EOSolutions

13201 NW Freeway, Suite 220
Houston, Texas 77040
T 713.533.8511 F 281.971.0521
www.eosolutions.net

April 3, 2020 **Electronic Submittal**

Mr. Kerwin Singleton
Chief, Planning Section
New Mexico Environment Department
525 Camino de los Marquez, Suite 1
Santa Fe, NM 87505-1816

Re: Regional Haze Study, Four Factor Analysis
Davis Gas Processing, Inc.
Denton Gas Plant
Lovington, Lea County, New Mexico
NSR Permit No. 0065-M7
Title V Permit No. P079-R3

Dear Mr. Singleton,

As requested in your electronic requests dated December 23, 2019 and February 13, 2020, Environmental Operational Solutions, LLC, on behalf of Davis Gas Processing, Inc., is submitting the additional requested information for the referenced facility. Each of the information requests pertaining to the Sour Gas Amine Treating System are provided below in bold font followed by each of our responses.

a) Consider and discuss replacing the primary control device, flare Unit 9F, with a sulfur recovery unit (SRU), such as Claus or LO-CAT sulfur recovery technologies. If technically feasible, include a four-factor analysis.

Response: The use of Lo-Cat sulfur recovery technology is a technically viable option at the Denton Gas Plant and a four-factor analysis is included as Attachment A.

b) Thank you for providing the cost analysis for acid gas injection (AGI) system amine unit control. It appears that the cost analysis that was submitted used the average of 2017-2018 emissions. Please explain the rational for using these emissions instead of using 2016 emissions, as NMED did during its source selection process.

Response: The 2017-2018 average emissions were initially selected simply because it represented the most recent data for the Denton Gas Plant. The AGI cost evaluation has been revised to use 2016 emissions for consistency with the NMED request.

c) Please include a discussion on the technical feasibility for redundant compression for the acid gas injection (AGI) system. If feasible, include the costs of completing a geophysical analysis and injection well/geologic reservoir feasibility study in a four-factor analysis.

Response: The use of redundant compression with the AGI system is technically feasible; however, it adds additional capital cost to the AGI system. The revised cost evaluation for the AGI system is enclosed as Attachment B and shows a cost effectiveness of $926 per ton of controlled emissions. This includes the cost of completing a geophysical analysis and injection well/geologic reservoir feasibility study. The expected overall compliance schedule for the AGI system option will increase to 13 to 19 months from the initial estimate of 12 to 18 months.

d) Provide the electronic spreadsheets used for control technology calculations.

Response: The electronic spreadsheets used for the control technology calculations are enclosed as a zip file.

Should you have any questions concerning this analysis, please feel free to contact me directly at (713) 983-0112 or via email at elena.hofmann@eosolutions.net or Karen Jones at (512) 917-4804 or via email at karen.jones@eosolutions.net.

Sincerely,

Elena L. Hofmann
President

Enclosures

Attachment A

Four Factor Analysis for a Lo-Cat System

Four Factor Analysis of a Lo-Cat System

Baseline Emissions from the Denton Gas Plant Acid Gas Flare

2016 baseline emissions were developed through a review of the Acid Gas Flare's sulfur dioxide (SO_2) emissions as previously submitted to NMED for the 2016 Emission Inventory. Actual SO_2 emissions were listed as 945.98 tons per year.

SO_2 Emission Control Option

The control option under evaluation is the Merichem Lo-Cat technology. The Lo-Cat technology was developed to provide an isothermal, low operating cost method for carrying out the modified Claus reaction and has been successfully used in several different industries worldwide, including oil and gas. As a general rule of thumb, the Lo-Cat technology's sulfur removal capacity niche ranges between 0.5 to 25 tons per day (TPD).

Lo-Cat technology contains a proprietary liquid reduction/oxidation catalyst that converts hydrogen sulfide (H_2S) to solid elemental sulfur (S°) by carrying out the direct oxidation of H_2S as follows: $H_2S + 1/2\ O_2 \rightarrow H_2O + S°$. Five sequential steps are involved with this oxidation reaction: absorption of H_2S into the aqueous, chelated iron solution and its subsequent ionization; the oxidation of hydrosulfide ions to elemental sulfur and the accompanying reduction of the active ferric iron to the inactive ferrous state; and the absorption of oxygen (from ambient air) into the aqueous solution followed by oxidation of the inactive ferrous iron ion back to the active ferric state.

An iron chelating agent is used in the Lo-Cat system and serves two purposes in the process chemistry. First, it serves as an electron donor and acceptor, or in other words, a reagent. Secondly, it serves as a catalyst in accelerating the overall reaction. Because of this dual purpose, the iron is often called a "catalytic reagent". Although there are many metals that can perform these functions, iron (Fe) was chosen for Lo-Cat technology primarily because it is inexpensive and safe to operate. The chelating agent(s) do not take part in the process chemistry and only serve to hold the iron ions in solution. In addition, the catalytic reagent is continually regenerated within the Lo-Cat process, which further contributes to the reduced cost of this system.

Iron will ordinarily precipitate at low concentrations as either ferric hydroxide $Fe(OH)_3$ or ferrous sulfide (FeS). The chelating agents are organic compounds that wrap around the iron, preventing the iron ions from forming precipitates. Lo-Cat technology uses a proprietary blend of chelating agents to hold the iron in solution over a wide operating range. Advantages of these systems include the ability to achieve H_2S removal efficiencies in excess of 99.9%, essentially 100% turndown on H_2S concentration and/or gas flow, and the production of only innocuous products and byproducts.

Elemental sulfur recovered by the Lo-Cat technology is considerably different from sulfur produced by other processes. Lo-Cat sulfur has a particle size that ranges from 8 to 45 microns, much smaller than sulfur generated by other means. And since this solid sulfur is formed in an aqueous solution, it does not contain trapped H_2S vapors that can evolve during subsequent handling. Sulfur recovered by the Lo-Cat technology also has a relatively soft texture with large internal and external surface areas that support microbial action in the soil. Lo-Cat sulfur is removed from the process as a "filter cake" composed of approximately 65 wt.% sulfur and 35 wt.% diluted Lo-Cat solution. The moisture content of the cake limits dust production during handling and subsequent use. Additionally, the Lo-Cat particle size, surface area, and moisture content support good reactivity, applicability, and safety for sulfur used in agricultural applications if potential buyers can be identified, which can vary depending on geographic region. As an alternative, the sulfur cake can be disposed at additional cost.

Cost of the Lo-Cat Process

Installation of a Lo-Cat system will include the following primary items:

- Absorber vessel with solution circulation pump;
- Oxidizer vessel;
- Proprietary sulfur filter system; and
- Deionized water treatment system.

The preliminary capital cost estimate was developed by the Merichem Company, the Lo-Cat technology developer and manufacturer, with a margin of error of +/- 50%. Other costs associated with operating this control system were developed from estimates provided by Design Group, an independent engineering design firm, current client labor rates and consistent with the guidance contained in the US EPA's document *EPA Air Pollution Control Cost Manual, 6th Edition, EPA-452/B-02-001, January 2002*. The expected emission reduction is based on essentially 100% control of the acid gas stream with potential emissions consisting of only fugitive H_2S emissions. The cost evaluation for the Lo-Cat system is contained in Table A-1 and is based on a 20-year life of the control system, amortized at 5.25% interest rate. This results in an annual cost effectiveness of $1,985 per ton of controlled SO_2 emissions for the Denton Lo-Cat system.

Timeline for Compliance with a Lo-Cat System

The estimate schedule includes the following:

- Vendor Feasibility Study — 6 weeks
- Engineering: — 10 – 14 weeks
- Procurement: — 20 – 30 weeks
- Construction: — 16 – 30 weeks
- Commissioning and startup: — 2 – 4 weeks
- Overall Compliance Schedule: — 44 – 84 weeks (12 – 21 months)

Energy and Non-Air Impact

The use of a Lo-Cat process will incur an annual energy penalty of approximately $105,000 due to additional electric power demands. Non-air impacts include the disposal of the Lo-Cat sulfur cake in the event a buyer for the produced sulfur cannot be identified.

Table A-1
Cost Effectiveness Evaluation of Lo-Cat System

Direct Costs	**Control Cost Formula**	**Cost**	**Comments**
Purchased Equipment Costs			
Control System (A)	1.00 * A	$7,000,000	Merichem Cost Estimate, ± 50%
Instrumentation	0.10 * A	$700,000	Per EPA Control Cost Manual
Sales Tax	0.03 * A	$210,000	Per EPA Control Cost Manual
Freight	0.05 * A	$350,000	Per EPA Control Cost Manual
Purchased Equipment Cost (PEC)	1.18 * A	*$8,260,000*	Per EPA Control Cost Manual
Direct Installation Costs			
Foundations and Supports	Provided by engineering design firm	$350,000	DG Cost Estimate, ± 50%
Handling and Erection	0.14 * PEC	$1,156,400	Per EPA Control Cost Manual
Electrical	Provided by engineering design firm		Included wth foundations and
Piping	Provided by engineering design firm		supports cost estimate
Installation	0.01 * PEC	$82,600	Per EPA Control Cost Manual
Painting	0.01 * PEC	$82,600	Per EPA Control Cost Manual
Direct Installation Cost	0.16 * PEC	*$1,671,600*	Per EPA Control Cost Manual
Site Preparation	As needed		
Buildings	As needed		
Total Direct Costs (DC)		*$9,931,600*	
Indirect Costs (Installation)			
Engineering	Provided by engineering design firm	$150,000	DG Cost Estimate, ± 50%
Construction and Field Expenses	0.05 * PEC	$413,000	Per EPA Control Cost Manual
Contractors	0.10 * PEC	$826,000	Per EPA Control Cost Manual
Startup	0.02 * PEC	$165,200	Per EPA Control Cost Manual
Performance Test	0.01 * PEC	$82,600	Per EPA Control Cost Manual
Contingencies	0.03 * PEC	$247,800	Per EPA Control Cost Manual
Total Indirect Costs (IC)	0.21 * PEC + Eng.	*$1,884,600*	
Total Capital Investment (TIC)	DC + IC	***$11,816,200***	

Notes:
Control system cost (A) includes absorber, oxidizer, water treatment, and proprietary sulfur filter system.
DG = Design Group

Table A-1
Cost Effectiveness Evaluation of Lo-Cat System

Direct Annual Costs	**Control Cost Formula**	**Cost**	**Comments**
Operating Labor			
Operator	0.5 hr/shift * 3 shifts per day, 365 days/yr	$16,425	Per EPA Control Cost Manual and DGP labor rates
Supervisor	15% of operator costs	$2,464	Per EPA Control Cost Manual
Operating Materials			
Maintenance			
Labor	0.5 hr/shift * 3 shifts per day, 365 days/yr	$19,163	Per EPA Control Cost Manual and DGP labor rates
Material	100% of maintenance labor	$19,163	Per EPA Control Cost Manual ing
Utilities			
Electricity	120 kw/hr, 8760 hr/yr, $0.10 kw-hr	$105,120	DG usage estimate
Chemicals	$649.52/day	$237,075	DG usage and cost estimate
Water	2 gal/min @ $4/1,000 gal water	$4,205	DG usage estimate
Total Direct Annual Costs (DC)		*$403,613*	
Indirect Annual Costs			
Overhead	60% of sum of operating and maintenance labor and maintenance	$32,850	Per EPA Control Cost Manual
Adminstrative Charges	2.0% * TCI	$236,324	Per EPA Control Cost Manual
Property Tax	1.0% * TCI	$118,162	Per EPA Control Cost Manual
Insurance	1.0% * TCI	$118,162	Per EPA Control Cost Manual
Capital Recovery Factor	20 yr life, 5.25% interest of TCI	$968,365	Per EPA Control Cost Manual
Total Indirect Annual Costs (IC)		*$1,473,863*	
Total Annual Costs (DC + IC)		***$1,877,476***	
Emission reduction from baseline (tpy SO_2)		946.0	100% control - 2016 emissions
Cost Effectiveness ($/ton of controlled emissions)		***$1,985***	Total annual cost/total tons of controlled emissions

Notes:
Chemicals include chelating compound, iron compound, antifoaming agent/surfactants, and potassium hydroxide.
Sulfur cake storage facilities, disposal costs, and/or revenue from sulfur cake sales are not included above.

Attachment B

Revised AGI System Cost Evaluation

Table 3-1
Cost Effectiveness Evaluation of Acid Gas Injection

Direct Costs	Control Cost Formula	Cost	Comments
Purchased Equipment Costs			
Control System (A)	1.00 * A	$3,030,000	DGP Cost Estimate, ± 25%
Instrumentation	0.10 * A	$303,000	Per EPA Control Cost Manual
Sales Tax	0.03 * A	$90,900	Per EPA Control Cost Manual
Freight	0.05 * A	$151,500	Per EPA Control Cost Manual
Purchased Equipment Cost (PEC)	1.18 * A	*$3,575,400*	Per EPA Control Cost Manual
Direct Installation Costs			
Foundations and Supports	0.08 * PEC	$286,032	Per EPA Control Cost Manual
Handling and Erection	0.14 * PEC	$500,556	Per EPA Control Cost Manual
Electrical	0.04 * PEC	$143,016	Per EPA Control Cost Manual
Piping	0.02 * PEC	$71,508	Per EPA Control Cost Manual
Installation	0.01 * PEC	$35,754	Per EPA Control Cost Manual
Painting	0.01 * PEC	$35,754	Per EPA Control Cost Manual
Direct Installation Cost	0.30 * PEC	*$1,072,620*	Per EPA Control Cost Manual
Site Preparation	As needed		
Buildings	As needed		
Geophysical Analysis and IW/Reservoir Feasibility Study		$100,000	
Total Direct Costs (DC)		*$4,748,020*	
Indirect Costs (Installation)			
Engineering	0.10 * PEC	$357,540	Per EPA Control Cost Manual
Construction and Field Expenses	0.05 * PEC	$178,770	Per EPA Control Cost Manual
Contractors	0.10 * PEC	$357,540	Per EPA Control Cost Manual
Startup	0.02 * PEC	$71,508	Per EPA Control Cost Manual
Performance Test	0.01 * PEC	$35,754	Per EPA Control Cost Manual
Contingencies	0.03 * PEC	$107,262	Per EPA Control Cost Manual
Total Indirect Costs (IC)	0.31 * PEC	*$1,108,374*	Per EPA Control Cost Manual
Total Capital Investment (TIC)	DC + IC	***$5,856,394***	

Notes:
Control system cost (A) includes drilling costs, main compressor, secondary compressor, piping, electrical and MCC upgrades, site leasing costs, and safety equipment.

Revised 3/20/2020

Table 3-1
Cost Effectiveness Evaluation of Acid Gas Injection

	Control Cost Formula	Cost	Comments
Direct Annual Costs			
Operating Labor			
Operator	0.5 hr/shift * 3 shifts per day, 365 days/yr	$16,425	Per EPA Control Cost Manual and DGP labor rates
Supervisor	15% of operator costs	$2,464	Per EPA Control Cost Manual
Operating Materials			
Maintenance			
Labor	0.5 hr/shift * 3 shifts per day, 365 days/yr	$19,163	Per EPA Control Cost Manual and DGP labor rates
Material	100% of maintenance labor	$19,163	Per EPA Control Cost Manual
Utilities			
Electricity	110 HP, 8760 hr/yr, $0.10 kw-hr	$71,857	Booster Compressor and Acid Gas Compressor
Total Direct Annual Costs (DC)		*$129,071*	
Indirect Annual Costs			
Overhead	60% of sum of operating and maintenance labor and maintenance materials	$32,850	Per EPA Control Cost Manual
Adminstrative Charges	2.0% * TCI	$117,128	Per EPA Control Cost Manual
Property Tax	1.0% * TCI	$58,564	Per EPA Control Cost Manual
Insurance	1.0% * TCI	$58,564	Per EPA Control Cost Manual
Capital Recovery Factor	20 yr life, 5.25% interest of TCI	$479,945	Per EPA Control Cost Manual
Total Indirect Annual Costs (IC)		*$747,051*	
Total Annual Costs (DC + IC)		***$876,121***	
Emission reduction from baseline (tpy SO_2)		946.0	100% control - 2016 emissions
Cost Effectiveness ($/ton of controlled emissions)		***$926***	Total annual cost/total tons of controlled emissions

Revised 3/20/2020