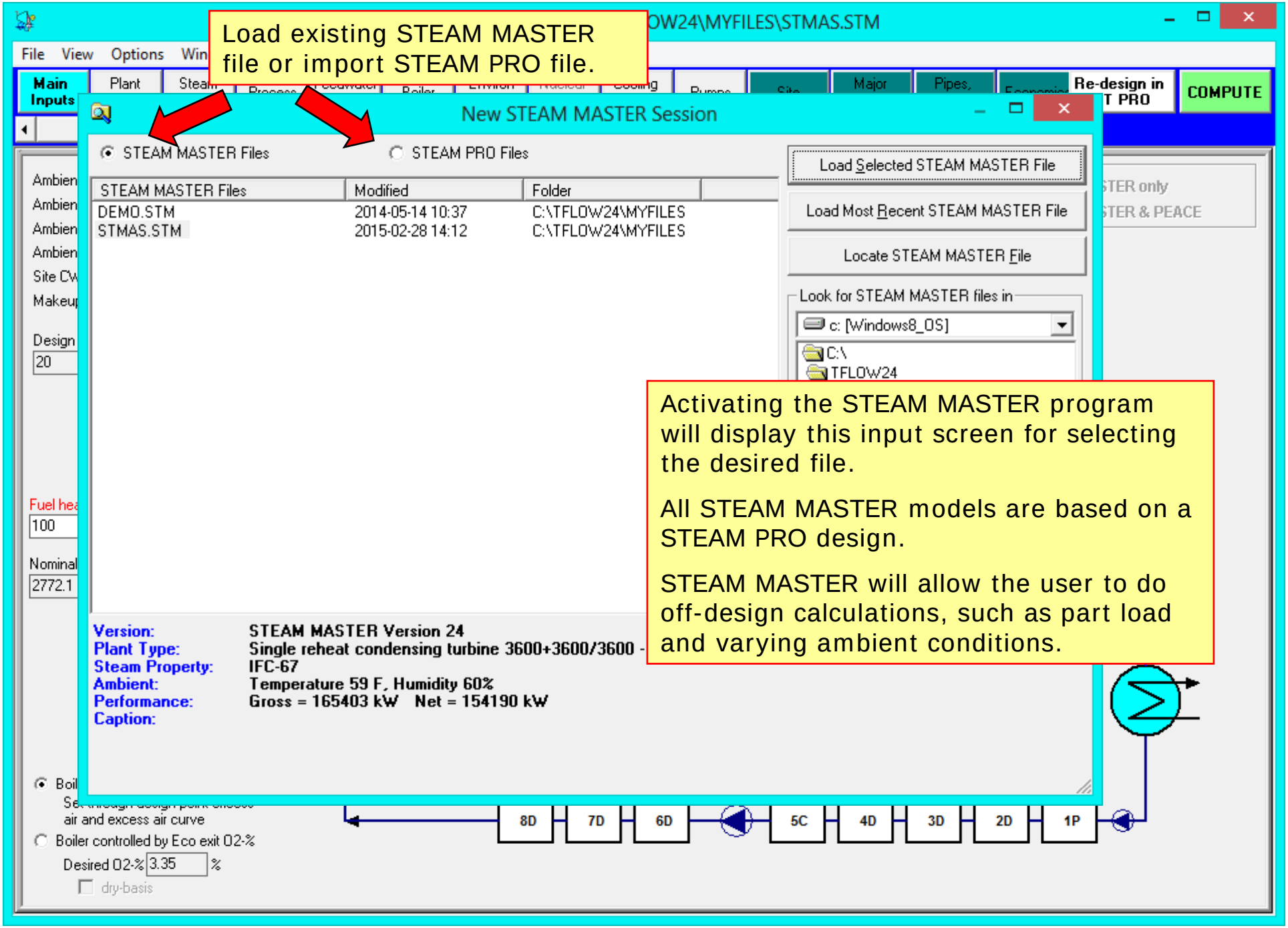
Thermoflow Inc.

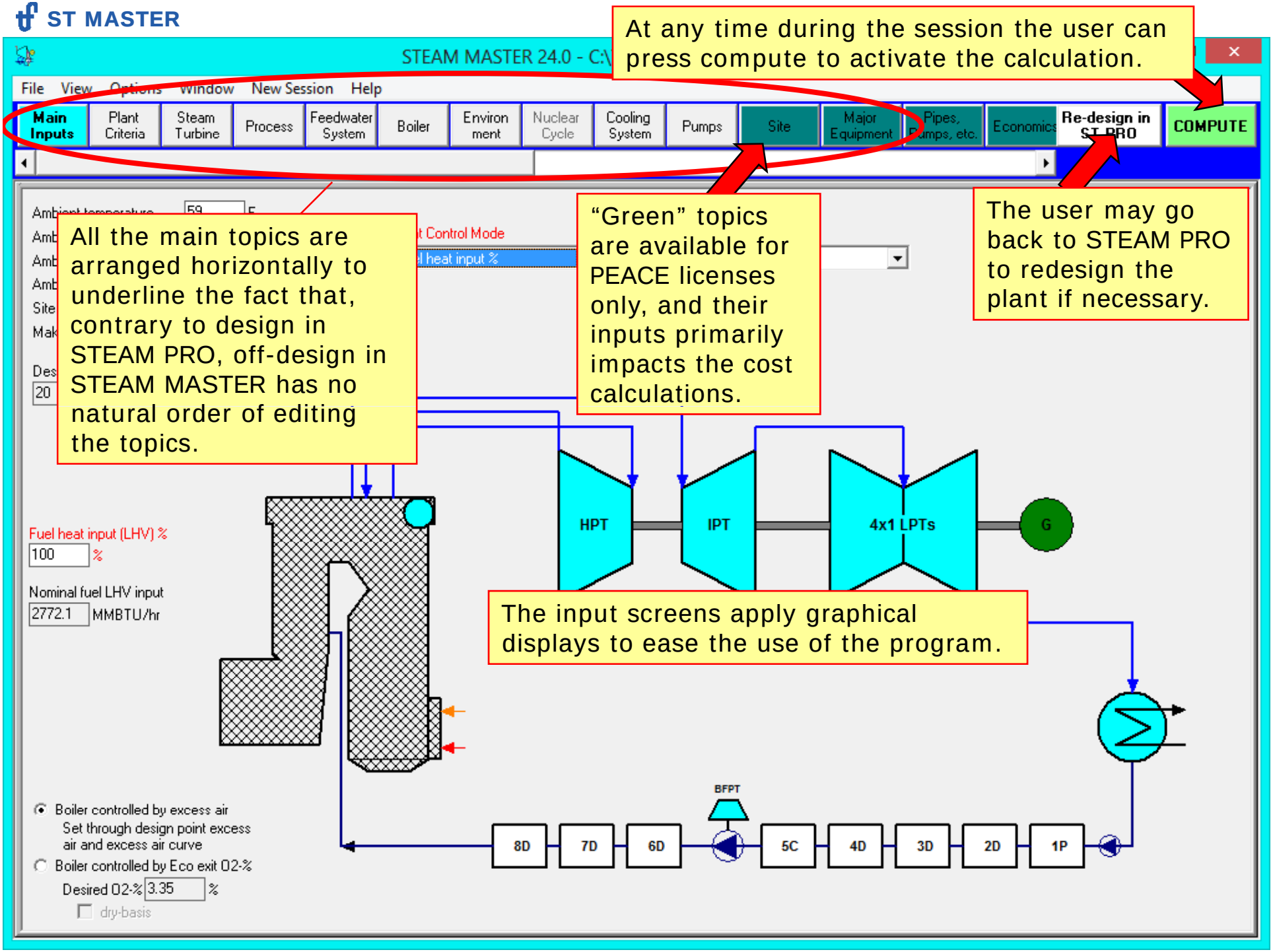
WHAT IS STEAM MASTER?

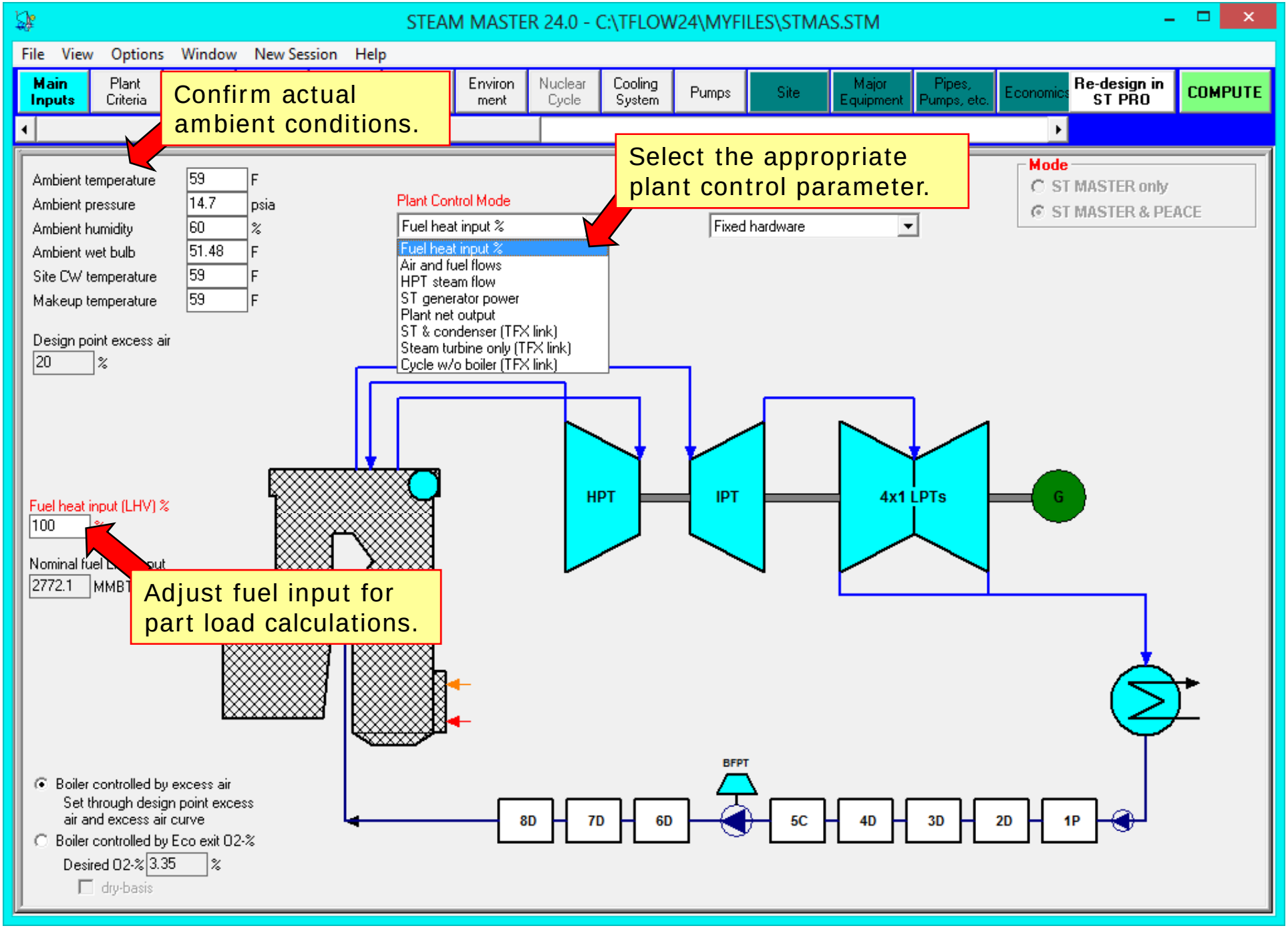
While **STEAM PRO** is the design program for conventional steam cycle plants, **STEAM MASTER** is the associated simulation program for off-design calculations.

- Use **STEAM MASTER** to evaluate designs at various ambient conditions and loads.
- All **STEAM MASTER** hardware inputs has automatically been initialized based on the design, which makes it possible to perform calculations by just changing a few parameters.
- Since **STEAM MASTER** hardware inputs are editable, the model may be fine tuned to match an existing plant or vendor data.
- In combination with **PEACE** (Plant Engineering and Construction Estimator), **STEAM MASTER** provides engineering details and cost estimation.

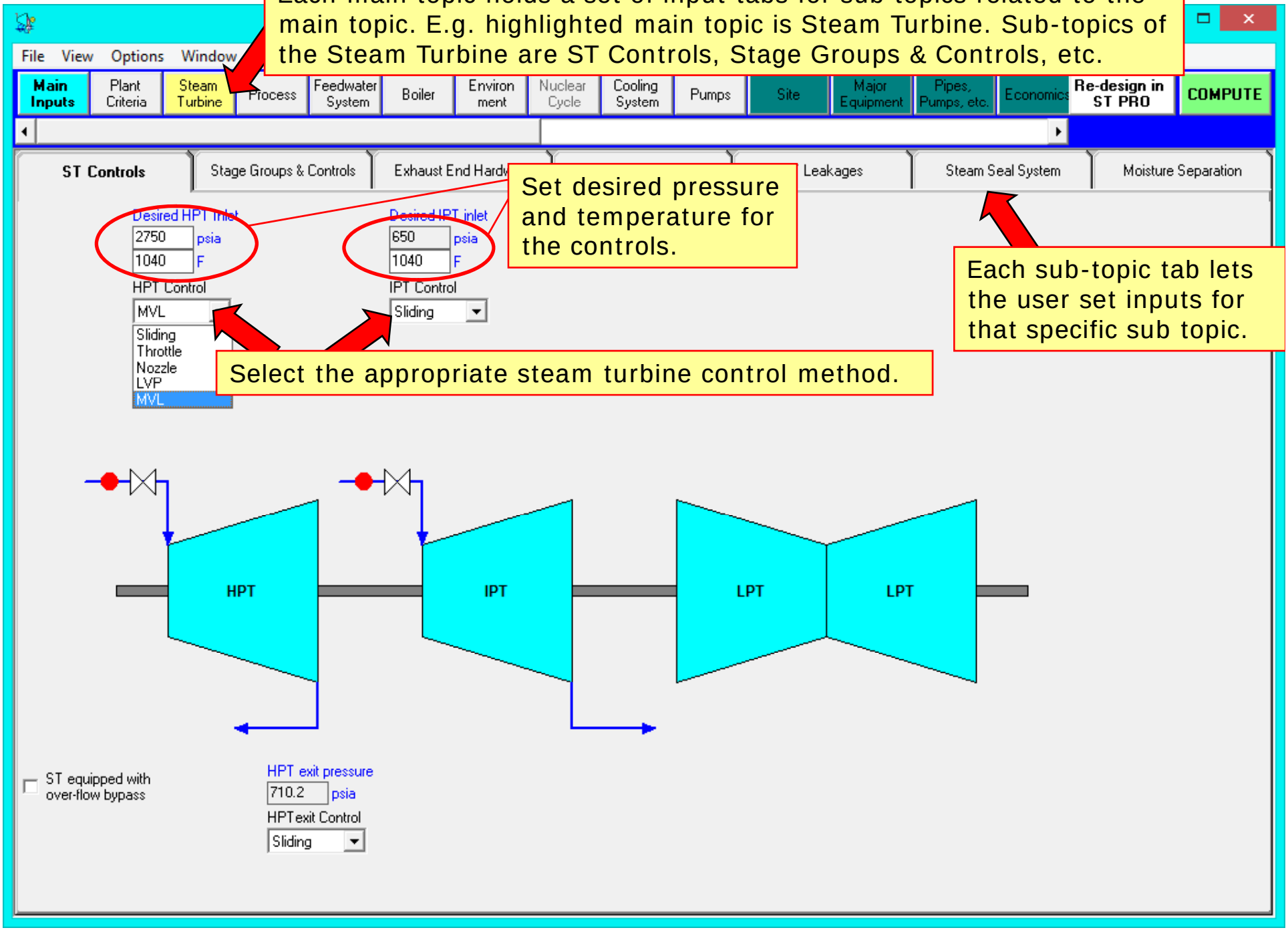

Load existing STEAM MASTER file or import STEAM PRO file.
New STEAM MASTER Session
STEAM MASTER Files
STEAM PRO Files
STEAM MASTER Files
Modified
Folder
DEMO.STM
2014-05-14 10:37
C:\TFLOW24\MYFILES
STMAS.STM
2015-02-28 14:12
C:\TFLOW24\MYFILES
Load Selected STEAM MASTER File
Load Most Recent STEAM MASTER File
Locate STEAM MASTER File
Look for STEAM MASTER files in
c: [Windows8_OS]
C:\
TFLOW24
Activating the STEAM MASTER program will display this input screen for selecting the desired file.
All STEAM MASTER models are based on a STEAM PRO design.
STEAM MASTER will allow the user to do off-design calculations, such as part load and varying ambient conditions.
Version: STEAM MASTER Version 24
Plant Type: Single reheat condensing turbine 3600+3600/3600 -
Steam Property: IFC-67
Ambient: Temperature 59 F, Humidity 60%
Performance: Gross = 165403 kW Net = 154190 kW
Caption:
Main Inputs
Plant
Major
Pipes,
Re-design in T PRO
COMPUTE
File View Options
Boiler controlled by Eco exit O2-%
Desired O2-% 3.35 %
dry-basis
8D
7D
6D
5C
4D
3D
2D
1P

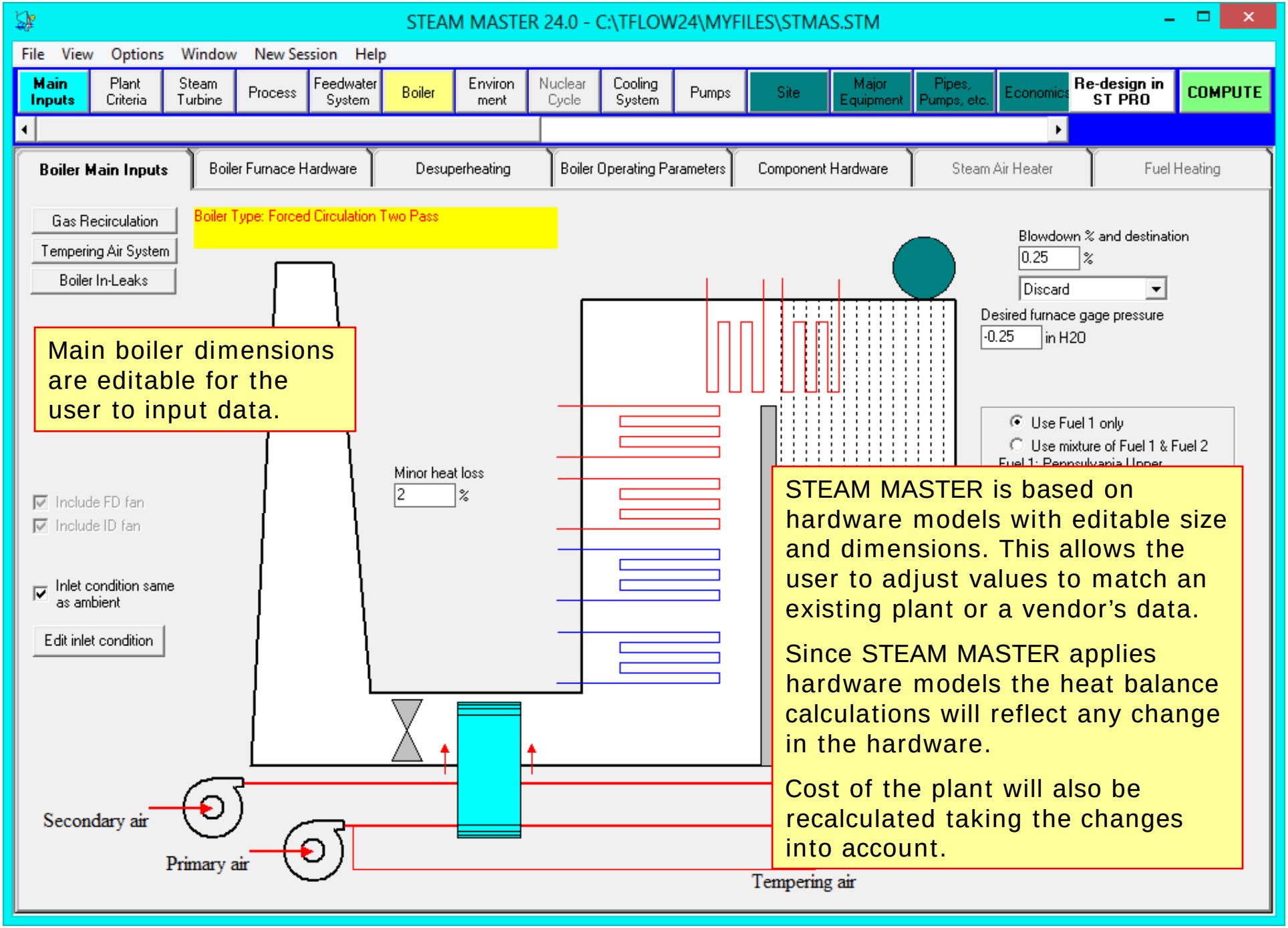
ST MASTER


At any time during the session the user can press compute to activate the calculation.
STEAM MASTER 24.0 - C:\
File View Options Window New Session Help
Main Inputs
Plant Criteria
Steam Turbine
Process
Feedwater System
Boiler
Environment
Nuclear Cycle
Cooling System
Pumps
Site
Major Equipment
Pipes, Pumps, etc.
Economics
Re-design in ST PRO
COMPUTE
All the main topics are arranged horizontally to underline the fact that, contrary to design in STEAM PRO, off-design in STEAM MASTER has no natural order of editing the topics.
"Green" topics are available for PEACE licenses only, and their inputs primarily impacts the cost calculations.
The user may go back to STEAM PRO to redesign the plant if necessary.
HPT
IPT
4x1 LPTs
G
Fuel heat input (LHV) %
100
%
Nominal fuel LHV input
2772.1
MMBTU/hr
The input screens apply graphical displays to ease the use of the program.
BFPT
8D
7D
6D
5C
4D
3D
2D
1P
Boiler controlled by excess air
Set through design point excess air and excess air curve
Boiler controlled by Eco exit O2-%
Desired O2-%
3.35
%
dry-basis


STEAM MASTER 24.0 - C:\TFLOW24\MYFILES\STMAS.STM
File View Options Window New Session Help
Main Inputs
Plant Criteria
Environment
Nuclear Cycle
Cooling System
Pumps
Site
Major Equipment
Pipes, Pumps, etc.
Economics
Re-design in ST PRO
COMPUTE
Confirm actual ambient conditions.
Select the appropriate plant control parameter.
Ambient temperature 59 F
Ambient pressure 14.7 psia
Ambient humidity 60 %
Ambient wet bulb 51.48 F
Site CW temperature 59 F
Makeup temperature 59 F
Design point excess air
20 %
Plant Control Mode
Fuel heat input %
Air and fuel flows
HPT steam flow
ST generator power
Plant net output
ST & condenser (TFX link)
Steam turbine only (TFX link)
Cycle w/o boiler (TFX link)
Fixed hardware
Mode
ST MASTER only
ST MASTER & PEACE
Fuel heat input (LHV) %
100
Nominal fuel
2772.1 MMBT
Adjust fuel input for part load calculations.
HPT
IPT
4x1 LPTs
G
BFPT
8D
7D
6D
5C
4D
3D
2D
1P
Boiler controlled by excess air
Set through design point excess air and excess air curve
Boiler controlled by Eco exit O2-%
Desired O2-% 3.35 %
dry-basis

ST MASTER


Each main topic holds a set of input tabs for sub topics related to the main topic. E.g. highlighted main topic is Steam Turbine. Sub-topics of the Steam Turbine are ST Controls, Stage Groups & Controls, etc.
File View Options Window
Main Inputs
Plant Criteria
Steam Turbine
Process
Feedwater System
Boiler
Environment
Nuclear Cycle
Cooling System
Pumps
Site
Major Equipment
Pipes, Pumps, etc.
Economics
Re-design in ST PRO
COMPUTE
ST Controls
Stage Groups & Controls
Exhaust End Hardw
Leakages
Steam Seal System
Moisture Separation
Set desired pressure and temperature for the controls.
Each sub-topic tab lets the user set inputs for that specific sub topic.
Desired HPT inlet
2750 psia
1040 F
HPT Control
MVL
Sliding
Throttle
Nozzle
LVP
MVL
Desired IPT inlet
650 psia
1040 F
IPT Control
Sliding
Select the appropriate steam turbine control method.
HPT
IPT
LPT
LPT
ST equipped with over-flow bypass
HPT exit pressure
710.2 psia
HPTexit Control
Sliding

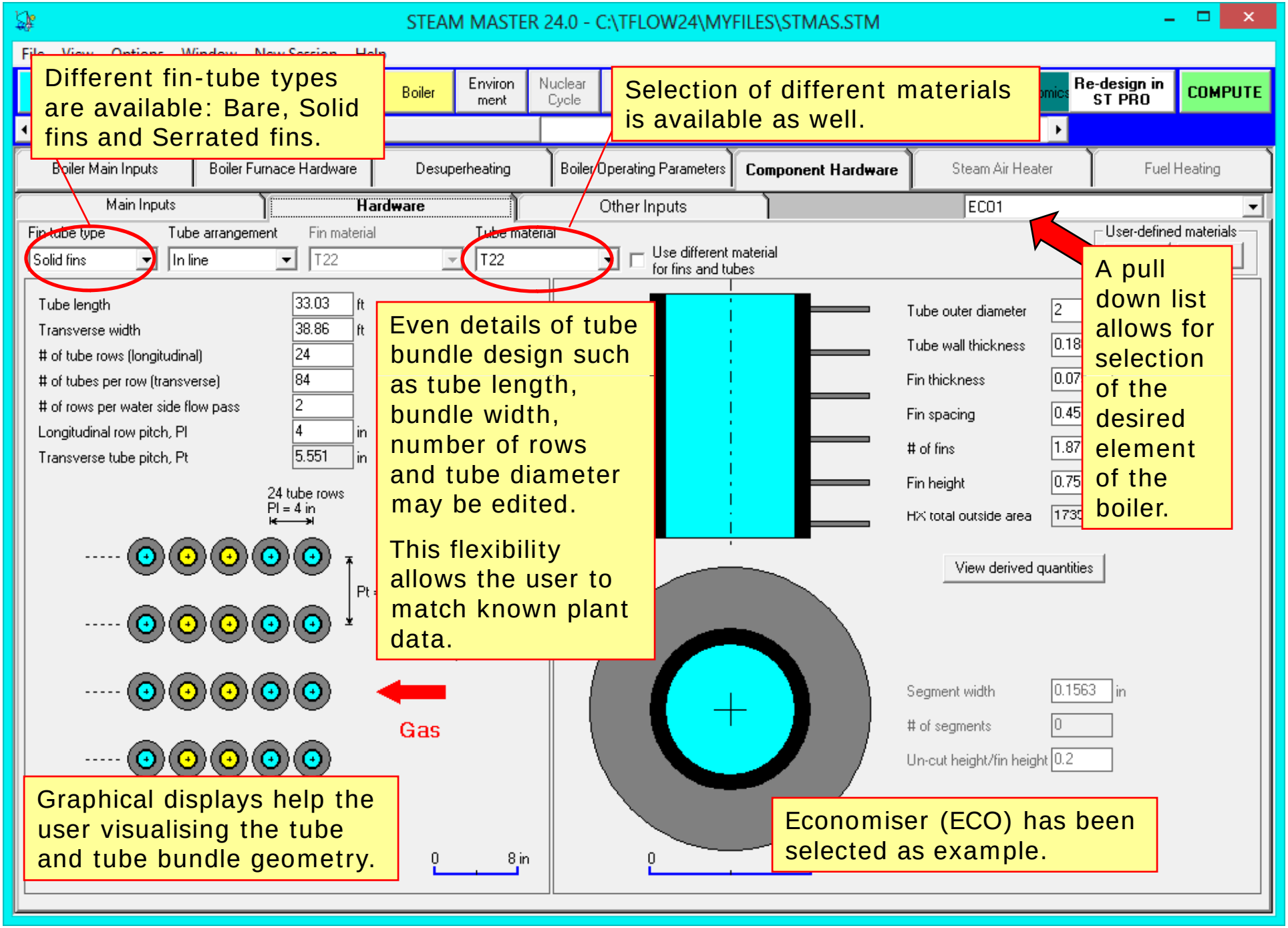


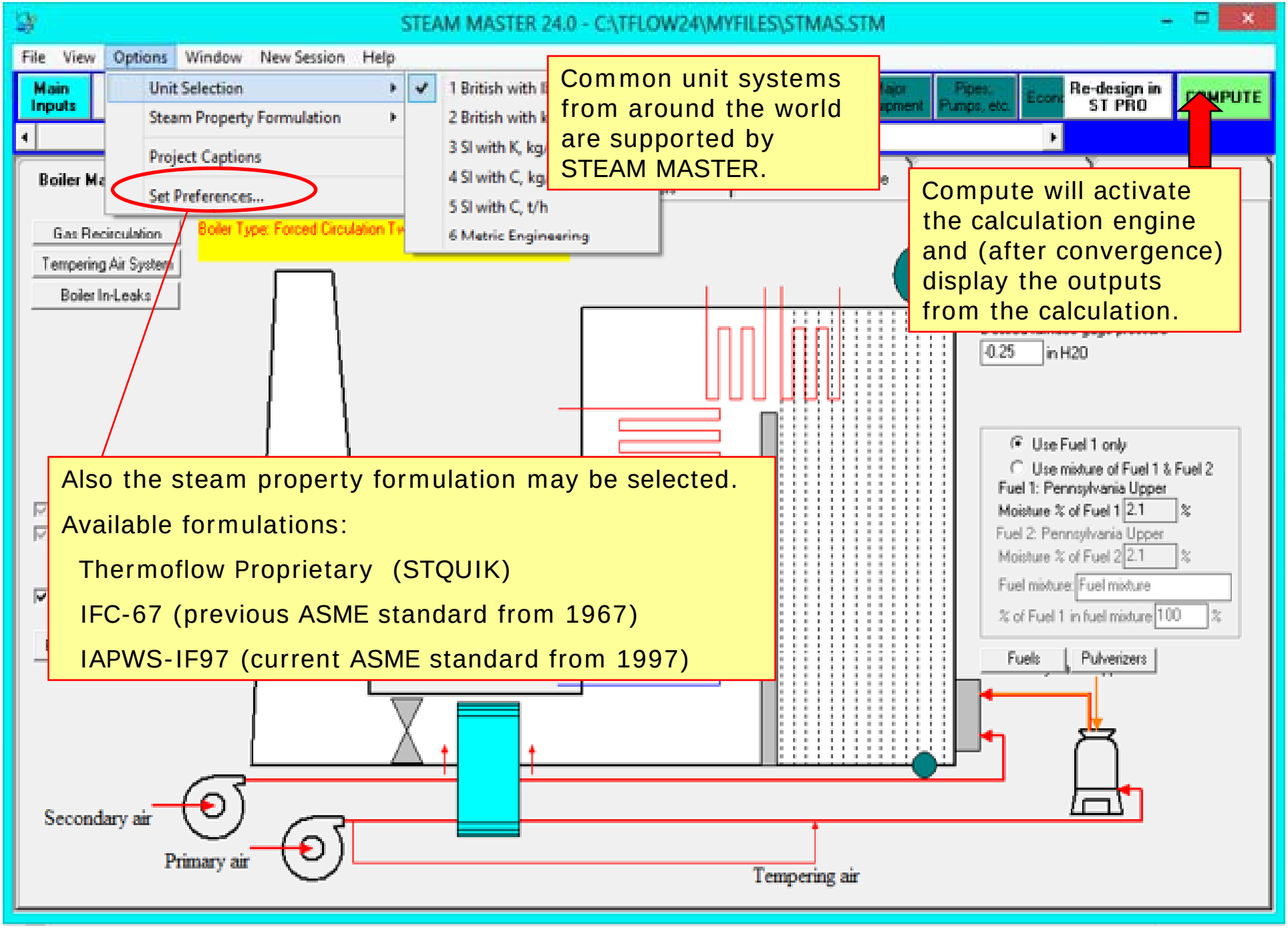
Main boiler dimensions are editable for the user to input data.

STEAM MASTER is based on hardware models with editable size and dimensions. This allows the user to adjust values to match an existing plant or a vendor's data.

Since STEAM MASTER applies hardware models the heat balance calculations will reflect any change in the hardware.

Cost of the plant will also be recalculated taking the changes into account.


STEAM MASTER 24.0 - C:\TFLOW24\MYFILES\STMAS.STM
Different fin-tube types are available: Bare, Solid fins and Serrated fins.
Selection of different materials is available as well.
Boiler
Environment
Nuclear Cycle
Re-design in ST PRO
COMPUTE
Boiler Main Inputs
Boiler Furnace Hardware
Desuperheating
Boiler Operating Parameters
Component Hardware
Steam Air Heater
Fuel Heating
Main Inputs
Hardware
Other Inputs
ECO1
Fin tube type
Solid fins
Tube arrangement
In line
Fin material
T22
Tube material
T22
Use different material for fins and tubes
User-defined materials
A pull down list allows for selection of the desired element of the boiler.
Tube length 33.03 ft
Transverse width 38.86 ft
# of tube rows (longitudinal) 24
# of tubes per row (transverse) 84
# of rows per water side flow pass 2
Longitudinal row pitch, Pl 4 in
Transverse tube pitch, Pt 5.551 in
Even details of tube bundle design such as tube length, bundle width, number of rows and tube diameter may be edited.
This flexibility allows the user to match known plant data.
24 tube rows
Pl = 4 in
Pt
Gas
Tube outer diameter 2
Tube wall thickness 0.18
Fin thickness 0.07
Fin spacing 0.45
# of fins 1.87
Fin height 0.75
HX total outside area 1735
View derived quantities
Segment width 0.1563 in
# of segments 0
Un-cut height/fin height 0.2
Graphical displays help the user visualising the tube and tube bundle geometry.
0
8 in
0
Economiser (ECO) has been selected as example.



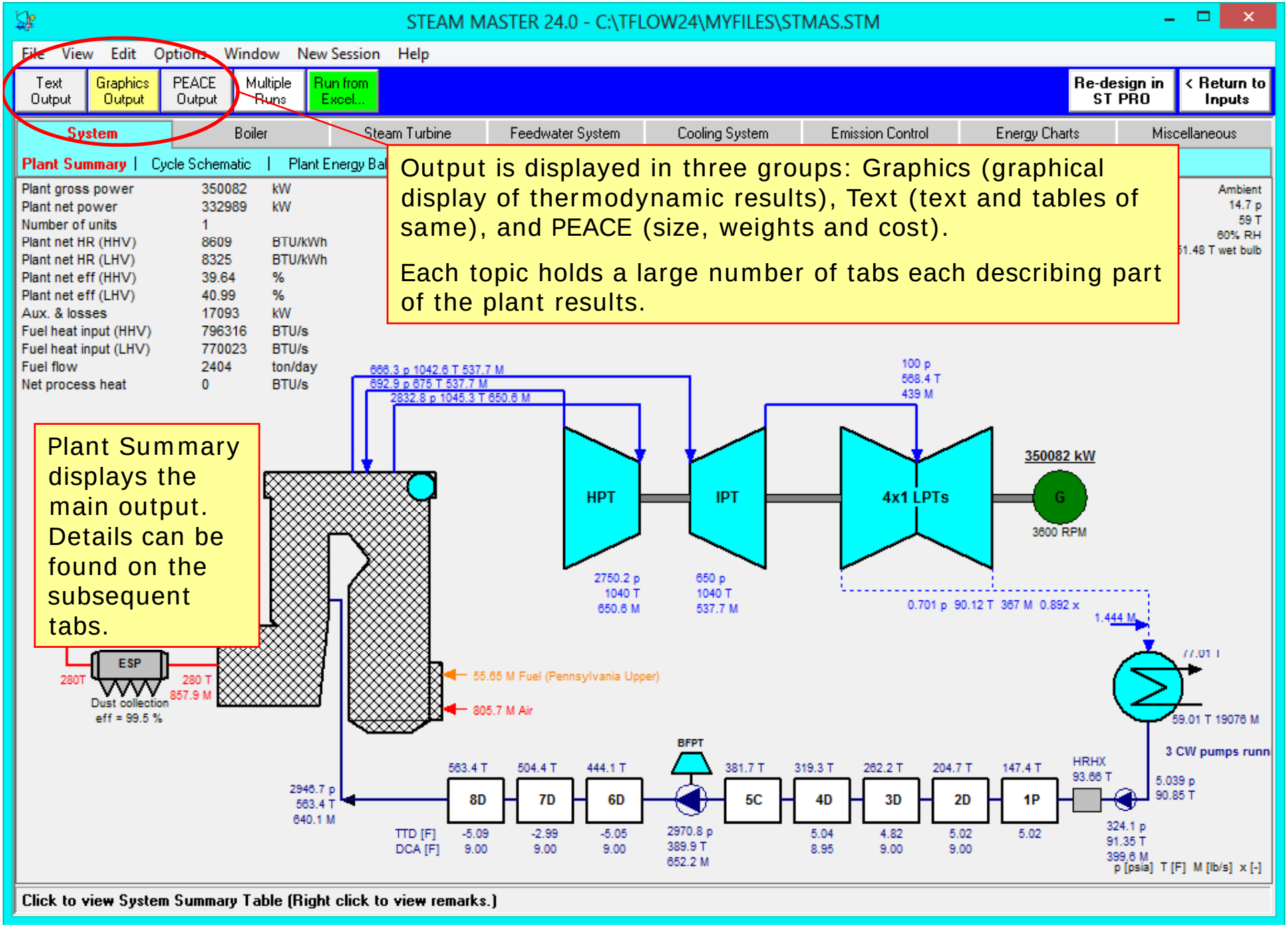
Common unit systems from around the world are supported by STEAM MASTER.

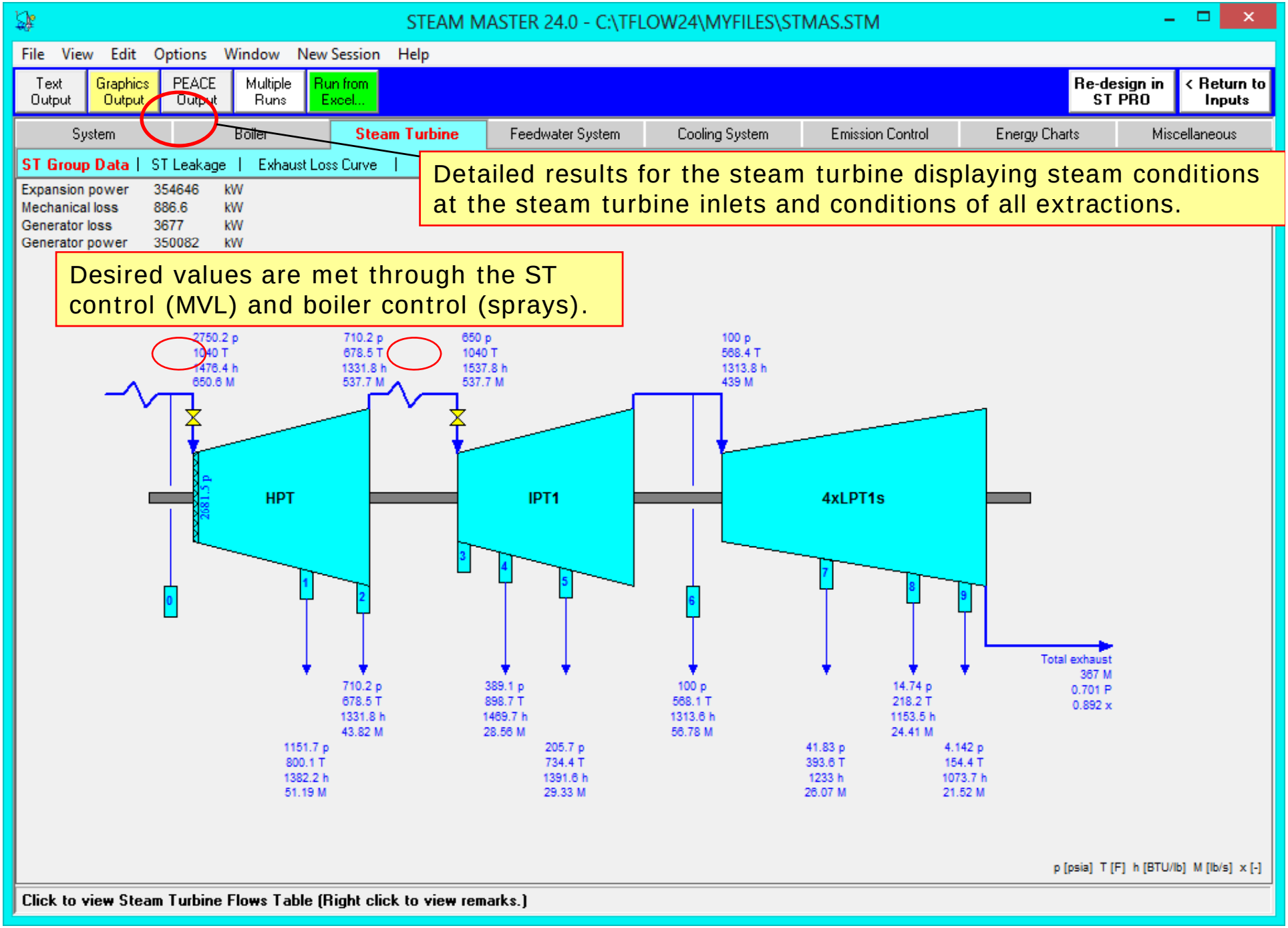
Compute will activate the calculation engine and (after convergence) display the outputs from the calculation.

Also the steam property formulation may be selected.

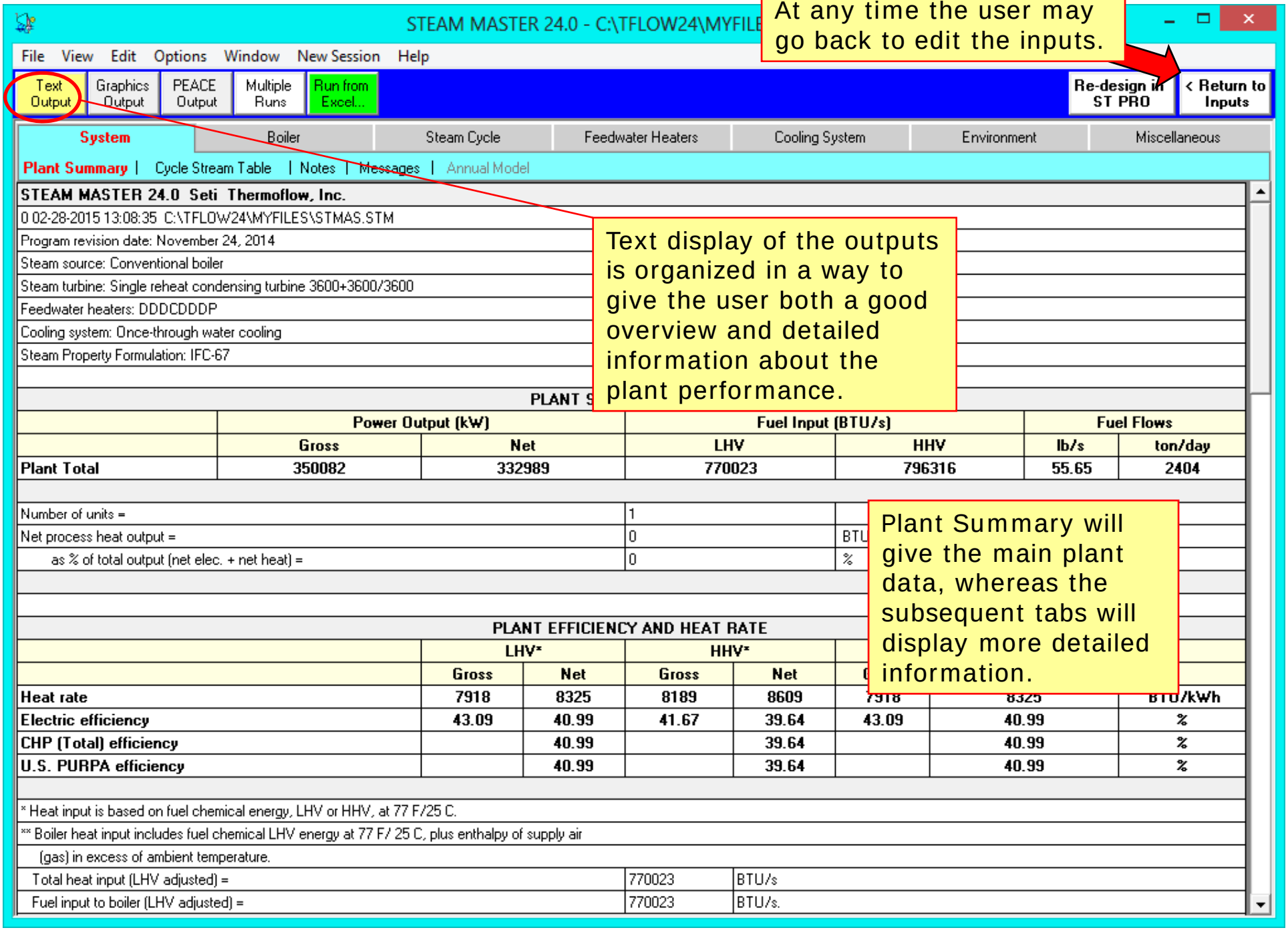
Available formulations:

- Thermoflow Proprietary (STQUIK)
- IFC-67 (previous ASME standard from 1967)
- IAPWS-IF97 (current ASME standard from 1997)


STEAM MASTER 24.0 - C:\TFLOW24\MYFILES\STMAS.STM
File View Edit Options Window New Session Help
Text Output
Graphics Output
PEACE Output
Multiple Runs
Run from Excel...
Re-design in ST PRO
< Return to Inputs
System
Boiler
Steam Turbine
Feedwater System
Cooling System
Emission Control
Energy Charts
Miscellaneous
Plant Summary | Cycle Schematic | Plant Energy Bal
Plant gross power 350082 kW
Plant net power 332989 kW
Number of units 1
Plant net HR (HHV) 8609 BTU/kWh
Plant net HR (LHV) 8325 BTU/kWh
Plant net eff (HHV) 39.64 %
Plant net eff (LHV) 40.99 %
Aux. & losses 17093 kW
Fuel heat input (HHV) 796316 BTU/s
Fuel heat input (LHV) 770023 BTU/s
Fuel flow 2404 ton/day
Net process heat 0 BTU/s
Output is displayed in three groups: Graphics (graphical display of thermodynamic results), Text (text and tables of same), and PEACE (size, weights and cost).
Each topic holds a large number of tabs each describing part of the plant results.
Plant Summary displays the main output. Details can be found on the subsequent tabs.
666.3 p 1042.6 T 537.7 M
692.9 p 675 T 537.7 M
2832.8 p 1045.3 T 650.6 M
100 p
568.4 T
439 M
HPT
IPT
4x1 LPTs
G
350082 kW
3600 RPM
2750.2 p
1040 T
650.6 M
650 p
1040 T
537.7 M
0.701 p 90.12 T 367 M 0.892 x
1.444 M
ESP
280T
280 T
857.9 M
Dust collection
eff = 99.5 %
55.65 M Fuel (Pennsylvania Upper)
805.7 M Air
59.01 T 19076 M
3 CW pumps runn
BFPT
563.4 T
504.4 T
444.1 T
381.7 T
319.3 T
262.2 T
204.7 T
147.4 T
HRHX
93.66 T
8D
7D
6D
5C
4D
3D
2D
1P
2946.7 p
563.4 T
640.1 M
5.039 p
90.85 T
TTD [F]
DCA [F]
-5.09
9.00
-2.99
9.00
-5.05
9.00
2970.8 p
389.9 T
652.2 M
5.04
8.95
4.82
9.00
5.02
9.00
5.02
324.1 p
91.35 T
399.6 M
p [psia] T [F] M [lb/s] x [-]
Ambient
14.7 p
59 T
60% RH
51.48 T wet bulb
Click to view System Summary Table (Right click to view remarks.)


STEAM MASTER 24.0 - C:\TFLOW24\MYFILES\STMAS.STM
File View Edit Options Window New Session Help
Text Output
Graphics Output
PEACE Output
Multiple Runs
Run from Excel...
Re-design in ST PRO
< Return to Inputs
System
Boiler
Steam Turbine
Feedwater System
Cooling System
Emission Control
Energy Charts
Miscellaneous
ST Group Data | ST Leakage | Exhaust Loss Curve |
Expansion power 354646 kW
Mechanical loss 886.6 kW
Generator loss 3677 kW
Generator power 350082 kW
Detailed results for the steam turbine displaying steam conditions at the steam turbine inlets and conditions of all extractions.
Desired values are met through the ST control (MVL) and boiler control (sprays).
2750.2 p
1040 T
1476.4 h
650.6 M
710.2 p
678.5 T
1331.8 h
537.7 M
650 p
1040 T
1537.8 h
537.7 M
100 p
568.4 T
1313.8 h
439 M
2681.5 p
HPT
IPT1
4xLPT1s
0
1
2
3
4
5
6
7
8
9
Total exhaust
367 M
0.701 P
0.892 x
710.2 p
678.5 T
1331.8 h
43.82 M
389.1 p
898.7 T
1469.7 h
28.56 M
100 p
568.1 T
1313.6 h
56.78 M
14.74 p
218.2 T
1153.5 h
24.41 M
1151.7 p
800.1 T
1382.2 h
51.19 M
205.7 p
734.4 T
1391.6 h
29.33 M
41.83 p
393.6 T
1233 h
26.07 M
4.142 p
154.4 T
1073.7 h
21.52 M
p [psia] T [F] h [BTU/lb] M [lb/s] x [-]
Click to view Steam Turbine Flows Table (Right click to view remarks.)

ST MASTER



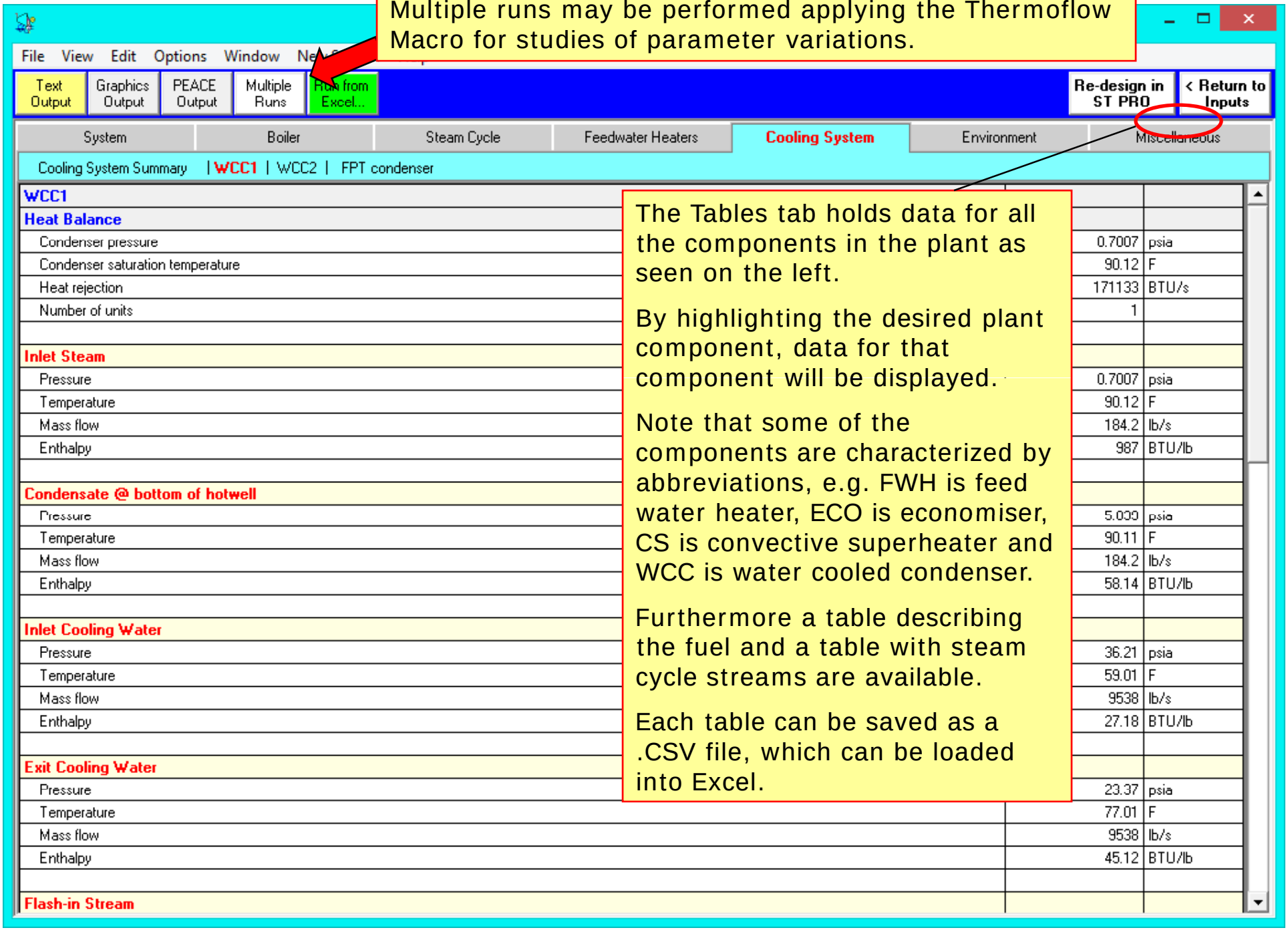
At any time the user may go back to edit the inputs.

Text display of the outputs is organized in a way to give the user both a good overview and detailed information about the plant performance.

Plant Summary will give the main plant data, whereas the subsequent tabs will display more detailed information.

ST MASTER

Multiple runs may be performed applying the Thermoflow Macro for studies of parameter variations.



The Tables tab holds data for all the components in the plant as seen on the left.

By highlighting the desired plant component, data for that component will be displayed.

Note that some of the components are characterized by abbreviations, e.g. FWH is feed water heater, ECO is economiser, CS is convective superheater and WCC is water cooled condenser.

Furthermore a table describing the fuel and a table with steam cycle streams are available.

Each table can be saved as a .CSV file, which can be loaded into Excel.

PEACE/STEAM MASTER 24.0 - Project Output [C:\TFLOW24\MYFILES\STMAS.STM]

File Edit View Cost Modifiers

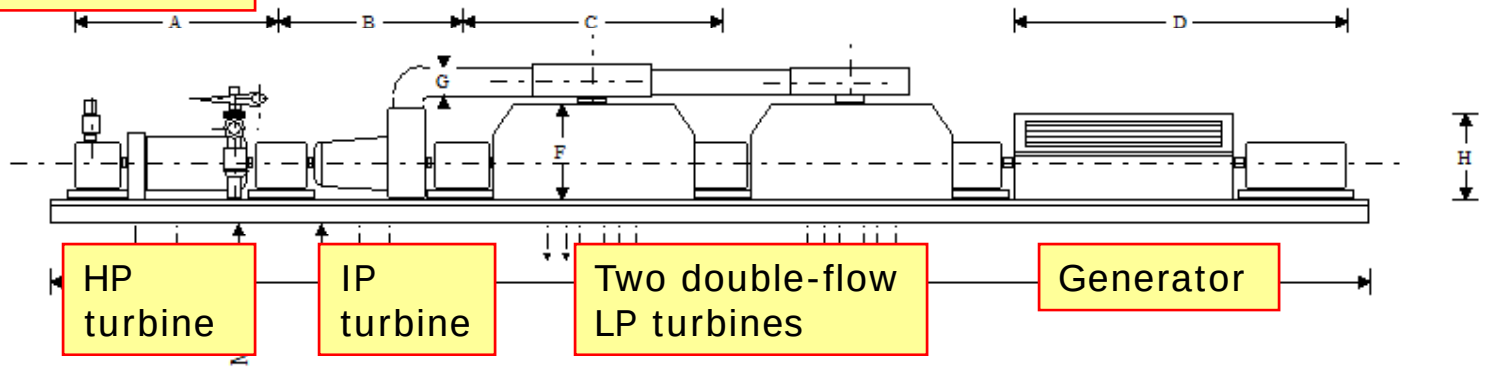
Preliminary Engineering: Schematics | Equipment Data | TFX Component Detail
Financial: Cost Report | Cash Flow
Heat Balance: Graphics | Text

Plant | Boiler | Emission Control | Steam Turbine | Feedwater Heaters | Cooling System | Piping | Pumps | Cash Flow

Elevation View | Plan View

Schematics showing the main components in the plant are selected through a Schematics List. Examples are: Site Plan, Boiler, Steam turbine (as shown), Condensers, Cooling towers, Feed-water heaters and pumps.

Displayed is the elevation view of the steam turbine.

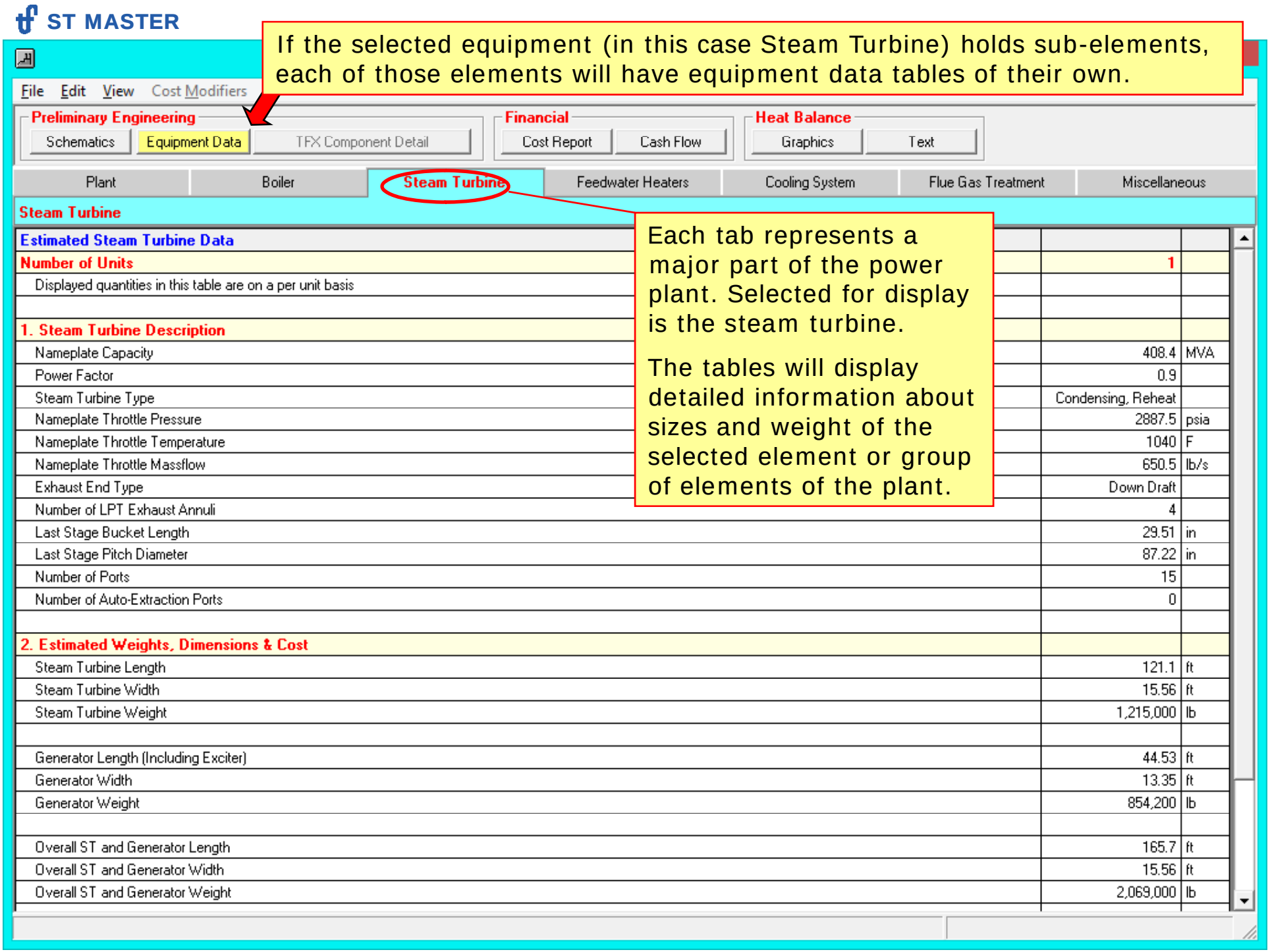


Steam turbine main dimensions

SHAPE, DIMENSIONS & SCALE ARE APPROXIMATE

A	B	C	D	E	F	G	H	I	J
27.24 ft	24.75 ft	34.57 ft	44.53 ft	176.6 ft	12.53 ft	3.911 ft	11.43 ft	-	-

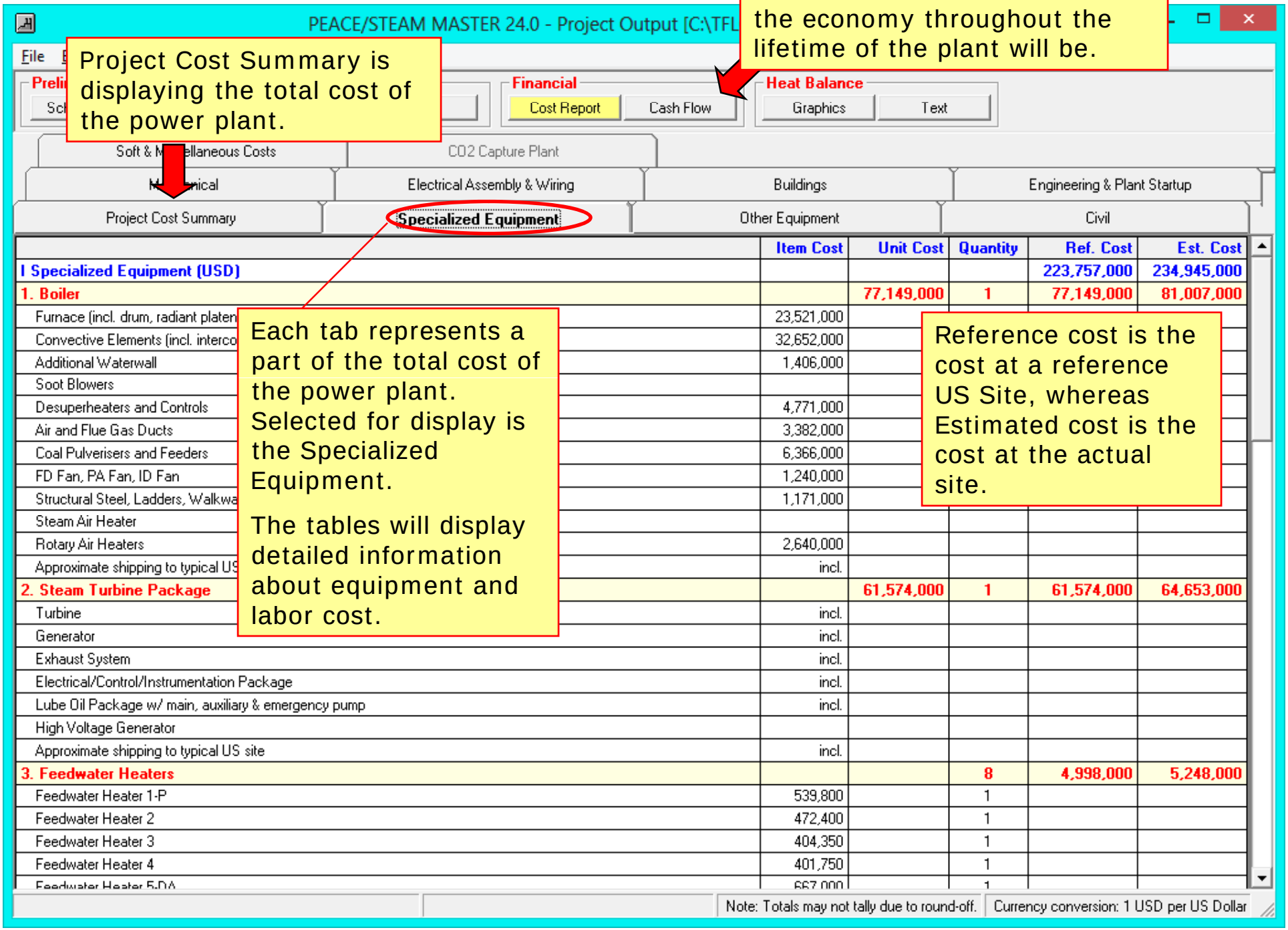
Thermoflow, Inc. | Company: Thermoflow, Inc.
User: Seti
STEAM TURBINE PACKAGE
ELEV
Date: 02/28/15
Drawing No.



Steam Turbine

Estimated Steam Turbine Data		
Number of Units	1	
Displayed quantities in this table are on a per unit basis		
1. Steam Turbine Description		
Nameplate Capacity	408.4	MVA
Power Factor	0.9	
Steam Turbine Type	Condensing, Reheat	
Nameplate Throttle Pressure	2887.5	psia
Nameplate Throttle Temperature	1040	F
Nameplate Throttle Massflow	650.5	lb/s
Exhaust End Type	Down Draft	
Number of LPT Exhaust Annuli	4	
Last Stage Bucket Length	29.51	in
Last Stage Pitch Diameter	87.22	in
Number of Ports	15	
Number of Auto-Extraction Ports	0	
2. Estimated Weights, Dimensions & Cost		
Steam Turbine Length	121.1	ft
Steam Turbine Width	15.56	ft
Steam Turbine Weight	1,215,000	lb
Generator Length (Including Exciter)	44.53	ft
Generator Width	13.35	ft
Generator Weight	854,200	lb
Overall ST and Generator Length	165.7	ft
Overall ST and Generator Width	15.56	ft
Overall ST and Generator Weight	2,069,000	lb

ST MASTER



Project Cost Summary is displaying the total cost of the power plant.

Cash Flow will tell the user how the economy throughout the lifetime of the plant will be.

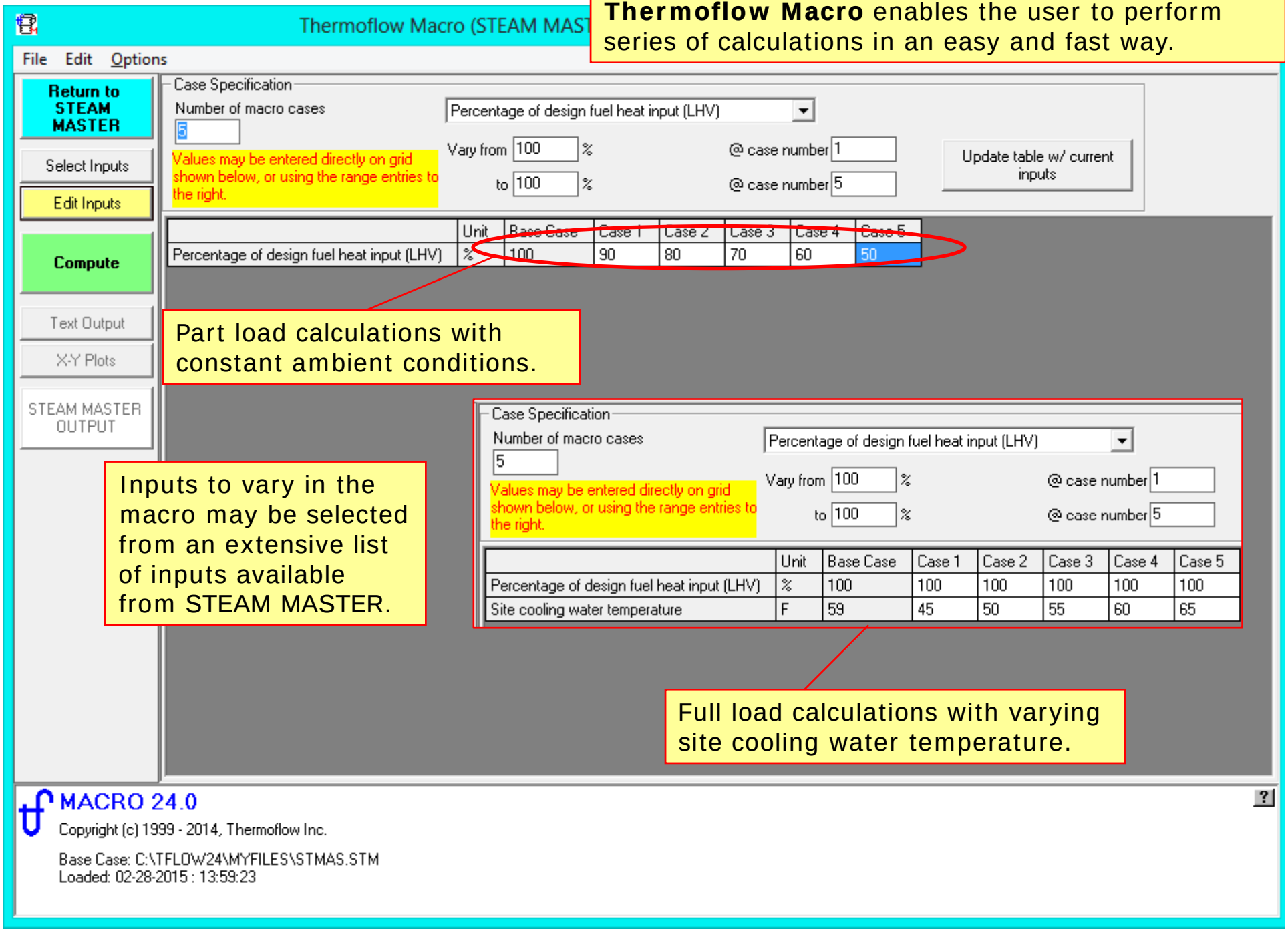
Each tab represents a part of the total cost of the power plant. Selected for display is the Specialized Equipment.

The tables will display detailed information about equipment and labor cost.

Reference cost is the cost at a reference US Site, whereas Estimated cost is the cost at the actual site.

ST MASTER

Thermoflow Macro enables the user to perform series of calculations in an easy and fast way.



Summary displays a fixed list of main output data.

R) 24.0 - C:\TFLOW24\MYFILES\STMAS.MSM

File Edit Options

Return to STEAM MASTER

Select Inputs

Edit Inputs

Compute

Text Output

X-Y Plots

STEAM MASTER OUTPUT

General - 4 | General - 5 | General - 6 | General - 7 | General - 8 | General - 9 | General - 10

Cost Report | Major Equipment | Cost Breakdowns | Macro Inputs | General - 1 | General - 2 | General - 3

Plant Summary | Steam Turbine | Cooling System | Steam Process / Addition | Feedwater Heaters | Boiler | Financial Summary

Right-click a column to summon details for that case.
Left-click any 'Messages' for details.

Plant Summary	Unit	Base Case	Case 1	Case 2	C
Computation Result Messages		OK	OK	OK	O
Ambient pressure	psia	14.7	14.7	14.7	1
Ambient temperature	F	59	59	59	5
Ambient relative humidity	%	60	60	60	6
Number Boiler/ST units in plant		1	1		
Plant gross output	kW	350082	31		
Plant net output	kW	332989	30		
Plant gross heat rate (LHV)	BTU/kWh	7918	79		
Plant net heat rate (LHV)	BTU/kWh	8325	83		
Plant gross elec eff (LHV)	%	43.09	43		
Plant net elec eff (LHV)	%	40.99	41		
U.S. PURPA eff (LHV)	%	40.99	41		
CHP Total eff (LHV)	%	40.99	41		
Plant gross heat rate (HHV)	BTU/kWh	8189	81		
Plant net heat rate (HHV)	BTU/kWh	8609	86		
Plant gross elec eff (HHV)	%	41.67	41		
Plant net elec eff (HHV)	%	39.64	39		
U.S. PURPA eff (HHV)	%	39.64	39		
CHP Total eff (HHV)	%	39.64	39		
Plant total fuel input (LHV)	kBTU/hr	2772082	24		
Plant total fuel input (HHV)	kBTU/hr	2866736	25		

Any of the general tabs allows the user to define which data (outputs as well as inputs) to display in that specific table.

All tables can be exported to Excel directly or saved as a .CSV file for later load into Excel.

MACRO 24.0

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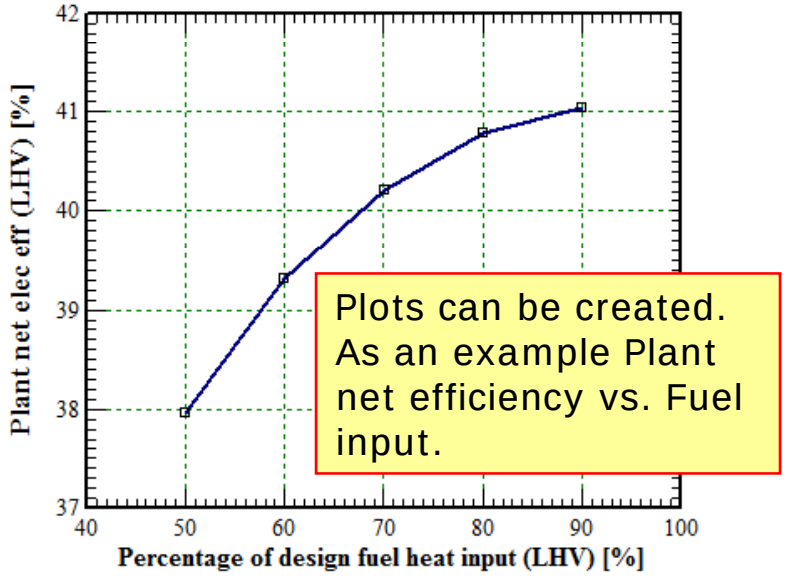
Base Load

For each case STEAM MASTER output can be displayed.

File Edit Options



Plots can be created. As an example Plant net efficiency vs. Fuel input.

Please contact Thermoflow for further information.

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