July 13th, 2020

Transmitted via email
David Joe
Bay Area Air Quality Management District (BAAQMD)
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San Francisco, CA 94105
Email: djoe@baaqmd.gov

Re: CBE Comments on BAAQMD Draft Rule 6-5 (Oil Refinery FCCUs) – The Rule Should Be Strengthened to Protect Environmental Justice Communities From Deadly $PM_{2.5}$ and Other Emissions

Dear Mr. Joe,

Communities for a Better Environment (CBE) is an Environmental Justice organization that has fought for oil refinery cleanup and pollution prevention for 40 years, especially to protect the health of disproportionately impacted communities of color. We have thousands of Bay Area members impacted by oil refineries who deserve pollution prevention to minimize deadly Particulate Matter (PM) emissions from refineries. We welcome the long-awaited draft regulation on refinery FCCUs (Fluid Catalytic Cracking Units). FCCUs are the centerpiece of refineries and the largest refinery emissions sources of $PM_{2.5}$ (tiny PM that can penetrate deep into lungs). We urge rule strengthening amendments and processes identified below.

This rule, if made stronger, can make a dramatic impact and save lives. Chevron's FCCU emits about 60% of the $PM_{2.5}$ from the entire refinery, making it the single largest point source of $PM_{2.5}$ in the city of Richmond.[1] Bay Area-wide, $PM_{2.5}$ is deadly and causes thousands of deaths per year.[2] This year $PM_{2.5}$ has been linked to additional hazards, as Harvard researchers have found that long-term exposure to $PM_{2.5}$ is correlated with higher death rates from Covid19.[3] In addition, FCCU catalyst regenerator vents release a range of other pollutants during coke burn off, including metal Hazardous Air Pollutants (HAPs) such as nickel, manganese, and chromium, as well as a wide range of organic HAPs.[4]

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[1] BAAQMD Emissions Inventory, Criteria Air Pollutants, various years
[2] 2017 Clean Air Plan, p. 195, C/7, available at https://www.baaqmd.gov/~/media/files/planning-and-research/plans/2017-clean-air-plan/attachment-a_-proposed-final-cap-vol-1-pdf.
[3] *Exposure to air pollution and COVID-19 mortality in the United States*. Xiao Wu, Rachel C. Nethery, Benjamin M. Sabath, Danielle Braun, Francesca Dominici. medRxiv 2020.04.05.20054502; doi: https://doi.org/10.1101/2020.04.05.20054502.
[4] *See e.g.*, Emission Estimation Protocol for Petroleum Refineries, RTI International, May 2011, p. 5-2 – 5-11, available at https://www3.epa.gov/ttnchie1/efpac/protocol/Emission_Estimation_Protocol_for_Petroleum_Refinerie_052011.pdf
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Primary particulate matter comes in two forms – directly-emitted particulate matter (called filterable PM) and condensable PM (caused by gaseous pollutants emitted from stacks which then cool, condense, and combine with other pollutants to form mostly $PM_{2.5}$ particulates in the air).[5] The majority, up to 90%, of the total PM created by FCCUs can be from condensables created just meters from the source stacks.[6] It is imperative that BAAQMD impose direct controls that include condensable PM emitted by FCCUs. Existing regulations and permit conditions addressing only filterable PM without consideration for condensables have ignored the bulk of the problem.[7]

Summary of Findings and Recommendations:

- We are encouraged that the District has chosen to prioritize this rule and treat this issue with the seriousness that it deserves.
- However, the proposed regulation standards do not require emission reductions from most refineries in the region and need strengthening in order to protect public health from deadly particulate matter and other pollutants.
- We urge the District hold an online public workshop well in advance of the public hearing to ensure adequate public participation. Many other agencies have conducted similar workshops amid Covid19 shelter-in-place orders.
- United States Environmental Protection Agency (U.S. EPA) and South Coast Air District (SCAQMD) data show that several refineries outside the Bay Area achieve total PM emission levels at half or less of the BAAQMD-proposed standard (to 0.01 gr/dscf or less, compared to BAAQMD-proposed 0.02 gr/dscf in the Draft Amendments to Rule 6-5). In addition, Valero Benicia achieves annual emissions much lower than all other Bay Area refineries by using Wet Gas Scrubbing technology, indicating it meets a much tighter standard.
- In addition, Sulfur Oxide (SO_x) limits are met by many refineries down to 5 ppm, compared to the BAAQMD-proposed standard of 25 ppm. The standard should be tightened to meet the levels already achieved by refineries and recommended as the BARCT level by SCAQMD.

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[5] In the case of ESPs using ammonia injection to increase collection efficiency, the main condensable particulate formed during cooldown of flue gas is ammonium sulfate, which forms from SO_x and ammonia emitted from the gas vent at high temperatures. SO_x reacts with water in the gas vapor to form sulfuric acid, which once condensed (between 200 and 300 F) is rapidly neutralized by ammonia to form ammonium sulfate and ammonium bisulfate, stable solids at ambient temperatures. *See* South Coast Rule 1105.1 Final Staff Report (2003), p. 123-125.

[6] *See e.g.*, WSPA source testing that found that 86.5% of PM was condensable PM (SCAQMD Final Staff Report for Proposed Rule 1105.1, Attachment E pg. 133); U.S. EPA Information Collection Request Component 3 Source Tests, 2007.

[7] *See e.g.*, Permit Condition 11066 from Chevron's Title V, BAAQMD, available at https://www.baaqmd.gov/~/media/files/engineering/title-v-permits/a0010/a0010_10_2019_renewal_proposed_permit_03-pdf.pdf?la=en.

- We request that you release the source test and emissions inventory data used in preparation of the Initial Staff Report (ISR), including the total PM levels met by each refinery in the same units used in the rule standards – gr/dscf – for comparison.
- We urge improvements to monitoring, and administrative requirements in the Proposed Rule.
- Source tests conducted to ensure compliance with this rule should be published online in a format accessible to the general public for transparency and to generate public trust.
- Cost figures cited in further reports should ensure that all costs, including capital costs, referenced in the upcoming socioeconomic analysis specify what is included (e.g. construction, demolition, engineering, equipment costs, etc.) and contextualize what is included in the project to allow for accurate comparison.

We urge the district to move forward with the strongest possible rule expeditiously.

A. This rule needs a public workshop before hearing

There is a need for and an obligation to provide at least one public workshop on this important rule which can save many lives, and which community-based organizations and community members have long sought. There are many regulatory agency models for carrying out public workshops online during the Covid19 pandemic if the District needs additional logistical preparation. We urge holding a public workshop which provides slides including education about impacts of $PM_{2.5}$ and other pollutants, benefits of maximizing emissions reductions, and Best Available Retrofit Control Technology (BARCT).

The District's 2013 Public Participation Plan supports the use of workshops in rulemakings like this one.[8] Public workshops are one method the District uses to "Involve" the public in order to gather input to "understand the perspectives of different community groups" and "to ensure a plan or rule is comprehensive and effective".[9] Workshops are held to "educate the public and solicit input on a specific issue" where "[d]iscussion and question-and-answer sessions can provide new ideas and approaches for an issue."[10]

The District's Public Participation Plan notes that workshops are distinct from the public hearing the District is required to hold prior to adoption of a new rule by California Health and Safety Code § 40725.[11] In fact, it is standard protocol in advance of the regulatory public hearing for

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[8] Bay Area Air District Public Participation Plan, December 2013, p. 28, available at https://www.baaqmd.gov/~/media/files/communications-and-outreach/community-outreach/public-engagement/ppp_final_121713.pdf?la=en.
[9] *Id*. at 12.
[10] *Id*. at 23.
[11] *Id*. at 53.

District staff to conduct "one or more public workshops for each rule or rule modification so that all affected and interested parties can discuss, comment on, and ask questions about the proposed rule."[12]

Many examples of online rulemaking, hearings, and workshops have been developed by regulatory agencies.[13] These meetings have included online discussions, methods to send email questions, methods to include speakers calling in or attending by methods such as Zoom, options for written comments before and after, presentations provided ahead, and coordination with community organizers who could facilitate community involvement.

Further, while the District does not appear to have a standard Environmental Justice policy, the California Air Resources Board (CARB)'s Policies and Actions for Environmental Justice also provide helpful guidance.[14] Policy II aims to strengthen "outreach and education efforts in all communities, especially low-income and minority communities" and in order to accomplish this, seeks to "solicit input […], develop additional information on air quality in communities, make this information more accessible, and educate communities on the public process used to make State and local decisions."[15] It is CARB policy to provide these communities "the opportunity to participate in the decision-making processes" while "[i]n partnership with local air districts".[16] Finally, one of the many specific actions listed to accomplish these policy goals is to "[h]old meetings in communities affected by our programs, policies, and regulations at times and in places that encourage public participation…"[17]

As described below, Rule 6-5 was also identified by the District as part of the AB617 BARCT process. Assembly Bill 617 (C. Garcia, 2017) upholds the need for strong public participation elements. The AB617 Blueprint adopted by the California Air Resources Board (CARB) found that common themes recommended during public engagement processes included those which *"Ensure transparency throughout the entire process of designing and implementing the Program."*[18] It is even more important in this case to provide a public workshop, since

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[12] *Id*.
[13] *See e.g.*, American Planning Association - Online Alternatives to In-Person Public Meetings in an Emergency, available at https://www.planning.org/blog/9199029/online-alternatives-to-in-person-public-meetings-in-an-emergency/; SCAQMD AB617 Wilmington / Carson / W. Long Beach Steering Committee Meeting, available at http://www.aqmd.gov/docs/default-source/ab-617-ab-134/steering-committees/wilmington/meeting-flyer-may13-2020.pdf?sfvrsn=14; SCAQMD Online Working Group Meeting - Rule 1109.1 (NO_x Reductions / Oil Refineries), available at http://www.aqmd.gov/home/news-events/calendar_v2?month=5&day=21&year=2020&id=47e2b0ef-c2b6-6f27-bf6f-ff00004a91a9.
[14] Policies and Actions for Environmental Justice, CARB, approved on December 13, 2001, available at: https://ww3.arb.ca.gov/ch/programs/ej/ejpolicies.pdf.
[15] *Id* at 4.
[16] *Id*.
[17] *Id*.
[18] Final Community Air Protection Blueprint, CARB, p. 11, available at: https://ww2.arb.ca.gov/resources/documents/final-community-air-protection-blueprint.

Richmond and other refinery communities in the Bay Area did not receive a formal Community Emission Reduction Plan (CERP) process.

In addition, the Blueprint described how CARB has carried out public engagement proceedings, including public workshops, to engage community members as part of AB617: *"Coordination with a wide variety of stakeholders is essential in helping to design and implement the Program at both the statewide and community level. In developing this Blueprint, we have received written comments from a number of stakeholders and conducted multiple outreach activities and different types of engagement, including: holding various community meetings and workshops, and participating in town halls, tours, and additional workshops organized by other public agencies and community groups."*[19]

Furthermore, during the hearing of the California Air Resources Board (CARB) in 2018 on AB617 plans, Rule 6-5 was promised to be brought to the public by BAAQMD in early 2019. Supervisor Gioia supported Bay Area refinery neighbors in his statements as a CARB Boardmember at this hearing, made this commitment, and also stated regarding the timeframe: *"I know advocates will come to our meeting and will hold the air district accountable to following this time frame of starting rule development in early 2019 and completing it . . . in 2020*" (Mr. Broadbent, BAAQMD APCO, concurred with this timeline during the hearing).[20] Although the public process was delayed a year and a half, this delay should not result in cutting public participation (including a public workshop) out of the process. The public process should not be rushed or short-circuited.

B. This rule must be held to BARCT scrutiny

Although the ISR does not name this explicitly, it is important not to forget that the District has committed itself to a rule that meets state standards on Best Available Retrofit Control Technology (BARCT). The San Francisco Bay Area Air Basin is currently in nonattainment status for both state and federal ozone and particulate matter air quality standards.[21] As a result, AB 617 requires the Air District to adopt an expedited schedule for implementation of BARCT by the earliest possible date, which it did in 2018.[22] Rule 6-5 was identified as one of the key rules to meet these requirements.[23]

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[19] *Id*. at 10.
[20] Transcript, CARB Board Hearing, Sept. 27, 2018, p. 149, available at: https://ww2.arb.ca.gov/2018-board-meetings.
[21] Air Quality Standards and Attainment Status, BAAQMD, available at https://www.baaqmd.gov/about-air-quality/research-and-data/air-quality-standards-and-attainment-status.
[22] Cal. Health & Safety Code § 40920.6(c)(1) (West); AB 617 Expedited BARCT Implementation Schedule (Adopted December 19, 2018), BAAQMD, available at https://www.baaqmd.gov/rules-and-compliance/rule-development/barct-implementation-schedule.
[23] AB 617 Expedited BARCT Implementation Schedule Final Staff Report, BAAQMD, December 2018, available at https://www.baaqmd.gov/~/media/files/ab617-community-health/barct/20181214_fsr_ab617_barct-pdf.pdf?la=en.

The statutory definition of BARCT that is used by the District legally requires an emission limitation that provides the "**maximum** degree of emissions reduction achievable by a class or category of source".[24] After environmental, energy, and economic impacts are considered, the final limitation adopted by the District should represent the strongest emission limitation possible. In fact, to reach such a high BARCT standard, the District is even allowed to implement an emissions limitation so strict that it would require new technology to achieve this new limit.[25] However, the Draft Rule need not force development of new technology to achieve the maximum degree of emissions possible; instead, it could implement a limit that properly reflects the PM emissions reductions that have already been achieved by several refineries around the country.

C. Lower total PM standards are achieved in practice and should be required

The ISR determines an appropriate total PM standard to be 0.02 grains of particulate matter per dry standard cubic foot of air (gr/dscf). **This standard is sufficiently weak that two out of the four Bay Area refineries with FCCUs, Marathon and Valero, won't be affected at all by this standard**.[26]

In **Table 1** we have summarized the current total PM_{10} emissions from the four refineries and the proposed emissions reductions under the Draft Amendment. To compare against what is already achieved in practice at the Valero refinery, we have calculated the emissions for each refinery if they were to meet the same rate that Valero currently achieves (considering the different unit capacities).

Due to its Wet Gas Scrubber (WGS), Valero represents the best achieved emissions levels among Bay Area FCCUs, notwithstanding the fact that Valero's emissions include both the exhaust from its FCCU as well as its fluid coker. In total, if the four refineries were held to the same emissions standard that Valero already achieves, the refineries collectively could reduce their FCCU PM_{10} emissions by 493 tpy, compared to the 250 tpy proposed.

[24] Cal. Health & Safety Code § 40406 (West); BAAQMD Rule 2-2-203; BAAQMD Rule 2-9-203 (emphasis added).
[25] *See Am. Coatings Assn. v. S. Coast Air Quality Mgmt. Dist.*, 54 Cal. 4th 446, 462–69 (2012).
[26] Initial Staff Report (ISR) for Draft Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units, BAAQMD, May 2020, p. 17, available at https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-6-rule-5-particulate-emissions-from-refinery-fluidized-catalytic-cracking-units/2020-amendment/documents/20200528_isr_0605-pdf.pdf?la=en

Refinery	FCCU Fresh Feed Capacity (bpd)	PM_{10} Emissions (tpy)		
		Current	Under Proposed Rule	If Refineries Met Valero's Emission Rate[27]
Chevron	80,000	245	165	92
Marathon	70,000	190	190 *(no change)*	81
PBF	67,400	309	139	78
Valero	72,000	83	83 *(no change)*	83
Total	289,400	827	577	334

Table 1: Bay Area Refinery FCCU Emissions and Proposed Reductions. Based on emissions data presented in Table 1 and estimated PM_{10} reductions in Table 2 in the ISR (80 tpy for Chevron and 170 tpy for PBF).

In addition, the data cited by the ISR to determine its proposed emissions standard shows multiple refineries outside the Bay Area achieving far lower emissions levels. The ISR refers to a set of source tests compiled by U.S. EPA in 2011. The study conducted a wide survey on refinery control technologies on several unit types, including FCCUs. For a subset of ten refineries, the U.S. EPA further required the refineries to conduct and submit source tests. **Seven out of the ten refineries surveyed achieved BAAQMD's proposed standard.** This demonstrates that BAAQMD's proposed standard is much looser than the best achievable.

Between these refineries and other examples compiled from South Coast AQMD documents, **we find that 0.01 gr/dscf total PM or better is a standard achieved in practice by at least five refineries (most over a decade ago).** Results are summarized in **Table 2**. If data were available for Valero Benicia, emissions inventory data suggest that it would also join this list.

[27] Emissions are calculated using emissions data in the ISR and Valero's emissions rate of 1.15 tons per year of PM_{10} per 1,000 bpd of FCCU fresh feed capacity.

Company	**ExxonMobil**	**Valero**	**Citgo**	**Marathon**		**-**
Location	**Torrance, CA**	**Port Arthur, TX**	**Lake Charles, LA**	**Garyville, LA**		**South Coast Air Basin**
PM Control Type	ESP	Venturi/wet scrubber	Venturi/wet scrubber	Venturi/wet scrubber[28]		Wet Gas Scrubber
Total Condensable (gr/dscf)	0.010	0.002	0.004	0.003	0.002	0.000
Filterable (gr/dscf)	0.001	0.006	-	0.006	0.008	0.003
Total PM (gr/dscf)	**0.010**	**0.008**	**0.006**	**0.009**	**0.011**	**0.003**

Table 2: Source Test Results from Several Refinery FCCUs Meeting Stricter Standards than those Proposed. "-" = Data not available or not recorded. Results for ExxonMobil, Valero, and Citgo from U.S. EPA Information Collection Request Component 3.[29] Results for Marathon in Garyville from a source test conducted under two different scrubbing conditions.[30] Results for unnamed refinery in SCAQMD's territory from a voluntarily test of its FCCU with wet gas scrubber.[31] See Attachments A-C for source test details and results.

The majority of these examples meeting stricter standards rely on wet scrubbing technology, which is a proven, achieved-in-practice technology that removes both filterable particulates *and* condensable precursors (such as SO_x), while mitigating the need to inject further precursors (namely ammonia). Wet Gas Scrubbing systems regularly achieve over 95% collection efficiency for particulates.[32]

Between these multiple examples of WGS systems used in practice to achieve 0.01 gr/dscf and lower total PM levels, the evidence strongly supports that WGS should not be treated as a fringe technology. On the contrary, survey data appear to show that it is already installed on a majority of FCCUs. In 2011, the U.S. EPA sent out a comprehensive industry-wide Information Collection Request (ICR) to all U.S. petroleum refineries. Component 1 included a questionnaire on processes and controls to be conducted by all refineries. Responses were received from 149 out of the 152 that were contacted. PM abatement technology was collected for 110 FCCUs across 97 refineries. Of these, 56 (51%) reported using a WGS, while 44 (40%) reported using an

[28] *See* Permit PSD-LA-719, Louisiana Department of Environmental Quality, December 2006, available at https://denr.sd.gov/Hyperion/Air/RefPermitGaryvilleRefineryLA20061227.pdf.
[29] *See* Attachment A: U.S. EPA Information Collection Request Component 3 Source Tests, 2007.
[30] *See* Attachment B: Stack Test Results – Unit 30 FCCU Regenerator Vent, Marathon Louisiana Refining Division, Garyville, LA.
[31] *See* Attachment C: Final Staff Report SO_x RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis, November, Appendix D, p. 250-251.
[32] Monitoring by Control Technique - Wet Scrubber For Particulate Matter, U.S. EPA, available at https://www.epa.gov/air-emissions-monitoring-knowledge-base/monitoring-control-technique-wet-scrubber-particulate-matter

ESP (4 reported using both a WGS and ESP). **As a result, WGS is a technology that has been used in practice for decades and was used by a majority of the industry nearly a decade ago.** It bears noting again that under *American Coatings (2012)*, the level used in a BARCT standard *need not require the technology to even exist today*.[33]

As a result, we request that you release the source test and emissions inventory data used in preparation of the ISR, including the total PM levels met by each refinery in the same units used in the rule standards – gr/dscf – for comparison. In the interest of transparency for future reports, we further ask District staff to explicitly separate what emissions are achievable using ESPs compared against what is achievable using WGSs.

D. Lower SO_x levels are achieved in practice and should be required

The ISR proposes using the Sulfur Oxide (SO_x) limits from the Federal New Source Performance Standards Subpart Ja, for new or modified FCCUs.[34] While adding a SO_x standard is an important addition to the rule, the proposed limit is far from the most stringent emission standard available.

The ISR proposes a limit of 25 parts per million by volume (ppmv) on a rolling 365-day basis. During evaluation of its RECLAIM program, SCAQMD reviewed facilities with wet scrubbers installed and found that Valero in Delaware City with two wet gas scrubbers (on both its FCCU and fluid coker units) *continuously* achieved 1 - 2 ppmv.[35] In total, SCAQMD found that of the ten FCCUs with wet scrubbers surveyed, all achieved a level below 18 ppmv, and six achieved levels below 5 ppmv in practice.[36] **Both SCAQMD consultants and staff recommended a BARCT level of 5 ppmv -- one-fifth of the standard that BAAQMD is now proposing.**[37]

[33] *See Am. Coatings Assn. v. S. Coast Air Quality Mgmt. Dist.*, 54 Cal. 4th 446, 462–69 (2012), ["BARCT is therefore a technology-forcing standard designed to compel the development of new technologies to meet public health goals." . . . "A standard that is technology-forcing need not ignore considerations of practicality." . . . "'best available retrofit control technology' is not limited to technology that already exists at the time a regulation is promulgated. BARCT also encompasses potential or developing technology that will enable compliance with emissions limits by the effective date of the regulation. Under section 40406 and related statutes, air pollution control districts may take continuing technological progress into account in determining what emissions reductions are 'achievable' when setting BARCT standards to meet their public health goals."].

[34] Initial Staff Report for Draft Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units, BAAQMD, May 2020, p. 16, available at https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-6-rule-5-particulate-emissions-from-refinery-fluidized-catalytic-cracking-units/2020-amendment/documents/20200528_isr_0605-pdf.pdf?la=en

[35] SCAQMD, 2010. Final Staff Report SO_x RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis, November, p. 43.

[36] *Id*. at 44.

[37] *Id*. at 45-46.

E. Rule enforcement should be strengthened and made more transparent

In addition to the emission standard used, we are very concerned about source testing accuracy in future rule compliance, to ensure that rule standards are not exceeded. We urge you to discuss the following during rulemaking and include provisions in the rule that include the following:

- Requiring independent testing (by the Air District rather than the refineries)
- Requiring testing under worst-case operating conditions (thus preventing testing under uncharacteristic conditions that hide high-emission operations)
- Identifying and requiring the strongest Quality Assurance / Quality Control measures
- Requiring sufficiently frequent testing to prevent health impacts associated with emission spikes (which can be hidden through averaging)
- Publishing source test results on a public page on the BAAQMD website for transparency with the public
- Clarifying language in the currently broad exemption listed in Section 6-5-114 of the Rule to ensure that it only applies if ammonia, urea, and other nitrogen-based additives are not used during abatement at all

We also urge the District to provide the public with more information about the advantages and disadvantages of the different source test protocols identified in the rule, and whether there are additional testing methods and/or CEMS (Continuous Emission Monitoring Systems) which could improve results.

F. Wet gas scrubbing cost figures reported in the ISR do not appear to accurately reflect the cited records

We anticipate in the next round of comments that site-specific cost estimates are provided for a thorough comparison between control options. However, we take issue with the way that cost figures are currently presented in the staff report for WGS systems and advise that care be taken with future cost comparisons to ensure that cost figures are not misrepresented.

In reporting capital costs for WGS systems, the ISR summarizes cost figures from an U.S. EPA document and two South Coast AQMD documents, stating the "capital costs… range from $20 million dollars to $100 million dollars."[38] This range does not comport with two of the three documents cited. BAAQMD originally summarized the referenced U.S. EPA report as showing

[38] Initial Staff Report for Draft Amendments to Regulation 6, Rule 5: Particulate Emissions from Petroleum Refinery Fluidized Catalytic Cracking Units, BAAQMD, May 2020, p. 11, available at https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-6-rule-5-particulate-emissions-from-refinery-fluidized-catalytic-cracking-units/2020-amendment/documents/20200528_isr_0605-pdf.pdf?la=en

capital costs estimates ranging from $18M to $25M.[39] The first South Coast AQMD document cited estimated capital costs ranging from $9.5M to $15M and reported capital cost estimates provided by one refinery for installation of a WGS of $30M.[40] The second is a Staff Report for South Coast AQMD's SO_x RECLAIM program, which reported capital cost estimates prepared by a consultant for five refineries. Two refineries were found to have capital costs between $60-70M, two were found with costs between $80-90M, and a single refinery was found to have a retrofit cost of $94M.[41] As a result, the range cited in the report appears to mischaracterize the actual costs found in the sources cited.

In addition, the Staff Report cites the flue gas scrubber cost upgrades from the Valero Improvement Project (VIP) as $750M, based on a single line item in a construction report.[42] However, the project components associated with that line item are vast. After amending its application (initially not designed to use the WGS to significantly abate FCCU emissions), Valero opted to make the following upgrades:

- Pre-scrubber
- Unfired waste heat boiler
- Caustic polisher
- Amine scrubber
- Amine regenerator
- New furnace with SCR
- Retrofitting two furnaces with new low-NO_x burners[43]

While these upgrades collectively reduced filterable PM, as well as ammonia, NO_x, and SO_x PM-precursors, these equipment and installation costs will not be required in general for a WGS upgrade. Citing a figure of $750M without contextualizing the upgrades included or providing a line item breakdown distorts perceptions of the actual capital cost requirements for other refineries.

As a result, we ask that all costs, including capital costs, referenced in the upcoming socioeconomic analysis specify the type of cost (e.g. construction, demolition, engineering,

[39] *See* Refinery Rules Technical Working Group Discussion Topics - Amendments to Regulation 6: Particulate Matter, Rule 5: Particulate Emissions from Refinery Fluidized Catalytic Cracking Units, p. 3.
[40] SCAQMD, 2003. Final Staff Report Proposed Rule 1105.1, October, p. 36-37.
[41] SCAQMD, 2010. Final Staff Report SO_x RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis, November, p. 131.
[42] *See* VIP Semi-Annual Construction Report, Valero Benicia Refinery, August 2012, p. 3, available at https://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/VIP_Construction_Report.pdf.
[43] *See* Revised Environmental Analysis for the Valero Improvement Project Amendments, Valero Benicia Refinery, October 2007, p. 2-9, available at https://www.ci.benicia.ca.us/vertical/sites/%7BF991A639-AAED-4E1A-9735-86EA195E2C8D%7D/uploads/VIP_Amendment_and_Environmental_Analysis.pdf.

equipment costs, etc.) and contextualize what is included in the project to allow for accurate comparison.

In conclusion, we urge you to tighten the rule as shown in our recommendations and schedule a public workshop in consultation with community members. If you have questions, please contact Dan Sakaguchi (dan@cbecal.org).

Thank you for your consideration.

Sincerely,

Dan Sakaguchi, CBE Staff Researcher

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Andrés Soto, CBE Richmond Organizer

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CC:
Jack Broadbent, BAAQMD Air Pollution Control Officer
Greg Nudd, BAAQMD Deputy Air Pollution Control Officer
John Gioia, Contra Costa County Supervisor, BAAQMD Board of Directors, CARB Boardmember

Attachments

Attachment A: Excerpts from Source Tests for ExxonMobil Torrance, Valero Port Arthur, and Citgo Lake Charles[44]

Attachment B: Excerpt from Source Test for Marathon Garyville[45]

Attachment C: Excerpt from Source Test for an Unnamed Refinery Within South Coast Basin[46]

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[44] Source Tests from U.S. EPA from Information Collection Request (ICR) Component 3, 2011, available at https://www.regulations.gov/docket?D=EPA-HQ-OAR-2010-0682.
[45] Stack Test Results – Unit 30 FCCU Regenerator Vent, Marathon Garyville, May 2014, p. 2-1, 2-4, available at https://www3.epa.gov/ttn/chief/old/ap42/ch05/s01/reference/ref_38c05s01_2015.pdf.
[46] SCAQMD, 2010. Final Staff Report SO_x RECLAIM, Part 1: BARCT Assessment & RTC Reductions Analysis, November, Appendix D, p. 250-251.

TABLE 4-14
PARTICULATE MATTER TEST RESULTS
EXXONMOBIL TORRANCE REFINERY
FLUID CATALYTIC CRACKER

Test No.	1-MH	2-MH	3-MH	Average	
Date:	June 30, 2011	June 30, 2011	July 1, 2011		
Start/Stop Time:	1016/1427	1554/1957	1500/1907		
Stack Flow Rate (dscfm):	230,519	231,457	242,018		
Sample Volume (dscf):	122.969	124.863	132.278		
Stack O_2 (%):	5.06	5.06	4.90		
Stack CO_2 (%):	14.04	14.08	14.30		
Moisture Fraction (%):	13.7	13.8	13.9		
Isokinetic Ratio (%):	99.2	100.3	101.7		
Compound	Grain Loading gr/dscf	Grain Loading gr/dscf	Grain Loading gr/dscf	Grain Loading gr/dscf	lb/hr
Filterable Particulate Matter(1)	0.00088	0.00090	0.00013	0.00064	1.26

(1) Particulate matter from Metals train. Front half and filter temperature at 320°F

TABLE 4-15
PARTICULATE MATTER (LESS THAN 2.5 MICRONS) TEST RESULTS
EXXONMOBIL TORRANCE REFINERY
FLUID CATALYTIC CRACKER

Test No.	$1\text{-}PM_{2.5}$	$2\text{-}PM_{2.5}$	$3\text{-}PM_{2.5}$	Average	
Date:	June 30, 2011	June 30, 2011	July 1, 2011		
Start/Stop Time:	1016/1443	1548/2014	1500/1921		
Stack Flow Rate (dscfm):	244,326	247,582	252,208		
Sample Volume (dscf):	81.652	82.996	83.261		
Stack O_2 (%):	5.03	5.06	4.90		
Stack CO_2 (%):	13.94	14.08	14.31		
Moisture Fraction (%):	15.2	14.6	13.4		
Isokinetic Ratio (%):	106.3	106.0	103.7		
Compound	Grain Loading gr/dscf	Grain Loading gr/dscf	Grain Loading gr/dscf	Grain Loading gr/dscf	lb/hr
Total Particulate Matter (less than 2.5 microns)	0.01431	0.00725	0.00814	0.00990	20.98
Solid Particulate Matter (less than 2.5 microns)	0.00025	0.00000	0.00000	0.00008	0.17
Condensible Inorganic Particulate Matter (less than 2.5 microns)	0.01357	0.00666	0.00793	0.00939	19.90
Condensible Organic Particulate Matter (less than 2.5 microns)	0.00049	0.00059	0.00020	0.00043	0.91

TABLE 4-13. FCCU-1241 WGS STACK PARTICULATE MATTER TEST RESULTS SUMMARY

	FCCU-5B-1	FCCU-5B-2	FCCU-5B-3	
TEST RUN :	FCCU-5B-1	FCCU-5B-2	FCCU-5B-3	
TEST DATE :	6/13/2011	6/13/2011	6/14/2011	
TEST TIME :	09:32 -11:45	13:40 - 17:03	07:52 - 11:12	Average
Stack Gas Parameters				
Temperature, av. °F	140.7	140.8	140.8	140.8
Velocity, av. ft/sec	23.018	22.826	22.597	22.813
Volume flow, acfm	169,484	168,067	166,382	167,978
Volume flow, scfm	149,344	148,071	146,293	147,903
Volume flow, dscfm	119,301	118,284	117,000	118,195
Volume flow, dscfh	7,158,050	7,097,012	7,019,978	7,091,680
Moisture, av. % vol	20.12	20.12	20.02	20.09
CO_2, av. % vol, db	17.24	17.42	17.04	17.23
O_2, av. % vol, db	0.92	0.73	1.20	0.95
Process Data				
Coke Burn Rate, lb/hr	22,373	22,858	29,679	24,970
Sample Train Data				
Time, min	120.0	120.0	120.0	
Volume, dscf	90.695	90.537	88.942	
Volume, dscm	2.569	2.564	2.519	
Isokinetic Ratio, %	102.3	103.0	102.5	
Particulate Matter (PM)				
Filterable PM collected, mg	49.83	33.17	24.54	35.85
Concentration				
gr/dscf	0.00848	0.00565	0.00426	0.00613
lb/dscf x 10^{-6}	1.2115	0.8078	0.6084	0.8759
Emission rate				
lb/hr	8.6690	5.7315	4.2694	6.2233
lb/1000 lb of coke burn	0.39	0.25	0.14	0.26
Condensable PM collected, mg	13.5	12.6	13.5	13.2
Concentration				
gr/dscf	0.00230	0.00214	0.00233	0.00226
lb/dscf x 10^{-6}	0.3282	0.3057	0.3334	0.3224
Emission rate				
lb/hr	2.3486	2.1685	2.3400	2.2857
Total PM collected, mg	63.3	45.7	38.0	49.0
Concentration				
gr/dscf	0.01077	0.00779	0.00659	0.00839
lb/dscf x 10^{-6}	1.5397	1.1135	0.9418	1.1983
Emission rate				
lb/hr	11.0176	7.9000	6.6095	8.5090
lb/1000 lb of coke burn	0.49	0.35	0.22	0.35
Scrubber Recirculation Liquid				
Total Dissolved Solids (TDS)				
mg/L	13,468	16,228	15,808	15,168
Scrubber Recirculation Liquid				
Total Suspended Solids (TSS)				
mg/L	907	590	997	831

Carbon Dioxide Content	vol%	17.92	18.07	17.98	17.99
Moisture Content	vol%	22.28	21.83	21.78	21.96
Wet Molecular Weight	lb/lb·mol	28.02	28.10	28.09	28.07
Velocity	ft/sec	38.06	36.23	38.95	37.75
Volumetric Flow Rate	dscfm	77,722	74,420	80,248	77,463

Sampling Parameters

Isokinetic Sampling Rate	%	94.95	94.90	94.28	94.71
Sample Volume	dscf	111.488	106.704	114.307	110.833
	dscm	3.157	3.022	3.237	3.138

Laboratory Results [1]

Organic Mercury	µg	[<0.015] BDL	[<0.012] BDL	0.023	0.017 DLL
Elemental Mercury	µg	0.411	0.413 DLL	0.427	0.417 DLL

Pollutants

Organic Mercury	µg/dscm	[<4.75E-03] BDL	[<3.97E-03] BDL	7.11E-03	5.28E-03 DLL
	lb/hr	[<1.38E-06] BDL	[<1.11E-06] BDL	2.14E-06	1.54E-06 DLL
Elemental Mercury	µg/dscm	0.130	0.137 DLL	0.132	0.133 DLL
	lb/hr	3.79E-05	3.81E-05 DLL	3.96E-05	3.86E-05 DLL

[1] Laboratory Results provided by Data Analysis Technologies, Inc.

BDL (below detection level) - all analytical values used to calculate and report an in-stack emissions value are less than the laboratory's reported detection level(s)

DLL (detection level limited) - at least one but not all values used to calculate and report an in-stack emissions value are greater than the laboratory's reported detection level(s)

1.3.8 U.S. EPA Method 5B/202 and ASTM D5907

Shaw conducted one hundred twenty minute test and two one hundred twenty eight minute tests during normal operating conditions. Particulate Matter (PM), Particulate Matter (PM) with condensables, Particulate Matter (PM) Non-sulfate, and Particulate Catch Weight were measured and the three tests were averaged.

Documentation supporting the results of this test program is presented in the appendices. A comprehensive summary of the test results and process operating conditions is presented on Table 8.

Table 8 Comprehensive Summary of Results U.S. EPA Method 5B/202 and ASTM D5907

Test No.	1	2	3	Average
Date	05/26/11	05/27/11	05/27/11	n/a
Start Time	16:15	10:42	14:58	n/a
End Time	18:49	13:06	17:16	n/a
Test Duration, min	120	128	128	125.33

Unit Operating Parameters

Oxygen Content	vol%	0.50	0.66	0.62	0.59
Carbon Dioxide Content	vol%	18.45	18.19	18.01	18.22
Moisture Content	vol%	19.79	19.69	20.07	19.85
Wet Molecular Weight	lb/lb·mol	28.41	28.39	28.32	28.37
Velocity	ft/sec	39.29	38.94	38.35	38.86
Volumetric Flow Rate	dscfm	83,318	82,935	81,025	82,426

Sampling Parameters

Isokinetic Sampling Rate	%	91.53	91.53	90.16	91.07
Sample Volume	dscf	79.111	83.999	80.840	81.317
	dscm	2.240	2.379	2.289	2.303

Laboratory Results [1]

Particulate Matter (PM)	mg	28.1	34.5	32.3	31.6
Condensible Particulate Matter (CPM)	mg	23.1	16.0	19.0	19.4
Particulate Matter (PM) Non-sulfate	mg	18.9	26.4	24.8	23.4
Particulate Catch Weight	mg	10,551.4	10,391.4	10,860.4	10,601.1
Sample Final Volume	L	0.500	0.470	0.490	0.487

Pollutants

Particulate Matter (PM)	gr/dscf	0.0055	0.0063	0.0062	0.0060
	lb/hr	3.91	4.50	4.28	4.23
Condensible Particulate Matter (CPM)	gr/dscf	0.0045	0.0029	0.0036	0.0037
	lb/hr	3.22	2.09	2.52	2.61
Particulate Matter (PM) Non-sulfate	gr/dscf	0.0037	0.0049	0.0047	0.0044
	lb/hr	2.63	3.45	3.29	3.12
Particulate Catch Weight [2]	mg/L	21,103	22,109	22,164	21,792

[1] Laboratory Results provided by Enthalpy Analytical, Inc.

[2] Particulate Catch Weight is per method ASTM D5907 and is represented as mg solids per liter of scrubber recirculation liquid

1.3.9 U.S. EPA Conditional Test Method 027 (CTM-027)

Shaw conducted one hundred twenty minute test and two one hundred twenty eight minute tests during normal operating conditions. Ammonia (NH_3) was measured and the three tests were averaged.

Documentation supporting the results of this test program is presented in the appendices. A comprehensive summary of the test results and process operating conditions is presented on Table 9.

Table 9 Comprehensive Summary of Results U.S. EPA Conditional Test Method 027 (CTM-027)

Test No.	1	2	3	Average
Date	05/26/11	05/27/11	05/27/11	n/a
Start Time	16:18	10:42	14:58	n/a
End Time	18:50	13:06	17:16	n/a
Test Duration, min	120	128	128	125.33

Unit Operating Parameters

Oxygen Content	vol%	0.50	0.66	0.62	0.59
Carbon Dioxide Content	vol%	18.45	18.19	18.01	18.22
Moisture Content	vol%	20.57	22.18	21.99	21.58
Wet Molecular Weight	lb/lb·mol	28.30	28.07	28.07	28.15
Velocity	ft/sec	33.53	37.81	37.65	36.33

RESULTS

Table 2-1:
FCCU Regenerator Vent – PM_{10}/$PM_{2.5}$, Condition 1

Run No.		1	2*	3	Average
Date (2014)		Mar 18	Mar 18	Mar 19	
Start Time (approx.)		10:45	17:56	09:14	
Stop Time (approx.)		12:01	19:09	10:23	
Process Conditions					
R_P	Coke Burn Rate (MPPH)	69.7	70.7	70.1	**69.9**
P_1	L/G	18.1	18.0	18.7	**18.4**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	2.3	2.3	2.3	**2.3**
CO_2	Carbon dioxide (dry volume %)	17.5	17.4	17.5	**17.5**
T_s	Sample temperature (°F)	144	144	144	**144**
B_w	Actual water vapor in gas (% by volume)	22.0	22.1	21.6	**21.8**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	268,000	264,000	272,000	**270,000**
Q_s	Volumetric flow rate, standard (scfm)	232,000	229,000	237,000	**235,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	181,000	178,000	185,000	**183,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	36.81	38.05	38.49	**37.65**
%I	Isokinetic sampling (%)	98.9	104.0	103.6	**101.2**
Laboratory Data					
m_n	Total FPM (g)	0.00888	0.02042	0.02006	
m_{CPM}	Total CPM (g)	0.00864	0.04941	0.00717	
m_{Part}	Total particulate (as pm10 & pm2.5) (g)	0.01752	0.06983	0.02723	
FPM Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	5.78	12.67	12.75	**9.26**
$E_{T/y}$	Particulate Rate (Ton/yr)	25.30	55.49	55.83	**40.56**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.08	0.18	0.18	**0.13**
CPM Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	5.62	30.66	4.56	**5.09**
$E_{T/y}$	Particulate Rate (Ton/yr)	24.60	134.28	19.96	**22.28**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.08	0.43	0.07	**0.07**
Total Particulate (as PM10 & PM2.5) Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	11.39	43.33	17.30	**14.35**
$E_{T/y}$	Particulate Rate (Ton/yr)	49.90	189.78	75.79	**62.84**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.16	0.61	0.25	**0.21**

Average includes 2 runs. * indicates that the run is not included in the average.
[1]Gas Flow Rate calculated using M2F and 2H test runs.

Table 2-5:
FCCU Regenerator Vent – $PM_{10}/PM_{2.5}$, Condition 2

Run No.		4	5	6	Average
Date (2014)		Mar 19	Mar 19	Mar 19	
Start Time (approx.)		11:23	13:27	15:31	
Stop Time (approx.)		12:32	14:38	16:41	
Process Conditions					
R_P	Coke Burn Rate (MPPH)	70.5	70.4	70.7	**70.6**
P_1	L/G	20.8	20.8	20.8	**20.8**
Cap	Capacity factor (hours/year)	8,760	8,760	8,760	**8,760**
Gas Conditions					
O_2	Oxygen (dry volume %)	4.3	2.8	1.4	**2.8**
CO_2	Carbon dioxide (dry volume %)	15.1	16.8	17.9	**16.6**
T_s	Sample temperature (°F)	145	145	144	**145**
B_w	Actual water vapor in gas (% by volume)	20.2	19.9	21.4	**20.5**
Gas Flow Rate					
Q_a	Volumetric flow rate, actual (acfm)	277,000	287,000	274,000	**279,000**
Q_s	Volumetric flow rate, standard (scfm)	242,000	250,000	239,000	**243,000**
Q_{std}	Volumetric flow rate, dry standard (dscfm)	188,000	195,000	186,000	**190,000**
Sampling Data					
V_{mstd}	Volume metered, standard (dscf)	39.26	38.52	37.46	**38.41**
%I	Isokinetic sampling (%)	98.8	101.6	102.2	**100.9**
Laboratory Data					
m_n	Total FPM (g)	0.02013	0.02019	0.02033	
m_{CPM}	Total CPM (g)	0.00485	0.00653	0.00446	
m_{Part}	Total particulate (as pm10 & pm2.5) (g)	0.02498	0.02672	0.02479	
FPM Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	12.78	13.52	13.37	**13.22**
$E_{T/y}$	Particulate Rate (Ton/yr)	55.96	59.22	58.58	**57.92**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.18	0.19	0.19	**0.19**
CPM Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	3.08	4.37	2.93	**3.46**
$E_{T/y}$	Particulate Rate (Ton/yr)	13.49	19.16	12.84	**15.16**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.04	0.06	0.04	**0.05**
Total Particulate (as PM10 & PM2.5) Results					
$E_{lb/hr}$	Particulate Rate (lb/hr)	15.86	17.90	16.30	**16.69**
$E_{T/y}$	Particulate Rate (Ton/yr)	69.45	78.38	71.41	**73.08**
E_{Rp}	Particulate Rate - Production-based (lb/Mlb Coke)	0.22	0.25	0.23	**0.24**

Average includes 3 runs.

[1]Gas Flow Rate calculated using M2F and 2H test runs.

Table C-2: Source Test from a Refinery in the District - FCCU with Wet Gas Scrubber

Test/Run ID		1	2	3	Average	
Date Tested	NA	10/8/2008	10/9/2009	10/9/2008		
Stack Oxygen	%	1.30	1.28	1.27	1.28	
Stack Carbon Dioxide	%	17.8	17.7	17.9	17.82	
Average Stack Volumetric Flow (Methods 5 and 6)	dscfm	128,982	128,276	124,384	127214	
Stack Temperature (Methods 5 and 6)	oF	134	132	132	132.88	
Stack Moisture Concentration (Methods 5 and 6)	%	15.29	14.53	14.39	14.73	
FCC Feed	MBPD	49.19	48.93	48.93	49.02	
FCC Feed	MBPH	2.05	2.04	2.04	2.04	
Coke Make (Burn)	lb/hr	39,274	39,389	39,389	39,351	
Coke Make (Burn)	Mlb/hr	39.27	39.39	39.39	39.35	
Catalyst Circulation Rate	ton/min	45.41	46.25	46.25	45.97	
Gas Flow to Scrubber/Circulation Ratio	gal/MACF	26.23	25.94	25.94	26.04	
Total WESP Power	KW	7.49	8.06	8.06	7.87	
#2 Lower WESP Spark Rate	spk/min	1.34	1.30	1.30	1.31	
#1 Lower WESP Spark Rate	spk/min	2.37	4.08	4.08	3.51	
#2 Upper WESP Spark Rate	spk/min	0.00	0.00	0.00	0.00	
#1 Upper WESP Spark Rate	spk/min	0.00	0.00	0.00	0.00	
Oxides of Nitrogen as NO_2 – Method 100.1						LIMIT(S)
as found	ppmv	12.1	18.4	17.8	16.08	
at 3% O_2	ppmv	11.0	16.8	16.2	14.7	
at 0% O_2%	ppmv	12.9	19.6	18.9	17.1	20
emission rate	ppmv	11.3	17.2	16.1	14.9	
Carbon Monoxide – Method 100.1						
as found	ppmv	40.9	39.6	43.5	41.3	
at 3% O_2	ppmv	37.4	36.1	39.7	37.7	
emission rate	lbs/hr	23.4	22.5	24.0	23.3	
VOC as Total Gaseous Non-Methane Organic – Method 25.3						
VOC as TOC in Impinger Vial - Sample A	ppmv	0.63				
VOC as TGNMO in Canister - Sample A	ppmv	50.1				
Combined Vial and Canister Conc. - Sample A	ppmv	50.73				
VOC as TOC in Impinger Vial - Sample B	ppmv	0.28				
VOC as TGNMO in Canister - Sample B	ppmv	65.9				
Combined Vial and Canister Conc. - Sample B	ppmv	66.18				
as found-Average	ppmv	58.46				
at 3% O_2	ppmv	53.39				
emission rate	lbs/hr	19.07				
Sulfur Oxides as SO_2 – SCAQMD Method 6.1						
Stack Volumetric Flow	dscfm	128.071	123.830	121.962	124.621	
Isokinetic Sampling Rate (I)	%	98	93	92	94	90<=I<=110
Stack Moisture Concentration	%	15.97	15.44	15.18	15.53	
Stack Temperature oF	ºF	135	132	132	133	
Corrected Gas Volume Collected	dscf	68.622	52.361	50.731	57.238	
SOx Conc. in Gas Sample	ppmv	1.270	0.810	0.706	0.929	
SOx Conc. in Gas Sample at 3% O_2	ppmv	1.160	0.739	0.644	0.848	
SOx Conc. in Gas Sample at 0% O_2	**ppmv**	**1.354**	**0.863**	**0.752**	**0.990**	**25**
SOx Emission Rate	lb/hr	1.65	1.02	0.87	1.18	
SOx Emission (lb/1000 coke burn)	lb/MB	0.04	0.03	0.02	0.03	9.80
Stack Particulate Matter (PM) – EPA Method 5 (Front ½)SCAQMD Method 5.2 (Back ½)						
Stack Volumetric Flow	dscfm	129,892	132,722	126,806	129,807	
Isokinetic Sampling Rate (I)	%	103	104	102	103	90<=I<=110
Stack Moisture Concentration	%	14.60	13.61	13.59	13.93	
Stack Temperature oF	ºF	134	132	133	133	
Corrected Gas Volume Collected	dscf	183.457	189.314	177.602	183.458	
Stack Total PM Mass	mg	42.60	34.55	34.45	37.20	
Stack Total PM - as found	gr/dscf	0.00358	0.00282	0.00299	0.00313	
Stack Total PM at 3% O_2	gr/dscf	0.00327	0.00257	0.00273	0.00286	
Stack Total PM emission rate	lb/hr	3.99	3.20	3.25	3.48	
Stack Solid PM Mass	mg	42.60	31.80	31.95	35.45	
Stack Solid PM - at found	gr/dscf	0.00358	0.00259	0.00278	0.00298	
Stack Solid PM at 3% O_2	gr/dscf	0.00327	0.00236	0.00253	0.00272	
Stack Solid PM Emission Rate	lb/hr	3.99	2.95	3.02	3.32	
Stack PM Emission (lb/1000 bbl of feed)	lb/MB	1.96	1.57	1.60	1.70	2.80
Stack PM Emission (lb/1000 coke burn)	lb/MB	0.10	0.08	0.08	0.09	1.00

Table C-2: Source Test from a Refinery in the District - FCCU with Wet Gas Scrubber (Cont.)

Inlet Particulate Matter (PM) – EPA Method 5						
Inlet Volumetric Flow	dscf	102,640	108,052	116,160	108,951	
Isokinetic Sampling Rate (I)	%	92	103	92	96	90<=I<=110
Inlet Moisture Concentration	%	16.39	16.10	10.20	14.23	
Inlet Temperature	ºF	561	570	567	566	
Corrected Gas Volume Collected	dscf	27.307	32.356	30.980	30.214	
Inlet Total PM Mass	mg	169.90	229.75	330.30	243.32	
Inlet Total PM - as found	gr/dscf	0.09602	0.10958	0.16454	0.12338	
Inlet Total PM at 3% O_2	gr/dscf	0.08770	0.09996	0.15006	0.11257	
Inlet PM emission rate	lb/hr	84.47	101.49	163.82	116.59	