DesignBuilder

# Extensibility Tools and API User Guide

DesignBuilder v7.3

October 2023

# Contents

# Extensibility Tools User Guide

## Overview

DesignBuilder can be extended through scripts or plugins. Each system is targeted at a different use-case and different levels of complexity. Both systems may be used at the same time, and multiple active plugins and scripts are supported.

Scripts are intended to hook into certain stages of a DesignBuilder simulation in order to modify or report on the process. Plugins are a superset of Scripts, providing extra functionality such as the ability to create a custom sub-menu in DesignBuilder's main-menu, which allow for ad-hoc processing of DesignBuilder data.

Scripts can be written in the C# or Python programming languages. Plugins are written in the C# programming language.

## The DesignBuilder API

The DesignBuilder API can be accessed through all of DesignBuilder scripting and plugin development options, including Python and C# scripting and plugins.

### DB.Api.Environment

For C#, DesignBuilder exposes its API to both extensibility systems by setting the ApiEvironment property on the IProperties interface, which IScript and IPlugin inherit. The Api.Environment object is the root API object, which can be used to access the rest of the API.

For Python, the global variable api_environment is set.

During start-up, DesignBuilder instantiates a single DB.Api.Environment object. This singleton object is used by all active scripts and plugins, and as such, a script or plugin cannot rely on the state of the system at any given time. For example, suppose a script modifies the system at point A in a simulation. The script is then called again at point B and may expect the state of the system to be as it was at point A. However, it is possible that another script or plugin (or even DesignBuilder itself) also modified the system between point A and B. We therefore suggest that no assertions are made about the state of the system at any given point.

DB.Api.Environment is partitioned into several major areas, including:

- CFD operations, accessible via DB.Api.Environment.CfdOperations, which exposes functionality relating to DesignBuilder's CFD system
- Event subscriptions, accessible via DB.Api.Environment.Events, which allow for scripts and plugins to be notified of certain changes to the system
- HVAC operations, accessible via DB.Api.Environment.HvacOperations, which exposes functionality relating to DesignBuilder's HVAC system
- Site operations, accessible via DB.Api.Environment.Site, which exposes functionality relating to the active site. Functionality relating to Buildings, Blocks, Zones, Surfaces, etc can be accessed from the Site object
- Environment operations, accessible directly from DB.Api.Environment, which exposes a lot of miscellaneous functionality such as undo/redo, navigation, etc.

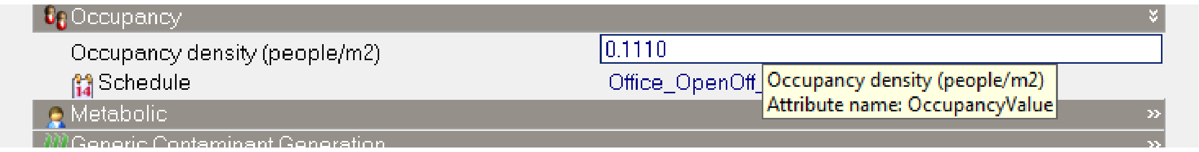
## Object Attributes

DesignBuilder uses object attributes to store much of the data for any given object (such as a building, block, zone, etc). An attribute is simply a key-value pair of strings that can be accessed via the GetAttribute and SetAttribute methods on any object that supports attributes. For example, to get the occupancy density for a zone you would use

DB.Api.Zone.GetAttribute("OccupancyValue"). To set the occupancy density to 0.1 you would use DB.Api.Zone.SetAttribute("OccupancyValue", (0.1).ToString()).

Generally, an object can have a lot of attributes and it is impractical to list and describe each one. Nevertheless, to get full use of the API you will need to know an attribute's name, or key, so that you can access or change its value. To help with this, you can enable DesignBuilder to show an attribute's name in a tooltip in DesignBuilder's GUI. To do this, simply enable Tools > Program options > Interface > Interface Style > Show attribute names in tooltips (you will need to enable "Show Tooltips in Model data" first, if it is not already enabled).

With "Show attribute names in tooltips" enabled, you can hover over an attribute in DesignBuilder and the tooltip will display that attribute's name, which you can then use with GetAttribute and SetAttribute. For example:



Occupancy

Occupancy density (people/m2) 0.1110

Schedule Office_OpenOff

Occupancy density (people/m2)
Attribute name: OccupancyValue

Metabolic

Generic Contaminant Generation

## DesignBuilder Hooks

During a DesignBuilder simulation, DesignBuilder can pass control to a script or plugin at certain points in the process. These points are called hook points, or hooks, or call points. Both scripts and plugins have access to the same hooks and any implemented hooks are called for each active script and plugin. That is to say, if you have 2 active plugins and 3 active scripts, all of which implement the same hook, DesignBuilder will pass control to all 5 hooks in the following order: All scripts in the order they appear in the Script Manager, followed by all plugins in alphabetical order of the plugin's assembly name.

The following hooks are available, with each hook point (in a category) being called in the order they are written:

Simulation:

- BeforeEnergyIdfGeneration (C#)/before_energy_idf_generation (Python) is called immediately before the EnergyPlus IDF file is created
- **BeforeEnergySimulation (C#)/before_energy_simulation (Python)** is called immediately before an EnergyPlus simulation starts
- **AfterEnergySimulation (C#)/after_energy_simulation (Python)** is called immediately after an EnergyPlus simulation has finished
- **BeforeHeatingIdfGeneration (C#)/before_heating_idf_generation (Python)** is called immediately before the EnergyPlus IDF file is created for a Heating design simulation
- **BeforeHeatingSimulation (C#)/before_heating_simulation (Python)** is called immediately before a Heating design simulation starts
- **AfterHeatingSimulation (C#)/after_heating_simulation (Python)** is called immediately after a Heating design simulation has finished
- **BeforeCoolingIdfGeneration (C#)/before_cooling_idf_generation (Python)** is called immediately before the EnergyPlus IDF file is created for a Cooling design simulation
- **BeforeCoolingSimulation (C#)/before_cooling_simulation (Python)** is called immediately before a Cooling design simulation starts
- **AfterCoolingSimulation (C#)/after_cooling_simulation (Python)** is called immediately after a Cooling design simulation has finished

Optimisation:

- **BeforeOptimisationStudy (C#)/before_optimization (Python)** is called immediately before an optimisation study starts
- **AfterOptimisationStudy (C#)/after_optimisation (Python)** is called immediately after an optimisation study has finished
- **OnDesignVariableChanged (C#)/on_design_variable_changed (Python)** is called when an optimization design variable of type "Custom Script" is changed before an optimisation simulation. The id and value of the variable are passed to this hook point. The Id's start at 10000 and are ordered as they appear in the Design Variables window
- Note that optimisation will run multiple simulations and for each simulation the **BeforeEnergyIdfGeneration** and **BeforeEnergySimulation** hooks are called

CFD:

- BeforeCfdSimulation (C#)/before_cfd_simulation (Python) is called immediately before a CFD simulation starts
- **AfterCfdSimulation (C#)/after_cfd_simulation (Python)** is called immediately after a CFD simulation has finished

Daylight Simulation:

- BeforeDaylightSimulation (C#)/before_daylight_simulation (Python) is called immediately before a daylighting simulation starts
- **AfterDaylightSimulation (C#)/after_daylight_simulation (Python)** is called immediately after a daylighting simulation has finished

Cost and Carbon:

- **BeforeCostAndCarbon (C#)/before_cost_and_carbon (Python)** is called immediately before generating a cost and carbon report
- **AfterCostAndCarbon (C#)/after_cost_and_carbon (Python)** is called immediately after generating a cost and carbon report

Misc:

- **AtCommandLine (C#)/at_command_line (Python)** is called when DesignBuilder is run from the command-line with the argument /process=ExternalCommand_<arg>, where arg is an optional string that is passed to the hook point
- **ScreenChanged (C# plugin v2 only)** is called when DesignBuilder changes screen. An enum corresponding to the new screen is passed as an argument.
- **ModelLoaded (C# plugin v2 only)** is called after a model (dsb file) has been opened or a new model has been created.
- **ModelUnloaded (C# plugin v2 only)** is called after a model has been unloaded (the file has been closed).

Note that before each hook point is called[1], for C#, the ActiveBuilding property on IProperties will be set to the instance of the building that the hook point is called by. For Python, the active_building global variable will be set. In the case that a building is not currently selected, ActiveBuilding/active_building will be null.

See section Plugin API Versions for more information on the available plugin versions.

[1] Except for ModelLoaded and ModelUnloaded

# Extending DesignBuilder With Scripts

## What is a Script?

A script is a means for users to extend a DesignBuilder simulation by providing custom functionality via the C# or Python programming languages. A script may modify or report on DesignBuilder's internal data at each of the hook points described in section

*DesignBuilder* Hooks.

Unlike a plugin, a script may only interact with DesignBuilder at the defined hook points and only exist during the lifetime of a simulation.

Scripts are saved with a model in the .dsb file, unlike plugins, which are separate from a model.

## Writing a C# Script

To extend DesignBuilder with a script using the C# programming language:

1. Open DesignBuilder, open or create a model and navigate to Tools > Scripts. This will open the *Script Manager*.

2. In the Script Manager, ensure the *Enable scripts* option is checked and click on the *Script* sub-item, which will open the *Select the Script* dialog. Here, you can see a list of scripts that are supplied with DesignBuilder. You will also notice that DesignBuilder supports three types of scripts; CS-Script, EMS, and Python-Script

   EMS scripts do not support the DesignBuilder API and work differently from CS-Scripts and Python-Scripts. Documentation for EMS scripts can be found here.

   Python-Scripts are not fully supported in DesignBuilder v6.0. Access to the API will be provided for Python scripts in v6.2.

3. In the Select the Script dialog, open the CS-Script tree folder and select any existing script. From here you may create a new script, or copy or edit the selected script by using the icons at the bottom of the dialog.

   Press the + button to create a new script.

4. The *Edit Script* window provides a basic text editor into which you can write your code. It is suggested, however, that an editor more suited to C# development is used to write your script from which you can copy the code into the Edit Script text box.

   Generally, a script will consist of a single class. You may choose to scope your class to a namespace, but it is not necessary. Copy the following code into the Edit Script text box

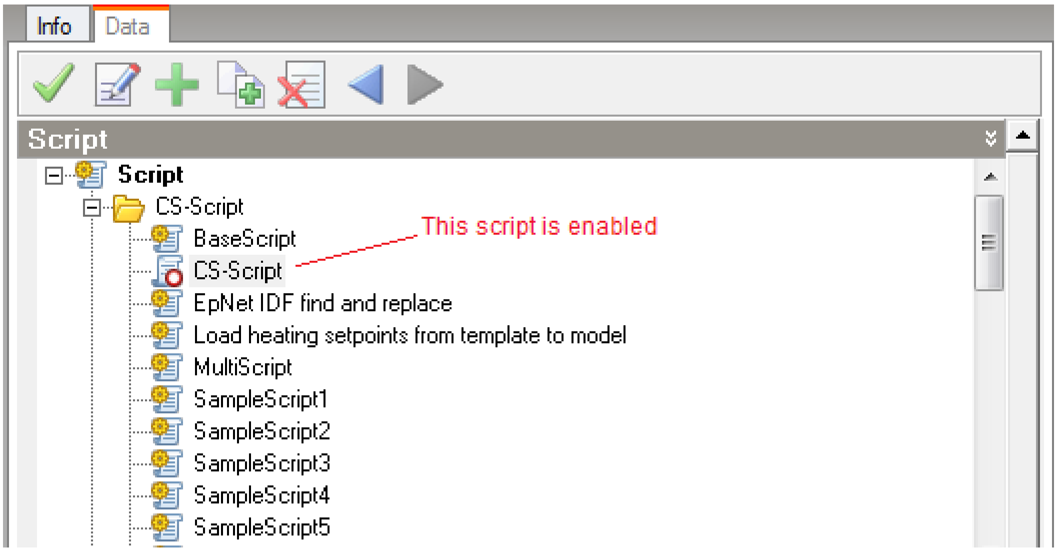
   ```
   public class ExampleScript
   {
   }
   ```

5. Click on the *Compile script* button in the Info pane and you should see the message "Script compiled with no errors." Press the OK button on the message box. The Compile script button is a convenient way of checking your script is syntactically correct before we run a simulation.

6. In order to enable this script to run during a simulation, make sure the *Enable program* checkbox in the Edit Script window is checked. It can be found just above the Edit Script textbox under the *Script*

header.

7. Press the OK button on the Edit Script window. This will take us back to the Script Manager window. You should now see your script listed in the tree view of the data pane with a red circle on its icon. This indicates that the script is enabled and will be run during a simulation.



8. Press the OK button on the Script Manager window. Navigate to the Simulation tab in DesignBuilder and run a new simulation. The simulation should complete as normal.

   This is the basic process required to create, write, and enable a script in DesignBuilder. The script we wrote in step 4, however, doesn't do a whole lot. In order for the script to be more useful it needs to hook in to DesignBuilder through various entry points.

9. Navigate back to the Script Manager and click on the script created in step 4. To edit the script, click the *Edit highlighted item* button , which will take you back to the  Edit Script window, where you can alter the script's code.

*10.* In order for DesignBuilder to pass control of a simulation to a script, a script must expose at least one of the hook points described in section

11. *DesignBuilder* Hooks. Each hook point defines a different stage in a simulation. A script can expose as many hook points as it chooses.

    From a C# point-of-view, a script must implement the DB.Extensibility.Contracts.IScript interface. This interface declares a method for each hook point that DesignBuilder can call.

    Because it's likely that a script will not want to provide an implementation for every hook point, a base class (DB.Extensibility.Contracts.ScriptBase) is also provided, which implements default functionality for the IScript interface.

    Add the following code to the existing script:

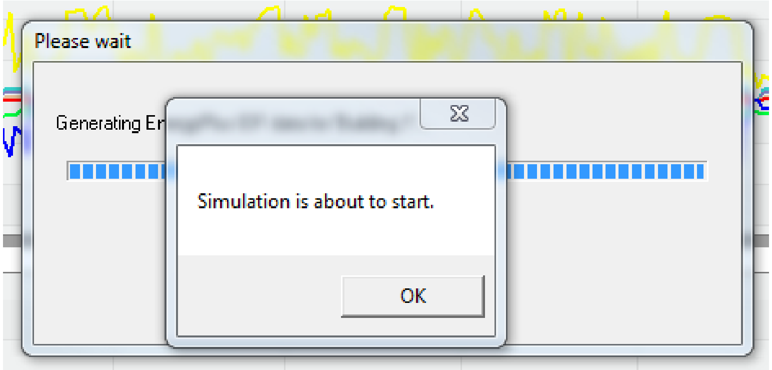
```
using DB.Extensibility.Contracts;

public class ExampleScript : ScriptBase, IScript
{
}
```

12. The script now does a bit more than the previous version, but not much. Technically, it exposes all hook points to DesignBuilder, but each is implemented with the default behaviour provided by DB.Extensibility.Contracts.ScriptBase. The default behaviour of ScriptBase is to do nothing. To remedy that, the script will have to override one of the methods. For the purposes of this example override the

BeforeSimulation hook point as follows

```
using System.Windows.Forms;
using DB.Extensibility.Contracts;

public class ExampleScript : ScriptBase, IScript
{
    public override void BeforeEnergySimulation()
    {
        MessageBox.Show("Simulation is about to start.");
    }
}
```

13. Click the Compile script button to make sure the code is syntactically correct, then press the OK button on the Edit Script window. Now press the OK button on the Script Manager window and run a new simulation. After the Loading data and Generating IDF stages of simulation, a messages box should appear as depicted below



Simulation is about to start.

To continue with the simulation press the OK button on the message box.

14. The script is now a fully functioning script that displays a message before simulation starts. It's not hard to imagine that this script could be modified to open a more useful window that allows users to view, or modify certain options before continuing with the simulation.

For more ideas of what can be done with a script please examine the example scripts provided by default. They can be found in the Script Manager window.

## Writing a Python Script

DesignBuilder Python scripting is based on the IronPython implementation of the Python v2.7 programming language.

To extend DesignBuilder with a script using the Python programming language:

1. Open DesignBuilder, open or create a model and navigate to Tools > Scripts. This will open the *Script Manager*.

2. In the Script Manager, ensure the *Enable scripts* option is checked and click on the *Script* sub-item, which will open the *Select the Script* dialog. Here, you can see a list of scripts that are supplied with DesignBuilder. You will also notice that DesignBuilder supports three types of scripts; CS-Script, EMS, and Python-Script.

3. In the Select the Script dialog, open the Python-Script tree folder and select any existing script. From here you may create a new script, or copy or edit the selected script by using the icons at the bottom of the dialog.

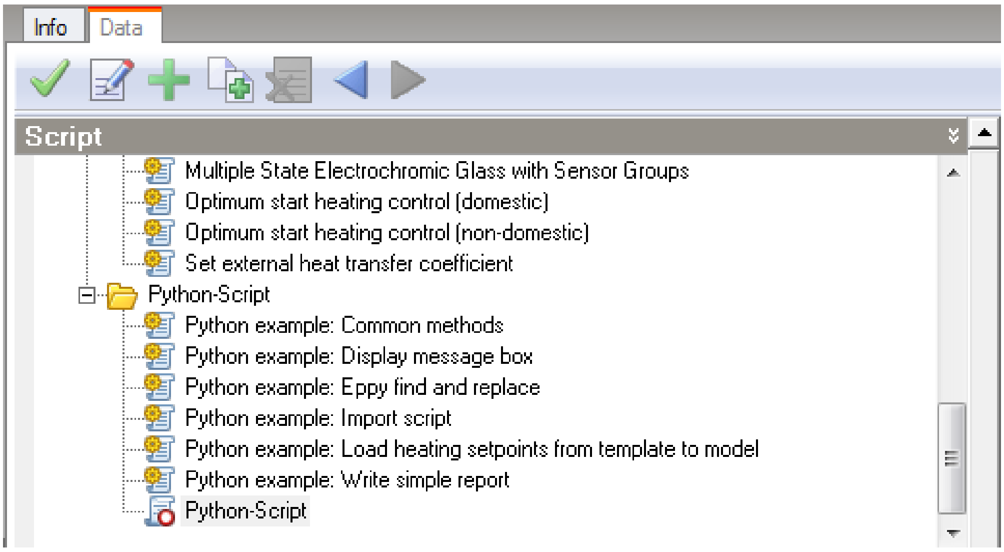
Press the button to create a new script.

4. The *Edit Script* window provides a basic text editor into which you can write your code. It is suggested, however, that an editor more suited to Python development is used to write your script from which you can copy the code into the Edit Script text box.

   In order to enable a script to run during a simulation, make sure the *Enable program* checkbox in the Edit Script window is checked. It can be found just above the Edit Script textbox under the *Script* header.

   The *Compile script* button in the Info pane is a convenient way of checking your script is syntactically correct before we run a simulation.

5. Press the OK button on the Edit Script window. This will take us back to the Script Manager window. You should now see your script listed in the tree view of the data pane with a red circle on its icon. This indicates that the script is enabled and will be run during a simulation.



- Multiple State Electrochromic Glass with Sensor Groups
- Optimum start heating control (domestic)
- Optimum start heating control (non-domestic)
- Set external heat transfer coefficient
- Python-Script
  - Python example: Common methods
  - Python example: Display message box
  - Python example: Eppy find and replace
  - Python example: Import script
  - Python example: Load heating setpoints from template to model
  - Python example: Write simple report
  - Python-Script

6. Press the OK button on the Script Manager window. Navigate to the Simulation tab in DesignBuilder and run a new simulation. The simulation should complete as normal.

   This is the basic process required to create, write, and enable a script in DesignBuilder. Our script, however, is empty and doesn't do a whole lot. In order for the script to be more useful it needs to hook in to DesignBuilder through various entry points.

7. Navigate back to the Script Manager and click on the script created in step 4. To edit the script, click the *Edit highlighted item* button , which will take you back to the  Edit Script window, where you can alter the script's code.

*8.* In order for DesignBuilder to pass control of a simulation to a script, a script must expose at least one of the hook points described in section

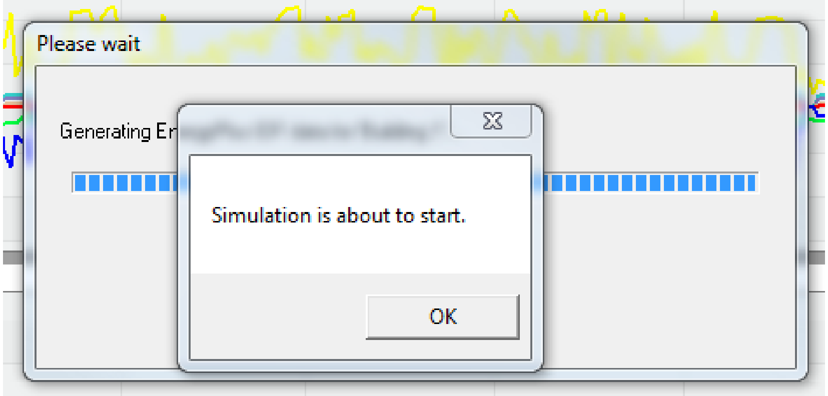
9. *DesignBuilder* Hooks. Each hook point defines a different stage in a simulation. A script can expose as many hook points as it chooses.

   From a Python point-of-view, all that is required is for a script to define a function with the same name as one of the hook points.

   Add the following code to the existing script:

```
import ctypes

def before_energy_simulation():
    ctypes.windll.user32.MessageBoxW(
        0, "Simulation is about to start.", "Title", 0)
```

10. Click the Compile script button to make sure the code is syntactically correct, then press the OK button on the Edit Script window. Now press the OK button on the Script Manager window and run a new simulation. After the Loading data and Generating IDF stages of simulation, a messages box should appear as depicted below



Simulation is about to start.

To continue with the simulation press the OK button on the message box.

11. The script is now a fully functioning script that displays a message before simulation starts. It's not hard to imagine that this script could be modified to open a more useful window that allows users to view, or modify certain options before continuing with the simulation.

    For more ideas of what can be done with a script please examine the example scripts provided by default. They can be found in the Script Manager window.

## Importing Other Scripts Into a Script

A DesignBuilder script can import 1 or more other scripts before it is run. This is useful if you want to combine scripts that may expose different hook points as if it were a single script, or if you want to store utility classes/methods in some base script, which you can use in other scripts.

In order to import a C# script into another, simply use the directive css_import <other script's name> as a comment at the top of the importing script. For example, say "ScriptParent" intends to import functionality from "ScriptChild", ScriptParent would include //css_import ScriptChild at the top of its file (this can be before or after the using statements). For Python, use the from/import directives. For example, to import a method called "show_message" from "ScriptChild", ScriptParent would include from ScriptChild import show_message

It is important to note that both the parent script and all child scripts must be enabled in the Script Manager window.

The name of the script is the one that appears in the Script Manager window with the following alterations: Any spaces or instances of the characters '<' (less than), '>' (greater than), '\' (back slash), '/' (forward slash), '?' (question mark), ':' (colon), ';' (semi-colon), '"' (quotation mark), ',' (comma), '*' (asterisks) will be replaced by underscores.

For example, a script with the name "Example: My script", will need to be imported with the name "Example__My_script".

If more than one enabled script implements the same hook point, each one will be executed in alphabetical order of the class name that implements it (C#), or the filename that implements it (Python).

# Extending DesignBuilder with Plugins

## What is a Plugin?

A plugin provides a more complete way of extending DesignBuilder. Plugins are a superset of C# Scripts so they are able to take advantage of the same hook points that scripts can use with the addition of being able to add a menu to DesignBuilder's top-level menu (if they choose).

Unlike scripts, which are interpreted at runtime, plugins are pre-built assemblies that are loaded by DesignBuilder. This gives the developer more freedom than a script because they are able to reference other assemblies and nuget packages.

Plugins can be used:

- As a more complete scripting solution. By implementing only the hook points and not providing a menu structure, a plugin will not be visible to a user but will still be used by DesignBuilder during a simulation. This is useful if you want to reference third-party assemblies, or your own libraries in your solution
- To allow for ad-hoc calculations, reports, or modifications to DesignBuilder's data. Because plugins can create their own menu in DesignBuilder they do not rely on being called by the hook points like scripts do. Plugin operations can be called whenever a menu item is pressed
- A more complete extension of DesignBuilder. Because plugins are virtually unrestricted they may provide a complete GUI-based solution. Whilst they cannot integrate with DesignBuilder's GUI, they can launch their own windows and work in a very similar manner to DesignBuilder's own Model Data Grid View (which can be found in Tools > Model data grid view… when the Edit tab is active)

One downside of the plugin system, however, is that **plugins are not saved with the .dsb file**. If you therefore want to share a model and a plugin is vital to your work, you will also need to share the plugin assemblies. Scripts on the other hand are saved with the model.

## Writing a Plugin

DesignBuilder loads plugins at start-up from .NET assemblies. Therefore, to develop a plugin you must create a new .NET class library. It is assumed that you already know how to do this as it is out of the scope of DesignBuilder's help.

Note that the API has only been tested using .NET framework v4.6 and the C# programming language. You should therefore use this combination for your plugin development work.

The example provided here assumes a .NET class library using the C# programming language.

To extend DesignBuilder with a plugin:

1. Communication between DesignBuilder and a plugin as achieved through the DesignBuilder API and a plugin-specific interface. It is therefore important that your project assembly references the DB.Api and DB.Extensibility.Contracts assemblies.

   The DB.Api assembly can be found in the "Components/DB.Api" directory of DesignBuilder's installation directory. DB.Extensibility.Contracts can be found in the "Components/DB.Extensibility" directory.

2. DesignBuilder uses Microsoft's Managed Extensibility Framework (MEF) to locate and load plugins. Your project assembly must therefore also reference System.ComponentModel.Composition

3. Now that your project assembly has the correct references it's time to create a class that DesignBuilder can interact with. As mentioned, DesignBuilder communicates with a plugin via a plugin-specific interface, namely DB.Extensibility.Contracts.IPlugin.

   Create the following new class in your project:

```
using System;
using DB.Extensibility.Contracts;

namespace DB.Extensibility.Plugins
{
    public class ExamplePlugin : PluginBase, IPlugin
    {
        public bool HasMenu
        {
            get { throw new NotImplementedException(); }
        }

        public string MenuLayout
        {
            get { throw new NotImplementedException(); }
        }

        public bool IsMenuItemVisible(string key)
        {
            throw new NotImplementedException();
        }

        public bool IsMenuItemEnabled(string key)
        {
            throw new NotImplementedException();
        }

        public void OnMenuItemPressed(string key)
        {
            throw new NotImplementedException();
        }

        public void Create()
        {
            throw new NotImplementedException();
        }
    }
}
```

Here, ExamplePlugin inherits IPlugin and PluginBase, both of which are provided by DB.Extensibilty.Contracts. IPlugin is the interface that DesignBuilder uses to communicate with a plugin and declares methods for plugin creation/initialisation, methods for the description and interaction of a plugin's menu, and methods relating to the various simulation hook points as described in section

4. *DesignBuilder* Hooks.

PluginBase provides default implementations of the simulation hook points. Inheriting from PluginBase is not required, but it's useful if don't intend to use the simulation hook points.

Note: The choice of namespace and class names are arbitrary.

5. DesignBuilder uses MEF to locate and load plugins. To make your plugin MEF aware, add the following code:

```
using System;
using System.ComponentModel.Composition;
using DB.Extensibility.Contracts;

namespace DB.Extensibility.Plugins
{
    [Export(typeof(IPlugin))]
    public class ExamplePlugin : PluginBase, IPlugin
    {
        public bool HasMenu
        {
            get { throw new NotImplementedException(); }
        }

        ...
    }
}
```

If you are unfamiliar with MEF, the new code tells MEF that the ExamplePlugin class should be made available to an importer as something that implements IPlugin.

6. The plugin is now properly configured with the required references, implements the required interface, provides default implementations for each simulation hook point, and is publically available to DesignBuilder for import. For all intents and purposes it is a valid plugin that can be loaded and used by DesignBuilder.

   Nevertheless, as it's currently implemented, the plugin is not very useful. To make it more useful we'll create a menu structure that will appear in DesignBuilder's top-level menu. The menu will have only 1 item, which will display a message box when pressed.

   A plugin's menu structure is described by a custom description language that is returned to DesignBuilder as a string via IPlugin.MenuLayout. The description language has the following rules:

   - The '*'(asterisk) character indicates a new menu item
   - Zero or more '>' characters indicate the indentation level of the menu item
   - The ',' (comma) character indicates the split between the menu item's name as will be displayed in DesignBuilder and the item's id (or key), which will be used in communication between DesignBuilder and the plugin. The text preceding the ',' (and after any '*' or '>' characters) is the displayed name, and the text proceeding the ',' is the menu item's id

   **Example 1:** The string "*Test Plugin,root*>Item 1,i1*>>Sub-item A,1a" would create a menu structure that looks like:

   Test Plugin (key = root)  
   -- Item 1 (key = i1)  
     -- Sub-item A (key = 1a)

   If a user press Sub-item A, DesignBuilder would inform the plugin by passing key "1a" to IPlugin.OnMenuItemPressed.

   **Example 2:** The string "*Test Plugin,root*>Item 1,i1*>Item 2,i2" would create a menu structure that looks like:

   Test Plugin (key = root)  
   -- Item 1 (key = i1)  
   -- Item 2 (key = i2)

   As well as MenuLayout, IPlugin declares 4 other methods that are used in the creation and usage of a plugin's menu. They are:

- **HasMenu**, which simply returns whether the plugin has a menu or not. If this returns false, the other menu-related methods will not be called
- **IsMenuItemVisible** returns whether a given menu item is currently visible or not. This is called when the plugin is first loaded and every time a menu item has been pressed
- **IsMenuItemEnabled** returns whether a given menu item is currently enabled or not. This is called when the plugin is first loaded and every time a menu item has been pressed
- **OnMenuItemPressed** is called when a user selects one of the plugin's menu items. The key of the menu item (as defined by MenuLayout) is passed to the method to indicate which item has been pressed

Note that because IsMenuItemVisible and IsMenuItemEnabled are called every time a menu item has been pressed, a plugin can include logic to dynamically change the structure of its menu by changing the visibility of menu items in response to user actions. This is described in more detail in section *Writing a Plugin With a Dynamic Menu*.

Using what we've learned, it's now possible to add a menu with 1 item that displays a message box when pressed, to the example plugin. The code looks like this:

```
using System.ComponentModel.Composition;
using System.Text;
using System.Windows.Forms;
using DB.Extensibility.Contracts;
        class MenuKeys
            public const string Root = "root";
            public const string ShowMessage = "showMessage";
        {
            get
            {
                return true;
            }
        }
        public string MenuLayout
        {
            get
            {
                StringBuilder menu = new StringBuilder();
                menu.AppendFormat(
                    "*Example Plugin,{0}", MenuKeys.Root);
                menu.AppendFormat(
                    "*>Show Message,{0}", MenuKeys.ShowMessage);
                return menu.ToString();
            }
        }
        public bool IsMenuItemVisible(string key)
        {
            return true;
        }

namespace DB.Extensibility.Plugins
{
    [Export(typeof(IPlugin))]
    public class ExamplePlugin : PluginBase, IPlugin
    {
        class MenuKeys
        {
            public const string Root = "root";
            public const string ShowMessage = "showMessage";
        }

        public bool HasMenu
        {
            get
            {
                return true;
            }
        }

        public string MenuLayout
        {
            get
            {
                StringBuilder menu = new StringBuilder();
                menu.AppendFormat(
                    "*Example Plugin,{0}", MenuKeys.Root);
                menu.AppendFormat(
                    "*>Show Message,{0}", MenuKeys.ShowMessage);
                return menu.ToString();
            }
        }

        public bool IsMenuItemVisible(string key)
        {
            return true;
        }

        public bool IsMenuItemEnabled(string key)
        {
            return true;
        }

        public void OnMenuItemPressed(string key)
        {
            return true;
        }

        public void OnMenuItemPressed(string key)
        {
            if (key == MenuKeys.ShowMessage)
            {
                MessageBox.Show("Menu item pressed!");
            }
        }

        public void Create()
        {
        }

        public void Create()
        {
        }
    }
}
```

7. Before continuing with the example, notice the IPlugin.Create method. This method is the first method called after DesignBuilder has loaded a plugin. It is only called once and can be used to initialise a plugin.

   If a plugin is to use the DesignBuilder API outside of the simulation hook methods (which are all passed an instance of the API), it is recommend that the Api.Environment object is stored as a member variable of the plugin at this point.

8. Continuing on, once the plugin has been built, the only thing left to do is to copy the assembly to a location that DesignBuilder expects to find plugins.

   Navigate to your local application data folder (usually, this can be found at C:\Users\username\AppData\Local\DesignBuilder, where “username” is your user name. The AppData directory may be hidden in which case you’ll have to enable “Show hidden files, folders, and drives” in

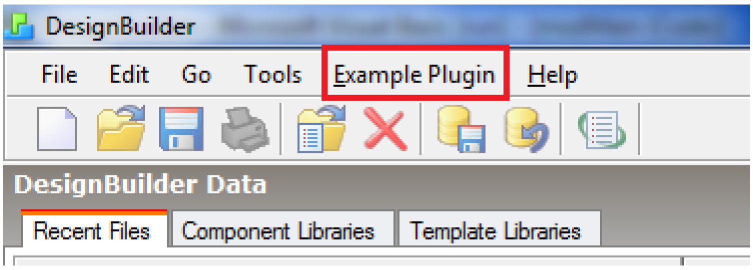
Windows Control Panel > Folder Options > View).

If there is no sub-directory called “User Plugins”, create one.

Each plugin assembly should be placed into its own directory in the “DesignBuilder/User Plugins” directory (the name of the directory does not matter). Note that DB.Api.dll and DB.Extensibility.Contracts.dll must also be present in this directory as well as any external assemblies that your plugin replies upon (E.G. EPNet.dll)

DesignBuilder will load all assemblies that export a class that implements IPlugin via MEF. If you do not wish a plugin to be loaded it must be removed from the User Plugins directory (or the Export class attribute can be removed and the plugin assembly rebuilt).

If everything went according to plan, you should see the following when you start DesignBuilder:



9. Pressing Example Plugin > Show Message should display a message box with the message “Menu item pressed!”.

## Writing a Plugin With a Dynamic Menu

Following on from the section *Writing a Plugin*, this section will show you how to exploit IPlugin.IsMenuItemVisible and IPlugin.IsMenuItemEnabled to create a menu that can change based on user interaction.

This section assumes you’ve already read *Writing a Plugin* and will therefore not explain the process in as much detail.

For this plugin, we are going to create a menu that can change the visibility and state of its menu items based on the user’s interaction. As a base we will start with the following code:

```
[Export(typeof(IPlugin))]
public class ExamplePlugin : PluginBase, IPlugin
{
    class MenuKeys
        public const string Root = "root";

    public bool HasMenu
    {
        get
        {
        }

    public string MenuLayout
        get
            StringBuilder menu = new StringBuilder();
            menu.AppendFormat(
                "*Example Plugin,{0}", MenuKeys.Root);
            return menu.ToString();

    public bool IsMenuItemVisible(string key)
    {
        public const string Root = "root";
    }
    public bool HasMenu
    {
        get
        {
            return true;
        }
    }

    public string MenuLayout
    {
        get
        {
            StringBuilder menu = new StringBuilder();
            menu.AppendFormat(
                "*Example Plugin,{0}", MenuKeys.Root);
            return menu.ToString();
        }
    }

    public bool IsMenuItemVisible(string key)
    {
        return true;
    }

    public bool IsMenuItemEnabled(string key)
    {
        return true;
    }

    public void OnMenuItemPressed(string key)
    {
    }

    public void Create()
    {
    }


    public bool IsMenuItemEnabled(string key)
    {
        return true;
    }

    public void OnMenuItemPressed(string key)
    {
    }

    public void Create()
    {
    }
}
```

1. It’s important to understand that when DesignBuilder loads a plugin for the first time, it will call IPlugin.HasMenu followed by IPlugin.MenuLayout (assuming HasMenu return true). This process is only carried out once because DesignBuilder needs to know the complete menu layout before it displays it’s GUI. IPlugin.IsMenuItemVisible and IPlugin.IsMenuItemEnabled, however, are called throughout the lifetime of the plugin.

   This is important because it means that IPlugin.MenuLayout must return the complete menu structure to DesignBuilder and only through toggling visibility can the structure be changed.

   With that in mind, add the following code to the plugin:

```
[Export(typeof(IPlugin))]
public class ExamplePlugin : PluginBase, IPlugin
{
    class MenuKeys
    {
        public const string Root = "root";
        public const string State = "state";
        public const string Visibility = "visibility";
        public const string EnableAll = "enableAll";
        public const string DisableAll = "disableAll";
        public const string VisibleAll = "visibleAll";
        public const string InvisibleAll = "invisibleAll";
    }

    ...

    public string MenuLayout
    {
        get
        {
            StringBuilder menu = new StringBuilder();
            menu.AppendFormat(
                "*Example Plugin,{0}", MenuKeys.Root);
            menu.AppendFormat(
                "*>State,{0}", MenuKeys.State);
            menu.AppendFormat(
                "*>>Enable All,{0}", MenuKeys.EnableAll);
            menu.AppendFormat(
                "*>>Disable All,{0}", MenuKeys.DisableAll);
            menu.AppendFormat(
                "*>Visibility,{0}", MenuKeys.Visibility);
            menu.AppendFormat(
                "*>>Make All Visible,{0}", MenuKeys.VisibleAll);
            menu.AppendFormat(
                "*>>Make All Invisible,{0}", MenuKeys.InvisibleAll);
            return menu.ToString();
        }
    }

    ...
}
```

2. Now the menu structure is defined the plugin will need some way of keeping track of the state of each menu item. I.E. Whether or not a menu item is visible or enabled. This can be done however you like, but in this example we shall create a simple class and a dictionary:

```
using System.Collections.Generic;

...

[Export(typeof(IPlugin))]
public class ExamplePlugin : PluginBase, IPlugin
{
    ...

    class MenuItem
    {
        public bool IsEnabled { get; set; }
        public bool IsVisible { get; set; }

        public MenuItem(
            bool enabled = true,
            bool visible = true)
        {
            IsEnabled = enabled;
            IsVisible = visible;
        }
    }

    private readonly Dictionary<string, MenuItem> mMenuItems =
        new Dictionary<string,MenuItem>();

    ...

    public void Create()
    {
        mMenuItems.Add(MenuKeys.Root, new MenuItem());
        mMenuItems.Add(MenuKeys.State, new MenuItem());
        mMenuItems.Add(MenuKeys.Visibility, new MenuItem());
        mMenuItems.Add(MenuKeys.EnableAll, new MenuItem());
        mMenuItems.Add(MenuKeys.DisableAll, new MenuItem());
        mMenuItems.Add(MenuKeys.VisibleAll, new MenuItem());
        mMenuItems.Add(MenuKeys.InvisibleAll, new MenuItem());
    }
}
```

Notice that IPlugin.Create is used to initialise the plugin. You could do this in the constructor if you prefer.

3. IPlugin.IsMenuItemVisble and IPlugin.IsMenuItemEnabled can now simply return the IsVisible or IsEnabled properties of the specific menu item like so:

```
[Export(typeof(IPlugin))]
public class ExamplePlugin : PluginBase, IPlugin
{
    ...

    public bool IsMenuItemVisible(string key)
    {
        return mMenuItems[key].IsVisible;
    }

    public bool IsMenuItemEnabled(string key)
    {
        return mMenuItems[key].IsEnabled;
    }

    ...
}
```

The menu structure is defined, the plugin has a means of keeping track of each menu item's state, and it can now report the state back to DesignBuilder. All that remains is to actually change the state of a menu item depending on the actions of the user.

Since each menu item will have a different action when pressed by the user, we will add a property to the nested MenuItem class to represent this:

```
class MenuItem
{
    public Action Action { get; set; }
    public bool IsEnabled { get; set; }
    public bool IsVisible { get; set; }

    public MenuItem(
        Action action = null,
        bool enabled = true,
        bool visible = true)
    {
        Action = action ?? delegate{};
        IsEnabled = enabled;
        IsVisible = visible;
    }
}
```

And then initialise each menu item with an appropriate action:

```
public class ExamplePlugin : PluginBase, IPlugin
{
    ...

    public void Create()
        mMenuItems.Add(MenuKeys.Root,
            new MenuItem());
        mMenuItems.Add(MenuKeys.State,
            new MenuItem());
        mMenuItems.Add(MenuKeys.Visibility,
            new MenuItem());
        mMenuItems.Add(MenuKeys.EnableAll,
            new MenuItem(OnEnableAll));
        mMenuItems.Add(MenuKeys.DisableAll,
            new MenuItem(OnDisableAll));
        mMenuItems.Add(MenuKeys.VisibleAll,
            new MenuItem(OnVisibleAll));
        mMenuItems.Add(MenuKeys.InvisibleAll,
            new MenuItem(OnInvisibleAll));
    private void OnEnableAll()
        mMenuItems[MenuKeys.DisableAll].IsEnabled = true;
        mMenuItems[MenuKeys.Visibility].IsEnabled = true;

    private void OnDisableAll()
        // don't disable EnableAll
        mMenuItems[MenuKeys.DisableAll].IsEnabled = false;
        mMenuItems[MenuKeys.Visibility].IsEnabled = false;

    private void OnVisibleAll()
    {
        mMenuItems.Add(MenuKeys.Root,
            new MenuItem());
        mMenuItems.Add(MenuKeys.State,
            new MenuItem());
        mMenuItems.Add(MenuKeys.Visibility,
            new MenuItem());
        mMenuItems.Add(MenuKeys.EnableAll,
            new MenuItem(OnEnableAll));
        mMenuItems.Add(MenuKeys.DisableAll,
            new MenuItem(OnDisableAll));
        mMenuItems.Add(MenuKeys.VisibleAll,
            new MenuItem(OnVisibleAll));
        mMenuItems.Add(MenuKeys.InvisibleAll,
            new MenuItem(OnInvisibleAll));
    }

    private void OnEnableAll()
    {
        mMenuItems[MenuKeys.DisableAll].IsEnabled = true;
        mMenuItems[MenuKeys.Visibility].IsEnabled = true;
    }

    private void OnDisableAll()
    {
        // don't disable EnableAll
        mMenuItems[MenuKeys.DisableAll].IsEnabled = false;
        mMenuItems[MenuKeys.Visibility].IsEnabled = false;
    }

    private void OnVisibleAll()
    {
        mMenuItems[MenuKeys.InvisibleAll].IsVisible = true;
        mMenuItems[MenuKeys.State].IsVisible = true;
    }

    private void OnInvisibleAll()
    {
        // don't make VisibleAll invisible
        mMenuItems[MenuKeys.InvisibleAll].IsVisible = false;
        mMenuItems[MenuKeys.State].IsVisible = false;
    }
}
```

Note that changing the visibility or enabled state of a parent menu item also affects the state of its children. E.G. OnDisableAll changes MenuKeys.Visibility's enabled state to false, which results in MenuKeys.VisibleAll and MenuKeys.InvisibleAll also being disabled.

4. Each relevant menu item now has an appropriate action or a default action to do nothing. The final piece in the puzzle is to forward IPlugin.OnMenuItemPressed to the correct menu item's action as follows:

```
[Export(typeof(IPlugin))]
public class ExamplePlugin : PluginBase, IPlugin
{
    ...

    public void OnMenuItemPressed(string key)
    {
        mMenuItems[key].Action();
    }

    ...
}
```

5. The plugin is now complete and can be copied to the User Plugin directory as described in section *Writing a Plugin* item 7. Upon starting DesignBuilder the plugin should be loaded and you can see how pressing Example Plugin > Visibility > Make All Invisible changes the structure of the menu (from the user's point-of-view).

## Plugin API Versions

When new plugin hookpoints are introduced a new plugin interface is created, which inherits the previous plugin interface. This ensures that plugins that support an older interface will still work without the plugin author having to change their code.

From v7.1.1 DesignBuilder supports two plugin interfaces, IPlugin and IPlugin2. In addition to supporting all IPlugin's hook points, IPlugin2 adds three new hook points – ScreenChanged, ModelLoaded, and ModelUnloaded. For your plugin to take advantage of the latest API you must define your plugin class accordingly:

```
[Export(typeof(IPlugin2))]
public class ExamplePlugin : PluginBase2, IPlugin2
{
}
```

### IPlugin supported hook points

This is a list of the supported hook points in the IPlugin interface:

```
void BeforeEnergyIdfGeneration();
void BeforeEnergySimulation();
void AfterEnergySimulation();
void BeforeHeatingIdfGeneration();
void BeforeHeatingSimulation();
void AfterHeatingSimulation();
void BeforeCoolingIdfGeneration();
void BeforeCoolingSimulation();
void AfterCoolingSimulation();
void BeforeDaylightSimulation();
void AfterDaylightSimulation();
void BeforeCfdSimulation();
void AfterCfdSimulation();
void BeforeOptimisationStudy();
void AfterOptimisationStudy();
void OnDesignVariableChanged(int variableId, string value);
void BeforeCostAndCarbon();
void AfterCostAndCarbon();
void AtCommandLine(string arg);
```

### IPlugin2 supported hook points

This is a list of the supported hook points in the IPlugin2 interface (in addition to the above IPlugin hook points):

```
        void ModelLoaded();
        void ModelUnloaded();
        void ScreenChanged(ScreenCode screenCode);
```

# Working with the DesignBuilder API

This section provides background information on how to work with the DesignBuilder Building Model using the API. The examples provided assume that you are developing a plugin using C# code but the same principles apply for C# and Python scripts.

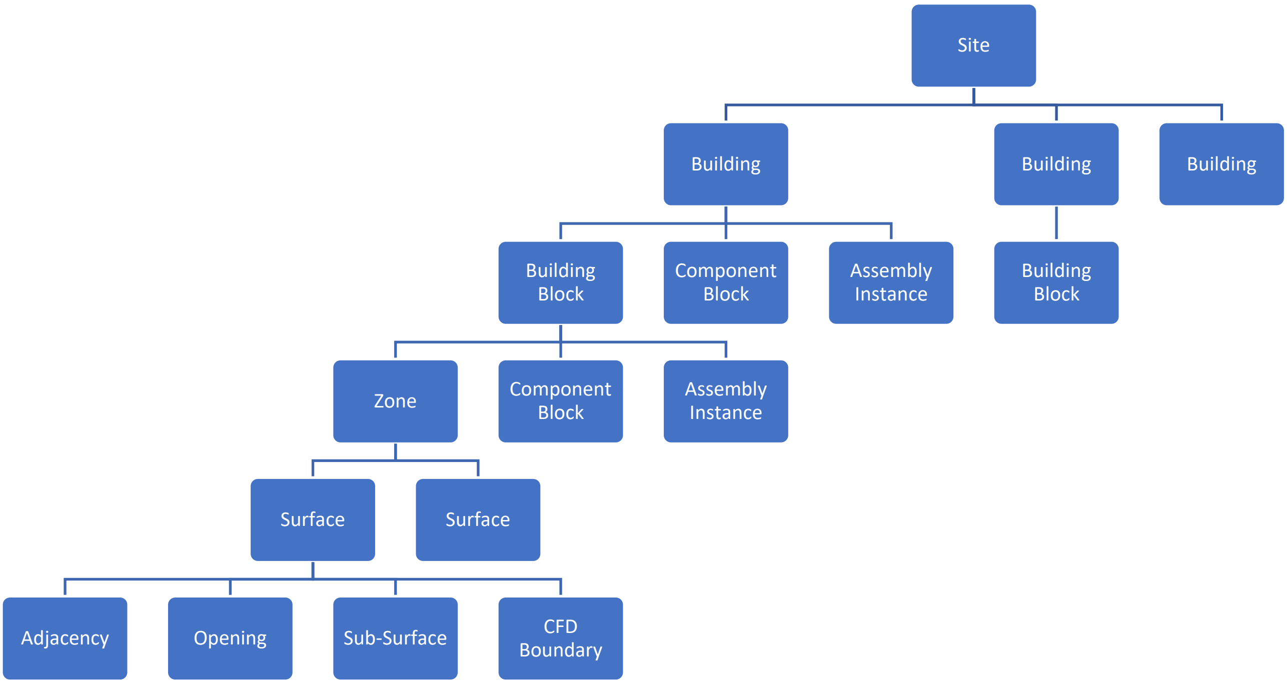
## DesignBuilder Building Model

The DesignBuilder building model consists of a hierarchy of objects that collectively represent a building or collection of buildings within a site. The hierarchy is essentially a tree like structure that starts with a single **Site** object at the top.

The **Site** object acts as a container for a single **Building** object or list of **Building** objects. A **Building** object at its simplest is composed of a single **Building Block** object or a list of **Building Block** objects but may also contain **Component Blocks** and **Assembly Instances**. A **Building Block** in turn at its simplest comprises a **Zone** or number of **Zones** but may also contain **Component Blocks** and **Assembly Instances**. **Zones** are composed of a number of **Surfaces** where each surface represents one of the bounding elements of the zone (walls, floors, ceilings/roofs). Each surface has at least one **Adjacency** and may have a number of **Openings**, **Sub-Surfaces**  and/or **CFD Boundaries**. An **Adjacency** is a segment of the surface, the geometry of which is essentially a polygon or list of polygons that represent the geometric portion of the surface that is adjacent to the outside of the building or to another zone in the building, an adjacency also contains additional information such as construction, etc. **Opening** objects represent any opening within the surface, including windows, doors and holes. **Sub-surfaces** are similar to Openings but are used to represent segments of a surface that have a different construction to the main area of the surface. **CFD Boundaries** are also similar to openings but are used to model various CFD boundary conditions including temperature and heat flux patches as well as ventilation boundaries. **Adjacencies**, **Openings**, **Sub-Surfaces** and **CFD Boundaries** are the lowest level objects in the DesignBuilder model hierarchy.

In a similar fashion to **Adjacencies**, the geometry of **Openings**, **Sub-Surfaces** and **CFD Boundaries** are essentially simple polygons and the objects also contain additional information concerning construction, etc.

Each level in the hierarchy is known as a **Level of Decomposition** (**Site**/**Building**/**Building Block**/**Zone**/**Surface**/**Opening**). At each **Level of Decomposition**, a number of different types of model object may be present (**Building Blocks**, **Component Blocks** and **Assembly Instances** at **Building level** and **Zones**, **Component Blocks** and **Assembly Instances** at **Building Block** level). These objects are known as **Decomposition Level Objects**.



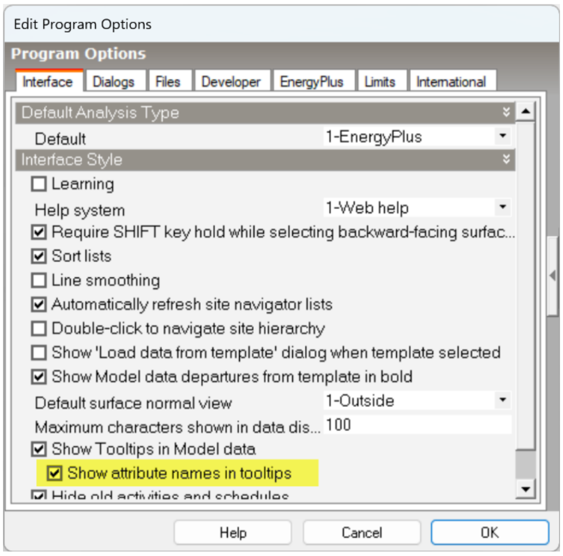
The various **Decomposition Level Objects** (**Site**, **Building**, **Building Block**, etc.) have corresponding API classes associated with them which provide various levels of functionality associated with the objects including access to attribute data. The API classes generally have the same names as the associated model objects.

## Decomposition Level Object Data and Attributes

All **Decomposition Level Objects** (**Site**, **Building**, **Building Block**, etc.) store data via **Attribute** objects which are simple pairs of string where one string is the name of the attribute and the other string is the value of the attribute. DesignBuilder employs an inheritance mechanism which allows object data stored in attributes to be automatically inherited from one **Level of Decomposition** to all levels below that level. If any item of data is changed from the inherited value at any **Level of Decomposition**, all objects below that level will automatically take on or inherit the value at that level. Attributes set at a particular level are known as **hard** attributes.

So, for example, if a design heating setpoint temperature of say 19.0 C is set at the **Building** level of decomposition, this setpoint will automatically be applied to all building blocks and building block zones within the building. However, if all zones in one particular building block require a setpoint temperature of 20.0 C, the setting can be made at the building block level and then all zones within that building block will automatically inherit the setpoint temperature of 20.0 C.

When developing application plugins, the application will normally require access to items of data belonging to various model objects which have been set via the DesignBuilder UI. To access this data, knowledge of the associated attribute name will be required. To facilitate this, a feature is built into the DesignBuilder UI to enable settings tooltips to include the name of the associated attribute. To switch this feature on, a setting is provided on the Program Options Dialog which can be accessed from the Tools menu:



Default Analysis Type

Default 1-EnergyPlus

Interface Style

☐ Learning

Help system 1-Web help

☑ Require SHIFT key hold while selecting backward-facing surfac...

☑ Sort lists

☐ Line smoothing

☑ Automatically refresh site navigator lists

☐ Double-click to navigate site hierarchy

☐ Show 'Load data from template' dialog when template selected

☑ Show Model data departures from template in bold

Default surface normal view 1-Outside

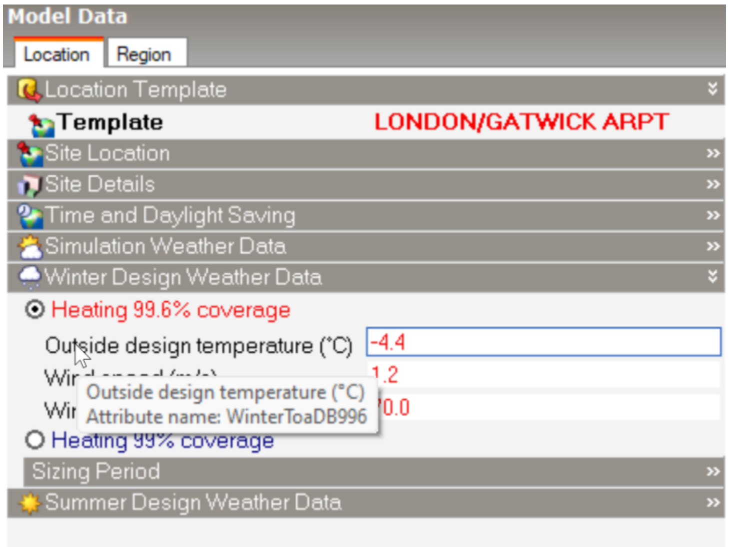
Maximum characters shown in data dis... 100

☑ Show Tooltips in Model data

☑ Show attribute names in tooltips

☑ Hide old activities and schedules

So, for example, to access the name of the attribute behind the site level ‘Winter outside design temperate’ you would navigate to the site level and move the cursor over the ‘Outside design temperature’ setting under the ‘Winter Design Weather Data’ header and wait for the tooltip to appear:



Location Template

Template LONDON/GATWICK ARPT

Site Location

Site Details

Time and Daylight Saving

Simulation Weather Data

Winter Design Weather Data

● Heating 99.6% coverage

Outside design temperature (°C) -4.4

Wir 1.2

Wir 0.0

Outside design temperature (°C)
Attribute name: WinterToaDB996

○ Heating 99% coverage

Sizing Period

Summer Design Weather Data

The attribute name ***WinterToaDB996*** appears on the tooltip. This name can then be used to extract the value of the setting from the site level object attribute:

```
outsideAirTemperature = site.GetAttributeAsDouble("WinterToaDB996");
```

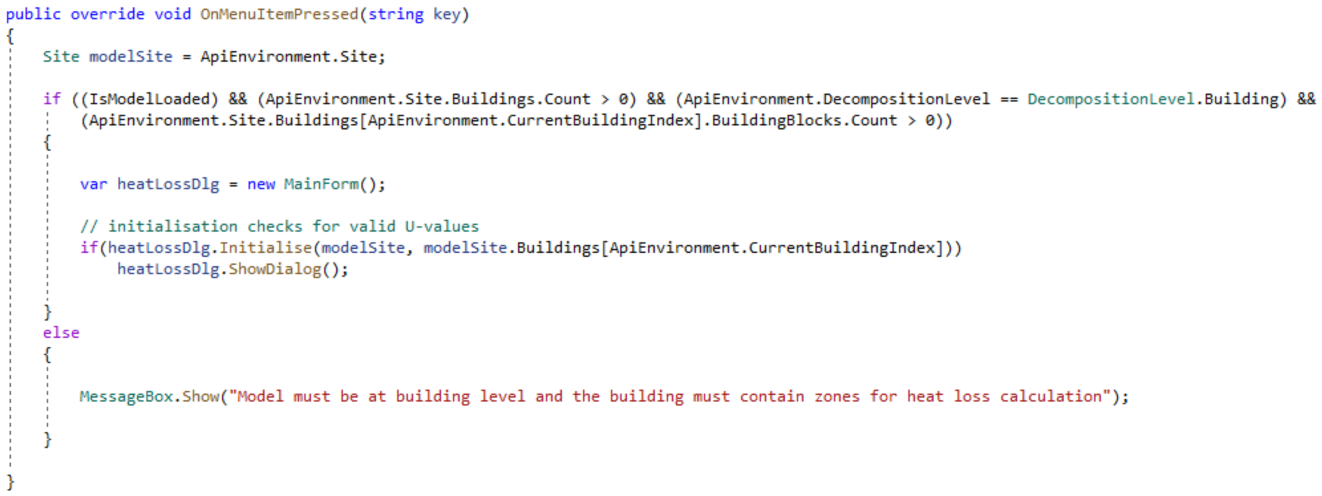
Notice that the method used to obtain the value of the site level attribute returns the value as a double. There are a number of such methods associated with the various API model objects that can be used to access attributes. These methods are described more fully in the next sections.

## The Site Object, Model Status and the API Environment Class

The highest level object in the model hierarchy is the ***Site*** object. The ***Site*** object enables access to all other objects in the model hierarchy as well as access to all of the tables that contain model data such as constructions, materials, glazing, etc. The ***Site*** object is accessed via the ***Environment*** object.

During start-up, DesignBuilder instantiates a single ***DB.Api.Environment*** object. This singleton object is used by all active scripts and plugins, and consequently developers should not create their own objects of this class but instead rely on the instance incorporated within the plugin, the ***ApiEnvironment*** object. As well as providing access to the model ***Site*** object, the ***APIEnvironment*** object may also be used to access the model status at the time of running the plugin. The model status includes various model states such as the current level of decomposition, current decomposition level object type, current building index, current zone index, etc.

In the example below the menu item handler ***OnMenuItemPressed*** uses the ***ApiEnvironment*** object to first make sure that the model contains a finite number of buildings and then checks that the current decomposition level is **Building**, it then obtains the current building index and uses it to access the current building  (a site may contain several buildings). A further check is then carried out to make sure that the current building contains a finite number of building blocks (and consequently zones):



```
public override void OnMenuItemPressed(string key)
{
    Site modelSite = ApiEnvironment.Site;

    if ((IsModelLoaded) && (ApiEnvironment.Site.Buildings.Count > 0) && (ApiEnvironment.DecompositionLevel == DecompositionLevel.Building) &&
        (ApiEnvironment.Site.Buildings[ApiEnvironment.CurrentBuildingIndex].BuildingBlocks.Count > 0))
    {

        var heatLossDlg = new MainForm();

        // initialisation checks for valid U-values
        if(heatLossDlg.Initialise(modelSite, modelSite.Buildings[ApiEnvironment.CurrentBuildingIndex]))
            heatLossDlg.ShowDialog();

    }
    else
    {

        MessageBox.Show("Model must be at building level and the building must contain zones for heat loss calculation");

    }

}
```

For further details of the plugin framework, please refer to Extending DesignBuilder with Plugins.

## DesignBuilder Tables

DesignBuilder makes extensive use of Table objects for a range of purposes. Most tables come into the following categories:

1. To hold databases of components and templates.
2. To hold results of calculations.
3. To define the layout of dialog.

The various types of Table are stored and accessed as follows:

1. All *model* component and template database tables are stored at site level and accessed from the site object. For example to access the model **Constructions** table use code like:

   `ConstructionTable = ApiEnvironment.Site.GetTable(“Constructions”)`

2. All *library* components and templates are stored in the **DB.Api.ApplicationComponents** and **DB.Api.ApplicationTemplates** objects respectively. Library components and templates are those that are defined from the opening screen. When a new model is created the library components and templates that may be associated with models are copied to the site level of the new model. Some databases are associated with the Application (e.g. **ProgramOptionTemplates**) and so are not copied to the model. These are listed at Appendix 1 List of Available Tables summary with “Y” in the Application column and in the TableOfTables with “True” in the **IsApplicationData** field.

3. All *dialog layout* tables are stored in and accessed from the **ApplicationTemplates** object since they are not model-dependent.

4. Predefined option lists. These are a special case of component database tables but are non-editable. These are listed at Appendix 1 List of Available Tables summary with “N” in the Editable column and in the TableOfTables with “False” in the **IsEditable** field.

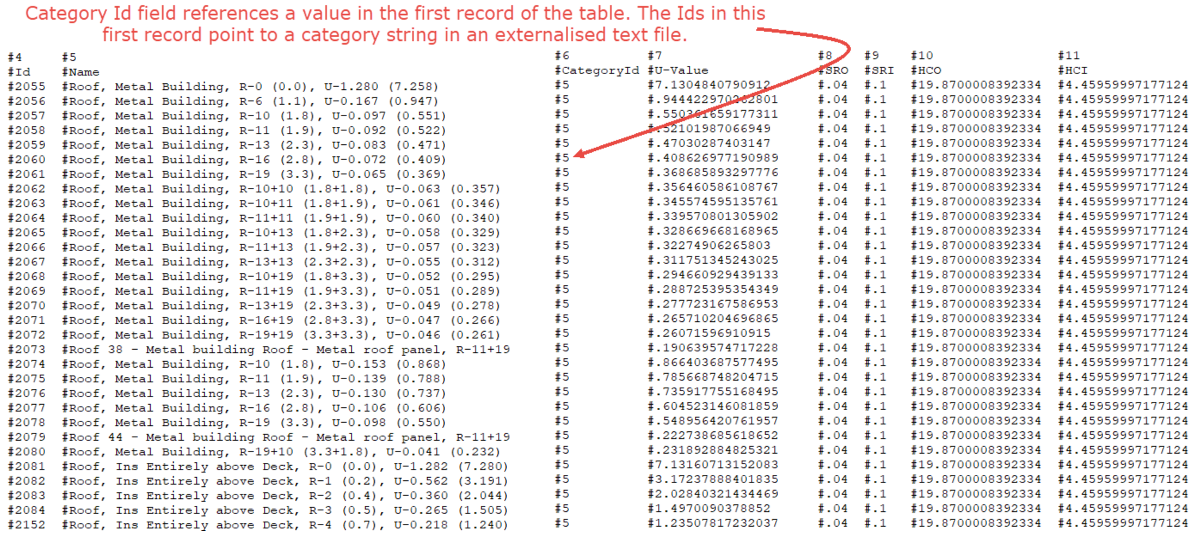
5. Tables containing *results of simulations* are stored with the appropriate model object. For example building level results are stored with and accessed from the building model object. Likewise results for blocks, zones, surfaces and openings are stored with the corresponding object in the model. See below in the Results tables section for more information on these tables.

## Component and Template database tables

All DesignBuilder tables consist of a number of records and each record includes a number of fields. Records and fields can be thought of as rows and columns respectively.

In component and template database tables, the first field (index 0) is normally the Id of the record which can be used to access a specific record in the database and subsequent fields contain the rest of the data.

The **Table** object has a ***Records*** method which returns a collection of records. This method can then be used to access specific records using the record Id.



Category Id field references a value in the first record of the table. The Ids in this first record point to a category string in an externalised text file.

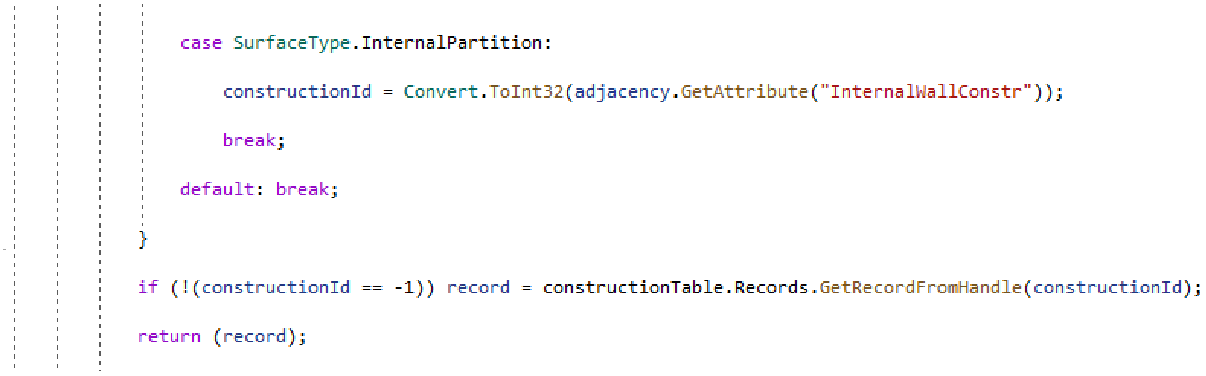
```
#4     #5                                                              #6          #7                 #8    #9    #10                #11
#Id    #Name                                                           #CategoryId #U-Value           #SRO  #SRI  #HCO               #HCI
#2055  #Roof, Metal Building, R-0 (0.0), U-1.280 (7.258)               #5          #7.1304840790912   #.04  #.1   #19.8700008392334  #4.45959997177124
#2056  #Roof, Metal Building, R-6 (1.1), U-0.167 (0.947)               #5          #.944422970262801  #.04  #.1   #19.8700008392334  #4.45959997177124
#2057  #Roof, Metal Building, R-10 (1.8), U-0.097 (0.551)              #5          #.550361659177311  #.04  #.1   #19.8700008392334  #4.45959997177124
#2058  #Roof, Metal Building, R-11 (1.9), U-0.092 (0.522)              #5          #.52101987066949   #.04  #.1   #19.8700008392334  #4.45959997177124
#2059  #Roof, Metal Building, R-13 (2.3), U-0.083 (0.471)              #5          #.47030287403147   #.04  #.1   #19.8700008392334  #4.45959997177124
#2060  #Roof, Metal Building, R-16 (2.8), U-0.072 (0.409)              #5          #.408626977190989  #.04  #.1   #19.8700008392334  #4.45959997177124
#2061  #Roof, Metal Building, R-19 (3.3), U-0.065 (0.369)              #5          #.368685893297776  #.04  #.1   #19.8700008392334  #4.45959997177124
#2062  #Roof, Metal Building, R-10+10 (1.8+1.8), U-0.063 (0.357)       #5          #.356460586108767  #.04  #.1   #19.8700008392334  #4.45959997177124
#2063  #Roof, Metal Building, R-10+11 (1.8+1.9), U-0.061 (0.346)       #5          #.345574595135761  #.04  #.1   #19.8700008392334  #4.45959997177124
#2064  #Roof, Metal Building, R-11+11 (1.9+1.9), U-0.060 (0.340)       #5          #.339570801305902  #.04  #.1   #19.8700008392334  #4.45959997177124
#2065  #Roof, Metal Building, R-10+13 (1.8+2.3), U-0.058 (0.329)       #5          #.328669668168965  #.04  #.1   #19.8700008392334  #4.45959997177124
#2066  #Roof, Metal Building, R-11+13 (1.9+2.3), U-0.057 (0.323)       #5          #.32274906265803   #.04  #.1   #19.8700008392334  #4.45959997177124
#2067  #Roof, Metal Building, R-13+13 (2.3+2.3), U-0.055 (0.312)       #5          #.311751345243025  #.04  #.1   #19.8700008392334  #4.45959997177124
#2068  #Roof, Metal Building, R-10+19 (1.8+3.3), U-0.052 (0.295)       #5          #.294660929439133  #.04  #.1   #19.8700008392334  #4.45959997177124
#2069  #Roof, Metal Building, R-11+19 (1.9+3.3), U-0.051 (0.289)       #5          #.288725395354349  #.04  #.1   #19.8700008392334  #4.45959997177124
#2070  #Roof, Metal Building, R-13+19 (2.3+3.3), U-0.049 (0.278)       #5          #.277723167586953  #.04  #.1   #19.8700008392334  #4.45959997177124
#2071  #Roof, Metal Building, R-16+19 (2.8+3.3), U-0.047 (0.266)       #5          #.265710204696865  #.04  #.1   #19.8700008392334  #4.45959997177124
#2072  #Roof, Metal Building, R-19+19 (3.3+3.3), U-0.046 (0.261)       #5          #.26071596910915   #.04  #.1   #19.8700008392334  #4.45959997177124
#2073  #Roof 38 - Metal building Roof - Metal roof panel, R-11+19      #5          #.190639574717228  #.04  #.1   #19.8700008392334  #4.45959997177124
#2074  #Roof, Metal Building, R-10 (1.8), U-0.153 (0.868)              #5          #.866403687577495  #.04  #.1   #19.8700008392334  #4.45959997177124
#2075  #Roof, Metal Building, R-11 (1.9), U-0.139 (0.788)              #5          #.785668748204715  #.04  #.1   #19.8700008392334  #4.45959997177124
#2076  #Roof, Metal Building, R-13 (2.3), U-0.130 (0.737)              #5          #.735917755168495  #.04  #.1   #19.8700008392334  #4.45959997177124
#2077  #Roof, Metal Building, R-16 (2.8), U-0.106 (0.606)              #5          #.604523146081859  #.04  #.1   #19.8700008392334  #4.45959997177124
#2078  #Roof, Metal Building, R-19 (3.3), U-0.098 (0.550)              #5          #.548956420761957  #.04  #.1   #19.8700008392334  #4.45959997177124
#2079  #Roof 44 - Metal building Roof - Metal roof panel, R-11+19      #5          #.222738685618652  #.04  #.1   #19.8700008392334  #4.45959997177124
#2080  #Roof, Metal Building, R-19+10 (3.3+1.8), U-0.041 (0.232)       #5          #.231892884825321  #.04  #.1   #19.8700008392334  #4.45959997177124
#2081  #Roof, Ins Entirely above Deck, R-0 (0.0), U-1.282 (7.280)      #5          #7.13160713152083  #.04  #.1   #19.8700008392334  #4.45959997177124
#2082  #Roof, Ins Entirely above Deck, R-1 (0.2), U-0.562 (3.191)      #5          #3.17237888401835  #.04  #.1   #19.8700008392334  #4.45959997177124
#2083  #Roof, Ins Entirely above Deck, R-2 (0.4), U-0.360 (2.044)      #5          #2.02840321434469  #.04  #.1   #19.8700008392334  #4.45959997177124
#2084  #Roof, Ins Entirely above Deck, R-3 (0.5), U-0.265 (1.505)      #5          #1.4970090378852   #.04  #.1   #19.8700008392334  #4.45959997177124
#2152  #Roof, Ins Entirely above Deck, R-4 (0.7), U-0.218 (1.240)      #5          #1.23507817232037  #.04  #.1   #19.8700008392334  #4.45959997177124
```

The above screenshot shows an extract from the **Constructions** table source file Constructions.dat.

You can find a copy of the dat files in the DesignBuilder\Data folder which can be accessed from within DesignBuilder using the “File > Folders > Library data” folder menu command.

The first 2 lines contain the category index lists and the field names respectively. The actual data starts on the third row which is record index 0.

Note the first Id field is used to access records. As an example of how this is used, the following code fragment shows how the construction Id for an internal partition adjacency is first obtained from the adjacency ***InternalWallConstr*** attribute and then used to obtain the associated record from the Constructions table using the ***GetRecordFromHandle*** method of the **Records** collection class:



```
                case SurfaceType.InternalPartition:

                    constructionId = Convert.ToInt32(adjacency.GetAttribute("InternalWallConstr"));

                    break;

                default: break;

            }

            if (!(constructionId == -1)) record = constructionTable.Records.GetRecordFromHandle(constructionId);

            return (record);
```

A full list of available component and template tables can be found in Appendix 1 List of available tables

## Categories

Each component and template database table includes a list of category Ids each of which points to externalised text in the LocalisedCategory_1.txt category text file. The number 1 denotes the English text and equivalent files exist for other languages as well.

Each data record in the database includes a category field called CategoryId (the third field) that contains an index into the category text file.

## Results tables

Results tables are accessed from the relevant model object using interval and 2-letter calculation codes as illustrated below.

The list of interval codes is:

- **Summary** – summary results
- **Annual** – annual results
- **Monthly** – monthly results
- **Daily** – daily results
- **Hourly** – hourly results
- **TimeSteply** – timestep results

The list of 2-letter calculation codes is:

- **SS** – simulation
- **HG** – cooling design
- **HL** – heating design

So, for example, to access the **summary cooling design** results table for a building, use code like:

BuildingSummaryTable = building.GetTable(“HGSummary”)

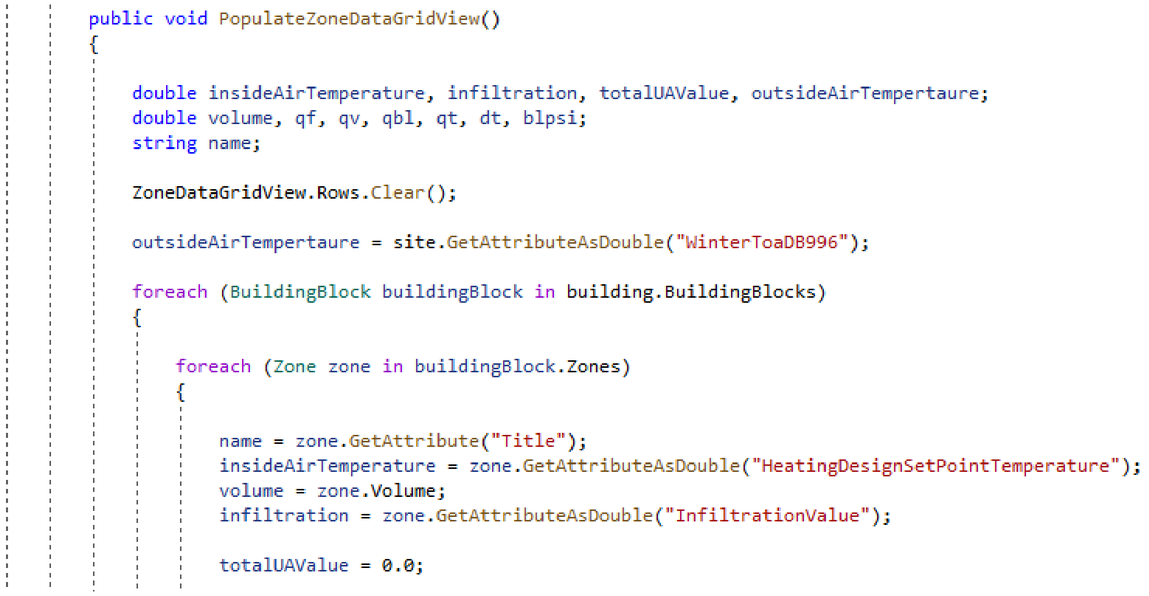
Or, to obtain a table with **annual simulation** zone level results:

ZoneAnnualTable = zone.GetTable(“SSAnnual”)

The easiest way to learn how to work with tables is to study example script and plugin code such as that provided in the DesignBuilder GitHub repository.

# Navigating Model Objects via the API

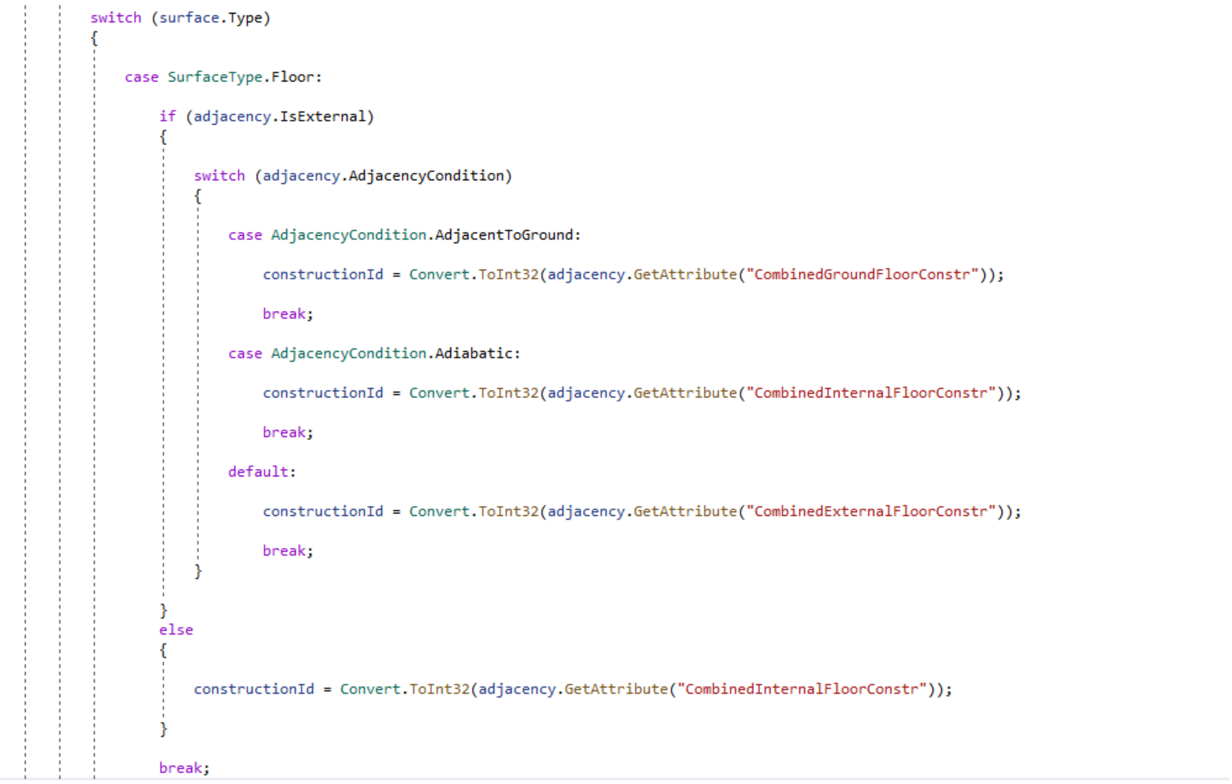
The API classes associated with the various **Decomposition Level** objects have methods to obtain collections of objects that can be housed at each particular level. For example the ***Building*** class has a ***BuildingBlocks*** method that returns a collection of all building blocks within the building and the ***BuildingBlock*** class has a ***Zones*** method that returns a collection of building zones. These methods can be used to iterate through the model hierarchy:



```
public void PopulateZoneDataGridView()
{

    double insideAirTemperature, infiltration, totalUAValue, outsideAirTempertaure;
    double volume, qf, qv, qbl, qt, dt, blpsi;
    string name;

    ZoneDataGridView.Rows.Clear();

    outsideAirTempertaure = site.GetAttributeAsDouble("WinterToaDB996");

    foreach (BuildingBlock buildingBlock in building.BuildingBlocks)
    {

        foreach (Zone zone in buildingBlock.Zones)
        {

            name = zone.GetAttribute("Title");
            insideAirTemperature = zone.GetAttributeAsDouble("HeatingDesignSetPointTemperature");
            volume = zone.Volume;
            infiltration = zone.GetAttributeAsDouble("InfiltrationValue");

            totalUAValue = 0.0;
```

## Zone Surface Types and Holes

Each zone surface has an associated type which refers to the zone element type by orientation: Wall, Flat Roof (Ceiling), Floor, Pitched Roof, etc. The API ***Surface*** class incorporates a ***Type*** which allows the type of the surface to be determined. Surface types are listed within the API enumerated type ***SurfaceType***. Surface types are important when determining construction information due to the way that the attribute inheritance system works. A particular adjacency or surface construction may not be explicitly stored at the adjacency or surface level but may be inherited from a higher level. Therefore when extracting construction data from an adjacency or surface level, the surface type must be used in order to determine which attribute to use. This is demonstrated in the example code below:

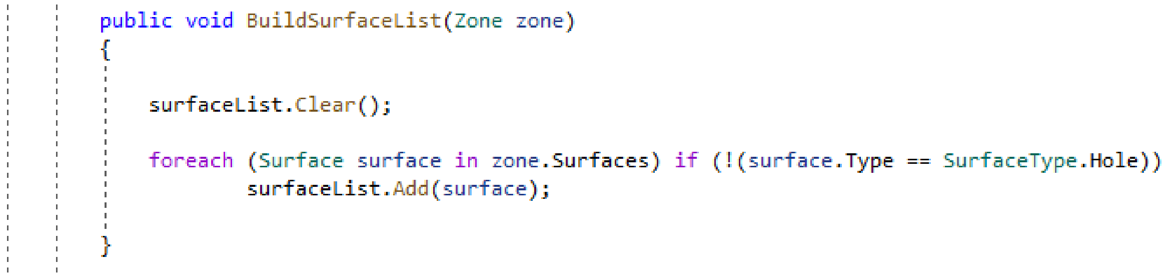


```
switch (surface.Type)
{

    case SurfaceType.Floor:

        if (adjacency.IsExternal)
        {

            switch (adjacency.AdjacencyCondition)
            {

                case AdjacencyCondition.AdjacentToGround:

                    constructionId = Convert.ToInt32(adjacency.GetAttribute("CombinedGroundFloorConstr"));

                    break;

                case AdjacencyCondition.Adiabatic:

                    constructionId = Convert.ToInt32(adjacency.GetAttribute("CombinedInternalFloorConstr"));

                    break;

                default:

                    constructionId = Convert.ToInt32(adjacency.GetAttribute("CombinedExternalFloorConstr"));

                    break;
            }

        }
        else
        {

            constructionId = Convert.ToInt32(adjacency.GetAttribute("CombinedInternalFloorConstr"));

        }

        break;
```

In this code fragment, the surface type is used to determine the element type that the adjacency belongs to (floor, wall, etc.), the adjacency is then checked to see if it’s an external or internal adjacency. If the surface type is a floor and the adjacency is  external, the **Adjacency** method ***AdjacencyCondition*** is then used to determine if the external adjacency is adiabatic, adjacent to the ground or internal in order to finally select the type of construction attribute from which to obtain the construction record Id.

When iterating through zone surface lists, special attention needs to be paid to surfaces representing holes. Zones containing voids, courtyards or nested zones will incorporate holes in ceiling and floor surfaces. These holes are represented as surfaces themselves within the zone surface list and would normally need to be discounted during the processing of zone surface lists.

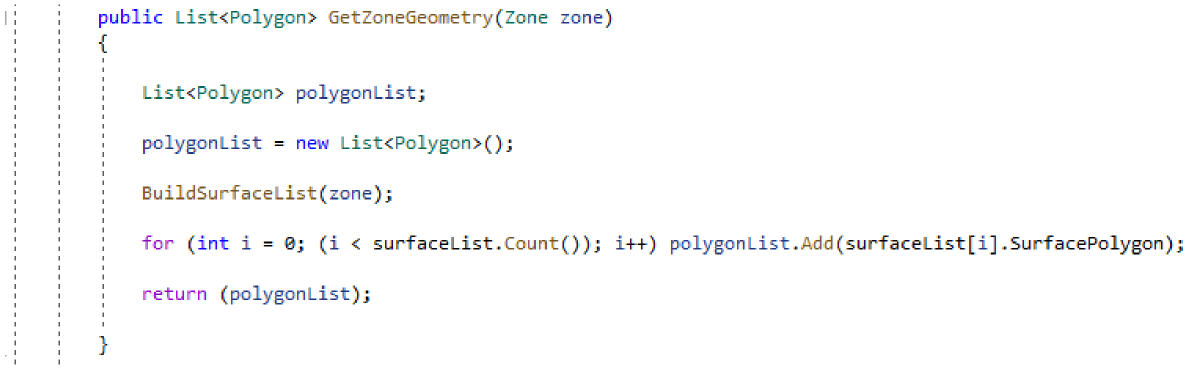
A temporary surface list can be created for a zone which excludes all surface holes:



```
public void BuildSurfaceList(Zone zone)
{

    surfaceList.Clear();

    foreach (Surface surface in zone.Surfaces) if (!(surface.Type == SurfaceType.Hole))
            surfaceList.Add(surface);

}
```

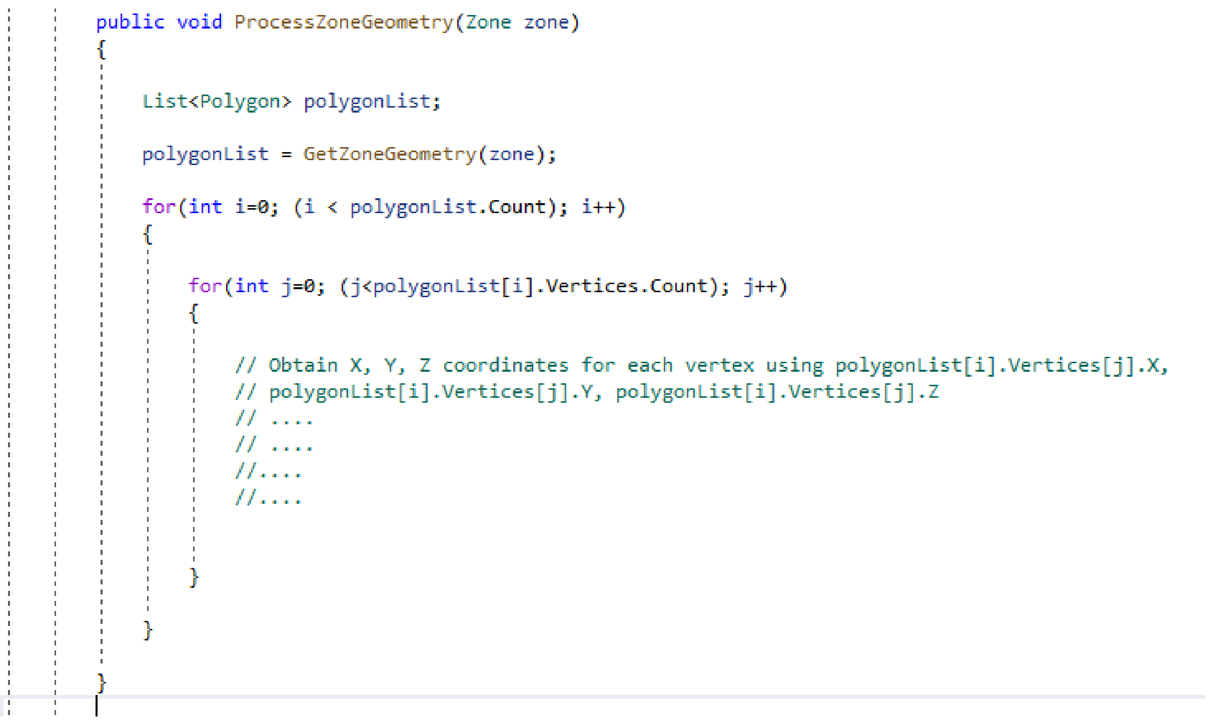
## Extracting Geometry

For certain applications, it may be desirable to obtain the underlying Cartesian geometry (coordinate information) that represents zone surfaces and surface elements (adjacencies and openings). The coordinate information may be obtained for surfaces and surface elements by means of **Polygon** objects. A **Polygon** object in the API is a collection of 3D points or vertices. A **Surface** object has a single **Polygon** associated with it which can be obtained using the ***SurfacePolygon*** method. So, for example, to obtain a list of polygons representing the geometry of a zone, the following code could be used:



```
public List<Polygon> GetZoneGeometry(Zone zone)
{

    List<Polygon> polygonList;

    polygonList = new List<Polygon>();

    BuildSurfaceList(zone);

    for (int i = 0; (i < surfaceList.Count()); i++) polygonList.Add(surfaceList[i].SurfacePolygon);

    return (polygonList);

}
```

The vertex information can then be obtained for each polygon by looping through the polygon vertices:



```
public void ProcessZoneGeometry(Zone zone)
{

    List<Polygon> polygonList;

    polygonList = GetZoneGeometry(zone);

    for(int i=0; (i < polygonList.Count); i++)
    {

        for(int j=0; (j<polygonList[i].Vertices.Count); j++)
        {

            // Obtain X, Y, Z coordinates for each vertex using polygonList[i].Vertices[j].X,
            // polygonList[i].Vertices[j].Y, polygonList[i].Vertices[j].Z
            // ....
            // ....
            //....
            //....


        }

    }

}
```

## Setting Startup Location

When a model is saved, DesignBuilder stores the location in the model that the user is currently navigated to. This allows it to open at the same location when the file is reloaded. The location is stored in the “SiteStartUpOptions” site-level attribute.

It can at times be useful to control this location. For example, when loading models from the command line users may wish to open at a specific building in the model. This can be controlled by writing code to update the “SiteStartUpOptions” attribute.

The attribute is a semi-colon delimited string that would look as below if the user was navigated to the first building when the model was last saved:

"1;0;0;-1;-1;-1;-1;-1;-1;-1;-1;-1;-1;-1;-1;-1;-1"

The items in the string in order are:

<table>
<tr><th>Meaning</th><th>Index in attribute</th><th colspan="3">Comments</th></tr>
<tr><td>Level</td><td>0</td><td colspan="3">DecompositionLevel</td></tr>
<tr><td rowspan="5">ObjectType</td><td rowspan="5">1</td><td><b>Name</b></td><td><b>Value in attribute</b></td><td><b>Explanation</b></td></tr>
<tr><td>Hierachy</td><td>0</td><td>object is one of site, building, block, zone etc in main building hierarchy</td></tr>
<tr><td>ComponentBlock</td><td>1</td><td>a component block</td></tr>
<tr><td>AssemblyInstance</td><td>2</td><td>an assembly instance</td></tr>
<tr><td>Plane</td><td>3</td><td>A shading plane loaded from a gbXML model</td></tr>
<tr><td>BuildingIndex</td><td>2</td><td colspan="3"></td></tr>
</table>

| | | |
|---|---|---|
| BlockIndex | 3 | |
| ComponentBlockIndex | 4 | |
| AssemblyInstanceIndex | 5 | |
| PlaneIndex | 6 | |
| ZoneIndex | 7 | |
| SurfaceIndex | 8 | |
| OpeningIndex | 9 | |
| HVACLoopIndex | 10 | |
| HVACSubLoopIndex | 11 | |
| HVACComponentIndex | 12 | |
| HVACSubComponentIndex | 13 | |
| HVACZoneGroupIndex | 14 | |
| HVACObjectType | 15 | HVACObjectType |

All indices are zero-based.

# API Reference

The DesignBuilder API Help Guide is the main source of help on all of the API classes, collections, enumerations etc.

# Example Scripts and Plugin Code Repository

DesignBuilder provides a GitHub repository of example scripts and plugin code which you can use to learn how to how about creating your own scripts and plugins.

# Appendix 1 List of Available Tables

The table below lists all of the tables included in DesignBuilder models and the library. It summarises the detailed information included in the full TableOfTables table.

The meaning of the data in the various columns is explained below the table.

| Table Name | Editable | Application | Template | Model Data | HVAC | Comments |
|---|---|---|---|---|---|---|
| Constructions | Y | N | N | N | N | Constructions database |
| Glazing | Y | N | N | N | N | Glazing database |
| Materials | Y | N | N | N | N | Materials database |
| Panes | Y | N | N | N | N | Panes database |
| Textures | Y | N | N | N | N | Texture database |
| WindowGas | Y | N | N | N | N | Window gas database |
| LocalShading | Y | N | N | N | N | Local shading database |
| InternalBlinds | Y | N | N | N | N | Internal blinds database |
| Vents | Y | N | N | N | N | Vents database |
| Holidays2 | Y | N | N | N | N | Holidays database |
| MetabolicRates | Y | N | N | N | N | Metabolic rates database |
| HolidaySchedule | Y | Y | Y | N | N | |
| Schedules | Y | N | N | N | N | Schedules database |
| Profiles | Y | N | N | N | N | Profiles database (used in 7/12 Schedules) |

| | | | | | | |
|---|---|---|---|---|---|---|
| ActivityTemplates | Y | N | Y | N | N | Activity templates database |
| ConstructionTemplates | Y | N | Y | N | N | Construction templates database |
| GlazingTemplates | Y | N | Y | N | N | Glazing templates database |
| FacadeTemplates | Y | N | Y | N | N | Façade templates database |
| LightingTemplates | Y | N | Y | N | N | Lighting templates database |
| HVACTemplates | Y | N | Y | N | N | Simple HVAC templates database |
| DHWTemplates | Y | N | Y | N | N | DHW templates database |
| ProgramOptionTemplates | Y | Y | Y | N | N | Program options database. DesignBuilder uses Id = 2. |
| MenuTools | Y | Y | Y | N | N | List of menu options - for internal use only |
| LocationTemplates | Y | N | Y | N | N | Location templates database |
| UKDDData | N | Y | Y | N | N | UK degree day data - for internal use only |
| Countries | N | Y | Y | N | N | Countries database - for internal use only. |
| RegionsRaw | N | Y | Y | N | N | For internal use only |
| HourlyWeather | Y | N | N | N | N | Hourly weather database |
| WBANWMOLocations | Y | Y | Y | N | N | For internal use only |
| TimeZones | Y | Y | Y | N | N | Time zones database – for internal use only |
| CpData | Y | N | Y | N | N | Wind pressure coefficient database |
| Cracks | Y | N | Y | N | N | Cracks data used for Calculated nat vent - for internal use only |
| Regions | Y | N | Y | N | N | Regions database |
| EnergyCodes | Y | N | Y | N | N | Energy codes database |
| Sectors | Y | N | Y | N | N | Building usage sectors database |
| ECMeasures | Y | Y | Y | N | N | Not used |
| LoadDataFromTemplate | Y | Y | Y | N | N | Data for the Load data from template dialog |
| NewBuilding | Y | Y | Y | N | N | New building dialog |
| NewSite | Y | Y | Y | N | N | New site (model) dialog |
| Messages | Y | Y | Y | N | N | List of messages - for internal use only |
| HGDisplayOptions | Y | N | Y | N | N | Cooling design display options panel |
| HLDisplayOptions | Y | N | Y | N | N | Heating design display options panel |
| SSDisplayOptions | Y | N | Y | N | N | Simulation display options panel |
| CheckDisplayOptions | Y | N | Y | N | N | SBEM/DSM display options panel |
| UpgradeAdvice | Y | Y | Y | N | N | For internal use only |
| Units | Y | Y | Y | N | N | Units database |
| ImportDXF | Y | Y | Y | N | N | Import floor plans dialog |
| Import3D | Y | Y | Y | Y | N | Import 3D models dialog |
| EquipmentList | Y | Y | Y | N | N | Detailed equipment gains |
| DataOptionTemplates | Y | Y | Y | Y | N | Model options dialog |
| DrawingTools | Y | Y | Y | Y | N | |
| HGCalcOptions | Y | Y | Y | Y | N | Cooling design calculation options |
| HLCalcOptions | Y | Y | Y | Y | N | Heating design calculation options |
| SSCalcOptions | Y | Y | Y | Y | N | Simulation design calculation options |

| | | | | | | |
|---|---|---|---|---|---|---|
| EnergyRatingCalcOptions | Y | Y | Y | Y | N | SBEM/DSM design calculation options |
| CFDCalcOptions | Y | Y | Y | Y | N | CFD design calculation options |
| ReportOptions | Y | Y | Y | Y | N | Cost and Carbon design calculation options |
| MovieCalcOptions | Y | Y | Y | Y | N | Movie generation dialog |
| ThreeDDisplayOptions | Y | Y | Y | Y | N | Visualisation display options panel |
| CFDDisplayOptions | Y | Y | Y | Y | N | CFD display options panel |
| tHEFFd | N | Y | Y | N | N | SBEM/DSM heating system coefficients – for internal use only |
| tCEFFd | N | Y | Y | N | N | SBEM/DSM cooling system coefficients – for internal use only |
| SBEMHVACSystems | Y | N | N | N | N | SBEM HVAC system database – for internal use only |
| SBEMLightingTypes | Y | N | N | N | N | SBEM lighting system database – for internal use only |
| EnergyPlusVersions | Y | Y | Y | N | N | EnergyPlus versions list – for internal use only |
| SBEMVersions | Y | Y | Y | N | N | SBEM versions list – for internal use only |
| SBEMHeatSourceFuelType | N | Y | Y | N | N | SBEM data |
| SBEMRecirculation | N | Y | Y | N | N | SBEM data |
| SBEMHeatRecovery | N | Y | Y | N | N | SBEM data |
| SBEMHeatRecoverySystemTypes | N | Y | Y | N | N | SBEM data |
| SBEMDHWEfficiencies | N | Y | Y | N | N | SBEM data |
| SBEMDHWFuels | N | Y | Y | N | N | SBEM data |
| SBEMConstructionLibrary | N | Y | Y | N | N | SBEM data |
| SBEMConstructionInference | N | Y | Y | N | N | SBEM data |
| SBEMGlazingInference | N | Y | Y | N | N | SBEM data |
| SBEMGlazingLibrary | N | Y | Y | N | N | SBEM data |
| SBEMFrameLibrary | N | Y | Y | N | N | SBEM data |
| SBEMFrameInference | N | Y | Y | N | N | SBEM data |
| SBEMRecommendations | N | Y | Y | N | N | SBEM data |
| NewCFDAnalysis | Y | Y | Y | Y | N | New CFD analysis dialog |
| IEEGrausdia | Y | Y | Y | Y | N | Not used |
| OPTCalcOptions | Y | Y | Y | Y | N | Optimisation, Parametric analysis and UA/SA calculation options dialog |
| CFDBoundaryConditions | Y | Y | Y | Y | N | CFD boundary conditions dialog |
| SubBuildings | Y | N | N | N | N | Not used |
| Transport | Y | N | N | N | N | Not used |
| FormatTest | Y | N | N | N | N | Not used |
| RMCalcOptions | Y | Y | Y | Y | N | Daylighting calculation options dialog |
| HeatingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| CoolingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| FanComponent | Y | N | N | Y | Y | Detailed HVAC dialog |
| PumpComponent | Y | N | N | Y | Y | Detailed HVAC dialog |
| Boiler | Y | N | N | Y | Y | Detailed HVAC dialog |
| ChillerEIR | Y | N | N | Y | Y | Detailed HVAC dialog |
| DirectAirADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| SeriesPIUADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| ParallelPIUADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| FourPipeInductionADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| SingleDuctCAVReheatADU | Y | N | N | Y | Y | Detailed HVAC dialog |

| | | | | | | |
|---|---|---|---|---|---|---|
| SingleDuctVAVReheatADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| SteamHumidifier | Y | N | N | Y | Y | Detailed HVAC dialog |
| FanCoilUnit | Y | N | N | Y | Y | Detailed HVAC dialog |
| SingleDuctVAVReheatVSFanADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| SingleDuctVAVNoReheatADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| DualDuctCAVADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| DualDuctVAVADU | Y | N | N | Y | Y | Detailed HVAC dialog |
| HVACZone | Y | N | N | Y | Y | Detailed HVAC dialog |
| HVACZoneGroup | Y | N | N | Y | Y | Detailed HVAC dialog |
| PlantLoop | Y | N | N | Y | Y | Detailed HVAC dialog |
| ChilledCeiling | Y | N | N | Y | Y | Detailed HVAC dialog |
| HeatedFloor | Y | N | N | Y | Y | Detailed HVAC dialog |
| CoolingTower | Y | N | N | Y | Y | Detailed HVAC dialog |
| AirLoop | Y | N | N | Y | Y | Detailed HVAC dialog |
| AirHandlingUnit | Y | N | N | Y | Y | Detailed HVAC dialog |
| Plenum | Y | N | N | Y | Y | Detailed HVAC dialog |
| CooledBeam | Y | N | N | Y | Y | Detailed HVAC dialog |
| SetpointManager | Y | N | N | Y | Y | Detailed HVAC dialog |
| CompactCurves | Y | N | N | N | N | Detailed HVAC dialog |
| CompactChillers | Y | N | N | N | N | Not used |
| CompactBoilers | Y | N | N | N | N | Not used |
| FrameConstruction | Y | N | N | N | N | |
| DXCoolingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| DXHeatingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| UnitaryHeatPump | Y | N | N | Y | Y | Detailed HVAC dialog |
| PackagedTerminalHeatPump | Y | N | N | Y | Y | Detailed HVAC dialog |
| DaylightDisplayOptions | Y | N | Y | Y | N | Daylight display options |
| WaterConvector | Y | N | N | Y | Y | Detailed HVAC dialog |
| ElectricConvector | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterRadiator | Y | N | N | Y | Y | Detailed HVAC dialog |
| ElectricRadiator | Y | N | N | Y | Y | Detailed HVAC dialog |
| PackagedTerminalAirConditioner | Y | N | N | Y | Y | Detailed HVAC dialog |
| UnitaryHeatCool | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterOutlet | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterOutletGroup | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterHeater | Y | N | N | Y | Y | Detailed HVAC dialog |
| RT2012DisplayOptions | Y | N | Y | N | N | RT2012 data |
| RT2012Versions | Y | Y | Y | N | N | RT2012 data |
| CFDComfortCalcOptions | Y | Y | Y | Y | N | CFD comfort calculation options dialog |
| PeoplePayback | Y | Y | Y | N | N | People payback calculator |
| CurrencyTemplates | Y | Y | Y | N | N | |
| RT2012Emetteurs | Y | N | Y | N | N | RT2012 data |
| RT2012VentMeca | Y | N | Y | N | N | RT2012 data |
| RT2012PuitsClimatique | Y | N | Y | N | N | RT2012 data |
| RT2012GenerateurCombustion | Y | N | Y | N | N | RT2012 data |
| LoadHVACTemplate | Y | Y | Y | N | N | Load Detailed HVAC template wizard |
| EvaporativeCooler | Y | N | N | Y | Y | Detailed HVAC |
| DetailedHVACTemplate | Y | N | Y | N | N | Detailed HVAC template data |
| SolarCollector | Y | N | N | Y | Y | |
| SolarCollectorTemplate | Y | N | N | N | N | |
| RT2012GenReseau | Y | N | Y | N | N | RT2012 data |
| OptimisationAnalysis | Y | N | Y | Y | N | Optimisation Analysis data |
| RT2012BallonsECS | Y | N | Y | N | N | RT2012 data |
| FangerComfort | Y | Y | Y | N | N | Fanger comfort dialog |
| OptimisationObjectives | Y | N | Y | N | N | Optimisation objective data |
| OptimisationConstraints | Y | N | Y | N | N | Optimisation constraint data |
| OptimisationVariables | Y | N | Y | N | N | Optimisation/parametric analysis and UA/SA variable data |

| | | | | | | |
|---|---|---|---|---|---|---|
| Variables | N | Y | Y | N | N | Optimisation/parametric analysis and UA/SA variable options list |
| RT2012ThermodynElecNonRev | Y | N | Y | N | N | RT2012 data |
| RT2012SourceAmont | Y | N | Y | N | N | RT2012 data |
| HeatPumpHeating | Y | N | N | Y | Y | Detailed HVAC dialog |
| HeatPumpCooling | Y | N | N | Y | Y | Detailed HVAC dialog |
| GroundHeatExchanger | Y | N | N | Y | Y | Detailed HVAC dialog |
| PerformanceSimple | Y | N | N | N | N | Simple PV panel data |
| PerformanceOneDiode | Y | N | N | N | N | One diode PV panel data |
| Tariffs | Y | N | N | N | N | Tariff analysis data |
| Inverters | Y | N | N | N | N | Inverter data |
| Distributions | Y | N | N | N | N | Electrical distribution data |
| Storage | Y | N | N | N | N | Electrical storage (battery) data |
| RT2012ThermodynElecAut | Y | N | Y | N | N | RT2012 data |
| ComponentCost | Y | N | N | N | N | |
| LifeCycleCost | Y | N | N | N | N | Life cycle cost data |
| WindTurbine | Y | N | N | N | N | Wind turbine data |
| GHETemplate | Y | N | N | N | N | Detailed HVAC dialog |
| ZoneExhaustFan | Y | N | N | Y | Y | Detailed HVAC dialog |
| HPHeatingCoeffsParas | Y | N | N | N | N | Detailed HVAC dialog |
| HPCoolingCoeffsParas | Y | N | N | N | N | Detailed HVAC dialog |
| CasaClimaOptions | Y | Y | Y | Y | N | Not used |
| RT2012ThermodynGazNonRev | Y | N | Y | N | N | RT2012 data |
| CoolingSystems | Y | N | N | N | N | Cooling design Cooling systems data |
| GeometryConventionTemplates | Y | N | Y | N | N | Geometry conventions data |
| EMSProgramManager | Y | N | N | Y | N | |
| EMSPrograms | Y | N | N | N | N | |
| FMUPrograms | Y | N | N | N | N | Not used |
| EMSInputData | Y | N | N | N | N | |
| SBEMSolarCollectors | Y | N | Y | N | N | SBEM solar collector data |
| VRFAirConditioner | Y | N | N | Y | Y | Detailed HVAC dialog |
| VRFTerminalUnit | Y | N | N | Y | Y | Detailed HVAC dialog |
| VRFDXCoolingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| VRFDXHeatingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| VRFAirConditionerTemplates | Y | N | N | N | N | Detailed HVAC dialog |
| VRFTUTemplates | Y | N | N | N | N | Detailed HVAC dialog |
| UnitaryWaterToAirHeatPump | Y | N | N | Y | Y | Detailed HVAC dialog |
| ZoneWaterToAirHeatPump | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterToAirHPDXCoolingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterToAirHPDXHeatingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| MoistureMaterials | Y | N | N | N | N | Moisture materials database |
| FuelEmissionFactors | Y | N | N | N | N | |
| FluidToFluidHeatExchanger | Y | N | N | Y | Y | Detailed HVAC dialog |
| DistrictCooling | Y | N | N | Y | Y | Detailed HVAC dialog |
| DistrictHeating | Y | N | N | Y | Y | Detailed HVAC dialog |
| FluidCooler | Y | N | N | Y | Y | Detailed HVAC dialog |
| WaterHeaterHeatPump | Y | N | N | Y | Y | Detailed HVAC dialog |
| AirToWaterHeatPumpCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| GroundDomain | Y | N | N | N | N | Ground domain data |
| SummaryOutputs | Y | N | N | N | N | Parametric outputs list |
| FilterSelection | Y | Y | Y | N | N | |
| MergeModelData | Y | Y | Y | Y | N | |
| BaselineBuilding | Y | Y | Y | N | N | ASHRAE 90.1 baseline building wizard |
| ASHRAE901LPD | N | N | N | N | N | ASHRAE 90.1 data |
| ElectrochromicSensor | Y | N | N | N | N | Electrochromic sensor data |
| OrientationShadingCalcs | Y | Y | N | N | N | |
| CFDMeshCreation | Y | Y | Y | Y | N | CFD+ create mesh dialog |
| OutdoorAirVAVADU | Y | N | N | Y | Y | Detailed HVAC dialog |

| | | | | | | |
|---|---|---|---|---|---|---|
| CostData | Y | Y | Y | Y | N | |
| DataPlotFieldIndexes | N | N | N | N | N | |
| ASHRAE901FloorDef | Y | N | N | N | N | ASHRAE 90.1 data |
| DIN41082 | Y | Y | Y | Y | N | DIN4108.2 dialog |
| LEPOSTVariables | N | N | N | N | N | LEED MEPC report data |
| RT2012ThermodynGazDS | Y | N | Y | N | N | RT2012 data |
| RT2012VRVGeneration | Y | N | Y | N | N | RT2012 data |
| RT2012BoucleEau | Y | N | Y | N | N | RT2012 data |
| RT2012ThermodynGazRev | Y | N | Y | N | N | RT2012 data |
| RT2012ThermodynElecDS | Y | N | Y | N | N | RT2012 data |
| RT2012Supervision | Y | Y | Y | Y | N | RT2012 data |
| RadiantSurface | Y | N | N | Y | Y | Detailed HVAC dialog |
| LEPOSTAirSideVs | N | N | N | N | N | LEED MEPC data |
| ChilledWaterStorage | Y | N | N | Y | Y | Detailed HVAC dialog |
| IceThermalStorage | Y | N | N | Y | Y | Detailed HVAC dialog |
| CTThermalPerformance | Y | N | N | N | N | Detailed HVAC dialog |
| HVACGenerator | Y | N | N | Y | Y | Detailed HVAC dialog |
| OptimisationOutputs | Y | N | Y | N | N | Parametric outputs list |
| S63AltMeasures | Y | N | N | N | N | SBEM data |
| RT2012Ascenseur | Y | N | Y | N | N | RT2012 data |
| RT2012ListeParkings | N | N | Y | N | N | RT2012 data |
| RT2012Parking | Y | N | Y | N | N | RT2012 data |
| RT2012ListeAscenseurs | N | N | Y | N | N | RT2012 data |
| SBEMShowers | Y | N | N | N | N | SBEM data |
| PaneGroups | Y | N | N | N | N | Pane group database |
| InsertMaterialLayer | Y | N | N | N | N | Insert material dialog |
| AdvancedCFDErrorList | N | Y | Y | N | N | CFD+ error list |
| FoundationKivaInputs | Y | N | N | N | N | Kiva foundations database |
| FoundationKivaSettings | Y | N | N | N | N | Kiva settings database |
| ProjectDetails | Y | Y | Y | Y | N | SBEM/DSM project details dialog |
| EditThemes | Y | Y | Y | N | N | Themes data |
| HTRadiantHeating | Y | N | N | Y | Y | Detailed HVAC dialog |
| A901BuildingAreaTypes | Y | N | N | N | N | ASHRAE 90.1 data |
| UnitarySystem | Y | N | N | Y | Y | Detailed HVAC dialog |
| GenericCoolingCoil | Y | N | N | Y | Y | Detailed HVAC dialog |
| DefunctPanes | N | Y | Y | N | N | List of Panes no longer supported in IGDB |

## Columns

### Editable

The “Editable” column indicates whether the table defines data and formats for a dialog. Tables with a “Y” in the Editable column are editable which means that as well as the data itself, an additional table is stored that describes the layout of the corresponding dialog.

The tables pointed to by records in TableOfTables are:

1. The table whose records provide the data itself. This table is based on the corresponding .dat file and can be accessed using the name indicated in the “Name” column of TableOfTables. This table is always present.

2. The corresponding formats table that defines the layout of the dialog. This table can be accessed by adding the text “Formats”. For example to access the formats table of the Constructions table the table name is “ConstructionsFormats”. This table is only present for editable tables.

This column corresponds to the “IsEditable” field in TableOfTables.

### Application

The “Application” column indicates whether the table defines data associated the overall DesignBuilder application as opposed to the currently loaded model, or to the library data if no model is loaded. Tables with a “Y” in the Application column are associated with the application and those with an “N” are associated with the model, or with the library if no model is loaded.

This column corresponds to the “IsApplication” field in TableOfTables.

### Template

The “Template” column indicates whether the table is for a template or component.

a) Tables with a “Y” in the Template column are template tables and so when no model is loaded are accessed from the DB.Api.ApplicationTemplates class.
b) Tables with a “N” in the Template column are component tables and so when no model is loaded are accessed from the DB.Api.ApplicationComponents class.

This column corresponds to the “IsTemplate” field in TableOfTables.

### Model Data

The “Model Data” column indicates whether data associated with the table is accessed from model attributes or from a table accessed from model site level (when a model is loaded).

a) Tables with a “Y” in the “Model Data” column access their data from model attributes when a model is loaded or from a table when no model is loaded. In this case, when a model is loaded the attribute names used to store the data are defined by the “Name” field in the fmt file and the level in the model where the data is loaded from is defined by the LowestDecompositionLevel field in the Formats.fmt model data layout table.
b) Tables with a “N” in the “Model Data” column access their data from a table regardless of whether a model is loaded or not.

This column corresponds to the “LoadFromSketch” field in TableOfTables.

### HVAC

The “HVAC” column indicates whether data associated with the table is associated with a Detailed HVAC component or not. “Y” indicates that it is and “N” indicates that it is not.

Note that HVAC tables only contain dialog layout data. The HVAC data itself is stored within the Detailed HVAC data structures.

This column corresponds to the “IsHVAC” field in TableOfTables.

# Appendix 2- DesignBuilder Dialogs and Database Tables

DesignBuilder uses database tables to hold component and template data and also to define the layout of dialogs. This Appendix should ideally be read with reference to some example .dat and .fmt files open in a text editor.

## DesignBuilder Data (.dat) file

*e.g. Constructions.dat*
Data (.dat) files contain the database records supplied with the installation of DesignBuilder. The user’s own custom records are appended to these and stored as part of their model (or as part of the library for library components and templates added on the opening screen). As with the format file, this is a text file with two lines of header information. The header is followed by a single line for each record in the database table. Each line (record) in the table is broken up into a number of fields using the # symbol as a delimiter.

## Header

The first header line has one field for each of the “Categories” that subsequent records fall into.
The content of each of these fields is the Id of the category found in the file Localised_Categories_1.txt.

The second line of the header is the list of Field names used by each record in the table.

**Note**:The first 3 fields in editable database tables must be the same as shown below.

## Data

The remaining lines in the format file specify values for the records in the Database. Each line contains the data for one record.

Common fields to all database tables are:

**Id** – a unique Id for the record – DesignBuilder Database records have Ids in range 1-9999, User records have Ids in range 10000 – 99999.

**Name** – Unique user-defined name for the record.

**CategoryId** – The index into the list of categories defined on the first line of the .dat file.

The remaining fields are different for each database depending on the requirements of the corresponding component or template.

# Table of Tables

The “Table of Tables” table is a special case of a data file. It is loaded from TableOfTables.dat and can be accessed through the API using code like:

```
Table = ApplicationTemplates.GetTable(“TableOfTables”)
```

It provides DesignBuilder with detailed information on each data table/dialog in the database.

You can find a copy of TableOfTables.dat in the DesignBuilder\Data folder which can be accessed from within DesignBuilder using the “File > Folders > Library data” folder menu command.

Note that Appendix 1 includes a summary of the list of tables included in TableOfTables.

This table uses the standard format for DesignBuilder database tables with fields as follows:

**Id** - A unique Id for the table.

**Name** –The name of the table which is the same as the stem of the filename of the .dat & .fmt files.

**CategoryId** – Always set to 1 - only 1 category for this table i.e. All.

**ParentNodekey** – this is a unique three-letter code used to represent the table. E.g. ^^Con for Constructions.

**CategoriesTableName** -

**Title** – The Integer index into in LocalisedText_1.txt defines title of the table (use title case text, e.g. “Constructions”) .

**IconName** – Stem of the filename of an Icon (bmp) file.

**IsTemplate** – Set to “True” if database table is a template object and “False” if a component.

**IsApplicationData** – Set to “False” if the data is stored in the dsb file, “True” if it is to be accessed at the application level or if data is .

**UseGroupToolbox** – Not used.

**AllowNameCopy** –

**NameFieldName** – The name of the “Name” field in the Database Table. Set to “Name” for all tables except LocationTemplates

**PropertyMode** – Set “True” if database values appear in the left-hand panel on the DesignBuilder main window, “False” if database values are edited in a pop-up dialog.

**LoadFromSketch** – Set “True” when data is to be read from model data attributes, “False” if the data is to be stored in a table (i.e. .dat file)

**IsWizard** – Is the dialog to be displayed in wizard form – normally “False”

**AllowDontShowFormNextTime** – When “True”, a checkbox is displayed at the bottom of the dialog to indicate that the dialog should not be displayed next time in a similar situation.

**AlwaysAllowEdit** – Set to “True” if the data can always be edited (e.g. program options dialog) or “False” if restrictions can apply (e.g. constructions dialog where the data may be library data and not editable).

**IsDownLoadable** – A mechanism exists to allow a single .dat file to be shared by multiple users over the internet. This was implemented for the Messageboard  (“Comments” table). Normally set to “False”.

**IsEditable** –“True” when a dialog exists (fmt file defined) or “False” for database tables without a dialog.

**Width** – The default width of the dialog used to edit the database values in twips.

**InfoWidth** – The default width of the pane at the RHS when “LearningMode” is on.

**Height** – Default height of dialog in twips.

**InfoMinimised** – “True” if the info panel on the right of the dialog is minimized by default

**ShowInNavigators** – “True” if the data in the table be shown in navigators.

**IsListTable** – “True” if the data a list of sub-items to be edited using a grid control (normally “False”)

**FilterByRegion** – When “True” the lists are filtered based on the region using the Region settings on the Program options dialog.

**SingularName** – What is the component called in its singular – integer identifier points to text in LocalisedText_1.txt.

**NumberCurrentRegionData** – Set to 0.

**RemoveEmptyCategoryNodesWhenNotShowOtherRegionsData** – Normally “False”, but set to “True” if empty category nodes in the navigator treeview should be removed. This will only be done when not showing all regions data as set on Program options dialog, International tab.

**ShowInSBEMMode** – “True” if the table should be displayed in navigator lists when the software is running in SBEM mode.

**IsHVAC** – “True” if the table defines the dialog layout for a Detailed HVAC component.

## DesignBuilder Table Format Files

Dialogs in DesignBuilder are mostly data-driven, meaning that the layout of the items on the dialog is defined using a “format file”. These format files are loaded into DesignBuilder tables at the time the software is built and at run time the software accesses the data from the tables and not from the format files.

Format files use the .fmt file extension, e.g. “Constructions.fmt”.

Most plugins do not need to access format files as they will include their own dialogs, however in certain cases it may be useful to understand how dialogs are created and in very unusual circumstances changes can be made by for example changing max/min or default values.

Third-party developers do not have direct access to the source .fmt files, but they can be accessed using the API as described above in Appendix 1 and, if necessary, regenerated using code like:

```
Table.SaveAsTextFile FMTFileName
```

The format file defines the layout of the items on the dialog. It is a text file with two lines of header information followed by a single line for each item displayed on the dialog. These items include database fields and items to control the layout of the dialog. Each line in the fmt file is broken up into a number of fields using the # symbol as a delimiter.

The first header line has one field for each of the tabs to be displayed on the dialog. The content of each of these fields is the Id of the title of the tab found in LocalisedText_1.txt.

The second line of the header is the list of identifiers for the fields in the remaining lines of the file. This second line should be the same for all formats.

The remaining lines in the format file specify the various controls shown on the dialog.

Each line has the following fields:

**Name** – A Name for the control on the dialog, if the control is used to edit a DesignBuilder Database field then the name should match the name of the corresponding field in the .dat file.

**Caption** – The integer index of the string used for the caption of the control. The index points into LocalisedText_n.txt which contains the actual string. Strings for the various supported languages come from these files depending on the language selected on the program options dialog:

- LocalisedText_1.txt – English
- LocalisedText_2.txt - Italian
- LocalisedText_3.txt - Spanish
- LocalisedText_4.txt - French

**Default** – The default value for newly created data. May be left blank. For Header data this value determines whether the header is open or closed by default. 1 means closed, 0 means open.

**Indent** – The level of indentation. If a control is part of a group of controls that only displayed when a checkbox is checked or a header is expanded then their indentation should be set to one greater than the "parent" checkbox or header item.

**OptionGroup** – used for linking radio buttons (ItemType = GreyOptionBox) to define the other radio button controls that should be cleared when this one is selected.

**ItemType** – An integer defining the type of control:

| **ItemType** | **Comments** |
|---|---|
| 0 – Header | Grey header can be opened or closed – no corresponding field required in .dat file for Header item types. |
| 1 – GreyCheckBox | Standard check box – when it is checked, child items are shown. |
| 2 – GreyOptionBox | Radio button – see also info under OptionGroup above. |
| 3 – Browse | In this case the table from which the data is to be selected should be entered in ListType. |
| 4 – Combo | List of sequential integers defined in ListType |
| 5 – Button | Not commonly used |
| 7 – Text or Numeric edit | Numeric data requires format, max and min values. If the data is non-numeric make sure to set the min and max values to 0. |
| 8 – Colour | A colour can be selected and displayed |
| 9 – Label | Non-editable data |

| | |
|---|---|
| 10 – TextCombo | Requires the list index in LocalisedLists_1.txt to defined in subsequent ListType field |
| 11 – Object | e.g. special control such as graph,  picture etc |
| 12 – Slider | Slider controls need to have a (unique within the table) ObjectIndex integer defined as well. |
| 13 – Profile Edit | In this case make sure to define a unique ObjectIndex integer. |
| 14 – Option Box | not used. |
| 15 – Check Box | not used. |
| 16 – File Browse | Browse for a file. |
| 17 – Path Browse. | Browse for a path. |
| 18 – Spring | Not used |
| 19 – Multi-Select Browse | Allows multiple items to be selected from a database table. |
| 20 – Multi-line edit | Multi-line editor for recording notes etc |
| 21 – Date | Enter a date |
| 22 – Grid | A grid control |
| 23 – Encrypted Filename Browse | Only for textures |
| 22 – Grid | A grid control |
| 30 – File Browse | Full Path |
| 31 – File Browse (EPW) | Browse for a weather file |
| 77 – Edit (Numeric or Autosize) | Like 7, 77 supports numeric input but also allows ‘Autosize’ or other text input |

**Labels** – The labels to be used for Slider or ProfileEdit controls. In this case the data in ListType (next field) is the minor increment for the slider or profile edit control.

**ListType** – Has a different meaning depending on ItemType:

| **ItemType** | **Meaning of data in ListType** |
|---|---|
| 3 (Browse) | Table name from which the item can be |
| 4 (Combo) | 3 integers separated by commas defines the start number, followed by the last number followed by the step.<br>e.g. 1,10,1 generates a list of 10 integers from 1 to 10. |
| 10 (TextCombo) | Selected Integer Id of a list of values from Localised_Lists |

**Enabled** – Whether the control is enabled or not. Normally set to “True”

**OrderIt**  – Not used

**Lowest Decomposition Level** – Used when the LoadFromSketch TableOfTable value is set to “True”. This is the decomposition level at which the data is loaded/stored from the model data.

- 0=site
- 1=building
- 2=block
- 3=zone
- 4=surface
- 5=opening

**Format** – A string specifying the number of decimal places should be displayed (e.g. 0.000) indicates 3 decimal places.

**Locked** – Set to “True” if user is not allowed to edit the data.

**Min -** Sets minimum permitted value for numeric controls. Set to 0 for non-numeric data.

**Max** – Sets maximum permitted value for numeric controls. Set to  0 for non-numeric data.

**ObjectIndex** – The index of the slider or ProfileEdit control.

**ValueLabel** – Used for ProfileEdit controls.

**TabIndex** – Sets which of the dialog tabs the control is to be displayed on. The first tab on the dialog has index 1.

**Id** – Used internally by DB, set to 0.

**Units** – For numeric data, this is Id of the Units for the value from DesignBuilder “Units” table (Units.dat). Leave it blank for non-numeric data, or 99 for numeric but with no units (factors etc).

**ShowNCM** – Indicates whether the data is shown when DB is running in SBEM mode. 1 for yes, 0 for no.

**ShowEnergyPlus** – Indicates whether the data is shown when DB is running in EnergyPlus mode. 1 for yes, 0 for no.

**ShowKLIMA** – Indicates whether the data is shown when DB is running in Klima mode. 1 for yes, 0 for no.

**ShowPT** – Indicates whether the data is shown when in PT IEE mode. 1 for yes, 0 for no (Not used).

**ShowES** - Indicates whether the data is shown when DB is running in Spanish mode (Not Used)

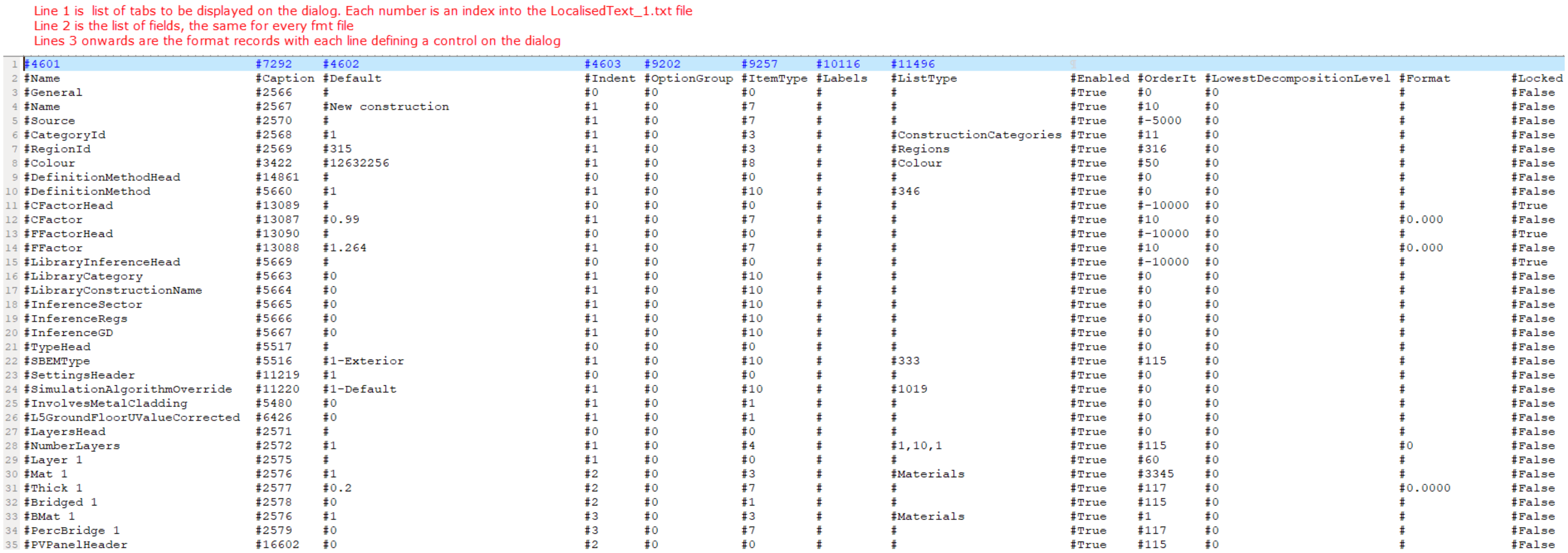
**ShowDE** - Indicates whether the data is shown when DB is running in German mode (Not Used)

**ShowFR** – Indicates whether the data is shown when using the RT2012 Analysis type.

**ShowDBSim** – Indicates whether the data is shown when running in DBSim mode (Not Used)

**ShowL5** - Indicates whether the data is shown when running in DSM mode.

The first few lines and fields of Constructions.fmt file are shown below to illustrate the layout of fmt files. Note the use of “#” characters as a field delimiter.



Line 1 is  list of tabs to be displayed on the dialog. Each number is an index into the LocalisedText_1.txt file
Line 2 is the list of fields, the same for every fmt file
Lines 3 onwards are the format records with each line defining a control on the dialog

```
 1 #4601                          #7292    #4602                 #4603   #9202        #9257     #10116    #11496
 2 #Name                          #Caption #Default              #Indent #OptionGroup #ItemType #Labels   #ListType               #Enabled #OrderIt #LowestDecompositionLevel #Format        #Locked
 3 #General                       #2566    #                     #0      #0           #0        #         #                       #True    #0       #0                        #              #False
 4 #Name                          #2567    #New construction     #1      #0           #7        #         #                       #True    #10      #0                        #              #False
 5 #Source                        #2570    #                     #1      #0           #7        #         #                       #True    #-5000   #0                        #              #False
 6 #CategoryId                    #2568    #1                    #1      #0           #3        #         #ConstructionCategories #True    #11      #0                        #              #False
 7 #RegionId                      #2569    #315                  #1      #0           #3        #         #Regions                #True    #316     #0                        #              #False
 8 #Colour                        #3422    #12632256             #1      #0           #8        #         #Colour                 #True    #50      #0                        #              #False
 9 #DefinitionMethodHead          #14861   #                     #0      #0           #0        #         #                       #True    #0       #0                        #              #False
10 #DefinitionMethod              #5660    #1                    #1      #0           #10       #         #346                    #True    #0       #0                        #              #False
11 #CFactorHead                   #13089   #                     #0      #0           #0        #         #                       #True    #-10000  #0                        #              #True
12 #CFactor                       #13087   #0.99                 #1      #0           #7        #         #                       #True    #10      #0                        #0.000         #False
13 #FFactorHead                   #13090   #                     #0      #0           #0        #         #                       #True    #-10000  #0                        #              #True
14 #FFactor                       #13088   #1.264                #1      #0           #7        #         #                       #True    #10      #0                        #0.000         #False
15 #LibraryInferenceHead          #5669    #                     #0      #0           #0        #         #                       #True    #-10000  #0                        #              #True
16 #LibraryCategory               #5663    #0                    #1      #0           #10       #         #                       #True    #0       #0                        #              #False
17 #LibraryConstructionName       #5664    #0                    #1      #0           #10       #         #                       #True    #0       #0                        #              #False
18 #InferenceSector               #5665    #0                    #1      #0           #10       #         #                       #True    #0       #0                        #              #False
19 #InferenceRegs                 #5666    #0                    #1      #0           #10       #         #                       #True    #0       #0                        #              #False
20 #InferenceGD                   #5667    #0                    #1      #0           #10       #         #                       #True    #0       #0                        #              #False
21 #TypeHead                      #5517    #                     #0      #0           #0        #         #                       #True    #0       #0                        #              #False
22 #SBEMType                      #5516    #1-Exterior           #1      #0           #10       #         #333                    #True    #115     #0                        #              #False
23 #SettingsHeader                #11219   #1                    #0      #0           #0        #         #                       #True    #0       #0                        #              #False
24 #SimulationAlgorithmOverride   #11220   #1-Default            #1      #0           #10       #         #1019                   #True    #0       #0                        #              #False
25 #InvolvesMetalCladding         #5480    #0                    #1      #0           #1        #         #                       #True    #0       #0                        #              #False
26 #L5GroundFloorUValueCorrected  #6426    #0                    #1      #0           #1        #         #                       #True    #0       #0                        #              #False
27 #LayersHead                    #2571    #                     #0      #0           #0        #         #                       #True    #0       #0                        #              #False
28 #NumberLayers                  #2572    #1                    #1      #0           #4        #         #1,10,1                 #True    #115     #0                        #0             #False
29 #Layer 1                       #2575    #                     #1      #0           #0        #         #                       #True    #60      #0                        #              #False
30 #Mat 1                         #2576    #1                    #2      #0           #3        #         #Materials              #True    #3345    #0                        #              #False
31 #Thick 1                       #2577    #0.2                  #2      #0           #7        #         #                       #True    #117     #0                        #0.0000        #False
32 #Bridged 1                     #2578    #0                    #2      #0           #1        #         #                       #True    #115     #0                        #              #False
33 #BMat 1                        #2576    #1                    #3      #0           #3        #         #Materials              #True    #1       #0                        #              #False
34 #PercBridge 1                  #2579    #0                    #3      #0           #7        #         #                       #True    #117     #0                        #              #False
35 #PVPanelHeader                 #16602   #0                    #2      #0           #0        #         #                       #True    #115     #0                        #              #False
```

## DesignBuilder Edit Screen Format file

The model data Edit Format data has 2 purposes:

1. To define the attributes used in DesignBuilder models

2. To define the layout of the UI items on the model data tabs, similar to pop-up dialogs.

The model data format file is loaded into DesignBuilder at the time the software is built and can be accessed using the EditFormats table from the ApplicationTemplates object (see code snippet below).

The source format file is called "Formats.fmt".

Most plugins do not need to access the model data format file as they will add their own dialogs, however in certain circumstances changes can be made. For example, it may be useful to change max/min or default values or even add new attributes and UI items. Also, it can be useful to obtain a full list of the model data attributes.

**Tip:** A sample plugin called **DBUIAdditionPluginExample** is provided in the GitHub repository. It illustrates show how to add new custom attributes and corresponding UI items.

Third-party developers do not have direct access to the source Formats.fmt file, but the data can be accessed using the API as described above in Appendix 1 and, if necessary, regenerated using code as follows:

```
FormatsTable = ApiEnvironment.ApplicationTemplates.GetTable("EditFormats")
FormatsTable.SaveAsTextFile "Formats.fmt"
```

Formats.fmt file is a text file with two lines of header information followed by a single line for each item displayed on the dialog. These items include database fields and items to control the layout of the dialog. Each line is broken up into a number of fields using the # symbol as a delimiter.

The layout of Formats.fmt is similar to the other table format files described in the previous DesignBuilder Table Format Files section so to avoid repetition only the exceptions are described here. Where no description is provided please refer to the previous section.

**Name**

**Caption**

**IsData** – Defines whether this item includes data (an attribute) or not. 1 if it is data, or 0 if it is not. For example header controls do not hold data and so have a value of 0.

**Default**

**Indent**

**OptionGroup**

**ItemType**

**Labels**

**ListType**

**Enabled**

**DataType** – Not used

**LowestDecompositionLevel** – the level down to which the attribute data is inherited.

**Format**

**Min**

**Max**

**Locked**

**SiteTab** – The index of the tab on which this control is displayed when at site level. A value of -1 means that the data is not displayed at site level.

The tabs are listed in Tabs.fmt. You can find a copy of the this file in the DesignBuilder\Data folder which can be accessed from within DesignBuilder using the “File > Folders > Library data” folder menu command.

**BuildingTab** – The index of the tab on which this control is displayed when at building level. A value of -1 means that the data is not displayed at building level.

**PBTab** – The index of the tab on which this control is displayed when at block level. A value of -1 means that the data is not displayed at block level.

**ZoneTab** – The index of the tab on which this control is displayed when at zone level. A value of -1 means that the data is not displayed at zone level.

**SurfaceTab** – The index of the tab on which this control is displayed when at surface level. A value of -1 means that the data is not displayed at surface level.

**OpeningTab** – The index of the tab on which this control is displayed when at opening level. A value of -1 means that the data is not displayed at opening level.

**ObjectIndex**

**ValueLabel**

**Visible** – True if this control is to be displayed, False if not.

**ParametricList** – for ProfileEdit controls this is the list of parametric options.

**UniqueCaption** – caption to be used for parametric simulation results.

**IconName** – name of the icon to be included in the control.

**ChangeUpdatesRenderedView** – 1 if changes to this attribute should result in the model being updated through a call to the UpdateTileAttributes API method, otherwise 0. UpdateTileAttributes regenerates default opening arrangements and rebuilds the OpenGL display using the latest attribute settings.

**ChangeUpdatesShading** – 1 if changes to this attribute should result in the shading results view being reset, otherwise 0. Not Used.

**HideWhenMerged** - 1 if this attribute should be hidden for child merged zones, otherwise 0.

**ChangeUpdatesHG** – 1 if changes to this attribute should result in the Cooling design results being deleted, otherwise 0. Not Used.

**ChangeUpdatesSS** – 1 if changes to this attribute should result in the Simulation results being deleted, otherwise 0. Not Used.

**ChangeUpdatesGeometry** – 1 if changes to this attribute should result in the API UpdateGeometry method being called, otherwise 0. UpdateGeometry regenerates zone inner volumes and the OpenGL display.

**MyTab** – The index of the tab on which this control is displayed. -1 if there is no UI item associated with this control.

**Id** – For internal use.

**Dirty** – For internal use.

**TemplateIdName** – The name of the Template attribute Id which is used to load data for this attribute. For example, if the attribute is loaded from Constructions Templates then this should have the value ConstructionTemplateId. Leave it blank if the data is not loaded from a template.

**Prefix** – Not used.

### Units

### ShowNCM

### ShowEnergyPlus

### ShowKLIMA

### ShowPT

### ShowES

### ShowDE

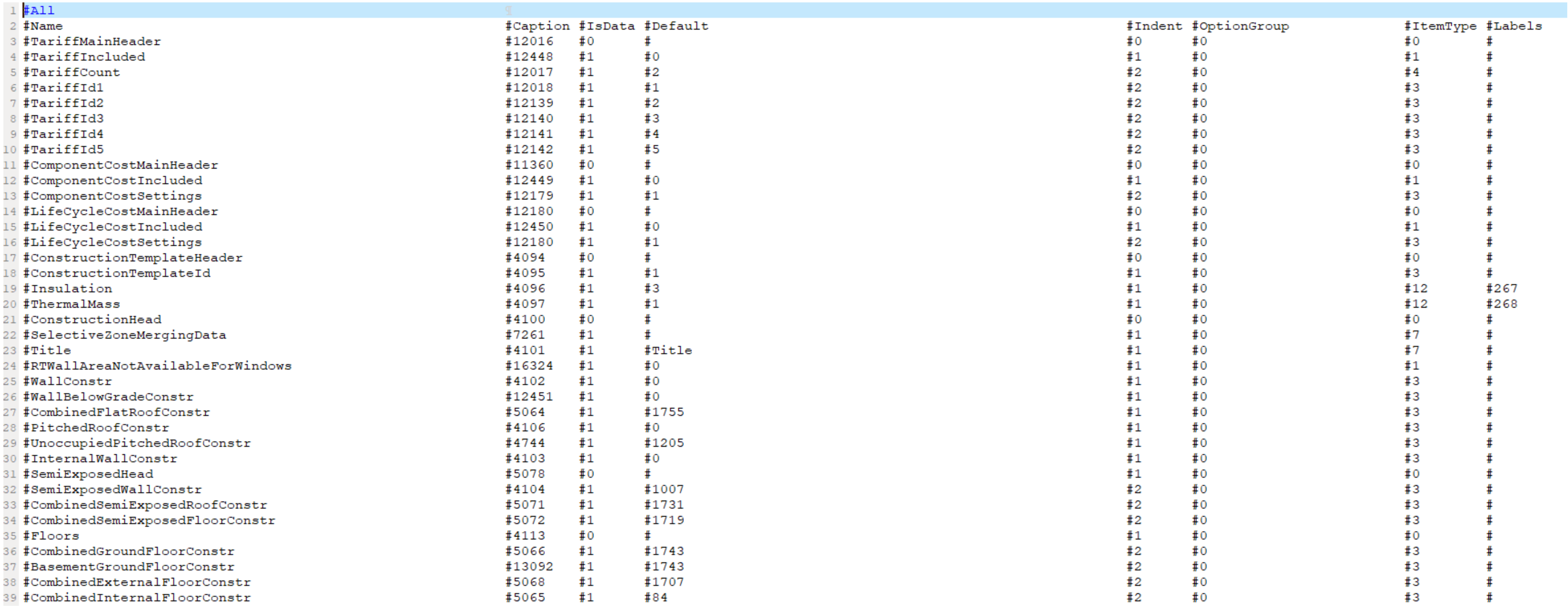
### ShowFR

### ShowDBSim

### ShowL5

The first few lines and fields of Formats.fmt file are shown below to illustrate the layout. Note the use of “#” characters as a field delimiter.

Line 1 is is not used
Line 2 is the list of format fields
Lines 3 onwards are the format records with each line defining a control on the Edit screen



```
 1 #All
 2 #Name                               #Caption #IsData #Default  #Indent #OptionGroup  #ItemType #Labels
 3 #TariffMainHeader                   #12016   #0      #         #0      #0            #0        #
 4 #TariffIncluded                     #12448   #1      #0        #1      #0            #1        #
 5 #TariffCount                        #12017   #1      #2        #2      #0            #4        #
 6 #TariffId1                          #12018   #1      #1        #2      #0            #3        #
 7 #TariffId2                          #12139   #1      #2        #2      #0            #3        #
 8 #TariffId3                          #12140   #1      #3        #2      #0            #3        #
 9 #TariffId4                          #12141   #1      #4        #2      #0            #3        #
10 #TariffId5                          #12142   #1      #5        #2      #0            #3        #
11 #ComponentCostMainHeader            #11360   #0      #         #0      #0            #0        #
12 #ComponentCostIncluded              #12449   #1      #0        #1      #0            #1        #
13 #ComponentCostSettings              #12179   #1      #1        #2      #0            #3        #
14 #LifeCycleCostMainHeader            #12180   #0      #         #0      #0            #0        #
15 #LifeCycleCostIncluded              #12450   #1      #0        #1      #0            #1        #
16 #LifeCycleCostSettings              #12180   #1      #1        #2      #0            #3        #
17 #ConstructionTemplateHeader         #4094    #0      #         #0      #0            #0        #
18 #ConstructionTemplateId             #4095    #1      #1        #1      #0            #3        #
19 #Insulation                         #4096    #1      #3        #1      #0            #12       #267
20 #ThermalMass                        #4097    #1      #1        #1      #0            #12       #268
21 #ConstructionHead                   #4100    #0      #         #0      #0            #0        #
22 #SelectiveZoneMergingData           #7261    #1      #         #1      #0            #7        #
23 #Title                              #4101    #1      #Title    #1      #0            #7        #
24 #RTWallAreaNotAvailableForWindows   #16324   #1      #0        #1      #0            #1        #
25 #WallConstr                         #4102    #1      #0        #1      #0            #3        #
26 #WallBelowGradeConstr               #12451   #1      #0        #1      #0            #3        #
27 #CombinedFlatRoofConstr             #5064    #1      #1755     #1      #0            #3        #
28 #PitchedRoofConstr                  #4106    #1      #0        #1      #0            #3        #
29 #UnoccupiedPitchedRoofConstr        #4744    #1      #1205     #1      #0            #3        #
30 #InternalWallConstr                 #4103    #1      #0        #1      #0            #3        #
31 #SemiExposedHead                    #5078    #0      #         #1      #0            #0        #
32 #SemiExposedWallConstr              #4104    #1      #1007     #2      #0            #3        #
33 #CombinedSemiExposedRoofConstr      #5071    #1      #1731     #2      #0            #3        #
34 #CombinedSemiExposedFloorConstr     #5072    #1      #1719     #2      #0            #3        #
35 #Floors                             #4113    #0      #         #1      #0            #0        #
36 #CombinedGroundFloorConstr          #5066    #1      #1743     #2      #0            #3        #
37 #BasementGroundFloorConstr          #13092   #1      #1743     #2      #0            #3        #
38 #CombinedExternalFloorConstr        #5068    #1      #1707     #2      #0            #3        #
39 #CombinedInternalFloorConstr        #5065    #1      #84       #2      #0            #3        #
```