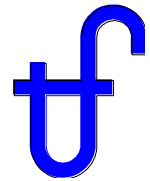May 29th, 2014

Dear Customer,

We are pleased to enclose a new release of our software suite, Version 24, with the new features and improvements summarised below.

GT PRO / GT MASTER / PEACE

(1) GT PRO's automated cycle design logic to select principal cycle pressures, temperatures, pinches, and approach temperature differences was revised and updated, for the first time in over ten years. With all defaults, this will create combined cycles with slightly higher output, efficiency and cost. The new default duct burner location, for reheat cycles using gas turbines with high exhaust temperatures, is downstream in the boiler after exhaust is cooled by highest temperature superheater and reheater. Old GT PRO files, that had been created using "Automatic" steam cycle logic, will be converted to "User-defined" when loaded into Version 24 to preserve their original design inputs.

(2) TIME for GT MASTER is a new program to facilitate accurate economic modeling of plants. It extends the Simplified Annual Analysis concept built into GT MASTER. TIME allows the year to be sub-divided into any number of bins, and allows you to select any GT MASTER inputs to edit in each bin. It includes a more detailed and flexible procedure to account for fuel consumption and power production during startup and shutdown periods. TIME also includes automated support for building annual cycles based on historical weather data that's supplied with the program, currently for US and Canadian locations only. TIME is included as part of the GT MASTER license.

(3) GT MASTER now includes a full-featured scripting language akin to that introduced in THERMOFLEX 23. 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 other GT MASTER outputs. GT MASTER's new Scripting feature lets you:

1. Define logic to set one or more GT MASTER model input parameters. For example, sample file `(GTM_Script1)ExtractionSelector.gtm` uses a script to automatically select a steam source with sufficient pressure to satisfy a process requirement. The script first takes steam from HPT extraction, but if the resulting pressure slides below required pressure, the script switches from using the extraction to using an HP letdown to ensure sufficient pressure.

2. Define custom output parameters computed from logic you define and GT MASTER parameters you choose. For example, sample file `(GTM_Script3)CustomOutputs` uses a script to compute total steam flow from all boiler pressure levels and ratio of total steam generation to GT exhaust flow rate. These outputs are included in GT MASTER's text output and can be used in ELINK too.

3. Call a DLL, run an EXE, or link to Excel so your GT MASTER models can run together with other programs. You can pass data between GT MASTER and other EXE/DLL programs or Excel worksheets. For example, sample file `(GTM_Script4)GTDataFromExcel` uses a script to select from amongst six sets of gas turbine data stored in a companion Excel workbook, and gather that data along with related inputs such as ambient conditions, fuel type, emissions data, etc. which are passed as inputs to GT MASTER. This is a useful way to run pre-defined conditions, say summer, winter, and shoulder season, for which you have vendor-guaranteed GT performance.

The LUA Scripting language is very easy to use for simple things that may require you to write only a single line of code. However, it's powerful enough to build full-featured programs with arrays, built-in math functions, logical branching, nested looping, subroutines, external program control, filesystem access, etc. Scripting is available in GT MASTER without need for any extra license.

(4) Other Improvements to GTP/GTM:

(4a) Gas turbines equipped with inlet air chilling can now include spare chillers, along with their additional cost and extra capacity for use in off-design.

(4b) Chilled water storage tanks are now sized, shown on the PEACE plot plan, and included in the PEACE cost estimate. Previously, the storage tank was virtual and used for thermodynamic modeling only.

(4c) GTP has a new option to specify water-side exit temperature for HP and IP economisers by approach to entering gas temperature.

(4d) In both GTP/GTM, the duct burner can now be specified to provide a given DT to flue gases as the fifth way to specify firing level.

(4e) In GTM, the duct burner can fire to a percentage of its rated capacity as a sixth method to specify firing level.

(4f) GTP now has an option to relax limits on HRSG input variables, similar to what's been available for gas turbine inputs for some time. Both switches are located on the **Calculation Options** tab of the **Plant Criteria** topic.

(4g) GTM now includes an option to automatically increase boiler tube thickness when the water/steam pressure exceeds the maximum allowable value, and to automatically change tube and/or fin material when the current maximum tube wall temperature and/or fin temperature exceeds the material limit. The switch to enable this feature is located on the **Miscellaneous** tab of the **HRSG Inputs** topic.

(4h) GTM has new options for controlling steam pressures and temperatures when the ST is bypassed to the condenser; located in the lower-right corner of the **ST Main Inputs** tab of the **ST Inputs** topic.

(4i) In both GTP & GTM, steam-cooled gas turbines can now use a primary and secondary source of steam, each supplying a portion of total cooling steam.

(4j) Salt concentration is now a user-input for seawater-cooled condensers, instead of a built-in assumption of 3.44%.

(4k) For plants including fresh-air dilution of flue gases, the programs now estimate fan power and approximate costs for the system.

(4l) Dilution air can now be introduced into the exhaust for simple cycles, to quench gases entering SCRs.

THERMOFLEX / PEACE

(1) PowerDraw, a fully flexible and easy-to-use graphics tool was added to THERMOFLEX. PowerDraw may be used to prepare simplified, custom heat balance diagrams. It allows the user to draw a schematic using the included library of component symbols. Additionally, users may create their own symbols from a collection of basic shapes. Heat balance data may be selected for display on the diagram, including overall system performance, specific stream parameters and component input/output parameters, as well as user-defined values.

PowerDraw diagrams can be re-used many times over by exporting the PowerDraw graphics to a file from which they can then be imported to other THERMOFLEX models. Sample files (S1-16), (S2-33), (S3-21), and (S5-08) include PowerDraw-created graphics to demonstrate some ways this feature can be used. PowerDraw is included as part of the THERMOFLEX/PEACE license.

(2) TFX's computation message display and review system was improved. A new message window helps the user navigate through the model while reviewing the messages. Double-clicking a message pertaining to a particular icon causes the icon to be found and highlighted, thereby making it much easier to identify and resolve issues.

(3) TFX has a new feature to display massflow and pressure lineage for streams. From the output view, right-click any stream and select `What sets this stream's flowrate/pressure` to summon a hierarchical list of all icon/nodes involved in establishing the selected stream's flowrate/pressure. This greatly simplifies the process of discovering how the flow in a particular model branch is set, or why the pressure of a particular stream differs from what you may have anticipated.

(4) A new "Flow Priority Promoter" component was introduced. Located on the `Controllers` tab of the component bar, it works with all fluid types. It can raise the flow priority of its inlet or outlet node (your choice) relative to the priority that would have been set by its opposite node; allowing the user to favor the flow-setting ability of a component that would otherwise be too weak in a given network. The sample file (S4-11A) illustrates use of this new component.

(5) A new "MED Effect" component was introduced. Located on the `Other Fluids` tab of the component bar, it is intended for building custom models of Multi-Effect Distillation (MED) systems with flexible configurations, connected as desired by the user. This is in contrast with the existing, less flexible macro icon which represents an entire MED system, introduced in 2004. Sample file (S6-02a) illustrates the use of the new MED Effect component.

(6) A new "General Turbine" component was introduced. Located on the `General` tab of the component bar, it works with all fluid types. This can be used to model energy recovery devices in high pressure loops handling incompressible fluids. Alternatively, it can represent turbo-expanders in loops handling compressible fluids. This component can be used in lieu of the fluid-specific expanders and turbines available for other fluids such as refrigerants.

(7) Other Improvements to TFX:

(7a) The CFB model was improved by the inclusion of two optional heat exchangers located in the solids return line after the cyclone. These heat exchangers can be incorporated in superheat and/or reheat circuits to model systems offered by some CFB manufacturers. Sample file (S1-14A) illustrates using this feature in a supercritical cycle.

(7b) The Reverse Osmosis (RO) model was improved to allow building multi-stage systems where an RO stage produces partially desalinated water. The RO component has an additional visage with a brine outlet to augment the existing visage that produces pure water. The RO component has new user-selectable flow dictation settings to accommodate modeling multi-stage systems hooked together in series.

(7c) A new, more informative shafts diagram is automatically built for models using TFX's shafts feature. Available on a flowsheet tab labeled `Shaft Diagram`, this report automatically arranges the icons connected on each shaft and shows pertinent shaft outputs.

(7d) The Search feature for icons and streams, available from the right-hand side menu, was improved to allow searching for assemblies and shafts; and to better highlight the located item by dimming the balance of the model and using a big arrow to point to the found item.

(7e) An intrinsic motor is now available for the fuel compressor and legacy pumps that had previously relied solely on TFX's shafts feature for coupling to drivers. Use of the intrinsic motor simplifies modeling most common situations where the component is driven by its own motor. The general shafts method is still available for situations where multiple driven/driver components are mechanically coupled together as in the case of helper turbines connected to pumps, etc.

(7f) The Reciprocating Engine library was expanded to include 12 additional large engines, listed at the end of this document.

(7g) The reciprocating genset model was revised to include another set of optional fluid connections to carry away heat from the engine. These may be used, for example, to handle inter/after cooler heat rejection. Also, two new virtual connections between the genset and any heat adders in the model have been created to allow more flexible, additional heat recovery options, such as from inter/after coolers or lube oil coolers.

STEAM PRO / STEAM MASTER / PEACE

(1) The CFB model was improved to include two optional heat exchangers located in the solids return line after the cyclone. These heat exchangers can be used as the final superheater or reheater to better model systems offered by some CFB manufacturers.

(2) Solid-fueled plants may now be optionally equipped with liquid fuel systems including storage tanks, pumps, and piping as needed to support plant startup. This feature impacts the site plan and total plant cost reported in PEACE. Startup fuel oil is included and characterized using inputs on the Equipment Options tab of the Boiler Sizing topic.

(3) Other Improvements to STP/STM:

(3a) An option to include auxiliary boiler(s), for the purpose of accounting for the installed cost of the boiler and its appurtenances, is now available. This feature, similar to that in GT PRO, is available from the Equipment Options tab of the Boiler Sizing topic.

(3b) The cost model for the ash handling system was revised resulting in a reduction in installed system cost for plants burning ash-laden fuels.

(3c) The cooling tower now allows specification of additional heat rejection, that is, beyond that from the main condenser. This feature is activated and defined on the Condenser Misc. Assumptions tab of the Cooling System topic in STEAM PRO. The condenser (LPT exhaust) was added as another destination for process steam added to the cycle to aid in modeling some steam turbine bypass arrangements.

New Features Common to all Programs

International currency factors were modified to be consistent with recent US dollar conversion rates. Labor and commodity costs were held at the same level as in Version 23. Price estimates for the major Specialized Equipment were updated, with lower price estimates in most cases. Despite these reductions, it is believed that PEACE cost estimates are still conservative (over-estimating costs by a reasonable safety margin, roughly in the 5%-10% range as of Spring, 2014).

The output menu for each of the five main programs includes a new button that will open the current model in Excel and make it available for use with ELINK. This feature requires you to have already installed ELINK in Excel using the procedure outlined in §2 of the ELINK help.

The captions available for editing in each PRO/MASTER program are now available for editing in ELINK. Likewise, the captions for THERMOFLEX flowsheet labels can also be edited in ELINK. These improvements allow you to set descriptive information for each ELINK case that'll be shown on program reports displayed by the native GUI.

Thermoflow's steam turbine model now has a new method to prorate the moisture penalty to only that portion of the expansion step below the Wilson line. Previously, if any portion of the expansion in a step occurred below the Wilson line, that entire step's efficiency was reduced.

Gas fuel dewpoint checks were introduced into each program so a message will be presented when conditions imply the fuel may contain condensed liquids. The calculation, however, continues to assume the fuel behaves as a gas without entrained liquids.

Plant Design Expert (PDE) & All-new webPDE

PDE's cycle selection and design logic was revised for compatibility with GT PRO's updated procedures. PDE's graphical user interface was rewritten and reorganized to make it easier to use. PDE continues to produce GT PRO-compatible files, which can also be imported into THERMOFLEX. It provides a very easy and quick way to begin a design when you'd like some assistance establishing the desired plant configuration and/or help choosing cogeneration stream sources.

Thermoflow has developed a new, internet-based version of PDE, licensed separately. webPDE runs in a browser so it can be used with many mobile computing platforms, such as tablets or smart phones, in addition to PC's. Graphical and text results are presented in the browser. Computations are run and files saved on Thermoflow's server; and these files may be downloaded by the user for detailed analysis and/or import into GT PRO, GT MASTER or THERMOFLEX. webPDE has the extra ability to run multiple cases for side-by-side comparison. This product was released, in beta form, to a limited group of customers in February, 2014. It will be available for general licensing starting June 15, 2014.

GAS TURBINE DATABASE

The gas turbine database was updated as shown below.

	Engines added to the database					
493	Kawasaki KG-12-V (60 Hz) [1]	513	GE GT-6B.03 DLN	524	GE GT-9F.05 DLN
495	Kawasaki KG-12 (60 Hz) [1]	514	GE GT-6B.03	527	GE GT-9F.05 DLN
492	Kawasaki KG-12-V (50 Hz) [1]	529	GE GT-6B.03	521	GE GT-9HA.01 DLN
494	Kawasaki KG-12 (50 Hz) [1]	520	GE GT-6F.03 DLN	525	GE GT-9HA.01 DLN
489	Kawasaki KG-18-V (60 Hz) [1]	512	GE GT-7E.03 DLN		
491	Kawasaki KG-18 (60 Hz) [1]	515	GE GT-7E.03	502	ALSTOM GT26 DLN (2006 MXL2)
488	Kawasaki KG-18-V (50 Hz) [1]	519	GE GT-7F.04 DLN	503	ALSTOM GT26 DLN (2011)
490	Kawasaki KG-18 (50 Hz) [1]	518	GE GT-7F.05 DLN	504	ALSTOM 13E2 DLN
		528	GE GT-7F.05 DLN	509	ALSTOM 13E2 DLN (MXL2)
500	GE LM2500 PJ (60 Hz)	522	GE GT-7HA.01 DLN		
501	GE LM2500 PJ (50 Hz)	526	GE GT-7HA.01 DLN	505	Siemens SGT5-2000E DLN (41 MAC)
510	GE LM2500 PE (60 Hz)	517	GE GT-9E.03 DLN	506	Siemens SGT5-2000E DLN (33 MAC)
511	GE LM2500 PE WIG (60 Hz)	523	GE GT-9F.03 DLN	507	Siemens SGT5-2000E DLN (25 MAC)
				508	Siemens SGT5-4000F DLN
	Existing engines with modified performance				
329	GE LM6000 PF DLE (60 Hz) [2]	477	MHI 701 J [2]	484	RR Trent 60 DLE (50 Hz) [2]
337	GE LM6000 PF DLE (50 Hz) [2]			485	RR Trent 60 DLE+ISI (50 Hz) [2]
		478	Hitachi H-80 (50 Hz) [2]	486	RR Trent 60 DLE (60 Hz) [2]
480	Siemens SGT6-8000H [2]	479	Hitachi H-80 (60 Hz) [2]	487	RR Trent 60 DLE+ISI (60 Hz) [2]
481	Siemens SGT6-5000F (eff enh) [2]			496	RR Trent 60 WLE (50 Hz) [2]
482	Siemens SGT6-5000F (hi eff) [2]			497	RR Trent 60 WLE+ISI (50 Hz) [2]
483	Siemens SGT6-5000F (hi op) [2]			498	RR Trent 60 WLE (60 Hz) [2]
				499	RR Trent 60 WLE+ISI (60 Hz) [2]

THERMOFLEX RECIPROCATING ENGINE DATABASE

The reciprocating engine database, built into THERMOFLEX, was updated as shown below.

	Engines added to the database				
387	Kawasaki KG-12-V (60 Hz)	386	Kawasaki KG-12-V (50 Hz)	378	WARTSILA 18V50SG (50 Hz)
389	Kawasaki KG-12 (60 Hz)	388	Kawasaki KG-12 (50 Hz)	379	WARTSILA 20V34SG (50 Hz)
383	Kawasaki KG-18-V (60 Hz)	382	Kawasaki KG-18-V (50 Hz)	380	WARTSILA 18V50SG (60 Hz)
385	Kawasaki KG-18 (60 Hz)	384	Kawasaki KG-18 (50 Hz)	381	WARTSILA 20V34SG (60 Hz)

[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 2013 Version 23 release.