solutions and the **rows** represent individual descriptive or performance parameters.



Click to open Decision Desktop

## Open the Decision Desktop

If the Decision Desktop window is not already open, you may open it by selecting **Decision Desktop** option from the **Windows** menu on the BDA main window or by clicking on the **Decision Desktop** button.



Decision Desktop window

[Click here to view Decision Desktop window.](#)

The contents of the Decision Desktop are controlled by actions in the Building Browser and SGE. This chapter refers back to the chapters on the Schematic Graphic Editor and the Building Browser several times, so it may be useful to read those sections first.

---

## Desktop parameters

Parameters are represented as rows in the Desktop. The name of the parameter is displayed in the first column, and its values for each solution are displayed in the corresponding Solution column.

### Select parameters for display

Parameters are added and deleted from the Desktop using the Building Browser.

To add or delete parameters on the Desktop, follow the procedure described under "Select parameters" on page 38. The output parameters you select will be displayed on the Desktop.

### ***Move parameters***

At this time, parameters cannot be moved in the Desktop. If you wish parameters to appear in a certain order then you must select them in that order. Otherwise, you can remove the parameters and then reselect them in the appropriate order desired.

### ***Calculate selected parameters***



*Click to Calculate Values*

To calculate the values of the performance parameters displayed in the Desktop for the *current* solution:

Select **Calculate Results** from the **SimTools** menu on the **main BDA toolbar**, or click the **Calculation** button on the main BDA toolbar.

You can also click on any solution name on the Desktop to recalculate its results.

**Note:** If changes have been made that affect the parameter values, the solution names on the Desktop column headers will appear in red, indicating that results need to be recalculated. The **Status** field in the Building Browser will indicate that the current solution is **Stale**.

The appropriate simulation tools are activated automatically by BDA to calculate values for the performance parameters currently on the Decision Desktop and the results are displayed in the corresponding cells of the Decision Desktop matrix. The **Status** field in the Building Browser will indicate that the current solution is **Up-to-Date**.

**Double-clicking** in any result cell of the Desktop that contains a graph, will open a separate window in which you can change the view settings and orientation of the graph as well as print the contents of the window. See Editing Desktop Graphics below.

---

## **Solutions**

Solutions are represented as columns in the Desktop. The first column contains parameter names corresponding to the values in the *Solution* columns.

### ***Display solutions***

Any existing solutions will be displayed automatically in the Decision Desktop.

### ***Move solutions***

At this time, solutions cannot be moved in the Desktop. Solutions are displayed in the order they are created.

### ***Update solutions***

When any change is made to a particular solution in the SGE, or to its objects or parameters in the Building Browser, the relevant solution name on the Decision Desktop column header will turn red, to indicate that the displayed results are not valid, that is they do not correspond to the current description of the solution. The **Status** field in the Building Browser indicates whether the current solution is **Stale** or **Up-to-Date**. To recalculate the values of displayed parameters, follow the procedure described above under Calculate Selected Parameters.

# Editing Desktop graphs

The appearance of the graphs displayed in the Decision Desktop may be customized. You may change the graph type, view, angle, text, etc. You may also save graphs as graphics files in bitmap, metafile or enhanced metafile formats, or send them to a printer.

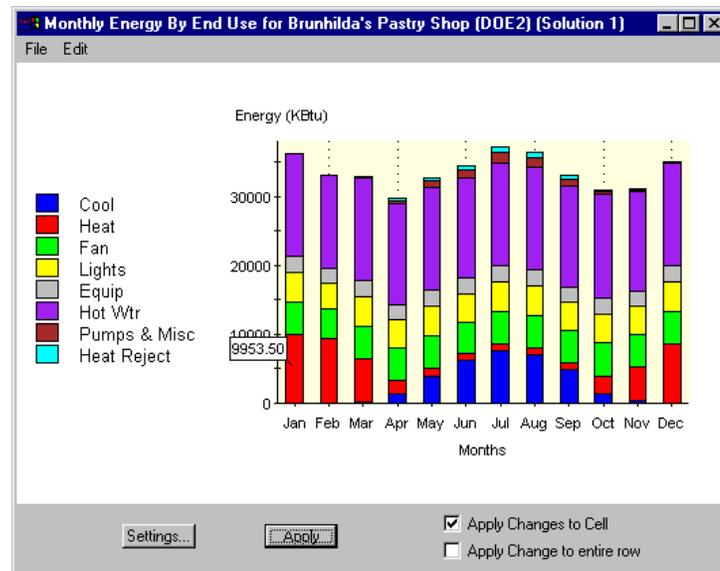
To customize a graph:

Double-click on the graph you wish to customize. Depending on the type of graph, a 2-dimensional (2D), 3-dimensional (3D), or Schedule graph display box will open.

The **File** menu on the graph display window can be used to save the contents of the graph display window to a file or to send it to a printer. The **Edit** menu is used to copy the contents of the graphical display window to the clipboard in three different formats: bitmap, metafile, or enhanced metafile. The **Settings** button opens a Settings dialog which can be used to change the graph appearance.

## Edit 2D graphs

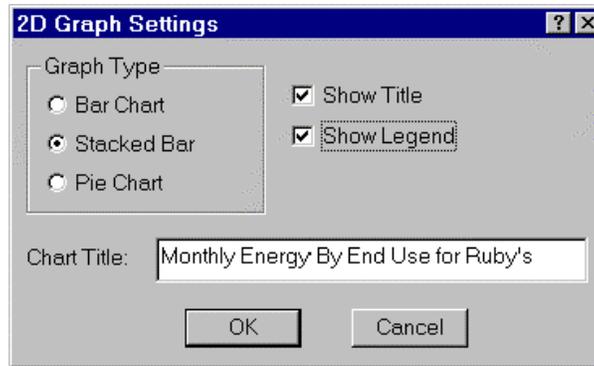
If you double-click on a 2D graph on the Desktop, a 2D graph display box will open. The changes you may make to the graph include changing the graph type (Bar Chart, Stacked Bar, or Pie Chart), show/hide the title and legend, and edit the chart title.



2D Graph Display dialog box

To modify the graph:

1. Click on the **Settings** button to open the 2D Graph Settings dialog box.

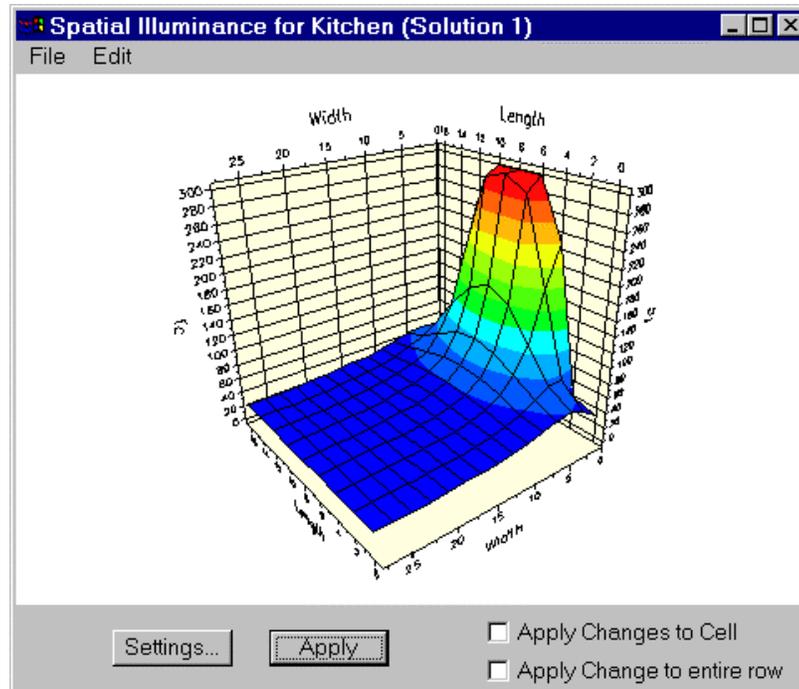


*2D Graph Settings dialog box*

2. You can change the graph type (Bar Chart, Stacked Bar, or Pie Chart) by selecting a radio button under *Graph Type*; show or hide the title and legend by selecting the corresponding checkbox; and edit the chart title by typing in the *Chart Title* entry field.
3. When you are satisfied with the changes, click **OK** to return to the 2D Graph Display window.
4. Select the *Apply Changes to Cell* or the *Apply Change to entire row* check box.
5. Click **Apply**.

### ***Edit 3D graphs***

If you double-click on a 3D graph on the Desktop, a 3D graph display will open. In this type of display, you may rotate the image with the mouse while holding down *both* mouse buttons. The changes you may make to the graph include changing the graph type (Surface Mesh or 3D Bar), show/hide the legend and title, contour projection, and editing the title text and maximum value (z-value). When computing the values for a new solution, the *y* and *z* values of the plots are automatically set to the maximum value for easy comparison of multiple solutions.



3D Graph Display dialog box

To modify the graph:

1. Click on the **Settings** button. The 3D Settings dialog box will open.



3D Graph Settings dialog box

2. You can change the graph type (Surface Mesh or 3D Bar) by selecting a radio button under Graph Type; select or deselect the *Show Title*, *Show Legend*, and *Project contours above graph* checkboxes; change the maximum value of the parameter value axis (z-axis); and edit the chart title by typing in the *Chart Title* entry field.
3. When you are satisfied with the changes, click **OK** to return to the 3D Graph Display window.
4. Select the *Apply Changes to Cell* or the *Apply Change to entire row* check box.
5. Click **Apply**.

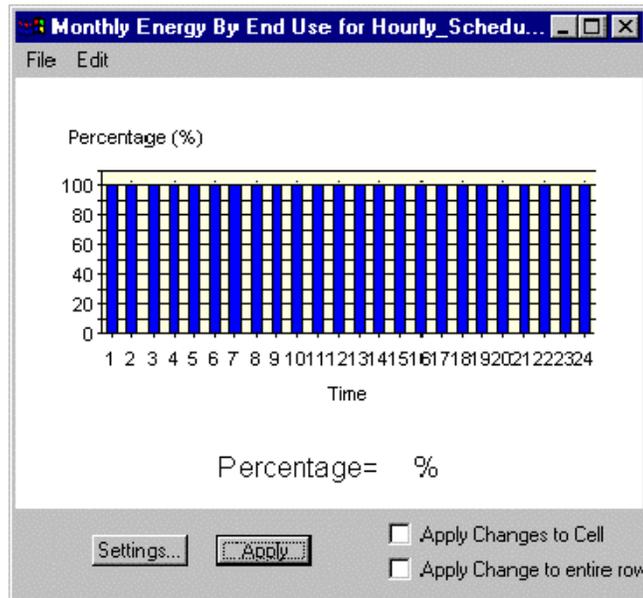
## Edit schedule graphs

If you double-click on a schedule graph on the Desktop, a graph display for schedules will open. Graphical displays for schedules are very similar to 2D graphs, with the exception that you may modify the values of the data displayed in a Schedule graph.

To modify values in a Schedule graph display, click and hold the mouse button above the top of a bar representing the value to be changed. The cursor will change to a double-headed arrow. While still holding the mouse button down, change the height of the bar by moving the mouse.

To modify a graphical display for a schedule:

1. Click on the **Settings** button to open the Schedule Graph Settings dialog box.



Graph Display dialog box for schedules

2. You can change the graph type (Bar Chart, Stacked Bar, or Pie Chart) by selecting a radio button under *Graph Type*; show or hide the title and legend by selecting the corresponding checkbox; and edit the chart title by typing in the *Chart Title* entry field.
3. When you are satisfied with the changes, click **OK** to return to the Schedule Graph Display window.
4. Select the *Apply Changes to Cell* or the *Apply Change to entire row* check box.
5. Click **Apply**.

---

## Printing and exporting graphs

Graphs may be sent directly to a printer, saved to a file in one of three formats (bitmap, metafile, and enhanced metafile), or copied and pasted in one of the same three formats. If you are unsure of which format to use, try bitmap first.

## ***Print graphs***

To print a graph:

1. Double-click on the graph in the Decision Desktop. The graph will open in a separate window.
2. From the **File** menu on the graph window, select **Print**. A standard Print dialog box will open.

## ***Export graphs***

Graphs may be saved in external files in bitmap, metafile, or enhanced metafile format. To export a graph:

1. Double click on the graph in the Decision Desktop. The graph will open in a separate window.
2. From the **File** menu on the graph window, select **Save**. A standard Save As dialog box will open. Make sure to select the appropriate file format and choose the location where the file will be saved.

## ***Copy graphs***

If you wish to copy a graph to paste into another application, use one of the three copy functions available.

To copy a graph:

1. From the **Edit** menu on the graph window, select **Copy as Bitmap**, **Copy as Metafile**, or **Copy as Enhanced Metafile**, depending on the file format you wish to use.
2. Open the file or application where the graph will be pasted, such as a word-processing document.
3. Paste the graph using the paste function of that application.

---

# Customizing the Desktop

At this time, customizing the appearance of the Desktop is limited to resizing its rows and columns.

## ***Resize rows and columns***

To resize a **row**, place the cursor over the line below the row. When the cursor changes from a cross to a line between two arrows, hold the left mouse button down and drag the line up or down to change the height of the row.

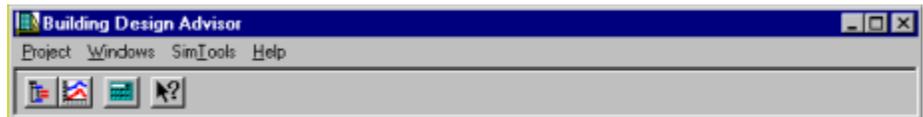
To resize a **column**, place the cursor over the line to the right of the column up in the column-heading row. When the cursor changes from a cross to a line between two arrows, hold the left mouse button down and drag the line to the left or right to change the width of the row.

# Tutorial

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## Launch the BDA Application

Select **Building Design Advisor** from the **Programs** section of the **Start Menu** on your Desktop. The main BDA window will open.

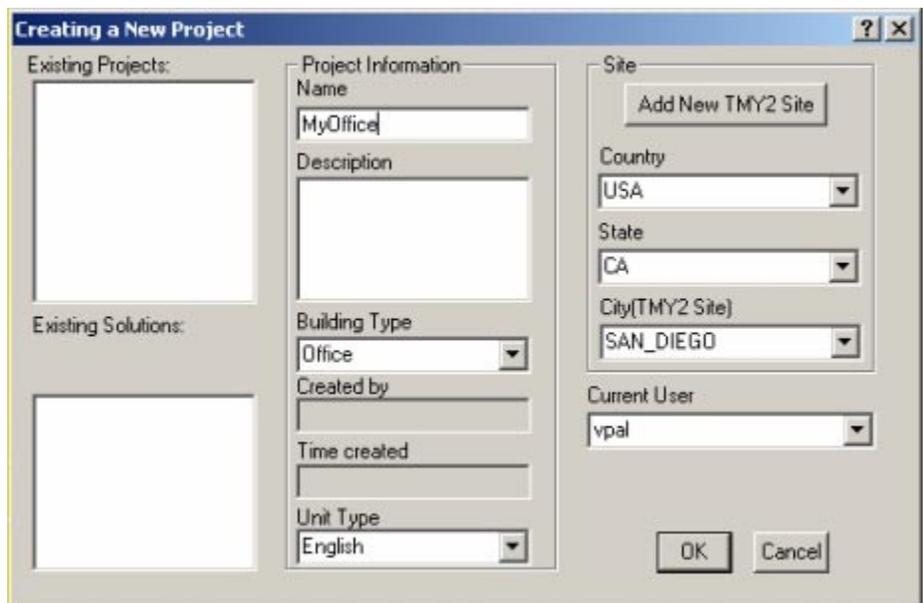


*Main BDA tool bar*

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## Create a new project

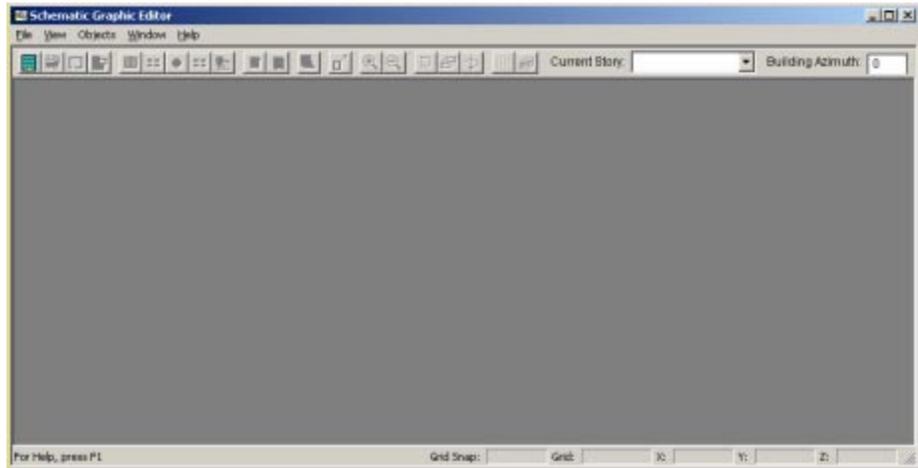
To create a BDA Project, select **New...** from the **Project Menu**. The **Creating a New Project** dialog box will open. Enter "MyOffice" as the **Name** of the Project. Select "Office" as the **Building Type** from the pull-down list. Select "USA" as the **Country**. Select "CA" (California) and "SAN\_DIEGO" as the **State** and **City**, respectively. Click on **OK** after you have made the selections.



---

## Create a New Design Solution in SGE

BDA will create the new Project file and launch the **Schematic Graphic Editor (SGE)**. **SGE** pops up as a window just below the main **BDA** tool bar.

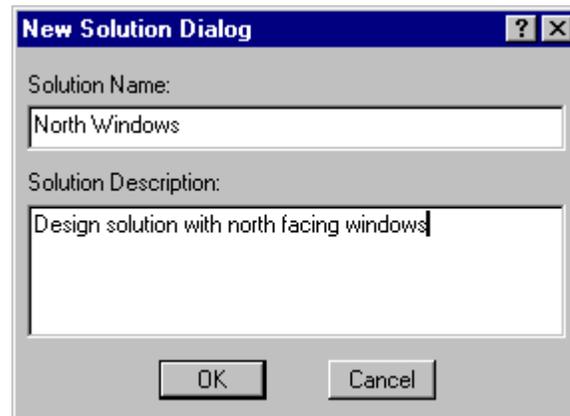


The Schematic Graphic Editor



New Solution Button

Select **New Solution** from the **File** menu in **SGE** or click on the **New Solution** button. The **New Solution Dialog** box will open. Specify "North Windows" as the solution name and click **OK**. The **New Story Dialog** box will open.

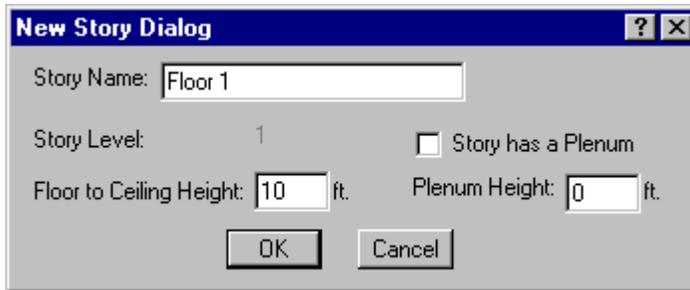


New Solution Dialog Box

---

## Create a New Story in SGE

Specify "Floor 1" as the new **Story Name**. The Story has the **Height** of 10 ft. and has no **Plenum** by default. Accept the defaults and click **OK**.



*New Story Dialog Box*

**Note:** By default, roofs are created with each story.

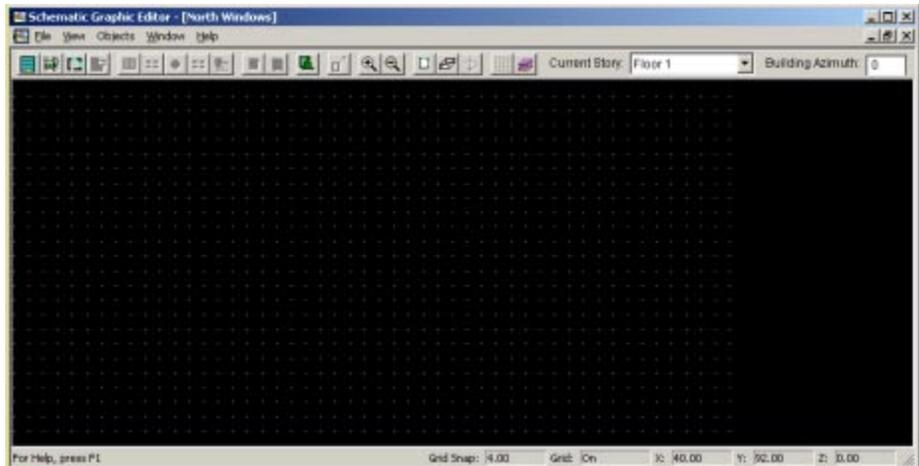
---

## Create Two New Spaces in SGE



*Grid Settings Button*

Once you have created a Story, the drawing screen becomes visible. Before you begin drawing spaces check the **Grid Settings** by clicking on the **Grid** button. By default, the drawing canvas is 200 ft. wide and 100 ft. high. The grid interval is 4 ft. Accept the default values and click **OK**.



*The drawing screen for the SGE*

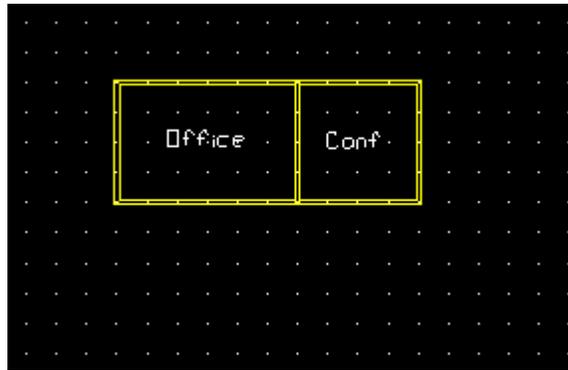


*New Space Button*

In the next few steps, we are going to create two spaces, an office and a conference room. After the completion of these steps the spaces should look like the spaces drawn in the figure below.

Click on the Space button on the SGE tool bar, or select the menu item **Object** → **Create** → **Space**. Select "Office (general)" as the **Space Type** from the drop-down list of available space types. The cursor will change to the drawing mode cross-wire shape. You need to draw a space that is 24 ft. in length (6 grid intervals in the X-direction) and 16 ft. in width (4 grid intervals in the Y-direction). To draw, click and release the left mouse button to specify each corner of the room. Double click to close the resulting polygon (double click at the end point of the third wall, to make a rectangle in this case). The **Space Name Dialog** box will open. Type "Office" as the name of the space and click **OK**. The name of the space appears on the screen as a text object. Position it over the newly created space and click to anchor the name in the desired position.

Similarly, create another room of **Type** "Conference", 16 ft. X 16 ft., next to "Office" as shown in the figure below. Name the space "Conference".



*Create two new spaces in SGE*

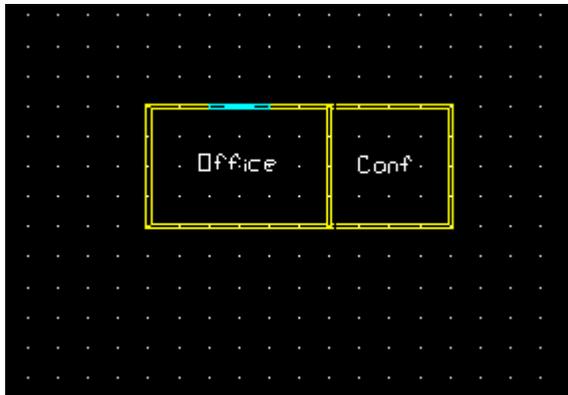
---

## Add Windows to the Spaces



*The Window Tool Button*

Select the space "Office" to add a **Window** to one of its walls. You can select the space by clicking on one of its walls or its name. This will activate the **Window** tool button. Click on the button and draw a window in the north wall of the space named "Office" by clicking and releasing the left mouse button to specify each of the two end points of the window. The window should be 8 ft. wide and centered on the wall as shown below.



*Adding windows to the spaces*

Similarly, add another window to the space named "Conference". The window should be 8 ft. wide and centered on the north wall of the conference space.

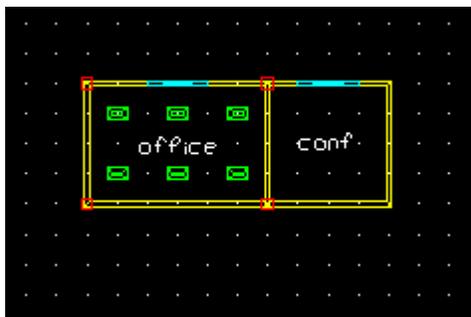
---

## Add Luminaires to a Space



*The Luminaire Tool Button*

Select the space "Office" to add luminaires. You can select the space by clicking on one of its walls or its name. This will activate the **Luminaire** tool button. Click on the button and click once on the grid point in the upper-left corner of the space to add a luminaire at this point. Select the toolbar button again and click within the space to add each additional luminaire. Add a total of six luminaires as shown in the drawing below.



*Adding luminaires to a space*

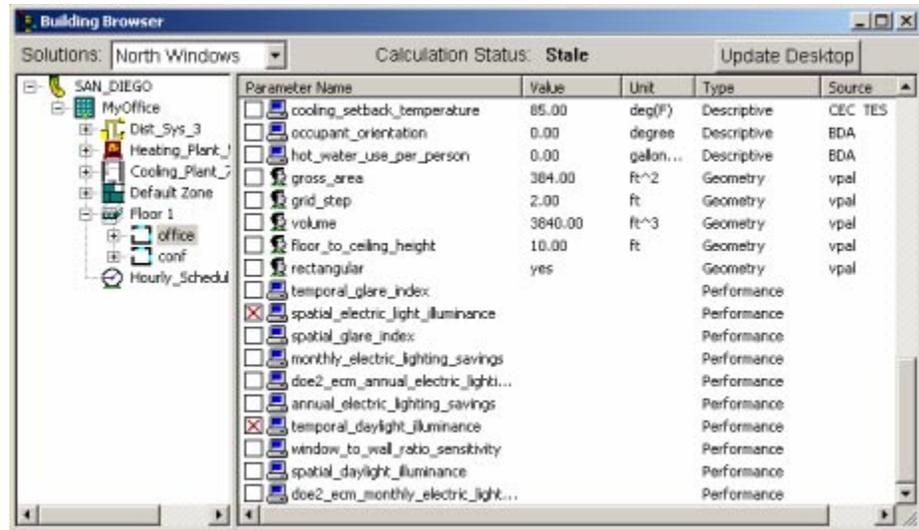
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## Navigate the Building Model in the Building Browser



*The Building Browser Button*

From the **BDA** main menu select the **Building Browser** button. The Building Browser will open. The **Building Browser (BB)** organizes all the building objects in a hierarchical manner and gives the user a simple and familiar means of navigating through the BDA building model and editing the values of objects and parameters. The Building Browser has two main panes. The left pane displays the **Object** instances and their **Relationships**. The right pane displays related **Object** instances and the **Parameters** associated with the **Object** selected in the left pane.



*The Building Browser*

Click on the plus (+) sign next to the **City Name** (SAN\_DIEGO, in this case) to open the object tree. Continue expanding the tree until you reach the **Space** level. Click on the icon next to "Office". The right pane of the **BB** now displays the objects and parameters associated with "Office". Scroll down to the bottom where the parameters of **Type** "Performance" are listed. These do not have values associated with them yet because their values are computed when we run simulations. Select "temporal\_daylight\_illuminance" by clicking on the **Checkbox** next to it. Also select "spatial\_electric\_light\_illuminance".

Let's select one more "performance" parameter at the **Building** level. Click on the icon next to the **Building** "MyOffice" in the left pane. In the right pane, select the parameter "doe2\_monthly\_energy\_by\_end\_use" by clicking on the **Checkbox** next to it. Push the **Update Desktop** button in the top, right hand corner of the **Building Browser**. The Decision Desktop opens.

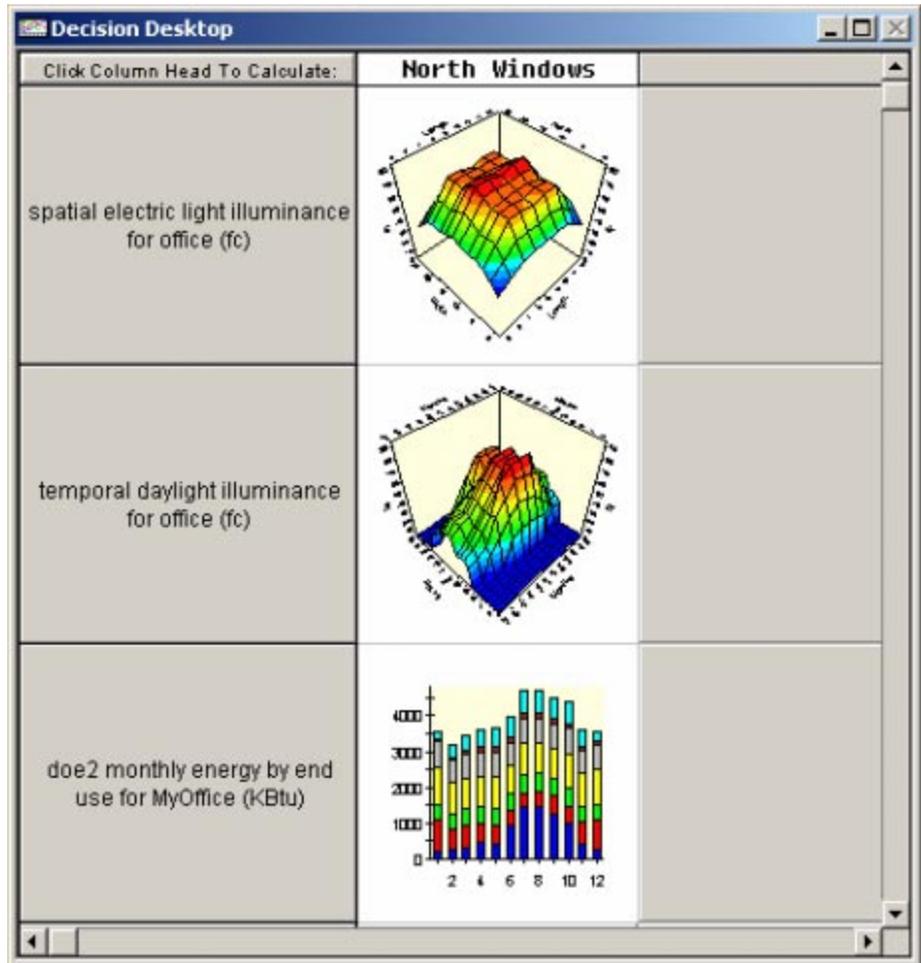
## Compute and View Results on the Decision Desktop



*The Calculation Button*

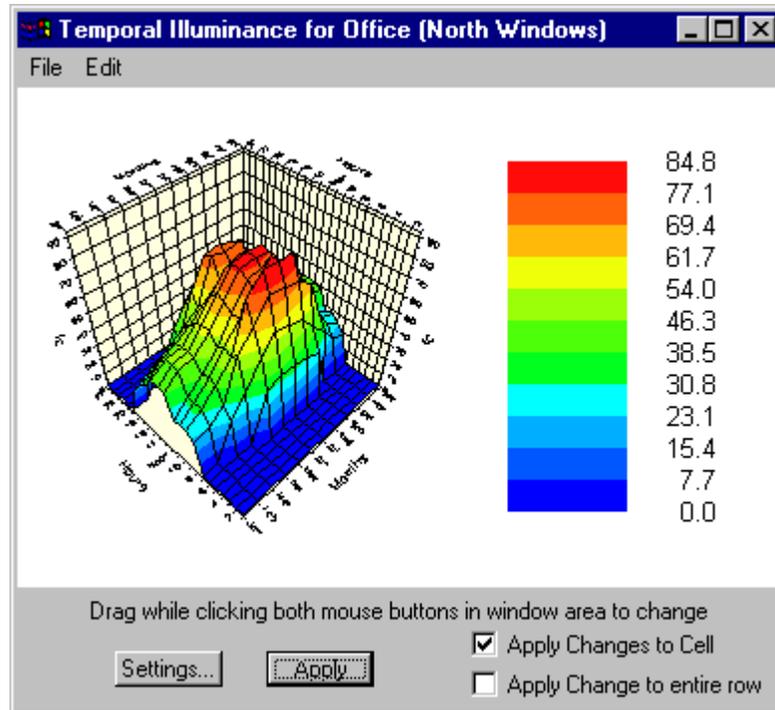
The **Parameters** selected from the **Building Browser** appear in the **Decision Desktop**, each in a new row. The name of the **Parameter** is displayed in the first column, and its **Value** for each solution is displayed in the corresponding **Solution** column. To calculate the values of the performance parameters displayed in the **Desktop** for the current **Solution**, select **Calculate Results** from the **SimTools** menu on the main BDA toolbar, or click the **Calculation** button on the main BDA toolbar. You can also click on any solution name on the top of the Desktop columns to calculate its results.

BDA will take a few seconds to run **DOE-2**, **ECM** and **DElight** to compute the results. The results will appear in the relevant cells of the Decision Desktop.



*The Decision Desktop*

**Double-Click** on the graph for "temporal\_workplane\_illuminance". The graph will open in a separate window. Maximize this window. Drag while holding down both mouse buttons to see the graph from different angles. Close the window when you are done.



Graph for Temporal Illuminance

## Add a Second Design Solution



New Solution Button

Make the SGE the active window. You need to create a new design solution that is similar to the first solution but has south facing windows.

Select **New Solution** from the **File** menu in **SGE** or click on the **New Solution** button. The **New Solution Dialog** box will open. Specify "South Windows" as the solution name and click **OK**. A new solution is created as a duplicate of the first solution.

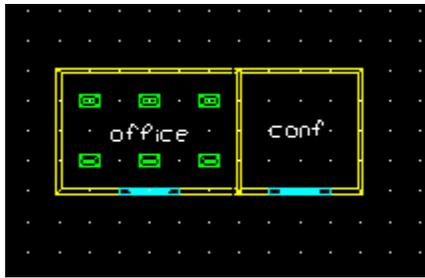
## Change the Window Location



The Window Tool Button

Delete the existing windows by selecting them one at a time and pushing the **Delete** key. Select the space "Office" to add a **Window** to its south wall. Click on the **Window** button and draw a window in the south wall of "Office" by clicking and releasing the left mouse button to specify each of the two end points of the window. The window should be 8 ft. wide and centered on the wall.

Similarly, add another window to the space named "Conference". The window should be 8 ft. wide and centered on the south wall of the conference space as shown below.

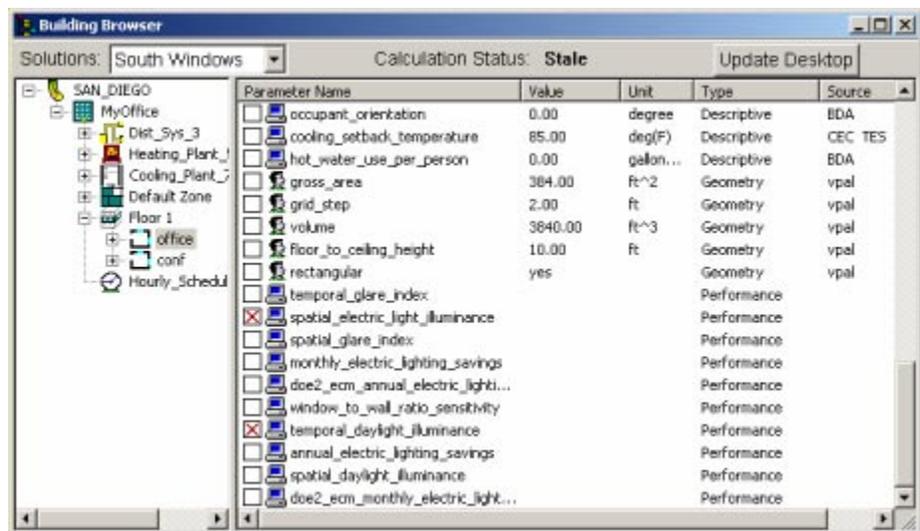


*Adding windows on the south walls*

## Navigate the Second Solution in the Building Browser

BDA automatically sets the new solution as the current solution in the **Building Browser**. Confirm that the new solution ("South Windows") is selected in the drop-down list on the top left hand corner of the Building Browser. The Building Browser displays the **Building Model** for the selected solution. Expand the **Building** tree until you reach the **Space** level. Click on the icon next to "Office". The right pane of the BB now displays the objects and parameters associated with "Office". Scroll down to the bottom where the parameters of Type "Performance" are listed. BDA has automatically set the parameters for computation in the new solution. Confirm that the parameters "temporal\_workplane\_illumiance" and "spatial\_electric\_light\_illumiance" are selected by seeing if the Checkboxes next to them have a red cross.

Similarly, confirm that the parameter "doe2\_monthly\_energy\_by\_end\_use" at the **Building** level is selected.



*The Building Browser*

## Compute Results for the Second Solution

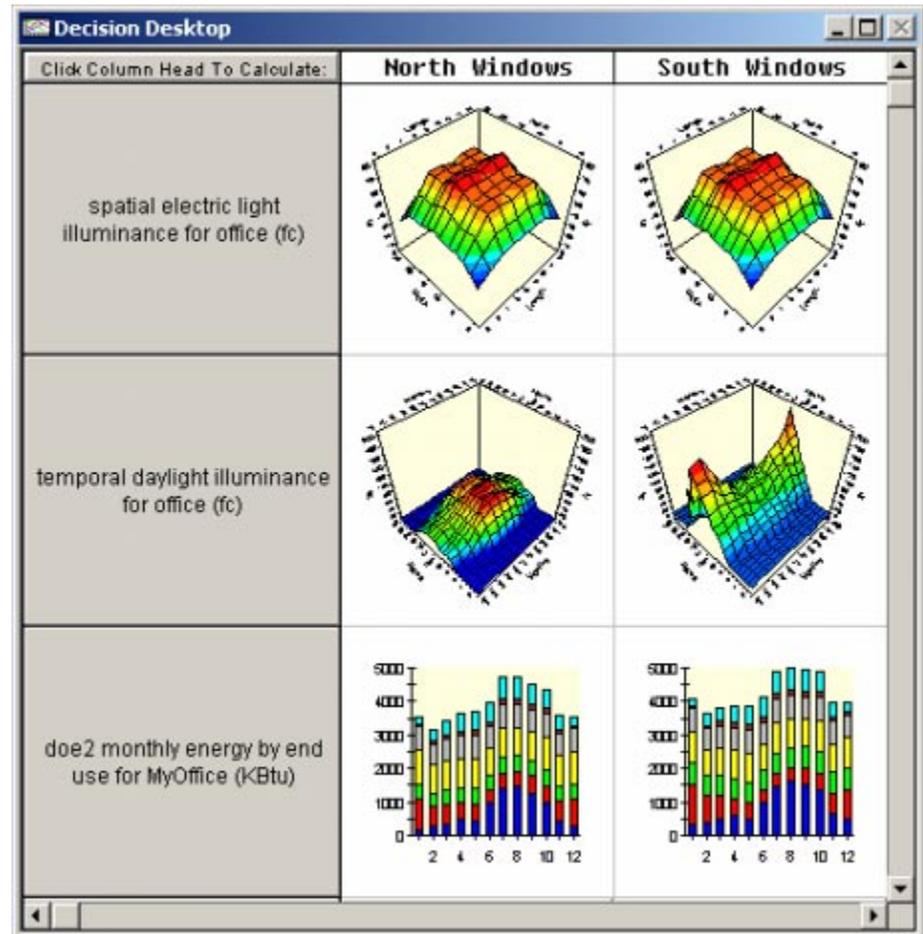
When you create a new **Solution** in **SGE**, **BDA** makes a copy of the **Source Solution** and another column is created in the **Desktop**. Whatever parameters were on the **Desktop** in the source solution, their exact copy will also be on the



The Calculation Button

**Desktop** in the new **Solution**. These results are not valid for the **New Solution** since you have changed the window location.

To re-calculate the results select **Calculate Results** from the **SimTools** menu on the main BDA toolbar, or click the **Calculation** button on the main BDA toolbar. You can also click on the new solution name on the **Desktop** to calculate its results. The new calculated values will appear in the cells of the new Solution column replacing the copies of the values from the source Solution.



The results for the new solution

## Add a Third Design Solution

Make the SGE the active window and the second solution the active solution. You need to create a new design solution that is similar to the second solution but the luminaires have a direct/indirect lighting distribution.

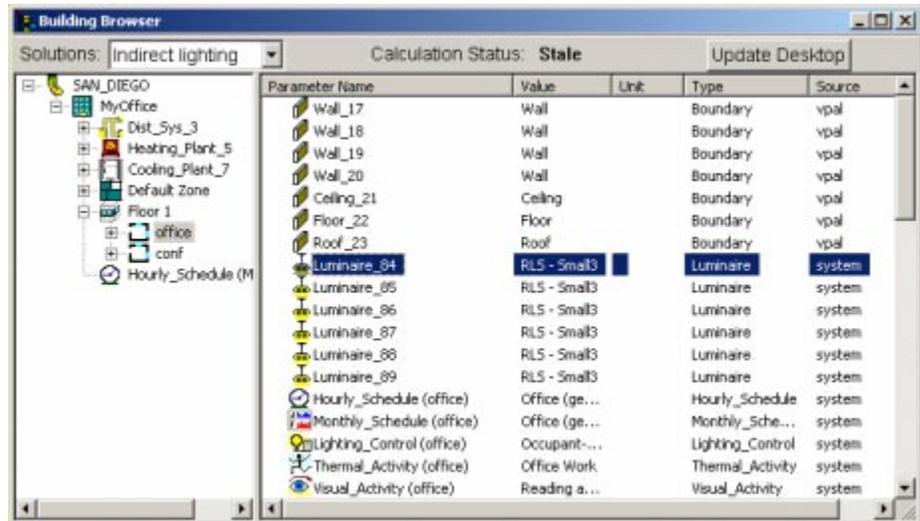


New Solution Button

Select **New Solution** from the **File** menu in **SGE** or click on the **New Solution** button. The **New Solution Dialog** box will open. Specify "Indirect lighting" as the solution name and click **OK**. A new solution is created as a duplicate of the second solution.

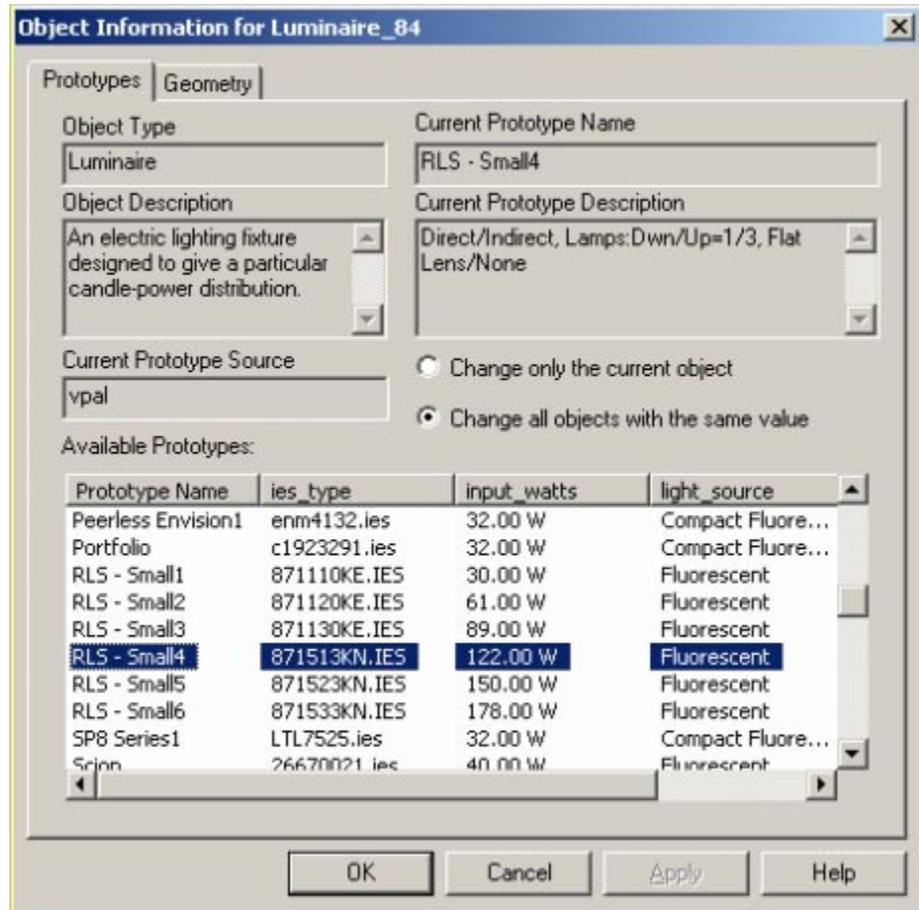
## Change the Luminaire Type

In the SGE, right mouse click on the space called "Office". From the pop-up menu select **Highlight Object in Building Browser**. The **Space** object is highlighted in the Building Browser as shown below.



*The space is highlighted in the Building Browser*

Select any one of the luminaire objects in the right pane of the Building Browser. Double click on the luminaire object. The **Object Information** dialog box opens. The current luminaire type is "RLS Small 3". Scroll down in the list of **Available Prototypes** and select "RLS Small 4" for the new luminaire type. Note that the prototype description specifies a partly indirect lighting distribution. Select the radio button for "Change all objects with the same value" and click OK. This will modify all luminaires of "RLS Small 3" type to "RLS Small 4" type. Confirm this in the Building Browser.



Object Information for luminaire

## Compute Results for the Third Solution



The Calculation Button

To re-calculate the results select **Calculate Results** from the **SimTools** menu on the main BDA toolbar, or click the **Calculation** button on the main BDA toolbar. You can also click on the new solution name ("Indirect lighting") on the **Desktop** to calculate its results. The new calculated values will appear in the cells of the new Solution column replacing the copies of the values from the source Solution. You can resize the **Decision Desktop** if you want to see the results of all three solutions together.

## Save the Project

To save your work without closing, select **Save** from the **Project** menu. Then select **Exit** from the **Project** menu to exit **BDA**. The project is saved in the Projects Database.

# BDA Building Model

The BDA Building Model represents the semantic network of all design object types and all possible relationships between them. The first section of this chapter defines all of the object types and lists their associated parameters. The second section defines the parameters.

---

## Objects

### Aperture

An opening in a boundary\_segment which may contain a window, skylight, door or trapdoor. Only windows are supported in the current version of BDA.

*parameters:*

- effective\_thermal\_conductance
- effective\_thermal\_resistance
- height
- percentage\_glazing\_area
- reference\_point\_co-ordinates
- surface\_area
- width

*relationships:*

- composed\_of Overhang
- composed\_of Fins
- has Ground\_Surface
- part\_of Boundary\_Segment
- composed\_of Glazing
- composed\_of Frame

### Boundary

A physical building plane separating two spaces.

*parameters:* none

*relationships:*

- contains Boundary\_Segment
- part\_of Space

### Boundary\_Segment

Portion of a boundary (Wall, Ceiling, or Floor) is adjacent to two spaces, or one space and the exterior.

*parameters:*

surface\_area

*relationships:*

has Construction  
contained\_in Boundary  
composed\_of Aperture  
composed\_of Finish

## **Building**

Set of grouped spaces defined by a common exterior envelope.

*parameters:*

azimuth  
building\_type  
daylight\_run\_hour  
daylight\_run\_month  
default\_floor\_to\_floor\_height  
doe2\_monthly\_energy\_by\_end\_use  
doe2\_monthly\_energy\_by\_fuel\_type  
doe2\_total\_energy\_by\_end\_use  
doe2\_total\_energy\_by\_fuel\_type  
doe2\_total\_energy\_use  
gross\_area  
reference\_point\_co-ordinates

*relationships:*

composed\_of Building\_Shade  
composed\_of Heating\_Plant  
composed\_of Cooling\_Plant  
composed\_of Distribution\_System  
has Hourly\_Schedule  
composed\_of HVAC\_Zone  
composed\_of Story

## **Building\_Location**

The building location choices determine the Terrain and Height Modifications for Wind\_Speed.

*parameters:*

shielding\_coefficient  
terrain\_parameter1  
terrain\_parameter2

*relationships:*

had\_by Site

## **Building\_Shade**

A rectangle adjacent to the building that casts a shade on the building that rotates with the building.

*parameters:*

visible\_reflectance  
visible\_transmittance

*relationships:*

has Monthly\_Schedule  
faced\_by Ground\_Surface  
part\_of Building

## Construction

Assembly of layers composed of different materials which define a boundary\_segment.

### *parameters:*

- boundary\_type
- effective\_thermal\_conductance
- effective\_thermal\_resistance
- inside\_film\_resistance

### *relationships:*

- composed\_of Material
- had\_by Boundary\_Segment

## Cooling\_Plant

The primary equipment that uses energy to provide cooling to a building.

### *parameters:*

- autosizing\_safety\_factor
- coefficient\_of\_performance
- cooling\_tower\_electricity\_consumption
- fuel\_type
- generation\_capacity
- monthly\_cooling\_loads
- monthly\_electric\_input\_to\_cooling
- monthly\_electrical\_energy
- number\_of\_units
- operation\_type
- rated\_pump\_power
- unit\_configuration

### *relationships:*

- uses Distribution\_System
- has Monthly\_Schedule
- part\_of Building

## Distribution\_System

Set of equipment connecting the cooling and heating plants with the HVAC\_zone.

### *parameters:*

- cool\_coil\_discharge\_temperature
- economizer\_enthalpy\_control
- economizer\_limit\_temperature
- fan\_control\_type
- heat\_coil\_discharge\_temperature
- minimum\_design\_ventilation
- minimum\_outside\_air\_fraction
- minimum\_relative\_humidity
- monthly\_cooling\_energy
- monthly\_electrical\_energy
- monthly\_fan\_electrical\_energy
- monthly\_heating\_energy
- rated\_fan\_capacity
- rated\_fan\_power

### *relationships:*

- used\_by Heating\_Plant
- used\_by Cooling\_Plant
- part\_of Building

used\_by HVAC\_Zone  
has Temperature\_Reset\_Control

## External\_Obstruction

See Building\_Shade.

## Finish

Coating or treatment used as the innermost or outermost construction layer (e.g., paint).

### *parameters:*

boundary\_type  
outside\_emissivity  
roughness  
solar\_absorptance  
visible\_reflectance

### *relationships:*

part\_of Boundary\_Segment  
facing Space

## Fins

Attached shades used in shading calculations for a wall and its apertures. The Left and Right fins are determined as seen from the outside of the aperture. They are vertically attached to the wall where the aperture is located.

### *parameters:*

left\_fin\_distance\_from\_aperture\_frame  
left\_fin\_top\_edge\_below\_aperture\_frame  
\_top\_edge  
left\_fin\_total\_depth  
left\_fin\_total\_height  
right\_fin\_distance\_from\_aperture\_frame  
right\_fin\_top\_edge\_below\_aperture\_frame  
\_top\_edge  
right\_fin\_total\_depth  
right\_fin\_total\_height

### *relationships:*

part\_of Aperture

## Fixed\_Shade

This could be a constructed element or a natural element, like a tree, that shades the exterior of the building. A fixed shade stays static when a building rotates. This version of BDA does not support fixed shades, only building shades, which rotate with the building.

### *parameters:*

azimuth  
height  
reference\_point\_co-ordinates  
tilt  
visible\_reflectance  
visible\_transmittance  
width

### *relationships:*

faced\_by Ground\_Surface  
has Hourly\_Schedule

## Frame

Enclosing, perimeter structure for an aperture element.

### *parameters:*

- thermal\_absorptance
- thermal\_conductance
- thermal\_resistance
- width

### *relationships:*

- part\_of Aperture

## Glazing

Aperture element which is composed of glass.

### *parameters:*

- angular\_dependence\_coeff\_of\_trans1
- angular\_dependence\_coeff\_of\_trans2
- angular\_dependence\_coeff\_of\_trans3
- angular\_dependence\_coeff\_of\_trans4
- angular\_dependence\_coeff\_of\_trans9
- glass\_type\_code
- inside\_visible\_reflectance
- number\_of\_panes
- outside\_emissivity
- shading\_coefficient
- thermal\_conductance
- thermal\_resistance
- type\_of\_glass
- visible\_transmittance

### *relationships:*

- has Glazing\_Spacer\_Type
- part\_of Aperture

## Glazing\_Spacer\_Type

Type of spacers between the panes of the glazing.

### *parameters:*

- spacer\_type

### *relationships:*

- had\_by Glazing

## Ground\_Surface

Ground surface on the site directly outside of an aperture or building\_shade.

### *parameters:*

- visible\_reflectance

### *relationships:*

- facing Fixed\_Shade
- facing Building\_Shade
- had\_by Aperture

## HVAC\_Zone

An agglomeration of one or more spaces with similar comfort conditioning requirements operated by the same HVAC control (e.g., thermostat).

*parameters:*

- monthly\_baseboard\_energy
- monthly\_heat\_addition\_load
- monthly\_heat\_extraction\_load
- monthly\_hours\_undercooled
- monthly\_hours\_underheated
- monthly\_maximum\_zone\_temperature
- monthly\_minimum\_zone\_temperature

*relationships:*

- part\_of Building
- uses Distribution\_System
- contains Space

## **Heating\_Plant**

Primary equipment that uses energy to provide heating to a building.

*parameters:*

- autosizing\_safety\_factor
- fuel\_type
- full\_load\_efficiency
- generation\_capacity
- monthly\_electric\_input\_to\_heating
- monthly\_electrical\_energy
- monthly\_fuel\_input\_to\_heating
- monthly\_heating\_loads
- number\_of\_units
- operation\_type
- pilot\_energy\_consumption
- rated\_pump\_power
- unit\_configuration

*relationships:*

- uses Distribution\_System
- has Monthly\_Schedule
- part\_of Building

## **Hourly\_Schedule**

Defines hourly values for occupancy or equipment status for weekdays, Saturdays and Sundays.

*parameters:*

- saturday\_values
- schedule\_type
- sunday\_values
- weekday\_values

*relationships:*

- had\_by Fixed\_Shade
- had\_by Building\_Shade
- had\_by Space
- had\_by Building

## **Infiltration\_Method**

Method used to calculate infiltration for the zone.

*parameters:* none

*relationships:*

has Hourly\_Schedule

### **Lighting\_Control**

System controlling the electrical lighting fixtures within a space.

*parameters:*

- light\_output\_fraction\_at\_min\_power
- lighting\_control\_probability
- minimum\_input\_power\_fraction
- number\_of\_steps\_in\_stepped\_system

*relationships:*

- uses Reference\_Point
- had\_by Space

### **Lighting\_Type**

Used to specify the type of overhead lighting used in the space. e.g. suspended fluorescent, or recessed fluorescent-vented or not vented, or incandescent. For mixed types of lighting within the same space, the recommended procedure is to select the dominant type and adjust the percentage of heat produced by the lighting in 'Light to Space'.

*parameters:* none

*relationships:*

- had\_by Space

### **Luminaire**

The electrical lighting fixture within a space.

*parameters:*

- ies\_type
- input\_watts
- light\_source
- luminaire\_manufacturer
- rotation

*relationships:*

- part\_of Space
- used\_by Reference\_Point

### **Material**

Substance that can be used as a layer in a construction.

*parameters:*

- conductivity
- density
- materials\_library\_code
- specific\_heat
- thermal\_conductance
- thermal\_resistance
- thickness

*relationships:*

- part\_of Construction

### **Monthly\_Schedule**

Defines monthly values for plant or distribution\_system availability for an entire year.

*parameters:*

- monthly\_values

schedule\_type

*relationships:*

had\_by Cooling\_Plant

had\_by Heating\_Plant

had\_by Space

## **Overhang**

Attached shade used in shading calculations for a wall and its apertures. It is horizontally attached to the wall where the aperture is located.

*parameters:*

overhang\_angle

overhang\_height\_above\_the\_aperture\_frame

overhang\_total\_depth

overhang\_total\_width

overhang\_width\_beyond\_the\_aperture\_frame

*relationships:*

part\_of Aperture

## **Plenum**

Air space between the ceiling of a space and the floor of the space above it.

*parameters:*

air\_volume\_ratio

gross\_area

volume

*relationships:*

part\_of Story

## **Reference\_Point**

Defines the position of an observer or of a control point within a space.

*parameters:*

electric\_light\_illuminance

x\_value

y\_value

*relationships:*

used\_by Lighting\_Control

uses Luminaire

part\_of Space

## **Site**

Geographic location of a project typically defined by the name of the closest city.

*parameters:*

altitude

atmospheric\_moisture

atmospheric\_turbidity

cec\_climatic\_zone

cooling\_degree\_days(65)

cooling\_degree\_hours(80)

heating\_degree\_days(65)

latitude

longitude

mean\_coinc\_summer\_wetbulb\_temp  
mean\_daily\_temperature\_range  
mean\_summer\_coincident\_humidity  
summer\_maximum\_drybulb\_temp  
summer\_maximum\_wetbulb\_temp  
time\_zone  
unit\_system  
wind\_speed  
winter\_minimum\_drybulb\_temp

*relationships:*

has Building\_Location  
has Weather\_Station\_Location

## Space

Architectural volume enclosed on all sides by construction boundaries.

*parameters:*

air\_changes\_per\_hour  
air\_volume\_ratio  
annual\_electric\_lighting\_savings  
area\_per\_person  
cooling\_setback\_temperature  
cooling\_setpoint\_temperature  
doe2\_annual\_electric\_lighting\_savings  
doe2\_monthly\_electric\_lighting\_savings  
doe2\_ecm\_annual\_electric\_lighting\_savings  
doe2\_ecm\_monthly\_electric\_lighting\_savings  
equipment\_heat\_gain\_latent\_fraction  
equipment\_heat\_gain\_sensible\_fraction  
equipment\_heat\_to\_hood\_ratio  
equipment\_power\_density  
floor\_to\_ceiling\_height  
fraction\_of\_space\_covered\_by\_furniture  
grid\_step  
gross\_area  
heating\_setback\_temperature  
heating\_setpoint\_temperature  
hot\_water\_use\_per\_person  
light\_heat\_to\_space\_ratio  
lighting\_control\_type  
lighting\_power\_density  
luminaire\_suspension\_length  
min\_outside\_air\_per\_person  
miscellaneous\_heat\_to\_hood\_ratio  
miscellaneous\_power\_density  
monthly\_electric\_lighting\_savings  
occupant\_orientation  
rectangular  
spatial\_glare\_index  
spatial\_daylight\_illuminance  
spatial\_electric\_light\_illuminance  
temporal\_glare\_index  
temporal\_daylight\_illuminance  
thermal\_activity\_type  
ventilation\_rate\_per\_person  
visual\_activity\_type

volume  
workplane\_height

*relationships:*

has Lighting\_Type  
has Visual\_Activity  
has Thermal\_Activity  
has Lighting\_Control  
has Monthly\_Schedule  
has Hourly\_Schedule  
part\_of Story  
composed\_of Luminaire  
composed\_of Reference\_Point  
faced\_by Finish  
composed\_of Boundary  
contained\_in HVAC\_Zone

### **Story**

Set of architectural spaces sharing the same level of a building. Multi-story spaces belong to their bottom story.

*parameters:*

floor\_to\_floor\_height  
level

*relationships:*

composed\_of Plenum  
composed\_of Space  
part\_of Building

### **Temperature\_Reset\_Control**

Mechanism which controls the temperature reset of the HVAC distribution\_system.

*parameters:*

cool\_coil\_max\_discharge\_temperature  
outside\_high\_limit\_temperature  
outside\_low\_limit\_temperature

*relationships:*

had\_by Distribution\_System

### **Thermal\_Activity**

Activity that alters the heat gain of a space.

*parameters:*

people\_latent\_heat\_gain  
people\_sensible\_heat\_gain

*relationships:*

had\_by Space

### **Visual\_Activity**

Activity that requires a certain minimum illuminance or lighting\_setpoint.

*parameters:*

lighting\_setpoint

*relationships:*

had\_by Space

## **Weather\_Station\_Location**

Determines the Terrain and Height Modifications for Wind\_Speed. .

*parameters:*

- wind\_speed\_measurement\_height
- wind\_speed\_terrain\_parameter1
- wind\_speed\_terrain\_parameter

*relationships:*

- had\_by Site

---

# **Parameters**

## **Air\_changes\_per\_hour**

The number of infiltration-caused air changes per hour at a wind speed of 10 mph for a space. Dimension: none

## **Air\_volume\_ratio**

The ratio of space air volume to space geometric volume. Dimension: percentage

## **Altitude**

Height above sea level. Dimension: length

## **Angular\_dependence\_coeff\_of\_trans (1-9)**

Coefficients in the angular dependence equation for solar transmittance in glazing. Dimension: none

## **Annual\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each month of a year. Savings are calculated by DELight based on the average daylight illuminance over the whole space. Dimension: percentage

## **Area\_per\_person**

Average floor area per person in a space at maximum (100%) occupancy. Dimension: area

## **Atmospheric\_moisture**

Amount of precipitable moisture in the atmosphere at a particular site at a particular time. Dimension: moisture

## **Atmospheric\_turbidity**

Amount of aerosols (i.e. particulate pollutants) in the atmosphere. Dimension: none

## **Autosizing\_safety\_factor**

Plant equipment sizing safety factor used by the Autosizing simulation tool to calculate design day loads. Dimension: percentage

## **Azimuth**

Angular distance from a reference location (usually 0 degrees). Dimension: plane\_angle

## **Boundary\_type**

Type of boundary (exterior wall, interior wall, ceiling, floor, roof). Dimension: none

## **Building\_shade\_transmittance**

The percentage of solar energy transmitted through the material of the building\_shade. Dimension: percentage

**Building\_type**

Type of building (residential, non-residential, etc.). Dimension: none

**CEC\_climatic\_zone**

One of 16 geographic areas in California for which the California Energy Commission (CEC) has established prescriptive energy efficiency requirements. Dimension: none

**Coefficient\_of\_performance**

Ratio of the rate of heat removed or delivered to the rate of energy input for a complete plant unit or system. Represents efficiency of the plant or system. Dimension: none

**Conductivity**

The quantity of heat that will flow through one square foot of homogeneous material, one inch thick, in one hour, when there is a temperature difference of one degree Fahrenheit between its surfaces. In DOE2.1E, the entry for this is expressed per foot of thickness, not per inch. Hence, values given per inch must be divided by 12 to obtain the correct entry. Dimension: thermal\_conductivity

**Cool\_coil\_discharge\_temperature**

Designed exit air temperature of the system cooling coil. Dimension: temperature

**Cool\_coil\_max\_discharge\_temperature**

Maximum coil exit air temperature achievable by reset or discriminator. Dimension: temperature

**Cooling\_degree\_days(50)**

Annual cumulative difference between a site's mean daily temperature and 50°F. The difference is counted only if the mean daily temperature is above 50°F. Dimension: degree\_day

**Cooling\_degree\_days(65)**

Annual cumulative difference between a site's mean daily temperature and 65°F. The difference is counted only if the mean daily temperature is above 65°F. Dimension: degree\_day

**Cooling\_degree\_hours(80)**

Annual cumulative difference between a site's mean hourly temperature and 80°F. The difference is counted only if the mean hourly temperature is above 80°F. Dimension: degree\_hour

**Cooling\_setback\_temperature**

Cooling thermostat setting during unoccupied periods. Dimension: temperature

**Cooling\_setpoint\_temperature**

Cooling thermostat setting during occupied periods. Dimension: temperature

**Cooling\_tower\_electricity\_consumption**

Total electricity consumption of the cooling tower during normal operation. Dimension: power

**Daylight\_run\_hour**

Hour of the day for which the DELight simulation runs the spatial calculation (acceptable values are 0 - 23). The day is assumed to be the 21st of the month. Dimension: none

**Daylight\_run\_month**

Month of the year for which the DELight simulation runs the spatial calculation (acceptable values are 1 - 12). The day is assumed to be the 21st of the month. Dimension: none

**Default\_floor\_to\_floor\_height**

Default vertical distance between the floor of one story and the floor of the story above it. Dimension: length

**Density**

Specifies the material density i.e. the mass of a substance per unit volume. Dimension: density

**DOE2\_annual\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each month of a year. Savings are calculated by DOE2.1E based on daylight illuminance at the center of the space. Dimension: percentage

**DOE2\_ECM\_annual\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each month of a year. Savings are calculated by DOE2.1E based on daylight illuminance and the electric lighting illuminance at a user-specified reference point. Dimension: percentage

**DOE2\_ECM\_monthly\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each hour of an average day in each month of a year. Savings are calculated by DOE2.1E based on daylight illuminance and the electric lighting illuminance at a user-specified reference point. Dimension: percentage

**DOE2\_monthly\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each hour of an average day in each month of a year. Savings are calculated by DOE2.1E based on daylight illuminance at the center of the space. Dimension: percentage

**DOE2\_monthly\_energy\_by\_end\_use**

Energy use of the building for each month, as calculated by DOE2.1E, broken down by end use such as space heating and cooling, fans, lighting, equipment, hot water, miscellaneous and heat reject. Dimension: energy

**DOE2\_monthly\_energy\_by\_fuel\_type**

Energy use of the building for each month, as calculated by DOE2.1E, broken down by fuel type such as electricity, gas, coal, #2 oil, #6 oil, district heating, district cooling, miscellaneous, and heat reject. Dimension: energy

**DOE2\_total\_energy\_by\_end\_use**

Total energy use of the building, as calculated by DOE2.1E, broken down by the end uses such as space cooling and heating, fans, lighting, equipment, hot water, miscellaneous and plant standby. Also HVAC aux, aux solar, cooling towers, pumps etc. Dimension: energy

**DOE2\_total\_energy\_by\_fuel\_type**

Total energy use of the building, as calculated by DOE2.1E, broken down by fuel type such as electricity, gas, coal, #2 oil, #6 oil, district heating, district cooling, other, and heating plant. Also, chilled water, steam, LPG, methanol and biomass. Dimension: energy

**DOE2\_total\_energy\_use**

All the energy used by a building during the year including all fuel types and all end uses, as calculated by DOE2.1E. Dimension: energy

**Economizer\_enthalpy\_control**

Indicates whether or not the economizer enthalpy control is in effect (acceptable values are "yes" or "no"). Dimension:none

**Economizer\_limit\_temperature**

Outside air temperature above which the economizer returns to minimum outside air operation. Dimension: temperature

**Effective\_thermal\_conductance**

Thermal conductance of a construction assembly including all framing, edge and interstitial effects but excluding air film on both sides. Dimension: thermal\_conductance

**Effective\_thermal\_resistance**

Net thermal resistance of a construction assembly including all framing, edge and interstitial effects but excluding air film on both sides. Dimension: thermal\_resistance

**Electric\_light\_illuminance**

The illuminance level at a reference point due to electric lighting. Dimension: illuminance

**Electricity\_and\_fuel\_usage\_meter\_by\_meter**

A performance parameter that shows calculated and projected electricity and fuel usage for each meter of the building. Dimension:energy

**Equipment\_heat\_gain\_latent\_fraction**

The fraction of the maximum equipment energy that is added to the space energy balance in the form of latent heat. The sum of equipment\_heat\_gain\_latent\_fraction and equipment\_heat\_gain\_sensible\_fraction must not exceed 1.00. If neither sensible or latent gain is specified, all heat from equipment will be considered sensible in DOE2.1E. Dimension: percentage

**Equipment\_heat\_gain\_sensible\_fraction**

This is the fraction of the maximum equipment energy, if any, that is added to the space energy balance in the form of sensible heat. The sum of equipment\_heat\_gain\_latent\_fraction and equipment\_heat\_gain\_sensible\_fraction must not exceed 1.00. If neither sensible or latent gain is specified, all heat from equipment will be considered sensible in DOE2.1E. Dimension: percentage

**Equipment\_heat\_to\_hood\_ratio**

Fraction of heat from electrical equipment that is exhausted through a hood. Dimension:percentage

**Equipment\_power\_density**

Maximum installed equipment plug load power density in a space. Dimension:power\_density

**Fan\_control\_type**

Refers to the method by which the HVAC distribution\_system fans are controlled. Dimension:none

**Floor\_to\_ceiling\_height**

Vertical distance between a floor boundary and a ceiling boundary. Dimension: length

**Floor\_to\_floor\_height**

Vertical distance between two floor boundaries (includes the plenum if one exists). Dimension: length

**Fraction\_of\_space\_covered\_by\_furniture**

The fraction of floor area covered by furniture. This parameter effects the interior mass of the building. Dimension: percentage

**Fuel\_type**

Primary type of fuel used by plant equipment. Dimension: none

**Full\_load\_efficiency**

Operating efficiency of plant generation equipment at full load (100% operation). Dimension: percentage

**Generation\_capacity**

Maximum equipment sustained power output. Dimension: power

**Glass\_type\_code**

A code number from the more than 200 possible choices in the DOE 2.1E Windows library. DOE-2.1E incorporates about 200 glass types from the Window 4.0 program based on single-, double-, triple-glazing, different tints, coatings, gas-fills, glass-thickness, gap widths. Dimension: none

**Grid\_step**

Distance between the calculated reference\_points. X and Y values in a lighting grid are assumed to be equal. Dimension: length

**Gross\_area**

Area included within surrounding exterior walls exclusive of interior courtyards. Dimension: area

**Heat\_coil\_discharge\_temperature**

Designed exit temperature of the system heating coil. Dimension: temperature

**Heating\_degree\_days(65)**

Annual cumulative difference between a site's mean daily temperature and 65°F. The difference is counted only if the mean daily temperature is below 65°F. Dimension: degree\_day

**Heating\_setback\_temperature**

Heating thermostat setting during unoccupied periods. Dimension: temperature

**Heating\_setpoint\_temperature**

Heating thermostat setting during occupied periods. Dimension: temperature

**Hot\_water\_use\_per\_person**

Maximum total domestic hot water usage per person exclusive of space heating or equipment process usage. Dimension: volumetric\_flow

**Hourly\_extraction\_rate**

The value the extraction rate (cooling) would be at the design conditions. This is not the value used in the simulation; that value is recalculated hourly and depends upon the loads, the conditions, the thermostat type, and the thermostatic throttling range. Dimension: energy (kBtu/hr)

**ies\_type**

The name of the IES formatted file that contains the luminaire specifications. Dimension: none

**Infiltration\_method\_type**

This parameter represents the infiltration\_method, namely, none, air-change, crack, or residential. Dimension: none

**Input\_watts**

The rated power input for a luminaire. Dimension: power

**Inside\_film\_resistance**

Specifies the combined convective and radiative air film resistance for the Inside wall, ceiling or floor surface. Dimension: none

**Inside\_visible\_reflectance**

Total inside (i.e. within a space) visible reflectance of a glazing assembly. Dimension: percentage

**Latitude**

Angular distance from the plane of the Earth's equator to the site. Dimension: plane\_angle

**Layer\_1, layer\_2, ..., layer\_9**

Layers in a Construction Material Sandwich. Dimension:none

**Left\_fin\_distance\_from\_aperture**

Horizontal distance between the fin and the closest vertical edge of the aperture. Dimension: length

**Left\_fin\_distance\_from\_aperture\_frame**

Horizontal distance between the fin and the closest vertical edge of the aperture frame. Dimension: length

**Left\_fin\_top\_edge\_below\_aperture\_frame\_top\_edge**

The height between the top edge of the aperture and the top edge of the fin. If this height is a positive number, the top of the fin starts below the top of the aperture by a distance equal to that number. If this height is a negative number, the top of the fin starts above the top of the aperture by a distance equal to that number. Dimension: length

**Left\_fin\_top\_edge\_below\_aperture\_top\_edge**

The height between the top edge of the aperture and the top edge of the fin. If this height is a positive number, the top of the fin starts below the top of the aperture by a distance equal to that number. If this height is a negative number, the top of the fin starts above the top of the aperture by a distance equal to that number. Dimension: length

**Left\_fin\_total\_depth**

Total depth of the fin perpendicular to the aperture. Dimension: length

**Left\_fin\_total\_height**

Total height of the fin along the aperture. Dimension: length

**Level**

The actual position of a story within the building, starting with 1 for the ground floor. Dimension: none

**Light\_heat\_to\_space\_ratio**

Fraction of lighting energy added to the space energy balance as a sensible heat gain. Dimension: percentage

**Light\_output\_fraction\_at\_min\_power**

Fraction of light produced by an electric lighting system when the lighting\_control is set at minimum power. Dimension: percentage

**Light\_source**

The lamp type used by a luminaire, e.g., fluorescent, incandescent, metal halide, halogen, etc. Dimension: none

**Lighting\_control\_probability**

Probability that the lighting\_control will dynamically respond in meeting lighting setpoint conditions. Dimension: percentage

**Lighting\_control\_type**

Type of lighting control device used. Dimension: none

**Lighting\_power\_density**

Installed lighting power density within a space. Dimension: power\_density

**Lighting\_setpoint**

Desired lighting level for the type of visual\_activity occurring in a space or zone. Dimension: illuminance

**Longitude**

Angular distance from the plane of Earth's prime (Greenwich) meridian to the site. Dimension: plane\_angle

**Luminaire\_manufacturer**

The manufacturer or distributor of a particular luminaire type. Dimension: none

**Luminaire\_suspension\_length**

The vertical distance between the luminaire center and the ceiling. Dimension: length

**Mean\_coinc\_summer\_wetbulb\_temp**

Mean wetbulb temperature coincident with the summer design day maximum drybulb temperature. Dimension: temperature

**Mean\_daily\_temperature\_range**

Mean daily temperature range during design day conditions. Dimension: temperature

**Mean\_summer\_coincident\_humidity**

Mean humidity ratio coincident with the summer design day maximum drybulb temperature. Dimension: percentage

**Min\_outside\_air\_per\_person**

Minimum outside air volumetric flow per person required in a space. Dimension: volumetric\_flow

**Minimum\_design\_ventilation**

Minimum design ventilation provided to an HVAC\_zone by a distribution\_system during occupied conditions. Dimension: percentage

**Minimum\_drybulb\_temperature**

Minimum drybulb temperature experienced by a site under design day conditions. Dimension: temperature

**Minimum\_input\_power\_fraction**

Minimum power fraction when the lighting\_system is operating at minimum power. Dimension: percentage

**Minimum\_outside\_air\_fraction**

Minimum acceptable constant flow rate of fresh air expressed as a fraction of the total air supply. Dimension: percentage

**Minimum\_relative\_humidity**

Minimum allowable relative humidity in an HVAC\_zone. Dimension: percentage

**Miscellaneous\_heat\_to\_hood\_ratio**

Fraction of heat from space miscellaneous equipment (e.g, a steam table), that is exhausted through a hood. Dimension: percentage

**Miscellaneous\_power\_density**

Maximum miscellaneous equipment (e.g., steam table) power density installed within a space. Dimension: power\_density

**Monthly\_baseboard\_energy**

Baseboard energy consumed monthly. Dimension: energy

**Monthly\_cooling\_energy**

Energy consumed for cooling on a monthly basis. Dimension: energy

**Monthly\_cooling\_loads**

Loads on the cooling\_plant on a monthly basis. Dimension: energy

**Monthly\_electric\_input\_to\_cooling**

Electric energy consumed by the plant for cooling on a monthly basis. Dimension: energy

**Monthly\_electric\_input\_to\_heating**

Electric energy consumed by the plant for heating on a monthly basis. Dimension: energy

**Monthly\_electric\_lighting\_savings**

Percentage of electric lighting savings that daylighting contributes for each hour of an average day in each month of a year. Savings are calculated by DELight based on average daylight illuminance over the whole space. Dimension: percentage

**Monthly\_electrical\_energy**

Electric energy consumed on a monthly basis. Dimension: energy

**Monthly\_energy\_by\_end\_use**

Energy use of the building for each month broken down by end use such as space heating and cooling, fans, lighting, equipment, hot water, pumps, miscellaneous, and heat reject. Dimension: energy

**Monthly\_energy\_by\_fuel\_type**

Energy use of the building for each month broken down by fuel type such as electricity, gas, coal, #2 oil, #6 oil, district heating, district cooling, other and heating plant. Dimension: energy

**Monthly\_fan\_electrical\_energy**

Electrical energy consumed by the fan on a monthly basis. Dimension: energy

**Monthly\_fuel\_input\_to\_heating**

Fuel consumed by the plant for heating on a monthly basis. Dimension: energy

**Monthly\_heat\_addition\_load**

This monthly total is the sensible heating requirement of this zone during the HVAC system operation hours. The loads are both sensible and latent. For a plenum, this values is for heat addition induced by the return air flow. For unconditioned zones, this values should be zero. Dimension: energy (millions Btu)

**Monthly\_heat\_extraction\_load**

This monthly total is the sensible cooling requirement of this zone during the HVAC system operation hours. The loads are both sensible and latent. For RESYS systems, the heat extraction may include natural ventilation. For a plenum, this value is for heat extraction and addition induced by the return air flow. For unconditioned zones, these values should be zero. Dimension: energy (millions Btu)

**Monthly\_heating\_energy**

Energy consumed for heating on a monthly basis. Dimension: energy

**Monthly\_heating\_loads**

Loads on the heating\_plant on a monthly basis. Dimension: energy

**Monthly\_hours\_undercooled**

The number of hours each month that the zone temperature was above the comfort range. Dimension: time

**Monthly\_hours\_underheated**

The number of hours each month that the zone temperature was below the comfort range. Dimension: time

**Monthly\_maximum\_zone\_temperature**

The maximum zone temperature month by month. Dimension: temperature

**Monthly\_minimum\_zone\_temperature**

The minimum zone temperature month by month. Dimension: temperature

**Monthly\_values**

Twelve values, one for each month of the year. Dimension: percentage

**Number\_of\_fins**

Number of fins (i.e. vertical exterior shading projections) associated with the aperture. Dimension: none

**Number\_of\_overhangs**

Number of overhangs (i.e. horizontal exterior shading projections) associated with the aperture. Dimension: none

**Number\_of\_panes**

Specifies whether glazing is single, double or triple. Dimension: none

**Number\_of\_steps\_in\_stepped\_system**

Number of steps (i.e. lighting level settings) in a stepped lighting system. Dimension: none

**Number\_of\_units**

Total number of heating or cooling generation units in a plant. Dimension: none

**Occupant\_orientation**

Direction toward which the occupant of a space is facing. Dimension: plane\_angle

**Occupied\_infiltration\_rate**

Infiltration rate during "occupied conditions". This infiltration\_rate generally refers to the rate when the HVAC system is "on". Dimension: volumetric\_flow

**Operation\_type**

Value denotes how the plant operates (acceptable values are "continuous" or "as needed"). Dimension: none

**Outside\_emissivity**

The infrared emissivity of the outside surface. It makes a difference in the loads calculations. Dimension: percentage

**Outside\_high\_limit\_temperature**

High limit outside temperature at which coil reset begins. Dimension: temperature

**Outside\_low\_limit\_temperature**

Low limit outside temperature at which coil reset stops. Dimension: temperature

**Overhang\_angle**

The angle between the overhang and the aperture (window). When set at 90 degrees, the overhang is perpendicular to the window. If less than 90 degrees, it is tilted down. If more than 90 degrees, it is tilted up. The range is 0 to 180 degrees.

Dimension: plane\_angle

**Overhang\_height\_above\_the\_aperture\_frame**

The vertical distance of the overhang from the top horizontal edge of the aperture frame. Dimension: length

**Overhang\_height\_above\_the\_lintel**

The vertical distance of the overhang from the top horizontal edge of the aperture. Dimension: length

**Overhang\_total\_depth**

The total depth of the overhang perpendicular to the window surface. Dimension: length

**Overhang\_total\_width**

The total width of the overhang along the aperture. Dimension: length

**Overhang\_width\_beyond\_the\_aperture\_frame**

The extended width of the overhang beyond the vertical edge of the aperture frame. Dimension: length

**Overhang\_width\_beyond\_the\_lintel**

The extended width of the overhang beyond the vertical edge of the aperture. Dimension: length

**People\_latent\_heat\_gain**

Total people latent heat gain given off to a space. Dimension: people\_heat\_gain

**People\_sensible\_heat\_gain**

Total people sensible heat gain given off to a space. Dimension: people\_heat\_gain

**Percentage\_glazing\_area**

Percentage of the aperture surface area which is composed of glazing. The remaining percentage is assumed to be composed of the framing. Dimension: percentage

**Pilot\_energy\_consumption**

Total energy consumption of the plant gas pilots (if any). Dimension: power

**Rated\_fan\_capacity**

Total rated fan capacity, measured in terms of volumetric flow, produced by a HVAC distribution\_system's fans.

Dimension: volumetric\_flow

**Rated\_fan\_power**

Total fan power necessary to operate the HVAC distribution system fans at full capacity. Dimension: power\_efficiency

**Rated\_pump\_power**

Total maximum pump power available from the plant. Dimension: power

**Rectangular**

Whether a space is rectangular in shape or not; valid values are "yes" or "no". Dimension: none

**Reference\_point\_co-ordinates**

Reference\_point\_co-ordinates are to be used with Fixed\_Shades, i.e. shades that do not rotate with the building. Dimension: length

**Right\_fin\_distance\_from\_aperture**

Horizontal distance between the fin and the closest vertical edge of the aperture. Dimension: length

**Right\_fin\_distance\_from\_aperture\_frame**

Horizontal distance between the fin and the closest vertical edge of the aperture frame. Dimension: length

**Right\_fin\_top\_edge\_below\_aperture\_frame\_top\_edge**

The height between the top edge of the aperture frame and the top edge of the fin. If this height is a positive number, the top of the fin starts below the top of the aperture by a distance equal to that number. If this height is a negative number, the top of the fin starts above the top of the aperture by a distance equal to that number. Dimension: length

**Right\_fin\_top\_edge\_below\_aperture\_top\_edge**

The height between the top edge of the aperture and the top edge of the fin. If this height is a positive number, the top of the fin starts below the top of the aperture by a distance equal to that number. If this height is a negative number, the top of the fin starts above the top of the aperture by a distance equal to that number. Dimension: length

**Right\_fin\_total\_depth**

Total depth of the fin perpendicular to the aperture. Dimension: length

**Right\_fin\_total\_height**

Total height of the fin along the aperture. Dimension: length

**Rotation**

The rotation of an object, measured counter-clockwise from the X-axis. Dimension: plane\_angle

**Roughness**

It is specified as a code-number that indicates the relative roughness of the exterior surface finish of an Exterior Wall or Roof. Dimension: none

**Saturday\_values**

Hourly values for a typical Saturday. Dimension: percentage

**Schedule\_type**

Type of schedule (e.g., occupancy, lighting, availability, etc.). Dimension: none

**Shading\_coefficient**

Ratio of solar heat gain through a fenestration product to solar gain through an unshaded 1/8" thick clear double strength glass under the same set of conditions without the effect of frames, mullions or sashes etc. Dimension: percentage

**Shielding\_coefficient**

Takes into account the shading from the surrounding trees and buildings. This is used in calculations for the Sherman Grimsrud infiltration method. This coefficient modifies the wind speed term in the model to account for changes in the wind pressure caused by local obstructions. Dimension: none

**Solar\_absorptance**

Portion of the radiant solar energy striking the surface that is absorbed by the substance. Dimension: percentage

**Spacer\_type**

The thermal values for a 2.5" external strip around the edge of the glass depend on U-value in the center of the glass and the Type of Spacer. Spacers in the glazing can be specified as aluminum, steel etc. or they are taken directly from the Window Library in DOE-2.1E. Dimension: none

**Spatial\_glare\_index**

Glare index measured at a single time over a grid of reference points. Dimension:none

**Spatial\_daylight\_illuminance**

Daylight illuminance measured at a single time over a grid of reference points. Dimension: illuminance

**Spatial\_electric\_light\_illuminance**

Electric lighting illuminance measured at a single time over a grid of reference points. Dimension: illuminance

**Specific\_heat**

The heat in calories required to raise the temperature of one gram of a substance one degree Celsius Dimension: specific\_heat

**Summer\_maximum\_drybulb\_temp**

Maximum drybulb temperature experienced by a site under summer design day conditions. Dimension: temperature

**Summer\_maximum\_wetbulb\_temp**

Maximum wetbulb temperature experienced by a site under summer design day conditions. Dimension: temperature

**Sunday\_values**

Hourly values for a typical Sunday. Dimension: percentage

**Surface\_area**

Area of a surface plane. Dimension: area

**Temporal\_glare\_index**

Glare index measured over time at a single reference point. Dimension: none

**Temporal\_daylight\_illuminance**

Daylight illuminance measured over time at a single reference point. Dimension: illuminance

**Terrain\_parameter1**

A constant used to modify the free stream wind speed to account for ground roughness and height above ground at the building site. Values range from 0.47 for the centre of a big city to 1.30 for the ocean. Dimension: none

**Terrain\_parameter2**

A constant used to modify the free stream wind speed to account for ground roughness and height above ground at the building site. Values range from 0.35 for the centre of a big city to 0.10 for the ocean. Dimension: none

**Thermal\_absorptance**

Portion of the radiant solar energy striking the surface that is absorbed by the substance. Dimension: percentage

**Thermal\_activity\_type**

Thermal\_Activity prototype most likely for a given Space prototype. Dimension: none

**Thermal\_conductance**

Rate of heat flow through a unit area of a body induced by a unit temperature difference between the surfaces.  
Dimension: thermal\_conductance

**Thermal\_resistance**

Mean temperature difference between two defined surfaces of a material or construction that induces unit heat flow through a unit area under steady conditions. Dimension: thermal\_resistance

**Thickness**

Smallest of the three linear measurements. Dimension: length

**Tilt**

Angular distance from a vertical plane perpendicular to the window for fins and from a horizontal plane perpendicular to the window for overhangs. Dimension: plane\_angle

**Time\_zone**

Time zone of the project site location. Dimension: none

**Total\_energy\_by\_end\_use**

Total energy use of the building broken down by the end uses such as space cooling and heating, fans, lighting, equipment, hot water, miscellaneous and plant standby. Also HVAC aux, aux solar, cooling towers, pumps etc.  
Dimension: energy

**Total\_energy\_by\_fuel\_type**

Total energy use of the building broken down by fuel type such as electricity, gas, coal, #2 oil, #6 oil, district heating, district cooling, other, and heating plant. Also, chilled water, steam, LPG, methanol and biomass. Dimension: energy

**Total\_energy\_use**

All the energy used by a building during the year including all fuel types and all end uses. Dimension: energy

**Transmittance**

The percentage of thermal gain or light transmitted through the material. Dimension: percentage

**Type\_of\_glass**

Type of glass used in a glazing assembly (i.e. transparent or translucent). Dimension: none

**Unit\_configuration**

Configuration of plant unit operation (acceptable values are "parallel" or "staged"). Dimension: none

**Unit\_system**

The system of units to be used for the numeric parameter values. The choice is between English and Metric units.  
Dimension: none

**Unoccupied\_infiltration\_rate**

Infiltration\_rate during "unoccupied" conditions. This infiltration rate generally refers to the rate when the HVAC system is "off". Dimension: volumetric\_flow

**Ventilation\_rate\_per\_person**

Average ventilation volumetric flow per occupant. Dimension: volumetric\_flow

**Visible\_reflectance**

Ratio of visible light reflected by a surface to the light incident upon it. Dimension: percentage

**Visible\_transmittance**

Visual property which rates the relative translucence of a material. Dimension: percentage

**Visual\_activity\_type**

Visual\_Activity prototype most likely for a given Space prototype. Dimension: none

**Volume**

Length multiplied by width multiplied by height of a space expressed as cubic units. Dimension: volume

**Weekday\_values**

Hourly values for a typical weekday. Dimension: percentage

**Width**

The horizontal length of an element, e.g. a window or a shading device. Dimension: length

**Wind\_speed**

The local wind speed of the building site. Dimension: velocity

**Wind\_speed\_measurement\_height**

Height (in feet) above ground level at which the wind\_speed measurement was made. For most weather stations, this information can be obtained from Local Climatological Data- Annual Summaries for 1981, published by: The National Climatic Data Center, Federal Building, Ashville, NC 28801. Dimension: length

**Wind\_speed\_terrain\_parameter1**

A constant used to modify the free stream wind\_speed to account for ground roughness and height above ground at the location of the weather station. Values range from 0.47 for the centre of a big city to 1.30 for the ocean. Dimension: none

**Wind\_speed\_terrain\_parameter2**

A constant used to modify the free stream wind speed to account for ground roughness and height above ground at the location of the weather station. Values range from 0.35 for the centre of a big city to 0.10 for the ocean. Dimension: none

**Winter\_minimum\_drybulb\_temp**

Minimum drybulb temperature experienced by a site under winter design day conditions. Dimension: temperature

**Workplane\_height**

Height from the floor at which the DELight simulation calculates the spatial illuminance. Dimension: length

**X\_value**

The X-coordinate for a reference point in terms of the global coordinate system. Dimension: none

**Y\_value**

The Y-coordinate for a reference point in terms of the global coordinate system. Dimension: none