

EESy Solutions

Engineering Equation Solver Newsletter

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Welcome

This is the 38th issue of EESy Solutions, a newsletter that provides news, tips, and other updates for users of the Engineering Equation Solver software. This issue introduces some new property functions and the associated property plots. It provides examples of the new IdealGasThermoProps procedure that allows multiple properties for an ideal gas to be determined with one line of code. It presents some new capabilities of directives. For academic users, It describes changes in Academic Update Service that will go into effect starting in June, 2020.

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 www.fchartsoftware.com.

Academic Update Service for 2020

Up to and including the 2019-2020 academic year, the EES Academic program has been designed to expire on September 1 of the following year. As a result, it has been necessary for departments to replace their existing EES programs each year with a newer version that was made available at no cost.

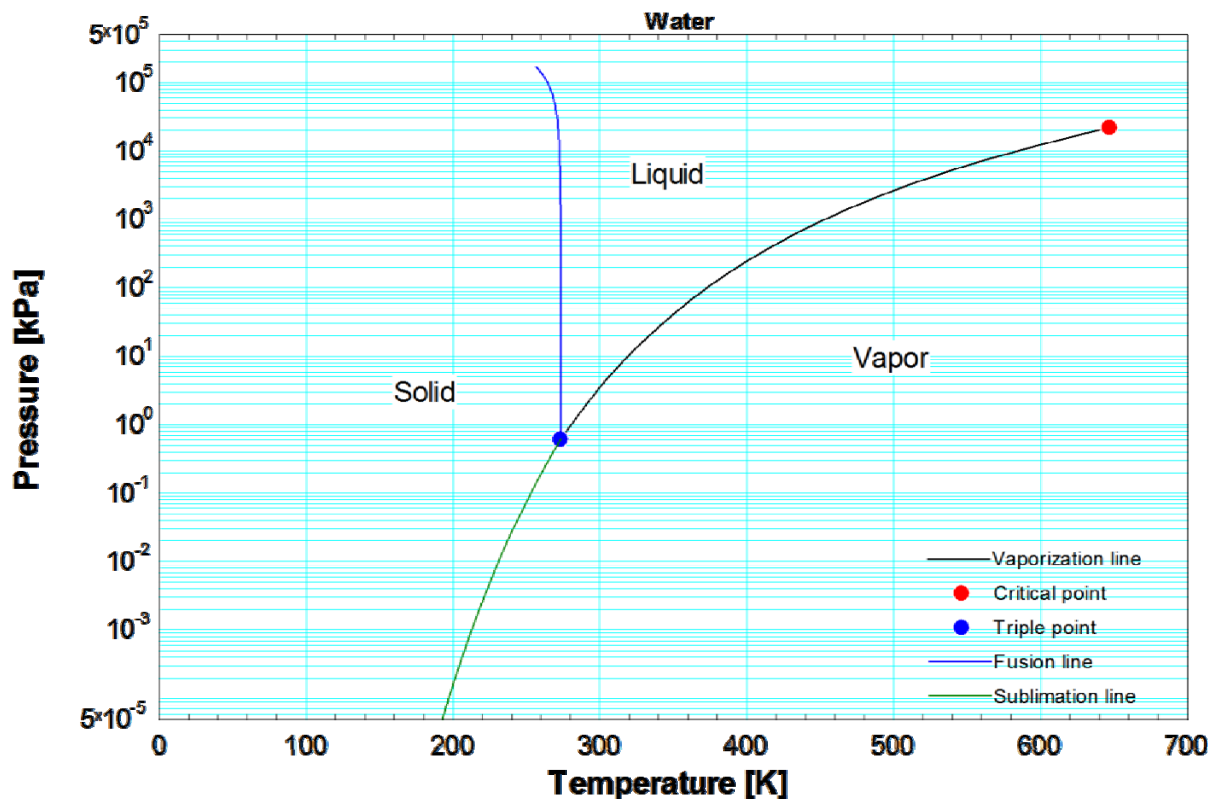
This policy will change in June of this year. The Academic version of EES that will be available in June, 2020 will not expire and it will no longer be necessary to replace the program. However, free access to our website to download the EES setup program will end on September 1, 2020. After this date, technical support and access to the Academic installation program residing on our website will only be available with an annual subscription to the Academic Update Service (AUS). The cost of this optional service is \$500 per year for the Academic Commercial version and \$1000 per year for the Academic Professional version. The optional Academic Update Service will allow departments to access the most recent version of EES and take advantage of new program enhancements and bug fixes after September 1, 2020. Departments that do not have a subscription to Academic Update Service can continue to use the Academic version of EES released in June 2020.

To summarize:

- The Academic Version of EES available in June 2020 will not expire.
- Without an annual subscription to Academic Update Service (AUS), it will no longer be possible to access our website to download the EES Setup after September 1, 2020.
- Technical support will not be available after September 1, 2020 unless a subscription to Academic Update Service is in place.

The P_Sublimation and P_Melting Functions

The figure below illustrates a Pressure-Temperature diagram for water. This type of plot clearly shows the three states of matter (solid, liquid, and vapor) and where they exist in pressure-temperature space. At very low temperatures, water exists as a solid. Increasing the temperature causes the solid to either transition to vapor (i.e., sublime) or liquid (i.e., melt) depending on the pressure. Note the interesting behavior where increasing pressure causes water to melt at lower temperatures. This behavior is particularly evident at high pressures, as indicated by the curvature of the melting line.



The sublimation line information is given by the function `P_Sublimation` which provides the pressure at which a substance sublimates as a function of temperature. The melting line information is given by the function `P_Melting` which provides the pressure at which a substance melts as a function of temperature.

This code provides the sublimation pressure for water at 250 K and the melting pressure for water at 270 K. Solving leads to a sublimation pressure of 76.01 Pa and a melting pressure of 39.31 MPa

Equations Window

\$UnitSystem SI Mass J K Pa

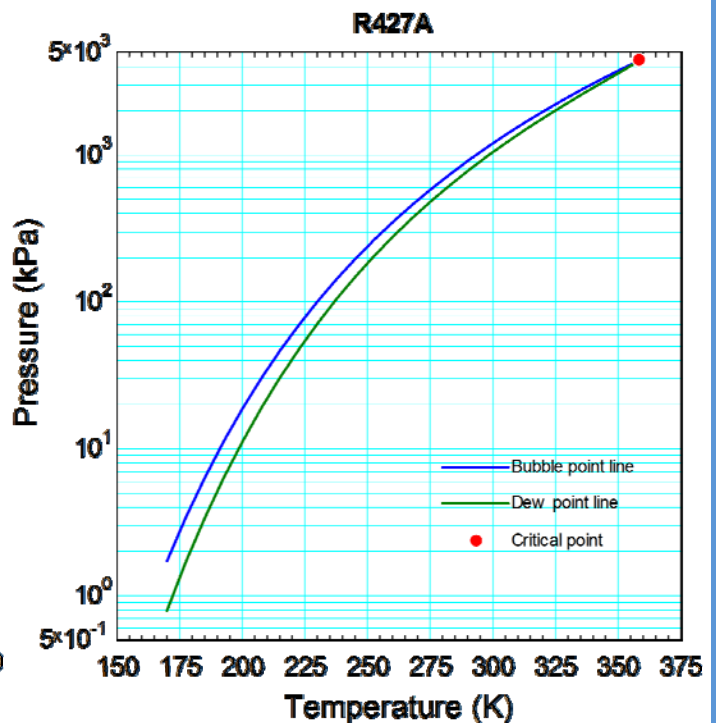
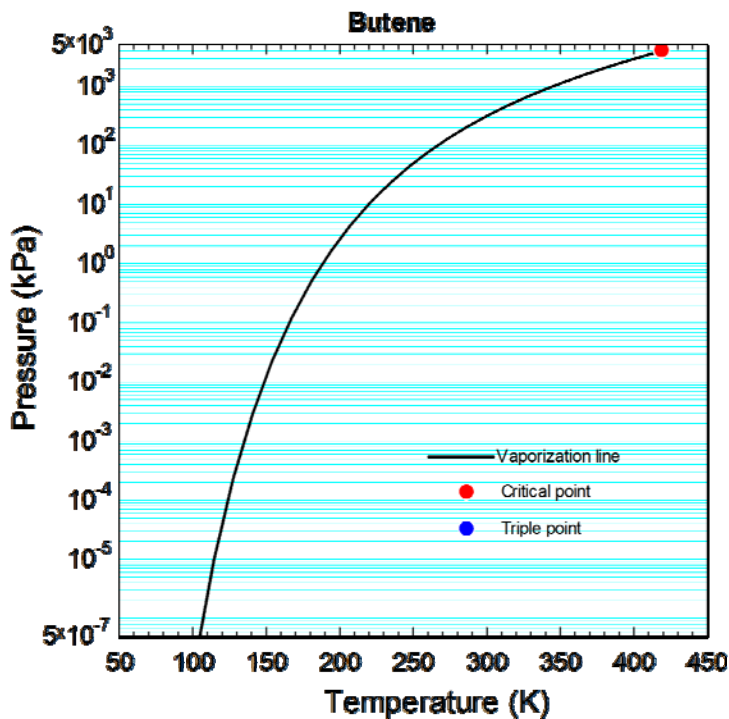
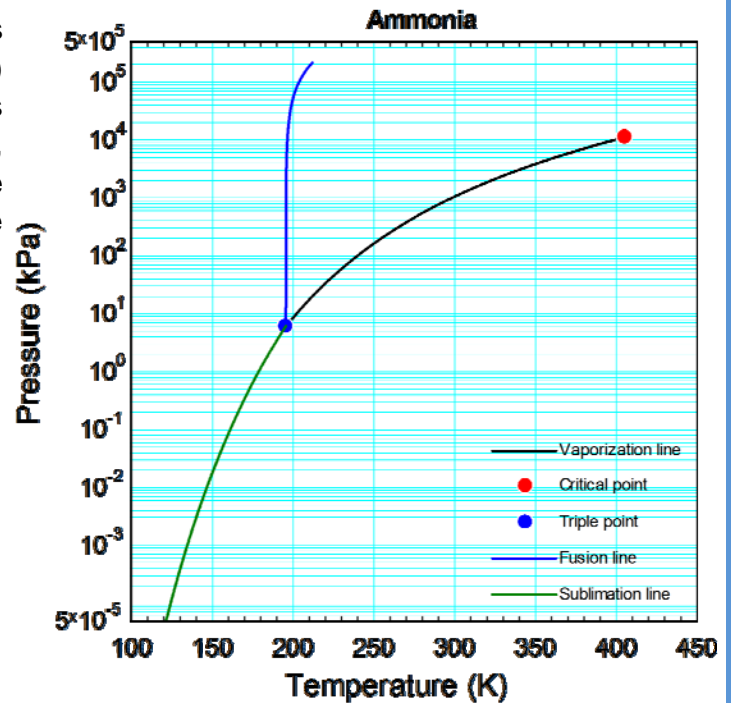
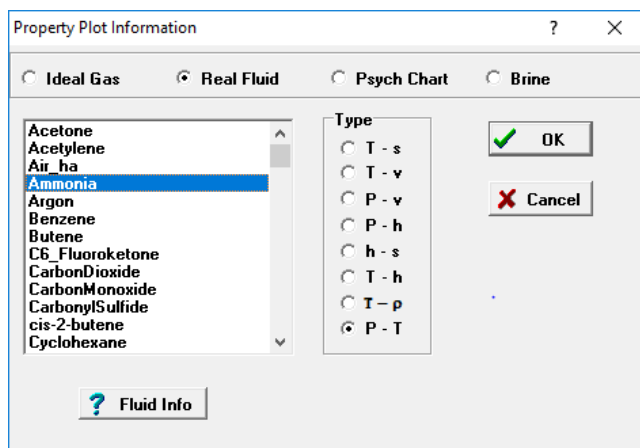
```
T_s=250 [K]
P_s=p_sublimation(Water,T=T_s)
T_m=270 [K]
P_m=p_melting(Water,T=T_m)
```

US Line: 7 Char: 1 Wrap: On Insert

P-T Property Plots

The addition of the P_Sublimation and P_Melting functions provide the option of displaying P-T property plots. Select Property Plot from the Plots menu and then select the Real Fluid radio button and the P-T plot option. The list of fluids for which the plot is available will populate the panel on the left. Select OK to create the plot.

If the sublimation and melting pressure functions are not available for the selected fluid (like Butene) only the vaporization line will be shown. For fluids where this information is available (e.g., Ammonia), the entire P-T plot will be shown. For mixtures (like R427A) both the bubble and dew point lines will be displayed.



The \$VarInfo Directive

The \$VarInfo directive allows variable information like guess values, limits, units, etc. that would otherwise be set in the Variable Information Window to be entered directly in the Equations Window.

Variable Information ? X

☒ Show array variables
☐ Show string variables

Variable	Guess	Lower	Upper	Display	Units	Alt Units	Key	Comment
P_m	39313	-infinity	infinity	A 0 N	Pa	MPa		
P_s	0.07601	-infinity	infinity	A 0 N	Pa			
T_m	270	-infinity	infinity	A 1 N	K			
T_s	250	-infinity	infinity	A 1 N	K			

The format of the \$VarInfo is below (all on one line):

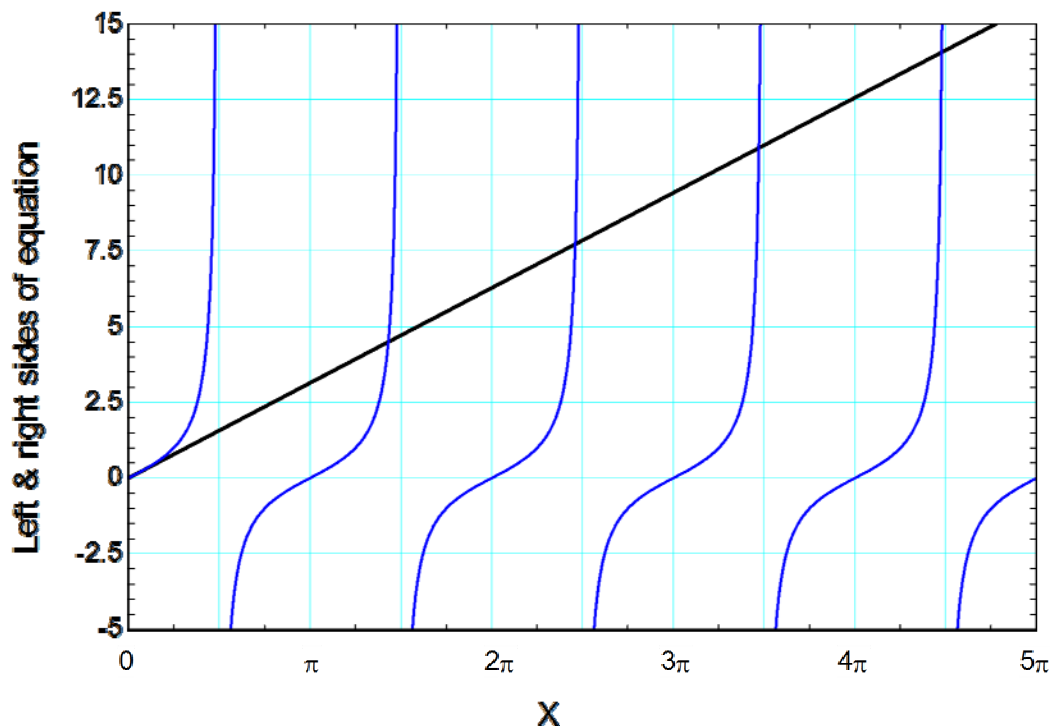
```
$VarInfo VariableName Guess=V1 Lower=V2 Upper=V3 Units='XXXX' AltUnits='YYYY' Display = F1 Style = Bold Key='Key variable comment'
```

An array variable can be provided both as the variable name as well as the guess values and limits.

For example, it is sometimes necessary to identify repeated roots to an equation like:

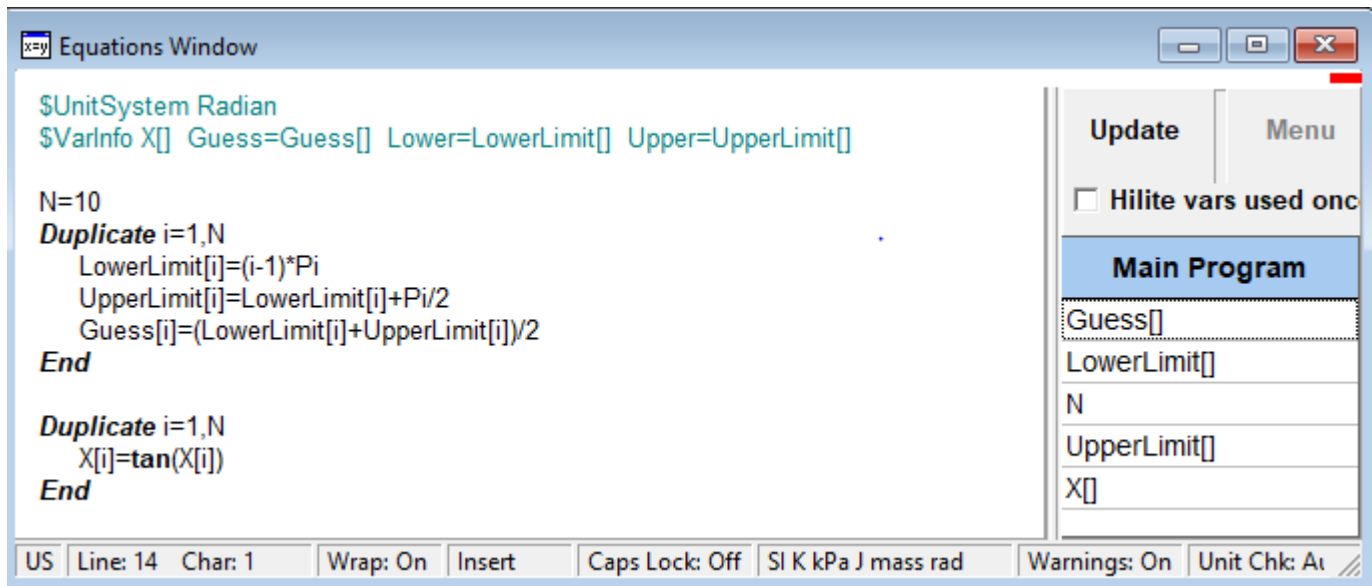
$$X = \tan(X)$$

The figure below illustrates the left (black line) and right (blue line) sides of the equation and indicates that each root can be found in an easily identified interval



The \$VarInfo Directive (continued)

A Duplicate loop is used to setup arrays that contain the limits and an appropriate guess value for each of the intervals. Then the \$VarInfo directive is used with these arrays to control the root-finding process. The result is the identification of as many of the repeated roots of the equation as is desired.



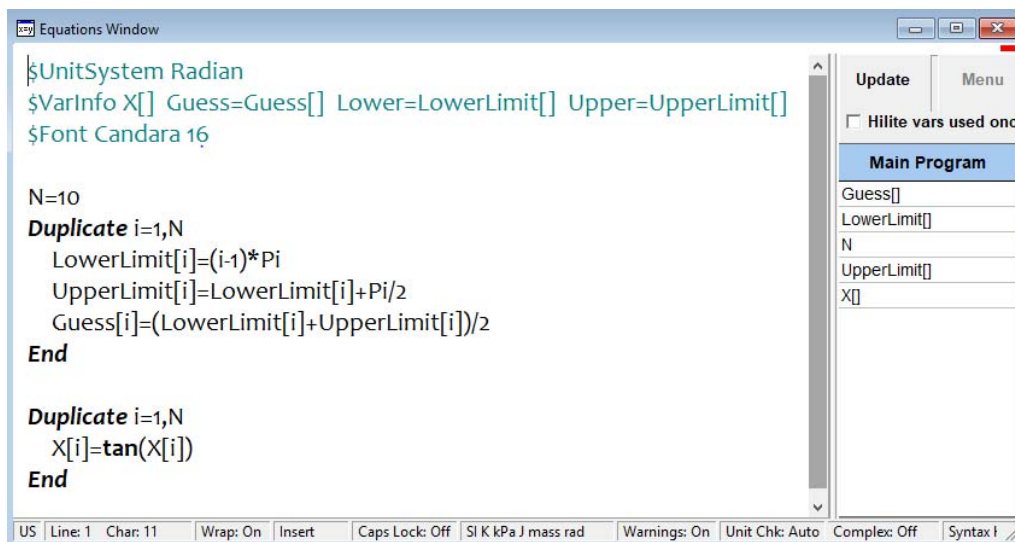
Arrays Table				
Main				
Sort	1 UpperLimit _i	2 LowerLimit _i	3 Guess _i	4 X _i
[1]	1.571	0	0.7854	0.001418
[2]	4.712	3.142	3.927	4.493
[3]	7.854	6.283	7.069	7.725
[4]	11	9.425	10.21	10.9
[5]	14.14	12.57	13.35	14.07
[6]	17.28	15.71	16.49	17.22
[7]	20.42	18.85	19.63	20.37
[8]	23.56	21.99	22.78	23.52
[9]	26.7	25.13	25.92	26.67
[10]	29.85	28.27	29.06	29.81

The \$Font Directive

A \$Font directive allows the font name and size to be specified in the Equations Window. This feature is only available in the Professional version of EES. The format is:

\$Font FontName FontSize

The parameter FontName must be a font that is installed in your system file and the font size is an integer between 5 and 40 that (optionally) sets the size.

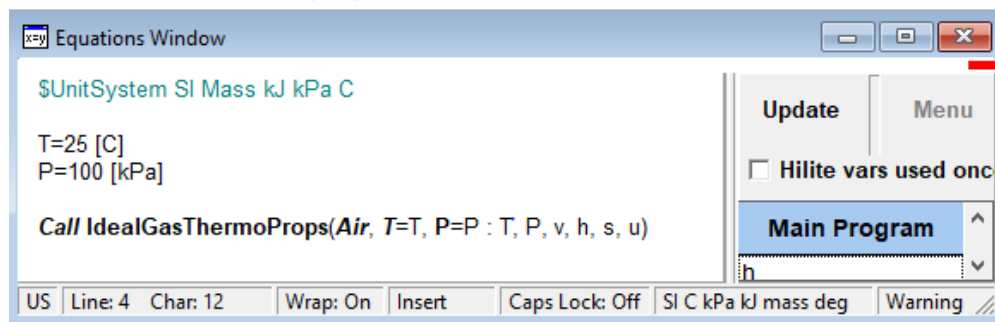


The IdealGasThermoProps Procedure

The IdealGasThermoProps procedure works like the RealThermoProps procedure in that it returns all of the thermodynamic properties for a specific state for a specified built-in ideal or NASA gas. This is convenient for a cycle model where you need property information for each state point. Using this procedure, you can avoid entering separate function calls for each of the properties of interest.

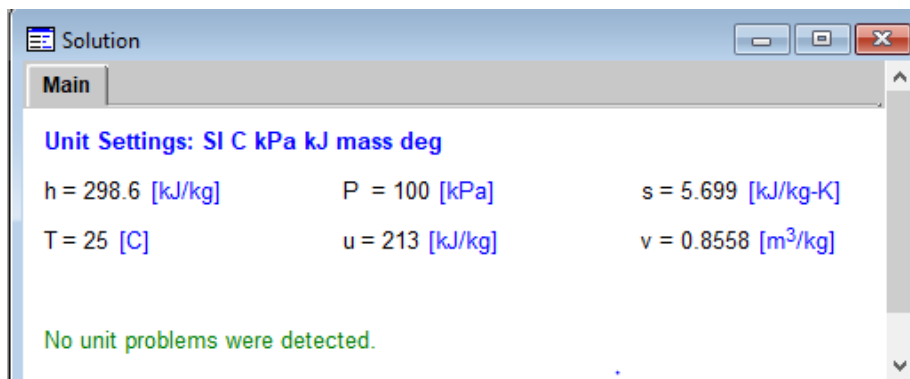
The procedure requires as inputs the name of the ideal gas and two property values that fix the state together with their indicators. The function returns temperature (T), pressure (P), specific volume (v), specific enthalpy (h), specific entropy (s), and specific internal energy (u), in that order. Note that EES does not reset the values of the output parameters that correspond to the inputs used to fix the state.

The example below determines the properties of air at 25°C and 100 kPa.



The IdealGasThermoProps Procedure (continued)

Solving leads to each of the properties being determined. Note that even though the values of T and P were previously set, they were not reset by the call to the IdealGasThermoProps procedure.



Other Recent Changes to EES

- Thermodynamic and transport property functions are provided for R515B (Solstice N15), R438A (M099), R407H, and Isooctane
- Several new functions have been added to the Transient Conduction Library, which is part of the Heat Transfer library in EES.
- The Conduction Shape Factors Library is now a subsection of the Steady State Conduction Library. A second subsection provides functions for various types of spreading and constriction resistances.
- The \$Include directive can be used to automatically load a library file having an extension of .lib, .dlf, .dlp, .dll, .fdl (or the equivalent 64 bit extensions, e.g., dlp64).
- Adding the /R flag to the \$Include directive will cause it to reload the specified library, even if it has been previously loaded.
- Adding the /A flag to the \$SaveVarInfo directive will cause variable information in all functions, procedures, subprograms and modules to be saved as well as those in the Main program.
- Mixture specific heat capacity and Prandtl number are now returned by IdealGasMixtureProps.



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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.

A 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 F-Chart Software if you wish to re-subscribe to Instant Update Service (IUTS).