February 24, 2021

David Joe
Bay Area Air Quality Management District
375 Beale Street, Suite 600
San Francisco, CA 94105

Dear Mr. Joe:

Re: Response to the Documentation Provided to the February 4, 2021 Workshop on Regulation 6 Rule 5

Based on the discussion in these documents the choice between Scenario A, the electrostatic precipitator (ESP), and scenario B, the wet gas scrubber (WGS) boils down to a matter of dollars. In one scenario the costs are compared to an assumed level of corporate profit, in a second, the effectivity in dollars per ton of pollutant removed, or, thirdly in a cost/benefit analysis comparing the costs of control to adverse health effects and deaths. In all these cases the values obtained as the capital cost for the facilities must be subjected to very careful review as they will strongly influence the outcome. I will only deal with the WGS since it is expected to be the BARCT for this application and staff determines that it is more expensive than the ESP.

Unfortunately, this documentation falls woefully short on this point.

1. The EPA document referenced is not at all applicable to facilities of this size.

The EPA report cited as reference 29 by Joe, United States Environmental Protection Agency (EPA), 2018a. EPA Air Pollution Control Cost Manual. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution has an equation for the costing of wet gas scrubbers which are limited to less than 90, 000 cfm.

$$\text{Cost}(\$2002)=1300Q_{sat}^{0.5}$$

where Q_{sat} is the saturated waste gas flow in cubic feet per minute for a system with a high flow venturi using alloy 276.

However, per staff, the Chevron refinery will require a single unit with 550,000 cfm and the PBF facility will require 3 facilities of 160,000 cfm each. There is no way that such an equation can be reliably extrapolated outside its limits to cover these much larger facilities. In addition, the EPA report demands that the following parameters be provided for the facility in order to do a “study level” estimate which is expected to be accurate to +-30%:

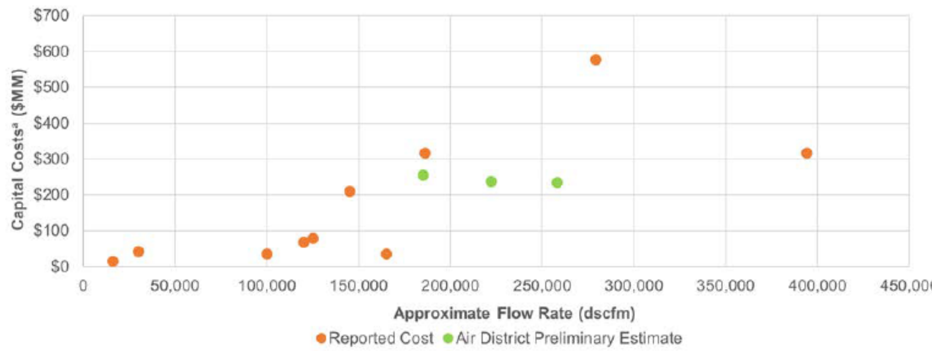
- Particle size distribution and loading;
- Waste gas flow rate, temperature and humidity;
- Gas velocity and pressure drop;
- Liquid-to-gas (L/G) ratio;
- Droplet size; and
- Residence time. “

In the staff reports only the waste gas flow rate has been provided.

2. **The data provided for the 10 comparison facilities provide no corroboration for the estimates given.**

Staff cites in their Table 7 reproduced here 10 facilities that have constructed WGS.

Figure 2 – Summary of Refinery Wet Gas Scrubber Capital Costs



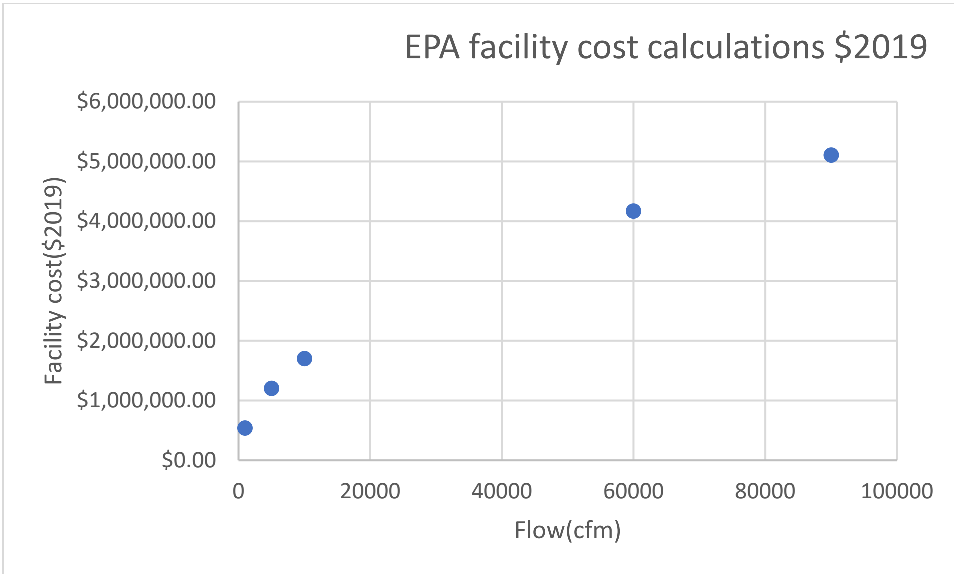
[a] Capital costs shown were adjusted to year 2019 dollars and California market cost basis where appropriate.

Table 7 – Adjusted Capital Costs of Refinery Wet Gas Scrubbing System Installations

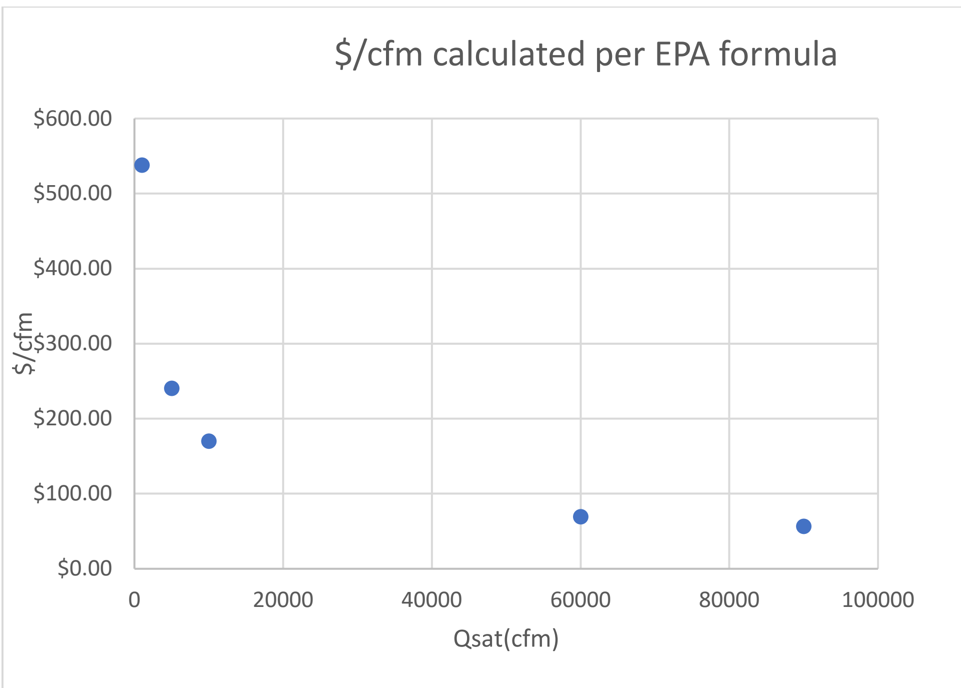
Installation/ Operational Year	Facility/Unit	Reported Capital Cost, Adjusted[a]	Approximate Flow Rate (dscfm)[b]
2011	HollyFrontier Woods Cross Unit 4 FCCU #1[46]	$16 MM	16,000
2015	HollyFrontier Cheyenne FCCU[47]	$43 MM	30,000
2004	Tesoro Mandan FCCU[48]	$36 MM	100,000
2008	Unspecified SCAQMD Refinery X FCCU[49]	$68 MM	120,000
2006	Shell Puget Sound Refinery FCCU[50]	$79 MM	125,000
2007	CITGO Lemont FCCU[51]	$210 MM	145,000
2004	Shell Deer Park FCCU[52]	$36 MM	165,000
2006	Valero Delaware City Refinery Coker[53]	$316 MM	186,000
2010	Valero Benicia FCCU and Coker[54]	$579 MM	280,000
2006	Valero Delaware City Refinery FCCU[55]	$316 MM	394,000

[a] Capital costs shown were adjusted to year 2019 dollars and California market cost basis where appropriate.
[b] dscfm = dry standard cubic feet per minute

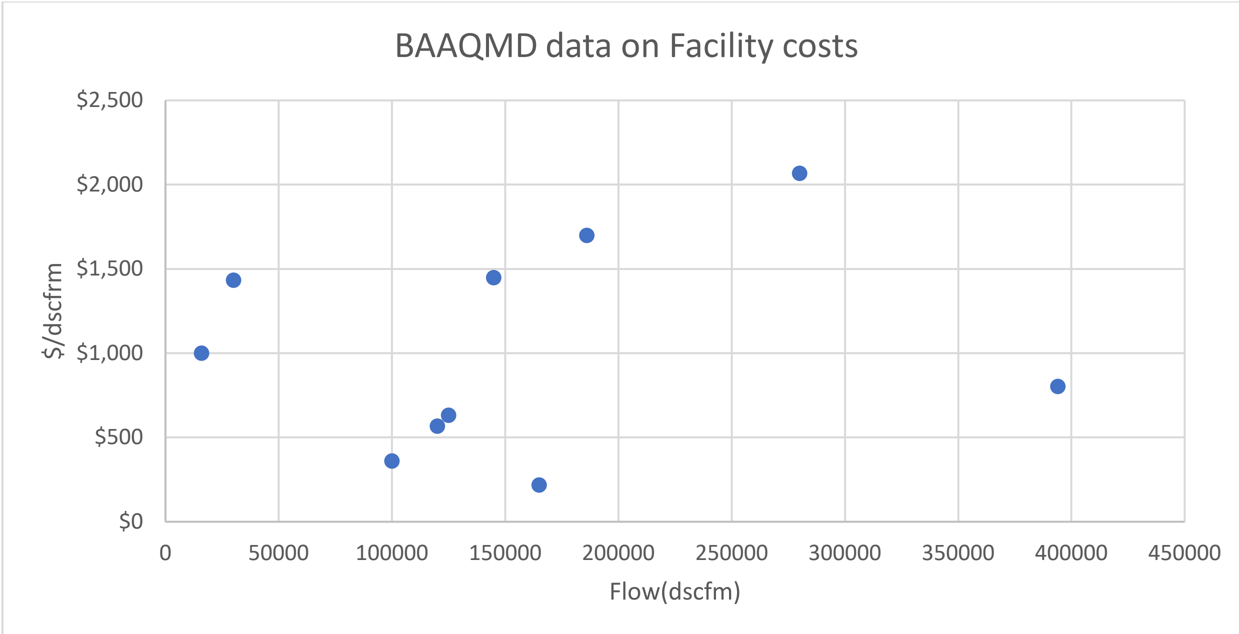
In order to see if there is any relationship to the systematic predictions of the EPA's equation above, I plotted the same graph of total cost vs. flow, correcting with the suggested extra factors direct, indirect, and retrofit costs, as well as using the Producer Price Index Inflation factor for Oil and Gas Machinery and Equipment from 2002 to 2019 to come up with a graph of $2019 vs. flow volume up to a maximum of 90,000 cfm, the limit of the equation.



Per the EPA, the cost per cfm should decrease as the size of the facility increase. This is indeed the case.



Below we plot the same graph of $/dcfm for the data in table 7 of the staff report cited above, where no systematic behavior appears, leading to the conclusion that there are other factors at work that make the cost estimates incomparable.



3. **In the absence of good cost guidance, prudent engineering demands that competitive estimates be provided by known equipment vendors.**
   In my 37-year professional career in universities, federal labs, and industry, I have purchased a large amount of custom-built industrial equipment. It has always been necessary to get at least 2 competitive bids on any equipment intended to be purchased. I would suggest that this be done for both the ESP and the WGS in order to provide a sound basis for comparison.

4. **Even in the case that the staff WGS estimates are correct, the WGS is still cost effective in a cost/benefit analysis.**
   Shown below is Table 12 from the staff report. For scenario B the estimated yearly costs of a WGS of $39M are not much higher than the benefits of $27M, considering the uncertainties in both estimates. In addition, on Page 31-32, regarding costs estimated for WGS installation and operation, Mr. Joe states
   "On the revenue side, the highest estimated cost impacts are at Marathon Martinez Refinery and PBF Martinez Refinery. At PBF Martinez Refinery, these impacts would amount to approximately 0.62 percent of estimated annual revenue at the facility. Translated to the wholesale price for gasoline, this equals about $0.75 per barrel or $0.02 per gallon."

   This means that even for the worst case the price increase to the consumer is negligible. As for me, I would rather pay at the pump rather than in the hospital.

2. Summary of Estimated Annual Reductions, Benefits, and Costs

Table 12 reproduces the bottom-line valuations from Table 11 alongside the estimates of emissions reductions and associated costs that were reported in previous sections.

Table 12 – Modeled Reductions, Valuations of Benefits, and Costs (Annual, Chevron Alone)

Scenario	Emission Reductions*	Valuation of Assessed Benefits†‡	Estimated Costs
A	80 ton/yr	\$6.8 MM to \$15 MM/yr	\$4.4 MM/yr
B	160 ton/yr	\$12 MM to \$27 MM/yr	\$39 MM/yr

** PM_{10} from FCCU. Modeled $PM_{2.5}$ / PM_{10} ratio for the Chevron FCCU is approximately 95%.*
† Based on EPA-approved valuations of the health impacts that were assessed.
‡ Valuations are in 2015 US Dollars, calculated using the EPA BenMAP system.