Torrance
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VIA OVERNIGHT DELIVERY AND E-MAIL: srees@aqmd.gov

Sarah Rees, Ph.D.
Acting Deputy Executive Officer
Planning and Rules
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Re: Supplementary Comments on South Coast Air Quality Management District Staff's 1109.1 Proposed Rule Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries Study Final Report, Prepared by Fossil Energy Research Corp. Released on November 2020.

Dear Dr. Rees,

Torrance Refining Company LLC ("TORC") is pleased to submit the following comments to the South Coast Air Quality Management District ("District") in response to the District's recently released report prepared by Fossil Energy Research Corporation ("FERCo") entitled "District Rule 1109.1 Study Final Report" (November 2020) ("FERCo Study") as part of the ongoing Proposed Rule 1109.1 Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries ("PR 1109.1") rulemaking process. Our comments specifically address certain sections of the FERCo Study as noted below. Please note that these comments supplement TORC's comment letters submitted to the District on November 20, 2020, December 14, 2020 and January 27, 2021.

2.2.2 Fluid Catalytic Cracking (FCC) Unit

The FERCo Study indicates on page 2-3 that oxides of nitrogen ("NOx") production occurs when the carbonaceous coke product burns off from the Fluidized Catalytic Cracking Unit ("FCC") catalyst. The NOx produced are known as thermal NOx. There is also additional NOx produced from FCC feed nitrogen compound trapped in the coke (fuel NOx), which is the origin of the majority of FCC NOx emissions. As it appears that the FERCo Study did not consider this fuel NOx impact on FCC NOx emissions, the study must be revised to address this effect in order for a technically accurate Best Available Retrofit Control Technology ("BARCT") analysis to be done for FCCs.

2.2.3 Sulfur Recovery Unit/Tail Gas Incinerator (SRU/TG)

The FERCo Study indicates on page 2-4 that the key role of a SRU/TG unit is to convert, or oxidize, various sulfur-containing compounds into sulfur dioxide (SO_2), a fraction of which will be further oxidized to sulfur trioxide (SO_3). Yet, although NOx is formed during this oxidation process at the end of the sulfur recovery unit ("SRU"), the FERCo Study fails to explain that NOx is also produced in the front end of the SRU.

The front end of the SRU includes the initial Reaction Furnace that oxidizes hydrogen sulfide ("H2S"), ammonia ("NH_3"), hydrogen cyanide (HCN), as part of the thermal Claus Reaction, the first fired preheater before the catalytic Claus reactors, and the Reducing Gas Generator ("RGG") that produces hydrogen by burning natural gas before the amine unit. Finally, the process flow continues to the incinerator (thermal oxidizer) burning off the remaining H2S (as Best Available Control Technology ("BACT") for SRU/TG unit).

Therefore, there are no Ultra-Low NOx Burners ("ULNB") solution to meet the proposed PR 1109.1 BARCT NOx level for the SRU, as the reaction furnace, preheater, RGG, and the control of the overall stack NOx at the TG cannot be controlled with just installation of ULNB for the thermal oxidizer. Therefore, since there is no technologically feasible BARCT, SRU/TG units need to be removed from PR 1109.1 as Refinery targeted equipment for reducing NOx emissions.

2.3 Fuel Type

Interestingly, the FERCo Study is silent in this section on the significance of olefins in the fuel gas. Olefins can increase NOx emission by as high as 15 percent. As it appears that the FERCo Study did not consider this, the study needs to be revised to address olefin content in fuel gas in order for there to be a technically accurate BARCT analysis.

2.5.1 Components of Incurred Technology Cost

Scope

On page 2-7, the FERCo Study indicates that an upgrade to the on-site electric power supply may be needed for SCR reactor auxiliary power demand, and further suggests, that if a portion of the power is otherwise utilized to another process, then the costs should be shared. However, this is not likely the case and the FERCo Study fails the cost-effectiveness associated with the need for additional power for SCRs required to meet PR 1109.1 BARCT NOx levels. For example, if a new substation is needed due to new induced draft ("ID") fan or other power requirement resulting from a SCR installation to comply with BARCT NOx levels, that substation cost needs to be solely included as part of the NOx reduction cost even though the substation may be designed with excess capacity for future equipment. Notably, the bulk cost of any power facility is a fixed cost that is not directly proportional to the capacity. As the new substation facilities would not have been needed if the NOx projects were not required to comply with PR 1109.1, the substantial cost of such facilities must be included as a factor in order for there to be a technically accurate BARCT analysis.

Process Equipment

In this section, the FERCo Study fails to recognize the distinct difference between Low NOx Burners ("LNB") and ULNB. It is a substantial upgrade to go from LNB to ULNB in cases when heater geometry technically allows the upgrade, which is not in every case. Due to RECLAIM or other permitting requirements to achieve NOx reduction over the years, all of TORC's Refinery Process Heaters and Boilers have already been retrofitted with LNB. In order to make the substantial upgrade from LNB to ULNB, additional fuel gas treatment is needed, which includes but not limited to, piping material upgrade, heat tracing, and fuel gas filtering. This type of upgrade is much more costly than what the FERCo Study indicates. Cost varies depending on type of Process Heater and number of burners each heater that would be replaced with ULNB. For example, at TORC's Refinery it can range from $8,000,000 for four Hydrocracker Heaters to $17,000,000 for just one Coker Heater. Boilers tend to be more expensive than Process Heaters ranging from $17,000,000 to $20,000,000 per boiler as they may require the use of external Flue Gas Recirculation ("FGR") and steam injections to meet BARCT NOx levels.

The FERCo Study also fails to distinguish/state that the amount of SCR related-equipment needed for a Boiler is different than what may be required for a Process Heater, even though the study did discuss the difficulty of upgrading an existing fired heater. It needs to again be emphasized that a Refinery Process Heater may have a complex convection section, and as result, the heater's convection section will need to be modified in order for the installed SCR to operate within the correct temperature parameters to optimally reduce NOx. Boilers typically do not have this same issue as was discussed and confirmed following the FERCo's presentation during the December 10, 2020 PR 1109.1 Working Group meeting. Thus, because of the differences discussed above and in order to properly evaluate SCR costs associated with Process Heaters and Boilers, neither the FERCo Study nor the District should combine this equipment into a single BARCT NOx level category.

3.0 Control Options

Ultra-Low NOx Burners

Overall, the FERCo Study is unclear regarding the fuel gas composition associated with ULNB. Fuel gas composition is the most critical variable regarding ULNB potentials for NOx emissions reductions in a particular application. In order for the FERCo Study to be to be a technically accurate, fuel gas composition must be properly factored into FERCo's analysis.

For example, the SOLEX™ burners mentioned in FERCo's Study require stoichiometric balance of air and fuel before combusting at its burner tips. Yet to maintain this air to fuel balance, highly complex process control is required. However, this type of process control and its cost have not been thoroughly evaluated in the FERCo Study, which is required in order to accurately evaluate the feasibility, safety, and cost-effectiveness of this ULNB technology. If such analysis was performed, it would show that even with highly complex process control equipment, maintaining this delicate air to fuel balance in a Refinery environment with its varying fuel composition is unlikely on a consistent basis.

The other two emerging ULNB technologies discussed in the FERCo Study, as acknowledged in the burner vendor's own study, have initial issues with burner interference due to closely positioned burners are still currently in pilot plant development stage associated with each ULNB technology. As a result, more research and development and field testing are required for both of these technologies before they are considered achieved in practice and potential BARCT NOx technologies.

SCR

The FERCo Study indicates on page 3-3 that the SCR NOx reactions occur at temperatures between 400°F to 900°F. In our experience, SCR catalyst temperature are typically between 450°F to 750°F (preferably between 500 °F – 650 °F for optimal NOx reduction) and reactions occurring outside of these temperatures are extreme cases involving specialty SCR catalysts that may or may not have the same consistent and repeatable NOx reduction performance. It is important to note that at lower temperatures SCR catalysts are prone to ammonium bisulfate ("ABS") plugging, reducing the life expectancy and efficacy of the catalyst.

On page 3-5, the FERCo Study focuses on the criticality of the NH3 injection grid ("AIG") design necessary to meet the NH_3 Root Mean Square ("RMS") target. The RMS is a measure of the AIG tuning effectiveness to provide a balanced (concentration) of the NH3 on the front surface of the SCR catalyst. However, the FERCo Study does not take into account how the flue gas ducting before and after the AIG influences the velocity RMS. The velocity RMS is one of the most important factors in meeting the NH3 RMS target to achieve high SCR performance (i.e., NOx control efficiency). Therefore, the FERCo Study's discussion of the AIG design for SCRs without also analyzing the velocity RMS is an over-simplification that yields inaccurate conclusions regarding SCR performance.

The FERCo Study on page 3-10 discusses the use of direct injection of ammonia into the flue gas stream without the use of an AIG as a way to save SCR cost, presumably both for capital and operating cost. It is TORC's experience that when SCR manufacturers have been asked about using direct injection, they will not guarantee its SCR NOx performance compared to traditional AIG injection. As a result, the use of direct injection should not be considered as an option until SCR manufacturers will guarantee the NOx performance of its SCRs to meet a technologically feasible and cost-effect BARCT NOx level.

The FERCo Study also seems to advocate on page 3-12 the use of a booster fan as a method of ammonia injection. The booster fan concept is conceptually similar to overcoming the pressure drop across the SCR catalyst bed by using an ID fan. The booster fan pushes the flue gas flow through, and the ID fan pulls it through the SCR catalyst bed. Conceptually, the booster fan can act as a NH_3 RMS mixing device in the SCR reactor. However, in order for it to work effectively, the entire flue gas flow must be pulled through the booster fan at a much higher flue gas temperature than what is potentially required for a typical ID fan. The higher the flue gas temperature, the lower the flue gas vapor density. Therefore, much larger booster and ID fans are needed to move the same amount of flue gas. Such large fans are not cost-effective on a large-scale SCR installation due to the drastic increase in capital cost and horsepower requirement (electrical cost), which have not been properly accounted for in preliminary cost-effectiveness calculations in the FERCo Study and/or by the District.

Additionally, although a booster fan can conceptually aid in mixing (i.e., NH3 RMS), that benefit is outweighed by the resultant parabolic flue gas flow which dramatically increases velocity RMS, resulting in the need for significantly longer ducting, which may not be possible to space constraints, or vanes to balance velocity RMS prior to contact with the SCR catalyst bed. This is the fundamental reason that the use of a booster fan as a method of ammonia injection is not recommended or guaranteed by any SCR manufacturer that we are aware of when the SCR performance requirement is 90%+ control efficiency.

The FERCo Study indicates on page 3-12 that it would be challenging, but not impossible, to meet a 2 ppmv BARCT NOx level with only an SCR. TORC adamantly disagrees with any conclusion that 2 ppmv NOx BARCT level can be achieved with SCR alone, particularly in a Refinery setting when firing refinery fuel gas. We are not aware of any SCR manufacturer that will guarantee such a consistent and repeatable SCR performance, even with greenfield SCR installation let alone a retrofit on existing Refinery equipment. Thus, the use of only an SCR to meet a 2 ppmv NOx BARCT level is not technically feasible, and depending on the application, not cost-effective. Furthermore, we are also not aware of any Refinery installation, greenfield or retrofit, that has met a 2 ppmv BARCT NOx level by stacking control equipment such as ULNB with SCRs. Therefore, 2 ppmv as BARCT is not supported by any current proven achieved in practice technology or stacking of technology found within the refining industry.

Even, if it were technologically feasible, the FERCo Study's solution of SCR reactor in series is not practical due to space constraints or cost-effective due the additional capital and operating costs associated with the additional capacity or multiple reactors.

Byproduct Emissions

On page 3-13, the FERCo Study indicates that where the precursors exist ABS particulate emissions theoretically occur at temperatures below 500°F. TORC agrees with the study that ABS will not likely form above 500°F or, more precisely, ABS's equilibrium temperature. For accuracy, TORC urges the District to carefully consider ABS equilibrium temperature in relation with PM emissions when permitting the SCRs that will be required to install under PR 1109.1. TORC has had one of its RECLAIM NOx shave SCR project permit applications held up with the District permitting group for many months due to NSR concerns related to ABS as a co-pollutant. This should be resolved before any adoption of PR 1109.1, otherwise, there will be significant permitting delays associated with the implementation of PR 1109.1

Upgrading Existing SCR Reactors

For Refinery equipment already equipped with SCRs for NOx control, the FERCo Study indicates on page 3-14 that "relatively minor" changes/modifications may be required to the existing SCR system if modeling shows that the system is capable of delivering a NOx performance at or near the PR 1109.1 BARCT NOx levels. However, subsequently, the FERCo Study goes on to note on page 3-14 that potentially a new ID/FD fan would be required or a redesign of the SCR, which is likely, and would not be a "relatively minor" change/modification. Then on page 5-6, the FERCo study provides an example of a major modification.

As recognized by the FERCo Study, upgrades to existing SCR systems would be much more complicated and costly than what can be considered as "relatively minor". However, despite this recognition, in estimating catalyst cost of existing SCR upgrade, the FERCo Study makes a leap of faith without considering all costs and assumes it is possible to achieve a 2 ppmv BARCT NOx level, which as stated previously has not been shown to be a technically feasible option within the refining industry.

4.0 SELECTIVE CATALYTIC REDUCTION COST BASIS: EPA MODEL AND INDUSTRY SOURCES

EPA Cost Model

The FERCo Study's review of the EPA model in Chapter 4, fails to recognize that mixing Process Heaters and Boilers within the same model (curve), will not properly provide an accurate cost estimate. As we have stated previously, Refinery Process Heaters may have a complex convection sections that may need to be modified in order for the installations of the SCRs to be in the correct temperature range for optimal NOx performance. Furthermore, a typical natural draft fired Process Heater will most likely require installation of a new ID fan due to the new pressure drop introduced by the SCR reactor and bed and possibility new coils to cool the flue gas before entering the SCR reactor. In some cases, a new electrical substation maybe needed to provide electrical power to the new ID fan. Refinery boilers typically do not have this issue, as the outlet temperature from the superheating coils are typically in the "sweet" SCR operating range for optimal NOx performance and most Boilers already have FD or ID fans. As such, grouping markedly dissimilar combustion equipment together in the same model or cost curve is an entirely inaccurate approach and dilutes the cost-effectiveness analysis. For accuracy, the FERCo and/or other District studies must use separate cost models for these two target Refinery equipment categories. Failure to do so will result in technically inaccurate BARCT analysis.

5.0 SITE VISIT OBSERVATIONS

Suggested Improvements

In this section, the FERCo Study did not address the possible need and design of cylindrical heaters for controlling the flue gas temperature for certain Process Heater SCR installations. With certain Process Heaters, there may be the need to cool the flue gas in order to meet the SCR design temperature for optimal NOx performance, which would be a major design consideration as to cost and technological feasibility. Accordingly, the FERCo Study must review this on a facility by facility basis. Failure to do so will result in technically inaccurate BARCT analysis.

Fluid Catalytic Cracker (FCC) Units

The FERCo Study appears on page 5-9 to indicate that for FCC units, installing SCRs in series would be required to meet the 2 ppm NOx limit. If that is the suggestion, then at a minimum, the District would need to double the BARCT control cost for FCC to include two SCR installations, assuming sufficient space exists in each case to install two SCRs in series.

6.0 CONCLUSIONS

On page 6-1, the FERCo Study lists, at a high-level, the study's conclusions. As discussed above, the study is based on a number of inaccurate assumptions and contains many deficiencies, which are highlighted below.

<u>Conclusion 3</u>

"Based on the site visits and discussions with refinery staff, there are some approaches worthy of consideration to enhance SCR performance and/or reduce cost:

- Heaters – direct injection of aqueous ammonia
- Heaters – utilize a booster fan as an ammonia mixer
- FCC Unit – consider retrofitting one of two ESPs arranged in series with catalytic filters widely used in the glass industry
- Incinerators – consider using tempering air to reduce gas temperature as is widely done with simple cycle gas turbines"

Direct injection of aqueous NH3 in Process Heaters; as TORC has indicated previously, no manufacturer/vendor will guarantee performance at 95%+ NOx control reduction. Utilizing a booster fan as an NH3 mixer in Process Heaters: again, no manufacturer/vendor will guarantee performance at 95%+ NOx control reduction. Further, a full-size FD fan installed after the Process Heater would cost the same amount or more than the AIG and NH3 skid it is trying to replace.

Conclusion 5

"To achieve the maximum emission reductions, a combination of LNB/ULNB and SCR will be necessary for devices with high NOx emissions."

Since LNB does not lower the burner NOx low enough even when combined with SCR to possibly get to the PR 1109.1 proposed 2 ppm BARCT NOx level, it should be removed from the conclusion.

Conclusion 6

"The EPA NOx costing model could be improved to better reflect refinery SCR systems, most notably the methodology to estimate the required catalyst volumes based on the current catalyst technology that is available."

The cost variance of upgrading existing SCR system installation is NOT in the size of the SCR catalyst, i.e., catalyst enclosure/box, but all the modifications around the catalyst for the system upgrade to support SCR optimal NOx performance.

* * *

In closing, due to the inaccurate assumptions and deficiencies in the FERCo Study, it cannot be basis to support the District's currently proposed PR 1109.1 BARCT NOx levels. Accordingly, the FERCo Study requires additional work and the District should direct FERCo to address these inaccurate assumptions and deficiencies as provided in our and other stakeholder comments, and then, issue a revised final report.

Thank you for the opportunity to submit comments on the FERCo Study. We stand ready to work diligently with District staff and other stakeholders to address the complex issues associated with PR 1109.1.

Please note that in submitting this letter, TORC reserves the right to supplement its comments as it deems necessary, especially if additional or different information is made available to the public regarding the PR 1109.1 rulemaking process.

If you have any questions regarding TORC's comments, please call or email me at steve.steach@pbfenergy.com or John Sakers at john.sakers@pbfenergy.com. Our office phone numbers are 310-212-4500 (Steve) and (310) 212-4292 (John).

Sincerely,

Steve Steach
Refinery Manager

cc: **<u>District Staff - via e-mail and overnight delivery</u>**

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