



Welcome!

Webinar #10. Supplementary Firing &
Control Loops in GT PRO/GT MASTER

August 31, 2017

The webinar will be starting on time (10:00 EDT)

Host: Meritt Elmasri (US office)

Presenter: Evgeny Zakharenkov

Thermoflow Training and Support

- Standard Training
- On-site Training course
- Advanced Workshop
- Webinars when new version is released
- Help, Tutorials, PPT, Videos
- Technical Support

→ Feature Awareness Webinars

Agenda

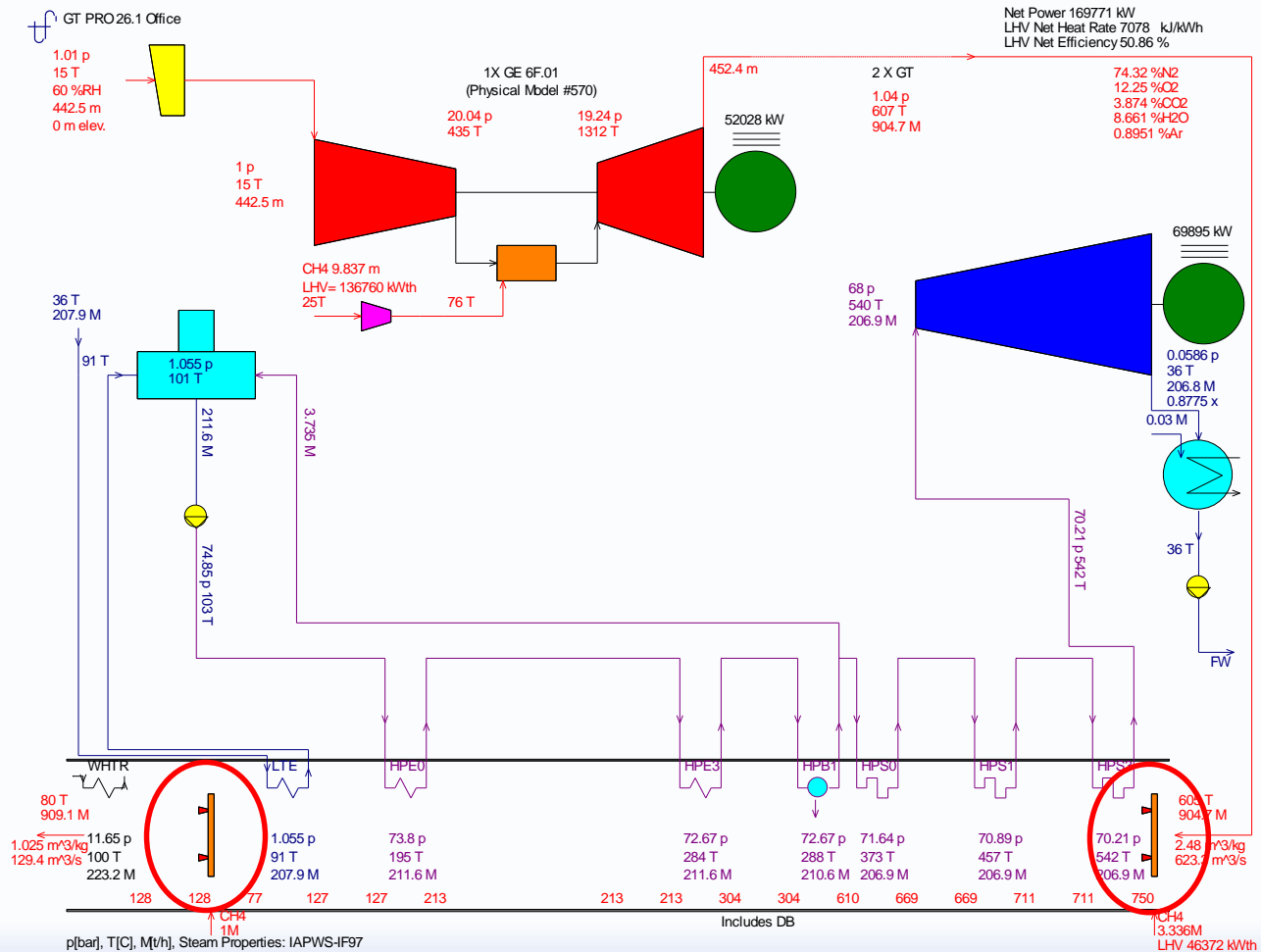
- Designing plants with supplementary firing
- HRSG with radiant surfaces
- Control Loops in GT MASTER

Designing plants with supplementary firing

When supplementary firing is used

- Flexible steam production and power output of the steam turbine.
- Flexible cogeneration plants for steam and hot water production.
- Compensation for changing ambient conditions (stabilizing steam temperature and mass flow rate).

GT PRO / GT MASTER allows to have up to two duct burners



How to set duct burners

GT PRO 26.1 - C:\TFLOW26\MYFILES\GTPRO.GTP

File View Options Window Excel Link Compare Files Scripts Custom Variable List Help

Navigator

New Session

Start Design

Plant Criteria

GT Selection

GT Inputs

ST-HRSG

HRSG Inputs

Water Circuits

HRSG Layout

Cooling System

ST Inputs

Environment

Other PEACE

Economics

Gasification

Desalination

HRSG Main Inputs

Duct Burner Fuel

Gas turbine fuel

Modify fuel

Duct Burner

1. Included, specify exit temperature

0. Not in plant

1. Included, specify exit temperature

2. Included, specify fuel flow

3. Included, specify LHV heat input

4. Included, specify HHV heat input

5. Included, specify gas temperature rise

6. Included, specify plant net output

Radiant Boiler / Additional Duct Burner

Included, specify fuel flow

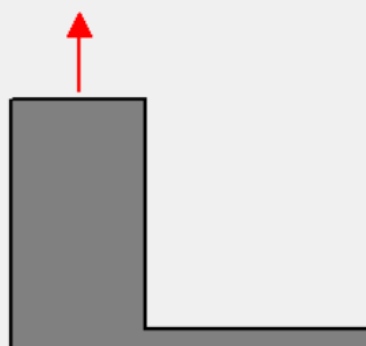
Fuel flow (plant total) 1 t/h

Steam Generation Dictated By

Pinch Mass flow

Min. stack temperature

Min. approach to sulphur dewpoint



HP Evaporator Circulation

Natural

HPE Exit T Specification

Approach subcooling

HP

Changing location of the duct burner

GT PRO 26.1 - C:\TFlow26\MYFILES\GTPRO.GTP

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Compute

Text Output

Graphics Output

PEACE Output

Carrying on...

Multiple Designs (MACRO)

Run from Excel (ELINK)

Diff Design Simulation (GT MASTER)

Fully-Flexible Design (THERMOFLEX)

HX Locations & Duties

Select the 'User-defined' Method to edit the HRSG layout. You may then drag heat exchangers to new locations, and edit heat exchanger exit temperatures where an input box is provided.

Method

Automatic

User-defined

Main DB Location

Automatic

User-defined

Design Point Desuperheating

	15	14	13	Zone 12			11	Zone 10			9	Zone 8			7	6	Zone 5		4	3	Zone 2		1	Zone 0		
Path				HPE0			HPE1	HPE2			HPE3			HPB1			HPS0			HPS1			HPS2			HPS3
2				194.7 C			194.7 C	194.7 C			284.4 C			288.4 C			372.9 C			457.4 C			457.4 C			542 C
1				101.1 C			194.7 C	194.7 C			194.7 C						288.4 C			372.9 C			457.4 C			457.4 C
0																										

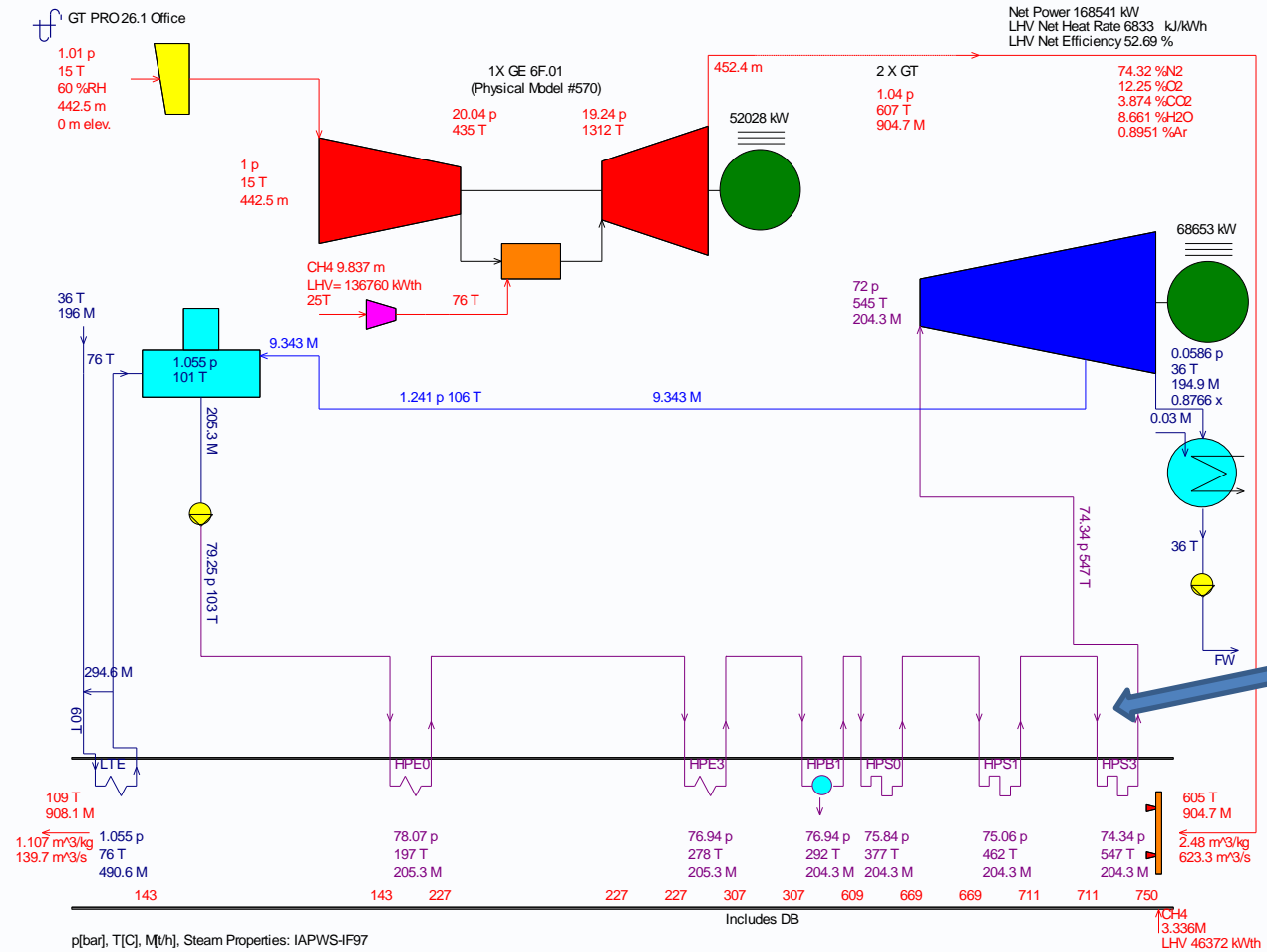
Duct Burner

*Switch to user-defined and drag duct burners to new locations

Plant model sample with supplementary firing

- Combined cycle based on 2xGE 6F.01.
- Supplementary firing (up to 750 C) to produce more power when electricity price is high.

Plant model sample with supplementary firing



Super Heaters undersized

Plant model sample with supplementary firing

Thermoflow Multi-Point Design 26.1 - C:\FLOW26\MYFILES\GTPRO.MGP

File Edit Options Help

Use HRSG from specific design: Nominal Design
 Use sizing options below

Model Determining HX & DB Location and Sequence
 Nominal Design

Duct Width & Tube Length
 Average From range: Min plus 1 * (Max - Min)

Superheater Areas
 Average From range: Min plus 0.7 * (Max - Min)

Evaporator Areas
 Average From range: Min plus 1 * (Max - Min)

Economizer Areas
 Average From range: Min plus 1 * (Max - Min)

Duct Burner Capacity
 Average From range: Min plus 1 * (Max - Min)

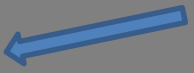
Drum Dimensions
 Average From range: Min plus 0.75 * (Max - Min)

Stack Dimensions
 Average From range: Min plus 0.75 * (Max - Min)

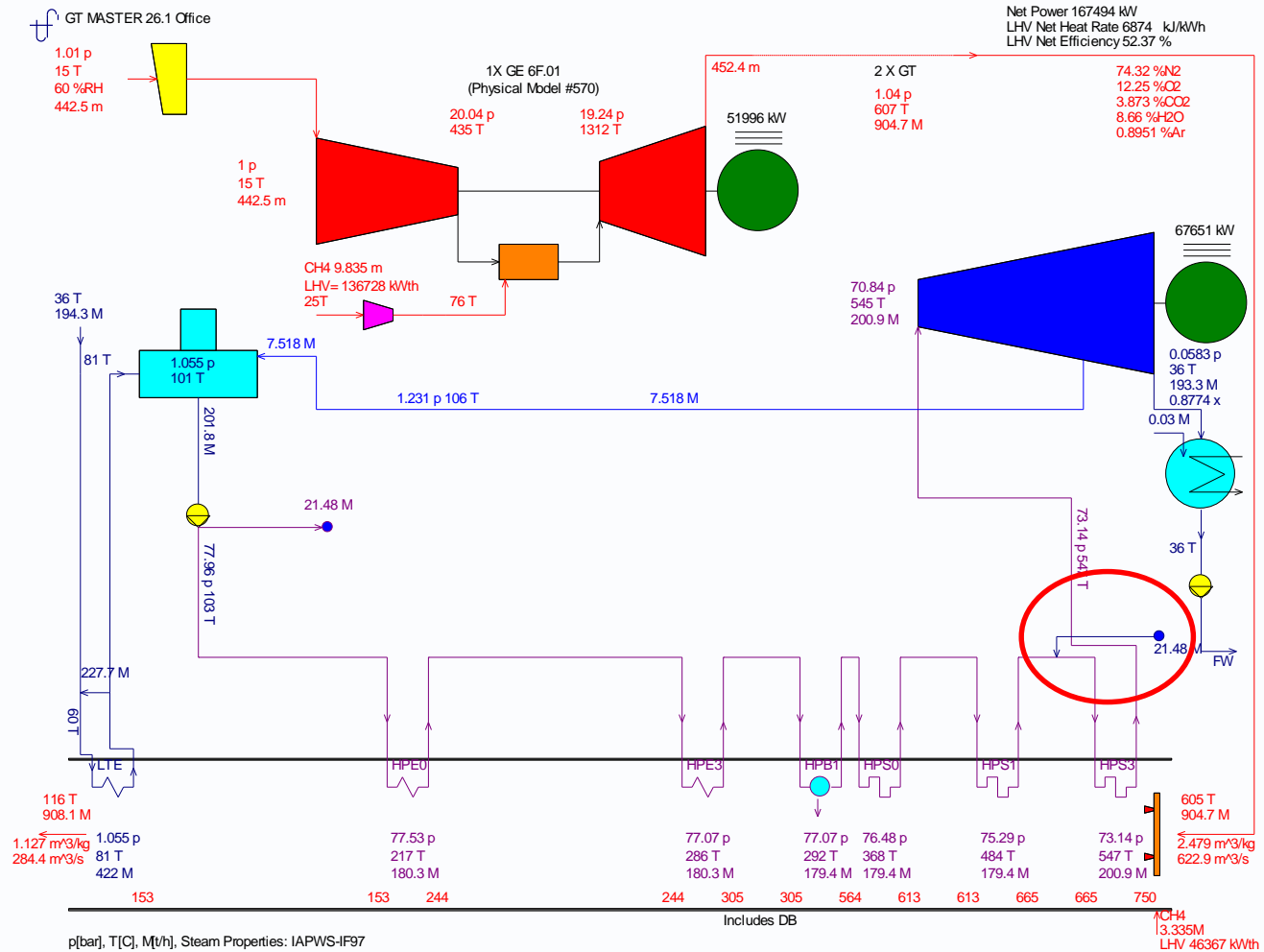
SCR & CD Catalyst Effectiveness
 Average From range: Min plus 1 * (Max - Min)

Radiant Boiler Projected Areas
 Average From range: Min plus 1 * (Max - Min)

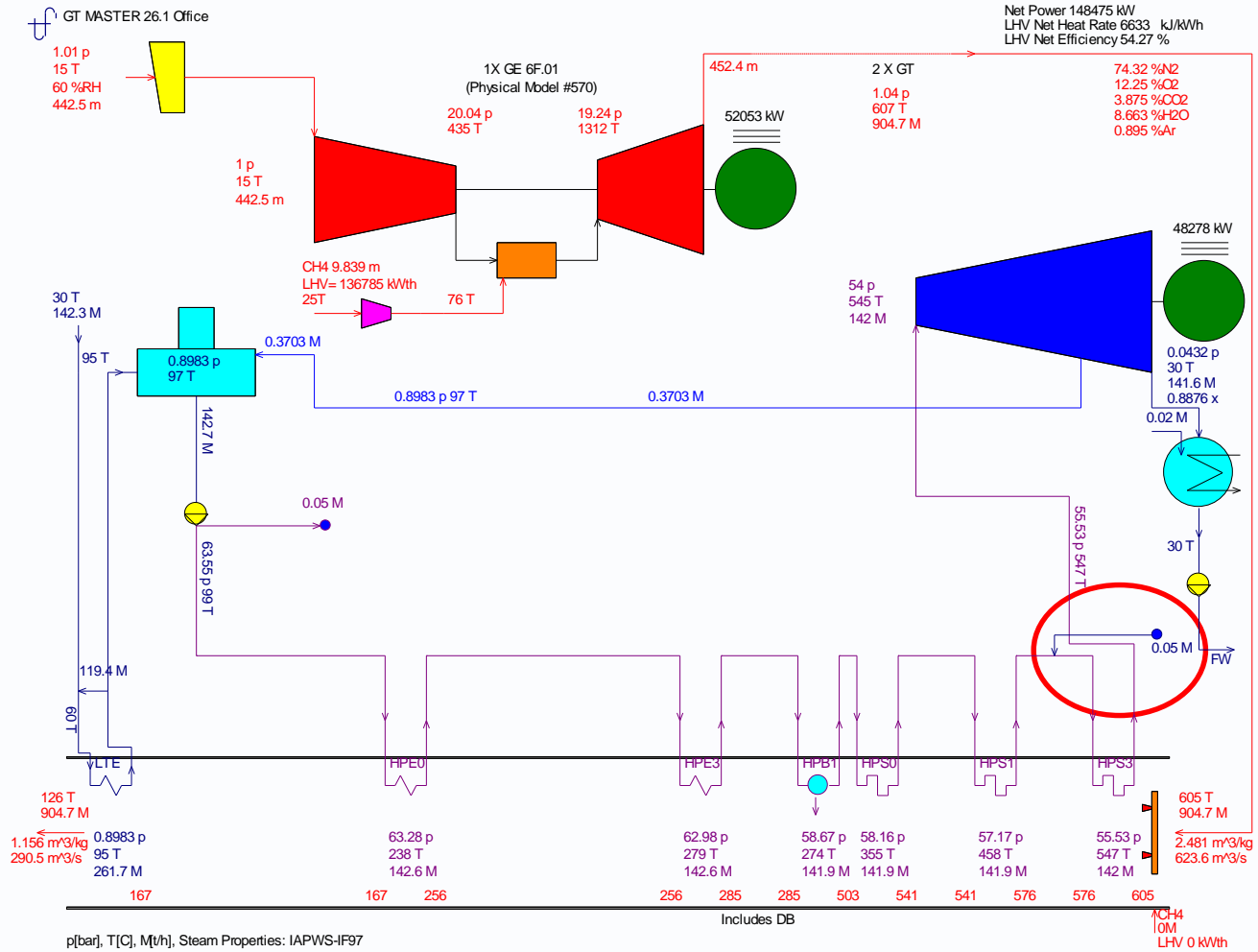
		Nominal Design	Design 1
User excluded this design entirely		no	no
HRSG compatible with HRSG in nominal design		yes	yes
Gas temperature reaching HRSG	C	604.6	604.6
Gas temperature after duct burner (if present)	C	750	604.6
Duct burner nameplate LHV capacity	kW	23,186	20,723
Overall heat transfer surface	m ²	23,919	12,994
Economisers	m ²	15,933	5,415
Evaporators	m ²	6,719	5,728
Superheater/Reheaters	m ²	1266.7	1,850
Duct width	m	3.547	3.254
Tube length	m	10.33	9.463
Main stack height	m	22.73	20.82
Main stack diameter	m	2.981	2.976
HP drum length	m	5.172	4.744
HP drum diameter	m	1.222	1.036
HP drum thickness	mm	51.37	43.56



Supplementary firing 750 C

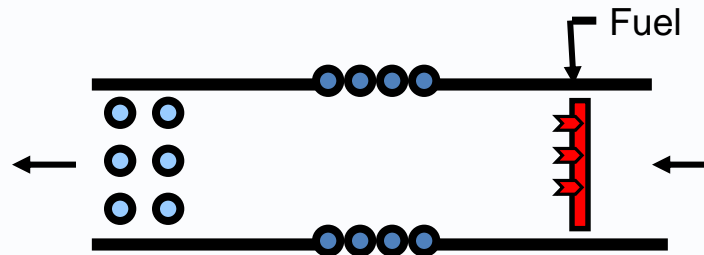


No supplementary firing



HRSG with radiant surfaces

- When the gas temperature is higher than 800 C the radiant heat exchange takes place.
- Radiant heat exchanges have to be used in this case (screens).



HRSG with radiant surfaces

GT PRO 26.1 - C:\TFLOW26\MYFILES\GTPRO.GTP

File View Options Window Excel Link Compare Files Scripts Custom Variable List Help

Navigator

- New Session
- Start Design
- Plant Criteria
- GT Selection
- GT Inputs
- ST-HRSG
- HRSG Inputs**
- Water Circuits
- HRSG Layout
- Cooling System
- ST Inputs
- Environment
- Other PEACE
- Economics
- Gasification
- Desalination
- Compute
- Text Output
- Graphics Output
- PEACE Output
- Carrying on...
- Multiple Designs (MACRO)
- Run from Excel (ELINK)

HRSG Main Inputs	Thermodynamic Design Assumptions	Hardware Design	Radiant Boiler
1. Fuel flow to radiant zone burner (per plant)	<input type="text" value="0"/> t/h		
2. Steam production in water wall region (per plant)	<input type="text" value="105"/> t/h		
3. Steam production in screen region (per plant)	<input type="text" value="45"/> t/h		
4. Screen radiation surface area/screen surface area per row	<input type="text" value="0"/>		
5. Radiation beam length correction factor	<input type="text" value="1"/>		
6. Water wall surface emissivity	<input type="text" value="0.8"/>		
7. Wall metal conductivity @ 500 F (260 C)	<input type="text" value="46.73"/> W/m-C		
8. Wall metal conductivity slope	<input type="text" value="-0.0249"/> W/m-C ²		
9. Wall thickness	<input type="text" value="5.08"/> mm		
10. Water side fouling factor	<input type="text" value="1.761E-4"/> m ² -C/W		
11. Gas side fouling factor	<input type="text" value="1.761E-4"/> m ² -C/W		
12. Gas side convective h.t.c. correction factor	<input type="text" value="1"/>		
13. Soot emissivity exponent correction factor	<input type="text" value="1"/>		
14. Correction factor for radiant flux	<input type="text" value="1"/>		
15. Aspect ratio of radiant section frontal area (0=automatic estimate)	<input type="text" value="0"/>		
16. Radiant section frontal area / HRB frontal area	<input type="text" value="1"/>		

HRSG with radiant surfaces

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 Carrying on...
 Multiple Designs (MACRO)
 Run from Excel (ELINK)
 Off Design Simulation (GT MASTER)
 Fully-Flexible Design (THERMOFLEX)

HX Locations & Duties

 HRSRG Heat & Mass Flow Additions
 HRSRG External Heat Transfer
 Design Point Desuperheating

Select the 'User-defined' Method to edit the HRSG layout. You may then drag heat exchangers to new locations, and edit heat exchanger exit temperatures where an input box is provided.

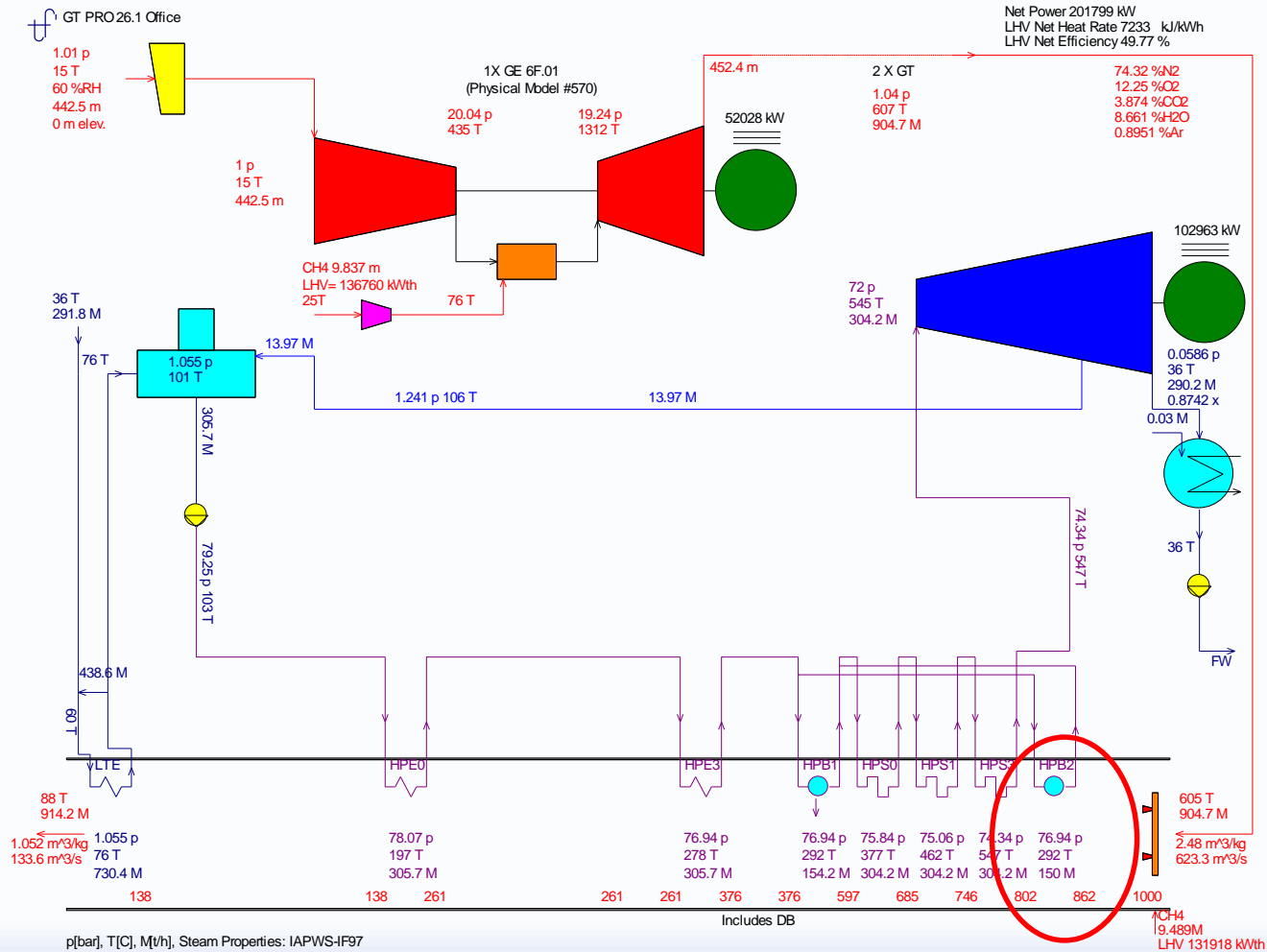
Method: Automatic User-defined
 Main DB Location: Automatic User-defined

Path	15	14	13	Zone 12			11	Zone 10			9	Zone 8			7	Zone 6			5	Zone 4			3	Zone 2			1	Zone 0			Path
2				HPE0			HPE1	HPE2			HPE3			HPB1	HPS0					HPS2											2
				196.7 C			196.7 C	196.7 C			278.3 C			292.3 C	377.2 C					462.1 C											
1				101.1 C			196.7 C	196.7 C			196.7 C									462.1 C	HPS3	547 C				HPB2					1
																				462.1 C		462.1 C				292.3 C					
0																															0

HPB2
 Duct Burner

Placing into radiant zone

HRSG with radiant surfaces



Control Loop in GT MASTER

- Control Loop is a tool for automatically searching for the values of inputs to the GT MASTER model that cause an output of the GT MASTER model to attain a certain, desired value.



Control Loop in GT MASTER

Control Loop Menu

GT MASTER 26.1 - Control Loop Menu

Control loop: Enabled Disabled Toggle lower window display

Current Control Loop Configurations

Set Point => Plant net output Tolerance %

Desired value [kW]

Primary control => GT load percentage from ^{X1} to ^{X2} [%]

Upper control => Duct Burner exit temperature from to [C]

Lower control => None from to

Select Set Point or Control Variables

Set Point variables

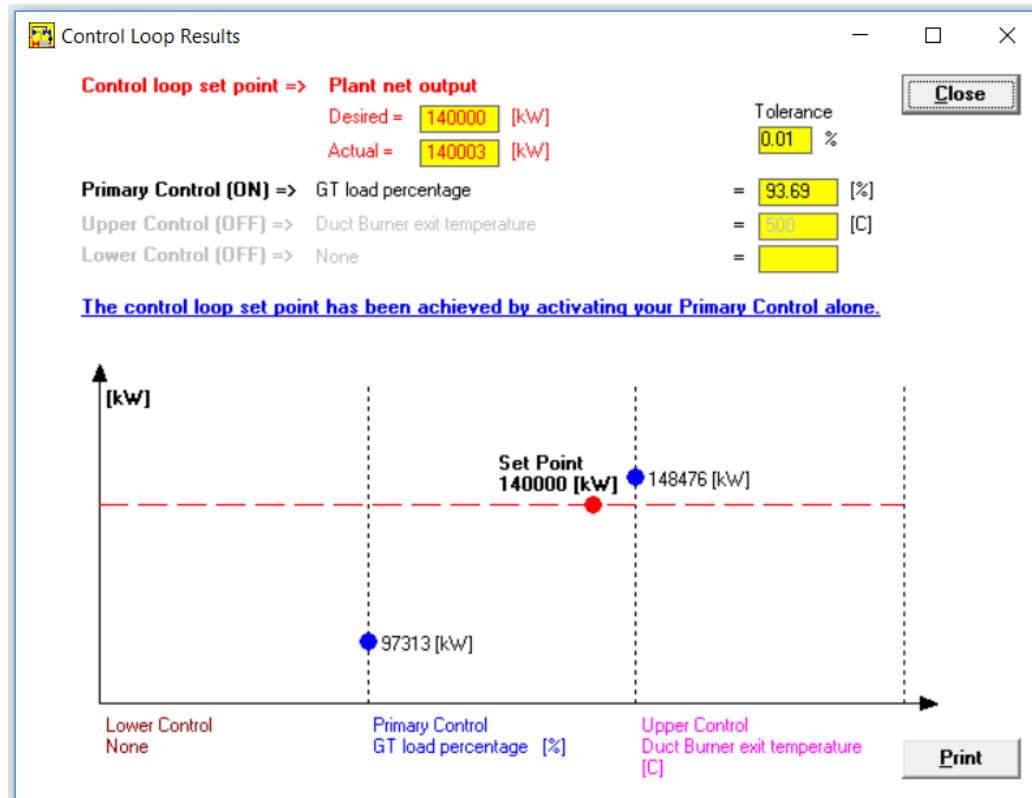
Plant operating variables Process streams HRSG massflow additions/extractions

None
Plant gross output
Plant net output
Steam turbine generator output
Plant gross heat rate
Plant net heat rate
Plant gross electric eff
Plant net electric eff
Gas turbine gross output
PURPA efficiency

Click on the list box to select Set Point variable. GT MASTER will iterate on Primary Control variable, and Upper or Lower Control variable if necessary, to achieve the desired set point value.

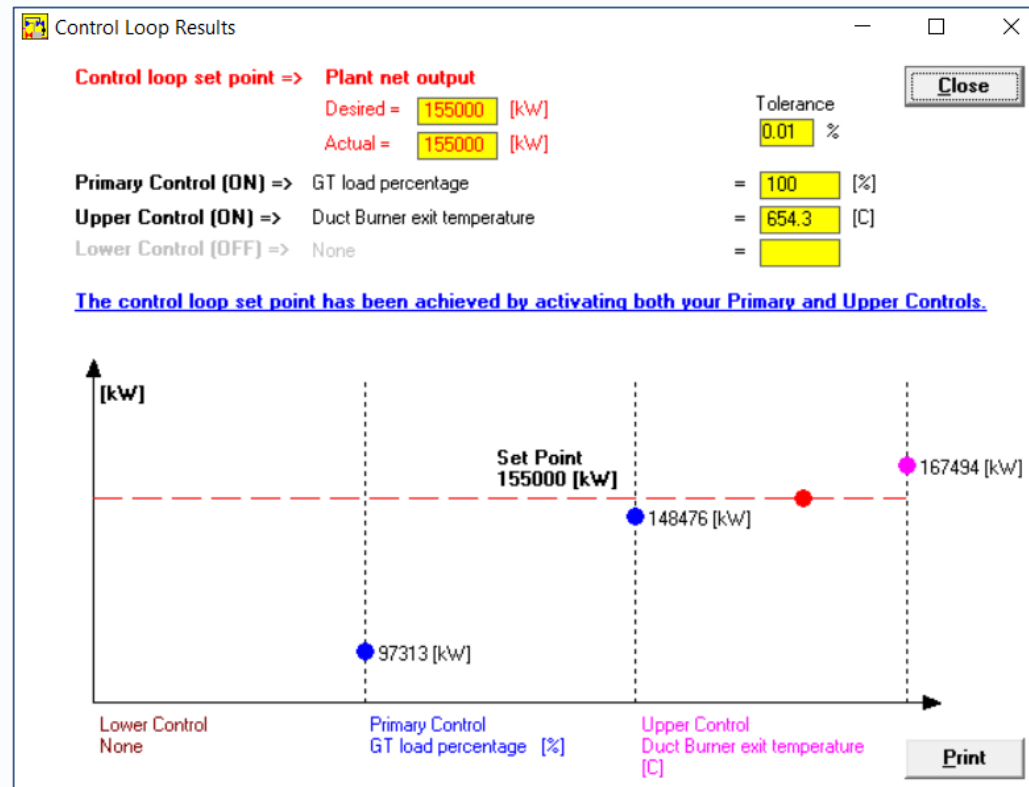
Control Loop in GT MASTER

Control Loop Results (140 MW)




Control Loop in GT MASTER

Control Loop Results (155 MW)



Control Loop in GT MASTER

Control Loop is available input for ELINK

 ELINK 26.1 (Save-ALL) ?		Base Case	Case 1	Case 2	Case 3	Case 4	Case 5
Copyright (c) 1999 - 2017 Base Case: C:\TFLOW26\MYFILES\GTPRO.gtm Loaded: 08-31-2017 : 10:53:39							
Computation Message ->		Messages	OK	OK	OK	OK	Messages
INPUT VARIABLE DESCRIPTION	Units	Input	Input	Input	Input	Input	Input
Plant net output		170000	90000	110000	130000	150000	170000
OUTPUT VARIABLE DESCRIPTION	Units	Output	Output	Output	Output	Output	Output
Plant net output	kW	167,494	89,995	110,005	129,994	149,999	167,494
GT load	%	100.0	54.47	69.98	85.9	100.0	100.0
GT fuel flow	t/h	9.835	6.502	7.583	8.696	9.839	9.835
Total duct burner fuel flow	t/h	3.335	0	0	0	0.2547	3.335
Duct burner exit temperature	C	750.0	647.1	638.2	620.7	616.0	750.0

Q & A session

Please send your questions to the
presenter in the webinar chat!

For further questions:
zakharenkov@thermoflow.com

Thank you!