eQUEST Training Module 4
Detail Edit Mode
and Parametrics

INTEGRATED *idl* DESIGN LAB

BOZEMAN
MONTANA STATE UNIVERSITY
SCHOOL OF ARCHITECTURE

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The Integrated Design Lab - Bozeman is funded by the Northwest Energy Efficiency Alliance. Our services include energy and lighting analysis for Montana architects and engineers who wish to become more aware of the environmental impacts of energy consumption.

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WHAT IS eQUEST?

eQUEST is a building energy simulation tool based on the older and more widely known energy analysis program, DOE-2, from the Lawrence Berkeley National Laboratory and James J. Hirsch and Associates. While DOE-2 was a powerful tool, it was too complicated to be useful to the entire design team and too time-consuming for it to fit into the budget of most projects.

eQUEST took the brains of DOE-2 and added a graphic user interface, wizards, and industry-standard defaults. Now eQUEST can be used for anything from basic energy strategizing to detailed life-cycle costing by anyone from new users to experienced energy modelers.

This training module series focuses on the intuitive side of eQUEST, understanding that not everyone has the time for or need to create highly detailed building simulations. Some of the benefits of simple energy modeling include:

- Gain an intuitive understanding of the effects that basic energy-saving variables can have on a design.
- Study relative cost analysis (i.e. cost #1 vs. cost #2 if x, y, z changes are made) in a short amount of time.
- Propose new and innovative energy design ideas to skeptical critics.

The Integrated Design Lab—Bozeman has created a series of four modules that teach the basics and some advanced features of eQUEST. Designed for architects, this module series explains everything from simple to more complex features, and gives users more tools for the building profession.

The modules will first walk you through the use of the Schematic Design Wizard, a wizard designed to be used in the earliest stages of design when little detailed information is known about the systems of the building. The Energy Efficiency Measure Wizard, a tool for analyzing multiple options for a model at once, is also covered. An introduction to the Design Development Wizard follows for when you are prepared for more specific modeling control. Then eQUEST's Life-Cycle Cost Analysis features are demonstrated. Finally, an in-depth explanation of how to perform Parametric Runs and use the Detail Data Edit mode is presented, providing the user with access to the more advanced features of eQUEST.

For more information concerning eQUEST and a free download, visit: http://www.doe2.com/ equest/.

<u>THE TRAINING MODULES</u>

Since eQUEST is a powerful vast computer program, four training modules have been created for the purposes of teaching eQUEST to the interested user. Each module builds on the information presented in the previous module and all of the modules include an example at the end that the user can recreate by following step-by-step instructions. Each module is explained in more detail below:

- **Module 1: Basic Energy Modeling and Comparative Runs**
  This module gives an overview of some of the very basic functions of eQUEST and teaches the user how to set up a simple energy model based on schematic design information. It then explains how to use the EEM Wizard to create multiple scenarios for portions of the model that can be compared in order to provide the user with data as to which scenario is the best for the building.

- **Module 2: Intermediate Energy Modeling**
  This module teaches the user how to navigate the DD Wizard and create a more comprehensive energy model for simulations. The module highlights some of the main features of this wizard and walks the user through creating a model from scratch, as well as updating a previously created SD model.

- **Module 3: Life-Cycle Cost Analysis**
  This module explains what a Life-Cycle Cost Analysis is and how to perform such an analysis using eQUEST.

- **Module 4: Advanced Energy Modeling and Complex Comparative Runs**
  This module shows the user how to modify the properties of an energy model to suit the specific needs of the project. The Detailed Data Edit mode is explored and Parametric Runs are created in order to perform more specific energy analyses.

MODULE 4:
Detail Edit Mode and Parametrics

MODULE TEXT

TABLE OF CONTENTS

EXECUTIVE SUMMARY

eQUEST is a free building energy simulation tool based on the older and more widely known energy analysis program, DOE-2, from the Lawrence Berkeley National Laboratory and James J. Hirsch and Associates (JJHA). Although DOE-2 is powerful, it is very complicated and can be very difficult for the entire design team to use. eQUEST integrates the DOE-2 engine with a graphic user interface, wizards, and industry-standard defaults, making it a useful design tool for both beginner and experienced energy modelers.

The Integrated Design Lab Bozeman has created a series of four modules that teach the basics and some advanced features of eQUEST. Designed for architects, this module series explains everything from the simplest to the more complex features, and gives users more tools for the building profession.

Module 4 in the series builds on the previous modules and explores the Detail Edit Mode and Parametric Runs in eQUEST. It is recommended that you already have a working knowledge of eQUEST and have read through Modules 1 through 3 before proceeding with this module. The Detailed Data Edit mode can be used for more advanced energy modeling and this module explains how to do just that. At the end of this module, the user will be able to create a more comprehensive energy model of a single building or multiple buildings and simulate different options to determine the best energy performance options.

ARE YOU USING THE LATEST VERSION OF eQUEST?

On August 25, 2010 JJHA released a new version of eQUEST, eQUEST v. 3.64. This version includes many program and utility rate updates. If you have not already upgraded to this new version, do so before beginning this tutorial. To learn more about eQUEST and to download your free copy, go to: doe2.com/equest.

Some things to ALWAYS keep in mind while working in eQUEST:

- **Work in a linear fashion.** It is important to note that the DD wizard overall is not dependent upon sequential modifications. The Detailed Interface does not need to be completed in a linear fashion; however, within each component you should still try to input information as linearly as possible because information on earlier screens will affect model choices on later screens.
- **Save frequently**. Like any computer program, some newer versions of eQUEST have a tendency to crash at inconvenient moments. Make sure you are prepared.
- **Keep it simple.** There are some details in your building design that will have little or no impact on energy performance. Leave them out!
- **Analyze the results with caution.** Always check the reports for numbers that seem inappropriate under the circumstances. While the computer is a valuable tool, it does not understand the output it is producing. Use your knowledge to recognize potential inaccuracies!
- **Update your version.** New versions of eQUEST come with better help and new features.

NOTE: This eQUEST Module assumes that the user already has a working knowledge of eQUEST and is familiar with the concepts and processes outlined in previous eQUEST modules. Please refer to Module 1, 2, and 3 if you are unfamiliar with any of the material presented here. All other manuals can be accessed at the following website: http://www.idlbozeman.com/equest/ For more information, please contact IDL Bozeman (see the front cover of this module for contact information).

NOTE: The material in this module is not recommended for beginners. Any and all information can be modified within Detail Edit Mode. It is just easiest to do this through the Wizards. If the user transverses back to a Wizard, all information modified in the Detail Edit Mode will be lost and replaced by the previous inputs made in the Wizards. Detailed Edit Mode will only modify the base model, with parametric runs replacing the EEM Wizard information.

THE DETAILED INTERFACE

Now that you have mastered the DD Wizard and EEM's, it is time to explore some advanced energy modeling in eQUEST. To do this, we will be using the Detail Edit Mode. Detail Edit Mode should be used after either of the two wizards, when detail about the systems or building components are needed. For instance, detail edit mode might be used to edit only one of several walls throughout the building exterior, creating a more accurate model. Each component of the building is individualized and can be edited independent of the other components.

In addition to providing you with more modeling flexibility, detail edit mode requires that you use more caution and take a greater responsibility for your energy model information than you did with the wizards. Within detail edit mode, you have more control over entering information about schedules, loads, zones, building construction, and HVAC systems. Consequentially, eQUEST uses more complex calculation methods within the model than it did in the other wizard models. So with this greater freedom, comes greater responsibility.

To help accommodate a more complex energy model, the eQUEST detailed interface is broken up into several categories that can be revisited in any order. This is different than the process used in either wizard which relies on sequential input in order to build a basic energy model.

Detail Edit Mode allows you to input or change data regardless of order and independent of the other building systems and components. However, it is still recommended that you work linearly in each component. All the information that you provided for either wizard will be kept as a baseline to add more detail upon, but you will not be allowed to go back into the wizards to change any information. Therefore, be sure that all the information that was input within the wizards is accurate to create a baseline.

The following pages describe how to use many features of the Detail Edit Mode in depth, but the basic screens and views within the Detail Edit Mode are listed here along with their respective detailed tab views:
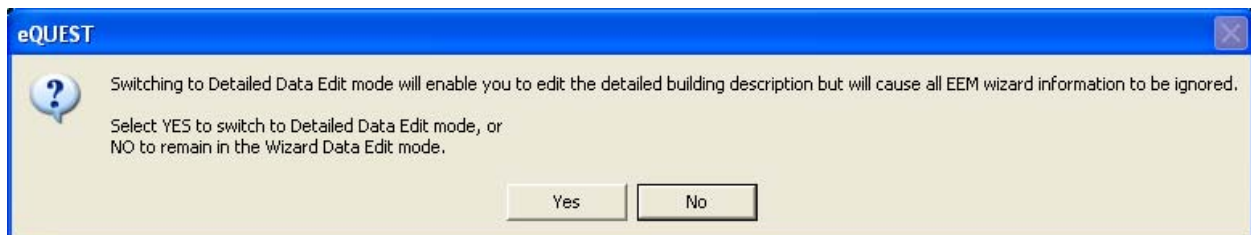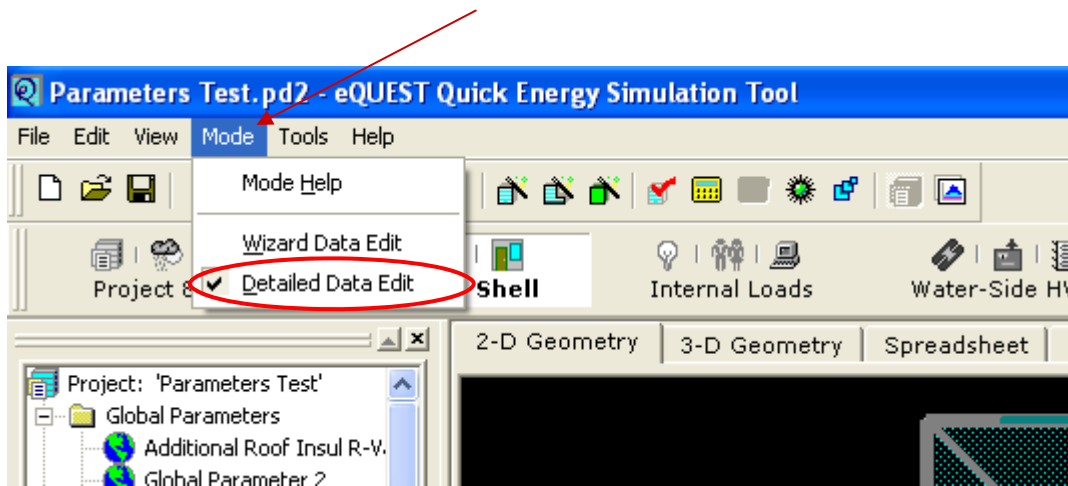
1. Building Shell Module
    - 2-D Geometry
    - 3-D Geometry
    - Spreadsheet/Tabbed Dialog
2. Project and Site Module
    - Spreadsheet/Tabbed Dialog
3. Internal Loads Module
    - Internal Loads
    - Spreadsheet/Tabbed Dialog
4. Water-Side HVAC Module
    - Plant Equipment
    - Spreadsheet/Tabbed Dialog
5. Air-Side HVAC Module
    - Air-Side HVAC System
    - Spreadsheet/Tabbed Dialog
6. Utility and Economics Module
    - Spreadsheet/Tabbed Dialog

Similar to the screens categorized within the wizards, the Detail Edit Mode has categorized the building systems into **Modules**. To access any of these modules, click the desired one from the module navigation bar near the top of the screen. Within each module, there are several ways of inputting data. These ways include the **Component Tree** and the **Detailed Tabs within the Module**. These will be further described in the following pages. Pictured below uses the Building Shell Module as an example to point out the different components.
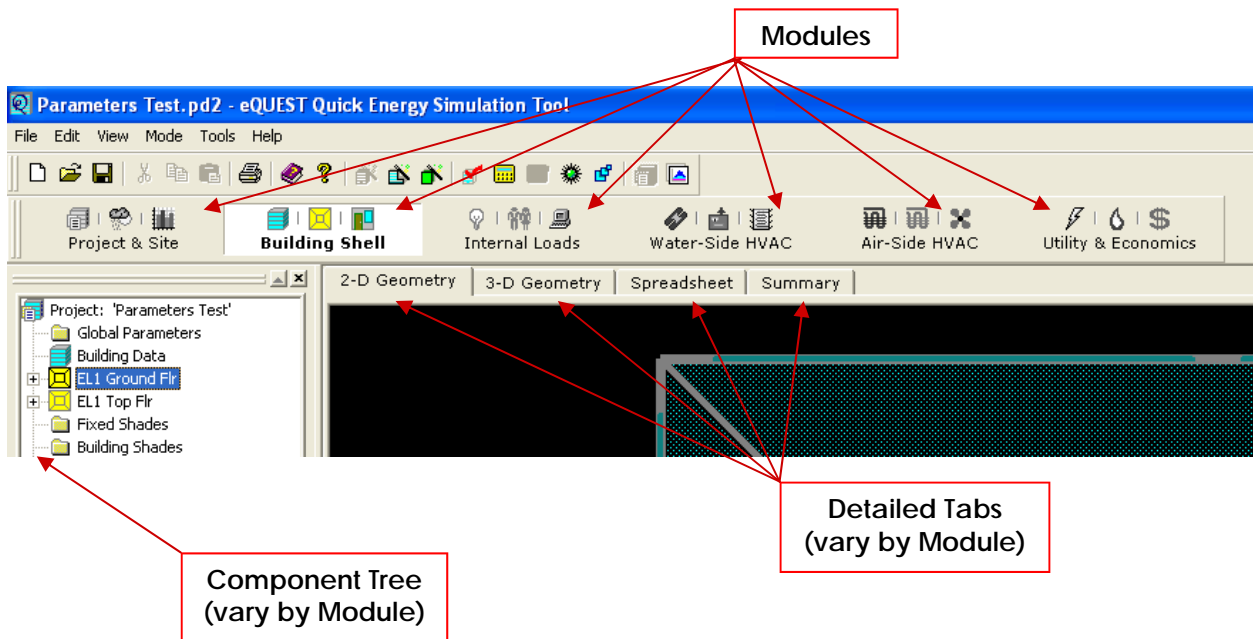
CHANGING FROM WIZARD DATA EDIT TO DETAILED DATA EDIT

To edit the model within Detail Edit Mode, the user must first change into that mode. This is completed from the menu bar on top, through the **Mode** tab menu, then select **Detailed Data Edit**. A warning message will appear to confirm the change of mode.

BUILDING SHELL MODULE

Upon entering Detailed Edit Mode, the user arrives at the Building Shell Module by default. Through this module, the user can edit any building shell component. For example, if you have only one wall that is different than the others, that specific wall can be changed independently of the others.

2-D Geometry Tab and Component Tree
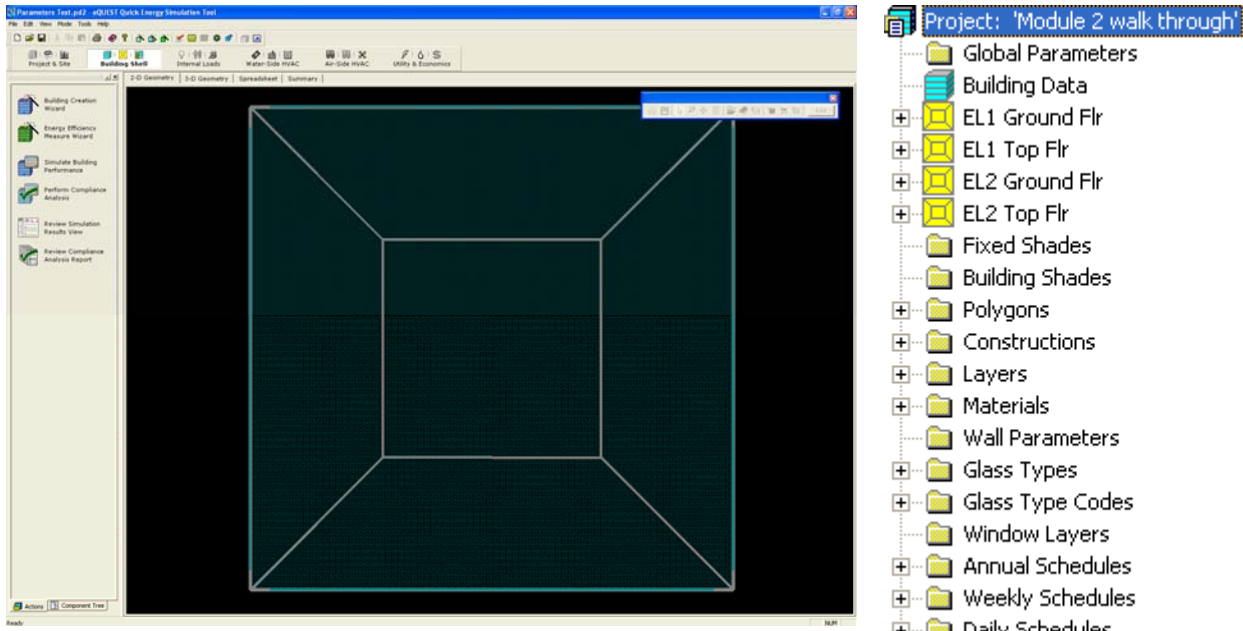
3-D Geometry Tab and Component Tree

Changing to the 3-D Geometry Tab is done by clicking on **"3D Geometry"** tab at the top of the detailed diagram area. All of the commands to zoom, pan, rotate, and tilt are all the same as previously done. Please refer to Module 1 for more information about the view commands.
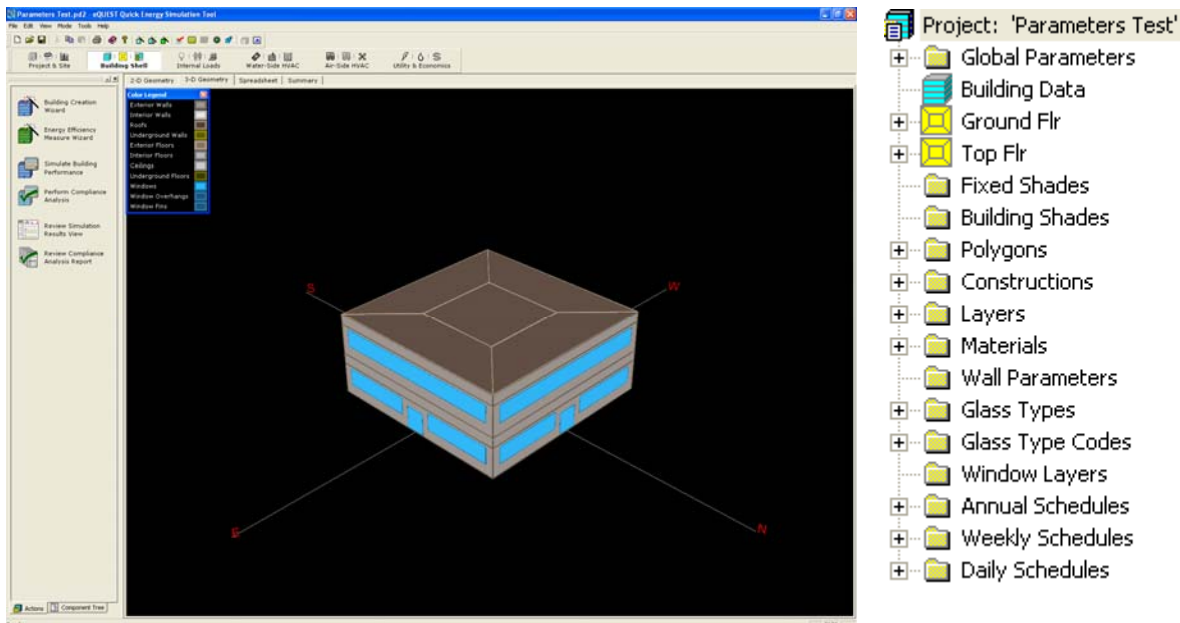
To look at any detail of any object, click on the desired object in 3D solid view. Every building object that is intersected by the mouse, even the objects hidden behind, will be seen in a pop up list. The selected object will then become highlighted in the Component Tree while also appearing a bold red border in 3D View.

The details of the selected component can be viewed two different ways, the spreadsheet view and the tabbed dialog view.

Tabbed Dialog View

After selecting the desired component to be edited, right click and expand the menu by the arrow on the right side. Select **"Properties"** to reveal the details of that component. Within the properties dialog, the details are broken down into Basic Specifications and Daylighting/ Shading/Other. All the information can be edited here directly, with all the modified information changing color to become red text.
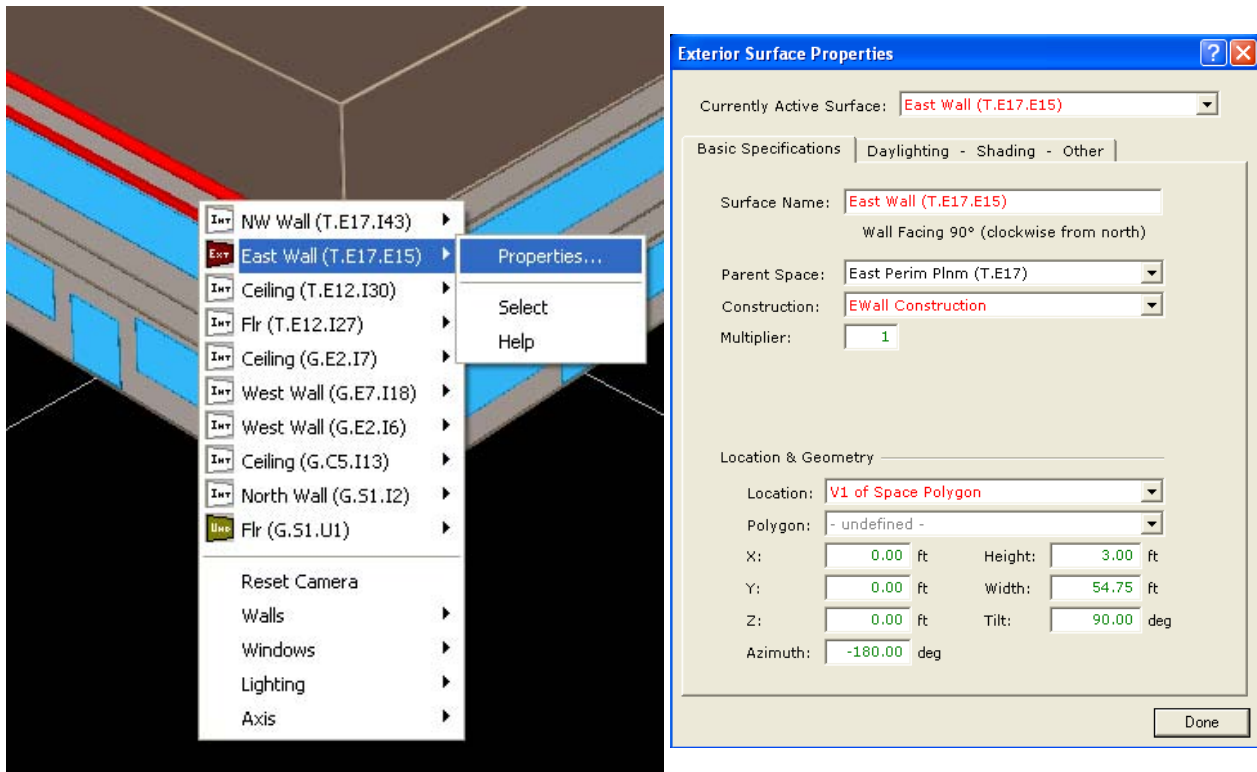
Spreadsheet View

After selecting an object in the 3D View, click to display the **Spreadsheet View Tab**. This has all the details of that component, with the selected object highlighted. Here, any detail can be modified to create a more detailed model.
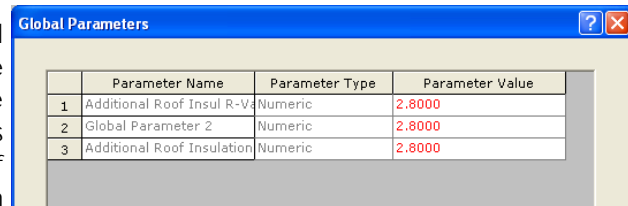
MODULE TEXT
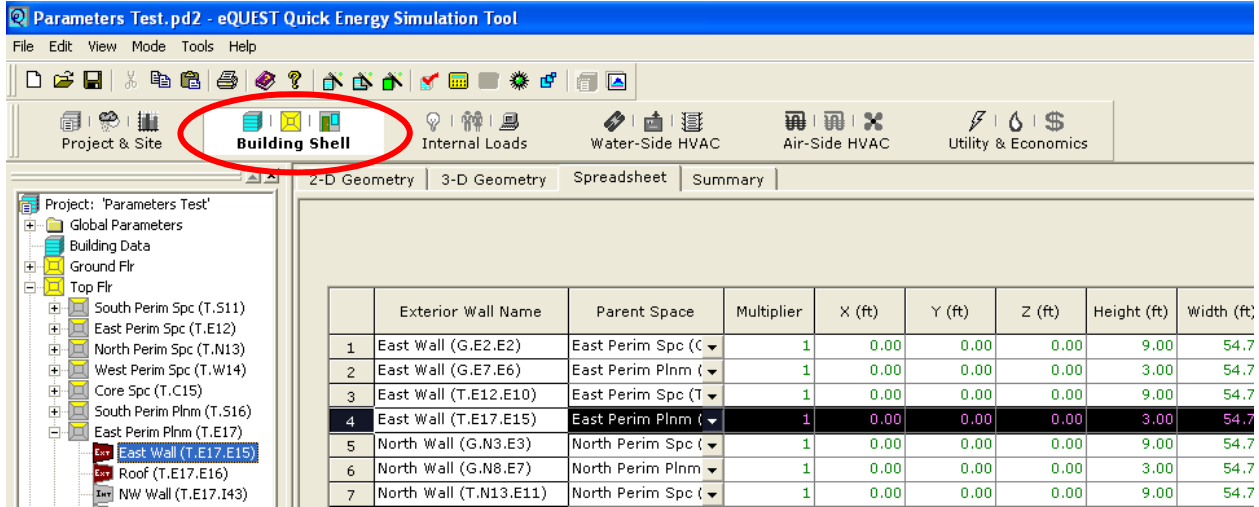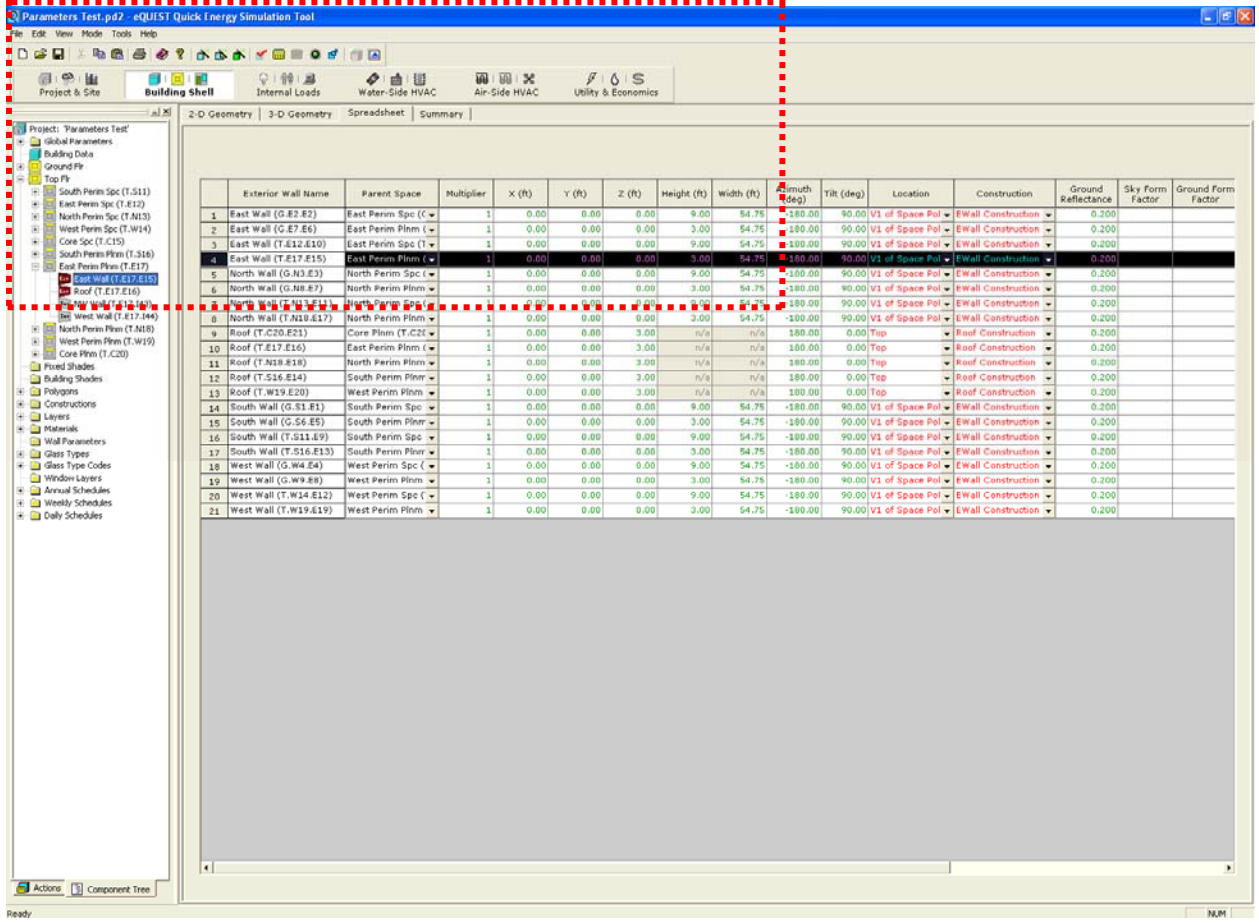
PROJECT AND SITE MODULE
From the project and site module, annual, weekly, and daily schedules can be modified to match the project. The project and site module has only one tab view, which is the spreadsheet view tab. The detail information can also be viewed in the tabbed dialog view. Important components to note in this module are the schedules and the global parameters. Global parameters are presented about later in this eQUEST Module 4.
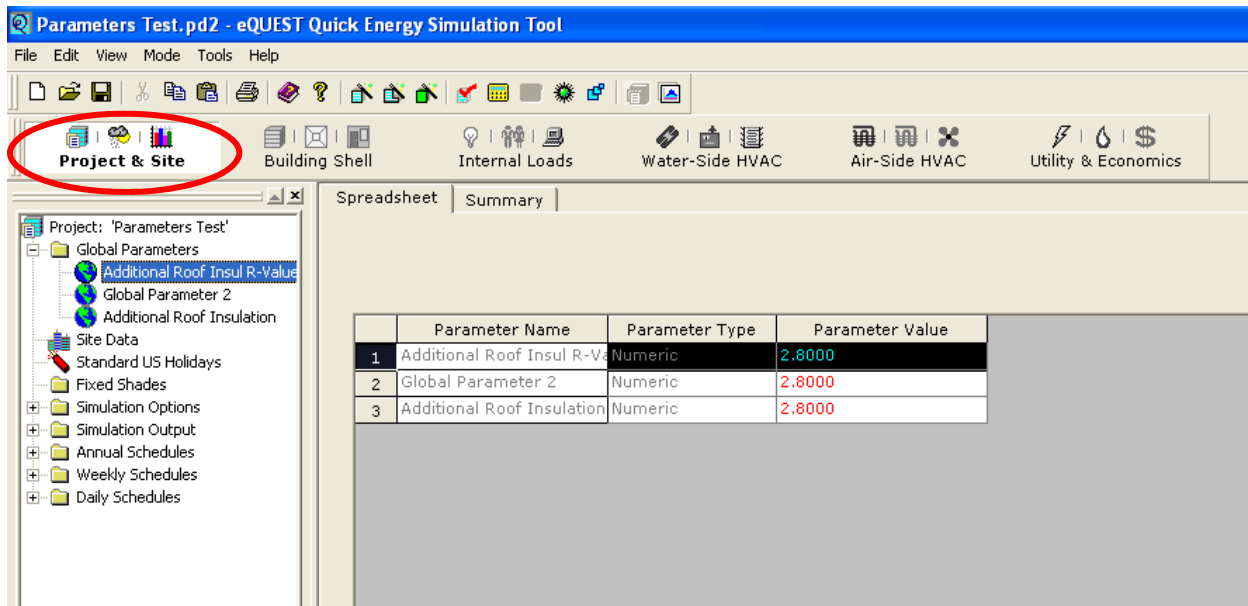
Tabbed Dialog View
Similar to the shell module, the desired component can be selected from the component tree.   Right clicking the component will bring up a menu. From this menu, click **"Properties"** to reveal the details of that component.   All the detail values can then be edited.

Spreadsheet View
To view the properties in the spreadsheet, the desired component must be selected from the component tree. After selected the component, the details of that component are visible.

INTERNAL LOADS MODULE
The Internal Loads Module is used to set and confirm internal loads.   Internal loads deal with people and equipment. Two examples of elements that can be modified within this module are defining which spaces are conditioned and defining building HVAC schedules.

Internal Loads View
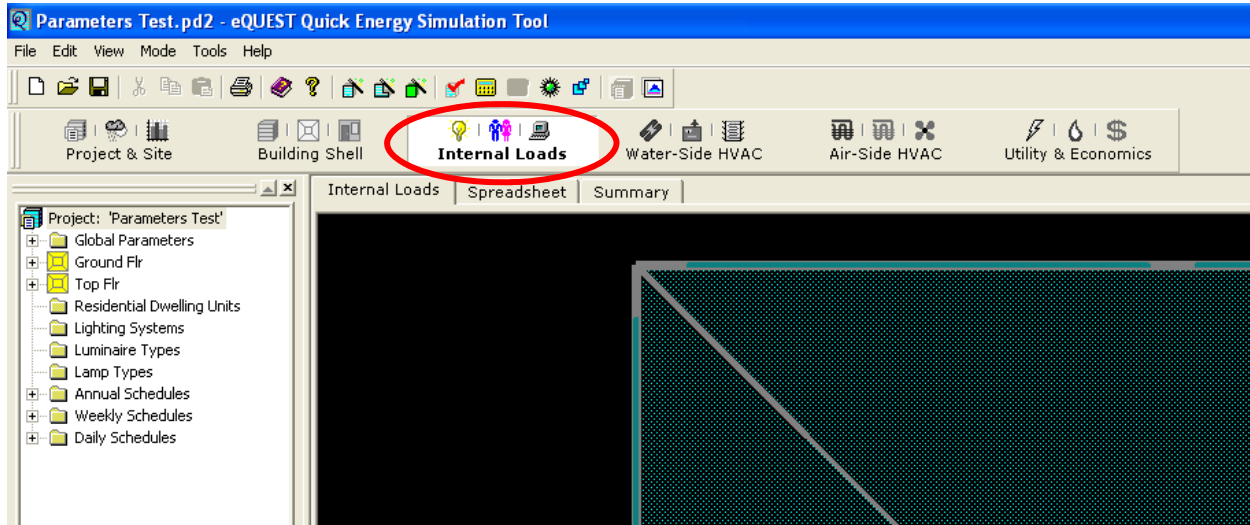
Tabbed Dialog View

Right click any of the components and select **"Properties"** to display a tabbed dialog of the internal loads details.
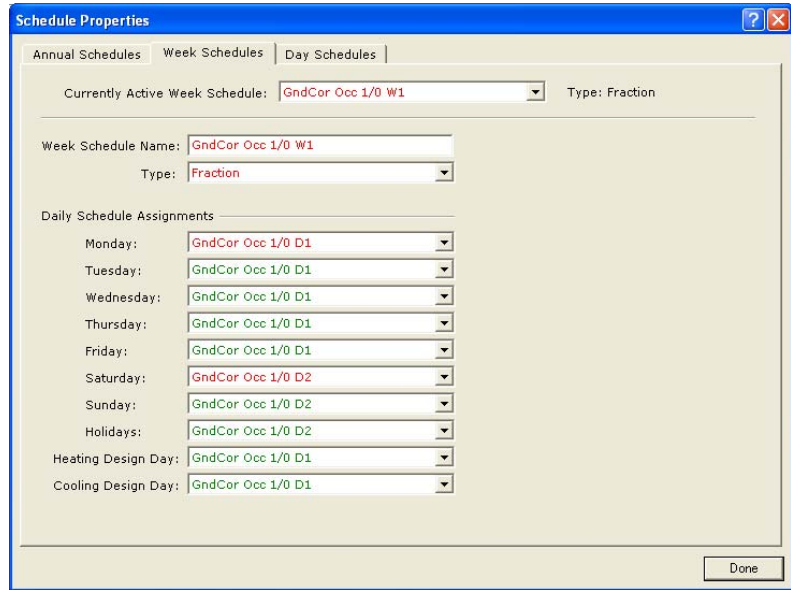
Spreadsheet View

To view the properties in the spreadsheet, the desired component must be selected from the component tree. After selected the component, the details of that component are visible by each pull down menu.

WATER SIDE HVAC MODULE

The Water Side HVAC Module is used to review, input, and modify features of the project water side of the HVAC System.

Plan Equipment View

Tabbed Dialog View

Right click any of the components and select **"Properties"** to display a tabbed dialog of the internal loads details.
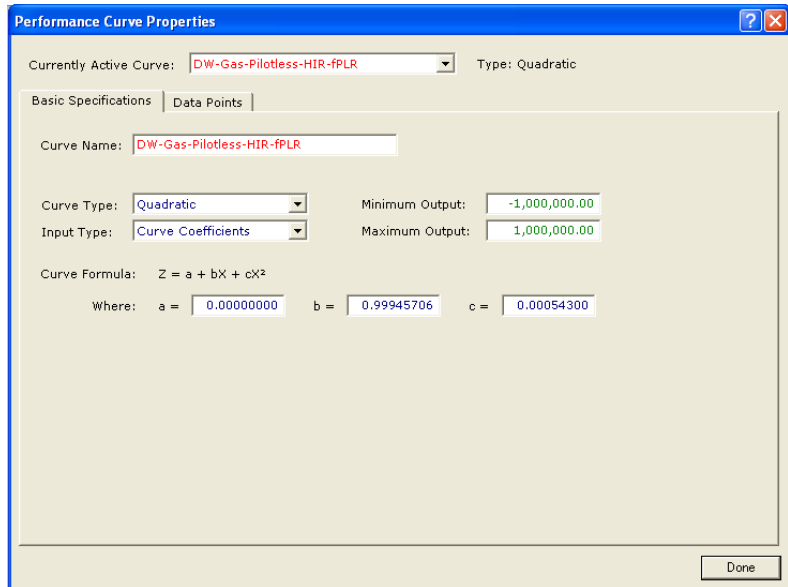
Spreadsheet View

To view the properties in the spreadsheet, the desired component must be selected from the component tree. After selected the component, the details of that component are visible.
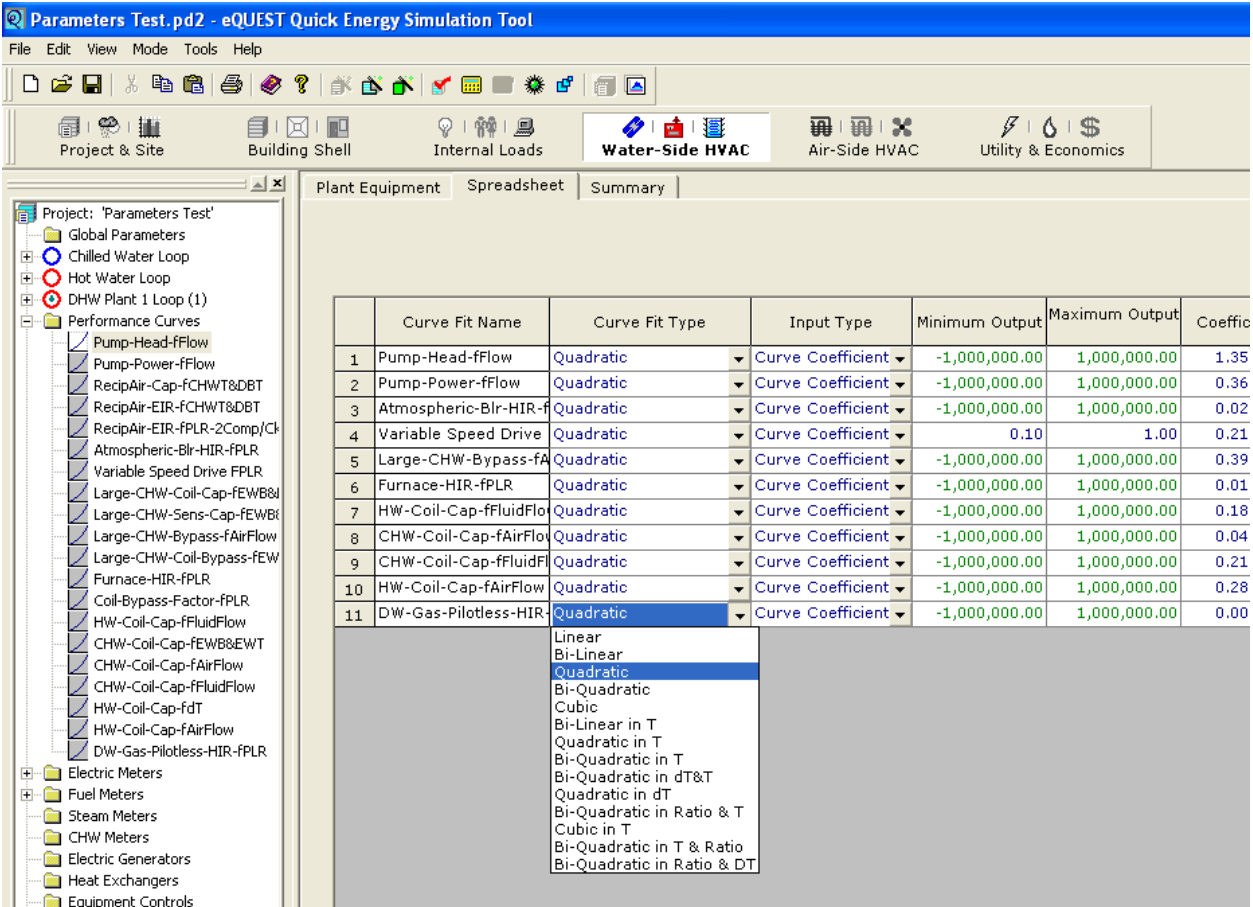
AIR SIDE HVAC MODULE
The Air Side HVAC Module is used to review, input, and modify features of the project air side.
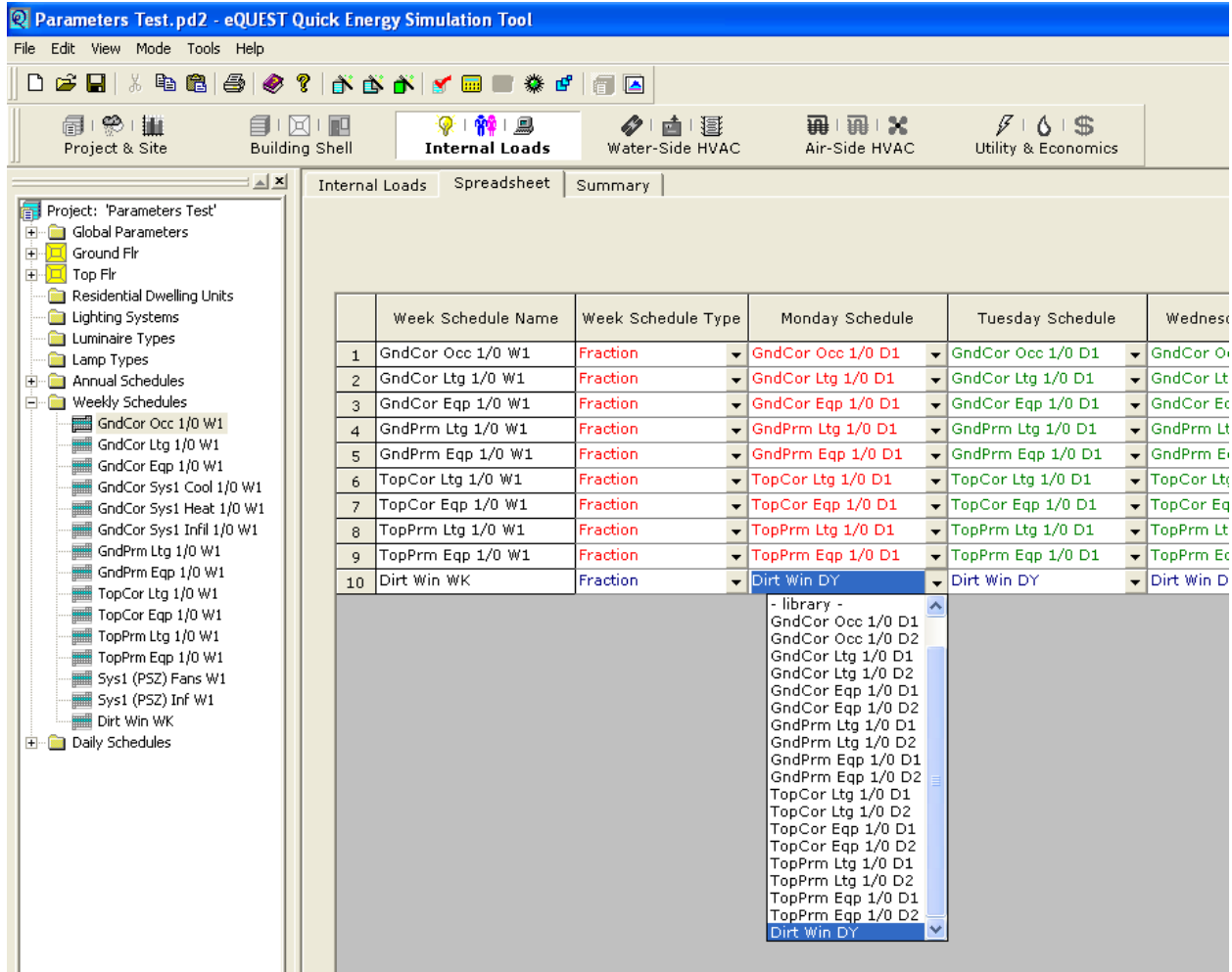
Plan Equipment View
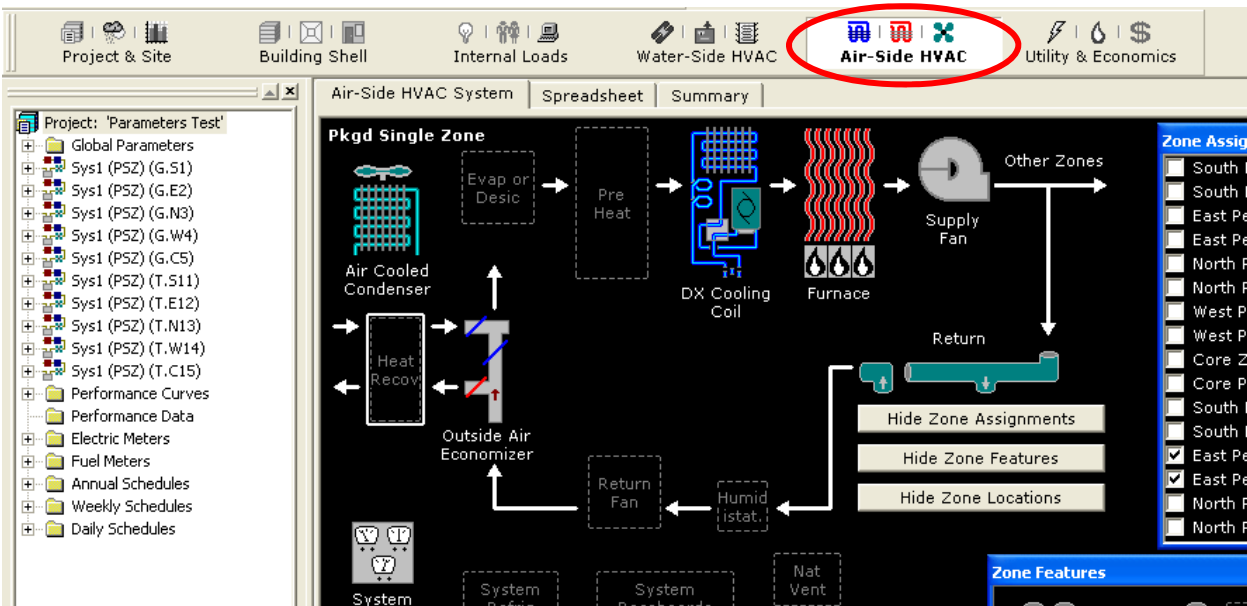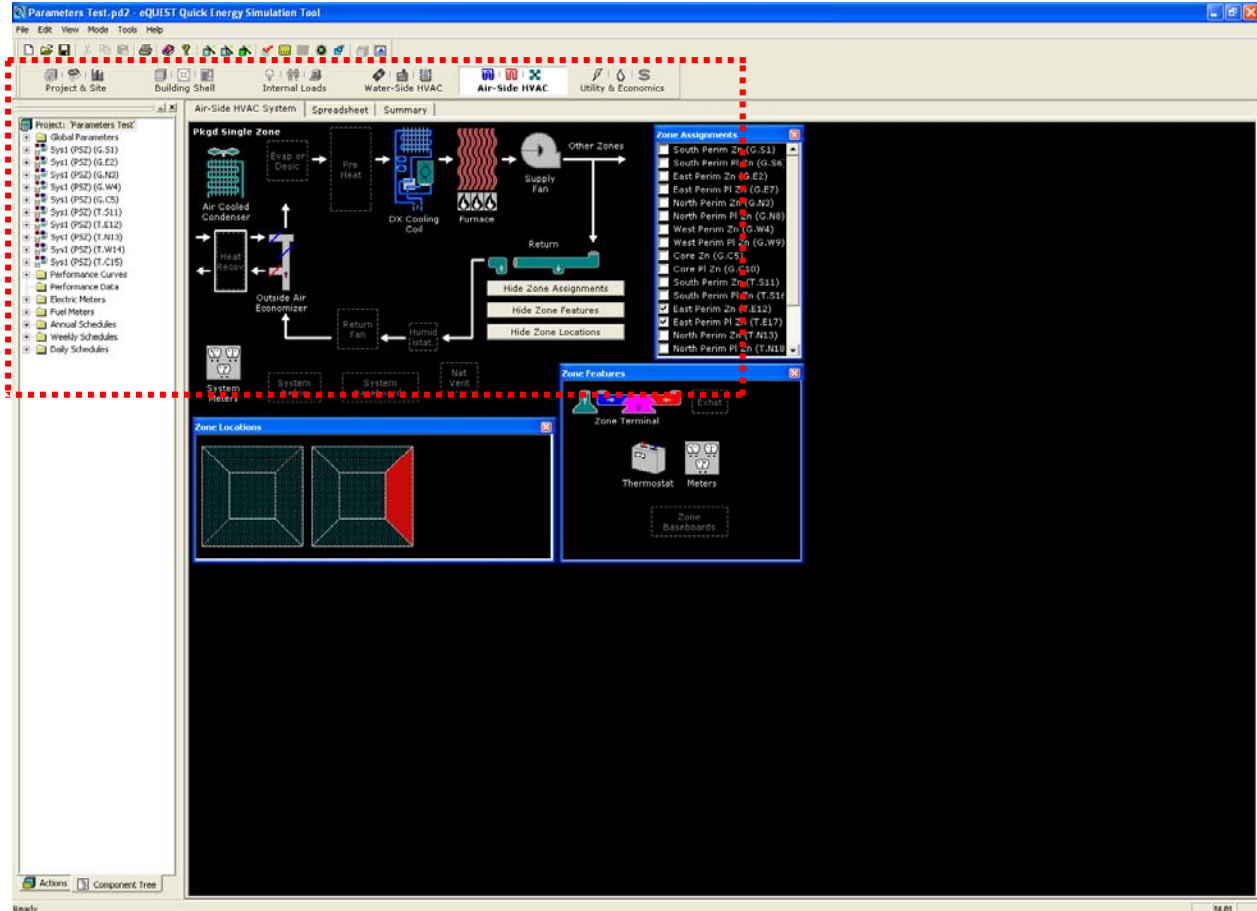
Tabbed Dialog View

Right click any of the components and select **"Properties"** to display a tabbed dialog of the internal loads details.
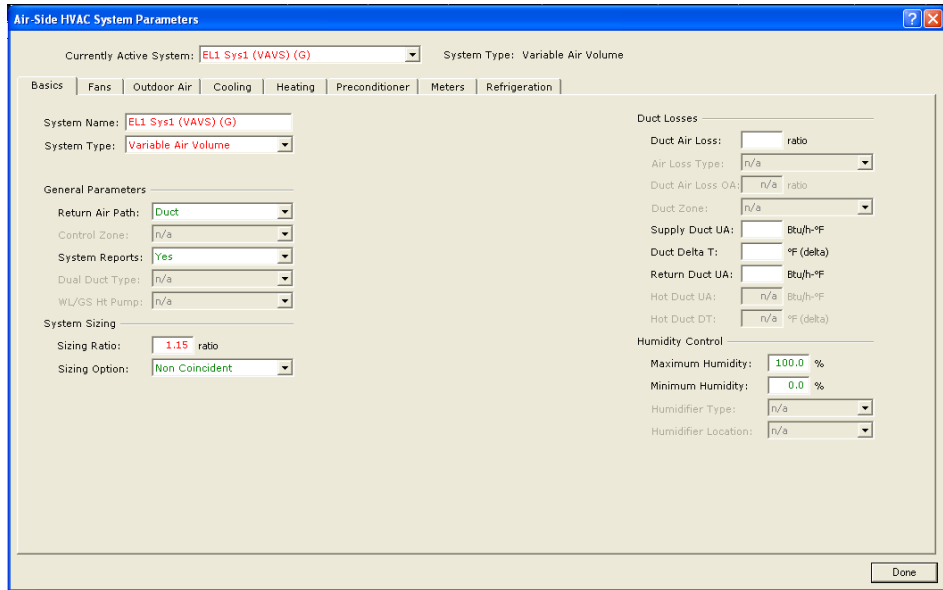
Spreadsheet View

To view the properties in the spreadsheet, the desired component must be selected from the component tree. After selected the component, the details of that component are visible.
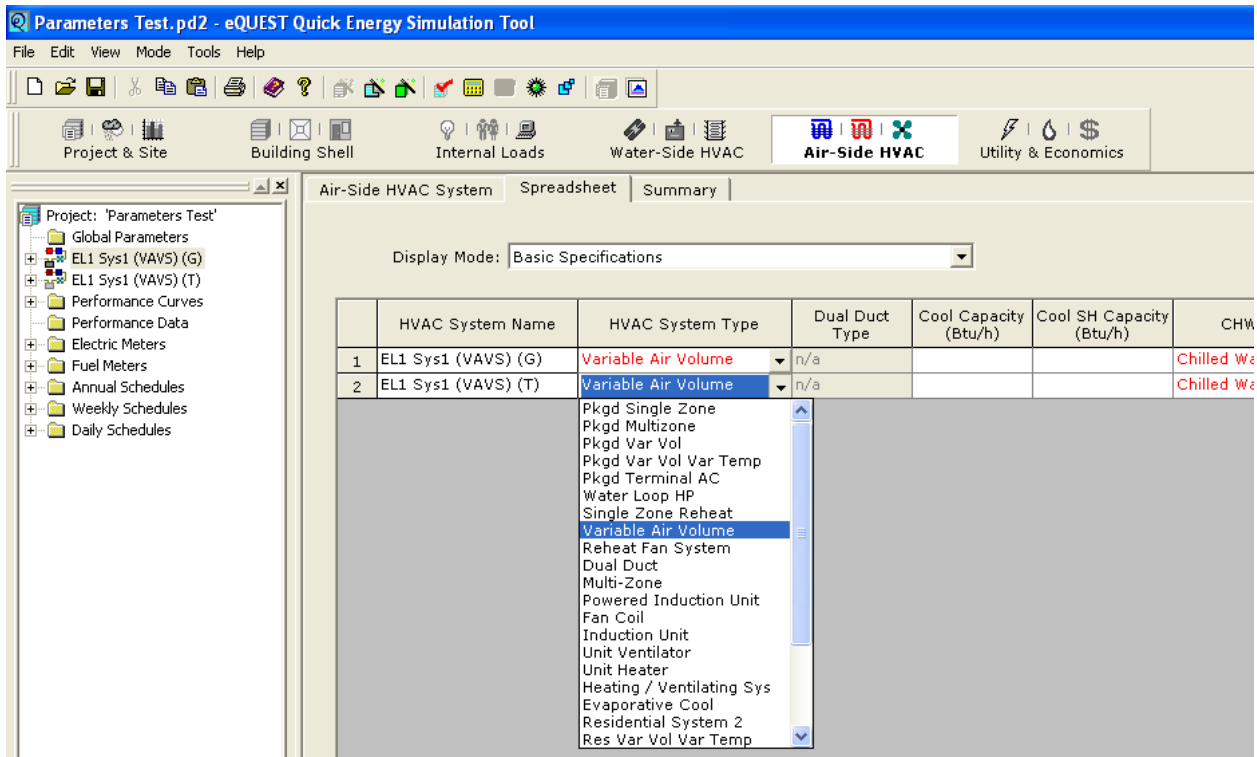
UTILITY AND ECONOMICS MODULE
The Utility and Economics Module is used to review, input, and modify features of utility rates and life-cycle costs. Here, users can input a specific utility schedule that is not defined through eQUEST.

Tabbed Dialog View
Similar to the other modules, the desired component can be selected from the component tree. Right clicking the component will bring up a menu. From this menu, click **"Properties"** to reveal the details of that component. All the detail values can then be edited.
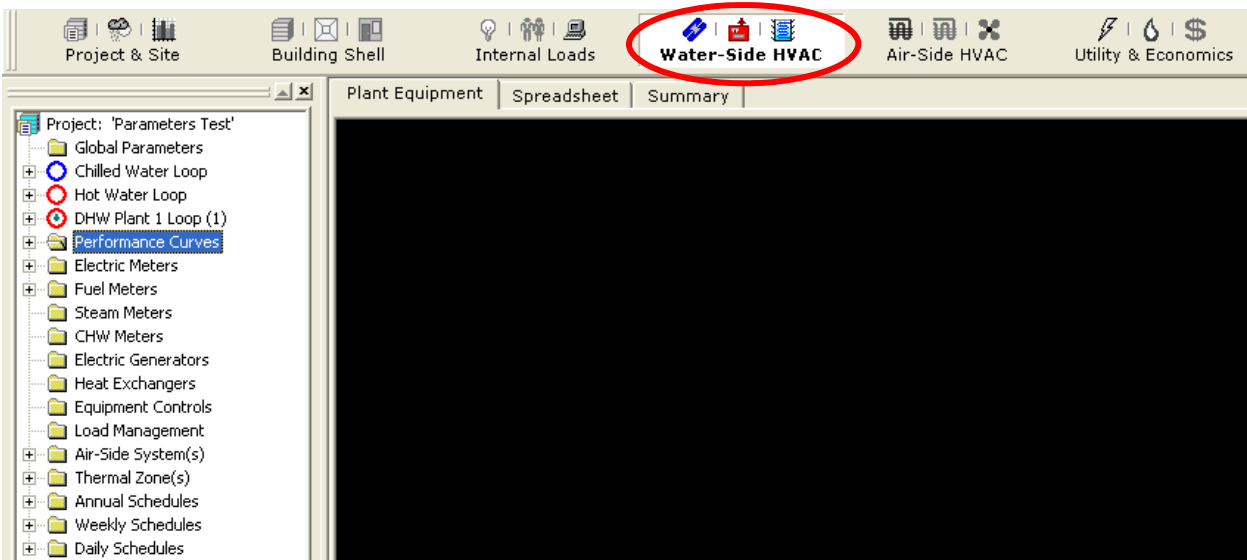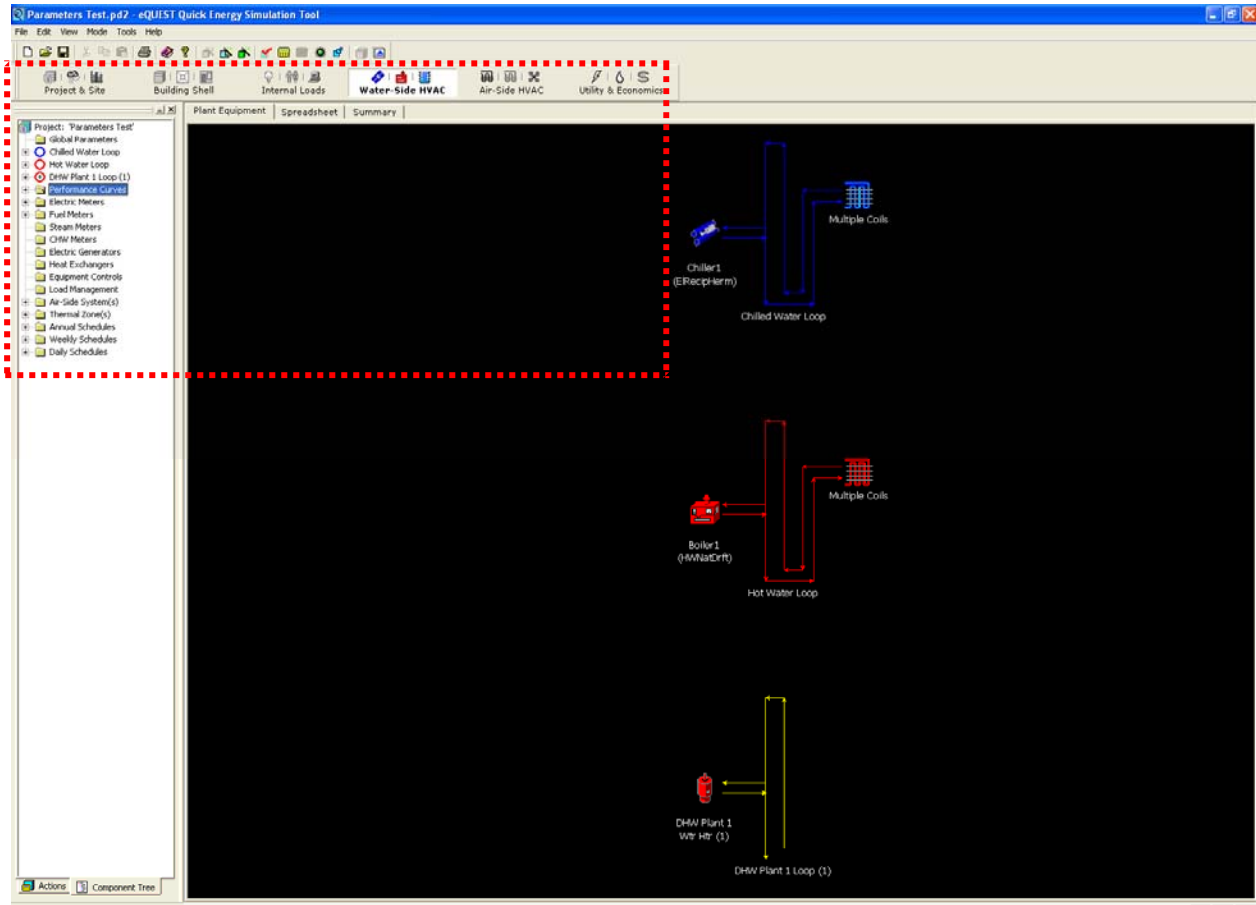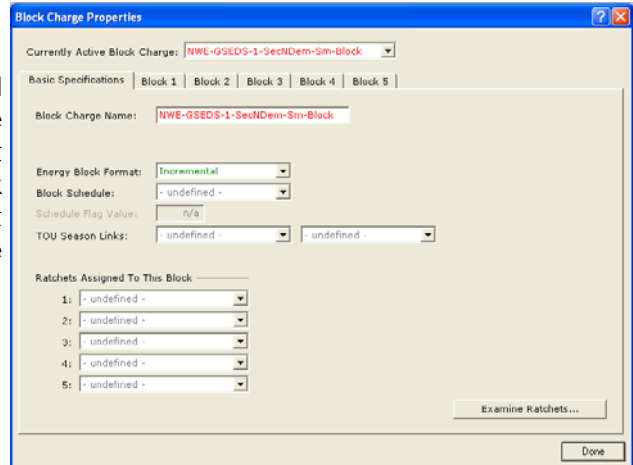
Spreadsheet View
To view the properties in the spreadsheet, the desired component must be selected from the component tree. After selected the component, the details of that component are visible.
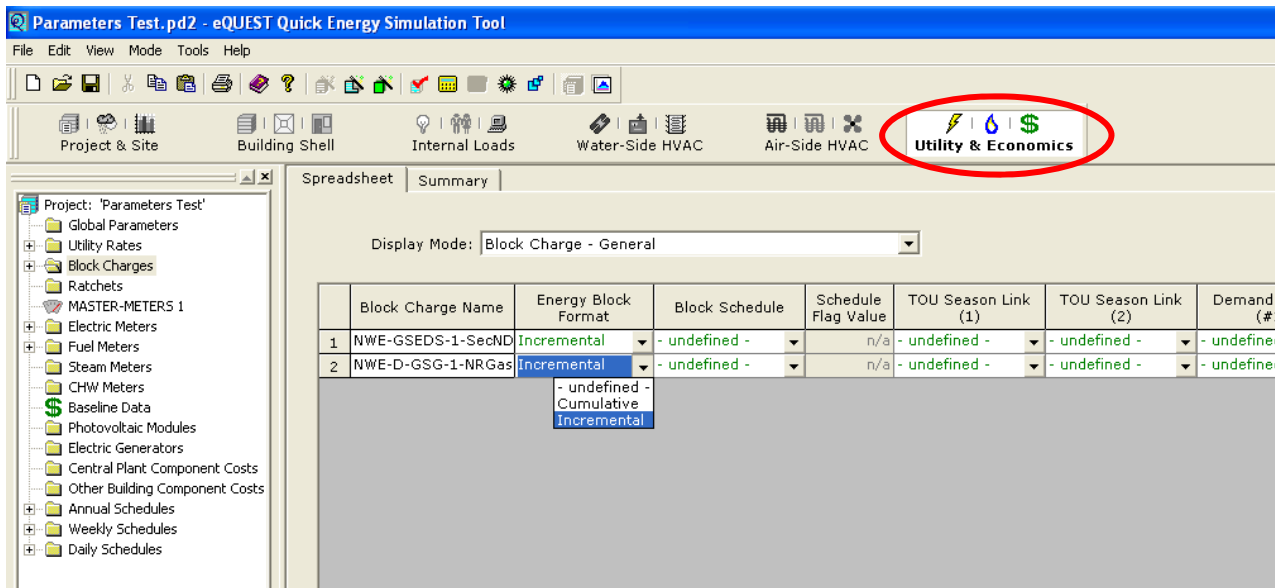
Building Description Language

Building Description Language (BDL) is the computer input language structure of the DOE-2 computation engine. BDL consists of a comprehensive list of commands and keywords that describe building construction, occupancy schedules, lighting schedules, etc. (See example below). Fortunately, eQuest allows the user to create a DOE-2 input file without needing to know BDL.

As mentioned in the Executive Summary of this manual, eQuest integrates the DOE-2 engine with a graphic user interface and wizards that make it a useful design tool for both beginning and experienced energy modelers. Experienced BDL users can go directly to the input file created by eQuest (.inp) and directly edit that file with a text editor. **This manual does not go into the nuances of BDL.** To learn more about direct BDL editing we recommend that you consult DOE-2 manuals **Volume 2: DOE– 2.2 Language Directory** and **Volume 3: DOE 2.2 Building Energy Use and Cost Analysis Program**. These manuals can be found at the DOE–2 website (doe2.com) and at the Integrated Design Lab website (idlbozeman.com).

```
$  ------------------------------------------------------
$            Materials / Layers / Constructions
$  ------------------------------------------------------

"EL1 EWall Cons Mat 2 (15.05)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 15.05
   ..
"EL1 Roof Cons Mat 4 (31.45)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 31.45
   ..
"EL1 IWall Cons Mat 2 (0.91)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 0.91
   ..
"EL2 EWall Cons Mat 2 (16.34)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 16.34
   ..
"EL2 Roof Cons Mat 4 (2.8)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 2.8
   ..
"EL1 UFMat (G.1.U2.M1)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 13.581
   ..
"EL2 UFMat (G.S1.U2.M1)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 12.1238
   ..
"EL2 UFMat (G.E2.U3.M1)" = MATERIAL
   TYPE              = RESISTANCE
   RESISTANCE        = 7.83091
   ..
```

PARAMETRIC RUNS

Parametric runs provide a secondary means to define and run multiple, alternative simulation cases, where each new case is a parametric variation of the base case.   Although similar to EEM runs, Parametric Runs modify the base building as defined in the Detailed Interface, rather than the SD or DD Wizard.   In general, Parametric Runs are more detailed and flexible than the EEM Wizard, but require more insight and steps to define.

NOTE: The only changes that can be made are changes to the attributes of the **existing** building components. No components may be created using Parametric Runs.

CREATING PARAMETRIC RUNS

Making Parametric Runs involves up to 6 steps, depending on the users preferred approach. The first approach requires that global parameters be defined. The second approach defines parametric runs and components which reference BDL commands and keywords directly, instead of requiring global parameters to be user defined. The use of global parameters is recommended when the parameter is a numeric value. The flow diagram is presented below.

STEP 1 Define Global Parameters
STEP 2 Assigning Global Parameters
- -

STEP 3 Defining Parametric Runs
STEP 4 Defining Parametric Components
STEP 5 Run Parametric Simulations
STEP 6 Analyze Parametric Simulation Results
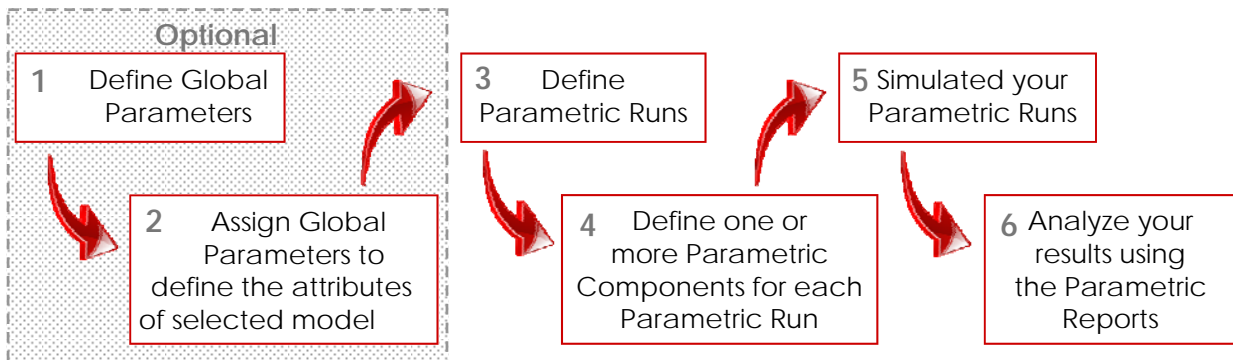
Examples of runs made using Parametric Runs are as follows:

Altering the efficiency, static pressure, head, operating temperature, performance, curve, or other property of an HVAC system.

Altering the solar/optical properties of a user-defined glass type.

Changing the assignment of glass types to any or all windows (the glass type must have been previously searched and defined from the library).

Altering the insulation levels in the walls or roofs.

Altering the lighting power density in one or more spaces.

Altering the orientation of the building, enabling automatic daylighting controls.

Altering the schedule of operations for lights, people, and equipment.

Altering the geometry (for example, dimensions or placements) of walls, roofs, buildings shades, etc.

Examples of runs that **cannot** be made using Parametric Runs are as follows:

Comparing rooftop systems versus built-up systems. If the rooftop system were the base case, defining the built-up case would require that circulation loops, pumps, and primary equipment be crated. This cannot currently be done using Parametric Runs. Instead, save the file as a different, unique name to manually create the built-up roof and separately run the two cases.

Changing HVAC system TYPEs using "Parameters". No DOE-2 DL "TYPE" keyword may be changed using Parameters. Instead, define Parametric Runs that directly reference BDL command/keywords. See the following pages and example for more information on BDL command keywords.

Installing skylights not included in the base case. To create a Parametric Run involving skylights, define them all within the base case, but dimension them to be of infinitesimal size. For the alternative run, "with skylights", simply increase the dimensions to the desired size. Remember that a parameter must be defined in the base model before it can be modified and analyzed through parametric runs.

Installing building shades not included in the base case. This is the same situation as described with the skylights above. Before going into Detail Data Edit, include all the desired building shades within the model, but dimension the size to be infinitesimal height. For the alternative run, simply increase the height to the desired dimension. Note that DOE-2 considers **Fins and Overhangs** to be properties of each window, thus these can be added without the trick of using infinitesimal dimensions.

Making parametric runs that involve retrieving items from the BDL Library or from the User Library. Be sure to retrieve all desired objects while in the base case, then alter the assignment references to them in the parametric runs. This technique will work for all objects that are permitted to be unused/unassigned during a simulation. Examples of objects that can be unassigned during a simulation include: opaque constructions, glass types, schedules, and polygons. Examples of objects that **cannot** remain unassigned during a simulation include: spaces and zones, HVAC systems, and primary equipment (loops, pumps, chillers, boiler, etc.)

In this Module series, we will not be getting into the detail of BDL (Building Description Language). We will explore creating parameters with numeric values only. If the user would like to get more in depth with Parametric Runs, please see other manuals such as **eQUEST's Introductory Tutorial** and the **Language Dictionary** located in **eQuest** manual **Volume 2: DOE-2.2**. Another resource is the Help menu within eQuest. Section 5 is dedicated to Parametric Runs in the **Modeling Procedures Quick Reference** guide. This **Modeling Procedures Quick Reference** guides you through a few different scenarios based on their baseline model.

STEP 1: DEFINE GLOBAL PARAMETERS

As mentioned previously, the use of global parameters is optional, but recommended when the parameter is a numeric quantity. Also, remember that a parametric value must exist in the base model before it can be changed under Parametric Runs.

To start, confirm that the mode is set to "**Detailed Data Edit**."
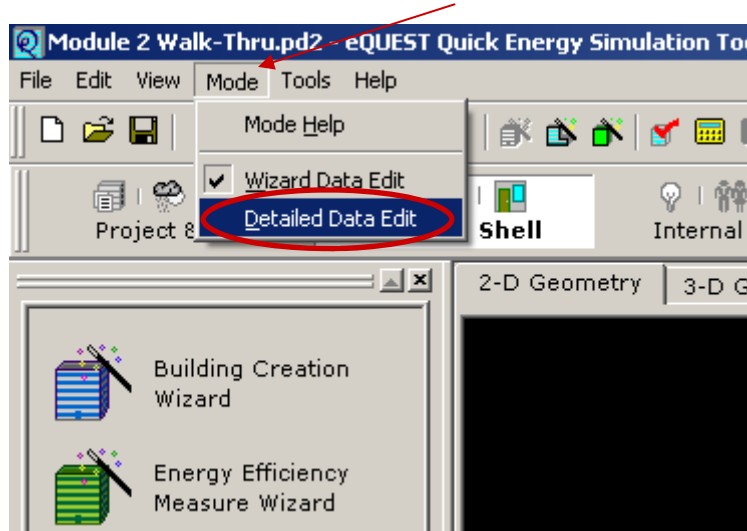
To define a Global Parameter right click on **Global Parameters** in the Component Tree. Then the Create Parameter box will appear. Select **Create Global Parameter**.
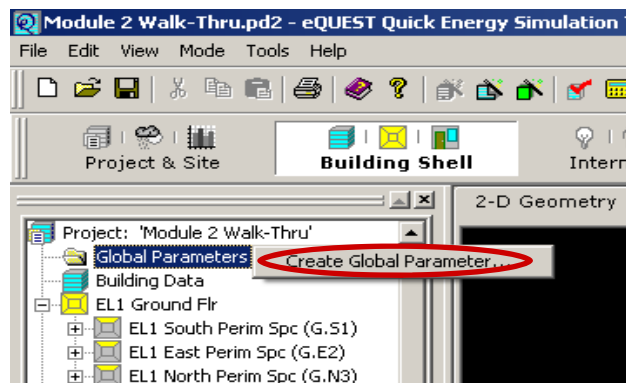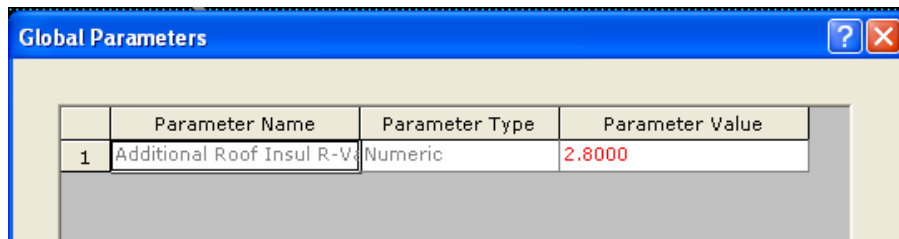
At the "Create Parameter" dialog box, name the parameter, define the parameter type (a numeric value is used in our example), and specify the parameter value.

In the **Parameter Name** field, type in the desired name (32 characters maximum). It is recommended to copy the name (Ctrl + C) for ease in Step 2. If the name could not be copied, it can be entered manually when needed in Step 2, but it must be replicated exactly how it was created with the same capitalization, spacing, and any short cut names spelling. Select "**Numeric Value**" under the **Parameter Type** pull down option menu. Enter the unit of the parameter in the **Parameter Value** field. For example, if dealing with roof insulation, enter the R-value of the parameter that you wish to simulate.
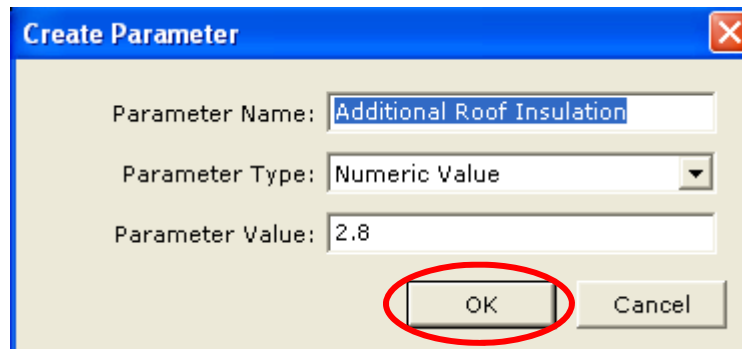
After you press "**OK**", the Global Parameters dialog is displayed and the parameter is added to the Component tree under the Global Parameters heading. To edit any global parameter double click it on the component tree.

STEP 2: ASSIGNING GLOBAL PARAMETERS

Having DEFINED a global parameter, you must also ASSIGN the parameter to a selected BDL keyword. In this example, the global parameter will be assigned to the roof layers description, in order to specify the amount of additional insulation included in the roof construction.

To do so, double click on the desired component in the Component Tree. In this example, double click the **Roof Construction Layer** . This will display the **Construction Layers Properties** dialog box. (Depending on what component you are selecting either **the Surface Construction, Layers, and Material Properties**; **Space Properties**; **Glass Type Properties, or Schedule Properties** dialog will appear. Note: In the **Layers** tab the items under **Material Name** list are in order from outside material to inside material).
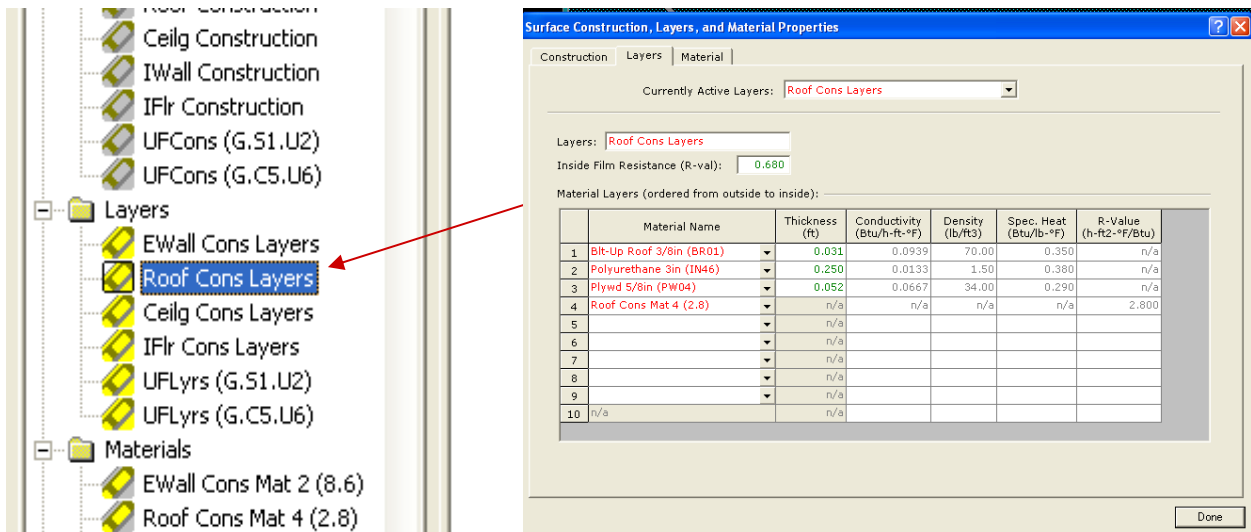
Next, select the **Materials** tab.

From the **Currently Active Building Material** field select the component you want to modify from the pull down list. In this example, we will be modifying **Roof Cons Mat 4**.
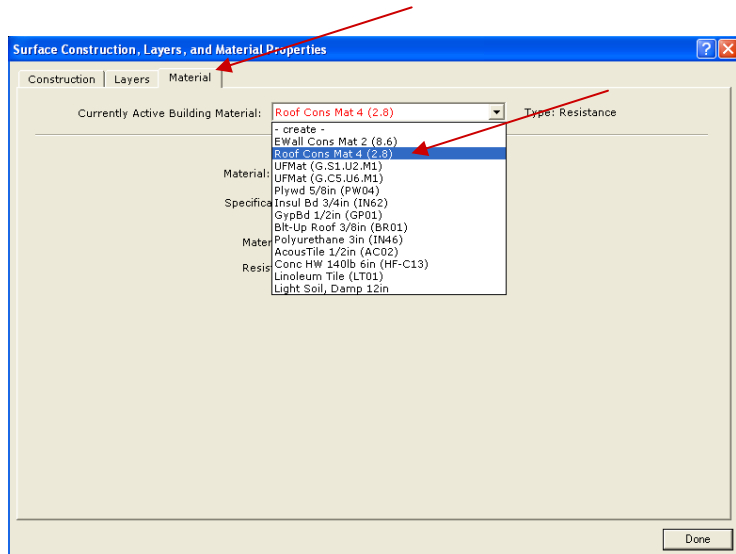
Next, right click on the "**Resistance**" input field and select "**Edit/ View User Expression**". This displays the User Input Expression dialog (shown in lower screenshot) into this initially blank space.
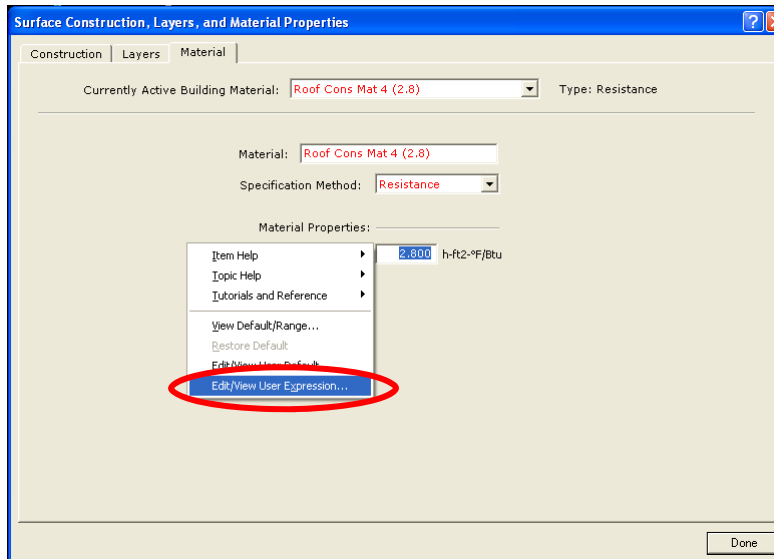
The User Input Expression dialog box will appear. Type **parameter** followed by an open and closed parenthesis. Inside the parenthesis, hit Ctrl + V to paste in the name of the global parameter copied in the previous step. If the name was not copied previously, type the exact name in this dialog box. The name must match exactly, with the same capitalization and any short cut names for the components. After the component name is input, confirm that it matches to the previous name and then press **OK.**
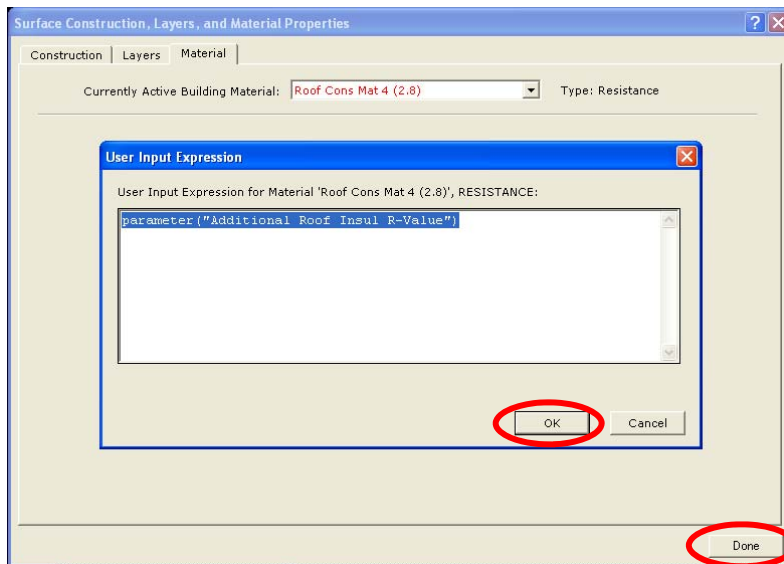
Confirm that the value now reads ,as the value input for the parameter. In this example, the value should read 2.8, the value of the global parameter defined previously. This dialog box can now be closed when all the correct information is input, click **DONE**.

Note that the magenta font indicates that the input value is derived from an expression. In this case, assigning a global parameter to the input.

STEP 3: DEFINING PARAMETRIC RUNS

Once the global parameters have been defined and assigned we can create a Parametric Run.

In the Tools menu select **Parametric Runs** from the drop down list. The **Parametric Run Definition** box will open where you will select **Create Parametric Run**. STEP FOUR will take you through the next tasks.
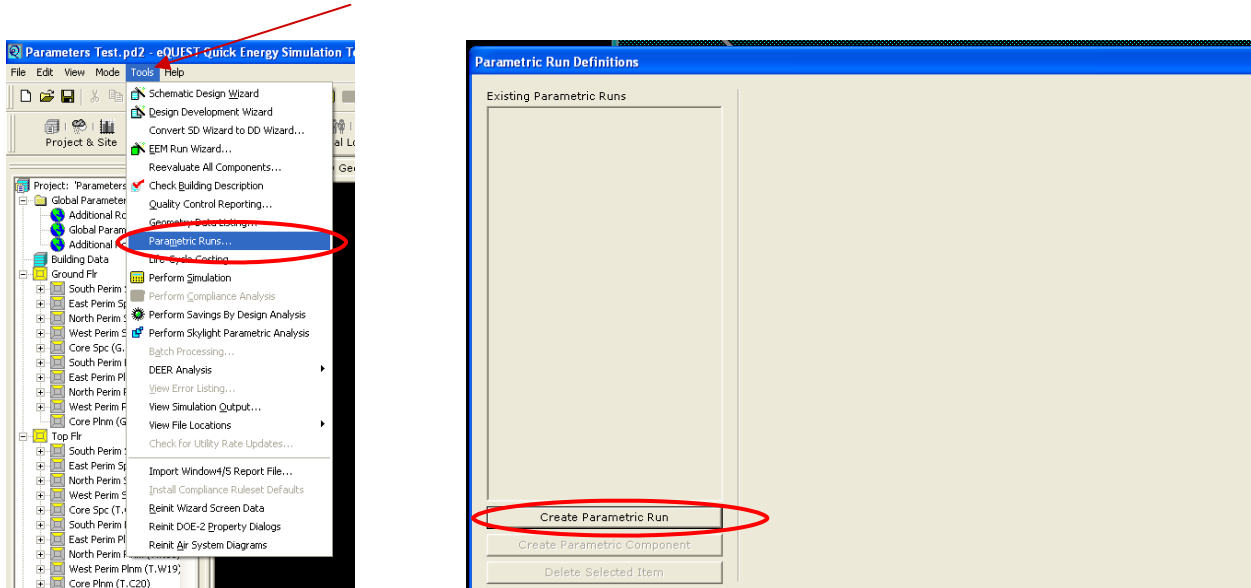
Rename the first parametric run. In this example, "Roof Insul (R18 to 39)" is used.
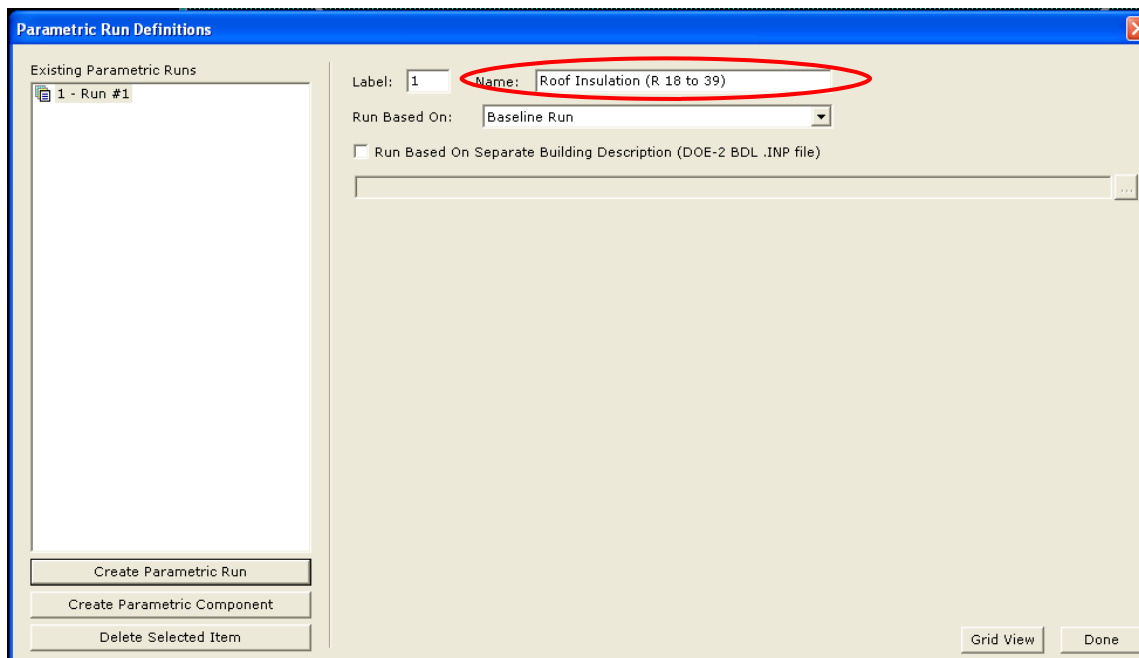
STEP 4: DEFINING PARAMETRIC COMPONENTS

Once the Parametric Run is created, the parametric components can be defined. This alters what the variable within the parametric is. First click **Create Parametric Component** in the lower left corner of the Parametric Run Definitions dialog.
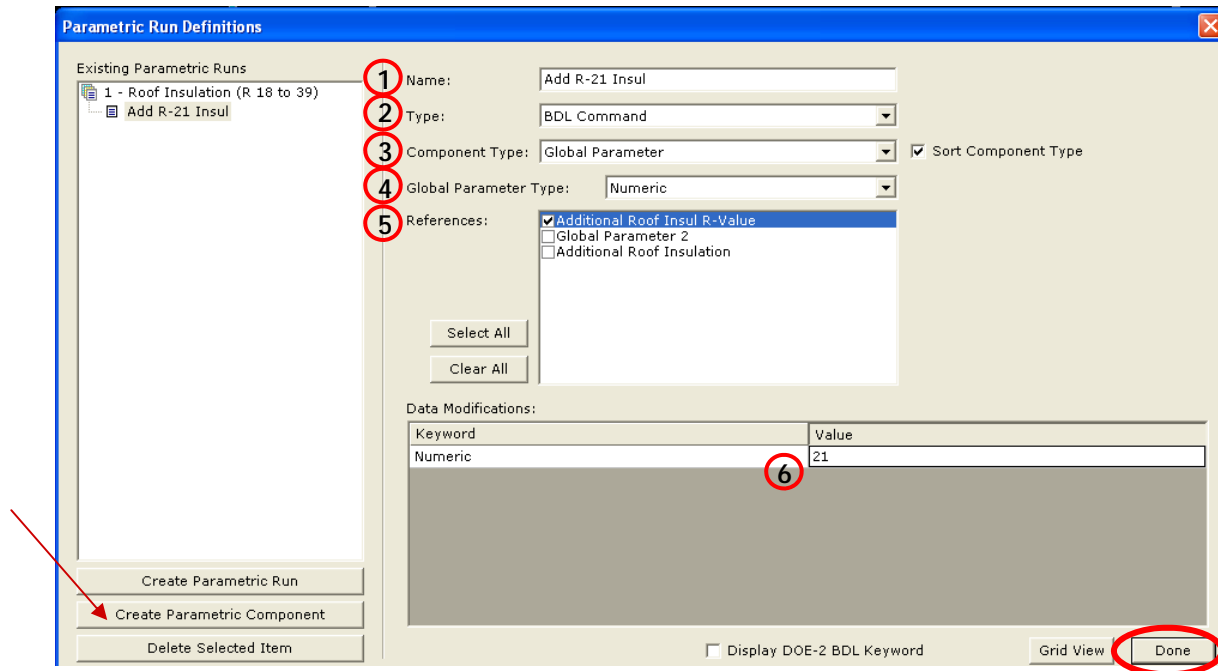
1. **Name.** Name the parametric (32 character maximum).
2. **Type**. Select "**BDL Command**" .
3. **Component Type**. Select **"Global Parameter."** Note that the only component types that appear on this list are components found in the base model. (If global parameters had not yet been defined, "Global Parameters" would not have been on the list.)
4. **Global Parameter Type**. Choose either **Symbolic** or **Numeric**. In this example we choose **Numeric**.
5. **References**. This window lists the components of the type indicated. Place a check in the box next to the corresponding component. In this example, place a check mark on **"Additional Roof Insul R-Value"**.
6. **Value**.   Change the base case parameter. In this example, we changed the R-value from 2.8 to 21.

Press **Done**.

More parametric runs may be created at this point in the process. After all the desired parametric runs are created for the model, they may all be simulated at one time.

STEP 5: RUN PARAMETRIC SIMULATIONS

To perform a simulation click on the calculator button on the tool bar at the top of the Detailed Interface Screen and the **Parametric Run Selection** dialog will appear.
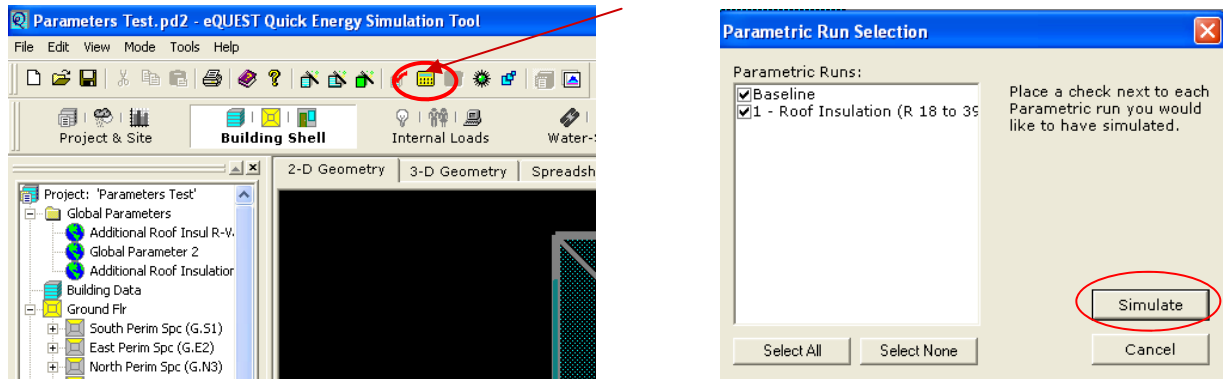
From the runs that you have created, select the desired runs that you would like to simulate. If you do not select all of the runs the Parametric Runs reports will not be fully populated. Click **Simulate** after all the desired runs are selected. You will then be prompted to **save** your project.

A series of **Simulation Progress** dialogs will appear while eQUEST is calculating the results. When the runs are calculated the **Simulation(s) Complete** dialog will appear. Here, select **"View Summary Results/Reports".** This will navigate the user into the Results module.
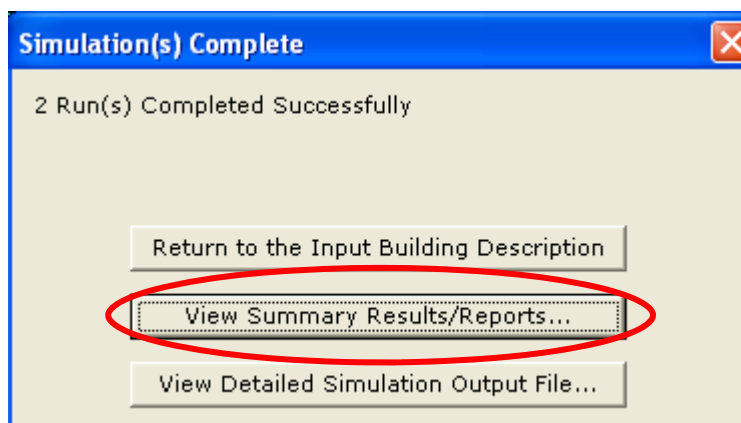
STEP 6: ANALYZE PARAMETRIC SIMULATION RESULTS

After selecting the **"View Summary Results/Reports"**, the user will be navigated to the Results module. You may also navigate into the Results module at any time by clicking on the Results Module button on the tool bar at the top of the Detailed Interface screen.
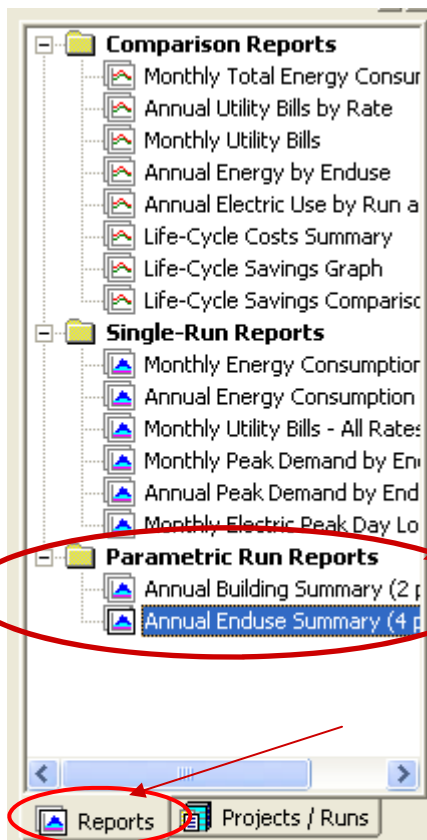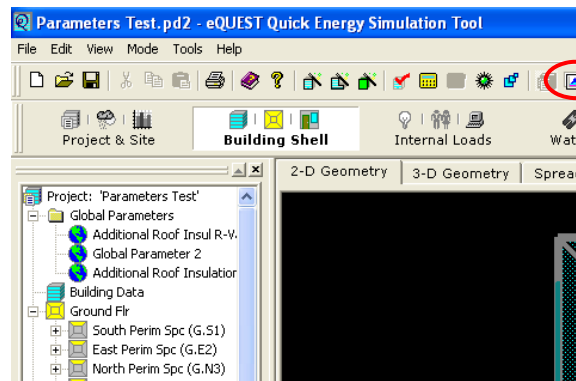
Access to the individual reports can be done by selecting the **Reports** tab at the lower left corner of the Results module screen. In this report tree, all the single run reports are listed as well as the parametric run comparisons. To view the comparisons, select on of the files under the **"Parametric Run Reports" folder**.

Two informative reports are the Annual Building Summary and the Annual Enduse Summary. From the **Reports "tree"** select Annual Building Summary report or the Annual Enduse Summary report.

The parametric report format provides a powerful quality control opportunity. By reporting the incremental and cumulative savings for each run, by enduse, the impacts of each run on each enduse can be closely looked at. A summary of the parametric comparison report is shown below (scaled down in size).

When comparing two or more runs, percentages and **Life Cycle Cost analysis (LCC)** are valuable information to compare. This leads you to a design decision that influences the initial cost of the building as well as the life cycle cost.

MODULE TEXT

Annual Energy and Demand (pg 1 of 2)

		Ann. Source Energy		Annual Site Energy		Lighting	HVAC Energy			Peak	
		Total Mbtu	EUI kBtu/sf/yr	Elect kWh	Nat Gas Therms	Electric kWh	Electric kWh	Nat Gas Therms	Total Mbtu	Elect kW	Cooling Tons
Annual Energy USE or DEMAND											
0	Base Design	766	127.78	55,662	1,962	16,438	16,435	1,854	241	34	16
1	0+Roof Insulation (R 18 to 39)	761	126.86	55,680	1,905	16,438	16,454	1,797	236	34	16

Incremental SAVINGS   (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)

1	0+Roof Insulation (R 18 to 39)	6	0.92 (1%)	-19 (-0%)	57 (3%)	0 (0%)	-19 (-0%)	57 (3%)	6 (2%)	0 (1%)	-0 (-0%)

Cumulative SAVINGS   (values (and % savings) are relative to the Base Case, negative entries indicate increased use)

1	0+Roof Insulation (R 18 to 39)	6	0.92 (1%)	-19 (-0%)	57 (3%)	0 (0%)	-19 (-0%)	57 (3%)	6 (2%)	0 (1%)	-0 (-0%)

Annual Costs (pg 2 of 2)

		Annual Utility Cost					Incentives		LCC
		Electric kWh($)	Electric kW($)	Electric Total($)	Nat Gas Total($)	Total ($)	Owner ($)	Design Team ($)	Total (PV$)
Annual COST									
0	Base Design	$ 4,775	--	$ 4,857	$ 2,770	$ 7,627			$ 52,965
1	0+Roof Insulation (R 18 to 39)	$ 4,776	--	$ 4,859	$ 2,695	$ 7,554			$ 52,403

Incremental SAVINGS   (values are relative to previous measure (% savings are relative to base case cost), negative entries indicate increased cost)

1	0+Roof Insulation (R 18 to 39)	$ -1	--	$ -2	$ 75	$ 73			$ 562

Cumulative SAVINGS   (values (and % savings) are relative to the Base Case, negative entries indicate increased cost)

1	0+Roof Insulation (R 18 to 39)	$ -1	--	$ -2	$ 75	$ 73			$ 562

Annual Electric Energy by Enduse (pg 1 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (kWh)											
0 Base Design	16,438	0	22,788	0	5,608	0	2,857	7,970	0	0	55,662
1 0+Roof Insulation (R 18	16,438	0	22,788	0	5,627	0	2,857	7,970	0	0	55,680

Incremental SAVINGS (MWh)   (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	-0.02 (-0%)	--	0.00 (0%)	0.00 (0%)	--	--	-0.02 (-0%)

Cumulative SAVINGS (MWh)   (values (and % savings) are relative to the Base Case, negative entries indicate increased use)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	-0.02 (-0%)	--	0.00 (0%)	0.00 (0%)	--	--	-0.02 (-0%)

Annual Electric Coincident Peak Demand by Enduse (pg 2 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Coincident Demand (kW)											
0 Base Design	6.4	0.0	6.5	0.0	18.4	0.0	0.0	2.9	0.0	0.0	34.2
1 0+Roof Insulation (R 18	6.4	0.0	6.5	0.0	18.3	0.0	0.0	2.9	0.0	0.0	34.0

Incremental SAVINGS (kW)   (values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	0.18 (1%)	--	--	0.00 (0%)	--	--	0.18 (1%)

Cumulative SAVINGS (kW)   (values (and % savings) are relative to the Base Case, negative entries indicate increased demand)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	0.18 (1%)	--	--	0.00 (0%)	--	--	0.18 (1%)

Annual Electric Non-Coincident Peak Demand by Enduse (pg 3 of 4)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
Annual Energy Non-Coincident Demand (kW)											
0 Base Design	6.4	0.0	6.5	0.0	18.4	0.0	0.5	2.9	0.0	0.0	34.2
1 0+Roof Insulation (R 18	6.4	0.0	6.5	0.0	18.3	0.0	0.5	2.9	0.0	0.0	34.0

Incremental SAVINGS (kW)   (values are relative to previous measure (% savings are relative to base case demand), negative entries indicate increased demand)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	0.18 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.18 (1%)

Cumulative SAVINGS (kW)   (values (and % savings) are relative to the Base Case, negative entries indicate increased demand)

	Ambient Lights	Task Lights	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	0.00 (0%)	--	0.00 (0%)	--	0.18 (1%)	--	0.00 (0%)	0.00 (0%)	--	--	0.18 (1%)

Annual Fuel Energy by Enduse (pg 4 of 4)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
Annual Energy USE (MBtu)										
0 Base Design	0.0	185.4	0.0	0.0	0.0	0.0	0.0	10.8	0.0	196.2
1 0+Roof Insulation (R 18	0.0	179.7	0.0	0.0	0.0	0.0	0.0	10.8	0.0	190.5

Incremental SAVINGS (MBtu)   (values are relative to previous measure (% savings are relative to base case use), negative entries indicate increased use)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	--	5.70 (3%)	--	--	--	--	--	0.00 (0%)	--	5.70 (3%)

Cumulative SAVINGS (MBtu)   (values (and % savings) are relative to the Base Case, negative entries indicate increased use)

	Misc Equip	Space Heating	Space Cooling	Heat Reject	Pumps & Aux	Vent Fans	Ht Pump Supp	Dom Ht Wtr	Exterior Usage	Total
1 0+Roof Insulation (R 18	--	5.70 (3%)	--	--	--	--	--	0.00 (0%)	--	5.70 (3%)

CONCLUSION

Energy modeling, especially when considered early in the design process, can have a significant effect on the quality of the design. It is a simple way to consider the impact of sustainable strategies, identify positive and negative features, and determine ways to improve overall energy efficiency and building performance. By using the information outlined in this module, anyone can create a sophisticated energy model and analyze its energy usage.

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- NorthWestern Energy in Montana
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