STOEL RIVES LLP
ATTORNEYS AT LAW

California Energy Commission
DOCKETED
12-AFC-02
TN # 69017
JAN. 03 2013

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KIMBERLY J. HELLWIG
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kjhellwig@stoel.com

January 3, 2013

VIA EMAIL

Ms. Felicia Miller, Siting Project Manager
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Re: Huntington Beach Energy Project (12-AFC-02)
Submittal of Email Correspondence Related to Air Quality

Dear Ms. Miller:

On behalf of Applicant AES Southland Development, LLC, please find enclosed herein for docketing email correspondence among the Applicant, South Coast Air Quality Management District, and California Energy Commission Staff regarding air quality.

Should you have any questions regarding this submittal, please do not hesitate to contact me directly at 916.319.4673.

Respectfully submitted,

Kimberly J. Hellwig
Paralegal

KJH:jmw
Enclosures
cc: Proof of Service List

[redacted]

From: stephen.okane@AES.com
Sent: Tuesday, December 04, 2012 3:10 PM
To: CPerri@aqmd.gov
Cc: Robert.Mason@CH2M.com; Jerry.Salamy@CH2M.com; McKinsey, John A.; Foster, Melissa A.; Tao.Jiang@energy.ca.gov; Gerry.Bemis@energy.ca.gov
Subject: Re: HBEP GHG emissions

Chris,
Sorry for the slow response I am on the road today. I have CH2M Hill pulling together a clear calculation for you on the CO2 emissions including our assumptions for actual operating conditions. We will provide that and our outstanding start up emissions tomorrow.

Stephen O'Kane
Sent from my mobile device

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Tuesday, December 04, 2012 11:22 AM
To: Stephen O'Kane
Cc: 'Robert.Mason@CH2M.com' <Robert.Mason@CH2M.com>; 'Jerry.Salamy@CH2M.com' <Jerry.Salamy@CH2M.com>; 'JAMCKINSEY@stoel.com' <JAMCKINSEY@stoel.com>; 'mafoster@stoel.com' <mafoster@stoel.com>; 'Tao.Jiang@energy.ca.gov' <Tao.Jiang@energy.ca.gov>; 'Gerry.Bemis@energy.ca.gov' <Gerry.Bemis@energy.ca.gov>
Subject: HBEP GHG emissions

Good morning Stephen-

I'm looking over the GHG portion of the project today. I noticed that the GHG emissions were calculated to be 1,082 lbs CO2/MW-hr (page 3-25). Could you provide (or point to where in the document) the detailed calculations to support this number? Thanks.

Chris Perri
Air Quality Engineer
South Coast Air Quality Management District
(909) 396-2696

[redacted]

[redacted]

[redacted]

[redacted]

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Wednesday, December 12, 2012 9:58 AM
To: Stephen O'Kane
Cc: Robert.Mason@CH2M.com; McKinsey, John A.; Foster, Melissa A.; Jerry.Salamy@CH2M.com; Miller, Felicia@Energy; 'Tao.Jiang@energy.ca.gov'; 'Gerry.Bemis@energy.ca.gov'
Subject: RE: HBEP start/stop emissions and GHG performance

Stephen,

Thanks. A follow up question on the start ups – at what point after start up would the SCR become functional?

Chris Perri
Air Quality Engineer
South Coast Air Quality Management District
(909) 396-2696

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Friday, December 07, 2012 4:34 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; McKinsey, John A.; Foster, Melissa A.; Jerry.Salamy@CH2M.com; Miller, Felicia@Energy; 'Tao.Jiang@energy.ca.gov'; 'Gerry.Bemis@energy.ca.gov'
Subject: HBEP start/stop emissions and GHG performance

Chris,

In response to your questions regarding detail on the estimated start/stop emissions for the Huntington Beach Energy Project turbines and the assumptions that went in to our calculation of GHG emissions per MW-hr, please see the attached letter and accompanying data. If you require further information or explanation for any of our assertions please don't hesitate to ask.

Thanks

Per: Stephen O'Kane
Permitting and Regulatory Approvals, Southland Repower Team

AES Southland
690 N. Studebaker Rd. | Long Beach, CA | 90803
Direct: 562-493-7840 | Cell: 562-508-0962 | Fax: 562-493-7737
stephen.okane@aes.com | www.aes.com

[redacted]

From: Jerry.Salamy@CH2M.com
Sent: Wednesday, December 12, 2012 12:39 PM
To: CPerri@aqmd.gov; stephen.okane@AES.com
Cc: Robert.Mason@CH2M.com; McKinsey, John A.; Foster, Melissa A.; Felicia.Miller@energy.ca.gov; Tao.Jiang@energy.ca.gov; Gerry.Bemis@energy.ca.gov; Keith.McGregor@CH2M.com; Elyse.Engel@ch2m.com
Subject: RE: HBEP start/stop emissions and GHG performance

Chris,

The design engineers estimated that within 12.5 minutes of fuel initiation, the SCR would be reach the minimum operating temperature for ammonia injection to commence for either a hot, warm, or cold start. Therefore, the NOx removal efficiency is 0 percent for the first 12.5 minutes after fuel combustion is initiated and 70 percent thereafter.

For a hot or warm start, the oxidation catalyst system is functional at the initiation of combustion with an average CO and VOC removal efficiencies of 72 percent and 28 percent, respectively. For a cold start, the oxidation catalyst system reaches the minimum operating temperature at 4 minutes of initiating combustion and is fully functional by minute 9. The an average CO and VOC removal efficiencies during the 9 minute period are 31 percent and 9 percent, respectively.

For shutdowns, the SCR and oxidation catalyst systems are functional over the entire shutdown period with an average NOx, CO, and VOC removal efficiencies of 30 percent, 80 percent, and 30 percent, respectively.

Thanks,

Jerry Salamy
Principal Project Manager
CH2M HILL/Sacramento
Phone 916-286-0207
Fax 916-614-3407
Cell Phone 916-769-8919

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Wednesday, December 12, 2012 9:58 AM
To: Stephen O'Kane
Cc: Mason, Robert/SCO; McKinsey, John A.; Foster, Melissa A.; Salamy, Jerry/SAC; Miller, Felicia@Energy; 'Tao.Jiang@energy.ca.gov'; 'Gerry.Bemis@energy.ca.gov'
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Per: Stephen O'Kane
Permitting and Regulatory Approvals, Southland Repower Team

AES the power of being global

AES Southland
690 N. Studebaker Rd. | Long Beach, CA | 90803
Direct: 562-493-7840 | Cell: 562-508-0962 | Fax: 562-493-7737
stephen.okane@aes.com | www.aes.com

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[redacted]

[redacted]

[redacted]

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Tuesday, December 18, 2012 10:34 AM
To: Chris Perri
Cc: 'Robert.Mason@CH2M.com'; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; 'Tao.Jiang@energy.ca.gov'; 'Gerry.Bemis@energy.ca.gov'; John Yee
Subject: RE: HBEP Fast Start Capabilities

Chris,

I will try to give you some insight into the fast start capabilities of our combined cycle design, without giving up any of our intellectual property. While we have pieced together off the shelf equipment in our design, it is the design of our fast start CCGT that we want to protect, which is primarily focused on the steam cycle.

Advances in gas turbine technology have largely focused on large industrial gas turbines to improve power density (unit size and MWs) and exhaust energy available to a heat recovery system (overall heat rate). The combination of these design considerations provides an economic benefit by employing fewer units to achieve a very high combined output and efficiency. However, these types of gas turbine combined cycle units require increasingly complex cooling schemes and the heat recovery components become very complex using multiple steam path flows (typically three) in a steam turbine that requires a large quantity of heat exchangers with unique material properties, in order for it to function with the high exhaust energy that is made available from the gas turbine. Thus, an unavoidable consequence of these large combined cycle applications are the limitations they place upon the thermal transient and speed by which these units can startup, heat-up and ramp from minimum to full power. It is also important to note that the efficiency of a gas turbine in a combined cycle application is not static, which is to say that heat rate increases significantly (efficiency drops considerably) when these types of units operate in partial load or off-base design conditions. These are systems designed for high efficiency, base load operations in an “always on” mode. In addition, the cost to start a large, advanced CCGT unit becomes very expensive as the maintenance accruals are very high per start.

AES has worked with all the gas turbine Original Equipment Manufacturer’s to identify gas turbines with a moderate base load output (100-120MW vs. 200-250 MW) and employ the most advanced design features (such as aero-derivative type components and Dry Low NOx combustion) such that the gas turbine retains rapid start capability and environmental performance. It should be noted that the fast start capability of the gas turbine alone is inherent in almost all gas turbine designs, it is the back-end steam cycle that limits the start and ramp speed. Consequently, AES has focused on the exhaust energy conditions of the candidate turbines to determine those that do not exceed the operating limits of materials suited to the rapid cycling of a heat recovery system. By focusing on a simpler steam cycle and steam turbine (single pressure - single admission) different more malleable materials could be employed. The end result is the "un-coupling" of the steam cycle limitations from the fast start capability of the gas turbine, through the use of proven and robust steam cycle components. There is no limit imposed on the rapid start and loading of the gas turbine to its maximum output by the steam cycle regardless of time after shutdown, i.e. cold, warm or hot. Additionally, the use of mid-sized gas turbines in a 3-on-1 configuration allows the turndown of a single unit (multi-staged) rather than the turndown of the entire facility which results in improved part-load efficiency through the full range of operation; gas turbines are simply turned on and off in stages to retain base load-like performance of the remaining units in operation.

So without giving too much away, we have merely simplified the steam cycle so that we don't limit the gas turbine. While the full load efficiency of our units are not as high as the largest J-class CCGTs because they have not been designed to serve the same load and market, our 3-on-1 design outperforms any simple cycle configuration, including the most recently permited (and under construction) plants in the SCAQMD. Our units meet or exceed the start and ramp capabilities of the LMS 100, but do it at heat rate about 1000 points lower and at lower NOx and VOC rates. The 501DA turbines are only 9ppm NOx machines (uncontrolled) vs the 25 ppm LMS 100.

I hope this information meets your needs.

Regards,

Stephen O'Kane

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Thursday, December 06, 2012 3:17 PM
To: Stephen O'Kane
Cc: 'Robert.Mason@CH2M.com'; 'Jerry.Salamy@CH2M.com'; 'JAMCKINSEY@stoel.com'; 'mafoster@stoel.com'; 'Tao.Jiang@energy.ca.gov'; 'Gerry.Bemis@energy.ca.gov'; John Yee
Subject: HBEP Fast Start Capabilities

Hi Stephen –

Your application states that the turbines can begin producing power within 10 minutes of a start, and the STGs are also able to produce power 'almost immediately' after a start with duct firing. I'd like to get some detailed discussion concerning the fast start capabilities of the Mitsubishi 501DA turbines. Can you provide information on what types of design considerations are incorporated into the turbines, the HRSGs, and other systems that allow these types of quick starts?

Thanks

Chris Perri
Air Quality Engineer
South Coast Air Quality Management District
(909) 396-2696

[redacted]

[redacted]

[redacted]

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Tuesday, December 18, 2012 2:36 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee; John Kistle
Subject: RE: Heat Rate Tables

Chris,

Your values are way off, not even close on heat rate. How did you come up with these? What other information are you using?

Stephen

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Tuesday, December 18, 2012 2:29 PM
To: Stephen O'Kane
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee
Subject: Heat Rate Tables

Stephen,

I'm just now trying to complete my heat rate tables for the 2 on 1 and 1 on 1 cases. I'm using the information you provided in a previous email, however, I'm not coming up with the same heat rates. For the 2 on 1 case, I've tried to break it down on a per turbine basis (I also assumed that the net output is 96.6% of the gross output). For both cases, I assumed that HHV/LHV = 1.13. Could you look at these tables and tell me if I've misinterpreted the data you provided? Thanks.

2-on-1 Operation

	85 F – 46% RH (Evaporative Cooling On)	66 F – 58% RH (Evaporative Cooling On)
Gas Turbine Heat Input, mmbtu/h HHV	1,354	1,403
Total Heat Input, mmbtu/h HHV (w/duct fire)	1,861	1,910
Gas Turbine Gross Output, kW	115,962	121,840
Steam Turbine Gross Output, kW	49,751	51,320
Total Gross Power Output, kW	165,713	173,160
Net Power Output, Kw	160,078	167,273
Net Plant Heat Rate, btu/kWh, LHV	10,288	10,104
Net Plant Heat Rate, btu/kWh, HHV	11,626	11,418

1-on-1 Operation

	85 F – 46% RH (Evaporative Cooling On)	66 F – 58% RH (Evaporative Cooling On)
Gas Turbine Heat Input, mmbtu/h HHV	1,354	1,403
Total Heat Input, mmbtu/h HHV (w/duct fire)	1,861	1,910
Gas Turbine Gross Output, kW	115,962	121,840
Steam Turbine Gross Output, kW	49,382	47,192
Total Gross Power Output, kW	171,222	163,152
Net Power Output, Kw	163,611	155,661
Net Plant Heat Rate, btu/kWh, LHV	10,066	10,858
Net Plant Heat Rate, btu/kWh, HHV	11,375	12,270

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Thursday, October 25, 2012 4:40 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy
Subject: RE: HBEP emission rates and modeling results

Chris,

Here's the data I can provide. If you really need the additional performance data at the other temperatures I will have to get our consultants to run some additional heat balance models. Please let me know as this is an extra expenditure and additional time to execute.

With these two temperature cases you can see the performance of the CCGT in both 1-on-1 and 2-on-1 modes. Additional data would merely show the same relative difference compared to the 3-on-1 case for different operating temperatures and humidities. Note the highlighted numbers. Our CCGT design actually provides the best performance on a heat rate basis (and consequently CO2e per MW) in the 2-on-1 case. Which is a big part of the design objective. Instead of the normal heat rate curve of a CCGT that deteriorates as output or load is decreased, this design will maintain a very constant heat rate across a wide range of output, and be able to ramp up and down output very quickly. Thus we achieve approximately 800-1,000 BTU/kwh better heat rate than a simple cycle LMS 100 and still provide the fast ramp and quick start support.

	32 F – 87% RH (Evaporative Cooling Off, Case 2)	ISO 59 F-60% RH (Evaporative Cooling Off)	66 F – 58% RH (Evaporative Cooling On, Case 7)	85 F - 45.75% RH (Evaporative Cooling On)	110 F-8% RH (Evaporative Cooling On, Case 12)
Gas Turbine Heat Input, mmbtu/h HHV[1]	1,498	1,388	1,403	1,354	1,350
Total Heat Input, mmbtu/h HHV (w/duct fire)[2]	2,005	1,895	1,910	1,861	1,857
Gas Turbine Gross Output, kW[3]	132,256	121,435	121,840	115,962	115,264
Steam Turbine Gross Output, kW[3]	49,579	51,865	50,192	48,523	43,632
Total Gross Power Output, kW[3]	181,835	173,300	172,032	164,485	158,896
Total Net Power Output, Kw[3]	175,925	167,583	166,328	158,901	153,352
Net Plant Heat Rate, btu/kWh, LHV	7,558	7,354	7,487	7,508	7,814
Net Plant Heat Rate, btu/kWh, HHV	8,516	8,285	8,435	8,459	8,803
Steam Turbine Gross Output, kW (2-on-1)			102,640	99,501	
Total Gross Power Output, kW (2-on-1)			346,320	331,425	
Total Net Power Output, Kw (2-on-1)			334,035	319,363	
Net Plant Heat Rate, btu/kWh, LHV (2-on-1)			7,337	7,408	
Net Plant Heat Rate, btu/kWh, HHV (2-on-1)			8,400	8,483	
Steam Turbine Gross Output, kW (1-on-1)			49,382	47,192	
Total Gross Power Output, kW (1-on-1)			171,222	163,154	
Total Net Power Output, Kw (1-on-1)			163,611	155,661	
Net Plant Heat Rate, btu/kWh, LHV (1-on-1)			7,489	7,600	
Net Plant Heat Rate, btu/kWh, HHV (1-on-1)			8,575	8,702	

Notes:
1. Cases 110F, 32F and 66F heat input taken directly from M501DA Gas Turbine Expected Performance and Emissions Provided by MPSA and included in Table 5.1B.2 of *HBEP_Appendix 5.1B_Ops Emissions Calcs.pdf*. ISO 59F Case Heat input taken from GT PRO model.

2. Total Heat Input per gas turbine with duct firing can only be achieved while operating in a 1-on-1 or 2-on-1 mode. The steam cycle is sized suc
the maximum heat input into the steam cycle is reached in a 3-on-1 mode without duct firing.

3. All output is provided on a per turbine basis assuming a 3-on-1 operating mode. To calculate total output for the entire power block these value
must be multiplied by 3

Stephen

[redacted]

[redacted]

[redacted]

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[redacted]

[redacted]

[redacted]

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Wednesday, December 19, 2012 11:36 AM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee
Subject: RE: Heat Rate Tables

Chris,

Here are some more heat rate data for various temperature and operating cases, including a summer temperature one-on-one duct firing case and a two-on-one duct firing case. We will also send over our assumptions and calculation method for calculating annual average CO2/MWh, which includes the contribution of duct firing under the assumed annual operating condition. As discussed, there are different assumptions that go into the different calculations for annual PM2.5 emissions; maximum month daily emissions; and predicted CO2/MWhr emissions. In each case we have made conservative assumptions to calculate the different regulatory requirements. One of the biggest differences our CCGT application will have compared to traditional supplemental fired CCGTs is how the duct burners are employed. The duct burners in our case are for ramp speed and not for power augmentation. It is not expected that the units would be parked at part load with duct firing and in the 3-on-1 case; we are physically constrained by the steam cycle and cannot duct fire with the three turbines at max load.

I hope this information helps. Additional information on our GHG calculations will follow shortly.

Stephen O'Kane

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Tuesday, December 18, 2012 2:29 PM
To: Stephen O'Kane
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee
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Net Power Output, Kw	160,078	167,273
Net Plant Heat Rate, btu/kWh, LHV	10,288	10,104
Net Plant Heat Rate, btu/kWh, HHV	11,626	11,418

1-on-1 Operation

	85 F – 46% RH (Evaporative Cooling On)	66 F – 58% RH (Evaporative Cooling On)
Gas Turbine Heat Input, mmbtu/h HHV	1,354	1,403
Total Heat Input, mmbtu/h HHV (w/duct fire)	1,861	1,910
Gas Turbine Gross Output, kW	115,962	121,840
Steam Turbine Gross Output, kW	49,382	47,192
Total Gross Power Output, kW	171,222	163,152
Net Power Output, Kw	163,611	155,661
Net Plant Heat Rate, btu/kWh, LHV	10,066	10,858
Net Plant Heat Rate, btu/kWh, HHV	11,375	12,270

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Thursday, October 25, 2012 4:40 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy
Subject: RE: HBEP emission rates and modeling results

Chris,

Here's the data I can provide. If you really need the additional performance data at the other temperatures I will have to get our consultants to run some additional heat balance models. Please let me know as this is an extra expenditure and additional time to execute.

With these two temperature cases you can see the performance of the CCGT in both 1-on-1 and 2-on-1 modes. Additional data would merely show the same relative difference compared to the 3-on-1 case for different operating temperatures and humidities. Note the highlighted numbers. Our CCGT design actually provides the best performance on a heat rate basis (and consequently CO2e per MW) in the 2-on-1 case. Which is a big part of the design objective. Instead of the normal heat rate curve of a CCGT that deteriorates as output or load is decreased, this design will maintain a very constant heat rate across a wide range of output, and be able to ramp up and down output very quickly. Thus we achieve approximately 800-1,000 BTU/kwh better heat rate than a simple cycle LMS 100 and still provide the fast ramp and quick start support.

	32 F – 87% RH (Evaporative Cooling Off, Case 2)	ISO 59 F-60% RH (Evaporative Cooling Off)	66 F – 58% RH (Evaporative Cooling On, Case 7)	85 F - 45.75% RH (Evaporative Cooling On)	110 F-8% RH (Evaporative Cooling On, Case 12)
Gas Turbine Heat Input, mmbtu/h HHV[1]	1,498	1,388	1,403	1,354	1,350
Total Heat Input, mmbtu/h HHV (w/duct fire)[2]	2,005	1,895	1,910	1,861	1,857
Gas Turbine Gross Output, kW[3]	132,256	121,435	121,840	115,962	115,264
Steam Turbine Gross Output, kW[3]	49,579	51,865	50,192	48,523	43,632
Total Gross Power Output, kW[3]	181,835	173,300	172,032	164,485	158,896
Total Net Power Output, Kw[3]	175,925	167,583	166,328	158,901	153,352
Net Plant Heat Rate, btu/kWh, LHV	7,558	7,354	7,487	7,508	7,814
Net Plant Heat Rate, btu/kWh, HHV	8,516	8,285	8,435	8,459	8,803
Steam Turbine Gross Output, kW (2-on-1)			102,640	99,501	
Total Gross Power Output, kW (2-on-1)			346,320	331,425	
Total Net Power Output, Kw (2-on-1)			334,035	319,363	
Net Plant Heat Rate, btu/kWh, LHV (2-on-1)			7,337	7,408	
Net Plant Heat Rate, btu/kWh, HHV (2-on-1)			8,400	8,483	
Steam Turbine Gross Output, kW (1-on-1)			49,382	47,192	
Total Gross Power Output, kW (1-on-1)			171,222	163,154	
Total Net Power Output, Kw (1-on-1)			163,611	155,661	
Net Plant Heat Rate, btu/kWh, LHV (1-on-1)			7,489	7,600	
Net Plant Heat Rate, btu/kWh, HHV (1-on-1)			8,575	8,702	

Notes:

1. Cases 110F, 32F and 66F heat input taken directly from M501DA Gas Turbine Expected Performance and Emissions Provided by MPSA and included in Table 5.1B.2 of *HBEP_Appendix 5.1B_Ops Emissions Calcs.pdf*. ISO 59F Case Heat input taken from GT PRO model.

2. Total Heat Input per gas turbine with duct firing can only be achieved while operating in a 1-on-1 or 2-on-1 mode. The steam cycle is sized suc the maximum heat input into the steam cycle is reached in a 3-on-1 mode without duct firing.

3. All output is provided on a per turbine basis assuming a 3-on-1 operating mode. To calculate total output for the entire power block these value must be multiplied by 3

Stephen

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Huntington Beach Energy Project (HBEP) AFC application Heat Balance Cases

Seventeen heat balance studies were performed to characterize various operating conditions of the HBEP equipment performance located in Huntington Beach, CA. Case 1represents the base case full load operating information for three combustion turbines and one steam turbine operating a full load. The typical information shown in Figure 2.1-4 and also the text of the Application for Construction (AFC) is from Heat Balance 1a (Case 1) Three combustion turbines (at max. heat input) without Evaporative Cooling Operation at Site Ambient Average Temperature (SAAT) conditions.

Cases 2 thru 17 represent alternate scenarios used to develop expected plant output, heat rate, and operating conditions at various equipment configurations and ambient temperatures.

Case	Heat Balance Number	Description	Ambient Temp Data Set	Dry Bulb (°F)	Wet Bulb (°F)	Relative Humidity (%)	Net Power (MW)	LHV Heat Rate (BTU/kWh)	Heat Input (MBTU/h)r	Flue Gas Flow (kpph /hr)	Flue Gas Temp (°F)	Case
1	1a	Three combustion turbines (at max. heat input) w.o. Evap. Cooling Operation	SAAT	65.8	56.8	57	488.8	7427	3630.9	9362	407	1
2	1b	Two combustion turbines (at max. heat input) w.o. Evap. Cooling Operation	SAAT	65.8	56.8	57	326.9	7406	2420.6	6241	389	2
3	1c	One combustion turbine (at max. heat input) w.o. Evap. Cooling Operation	SAAT	65.8	56.8	57	160.0	7564	1210.3	9121	386	3
4	2a	Three combustion turbines (at max. heat input) w. Evap. Cooling Operation	SAAT	65.8	56.8	57	499.2	7433	3711.3	9510	408	4
5	2b	Two combustion turbines (at max. heat input) w. Evap. Cooling Operation	SAAT	65.8	56.8	57	334.0	7407	2474.2	6340	391	5
6	2c	One combustion turbine (at max. heat input) w. Evap. Cooling Operation	SAAT	65.8	56.8	57	163.6	7561	1237.1	3170	388	6
7	3a	Three combustion turbines (at max. heat input) w. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	476.7	7508	3579.9	9200	408	7
8	3b	Two combustion turbines (at max. heat input) w. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	319.4	7473	2386.6	6134	390	8
9	3b(1)	Two combustion turbines (at max. heat input) w. Evap. Cooling and Duct Burner Operation	SMMAAT	85	69.7	45.75	356.1	7769	2384.0	6151	383	9
10	3c	One combustion turbine (at max. heat input) w. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	155.7	7666	1193.3	3067	387	10
11	3c(1)	One combustion turbine (at max. heat input) w. Evap. Cooling and Duct Burner Operation	SMMAAT	85	69.7	45.75	202.2	8121	1190.7	3087	356	11
12	4a	Three combustion turbines (at min. heat input) w.o. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	345.9	7810	2701.8	7237	380	12
13	4b	Two combustion turbines (at min. heat input) w.o. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	229.5	7849	1801.2	4825	371	13
14	4b(1)	Two combustion turbines (at min. heat input) w.o. Evap. Cooling Operation w. portion of HRSG steam sent to ACC	SMMAAT	85	69.7	45.75	202.2	8907	1801.2	4825	371	14
15	4c	One combustion turbine (at min. heat input) w.o. Evap. Cooling Operation	SMMAAT	85	69.7	45.75	110.5	8150	900.6	2412.3	368	15
16	5	Three combustion turbines (at max. heat input) w.o. Evap. Cooling Operation (minimum winter site temperature of 1 hr. duration)	SMWAT	32	30.75	87.6	527.8	7490	3952.8	10065	411	16
17	6	Three combustion turbines (at max. heat input) w. Evap. Cooling Operation (maximum summer site temperature of 1 hr. duration)	SPSAT	110	67	7.31	460.1	7738	3560.1	9178	415	17

Information Sources Used for Developing Heat Balance Cases

Heat balances information was obtained inputting manufacturer design information for combustion turbines (CT), heat recovery steam generators (HRSG) and steam turbine (ST) into the GT Pro Heat Balance Software Program. The centerline of the air intake is assumed to be 30 ft. elevation. The site elevation is 7 ft.

The weather data used for the heat balances use Santa Ana (John Wayne Airport), CA Weather Data (Dry Bulb, Wet Bulb, Relative Humidity). The Santa Ana weather data was obtained from the following internet websites:

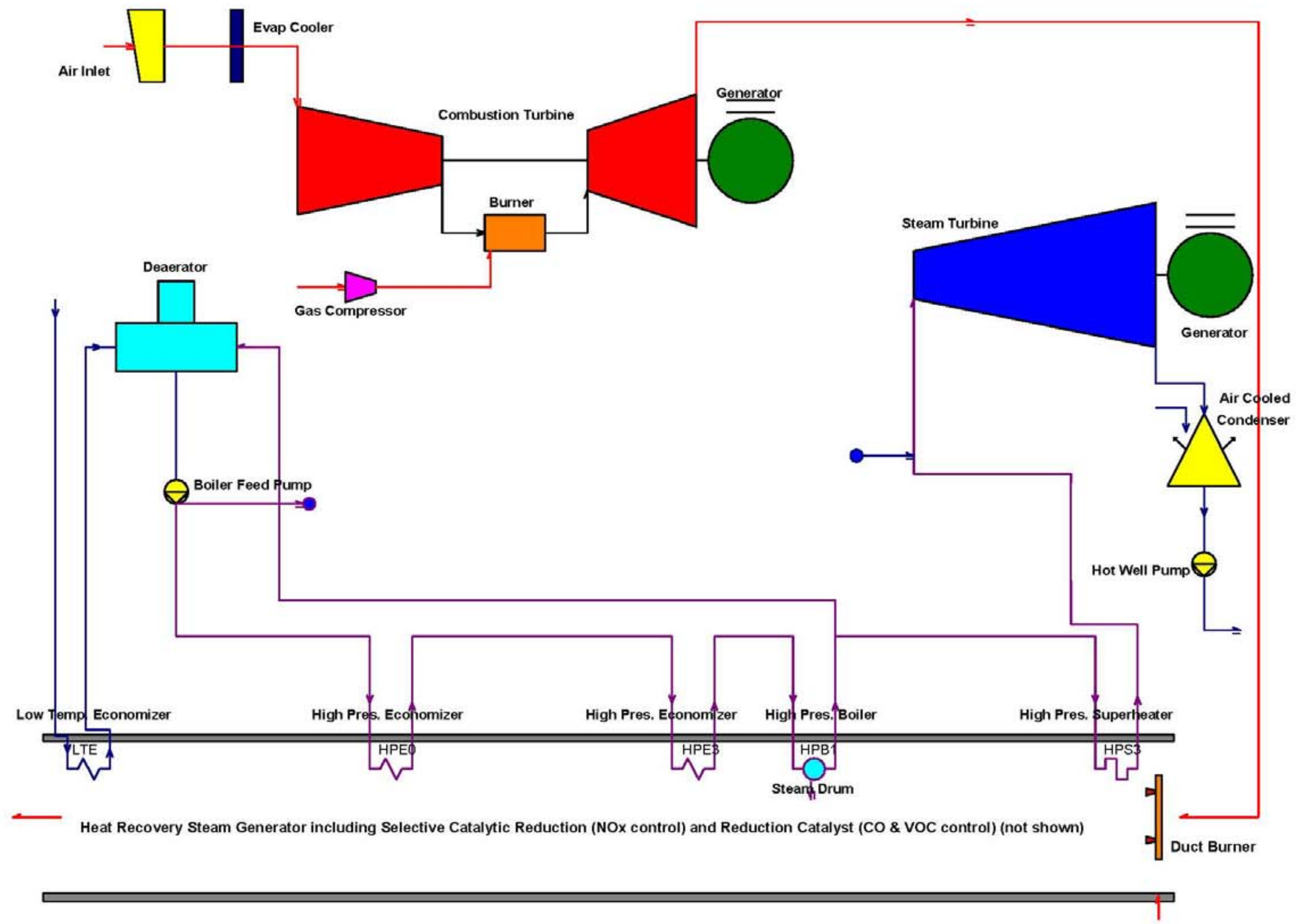
Average Dry Bulb	http://www1.ncdc.noaa.gov/pub/data/normals/1981-2010/products/station/USC00047888.normals.txt
Average Wet Bulb	http://www.wrcc.dri.edu/htmlfiles/westcomp.wb.html
Daily Max Dry Bulb	http://hurricane.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl
Daily Min Dry Bulb	http://hurricane.ncdc.noaa.gov/cgi-bin/climatenormals/climatenormals.pl
MCWB	http://web.utk.edu/~archinfo/EcoDesign/escurriculum/weather_data/reports/los_angeles_ca.pdf
30 Year Max Dry Bulb	http://weather-warehouse.com/WeatherHistory/PastWeatherData_SantaAnaFireStn_SantaAna_CA_July.html
30 Year Max Wet Bulb	http://web.utk.edu/~archinfo/EcoDesign/escurriculum/weather_data/reports/los_angeles_ca.pdf
30 Year Min Dry Bulb	http://weather-warehouse.com/WeatherHistory/PastWeatherData_SantaAnaFireStn_SantaAna_CA_December.html
30 Year Min Wet Bulb	http://web.utk.edu/~archinfo/EcoDesign/escurriculum/weather_data/reports/los_angeles_ca.pdf

Various analytical methods were used to determine the dry and wet bulb temperatures and relative humidity data for four temperature cases:

1. Site Peak Summer Ambient Temperature (SAAT) is 65.8 °F (Dry Bulb) and 56.8 °F (Wet Bulb) and relative humidity (RH) of 57%).
2. Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%).
3. The 30 year, one hour duration, Site Peak Summer Ambient Temperature (SPSAT) is 110 °F (Dry Bulb) and 67 °F (Wet Bulb) and relative humidity (RH) of 7.31%).
4. The 30 year, one hour duration, Site Minimum Winter Ambient Temperature (SMWAT) is 32 °F (Dry Bulb) and 30.75 °F (Wet Bulb) and relative humidity (RH) of 87.6%).

Legend for Typical Equipment Configuration for Huntington Beach Heat Balance Case

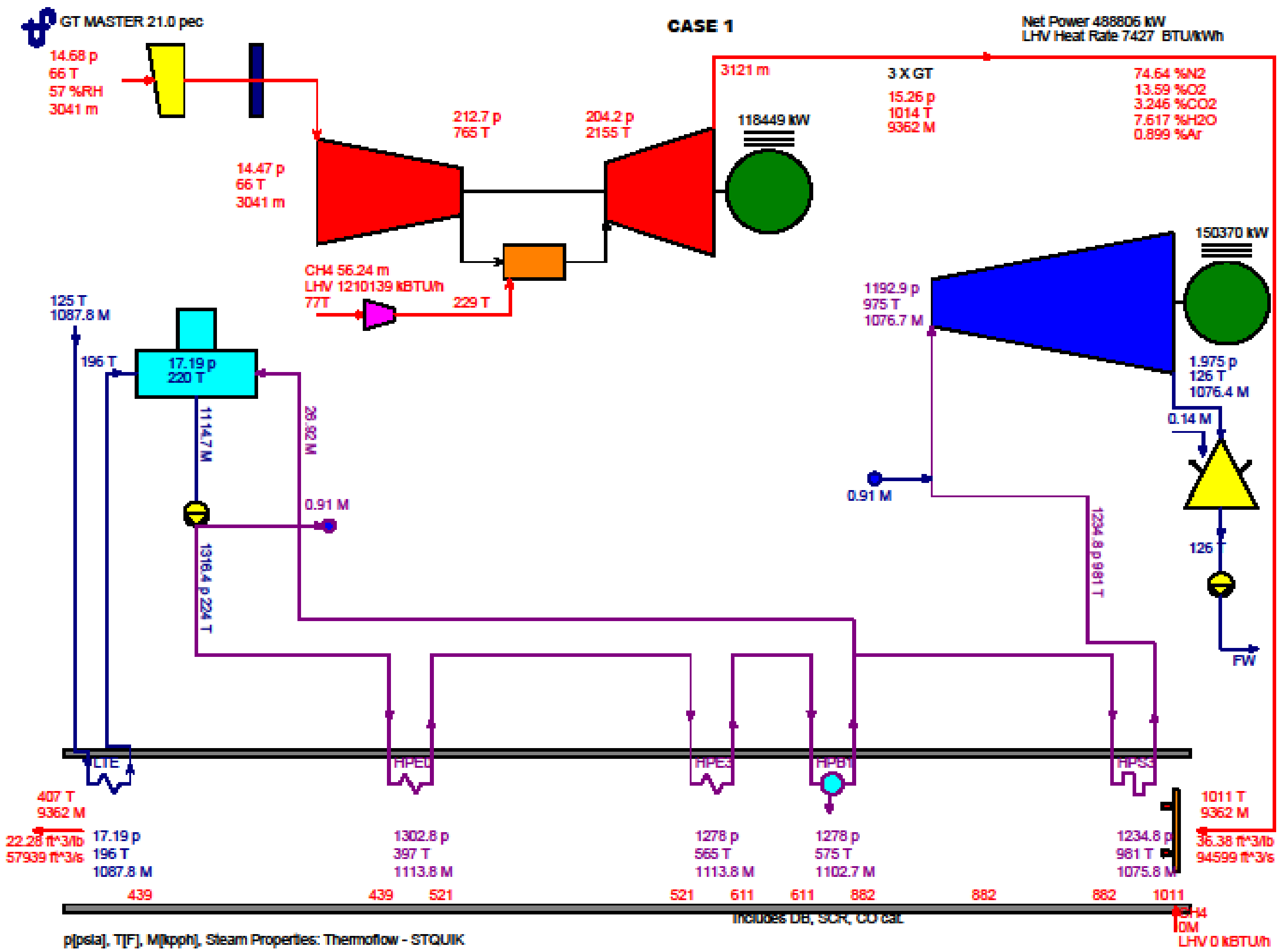
(If more than one combustion turbine is installed then the estimated operating information shown represents the sum of the number of combustion turbines modeled. Every combustion turbine represented is paired with its own HRSG)



Huntington Beach Energy Project
Heat Balance Legend

Case 1

Case 1 Heat Balance Number 1a Three Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

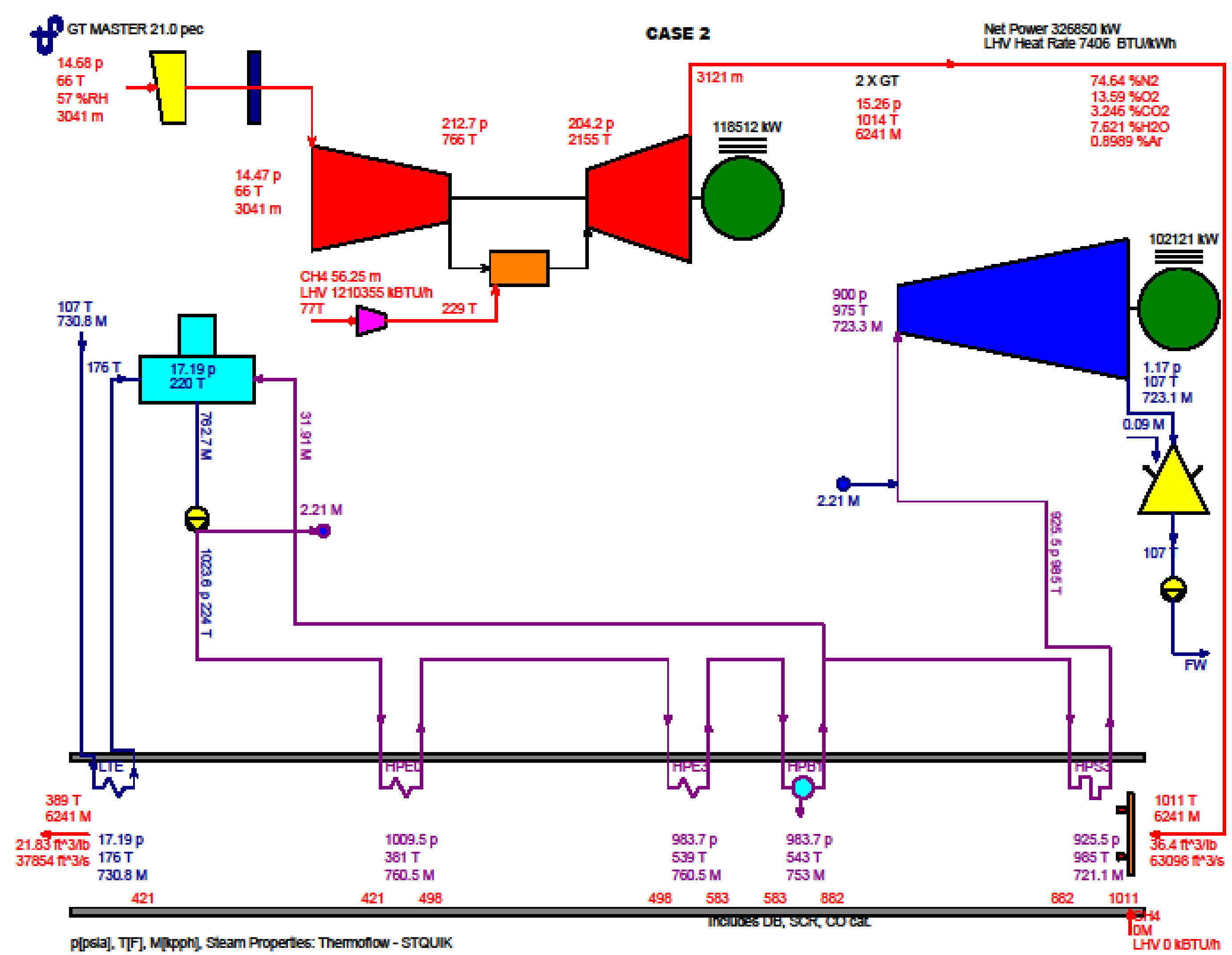


Case 1 Heat Balance Number 1a Three Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 2

Case 2 Heat Balance Number 1b   Two Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling

Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

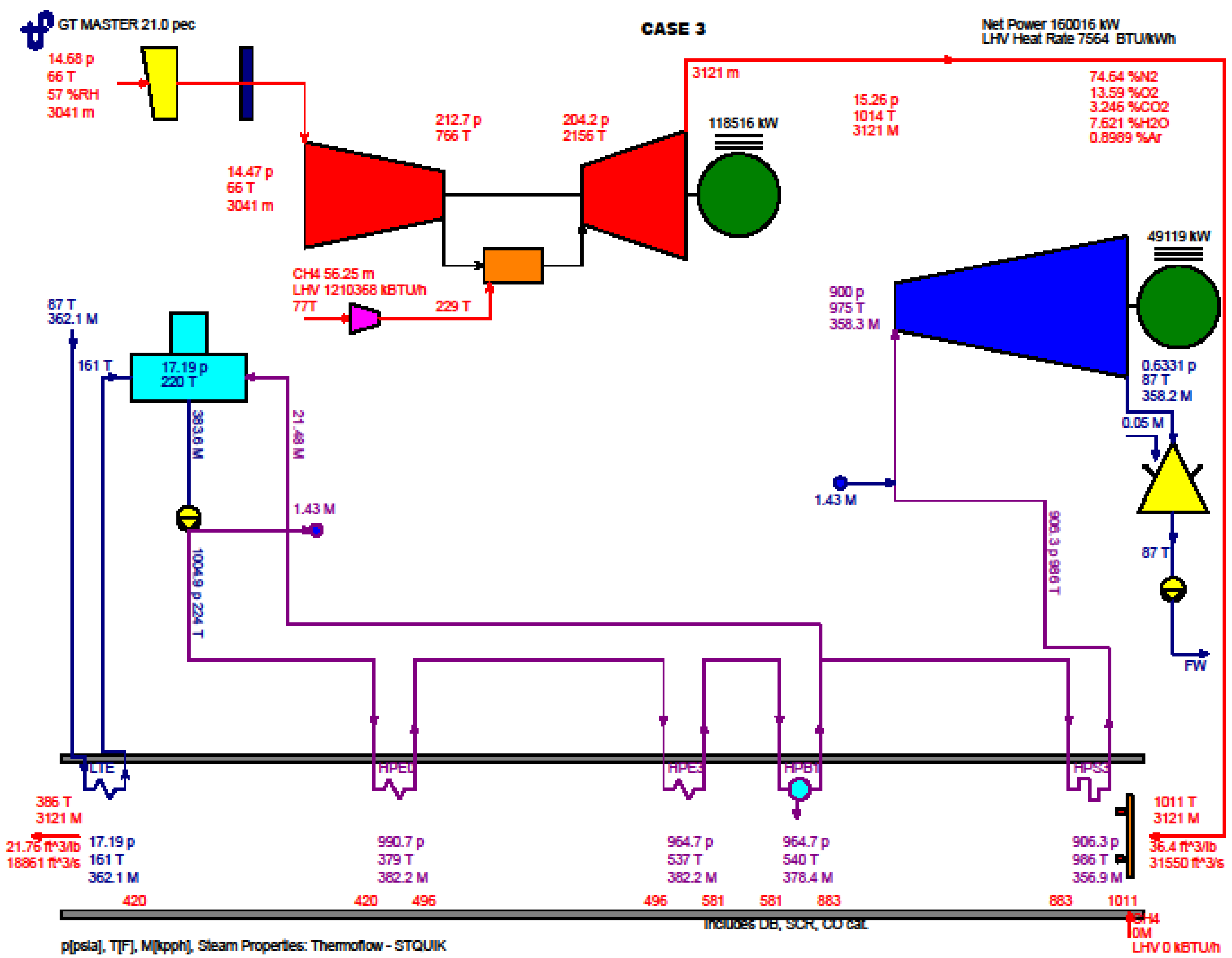


Case 2 Heat Balance Number 1b   Two Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 3

Case 3 Heat Balance Number 1c One Combustion Turbine Operating at Maximum Heat Input without Evaporative Cooling

Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

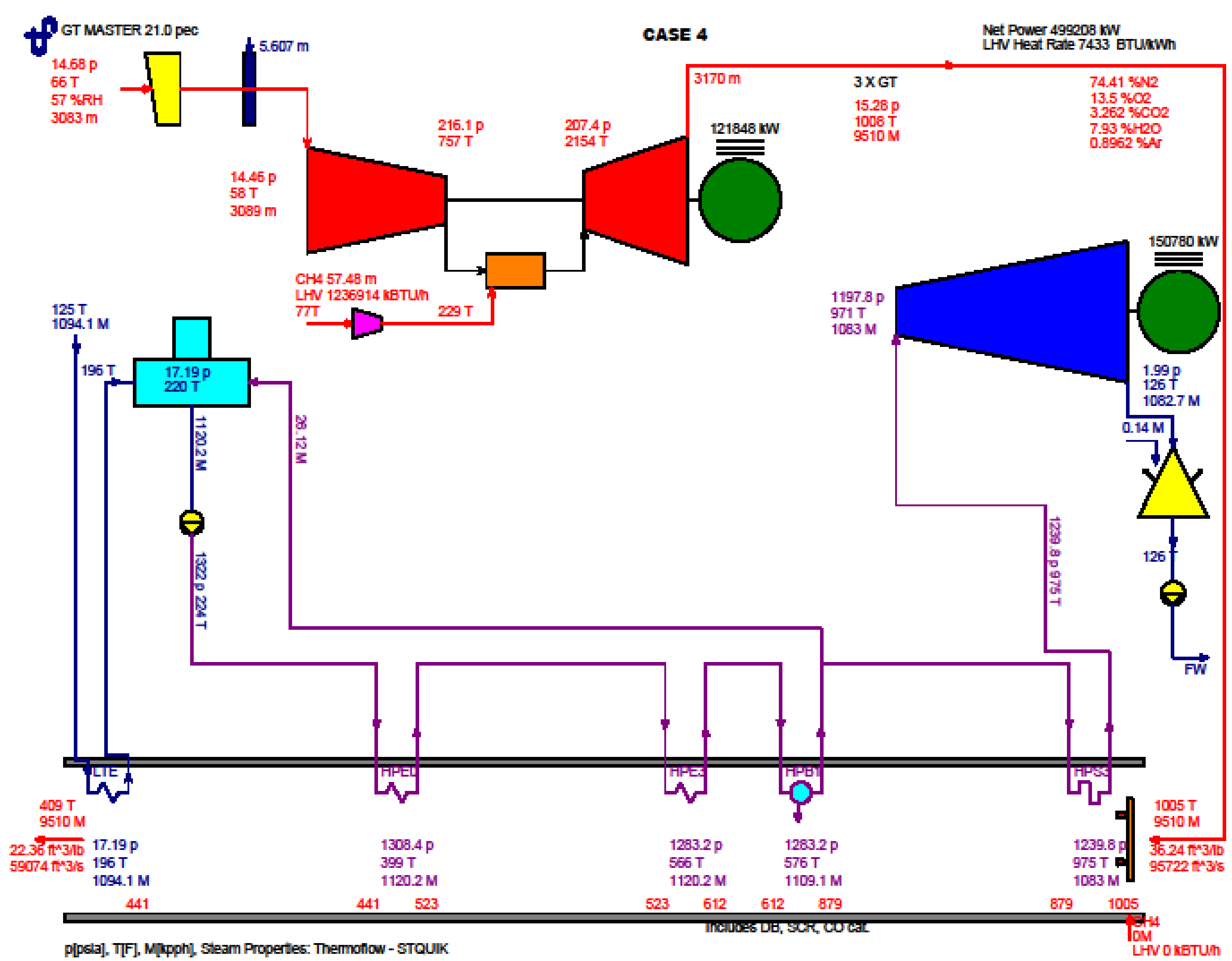


Case 3 Heat Balance Number 1c One Combustion Turbine Operating at Maximum Heat Input without Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 4

Case 4 Heat Balance Number 2a Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling

Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

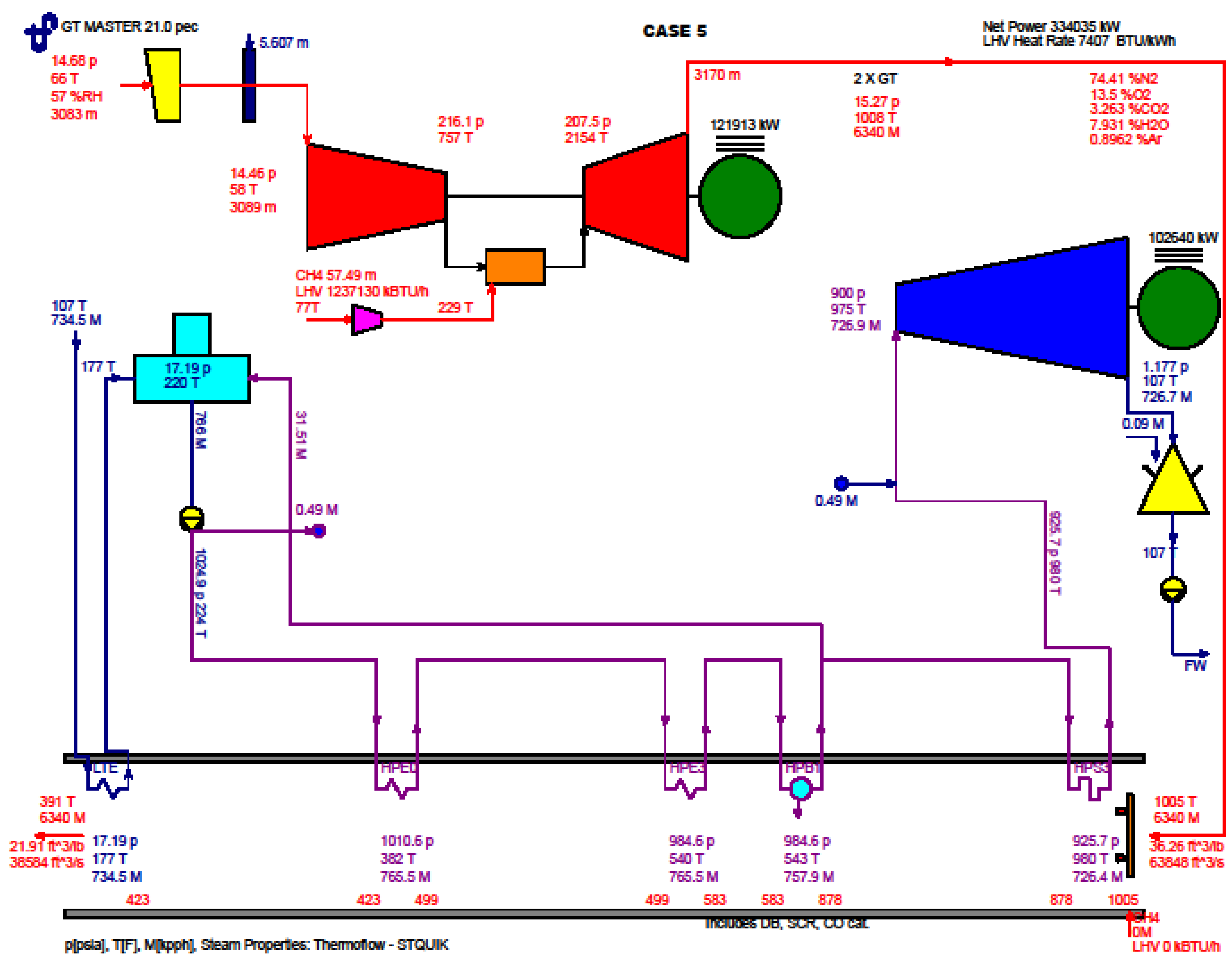


Case 4 Heat Balance Number 2a Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 5

Case 5 Heat Balance Number 2b Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling

Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

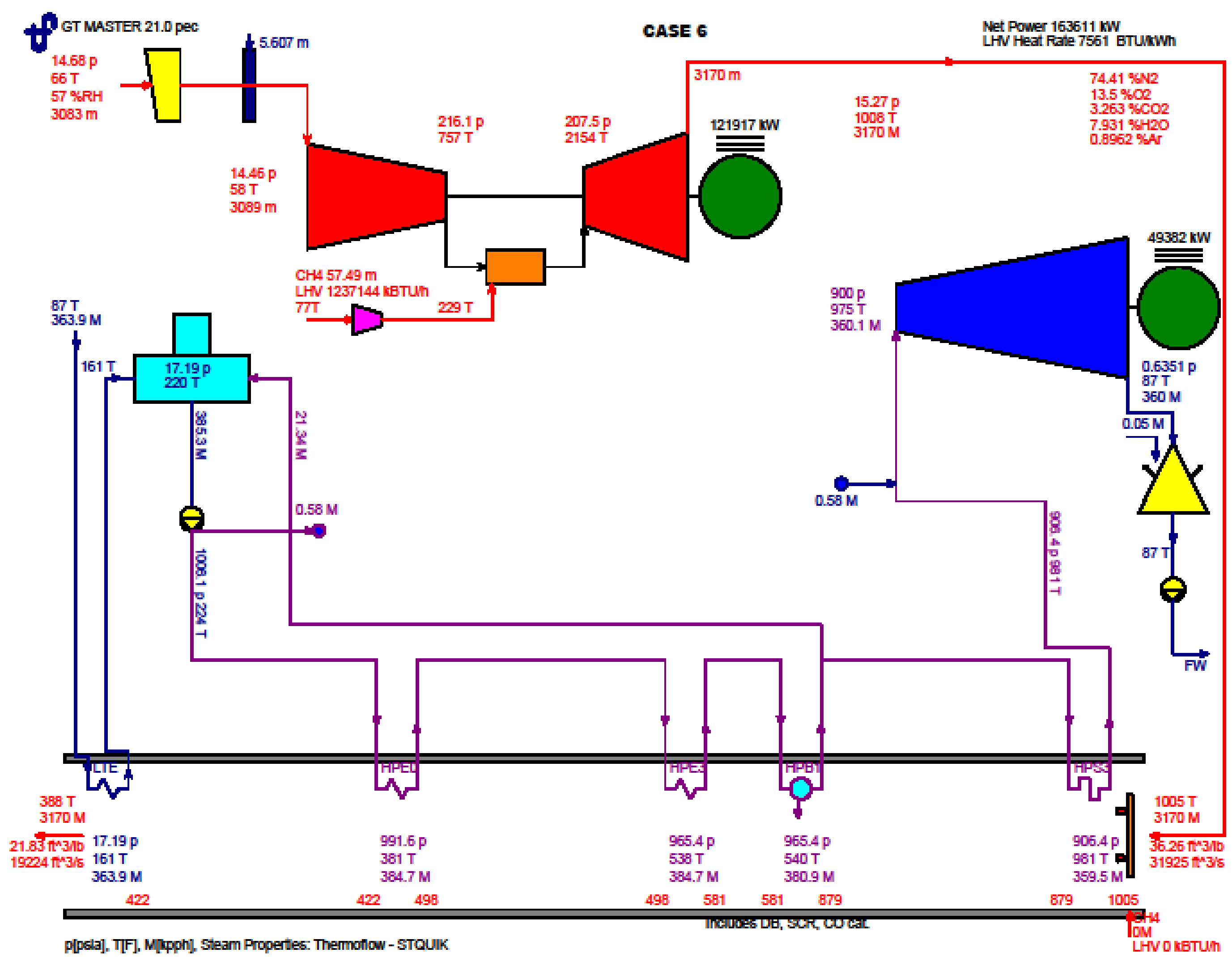


Case 5 Heat Balance Number 2b Two Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 6

Case 6 Heat Balance Number 2c One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling

Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

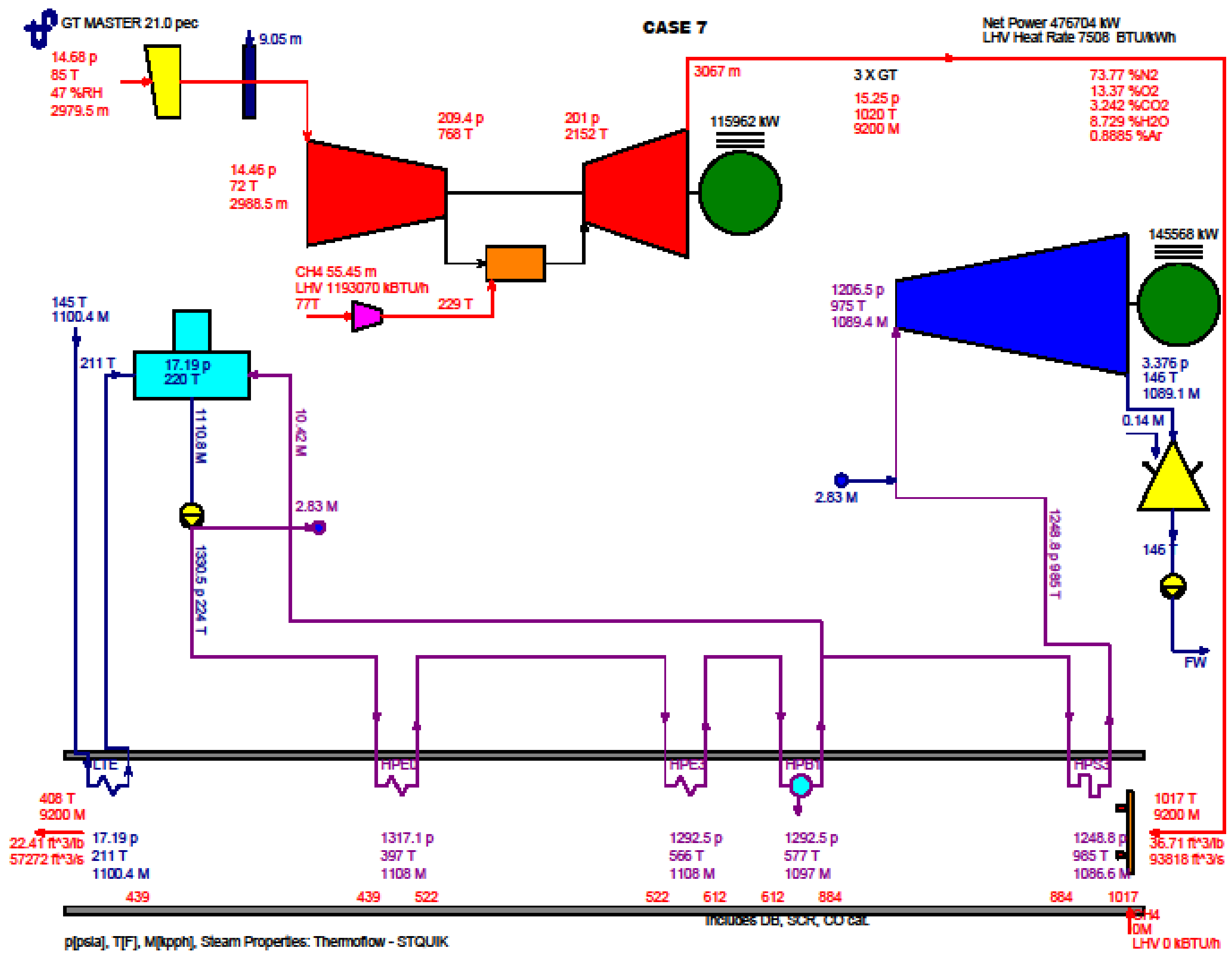


Case 6 Heat Balance Number 2c One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling
Site Average Annual Temperature (SAAT), Dry Bulb 65.8 F, Wet Bulb 56.8 F, Relative Humidity 57%

Case 7

Case 7 Heat Balance Number 3a Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

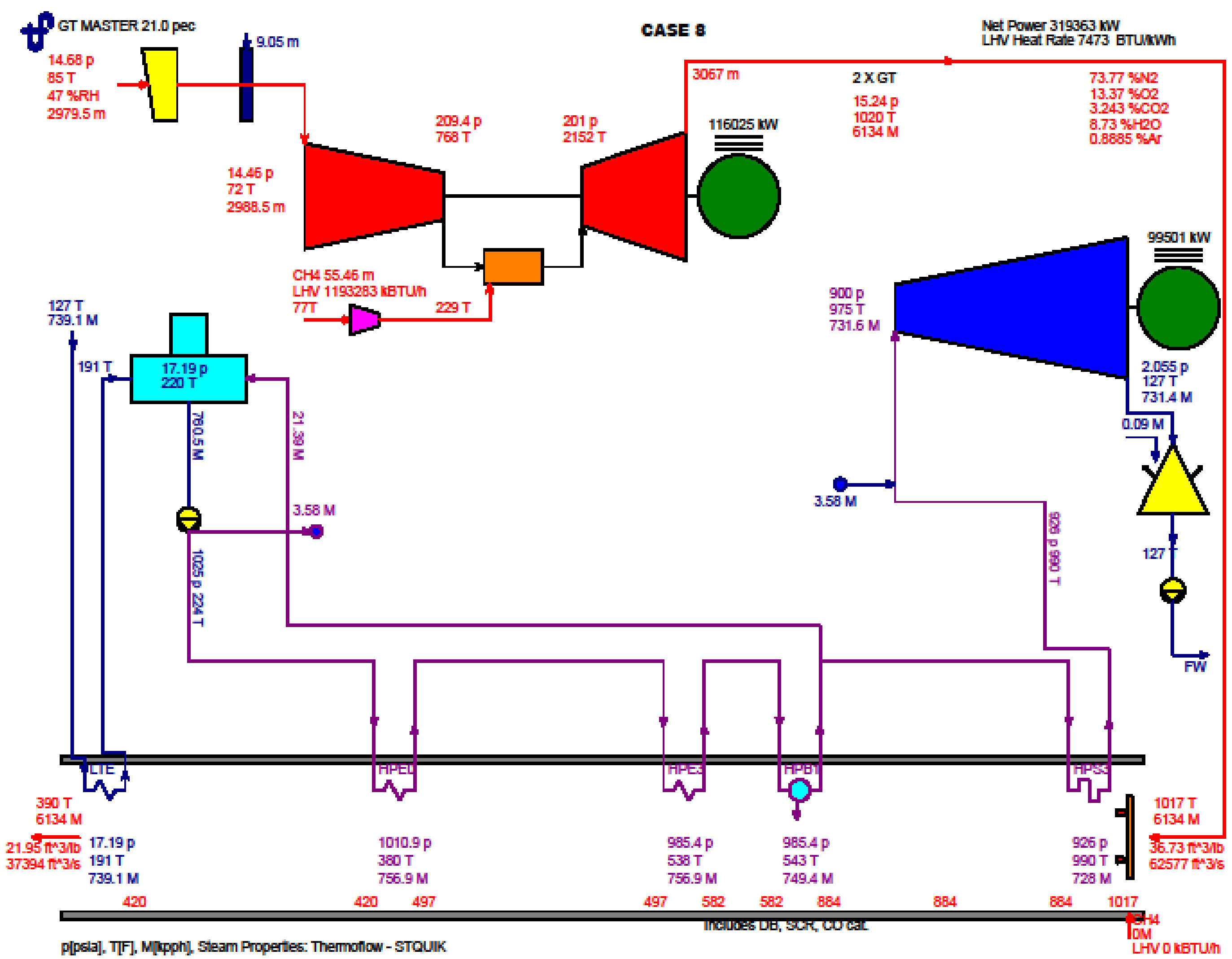


Case 7 Heat Balance Number 3a Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 8

Case 8 Heat Balance Number 3b Two Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

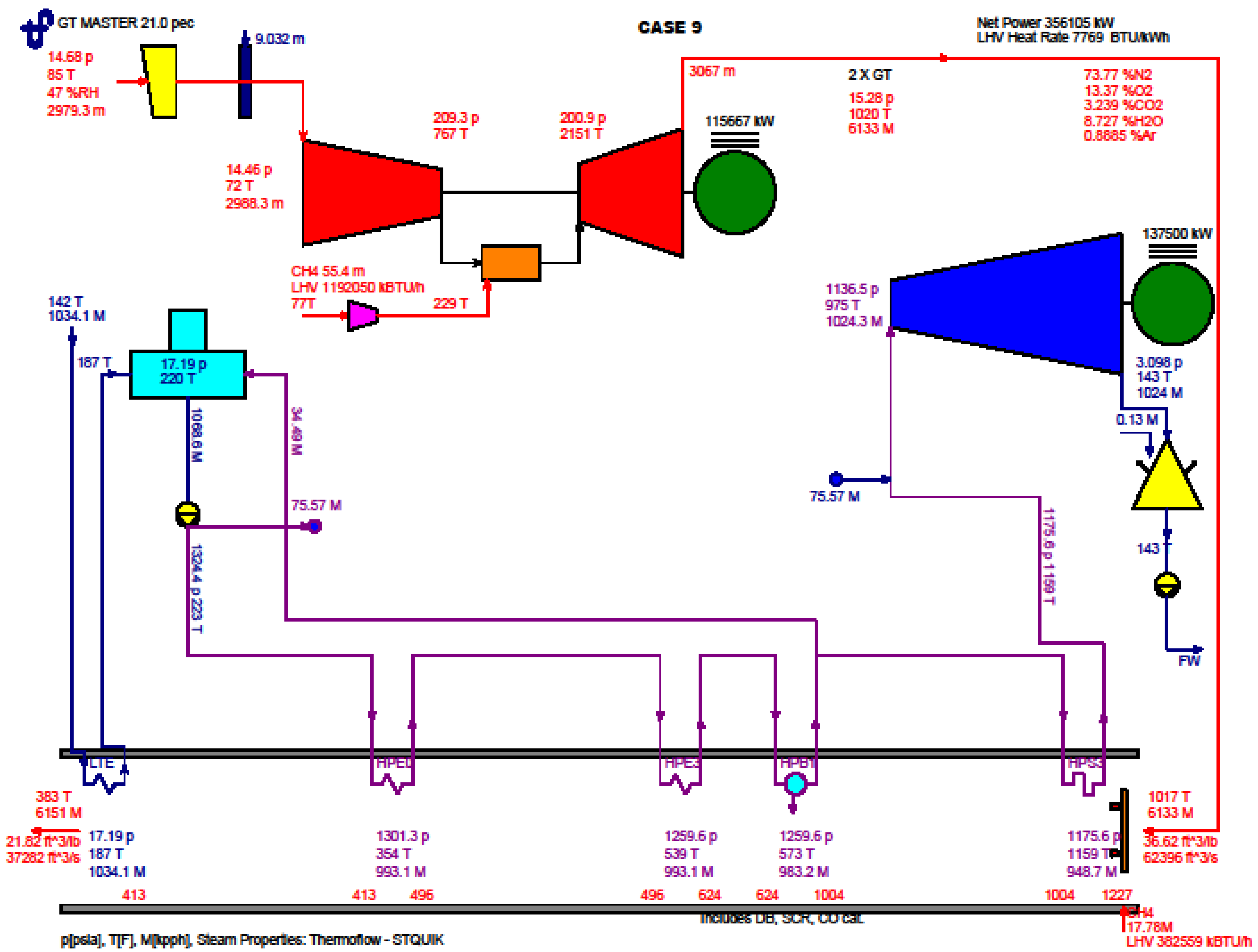


Case 8 Heat Balance Number 3b Two Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 9

Case 9 Heat Balance Number 3b(1)   Two Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling and Duct Burner

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

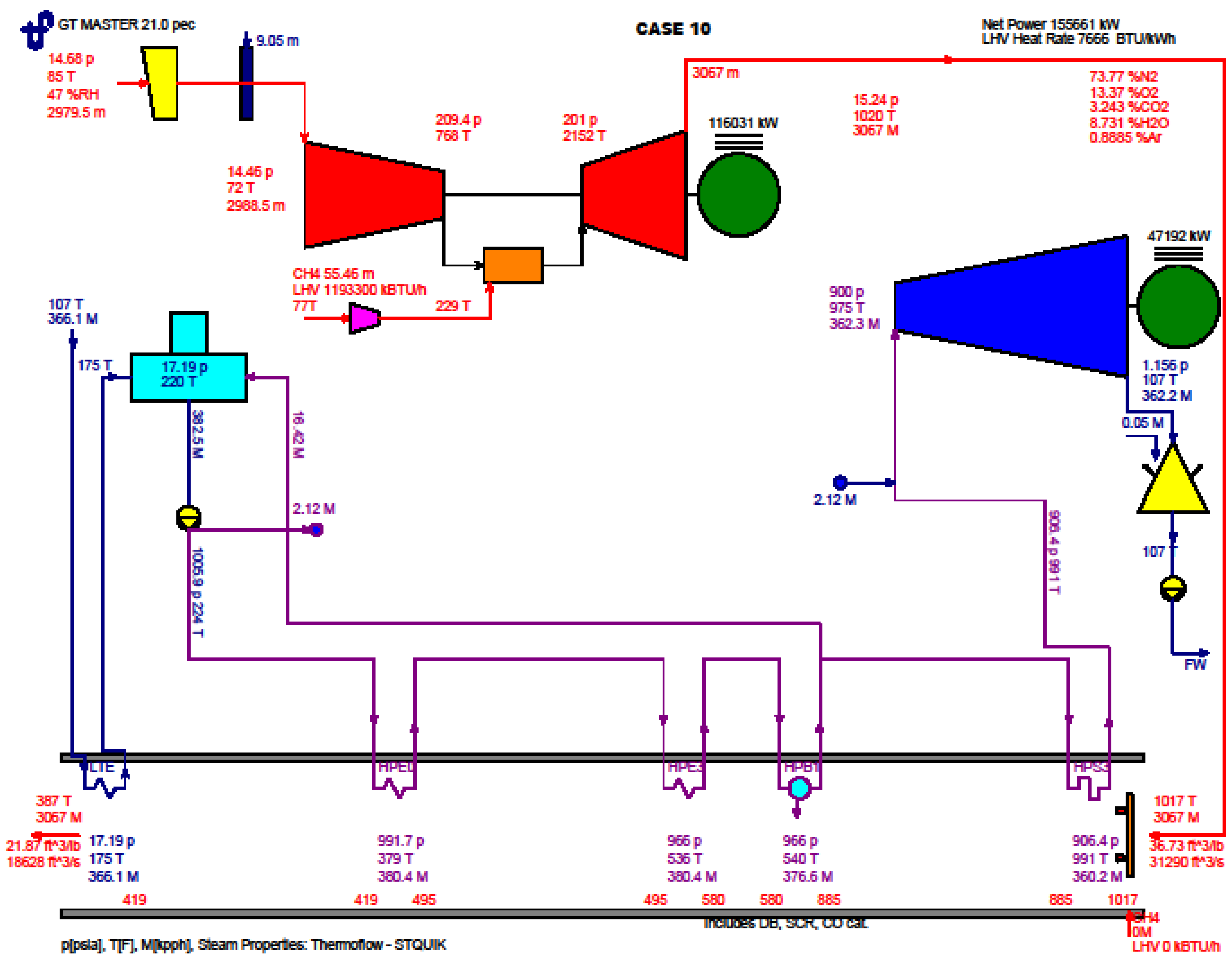


Case 9 Heat Balance Number 3b(1) Two Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling and Duct Burner
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 10

Case 10 Heat Balance Number 3c One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

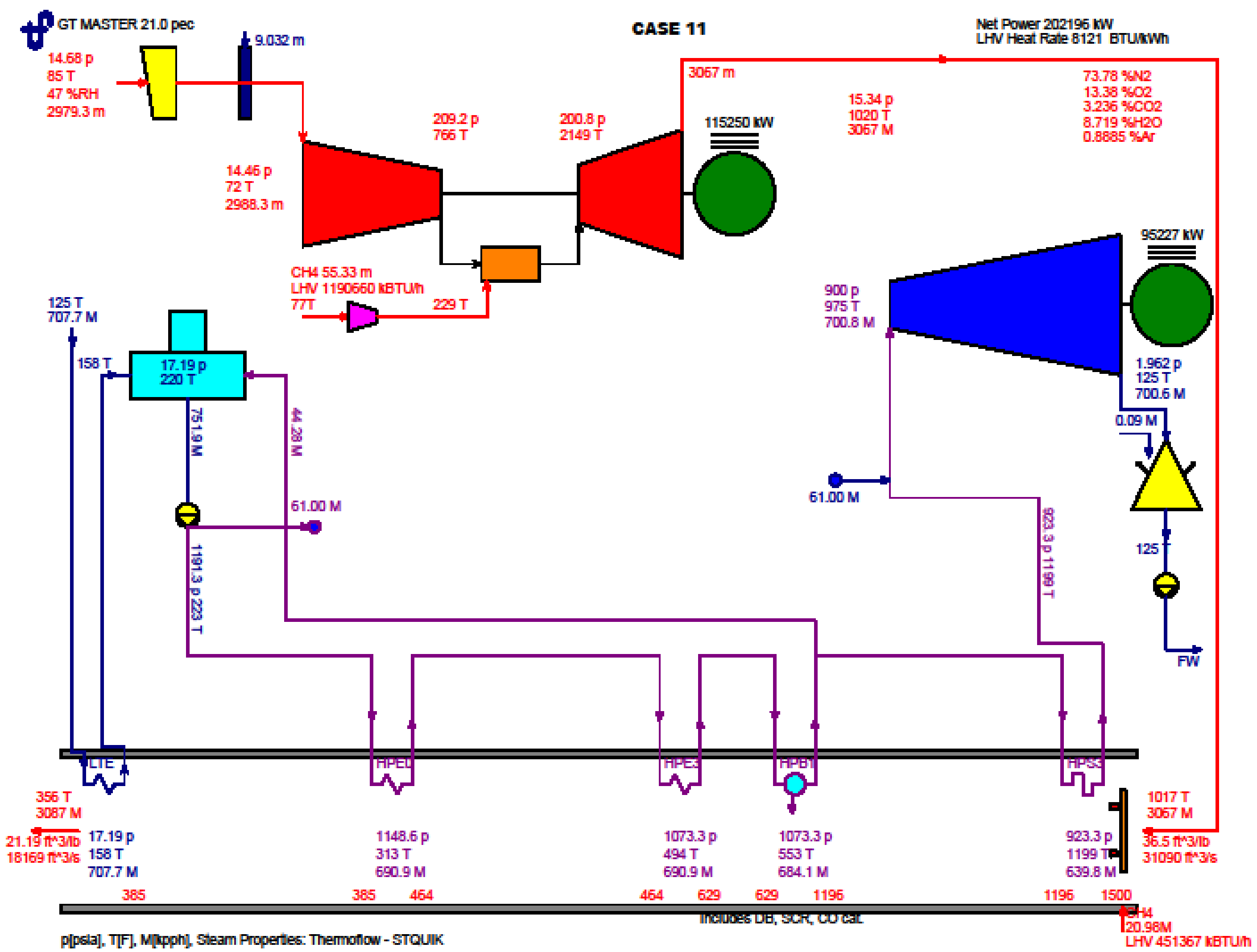


Case 10 Heat Balance Number 3c One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 11

Case 11 Heat Balance Number 3c(1) One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling and Duct Burning

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

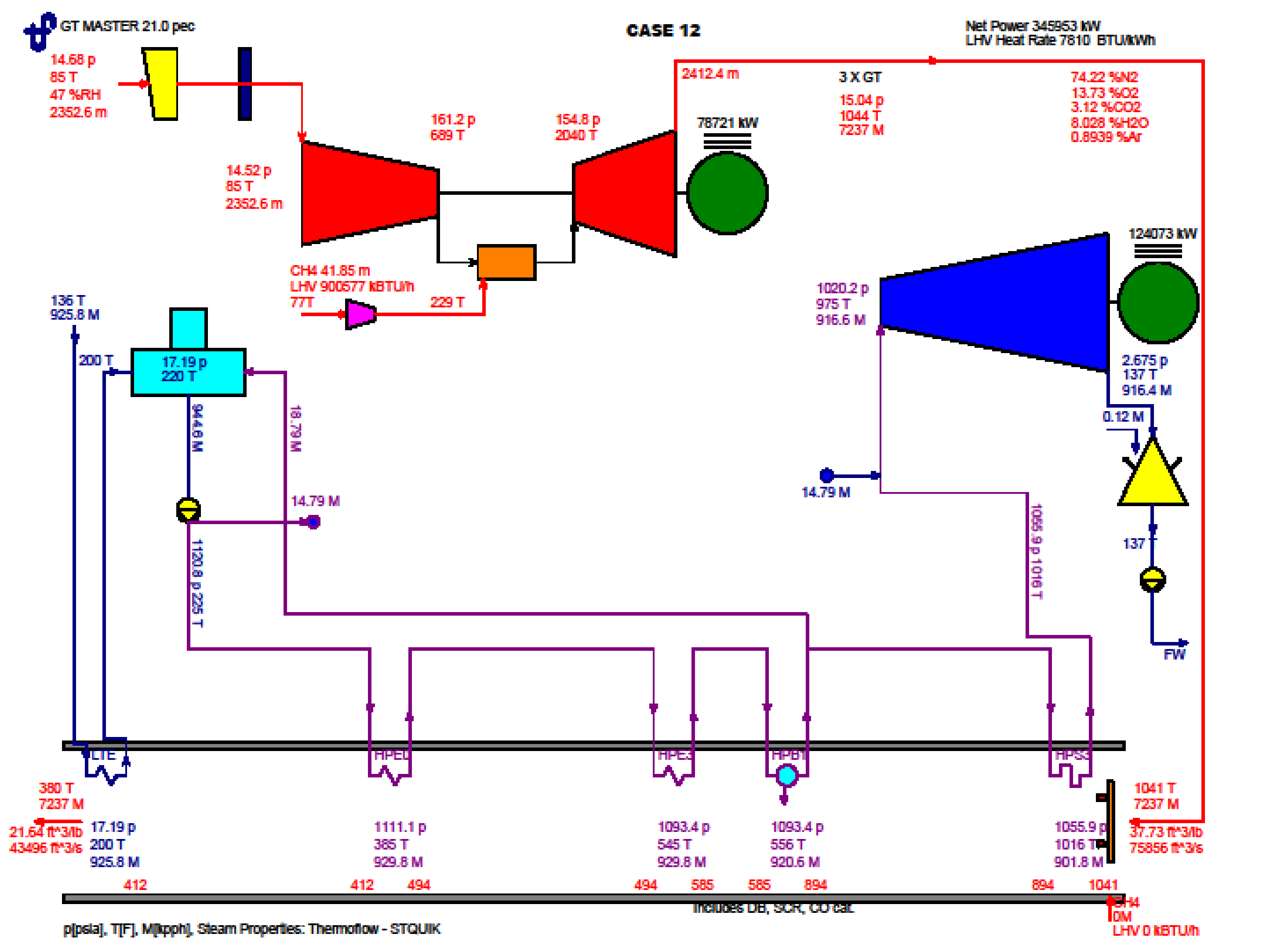


Case 11 Heat Balance Number 3c(1) One Combustion Turbine Operating at Maximum Heat Input with Evaporative Cooling and Duct Burning
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 12

Case 12 Heat Balance Number 4a Three Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

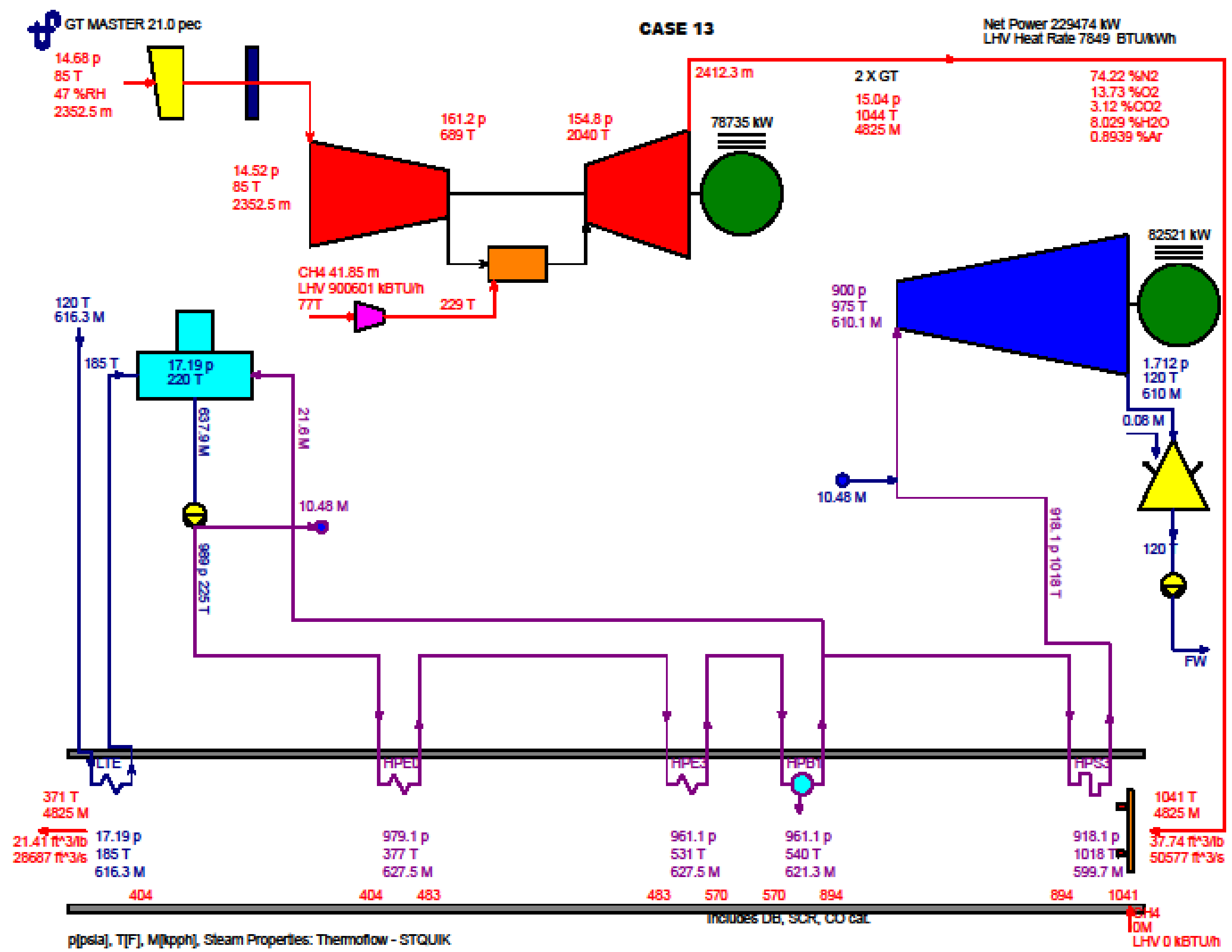


Case 12 Heat Balance Number 4a Three Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 13

Case 13 Heat Balance Number 4b   Two Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

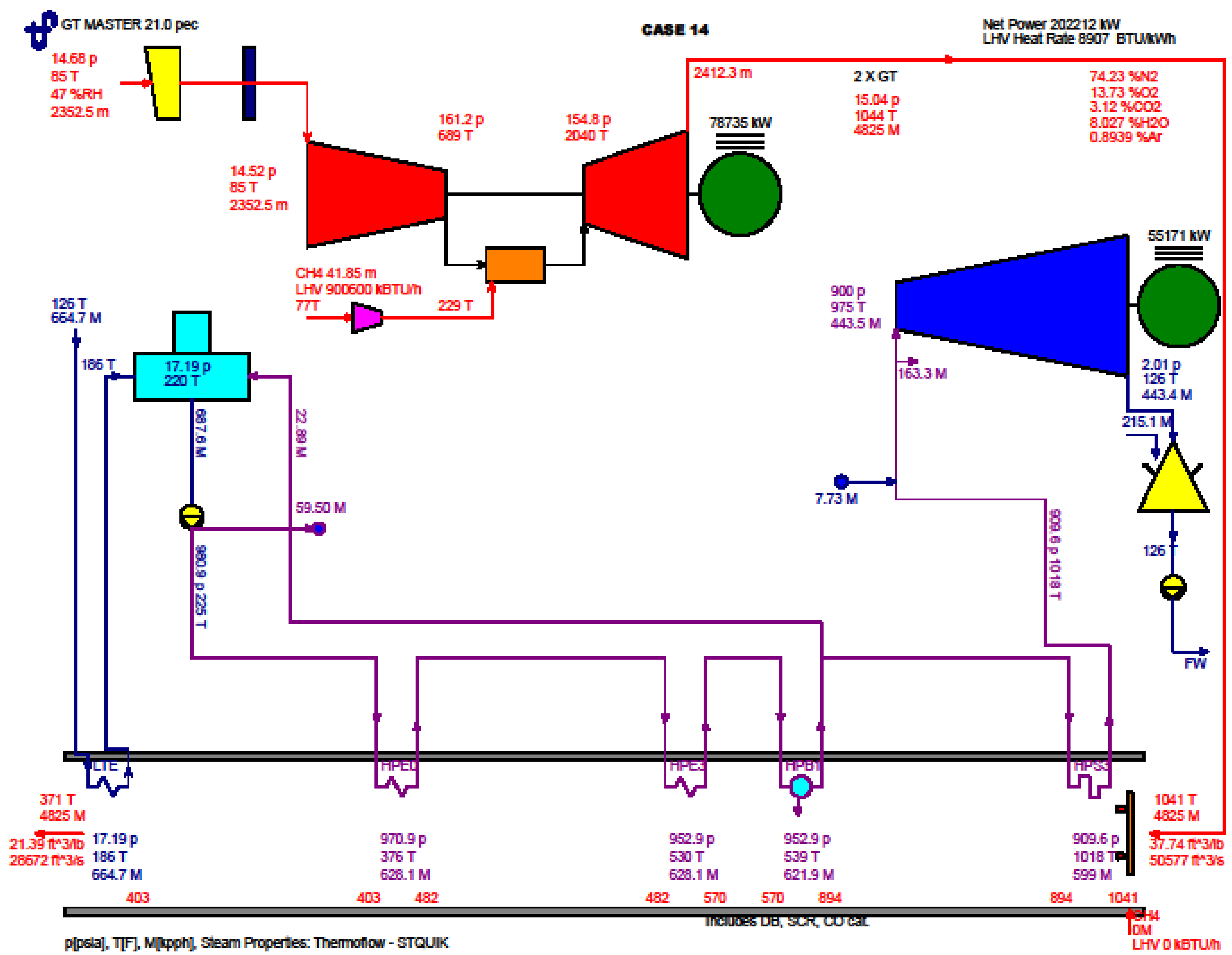


Case 13 Heat Balance Number 4b   Two Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 14

Case 14 Heat Balance Number 4b(1) Two Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling w. portion of HRSG steam sent to ACC

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

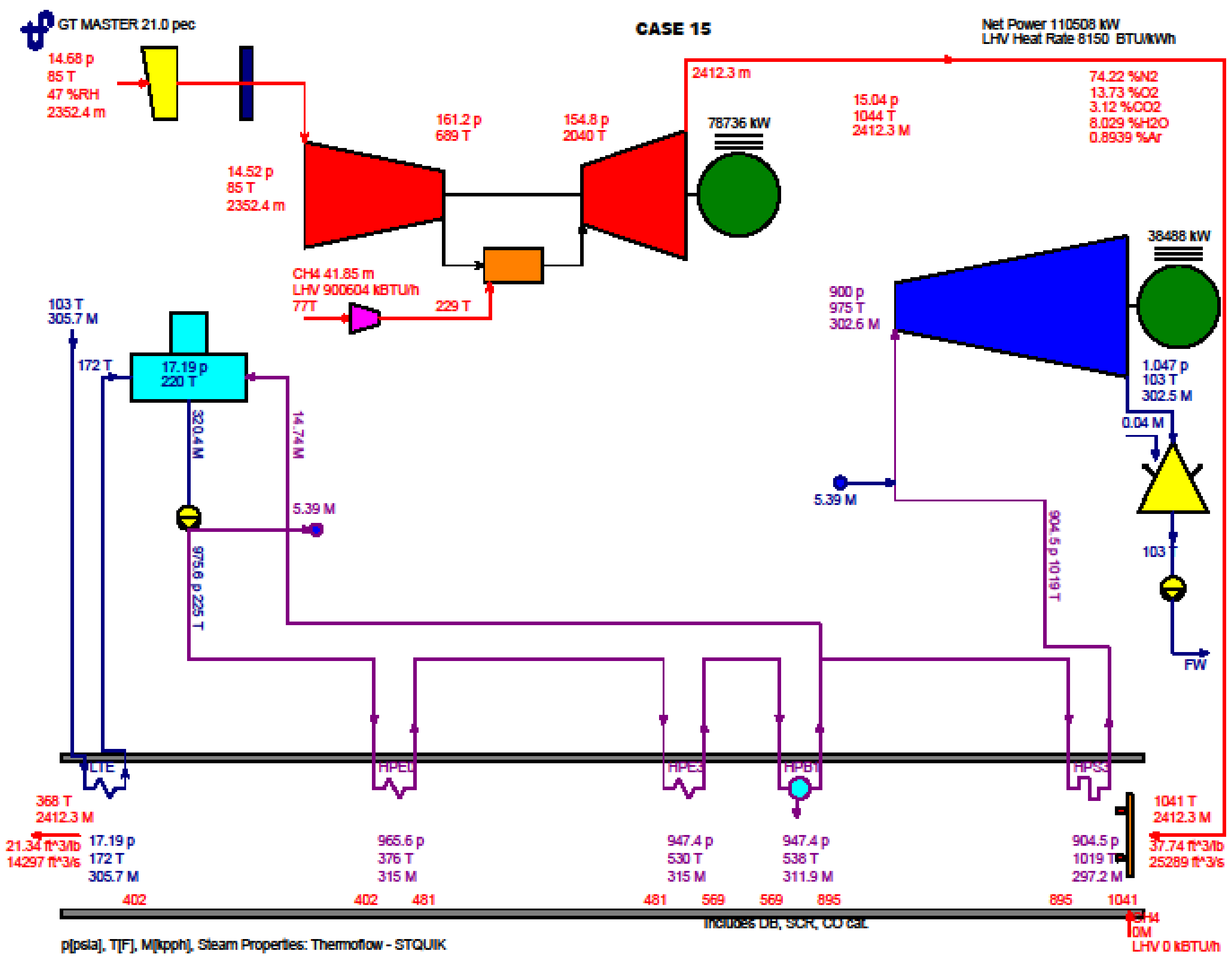


Case 14 Heat Balance Number 4b(1) Two Combustion Turbines Operating at Minimum Heat Input without Evaporative Cooling w. portion of HRSG steam sent to ACC
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 15

Case 15 Heat Balance Number 4c One Combustion Turbine Operating at Minimum Heat Input without Evaporative Cooling

Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

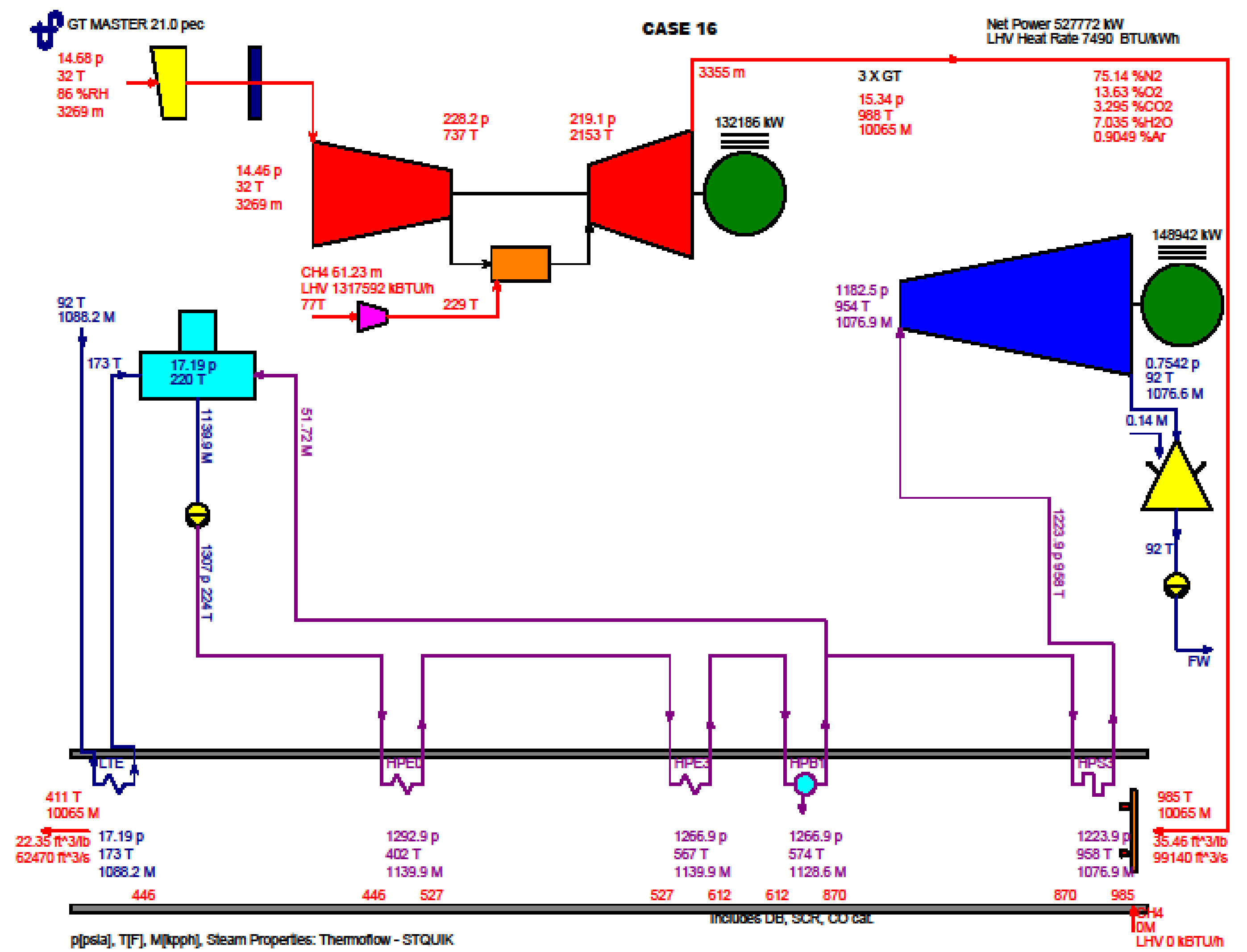


Case 15 Heat Balance Number 4c One Combustion Turbine Operating at Minimum Heat Input without Evaporative Cooling
Site Monthly Maximum Average Ambient Temperature (SMMAAT) is 85 °F (Dry Bulb) and 69.7 °F (Wet Bulb) and relative humidity (RH) of 45.75%)

Case 16

Case 16 Heat Balance Number 5 Three Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling

Site Minimum Winter Ambient Temperature (SMWAT) is 32 °F (Dry Bulb) and 30.75 °F (Wet Bulb) and relative humidity (RH) of 87.6%)

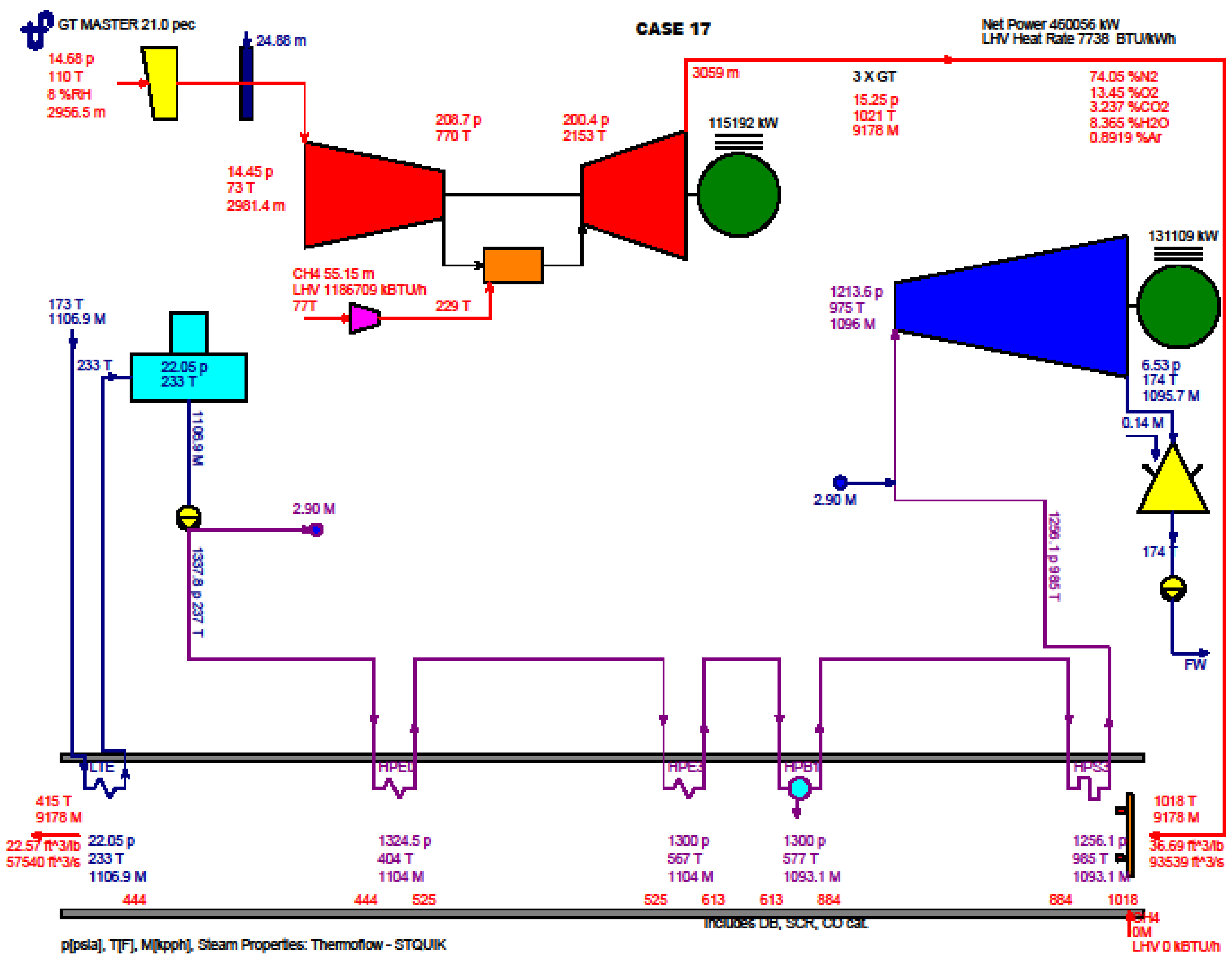


Case 16 Heat Balance Number 5 Three Combustion Turbines Operating at Maximum Heat Input without Evaporative Cooling
Site Minimum Winter Ambient Temperature (SMWAT) is 32 °F (Dry Bulb) and 30.75 °F (Wet Bulb) and relative humidity (RH) of 87.6%)

Case 17

Case 17 Heat Balance Number 6 Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling

Site Peak Summer Ambient Temperature (SPSAT) is 110 °F (Dry Bulb) and 67 °F (Wet Bulb) and relative humidity (RH) of 7.31%)



Case 17 Heat Balance Number 6 Three Combustion Turbines Operating at Maximum Heat Input with Evaporative Cooling
Site Peak Summer Ambient Temperature (SPSAT) is 110 °F (Dry Bulb) and 67 °F (Wet Bulb) and relative humidity (RH) of 7.31%)

[redacted]

[redacted]

[redacted]

[redacted]

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Wednesday, December 19, 2012 12:44 PM
To: 'Chris Perri'
Cc: 'Robert.Mason@CH2M.com'; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; 'Miller, Felicia@Energy'; 'John Yee'
Subject: RE: Heat Rate Tables

Chris,

As promised, here is the additional information on GHG calculations and heat rates including heat rates with duct burning at the 71o average temperature case. We have revised our December 7, 2012 response to Data Request DR7 to clarify how the heat rates and pounds of CO2 per megawatt-hour were calculated. Attached are revised Tables DR7-1R and DR7-3R.

Revised Table DR7-1R presents the same information included in the December 7th submittal, but includes clarifying notes to show where duct burners are being used during each state of power generation. As I already mentioned, duct burners are being used during turbine start ups to close the electrical production gap when the second and third turbine of each power block is started. AES would not operate all three turbines per power block with duct burners firing (nor is this thermally feasible due to the physical rating of the steam turbines). In addition to denoting duct burner usage, we have included a note on the 1 power block table that explains that the states represent the number of turbines in operation (State 1 is a 1 on 1 configuration, State 2 is a 2 on 1 configuration, etc.).

Revised Table DR7-3R includes additional notes explaining how the weighted annual average heat rate (with starts and stops but no degradation) and the CO2 efficiency were calculated. Briefly, we calculated the weighted annual average heat rate by multiplying the average heat rate (including duct burner operation) for each State by the number of hours for that State plus the start up and shutdown heat rates (again multiplied by the number of assumed operating hours for each). This product was divided by the total number of operating hours. The average heat rate of each State was used to represent a realistic heat rate for each State. It is unlikely that HBEP will be called on to operate a significant number of hours at a 70% turbine load rate. Likewise, since the duct burners are not intended to be used as peaking capacity, AES does not expect to operate in the duct fired mode for a significant number of hours. Therefore, the average heat rate for each State was used as a conservative assumption to approximate how HBEP is expected to operate. Below is the annual average heat rate calculation:

(State 1 - 250 hrs * 7564 btu/kWh + State 2 - 3200 hrs * 7353 btu/kWh + State 3 - 1460 hrs * 7350 btu/kWh + Start Up - 93.6 hrs * 18267 btu/kWh + Stop - 98.8 hrs * 16520 btu/kWh)/(4910 hrs + 93.6 hrs + 98.8 hrs) = 7740 btu/kWh Gross

The CO2 efficiency was calculated by assuming an 8% degradation on the plant gross heat rate (7740 btu/kWh gross / (1 – 0.08)) = 8413 btu/kWh gross) and using the natural gas CO2 emission factor of 53.02 kg CO2/MMBtu-HHV. Below is the calculation:

(8413 btu/kWh * 1000 kWh/MWh * 1.1 HHV/LHV * 1*10-6 MMBtu/Btu * 53.02 kg CO2/MMBtu-HHV * 2.205 lb/kg = 1082 lb CO2/MMWH)

Stephen

From: Stephen O'Kane
Sent: Wednesday, December 19, 2012 11:36 AM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee
Subject: RE: Heat Rate Tables

Chris,

Here are some more heat rate data for various temperature and operating cases, including a summer temperature one-on-one duct firing case and a two-on-one duct firing case. We will also send over our assumptions and calculation method for calculating annual average CO2/MWh, which includes the contribution of duct firing under the assumed annual operating condition. As discussed, there are different assumptions that go into the different calculations for annual PM2.5 emissions; maximum month daily emissions; and predicted CO2/MWhr emissions. In each case we have made conservative assumptions to calculate the different regulatory requirements. One of the biggest differences our CCGT application will have compared to traditional supplemental fired CCGTs is how the duct burners are employed. The duct burners in our case are for ramp speed and not for power augmentation. It is not expected that the units would be parked at part load with duct firing and in the 3-on-1 case; we are physically constrained by the steam cycle and cannot duct fire with the three turbines at max load.

I hope this information helps. Additional information on our GHG calculations will follow shortly.

Stephen O'Kane

From: Chris Perri [mailto:CPerri@aqmd.gov]
Sent: Tuesday, December 18, 2012 2:29 PM
To: Stephen O'Kane
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy; John Yee
Subject: Heat Rate Tables

Stephen,

I'm just now trying to complete my heat rate tables for the 2 on 1 and 1 on 1 cases. I'm using the information you provided in a previous email, however, I'm not coming up with the same heat rates. For the 2 on 1 case, I've tried to break it down on a per turbine basis (I also assumed that the net output is 96.6% of the gross output). For both cases, I assumed that HHV/LHV = 1.13. Could you look at these tables and tell me if I've misinterpreted the data you provided? Thanks.

2-on-1 Operation

	85 F – 46% RH	66 F – 58% RH

	(Evaporative Cooling On)	(Evaporative Cooling On)
Gas Turbine Heat Input, mmbtu/h HHV	1,354	1,403
Total Heat Input, mmbtu/h HHV (w/duct fire)	1,861	1,910
Gas Turbine Gross Output, kW	115,962	121,840
Steam Turbine Gross Output, kW	49,751	51,320
Total Gross Power Output, kW	165,713	173,160
Net Power Output, Kw	160,078	167,273
Net Plant Heat Rate, btu/kWh, LHV	10,288	10,104
Net Plant Heat Rate, btu/kWh, HHV	11,626	11,418

1-on-1 Operation

	85 F – 46% RH (Evaporative Cooling On)	66 F – 58% RH (Evaporative Cooling On)
Gas Turbine Heat Input, mmbtu/h HHV	1,354	1,403
Total Heat Input, mmbtu/h HHV (w/duct fire)	1,861	1,910
Gas Turbine Gross Output, kW	115,962	121,840
Steam Turbine Gross Output, kW	49,382	47,192
Total Gross Power Output, kW	171,222	163,152
Net Power Output, Kw	163,611	155,661
Net Plant Heat Rate, btu/kWh, LHV	10,066	10,858
Net Plant Heat Rate, btu/kWh, HHV	11,375	12,270

From: Stephen O'Kane [mailto:stephen.okane@AES.com]
Sent: Thursday, October 25, 2012 4:40 PM
To: Chris Perri
Cc: Robert.Mason@CH2M.com; 'Jerry.Salamy@CH2M.com'; McKinsey, John A.; Foster, Melissa A.; Miller, Felicia@Energy
Subject: RE: HBEP emission rates and modeling results

Chris,

Here's the data I can provide. If you really need the additional performance data at the other temperatures I will have to get our consultants to run some additional heat balance models. Please let me know as this is an extra expenditure and additional time to execute.

With these two temperature cases you can see the performance of the CCGT in both 1-on-1 and 2-on-1 modes. Additional data would merely show the same relative difference compared to the 3-on-1 case for different operating temperatures and humidities. Note the highlighted numbers. Our CCGT design actually provides the best performance on a heat rate basis (and consequently CO2e per MW) in the 2-on-1 case. Which is a big part of the design objective. Instead of the normal heat rate curve of a CCGT that deteriorates as output or load is decreased, this design will maintain a very constant heat rate across a wide range of output, and be able to ramp up and down output very quickly. Thus we achieve approximately 800-1,000 BTU/kwh better heat rate than a simple cycle LMS 100 and still provide the fast ramp and quick start support.

	32 F – 87% RH (Evaporative Cooling Off, Case 2)	ISO 59 F- 60% RH (Evaporative Cooling Off)	66 F – 58% RH (Evaporative Cooling On, Case 7)	85 F - 45.75% RH (Evaporative Cooling On)	110 F-8% RH (Evaporative Cooling On, Case 12)
Gas Turbine Heat Input, mmbtu/h HHV[1]	1,498	1,388	1,403	1,354	1,350
Total Heat Input, mmbtu/h HHV (w/duct fire)[2]	2,005	1,895	1,910	1,861	1,857
Gas Turbine Gross Output, kW[3]	132,256	121,435	121,840	115,962	115,264
Steam Turbine Gross Output, kW[3]	49,579	51,865	50,192	48,523	43,632
Total Gross Power Output, kW[3]	181,835	173,300	172,032	164,485	158,896
Total Net Power Output, Kw[3]	175,925	167,583	166,328	158,901	153,352
Net Plant Heat Rate, btu/kWh, LHV	7,558	7,354	7,487	7,508	7,814
Net Plant Heat Rate, btu/kWh, HHV	8,516	8,285	8,435	8,459	8,803
Steam Turbine Gross Output, kW (2-on-1)			102,640	99,501	
Total Gross Power Output, kW (2-on-1)			346,320	331,425	
Total Net Power Output, Kw (2-on-1)			334,035	319,363	
Net Plant Heat Rate, btu/kWh, LHV (2-on-1)			7,337	7,408	
Net Plant Heat Rate, btu/kWh, HHV (2-on-1)			8,400	8,483	
Steam Turbine Gross Output, kW (1-on-1)			49,382	47,192	
Total Gross Power Output, kW (1-on-1)			171,222	163,154	
Total Net Power Output, Kw (1-on-1)			163,611	155,661	
Net Plant Heat Rate, btu/kWh, LHV (1-on-1)			7,489	7,600	
Net Plant Heat Rate, btu/kWh, HHV (1-on-1)			8,575	8,702	

Notes:

1. Cases 110F, 32F and 66F heat input taken directly from M501DA Gas Turbine Expected Performance and Emissions Provided by MPSA and included in Table 5.1B.2 of *HBEP_Appendix 5.1B_Ops Emissions Calcs.pdf.* ISO 59F Case Heat input taken from GT PRO model.

2. Total Heat Input per gas turbine with duct firing can only be achieved while operating in a 1-on-1 or 2-on-1 mode. The steam cycle is sized suc the maximum heat input into the steam cycle is reached in a 3-on-1 mode without duct firing.

3. All output is provided on a per turbine basis assuming a 3-on-1 operating mode. To calculate total output for the entire power block these value must be multiplied by 3

Stephen

Table DR7-1R HBEP Heat Rate Estimate

HBEP Expected Annual Average Operating Profile at an Ambient Air Temperature of 71 F[1]																	Expected Annual Hours
Blocks 1 and 2	**Hours/year**		250			DB[3]		3200			DB			1460			4910
Net Plant Power	**kW**	233954	261500	288570	322300	407140	482162	537404	591440	658918	735826	726498	735836	807312	886132	984530	
Estimated Gross Heat Rate, LHV[2]	**Btu/kW-hr**	7730	7562	7439	7351	7740	7501	7359	7259	7191	7453	7467	7451	7348	7267	7217	
				State 1					State 2					State 3			
	Average Kw	302693			**Average State 1**	7564	**Average Kw**	601150		**Average State 2**	7353		**Average Kw**	828062		**Average State 3**	7350

HBEP Performance for 1 Power Block[4]						DB					DB					
Net Plant Power	**kW**	116977	130750	144285	161150	203570	241081	268702	295720	329459	367913	363249	367918	403656	443066	492265
Net Heat Rate, LHV[2]	**Btu/kW-hr**	7969	7796	7669	7578	7979	7733	7587	7484	7413	7683	7698	7681	7575	7492	7440
Estimated Gross Heat Rate, LHV	**Btu/kW-hr**	7730	7562	7439	7351	7740	7501	7359	7259	7191	7453	7467	7451	7348	7267	7217

1. Operating data from TFLINK 71F Part Load Curve.xls.
2. Station loads ranging from 3.3 to 5.7% and selecting a conservatively low load results in a conservatively high gross heat rate, for estimating annual average CO2. Therefore, a 3% station load was selected to convert the gross heat rates to net heat rates.
3. DB = Duct firing.
4. State 1 represents a 1 on 1 configuration, State 2 represents a 2 on 1 configuration, and State 3 represents a 3 on 1 configuration.

Conservative average station load 3%

Table DR7-3R HBEP Calculate Annual Average CO2 (lb/MWh)

Annual Average - Assume all hours for each State are at the average heat rate for that State

Start Up and Stop Heat Rate Calculations

624	startups / yr	
9	min / startup	
93.6	hours startup / year	
18267	Btu/ gross kWh	Effective Heat Rate during Turbine Start
624	stops / yr	
9.5	min / stop	
98.8	hours stops / year	
16520	Btu/kWh Gross	Effective Heat Rate during Turbine Stops

Plant CO2 Efficiency Calculation

7740	Btu LHV / kWh Gross	Weighted Annual Average Heat Rate with SU/SD and no Degradation.
		(250 hrs * 7564 Btu/kWh + 3200 hrs * 7353 btu/kWh + 1460 hrs * 7350 btu/kWh + 18267 btu/kWh * 93.6 hrs + 16520 btu/kWh * 98.8 hrs)/(4910 hrs + 93.6 hrs + 98.8 hrs)
8%	Assumed Plant Degradation	
8413	Btu LHV / kWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation (7740 btu/kWh / (1 - 0.08))
1082	lb CO2 /MWh Gross	Annual Average CO2 Efficiency with SU/SD and Degradation
		(8413 btu/kWh * 1000 kWh/MWh * 1.1 HHV/LHV * 1*10^{-6} MMBtu/Btu * 53.02 kg CO2/MMBtu-HHV * 2.205 lb/kg)

BEFORE THE ENERGY RESOURCES CONSERVATION AND DEVELOPMENT COMMISSION OF THE STATE OF CALIFORNIA
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APPLICATION FOR CERTIFICATION FOR THE HUNTINGTON BEACH ENERGY PROJECT

Docket No. 12-AFC-02
PROOF OF SERVICE
(Revised 12/24/12)

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*indicates change

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DECLARATION OF SERVICE

I, Judith M. Warmuth, declare that on January 3, 2013, I served and filed copies of the attached **Submittal of Email Correspondence Related to Air Quality** dated January 3, 2013. This document is accompanied by the most recent Proof of Service list, which I copied from the web page for this project at: http://www.energy.ca.gov/sitingcases/huntington_beach_energy/index.html.

The document has been sent to the other parties in this proceeding (as shown on the Proof of Service list) and to the Commission's Docket Unit, as appropriate, in the following manner:

(C*heck one*)

For service to all other parties and filing with the Docket Unit at the Energy Commission:

☒ I e-mailed the document to all e-mail addresses on the Service List above and personally delivered it or deposited it in the US mail with first class postage to those parties noted above as "hard copy required"; **OR**

☐ Instead of e-mailing the document, I personally delivered it or deposited it in the US mail with first class postage to all of the persons on the Service List for whom a mailing address is given.

I declare under penalty of perjury under the laws of the State of California that the foregoing is true and correct, and that I am over the age of 18 years.

Dated: January 3, 2013

Judith M. Warmuth

Judith M. Warmuth