From: Steve Langevin
To: Aimee Wilson/R6/USEPA/US@EPA
Cc: Prosser, Rex; Deru, Cody; Shanon DiSorbo
Subject: Copano GHG Permit - Turbine Performance Standard
Date: 11/16/2012 12:42 PM
Attachments: Turbine-WHRU Efficiency.xlsx

Aimee

Per our recent discussions, Copano is proposing a change to the CO2e performance standard that we believe addresses EPA's concerns. The 1.32 lb CO2e/hp-hr standard that was originally proposed does not take into account the heat recovered from the turbine exhaust by the waste heat recovery units (WHRU). Copano now proposes a performance standard of 0.84 lb CO2e/hp-hr for the overall turbine/WHRU system. This reflects an overall thermal efficiency of about 40%, and a calculation to support it is attached. In a previous response, Copano explained that although the turbines alone tend to have a lower thermal efficiency than engines used for compression, use of WHRUs to recover waste heat from the turbine exhaust results in a more energy efficient system overall. This is shown below in the example calculations for various turbine loads. As you can see, when the heat recovered in the WHRU is included, the efficiencies are much higher.

As with the turbine-only efficiency, an average turbine load of 70% is appropriate to reflect expected gas processing rate variations and ambient conditions which will both affect actual turbine operating load. The table below also reflects full WHRU load and new equipment conditions. This is taken into account in the attached calculations for the proposed standard.

Copano will measure flow and temperature on the hot oil system that uses the recovered heat. The amount of heat (mmbtu/hr) recovered by the WHRU can be calculated from these measurements, converted to hp, and then added to the hp output of the turbine alone to obtain a total output of the overall system for use in calculating the efficiency and the CO2e emission rate in lb/hp-hr for comparison to the proposed revised standard.

If you have any questions or would like to discuss this, Copano is available at your convenience for a conference call or meeting.

Thanks
Steve

Overall Turbine/WHRU System Efficiencies

Gas Turbines						
Ambient Temp	95 °F	95 °F	95 °F	95 °F	95 °F	95 °F
Engine Load	50%	60%	70%	80%	90%	100%
Turbine Engine Output HP	6,500	7,800	9,099	10,400	11,700	13,000
Fuel Flow, mmbtu/hr	80.32	86.06	91.04	95.54	99.47	104.85
Turbine Engine Firing Rate, HP	31,566	33,822	35,779	37,547	39,092	41,206
Turbine Efficiency	**20.59%**	**23.06%**	**25.43%**	**27.70%**	**29.93%**	**31.55%**
WHRU's						
WHRU Output, mmbtu/hr	22	26.4	30.8	35.2	39.6	44
WHRU Firing Rate, HP	8,646	10,375	12,104	13,834	15,563	17,292
Split Between Turbines	4,323	5,188	6,052	6,917	7,781	8,646
Overall System Efficiency						
Turbine Engine + WHRU	**34.29%**	**38.40%**	**42.35%**	**46.12%**	**49.84%**	**52.53%**
Assumption: Linear relationship between WHRU requirement and plant throughput.						

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Emission Factors from Tables C-1 & C-2 of Appendix A to 40 CFR Part 98 Subpart C

Pollutant	kg/mmBtu	lb/mmbtu, hhv
CO2	53.02	116.78
CH4	0.001	0.0022
N2O	0.0001	0.00022

Factors are for natural gas

CO2 Equivalents (ton/ton):

CO2	1.0
CH4	21.0
N2O	310.0

Proposed Turbine/WHRU Efficiency Limit:

39.5%	proposed annual average limit to reflect reduced load, site conditions, & degredation
2545	btu/hp-hr (published constant)
6,443	btu/hp-hr, LHV @ 25% efficiency
7,149	btu/hp-hr, HHV @ 25% efficiency
116.90	lb CO2e/mmbtu (sum of CO2, CH4, N2O emission factors)
0.84	**lb CO_2e/hp-hr**