

EESy Solutions

Engineering Equation Solver Newsletter

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Welcome

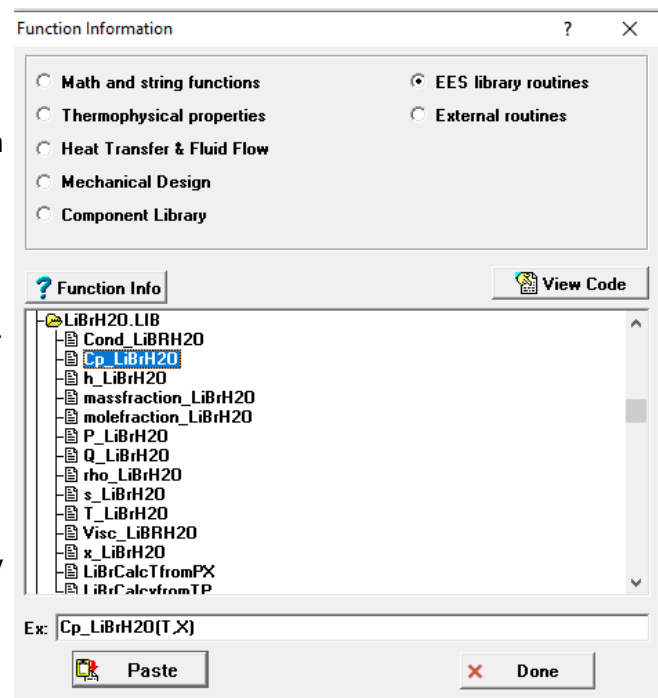
This is the 41st issue of EESy Solutions, a newsletter that provides news, tips, and other updates for users of the Engineering Equation Solver software. This issue discusses the creation of effective EES libraries. EES libraries can house families of functions that are generally useful. They can be made automatically compatible with the unit system set by the user and integrated with help files. This issue also discusses enhanced abilities to place and control graphic objects on the Diagram Window.

EES has been commercially available for more than two decades. If you have missed any of the previous issues of EESy Solutions, they can be downloaded from <https://fchartsoftware.com>.

Libraries in EES

Internal functions and procedures are EES code units that can greatly enhance the functionality of the software. These can be placed at the top of an EES program, in which case they are accessible only within that program. However, functions and procedures that can be accessed from any EES program can be saved in their own EES library file (a .lib or .lib64 file) in which case they can be automatically loaded when EES starts and accessed transparently by the user. Library files can be created that are compatible with the current EES unit system and associated with online help files.

There are a large number of these libraries already available in EES. These can be seen by selecting the Function Info command from the Options menu and then selecting the *EES library routines* radio button.

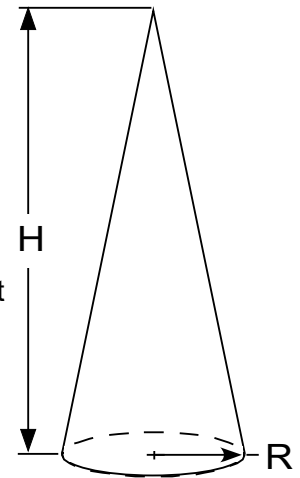


The Function Information dialog for the LiBrH2O library.

Creating a Library in EES

To illustrate the techniques, we will create an EES library called Geometry.lib that contains a procedure to compute the surface area and volume of a geometric shape. Start by opening an EES file and saving it as Geometry.lib. You can save this file anywhere, but it will be automatically loaded when EES starts if you save it in the UserLib (or UserLib64) directory or within a subfolder in this directory.

We will write a single procedure in the Geometry.lib file called **ConeGeometry** that returns both the surface area and volume of a cone with inputs height and radius. A more useful library will consist of many functions or procedures (or subprograms) that do a variety of related things. For example, we might add additional procedures that deal with cubes, spheres, etc.



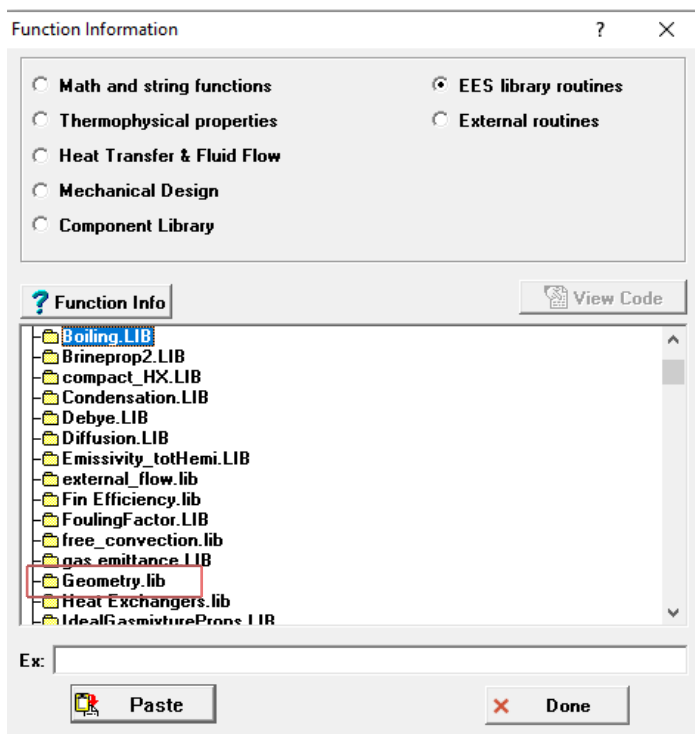
Our first pass at the **ConeGeometry** procedure is shown. If you close Geometry.lib and start EES you can see that the Geometry library has automatically been loaded by selecting Function Information from the Options menu and then selecting the EES library routines button. You can access the functions and procedures in Geometry.lib (in this case, just ConeGeometry) as if they were built into EES.

```

Equations Window
Procedure ConeGeometry(R, H: A, V)
  A = pi*R*(R+sqrt(H^2+R^2))
  V = pi*R^2*H/3
End

```

First pass at the ConeGeometry procedure



Function Information dialog with EES library routines selected

```

Equations Window
H = 0.5
R = 0.1
Call conegeometry(H, R: A, V)

```

Solution

Unit Settings: SI C kPa kJ mass d			
A = 1.586	H = 0.5		
R = 0.1	V = 0.02618		

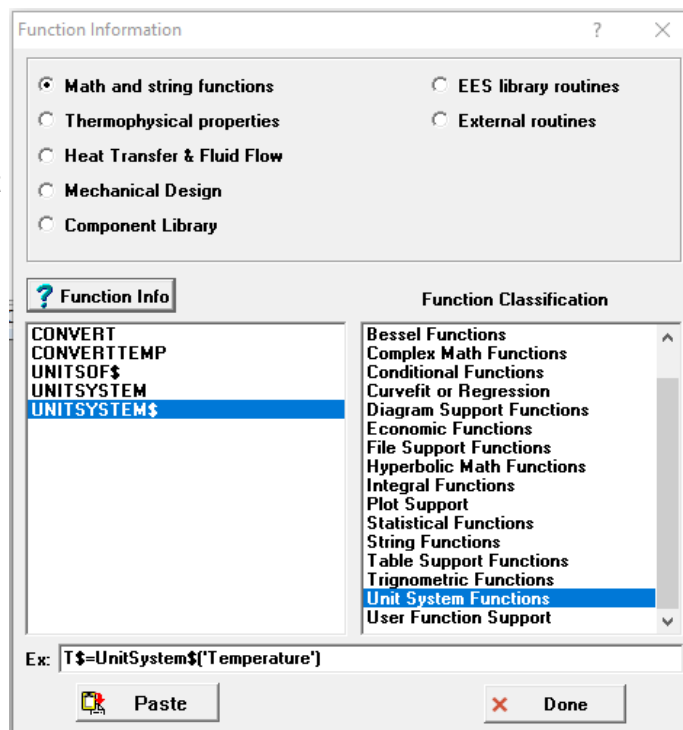
Calling the ConeGeometry Procedure from EES

Dealing with Units in Libraries

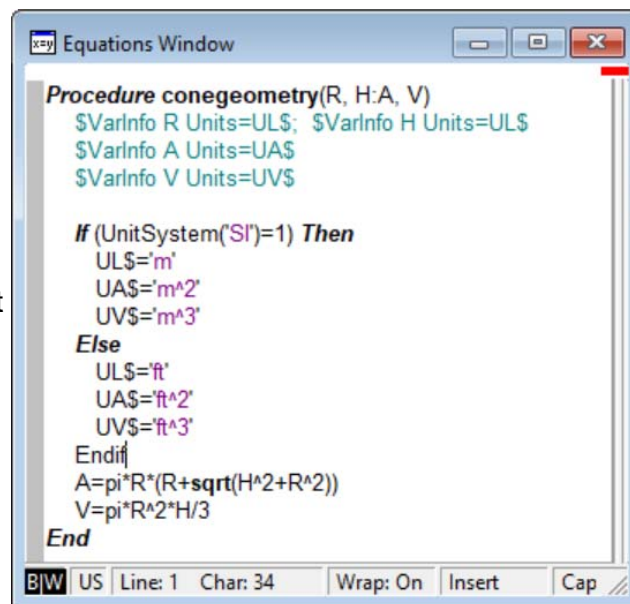
It is easy to write the function so that it operates in one set of units. However, in order for it to be of general use when called from any EES program, it must operate properly in any set of units. Therefore, we need to modify our Geometry library so that it works properly in the unit system selected by the user. To do this we need to use the Unit System functions built into EES; these can be examined by selecting the Function Info menu from the Options menu and then selecting the *Math and string functions* radio button. Scroll down to the Unit System Functions in the Function Classification Window and click on it.

The Unit System function that is most useful for this library is **UnitSystem** which provides information about the current unit setting for EES. **UnitSystem** takes a single string as the input argument and it returns either a 1 (true) or 0 (false) depending on whether the unit settings are consistent with the value indicated by the string. For example, **UnitSystem('Mass')** will return 1 if the EES unit system is set to a mass basis and 0 otherwise.

For the **ConeGeometry** procedure, we're interested in knowing the units of length, area, and volume, which will only differ depending on whether EES is set to SI or English units. Therefore, we can use the **UnitSystem** function with the argument 'SI' to determine which of these systems is being used. Based on the unit system, the appropriate units of length, area, and volume are set in the strings UL\$, UA\$, and UV\$, respectively. The last step is to assign the units in UL\$, UA\$, and UV\$ to the variables in the procedure. This could be done using the Variable Information menu command in the Options menu. However, a better method is to use a \$VarInfo directive to assign the units of each variable within the procedure itself. The \$VarInfo directive can be placed in an EES program in order to set variable information such as the guess value, limits, units, alternate units, and display format that would otherwise be set in the Variable Information Window. Here, we'll use \$VarInfo directives in the **ConeGeometry** procedure to specify the units of the variables that are used as inputs and outputs.



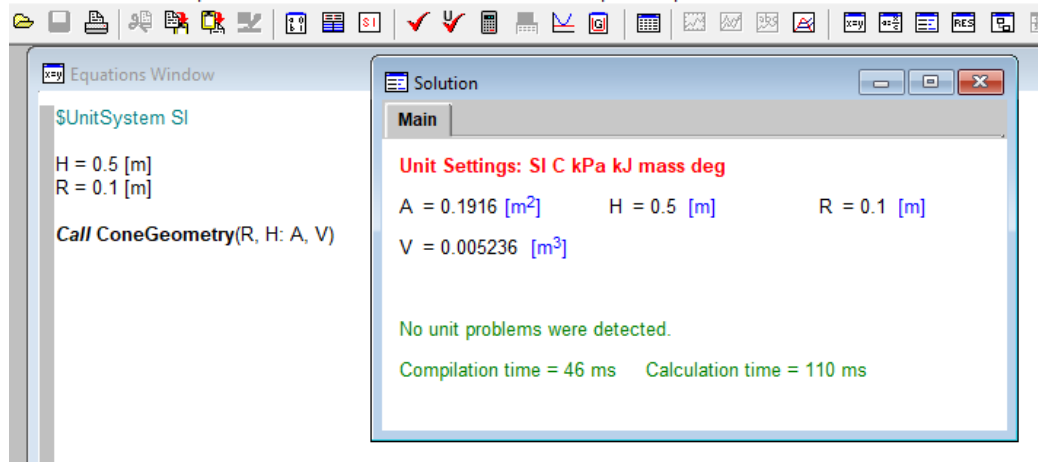
Unit System Functions



Procedure with units of variables set

Dealing with Units in Libraries (continued)

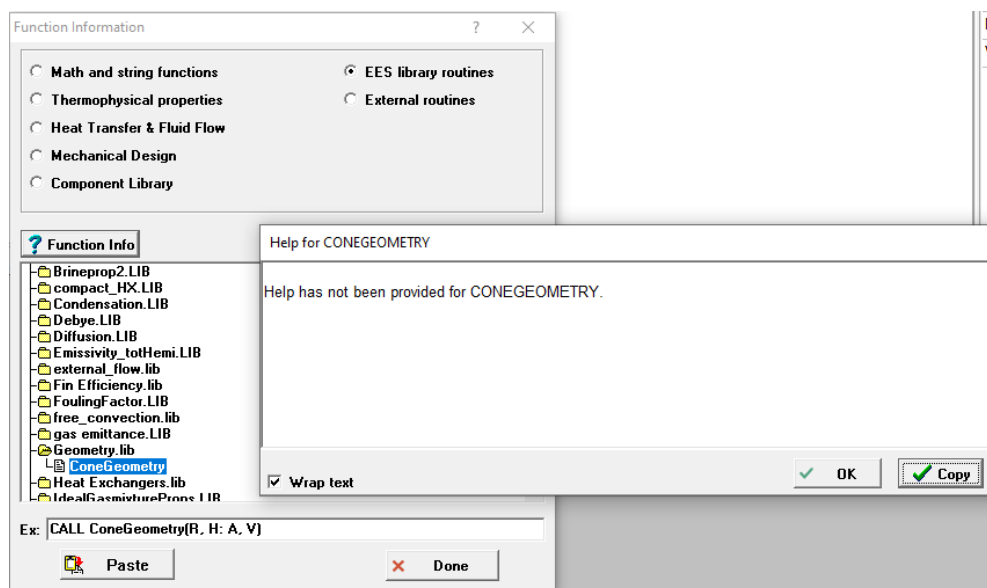
Any unit checking that occurs for a program calling the library will check that the input and output units match those set in the calling program and issue a warning if this is not the case. The ConeGeometry procedure expects that any EES program using the English unit system will be using ft as the length unit and any EES program using the SI unit system will be using m as the length unit.



Calling the ConeGeometry procedure from an EES file with SI units

Providing Help to Libraries

If a library file is to be useful, it is necessary to provide some documentation for the functions, procedures and subprograms that it contains. If help information is available, it can be accessed using the **Function Info** button that appears in the Function Information dialog. For example, if you click on the ConeGeometry procedure within the Geometry folder and select the **Function Info** button, you'll currently get a message saying that no help is available.



No Help Available message for ConeGeometry Function

Providing Help to Libraries (continued)

There are a few ways to add help information to a library. The easiest is just to add text in the library itself. EES will pick up a comment placed in the code that starts with \$ followed by the name of the function, procedure, or subprogram.

```

Equations Window

Procedure ConeGeometry(R, H: A, V)
{$ConeGeometry
The procedure ConeGeometry computes the surface area and volume of a cone.
Inputs:
  R: radius (in m or ft)
  H: height (in m or ft)

Outputs:
  A: area (in m^2 or ft^2)
  V: volume (in m^3 or ft^3)
}

$VarInfo R Units = UL$; $VarInfo H Units = UL$; $VarInfo A Units = UA$; $VarInfo V Units = UV$

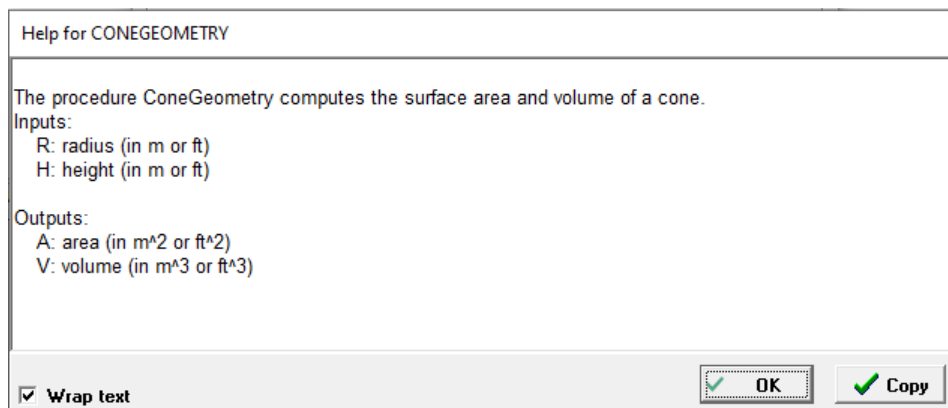
If (UnitSystem('SI')=1) Then
  UL$ = 'm'
  UA$ = 'm^2'
  UV$ = 'm^3'
Else
  UL$ = 'ft'
  UA$ = 'ft^2'
  UV$ = 'ft^3'
Endif

A = pi*R*(R+sqrt(H^2+R^2))
V = pi*R^2*H/3

End

```

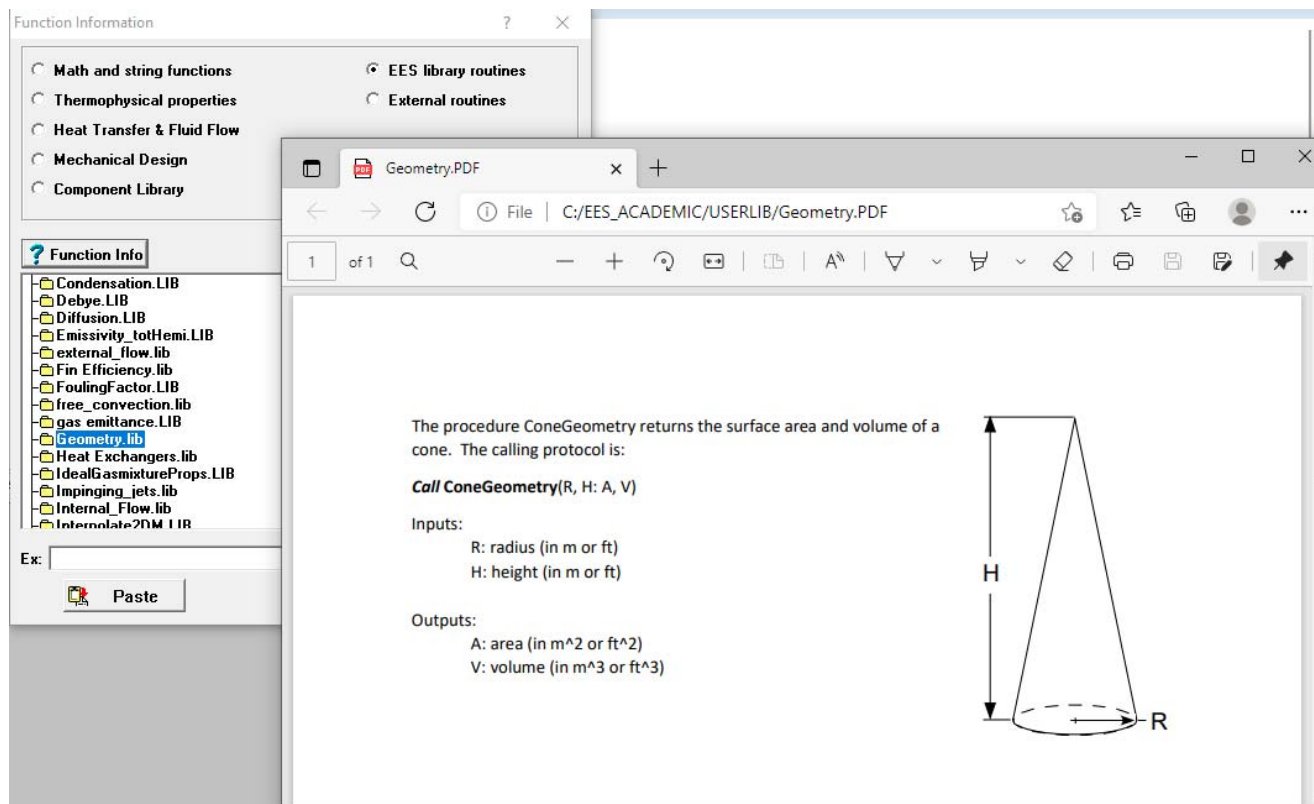
ConeGeometry Procedure with Help Message



Popup Help Message that appears

Help for Libraries (continued)

It's also possible to develop much more sophisticated and attractive dedicated .pdf, .htm, or .chm help files. For example, you can create a help file named Geometry.pdf and place it in the same directory as the library. The .pdf file will be displayed when you select **Function Info** from the Function Information dialog.



Dedicated Help File for the Geometry library

Loading Libraries

It is not necessary to save your library in the Userlib directory. If you save a library in a different directory then it will not be loaded automatically when EES starts. You could load the library manually by selecting Load Library from the File menu and navigating to the directory that contains the .lib (or .lib64) file. A more convenient way of loading a library into an EES program is with the \$Include directive. Place the \$Include directive at the top of the EES code in order to automatically load the library.

Note that once the library is loaded into the EES file it will not be reloaded, even if the code in the library is altered. When you are developing and testing a library file it is convenient to use the \$Include directive with the /R option, which loads the library every time the equations are compiled.

```

Equations Window
$Include C:\temp\Geometry.lib
H = 0.5 [m]
R = 0.1 [m]
Call conegeometry(R, H: A, V)

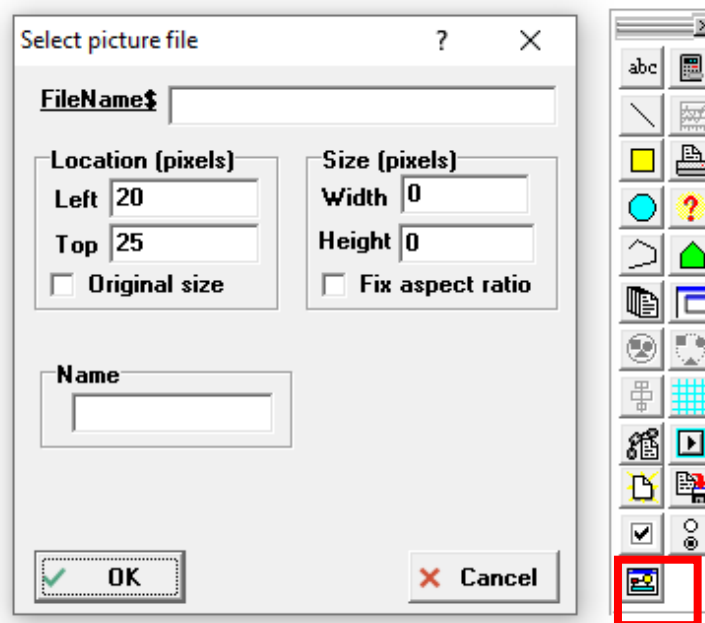
```

Use of the \$Include directive

The Add Picture Control in the Diagram Window

Some types of graphic items could previously be added to the Diagram Window when it is in Development Mode by copying the item to the clipboard and pasting it into the window. The item could then be dragged and resized. A new feature extends the capability to add graphic items to the Diagram Window.

The Add Picture control on the Diagram Window toolbar (Professional version) will activate the Add Picture dialog. The Add Picture control allows a picture to be loaded from a stored file in almost any format (.bmp, .emf, .png, .gif, .jpg, and .tif). If you provide a name in the Name box then you can programmatically control the aspects of the picture including its position (Name.left, Name.top, Name.width, Name.height, and Name.angle) and its display status (Name.Hide and Name.transparent). More importantly, you can specify which file is to be displayed (Name.FileName\$). Name.FileName\$ is a normal EES string variable. It can be used within the Equations window or within Diagram Window controls such as drop-down lists, radio buttons, and check boxes to control which picture is displayed.



Add Picture dialog

Example with the Add Picture Control

In order to illustrate the use of the Add Picture Control we will build a Diagram Window that allows the user to choose between two types of compact heat exchanger geometries and displays a picture of the chosen core on the window. The heat transfer coefficient for ambient air passing through the core is calculated and displayed. The user can select the flow rate, frontal area, and size of the liquid channels.

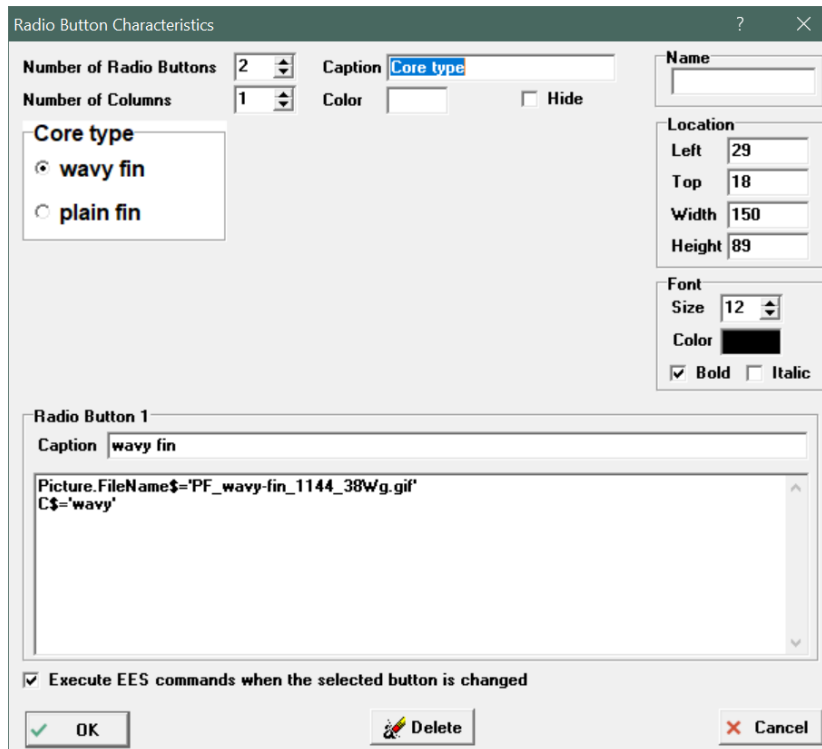
We will start by adding a Picture Control box on the Diagram Window. Name the control (Picture) so that we can control its attributes. In this example we'll control the file name of the picture to display. The EES code is shown here.

```
$UnitSystem SI Mass J C kPa
Fluid$ = 'Air'
T = 20 [C]
P = 100 [kPa]
$Varinfo h units='W/m^2-K'
$If CS = 'wavy'
  Call chx_h_pf_wavy_fin('PF_wavy-fin_1144_38W', m_dot, A_fr_tot, b_2, Fluid$, T, P:h)
$Else
  Call chx_h_pf_plain_fin('PF_plain-fin_20', m_dot, A_fr_tot, b_2, Fluid$, T, P:h)
$EndIf
```

EES code for the Add Picture example

Example with the Add Picture Control (continued)

The string C\$ selects the core to be used. Input variables \dot{m} , $A_{fr,tot}$, and b_2 are set from the Diagram Window. On the Diagram Window, add input boxes for these variables, an output box for h , and also a radio button group that can be used to set the value of C\$ and the file name of the picture. Select the *Execute EES commands when the selected button is changed* control at the bottom of the Radio button dialog so that the picture changes when the radio button is selected. Add a Calculate button to the Diagram window to initiate calculations.



Radio Button Group

The result is shown below. The picture changes as the user selects either wavy or plain fin in the Diagram window (Application mode). The calculate button initiates the calculations and displays the heat transfer coefficient for the selected heat exchanger core.

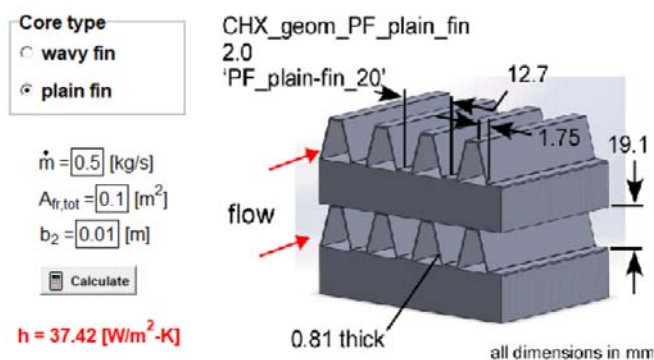


Diagram Window with Plain Fin selected

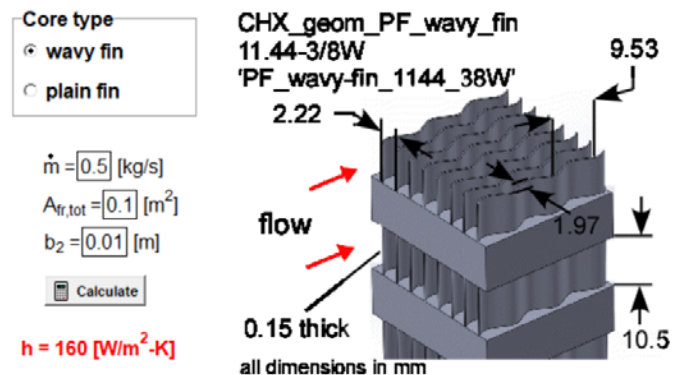


Diagram Window with Wavy Fin selected

Other Recent Changes to EES

- The Diagram Link Button dialog in the Professional version now allows buttons to be displayed as pictures.
- The thermodynamic and transport properties of sodium (solid, liquid, and vapor) are available in the Liquid Metals library.
- The Lienhard (2020) correlation has been added to provide the local and average heat transfer coefficient on a flat plate. This correlation deals more accurately with the transition region.
- Thermodynamic and transport properties have been added for Ethylene Oxide and Chlorine.
- The Saturation% property function returns the mass fraction (as a %) of a saturated brine.
- The AddPlotLine macro command allows a line to be drawn on an existing plot using a macro.
- A light-gray margin is displayed at the left side of the Equations Window if it is configured for word wrapping. A red + symbol will be shown in the margin of a line if it is a continuation (or wrapped) line.
- Functions arcsin, arccos, arctan, cosh, and sinh now work for complex arguments.
- The functions for the wavy fin plate, plate strip fin, pin fin, finned flat, and plain fin heat exchanger cores have been updated in the Compact Heat Exchanger library.
- The DuplicateTable and DuplicateLookupTable macro commands will duplicate Parametric and Lookup Tables, respectively.
- The substances d_Limonene, CO2_solid, CH4_solid, Hanyes_230, Inconel_625, and N2_solid have been added to the Incompressible Substance Library.
- Sublimation data are provided for nitrogen and oxygen.
- The AlterValues macro command now allows autofilling of columns in Parametric and Lookup Tables.
- Values from tables can now be copied in a transposed format and with Alternate Units.
- Macro commands are available to control the visibility of objects in the Diagram window using the name of the object and the attribute hide (Object.Hide) or show (Object.Show).
- The leftmost panel in the Equations Window status bar allows you to switch between a black or a white background. Colors set with their default values will be adjusted for visibility on the black background.
- Correlations for zig-zag channel geometries have been added to the Internal Flow Heat Transfer library.



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Instant Update & Technical Service

EES uses a different model for updating than most other programs. Each time that there is a change in the EES program, either to correct a problem or to add a new feature, the version number is incremented by 0.001 and the latest version of EES is placed on our website. Although the program has become very robust and stable, there have been many new versions of EES released since the last EESy Solutions was distributed.

Any user who has a current subscription to our Instant Update Service can download the latest version. All new non-academic licenses of EES are provided with one year of Instant Update Service. The fee to continue Instant Update Service after the first year is 20% of the current cost of the program per year if renewed within 12 months after expiration. Contact us if you wish to re-subscribe to Instant Update Service (IUTS).