



February 22, 2013

Dear Customer,

We are pleased to enclose a major upgrade to our software suite, Version 23, with the following highlights:

- (1) Transient HRSG analysis is now available for GT MASTER boilers.
- (2) The gas turbine list in GT PRO/GT MASTER now includes some combustion (piston) engines.
- (3) THERMOFLEX includes a built-in full-featured scripting language that allows you to add your own logical blocks to models.
- (4) A new spreader-stoker grate boiler was added to STEAM PRO & STEAM MASTER, and a comprehensive heat balance diagram is now available.
- (5) ELINK has a new graphical menu and now allows multiple ELINK worksheets per workbook.

These developments along with other smaller improvements are described in below.

GT PRO / GT MASTER / PEACE

Transient HRSG modeling is included for GT MASTER plant models. Transient analysis is performed using a standalone program, launched using the **Transient Analysis** button from GT MASTER's output menu. The boiler hardware description produced in GT PRO, and editable in GT MASTER, is shown in detail in the PEACE output. These weights together with specific heats of heat exchanger finned tubing, evaporator drums, interconnecting headers, inner liner, and resident water/steam define the thermal capacitance of the boiler components, the key inputs to the transient analysis. The program computes the energy stored in each of these thermal masses and how energy storage changes over time as the plant undergoes user-defined changes to load and operating conditions. Outputs show time traces of power, steam flows, pressures, and temperatures throughout the plant. Now, the transient implications of HRSG design and construction details can be computed for GT MASTER HRSGs.

The gas turbine list in GT PRO/GT MASTER now includes combustion (piston) engines. GT PRO has new logic for creating plant designs using combustion engines. The switch 'Use combustion engines instead of gas turbines' on the **New Session** topic invokes the automated support for plants designed with a larger number of smaller engines in simple or combined cycle. The relatively small amount of exhaust energy available from combustion engines is most suitable for use in single pressure bottoming cycles with modest steam conditions. GT PRO automatically suggests design parameters consistent with these facts.

GT PRO models can be directly imported into THERMOFLEX from the GT PRO output menu. The **Fully-Flexible Design** button invokes the import wizard used to create a THERMOFLEX model from the current GT PRO design. THERMOFLEX can now import GT PRO models that include up to twelve engines in a single plant.

An input to specify a fixed pressure loss at the exit of each heat exchanger is available in GT MASTER. In addition, a resistance coefficient is also available to specify a flow-dependent pressure loss at the exit of each heat exchanger. These new inputs can be used to include pressure losses from valves and other flow restrictions not associated with the pressure drop from flow through HX tubing.

Water temperature leaving the final economizer in the IP and HP circuits can be specified as approach to gas temperature, in addition to the subcooling input that's been in GT PRO since 1988.

The water cooled condenser model now includes an additional thermal resistance due to presence of a user-defined amount of non-condensable gases. This implements a feature that's been part of THERMOFLEX and STEAM PRO/STEAM MASTER since 2005.

The PEACE electrical system model supports multiple generators per step-up transformer. This arrangement is generally reserved for plants with a larger number of smaller generators, to reduce cost, and is chosen automatically in these situations.

THERMOFLEX / PEACE

THERMOFLEX now includes a built-in full-featured scripting language. The Script Manager input menu lets you create, define, compile, and test scripts (programs). Scripts are executed during the computation, and script results are available alongside all other THERMOFLEX outputs for display on the model flowsheets, and in report tables.

THERMOFLEX's new Scripting feature lets you:

1. Define custom output parameters computed from logic you define and THERMOFLEX parameters you choose. So, for example, you can create special-purpose efficiency definitions that are reported as additional model results.
2. Define logic to set one or more THERMOFLEX model input parameters. For example, you could use a script to compute performance for an M-on-N GTCC using a model of a 1-on-1 GTCC by defining two parameters set in your script; Number of GT/HRSGs (=M) and Number of STs (=N). This is illustrated in the sample file `'(S3-22)Modeling M-on-N Plant Using Scripts.tfx'`.
3. Call a DLL, or run an EXE, so your THERMOFLEX models can run together with other programs. You can pass data between THERMOFLEX and other EXE/DLL programs to interchange current values for related variables such as pressures, temperatures, flowrates, etc.
4. Define your own components to process THERMOFLEX streams based entirely on your own code and logic.

The Scripting language is extremely easy to use for simple things that may require you to write only a single line of algebraic code. However, it's powerful enough that you can build full-featured programs with arrays, built-in math functions, logical branching, nested looping, subroutines, external program control, filesystem access, etc.

Scripting is available without need for any extra license.

Fluid Specification components now have a flow-multiplier (divider) mode. In this mode the inflow and outflow are related by a multiple you specify. In addition, the energy accounting system has a multiplier for each thermal energy source/sink, each electrical generator, and every auxiliary load in the model. These flow and energy multipliers make it possible to build multi-unit plant models using single-unit component models. For instance you can build a 3-on-1 GTCC model using a single GT/HRSG block instead of requiring three identical GT/HRSG blocks. The flows to/from the GT/HRSG block are connected to the plant through Fluid Spec icons, in multiplier/divider mode, so the model building and computation process only involves one GT/HRSG train, but the model outputs represent a plant with three GT/HRSG blocks feeding a single ST/Condenser block. This is illustrated in sample file `'(S3-22)Modeling M-on-N Plant Using Scripts.tfx'`.

The water/steam and gas/air sources and sinks were modified to make it easier to build modular models and reuse model blocks you create to represent boilers, steam turbines, etc. An 'Alternate Source' supply node was added to the Source icons, and an 'Alternate Sink' discharge node was added to the Sinks. When these optional nodes are connected, the Source and Sink icons are simply pass-through links to upstream and downstream points in the model. When disconnected, the sources and sinks provide the boundary conditions to the model. With this feature, separately defined models of steam turbines, cooling systems, boilers, etc. can be defined and tuned in

isolation, and then used and reused in other models directly, without modification. This is illustrated in sample file '(S3-22)Modeling M-on-N Plant Using Scripts.tfx'.

Users with a license for the General Electric 'APPS' program can now use it to model gas turbine performance in THERMOFLEX. This implements a feature that's been part of GT PRO/GT MASTER since 2005.

Solid and liquid fuel definitions now include mercury content. Flue gas streams from boilers and combustors burning mercury-laden fuels carry the trace mercury massflow to downstream icons that have passive or active mercury removal ability. The Electrostatic Precipitator (ESP), Fabric Filter, and Flue Gas Desulphurisation icons have inputs to define the mercury capture effectiveness for plants with and without Active Carbon Injection. The Emissions output report tallies the mercury flows and reports plant total mercury emissions levels at the collective 'stack'.

Logical header now includes visages for headers with three, six, nine, twelve, or fifteen nodes.

STEAM PRO / STEAM MASTER / PEACE

A Spreader-Stoker Grate Boiler is now available for selection from the **New Session** topic. This boiler type is often used in smaller plants burning biomass, but may also be used for coal, sludge, and other fuels. Traveling and stationary grate options are provided along with options to cool the grate by heating combustion air or feedwater.

Solid and liquid fuel definitions now include mercury content. Flue gas handling and treatment systems include passive mercury capture, or active mercury control using Activated Carbon Injection. The Electrostatic Precipitator (ESP), Fabric Filter, and Flue Gas Desulphurisation subsystems now have inputs to define the mercury capture effectiveness. The Emissions output report tallies the mercury flows and reports plant total mercury emissions levels at the stack. The PEACE cost report includes the capital and installation costs associated with the Activated Carbon Injection system and storage silo.

STEAM PRO and STEAM MASTER now include a Comprehensive Heat Balance diagram available from the System output tab. This shows all heat balance results on a single diagram that can be zoomed and panned as needed to review the result. This diagram was originally released in a revision to Version 22.

COMMON ITEMS

Plant costs reported in PEACE outputs were increased by 3% to account for inflation. International currency factors were modified to be consistent with recent conversion rates.

Water cooled condensers now have an option to use the Heat Exchange Institute (HEI) method to calculate the condenser overall heat transfer coefficient. This method, which depends on water velocity, inlet water temperature, tube diameter, tube wall thickness, tube material, and cleanliness factor, typically yields condensers that are within 5% of the size of those computed using the physically-motivated hardware-based model that's always been in the programs.

ELINK has a number of new and modified features, some of which were introduced in Version 22 revisions.

- 1) Excel (version 2007 SP2 and later) has a new graphical ELINK menu on the Excel ribbon.
- 2) ELINK now allows you to build a single workbook that includes multiple ELINK worksheets.
- 3) You can re-arrange the display order of Input & Output variables from the selection menu.
- 4) ELINK supports multiple versions. Previously, you were required to upgrade ELINK workbooks to the latest installed version.
- 5) ELINK has a new 'Save-ONE' mode that stores only the base case heat balance file, not the files for every case, to reduce size of the Excel workbook. (In revision to Version 22)
- 6) ELINK supports up to 10,000 cases in Excel 2007 and beyond. (In revision to Version 22)

GAS TURBINE DATABASE

The gas turbine database was updated as shown below.

Engines added to the database					
468	WARTSILA 18V50SG (50 Hz) ¹	475	GE 9FB.01	473	OPRA OP16
469	WARTSILA 20V34SG (50 Hz) ¹	465	GE 9FB.05 ²		
470	WARTSILA 18V50SG (60 Hz) ¹			474	KHI GPB300D
471	WARTSILA 20V34SG (60 Hz) ¹	466	Solar Mars 100-16000S ²		
		467	Solar Mars 100-16000S ²	472	Siemens SGT6-5000F(5)
463	MHI 701 F4 ²				
464	MHI 701 F5 ²			476	ALSTOM GT13E2 (2012)
Existing engines with modified performance					
313	GE 9FA.03 ²				

¹ These are combustion (piston) engines, but are selected from the Gas Turbine Selection topic.

² These engines were included in web revisions since the February 2012 Version 22 release.