CHAMISA ENERGY

February 28, 2013

Mr. David F. Garcia
Acting Director
Multimedia Planning and Permitting Division
U.S. Environmental Protection Agency, Region 6
1445 Ross Avenue, Suite 1200
Dallas, TX 75202-2733

Re: Additional Information Requested for Chamisa CAES at Tulia, LLC
Greenhouse Gas (GHG) Prevention of Significant Deterioration (PSD)Permit
Tulia, Swisher County, TX

Dear Mr. Garcia:

Thank you for providing the February 11 Application Completeness Determination and request for additional information. This letter provides our response to the February determination.

We recently received updated turbine performance data from our turbine supplier. The updated performance data shows slightly different fuel usage rates and power production capabilities, slightly lower generation of CO_2 emissions, and slight changes in emissions of non-GHG. These updated data are reflected in the attached, updated 8 pages of our PSD permit application.

The 7 areas for which additional information was requested in the February 11 Application Completeness Determination are reprinted below in *italics*. Our responses follow each numbered area in regular typeface.

1. *Please provide an additional impacts analysis as required by 40 CFR 52.21(o). Note that the depth of your analysis will generally depend on existing air quality, the quantity of emissions, and the sensitivity of local soils, vegetation, and visibility in the impact area of your proposed project. In your analysis, please fully document all sources of information, underlying assumptions, and any agreements made as a part of the analysis.*

Chamisa Response: EPA's permitting guidance for GHG[1] indicates there is no need to conduct analyses of additional impacts on Class I areas, soils and vegetation because quantifying the

[1] U.S. EPA, PSD and Title V Permitting Guidance for Greenhouse Gases, EPA-457/B-11-001, March 2011.

impacts attributable to a single source is not feasible with current climate change models. EPA's specific guidance states that "*...Although it is clear that GHG emissions contribute to global warming and other climate changes that result in impacts on the environment, including impacts on Class I areas and soils and vegetation due to the global scope of the problem, climate change modeling and evaluations of risks and impacts of GHG emissions is typically conducted for changes in emissions orders of magnitude larger than the emissions from individual projects that might be analyzed in PSD permit reviews. Quantifying the exact impacts attributable to a specific GHG source obtaining a permit in specific places and points would not be possible with current climate change modeling. Given these considerations, GHG emissions would serve as the more appropriate and credible proxy for assessing the impact of a given facility. Thus, EPA believes that the most practical way to address the considerations reflected in the Class I area and additional impacts analysis is to focus on reducing GHG emissions to the maximum extent. In light of these analytical challenges, compliance with the BACT analysis is the best technique that can be employed at present to satisfy the additional impacts analysis and Class I area requirements of the rules related to GHGs...Applicants and permitting authorities should note that, while we are not recommending these analyses for GHG emissions, the incorporation of GHGs into the PSD program does not change the need for sources and permitting authorities to address these requirements for other regulated NSR pollutants. Accordingly, if PSD is triggered for a GHG emissions source, all regulated NSR pollutants which the source emits in significant amounts would be subject to these other PSD requirements. Therefore, if a facility triggers review for regulated NSR pollutants that are non-GHG pollutants for which there are established NAAQS or increments, the air quality, additional impacts, and Class I requirements must be satisfied for those pollutants and the applicant and permitting authority are required to conduct the necessary analysis.*"

As noted in Section 5.0 of the permit application concerning PSD applicability, the Chamisa Facility is not subject to PSD for non-GHG pollutants because the emissions of non-GHG are less than the significant increase levels defined for those pollutants in the PSD rules. Based on EPA policy for GHG pollutants, and the inapplicability of PSD to non-GHG pollutants, no additional impacts analysis is required. In any case, no significant additional impacts are expected from the proposed facility. Atmospheric dispersion modeling[2] conducted of the non-GHG pollutants indicates that the resulting impacts will be below significant impact levels. This indicates that the facility emissions will cause no significant impacts on soils, vegetation, or visibility. The power plant and other on-site operations will employ less than 65 staff, including administrative staff. The addition of these staff and their families to Swisher and adjacent counties are not expected to result in significant secondary impacts on the area.

[2] This modeling was conducted to determine if the air emissions from the proposed facility would cause any significant off-property impacts for consideration in the forthcoming Biological Assessment Report.

2. *What are the proposed monitoring requirements for the combustion turbines' operating parameters? How will the air/fuel ratio be assured during operation of the combustion turbine, e.g., alarms, alerts, and/or continuous monitoring? Will O_2 or CO_2 analyzers be utilized? Was it considered as part of your BACT analysis? If so, why was it eliminated? What will be the target ratio? Please provide more details of what operating parameters you are proposing to monitor to ensure good combustion.*

> Chamisa Response: Economic factors motivate Chamisa to operate the turbines efficiently to minimize fuel usage and maximize power production. Specific turbines' operating parameters will be monitored as part of the process controls used on the turbines, as further discussed in Response 4. However, we do not propose to monitor any of these as part of the GHG PSD permit. Although it was not specified in the permit application, Chamisa is proposing to use CO_2 analyzers to directly measure the principal GHG component. With the measured values of electricity generation, the facility will be able to directly record and monitor the emission of CO_2 per unit of electricity produced. Records on the usage of natural gas fuel (and the use of EPA emission factors) will provide a backup calculation of CO_2 emissions in the event of CO_2 analyzer outages. The minor GHG component emissions from the turbine will be determined from fuel usage data and EPA emission factors. These measurements directly provide verification of GHG emissions and overall combustion and power production efficiency. We propose that the CO_2 analyzers meet the design, installation, and performance specifications in Performance Specification 3 of Appendix B of 40 CFR 60, and the quality assurance procedures of Appendix F of 40 CFR 60.

3. *On page 36 of the permit application, in Table 7 entitled "Proposed Emission and Production Limits," there are two proposed limits for the turbine. Please provide supplemental data to explain the rationale for proposing the following limits: 550 lbs CO_2/MWh (net) at maximum load and 620 lbs CO_2/MWh (net) at any load from 25% to 100%. The limits appear to contradict the other. It is not clear the difference between "maximum load" and "100% load". Please provide an explanation for terms and the mode of operation. Also on page 32, it is stated that the Chamisa Facility will achieve heat rates over a range of plant operating rates of 50% - 100% of 4511 — 4674 (HHV) BTU per net kWh produced. Please provide a proposed BACT limit for the turbines that takes into account load fluctuations and performance degradation between overhauls. Please provide the calculations and the rationale that indicates operating these turbines at the heat loads used in the calculations is energy efficient as BACT. Please provide data for the combustion turbine that includes heat load and efficiency data that was selected. (This information can be graphically represented). What is the company's proposed compliance monitoring methodology for this limit?*

> Chamisa Response: Based on the updated performance data received from our turbine supplier, the values for CO_2 emissions per unit of power produced have been updated to be 540 lbs CO_2/MWh (net) at maximum load, and 630 lbs CO_2/MWh (net) at any other operating load. The proposed limit for maximum load reflects the limit at 100% load. The limit proposed for the

range of loads from the lowest sustainable load of 25% to the 100% load reflects the highest production rate of CO_2 over the full operational range. These values reflect a maximum 3% deterioration in turbine performance between overhauls. Our proposed emission levels for compliance monitoring were intended to establish the maximum load limit as a level which would be demonstrated in initial performance testing. The limit over the full performance range would then be established as the highest value expected over the full load range. The proposed limit for the full performance range is only 16.7% above the level achieved at maximum load.

Over the operating range of 50% to 100% load, the updated vendor performance data indicate a heat rate of 4502 to 4581 BTU (HHV)/kWh (net). At lower loads, the heat rate would gradually increase to a maximum of 5206 BTU (HHV)/kWh (net) at the lowest sustainable load. Because the emission limits in lbs of CO_2/MWh directly measure and reflect overall process efficiency, we do not propose additional limits on heat rate itself as permit limits.

As noted in Table 7 of the PSD Permit Application, we propose that compliance with the emission limits of lbs CO_2/MWh be established from 30-day rolling averages of the measured values.

Vendor data and calculated parameters for turbine performance are tabulated below and also graphically portrayed on the next page.

Dresser-Rand SMARTCAES Turbo-Expander Predicted Emissions Rates and Performance
Chamisa Energy LLC CAES Plant, Tulia, TX
Revision R11 - January 28, 2013

	LSL	Part Load 3	H2O "Off"	H2O "On"	Part Load 2	Part Load 1	HSL
Air Flow Per Train (lb/sec)	100	125	145	145	200	300	400
Load (%)	25%	31%	36%	36%	50%	75%	100%
Gas Flow Per Train(lb/sec)	0.993	1.535	1.975	2.034	3.238	5.508	7.592
Water Inj Per Train (lb/sec)	0	0	0	0.814	1.295	2.203	3.037
Exhaust Flow (lb/sec)	100.99	126.54	146.98	147.85	204.53	307.71	410.63
Heat Rate (BTU/kWh) HHV Basis (gross) [3]	4925	4667	4542	4612	4466	4408	4389
Expander Train Output (KW) (gross)	16,338	26,645	35,227	35,727	58,750	101,235	140,172
Heat Rate (BTU/kWh) HHV Basis (net) (est.)[3]	5206	4827	4659	4729	4581	4521	4502
Expander Train Output (KW) (net) (est.)	15,457	25,764	34,346	34,846	57,281	98,704	136,668
CO_2 (Per Train) from D-R Exhaust Gas Compositions							
lb/hr	9,742	14,995	19,258	19,831	31,504	53,503	73,702
lbs/MWh (gross)	596	563	547	555	536	529	526
lbs/MWh (net) (est.)	630	582	561	569	550	542	539

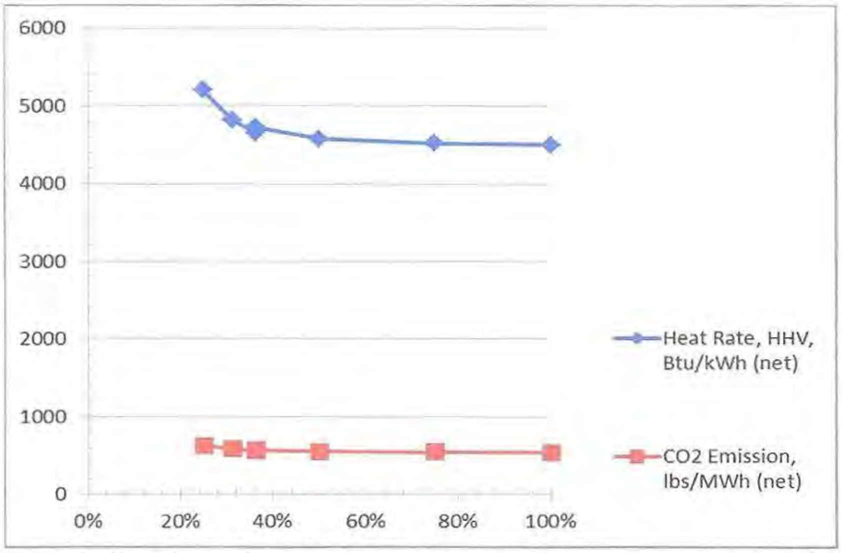

Figure 1. Heat Rate and Emission Data at Different Operating Loads

4. *Please provide supplemental information that discusses in more detail the maintenance and operating practices that will be utilized to ensure proper combustion occurs in the turbines.*

Chamisa Response: Attached are Tables 1 and 1A that contain Dresser-Rand's recommended inspection and maintenance intervals for the Low Pressure Turbo-expander and High Pressure Turbo-expander, respectively, used in Chamisa Energy's CAES process. The maintenance schedules include anticipated inspection and maintenance intervals for each of the major components – combustion liners, fuel nozzles, and transition ducts (LP only) – that affect performance of the combustion systems.

The combustion components specified for Chamisa are identical to combustion components in service at PowerSouth's McIntosh CAES plant for over 10 years. (The McIntosh plant is the only operating CAES unit in the U.S.) The inspection and maintenance intervals in the tables are very conservative compared to experience with the McIntosh combustion systems, which have required only minor repairs and refurbishment since they were first installed. The McIntosh experience forms the basis for the maintenance intervals specified in Tables 1 and 1A.

During expander train operation, combustion system performance will be continuously monitored in two distinct manners.

The first is comparison of measured to expected air-fuel ratios during operation. The air-fuel ratio of the turbo-expanders' combustion system will be controlled by monitoring the turbine inlet temperatures at the combustor exits. A secondary measurement based on the apparent fuel-air ratio based on the inlet air mass flowmeter, and the HP and LP fuel gas flowmeters, provides a double check. Both means of determining and controlling the fuel-air ratio will be in continuous operation while the turbo-expanders are in operation. Sufficient discrepancy between fuel-air ratios based on the temperature measurements and those based on air and fuel mass flow measurements will trigger an alert to the operators.

The second manner by which operation of the combustion system will be monitored is by comparing emissions data for CO and CO_2 from the CEMS to expected values for the power output and air mass flow rate at which the turbo-expanders are operating. Like the air-fuel measurements, discrepancies will trigger an alert to the plant operations and maintenance staff.

5. *Please provide supplemental benchmark data that compares the proposed recuperator for this project to those used in similar or existing sources. What is the company's proposed monitoring requirements to ensure the heat recovery efficiency for the recuperator is being met? What instrumentation or controls will alert on-site personnel to problems? Please provide benchmark data that compares other currently operating CAES installations to the proposed Chamisa project that includes recuperator efficiency, electricity output, heat rate, number of expanders, cavern operating pressure, and hours of storage.*

Chamisa Response: Worldwide, there are two operating CAES plants. Since the Huntorf CAES Plant in Germany is not equipped with a recuperator, the only comparison we can make is to the exhaust recuperator installed at PowerSouth's McIntosh CAES Plant. Compared to the McIntosh recuperator, which incorporates features to improve its tolerance to high-sulfur fuels, the Chamisa recuperator will perform at a much higher level of heat recovery due to the plant's use of only low sulfur fuel gas.

Attached are two tables that lay out relevant benchmark data for the Chamisa CAES recuperator. One table, labeled "As-Tested Recuperator Effectiveness - McIntosh CAES Plant , illustrates performance data for the recuperator currently in service at PowerSouth's McIntosh CAES Plant. The data on which this table is based were taken during performance testing at the McIntosh plant in May 1992. The second table, labeled "Predicted Recuperator Effectiveness - Chamisa Energy LLC, Tulia, TX CAES Plant", shows predicted recuperator performance for Chamisa's Tulia CAES plant.

Two measures of recuperator effectiveness have been used. At the time McIntosh was designed, the recuperator design was specified on the basis of temperature effectiveness. The recuperator was designed to achieve an approach temperature no greater than 30% of the temperature difference between the Low Pressure Turbo-expander exhaust, and cavern air temperature at the recuperator inlet. (This limitation was established due to concerns related to the high sulfur content of fuels possibly to be used at McIntosh.) For current designs like Chamisa, a more traditional effectiveness definition is used, based on the fraction of the available enthalpy that is used, taking account of differences in composition, heat capacity, and mass flow between the inlet air and turbine exhaust streams. Both measures of recuperator effectiveness are shown in the tables to facilitate comparison between the as-tested recuperator performance at McIntosh and the predicted performance of the Chamisa recuperator. It should also be noted that the design effectiveness for the Chamisa recuperator is significantly higher than that of McIntosh. Where the McIntosh recuperator was designed for a nominal effectiveness of 70%, the Chamisa recuperator is designed for a nominal effectiveness of 90%.

The heat recovery performance of the Chamisa recuperator will be monitored continuously during plant operation. Pressure and temperature measurements of the air at the recuperator inlet and recuperator outlet, and of the combustion gas at the turbine exhaust will be monitored and compared to expected values based on the turbo-expander train's air mass flow and gas fuel input.

Benchmark data for the proposed Chamisa facility and the two existing CAES facilities are summarized below.

	Chamisa CAES	McIntosh	Huntorf
Power Production Capacity, MW	280 (total of 2 trains)	110	290
Heat Rate at Maximum Production, BTU (HHV)/kWh	4389 (gross) – 4502 (net)	4555	6175
Design Recuperator Efficiency, %	90	70	N/A (no recuperator)
No. of Expanders	2	2	2
Cavern Pressure, psig	940-1800	1100	600-1000
Hours of Storage	36-48	26	3-4

6. *Chamisa proposes a natural gas generator. The generator will operate during emergencies for backup power generation. Please provide benchmark comparison efficiency and design data for the emergency generator to existing or similar sources.*

Chamisa Response: There are only a few options available for a natural gas-fired generator sized to provide 1400 kW of electrical power. The unit represented in the permit application is a Caterpillar G3516B-DM5498 or an equivalent unit. The proposed unit will achieve a NOx emission level of 0.5 grams/ghp-hr using lean burn technology, without requiring post-combustion emission control. Given its limited operating hours, the unit will emit only 104 tons/yr of CO_2-e.

We have found two similar units which can be benchmarked against the proposed unit. They have somewhat better energy efficiencies, and achieve similar NOx emission levels of 0.5-0.7 grams/hp-hr. The key performance characteristics of the proposed unit and the two possible benchmark units are summarized below:

Caterpillar G3516B-DM5498	Cummins C1400N6C-QSK60G	Waukesha 8L-AT27GL
1400 kWe	1400 kWe	1400 kWe
16V, turbocharged, water-cooled	16V, turbocharged, water-cooled	8V, turbocharged, water-cooled
Displacement: 69L	Displacement: 60.3L	Displacement: 143L
Compression Ratio: 11.1:1	Compression Ratio: 11.4:1	Compression Ratio: 9:1
14.15 MM BTU (LHV)/hr	13.17 MM BTU (LHV)/hr	12.87 MM BTU (LHV)/hr
10,107 BTU (LHV)/kWh	9,407 BTU (LHV)/kWh	9,192 BTU (LHV)/kWh

While the benchmark units appear to have heat rates which are 7-10% lower than the proposed unit, the other design characteristics and features of the benchmark units may not be comparable to the proposed unit. Given the small difference in heat rates, and the correspondingly small differences in GHG emissions, we believe that the performance of the proposed and benchmark units are essentially comparable.

7. *In Tables 2 and 3 of the permit application, please supplement emission calculations with fuel analysis results for the combustion turbines and generator and include the carbon factor (lbs of carbon/lb of fuel) for these fuel compositions.*

Chamisa Response: Based on three months of gas composition data, the average carbon composition of natural gas to be used at the proposed plant is 0.721 lbs carbon per lb of gas, with a range of 0.717 to 0.726 lbs carbon per lb of gas. The bases for these calculated values are tabulated below.

Chamisa CAES at Tulia Gas Quality Data, 2/18/2012-5/21/2012 for Nearby Site Near Lubbock

			Composition, % mol or vol															
	BTU (HHV)	Gravity	CO_2	N_2	Methane	Ethane	Propane	Ibutane	Nbutane	Ipentane	Npentane	C6	C7	VOC	moles C per 100 moles gas	lbs C per 100 lb-moles gas	lbs gas per 100 lb-moles gas	lbs C per lb gas
AVERAGE	1050.451	0.610	0.111	2.868	89.330	6.874	0.702	0.028	0.062	0.007	0.007	0.005	0.006	0.817	105.797	1270.622	1762.939	0.721
MAXIMUM	1098.862	0.653	0.374	3.866	91.517	9.932	2.458	0.164	0.296	0.025	0.023	0.014	0.015	2.995	121.398	1457.99	2032.416	0.717
MINIMUM	1027.498	0.596	0.072	2	83.078	5.064	0.242	0.004	0.018	0.002	0.002	0.001	0.002	0.271	94.132	1130.525	1556.538	0.726
MW			44.01	28.01	16.04	30.07	44.01	58.12	58.12	72.15	72.15	86.17	100	46.60479				

Calculation Bases:

[moles C per 100 moles gas] = ∑ [(% Composition i) * (No. of carbons in formula for i)]

[lbs C per 100 lb-moles gas] = [lb-moles C per 100 lb-moles gas] * (12.01 lbs C/lb-mole C)

[lbs gas per 100 lb-moles gas] = ∑ [(% Composition i, lb-moles of i/100 lb-moles gas) * (MW of Component i, lbs/lb-mole i)]

[lbs C per lb gas] = [lbs C per 100 lb-moles gas) / [lbs gas per 100 lb-moles gas]

If you or your staff have additional questions or require additional information, please contact me. We will be submitting in the near future our Biological Assessments and Cultural Resources Reports.

Sincerely yours,

Alissa Oppenheimer
Managing Director
Chamisa Energy, LLC

Enclosure

cc: Mr. Mike Wilson, P.E., Director, Air Permits Division, TCEQ

Updated Pages of PSD Permit Application for

Chamisa CAES at Tulia, LLC

TABLE OF CONTENTS

PAGE NO.

The seal appearing on this document was authorized by Patrick J. Murin, P.E. 67271 on 2/26/2013
P.E. Expiration Date: 12/31/2013

Murin Environmental Inc.
TBPE Registration No. F-7702
Firm Registration Expiration Date: 3/31/2014

	Turbine 1			Turbine 2			Emergency Gen		NG-Purge		NG-Fugitives		SF_6 Fug	TOTAL	
	Normal, lb/hr	SSM, lb/hr	Total*, tons/yr	Normal, lb/hr	SSM, lb/hr	Total*, tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	lb/hr	tons/yr	tons/yr	tons/yr	PSD Significant Increase Levels, tons/yr
CO_2	73,702	73,702	198,572	73,702	73,702	198,572	1,729	86.45	29.1	0.116	0.01	0.044		397,230	N/A
CH_4	5.29	5.29	14.25	5.29	5.29	14.25	16.88	0.84	2592.4	10.37	0.92	4.03		43.74	N/A
N_2O	1.85	1.85	4.98	1.85	1.85	4.98								9.96	N/A
SF_6													0.0073	0.0073	N/A
GHG	73,709	73,709	198,591	73,709	73,709	198,591	1,746	87.29	2,622	10.49	0.93	4.07	0.0073	397,284	100,000
CO_2-e	74,387	74,387	200,417	74,387	74,387	200,417	2,083	104	54,470	217.89	19.3	84.67	174.47	401,415	100,000

*Total GHG emissions reflect normal operation of each turbine train for an average of 5000 hours operation at maximum production per year, and startup and shutdown operations, but each train could actually operate at greater hours at lower producton levels or at maximum production if the other train was operated less, to keep emissions below the total for the two turbines.

Bases for Calculations

- Total Annual Operating Hours, Normal Maximum Operation, Per Turbine*	5000
*Not proposed as a limit for each unit, but as a basis for development of an operations and emissions cap.	
- Total Number of Startups Per Year, Per Turbine	700
- Maximum Duration of Startup, min	30
- Maximum Annual Startup Hours, Per Turbine	350
- Total Number of Shutdowns Per Year, Per Turbine	700
- Maximum Duration of Shutdown, min	3.3
- Normal Operating Hours, % of Total	92.8%
- Startup, Shutdown, or Maintenance (SSM) Hours, % of Total	7.2%
- Maximum Annual Shutdown Hours, Per Turbine	38.5
- Basis of Turbine Emission Rates	Vendor data except as noted
- Maximum Turbine Firing Duty, MM Btu/hr (HHV), Per Turbine	615.215

Maximum Emission Rates

	Turbine 1						Turbine 2					
	Normal, lb/hr	Startup, lbs/start-up	Startup, lbs/hr (incl. normal operation)	Shutdown, lbs/shutdown	Shutdown, lbs/hr (incl. normal operation)	Annual, tons/yr	Normal, lb/hr	Startup, lbs/start-up	Startup, lbs/hr (incl. normal operation)	Shutdown, lbs/shutdown	Shutdown, lbs/hr (incl. normal operation)	Annual, tons/yr
CO_2	73,702	N/A	73,702	N/A	73,702	198,572	73,702	N/A	73,702	N/A	73,702	198,572
CH_4	5.29	N/A	5.29	N/A	5.29	14.25	5.29	N/A	5.29	N/A	5.29	14.25
N_2O	1.85	N/A	1.85	N/A	1.85	4.98	1.85	N/A	1.85	N/A	1.85	4.98
CO_2-e	74,387	N/A	74,387	N/A	74,387	200,417	74,387	N/A	74,387	N/A	74,387	200,417

Tabulation of CH_4, and N_2O Emission Factors from AP-42, Tables 3.1-2a and 3.1-3

CH_4	0.0086	lbs/MM Btu
N_2O	0.003	lbs/MM Btu

Calculation of CO_2 Hourly Emissions

(20.682 lb/sec CO2) X (3600 sec/1 hour) = 73702 lbs/hr

Tabulation of GHG Warming Potential Equivalency Factors (40 CFR Part 98 Subpart A, Table A-1)

CO_2	1	kg CO_2-e/kg CO_2
CH_4	21	kg CO_2-e/kg CH_4
N_2O	310	kg CO_2-e/kg N_2O

Calculation of CO_2-e Hourly Emissions

(73,702 lb CO2/hr) X (1lb CO2-e/lb CO2) + (5.29 lbs CH4/hr) X (21 lb CO2-e/lb CH4) + (1.85 lbs N2O/hr) X (310 lb CO2-e/lb N2O) =
74,387 lbs CO_2-e/hr

Note: AP-42 is the U.S. EPA's *Compilation of Air Pollutant Emission Factors* , 5th Edition.

5.0 PSD APPLICABILITY SUMMARY

As shown in Table 1, the Chamisa Facility will emit 397,284 tons/yr of GHG pollutants, and 401,415 tons/yr of CO_2-e pollutants. As shown in Table 1F, the Chamisa Facility is not subject to PSD for non-GHG pollutants because the emissions of non-GHG are less than the significant increase levels defined for those pollutants in the PSD rules.

Sources and emissions subject to PSD permitting requirements because of their potential to release GHG emissions are subject only to some of the requirements of the PSD rules. The primary requirement of a PSD permit for GHG emissions is to require that the permitted facilities use the Best Available Control Technology (BACT) for controlling GHG emissions. The resulting PSD permit specifies emission levels reflecting the use of BACT, including emissions monitoring and other requirements to ensure that the BACT emission levels are maintained during operations. An analysis of and rationale for BACT for the GHG sources at the Chamisa Facility are provided in Section 6.0.

The Chamisa Facility is not subject to other PSD permit requirements. It is not subject to an analysis of ambient air impacts because there are no National Ambient Air Quality Standards or PSD Ambient Air Increments for GHG emissions. It is not subject to preconstruction ambient air monitoring because of the nature of GHG emissions and their potential global impact; there is no benefit for the gathering of local ambient air monitoring data on GHG pollutants. EPA’s permitting guidance for GHG also indicates there is no need to conduct analyses of additional impacts on Class I areas, soils and vegetation because quantifying the impacts attributable to a single source is not feasible with current climate change models.[4]

[4] U.S. EPA, PSD and Title V Permitting Guidance for Greenhouse Gases, EPA-457/B-11-001, March 2011.

TABLE 1F
AIR QUALITY APPLICATION SUPPLEMENT

Permit No.: **TBD**	Application Submittal Date: **October, 2012, rev. Feb. 2013**
Company: **Chamisa CAES at Tulia, LLC**	
RN: **TBD**	Facility Location: **Plant site is SW of Intersection of I-27 and State Highway 86, SW of Tulia**
City: **Tulia**	County: **Swisher**
Permit Unit I.D.: **Chamisa CAES at Tulia**	Permit Name: **Chamisa CAES at Tulia**
Permit Activity: ☒ New Source ☐ Modification	

Complete for all Pollutants with a Project Emission Increase.	**POLLUTANTS**							
	Ozone							
	VOC	**NO_x**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**NO_X**	**SO_2**	**CO_2-e**
Nonattainment?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
PSD?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**Yes**
Existing site PTE (tpy)?	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Proposed project emission increases[1]?	6.27	38.00	40.04	8.29	7.61	38.00	4.64	401,415
Is the existing site a major source?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**
If not, is the project a major source by itself?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**Yes**
If site is major source, is project increase significant? **N/A**								
If netting required, estimated start of construction: **N/A since a new grassroots plant is proposed**								
5 years prior to start of construction **N/A**	contemporaneous							
Estimated start of operation **N/A**	period							
Net contemporaneous change, including proposed project (tpy)	6.27	38.00	40.04	8.29	7.61	38.00	4.64	401,415
Major NSR Applicable?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**Yes**

	Managing Director	02/28/2013
Signature	***Title***	***Date***

[1] Sum of proposed emissions minus baseline emissions, increases only.

The representations made above and on the accompanying tables are true and correct to the best of my knowledge.

6.1.4 Step 4 - Evaluate the most effective controls and document results.

Post-combustion capture of CO_2 could potentially remove 90%, or 357,430 tons per year of CO_2 from the two turbine train exhausts.

Costs for CCS applied to natural gas-fired gas turbines, primarily in combined cycle applications, have been widely examined in studies conducted by the U.S. Department of Energy, the Interagency Task Force on Carbon Capture and Storage, the Electric Power Research Institute, and others. Results of the most recent of these have been presented in the "The Cost of Carbon Capture and Storage for Natural Gas Combined Cycle Power Plants"[15] along with additional estimates generated from Carnegie Mellon University's Integrated Environmental Control Model. These cost estimates can be readily extrapolated to the CAES turbine exhaust because the exhausts from both CAES turbines and combined cycle power plants have similar characteristics, including similar levels of impurities and carbon dioxide (3-5% by volume). One difference is the scale of the production facility. The studied combined cycle power plants have all featured two F Class gas turbines with a total power output approximately twice that of the two CAES gas turbines. This difference in scale results in a higher capital cost per unit of power produced or carbon dioxide removed for the CAES turbines. While Chamisa has considered that effect in the calculation of capital cost below, we have not escalated the annualized costs to consider the higher relative capital cost for a CCS system used with CAES turbines. The annualized costs for a CAES facility can thus be expected to be even higher than the estimates provided below. Costs are presented in 2011 dollars.

Cost Component	CCS Cost for Chamisa CAES
Total Capital Cost	$230 million
Total Annualized Cost	$22-37.5 million
Cost Effectiveness	$62-105/ton CO_2 removed

The capital costs include the CO_2 absorption trains, CO_2 compression trains, CO_2 pipeline costs, and costs for the injection of CO_2 into storage sites or EOR sites. The total annualized costs included annualized capital costs and all fixed and variable operating and maintenance costs. These costs can be expected to reasonably represent the minimum costs of CCS for the Chamisa facility. The cost of CCS would increase the cost of electricity produced at the plant by $0.015-0.026/kWh. Included in these costs are the cost of the higher energy demands at the plant due to the use of CCS, with an expected increase in energy usage (or a reduction in the net power from the plant) of about 15%. The costs estimates were developed with data from the paper cited above and from the Global CCS Institute's 2012 Status Report.[16]

CCS may also have adverse environmental impacts on subsurface and surface water qualities, but like many aspects of CCS, the extent of these and other environmental effects is uncertain.

Finally, it is worth noting that anthropogenic CO_2 used and trapped within an EOR reservoir may not serve the goal of reducing overall GHG emissions. The objective of using CO_2 in EOR operations is to

[15] E.S. Rubin and Haibo Zhai (Carnegie Mellon University), "The Cost of Carbon Capture and Storage for Natural Gas Combined Cycle Power Plants", Environmental Science and Technology, 2012, **46**, 3076-3084.
[16] Global CCS Institute, The Global Status of CCS: 2012, Canberra Australia, 145.

produce oil which will be combusted and emit GHG gasses. Consequently, the net result of a CCS system that is used for EOR could ultimately result in zero GHG savings.[17]

The base case option of the CAES turbine system will not entail the CCS costs or energy impacts. In addition, the Chamisa Facility will achieve heat rates over a range of plant operating rates of 50-100% of capacity of 4502-4581 BTU (HHV basis) per net kWh produced.[18] This compares favorably to a heat rate of approximately 7000-7500 BTU/kWh for natural gas combined cycle power plants, and to a heat rate of 10,200 for simple cycle gas turbines. It also compares favorably to the heat rate of 4390-4773 Btu/kWh reported for another recently proposed CAES facility.[19] The heat rate distinctions directly correlate to a reduced potential for GHG emissions as well.

6.1.5 Step 5 - Select the BACT.

Economic, energy, and environmental impacts all argue against the selection of CCS as BACT. The higher annual costs, and the resulting impact on the costs of produced electricity, would in fact result in the cancellation of the Chamisa Facility, if CCS were required as BACT. CCS is also not considered technically viable. BACT for GHG emissions is the use of the efficient gas turbine CAES technology proposed for the Chamisa Facility, with both turbine trains operated and maintained properly according to the manufacturer recommendations.

6.2 Emergency Generator

The natural-gas fired emergency generator will normally operate less than 100 hours per year in non-emergency operations. GHG from the Emergency Generator will amount to 104 tons/yr of CO_2-e emissions, and 87.29 tons/yr of GHG emissions on a mass basis.

6.2.1 Identify all available control technologies.

There are two options for control of GHG emissions from the emergency generator. The first is to implement the add-on CCS option. The second is to maintain and operate the emergency generator properly, according to manufacturer recommendations and good combustion practice.

6.2.2 Eliminate technically infeasible options.

The use of CCS is not technically feasible for the emergency generator due to the generator’s infrequent but critical operating requirements for quick response, short-duration operation; the operating period for the generator would usually end before the CCS absorption unit has reached normal operation. Except for its periodic testing, the emergency generator is intended to operate only for emergency situations when grid power may not be available, when its entire electrical output is required for the emergency situation. No CCS systems have been demonstrated for use on emergency generators.

Maintaining and operating the generator properly is technically viable, as demonstrated by widespread use of these units.

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[17] Global CCS Institute, The Global Status of CCS: 2012, Canberra Australia, 153.

[18] The heat rate increases to 4659 Btu/kWh at 36% load and to 5206 Btu/kWh at 25% load, which is just above the lowest sustainable load level. All heat rate values are based on 3% heat rate degradation between overhauls, and internal energy demand of 2.5% of gross power generated; except that internal energy demand at loads below 50% are estimated as a constant load of 900 kW).

[19] Bethel Energy Center, Anderson County, Texas, Prevention of Significant Deterioration Greenhouse Gas Permit Application, June 2012, Submitted to US. EPA Region 6.

Emission Source	Emission and Production Limits	Monitoring Requirements	Maintenance Requirements
Gas expander turbine trains	• 400,834 tons/yr CO_2-e from both trains • 74,387 lbs/h CO_2-e from each train • 6,270,000 MM Btu/yr (HHV basis), total from both trains • 1,425,000 MWh (net)/yr, total from both trains • 540 lbs CO_2/MWh (net) @ max. load • 630 lbs CO_2/MWh (net) @ any load from 25% to 100% load	• Determine hourly and annual GHG emissions using 40 CFR 98.43 • Determine and record annual GHG emissions on a rolling 12-month basis • Determine and record lbs CO_2/MWh (net) as a rolling 30-day average • Record annual fuel usage in MM BTU/yr (HHV basis) and net electricity output in MWh/yr on a rolling 12-month basis	• Operate and maintain all equipment according to manufacturer recommendations
Emergency generator	• 104 tons/yr CO_2-e	• Determine annual GHG emissions using 40 CFR 98.33 on a calendar year basis	• Operate and maintain all equipment according to manufacturer recommendations
Natural Gas Piping Fugitive Leaks	• 84.7 tons/yr CO_2-e	• Record leak observations reporting by operating and maintenance staff	• Operate and maintain all equipment according to manufacturer recommendations
Natural Gas Maintenance Purges	• 218 tons/yr CO_2-e	• Record purge volumes and determine annual GHG emissions on a calendar year basis	• Operate and maintain all equipment according to manufacturer recommendations
SF_6 Fugitive Leaks	• 174 tons/yr CO_2-e	• Use inventory records to determine SF_6 and CO_2-e emissions on a calendar year basis • Monitor for leaks using halogen detector on a monthly basis	• Implement a recycling program so that SF_6 is evacuated into portable cylinders rather than vented to atmosphere. • Operate and maintain all equipment according to manufacturer recommendations

Table 7. Proposed Emission and Production Limits, Monitoring, and Maintenance Requirements

Tables 1 and 1A in Support of

Response to Question 4

Table 1. Dresser-Rand Model EA-418 Turbo-Expander Maintenance Schedule

Component	Dresser Rand Recommended Maintenance Activity				Component Replacement			
	Estimated Repair Turn-Around[1]	Borescope Inspect	Hot Gas Path Inspect-Repair Interval[2]		Replacement Lead Time	Repair/Replacement Interval[4]		
	Weeks	Starts	Starts	EOH (Hours)[3]	Weeks	Minor Repair	Major Repair	Retire
Combustion Liners	6	750	1500	24000	18	72000	na	144000
Transition Pieces	12	750	1500	24000	26	72000	na	144000
Fuel Nozzles	6	750	1500	24000	18	72000	na	144000
Stage 1 Nozzles	26	750	1500	24000	80	48000	96000	144000
Stage 2 Nozzles	26	750	1500	24000	80	72000	na	144000
Stage 3 Nozzles	26	750	1500	24000	80	96000	na	na
Stage 4 Nozzles	26	750	1500	24000	80	96000	na	na
Stage 1 Buckets	20	750	1500	24000[5]	80	72000	na	144000
Stage 2 Buckets	20	750	1500	24000[5]	80	72000	na	144000
Stage 3 Buckets	20	750	1500	24000	80	72000	na	144000
Stage 4 Buckets	20	750	1500	24000	80	72000	na	144000

Notes:

(1) Dependent on the type of repair; time given is guideline only. (Based on most complex repair option)

(2) Whichever comes first.

(3) EOH Calculation:

Starts -	Emergency Start (<10	50 EOH
	Fast Start (=10 < 15 M	25 EOH
	Normal Start(>15 Min)	15 EOH
Operating Hours -	1600°F TIT	EOH = 1 X actual fired hours
	1550°F TIT	EOH = .75 X actual fired hours
	</=1500°F TIT	EOH = .5 X actual fired hours
	Part load hours	EOH = 1 X (actual output/rated output)

(4) Replacement Intervals are guideline only. Individual part replacement intervals depend on HGPI & repair history. Consult D-R Engineering

(5) Stage 1 & 2 buckets must be removed from disk to inspect bucket and disk fir trees at 1st HGPI. All stages at subsequent HGPI's.

Table 1A. Dresser-Rand Model 6T CAES High Pressure Turbo-Expander Maintenance Schedule

Component	Dresser Rand Recommended Maintenance Activity				Component Replacement	
	Estimated Repair Turn-Around(1)	Borescope Inspect	Gas Path Inspect-Repair Interval(2)		Replacement Lead Time	Replacement Interval(4)
	Weeks	Starts	Starts	EOH(3) (hrs)	Weeks	Starts/EOH
Combustion Liners	6	750	1500	24000	18	4500/72000
Fuel Nozzles	6	750	1500	24000	18	4500/72000
Stage 1 Nozzles	26	750	1500	24000	30	9000/144000
Stage 2 - 6 Nozzles	26	NA	1500	24000	30	9000/144000
Stage 1 Buckets	12	750	1500	24000	30	9000/144000
Stage 2 - 6 Buckets	12	NA	1500	24000	30	9000/144000
Rotor	20	NA	1500	24000	60	9000/144000(5)

Notes:

(1) Dependent on the type of repair; time given is guideline only. (Based on most complex repair option)

(2) Whichever comes first.

(3) EOH Calculation — Starts: 15 hours/start (power-gen or compressor start using expanders)

Operating Hours: ≥ 1000oF TIT — EOH = 1.0 X actual hours

<1000°F TIT — EOH = .75 X actual hours

(4) Intervals are guideline only. Actual intervals depend on results of GPI & repair history.

(5) Rotor may be debladed, and rebladed for continued service, dependent on inspection results. Consult D-R Engineering.

Tables in Support of

Response to Question 5

As-Tested Recuperator Effectiveness - McIntosh CAES Plant
May 1992 Performance Test Data

Net Plant MW Output	108.82	102.04	76.20	50.61	25.00	10.11
Gross MW (Generator)	109.81	103.01	77.03	51.32	25.46	10.74
HP Combustor Inlet						
Pressure PSIA	595.7	566.06	451.24	339.53	221.07	141.49
Temp F (avg)	522.3	530.16	572.05	593.23	601.85	605.53
LP Exp Exh						
Pressure PSIA	15.17	15.14	14.99	14.88	14.77	14.72
Temp F (avg)	705.04	715.36	766.97	797.87	798.96	801.76
Mass Flow Rates (lb/sec)						
Inlet	334.4	317.2	252.6	190.1	123.9	79.3
Exhaust	340.5	322.9	257.0	193.1	125.5	80.1
Fuel Flow Rate (lb/sec)	6.10	5.74	4.44	3.03	1.65	0.80
Net Plant HR (BTU/kWhr)	4588	4609	4771	4908	5391	6498
Temperature Effectiveness	70.04%	70.15%	70.99%	70.89%	72.00%	72.24%
Enthalpy Effectiveness	64.22%	65.50%	67.00%	69.20%	70.90%	71.80%

Notes:

1. Effectiveness values based on test data taken at McIntosh CAES plant May 1992.

2. Design <u>Temperature</u> Effectiveness for McIntosh recuperator = 70%.

3. Calculated enthalpy effectiveness based on fuel gas w/ 23840 BTU/lb (HHV)

Predicted Recuperator Effectiveness - Chamisa Energy LLC, Tulia, TX CAES Plant

Gross KW (Generator)	140,172	101,235	58,750	35,727	16,338
HP Combustor Inlet					
Pressure PSIA	800	566.06	451.24	339.53	221.07
Temp F (avg)	607	666	748	748	745
LP Exp Exh					
Pressure PSIA	15.17	15.14	14.99	14.88	14.77
Temp F (avg)	665	750	800	800	800
Mass Flow Rates (lb/sec)					
Inlet	400.0	300.0	200.0	145.0	100.0
Exhaust	410.1	307.4	204.7	146.9	100.9
Fuel Flow Rate (lb/sec)	7.37	5.35	3.14	1.97	0.96
Gross Plant HR (BTU/kWhr)	4261	4280	4336	4478	4782
Temperature Effectiveness	89.73%	87.08%	92.57%	92.57%	92.14%
Enthalpy Effectiveness	90.00%	90.90%	92.30%	92.50%	92.10%

Notes:

1. Effectiveness values from RGP Engineering Data Sheet dated 1-20-2013

3. Calculated enthalpy effectiveness based on fuel gas w/ 222509 BTU/lb (HHV)