APPENDIX 5.13A

Visual Plume Assessment

Mariposa Energy Project Visible Plume Assessment

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CH2M HILL was tasked to assess the potential of visible plume formation from the operation of the Mariposa Energy Project (MEP). The purpose of this assessment is to determine if visible plumes formation can occur from the project, potentially resulting in significant visual resources or transportation system impacts.

MEP is a combustion turbine-based project, located in eastern Alameda County, in the rolling hills south west of the community of Mountain House. MEP will be a "peaking" power plant, expected to operate during periods of high electrical demand (typically occurring during warm weather).

Basics of Visible Plume Formation

Visible plumes from power plants (and other sources) form when the mass of water in an exhaust plume exceeds the saturation point of the exhaust gases. The saturation point of air is directly related to its temperature with warm air having a higher saturation point (being able to carry more water in a vapor state) than cold air. When the saturation point is reached, water will condense out of vapor state to a liquid state, forming fine water droplets. These water droplets are what is visible in an exhaust plumes.

MEP Visible Plume Assessment

CH2M HILL assessed MEP's potential for visible plumes to occur by determining the absolute humidity of the combustion turbine exhaust gases at the minimum and maximum ambient air temperatures for the project area. The ambient temperatures selected were of 17 and 112 degrees Fahrenheit (°F), respectively, based on a review of long-term weather records. The turbine exhaust temperature and method of calculating the absolute humidity is shown on Exhibit 1.

The turbine exhaust gas absolute humidity is calculated by dividing the mass of water vapor (shown as the percentage of "H_2O Mole % Wet" on Exhibit 1) in the exhaust gas by the mass of dry air (calculated by subtracting the percent water from 100 percent or 100 - H_2O Mole % Wet) times the ratio of the molecular weight of water (18 lb/lb-mol) over the molecular weight of dry air (29.4 lb/lb-mol).

We plotted the turbine exhaust gas absolute humidity and temperature for two scenarios on psychrometric charts to determine if the turbine exhaust gas would reach the saturation point at the two selected ambient temperatures. Visible plume formation would occur any time that the plotted line crossed over the saturation (100% relative humidity) line.

Exhibit 2 presents the plot at the high ambient temperature of 112 °F, showing that the turbine exhaust gases leaving the stack at 863 ˚F would be at approximately 15 percent of the saturation point when reaching equilibrium with the ambient air. The curved line at the far left of this plot is the saturation point. Based on this plot it is very unlikely that visible plumes would be formed.

Exhibit 3 presents the plot at the low ambient temperature of 17 °F. Again, the solid curved line on the far left of this plot is the saturation point, and the plot shows that the turbine exhaust gases leaving the stack at 780˚F would be at approximately 80 percent of the saturation point when reaching equilibrium with the ambient air. At this ambient temperature, the visible plumes are more likely to form but are still not expected.

Conclusion

The results of this assessment are that the probability of visible plume formation from the MEP is unlikely at cooler ambient temperatures and highly unlikely at warmer ambient air temperatures. Therefore, potential visual resource and transportation impacts from visible plume formation from the operation of the MEP are not likely to significant. This conclusion is consistent with recent visible plume determinations for peaking power plant by the California Energy Commission.[1]

[1] MCC Chula Vista - http://www.energy.ca.gov/sitingcases/chulavista/documents/index.html and Starwood Power - http://www.energy.ca.gov/sitingcases/starwood/documents/index.html.

Estimated Average Engine Performance NOT FOR GUARANTEE, REFER TO PROJECT F&ID FOR DESIGN

GE Energy

Performance By: **BRYAN2**
Project Info:

Engine: **LM6000 PC-SPRINT w/ FIGV at -5 Degrees**
Deck Info: **G0125O - 8fk.scp**
Generator: **BDAX 290ERT 60Hz, 13.8kV, 0.9PF (14839)**
Fuel: **Gas Fuel #10-1, 19000 Btu/lb,LHV**

Date: **01/29/2009**
Time: **1:47:28 PM**
Version: **3.7.6**

Case #	**100**	**101**
Ambient Conditions		
Dry Bulb, °F	17.0	112.0
Wet Bulb, °F	15.8	73.2
RH, %	80.0	15.0
Altitude, ft	120.0	120.0
Ambient Pressure, psia	14.633	14.632
Engine Inlet		
Comp Inlet Temp, °F	17.0	112.0
RH, %	80.0	15.0
Conditioning	NONE	NONE
Tons or kBtu/hr	0	0
Pressure Losses		
Inlet Loss, inH20	5.00	5.00
Volute Loss, inH20	4.00	4.00
Exhaust Loss, inH20	12.00	12.00
kW, Gen Terms	**49941**	**32156**
Est. Btu/kW-hr, LHV	**8411**	**9508**
Fuel Flow		
MMBtu/hr, LHV	420.1	305.7
lb/hr	22108	16092
NOx Control	**Water**	**Water**
Water Injection		
lb/hr	22493	13014
Temperature, °F	100.0	100.0
SPRINT	**OFF**	**LPC**
lb/hr	0	8022
Control Parameters		
HP Speed, RPM	10134	10397
LP Speed, RPM	3600	3600
PS3 - CDP, psia	470.1	354.6
T3CRF - CDT, °F	945	999
T48IN, °R	1962	1975
T48IN, °F	1503	1515
Exhaust Parameters	**T_{exh}**	**T_{exh}**
Temperature, °F	780.3	862.9
lb/sec	313.2	234.7
lb/hr	1127562	845007
Energy, Btu/s- Ref 0 °R	99178	80276
Energy, Btu/s- Ref T2 °F	62009	46541
Cp, Btu/lb-R	0.2714	0.2768
Emissions (NOT FOR USE IN ENVIRONMENTAL PERMITS)		
NOx ppmvd Ref 15% O2	25	25
NOx as NO2, lb/hr	42	31
CO ppmvd Ref 15% O2	65	8
CO, lb/hr	66.80	5.87
CO2, lb/hr	55834.29	40706.15
HC ppmvd Ref 15% O2	11	2
HC, lb/hr	6.37	0.97
SOX as SO2, lb/hr	0.00	0.00

Exh Mole % Wet (NOT FOR USE IN ENVIRONMENTAL PERMITS)		
AR	0.8731	0.8579
N2	73.1780	71.9031
O2	13.5211	13.3905
CO2	3.1776	3.0719
H20	9.2408	10.7734
SO2	0.0000	0.0000
CO	0.0060	0.0007
HC	0.0010	0.0002
NOX	0.0023	0.0022

Case # 100 @ 17°F

$$\frac{\text{lb } H_2O}{\text{lb Dry Air}} = \frac{9.2408}{90.759} * \frac{18.0}{29.4} = 0.0623$$

T_{exh} = 780.3 °F

Not possible for visible plume to form because there is no area to left and above point where both tangent lines intersect with the saturation cure

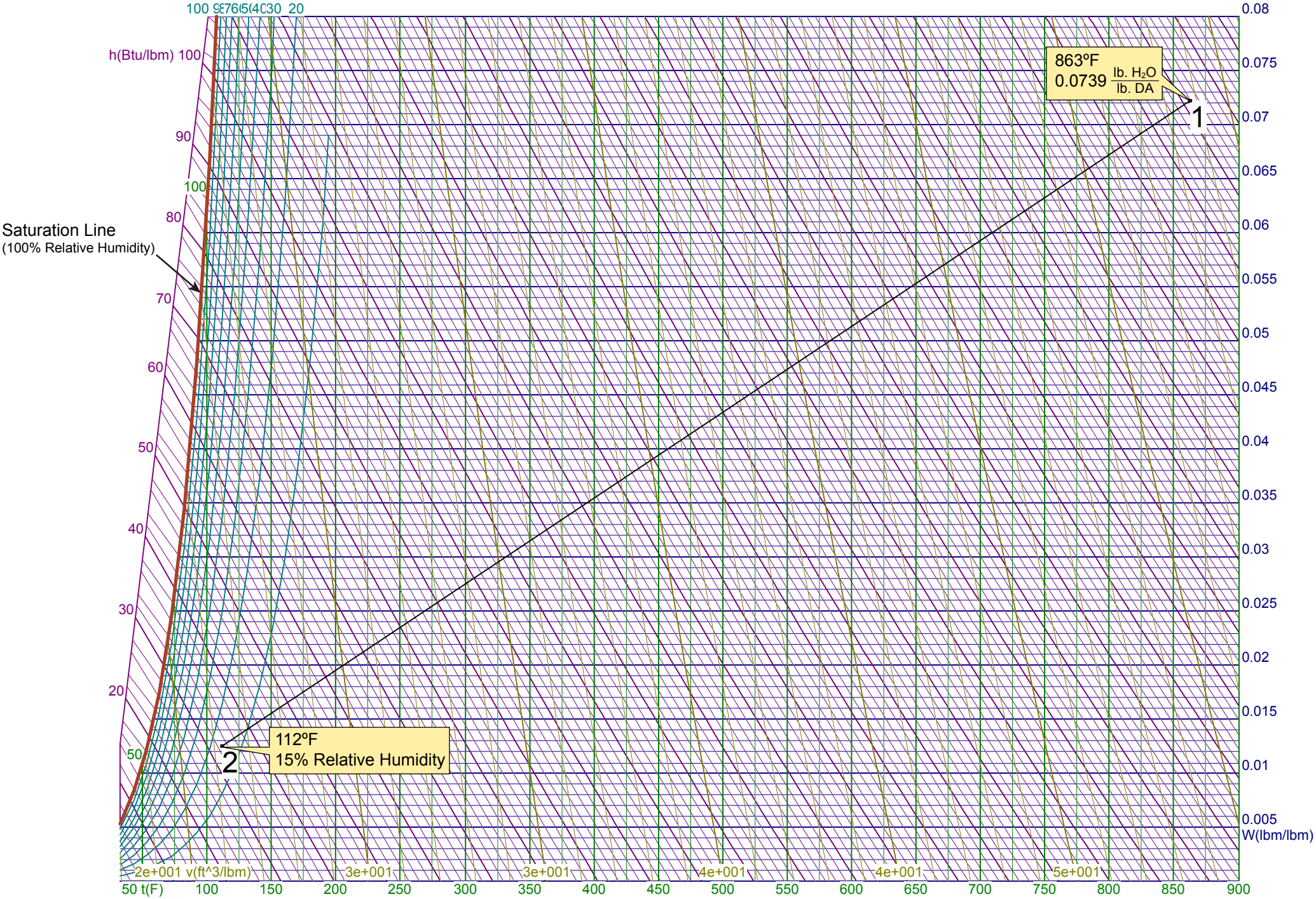
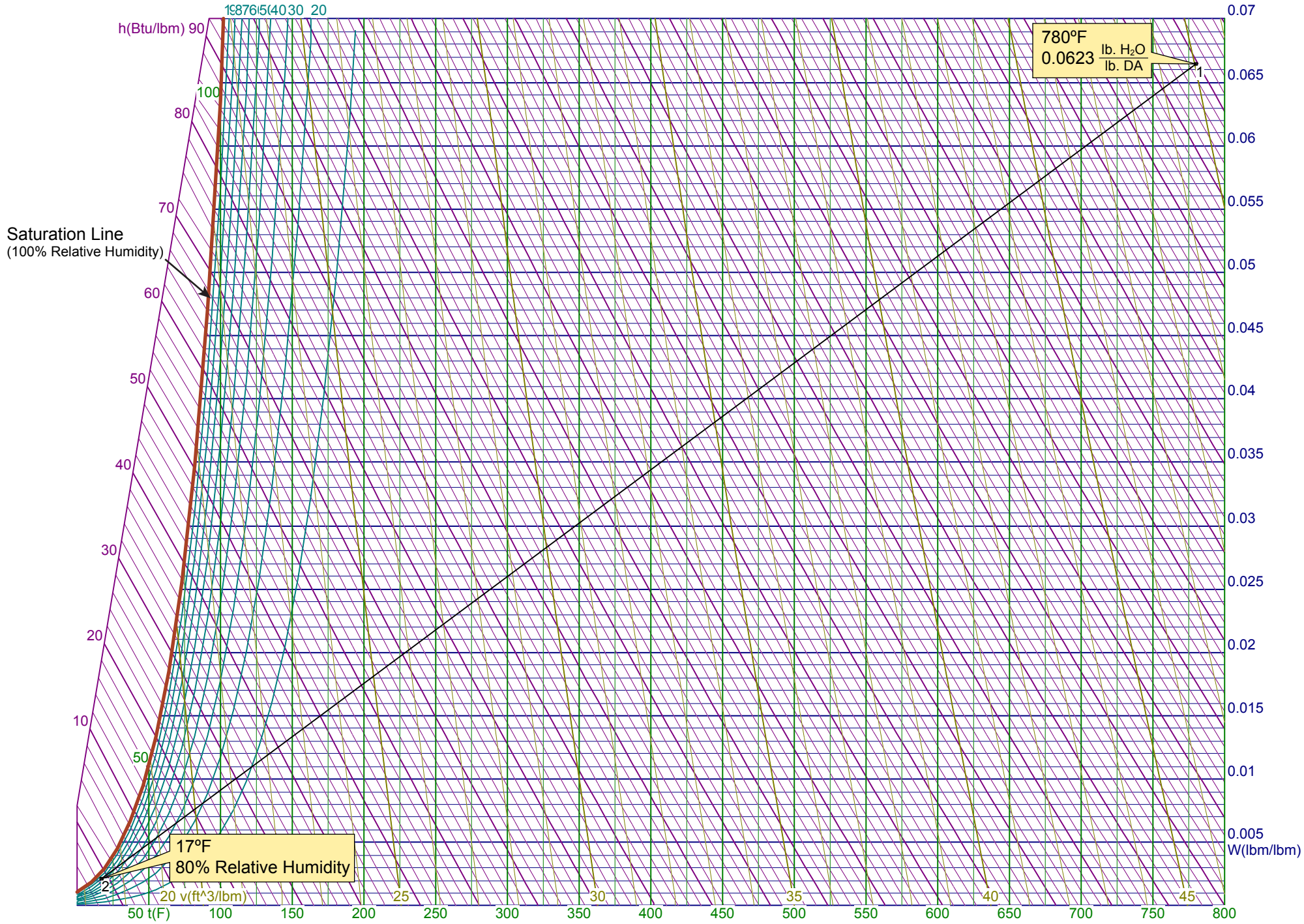
Case # 101 @ 112°F

$$\frac{\text{lb } H_2O}{\text{lb Dry Air}} = \frac{10.7734}{89.227} * \frac{18.0}{29.4} = 0.0739$$

T_{exh} = 862.9 °F

Not possible for visible plume to form because there is no area to left and above point where both tangent lines intersect with the saturation cure

Mariposa Energy Facility - 112ºF Case



Mariposa Energy Facility - 17ºF Case