Patty Senecal
Director, Southern California Region

February 26, 2021

Michael Krause
Manager, Planning and Rules
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Via e-mail at: mkrause@aqmd.gov

Re: SCAQMD Proposed Rule 1109.1, NO_X Emission Reduction for Refinery Equipment
WSPA Comments on Preliminary Proposed BARCT for Fluid Catalytic Cracking Units

Dear Mr. Krause,

Western States Petroleum Association (WSPA) appreciates the opportunity to participate in the Working Group Meetings (WGMs) for South Coast Air Quality Management District (SCAQMD or District) Proposed Rule 1109.1, NO_X Emission Reduction for Refinery Equipment (PR1109.1). This proposed rulemaking is part of the District's larger project to transition facilities in the Regional Clean Air Incentives Market (RECLAIM) program for NO_X emissions to a command-and-control structure (i.e., the "RECLAIM Transition Project"). WSPA is a non-profit trade association representing companies that explore for, produce, refine, transport, and market petroleum, petroleum products, natural gas, and other energy supplies in five western states including California. WSPA has been an active participant in air quality planning issues for over 30 years. WSPA-member companies operate petroleum refineries and other facilities in the South Coast Air Basin that are within the purview of the RECLAIM Program administered by the SCAQMD and will be impacted by PR1109.1.

On October 23, 2020, SCAQMD released a first draft of rule language for PR1109.1.[1] The draft language included preliminary NO_x Best Available Retrofit Control Technology (BARCT) levels (or "endpoints"). And on December 24, 2020, SCAQMD released a second draft.[2] There are significant shortcomings with the District's preliminary BARCT proposal for PR1109.1. Specific to the refinery fluid catalytic cracking units (FCCU), the District has failed to demonstrate technical feasibility and cost-effectiveness. These problems are discussed below.

General Comments

The California Health & Safety Code requires the District, in adopting any BARCT standard, to ensure the standard is technologically feasible, and take into account "environmental, energy, and economic impacts" and to assess the cost-effectiveness of the proposed control options.[3] Cost-effectiveness is defined as the cost, in dollars, of the control alternative, divided by the emission reduction benefits, in tons, of the control alternative.[4] If the cost per ton of emissions

[1] Proposed Rule 1109.1. Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries. Rev. October 23, 2020. (Initial Draft for Discussion Purposes).
[2] Proposed Rule 1109.1. Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries. Rev. December 24, 2020. (Second Draft for Discussion Purposes).
[3] California Health & Safety Code §40406, 40440, 40920.6.
[4] California Health & Safety Code §40920.6.

reduced is less than the established cost-effectiveness threshold, then the control method is considered to be cost-effective. Cost-effectiveness evaluations need to consider both capital costs (e.g., equipment procurement, shipping, engineering, construction and installation) and operating costs (including expenditures associated with utilities, labor, and replacement). Currently, the District is applying a cost-effectiveness threshold of $50,000 per ton of NO_X emissions reduced for BARCT rules. This threshold is consistent with what was applied in the 2016 Air Quality Management Plan (2016 AQMP).[5]

1. The District's third-party consultants identified significant issues with the technical feasibility of Staff's proposed BARCT endpoints. The District's preliminary analysis fails to fully consider these issues in its assessment.

As part of the PR1109.1 rule development, SCAQMD contracted two third-party consultants to review the preliminary BARCT assessment. The assignments for each consultant were defined as follows:[6]

- Norton Engineering Consultants (NEC):
    - Perform a BARCT feasibility assessment which includes commercially viable NO_X control technologies and emission reduction levels that each technology can achieve and any caveats associated with achieving NOx reductions; and
    - Review and verify cost analysis including the use of the U.S. Environmental Protection Agency (EPA) SCR Cost Model, model input assumptions, local labor costs, and other factors that affect the cost-effectiveness evaluation.
- Fossil Energy Research Corporation (FERCo):
    - Conduct facility visits to make detailed on-site observations and engineering evaluations of affected equipment;
    - Review the feasibility of installation, including feasibility of installation of new control technologies;
    - Consider challenges associated with installation of control technologies such as space constraints, and burner technology; and
    - Determine if further optimization can be performed on currently installed NO_X control systems to help achieve further emission reductions.

NEC presented its draft report to the District on December 4, 2020.[7] The NEC report describes the source of NOx emissions from the FCCU as (1) NOx formed in the regenerator, and (2) NOx formed in the combustion zone of the CO boiler downstream of the regenerator in a partial burn FCCU configuration. They conclude that the most effective treatment for NOx emissions from the FCCU regenerator and CO boiler is to implement an "end-of-pipe" solution, and note that SCR is expected to continue to be the technology of choice in the District. NEC states that reaching the proposed BARCT endpoint of 2 ppm NOx will require retrofit features including:

[5] SCAQMD Final 2016 Air Quality Management Plan, Approved March 3, 2017.
[6] Execute Contracts for Engineering Consultant to Review the BARCT Assessment for Proposed Rule 1109.1 – NOx Emission Reductions for Refinery Equipment. SCAQMD Governing Board Meeting. May 3, 2019.
[7] Norton Engineering Consultants NOx BARCT Analysis Review, December 4, 2020, (NEC Report).

- Lower space velocity (larger unit footprint, essentially an entire replacement)
- Additional catalyst beds;
- Additional ammonia (NH3) injection grids (AIG) and/or ammonia destruction beds; and
- Increased NH3-to-NOx stoichiometric ratio (NSR).[8]

The above items are critical limitations in determining technical feasibility of FCCU control technologies.

FERCo presented its report to SCAQMD in November 2020.[9] FERCo agreed that NOx reduction using low or ultra-low NOx burners is not feasible for FCCUs due to the solid coke combustion process and concluded that NOx reduction from FCCU will require post combustion technologies. FERCo concluded that refineries may be space-challenged to install SCR on some devices, and that the U.S. EPA SCR Cost Model could be improved to better reflect refinery SCR systems, including the methodology to estimate required catalyst volumes. They also noted that existing FCCUs would need to be evaluated on a case-by-case basis to see how they can be upgraded to meet the new BARCT limit, or if major modifications are necessary.

Together, NEC and FERCo identified important engineering design requirements as limitations to the technical feasibility of the proposed 2 ppm endpoint. These have yet to be fully considered by the District. We call particular attention to three of them:

A. NEC's expert opinion was that low space velocity will be necessary to meet the proposed 2 ppm NOx endpoint.[10] The NEC report states that a larger footprint will be required to achieve lower space velocity, which would essentially be an entire replacement.[11] As a critical design requirement, FERCo should have considered whether existing SCR installations could be retrofit to meet the requirement during their on-site reviews. While FERCo noted spatial constraints, FERCo did not give any apparent consideration to whether the space velocity limitation identified by NEC would effectively trigger a significant FCCU redesign or even total replacement.

   In WGM #16, (December 20, 2020) District staff acknowledged that they have not examined whether any of the equipment which would potentially be subject to the proposed 2 ppm endpoint would meet the low velocity design requirement. Staff further indicated they have not obtained the technical information necessary to do so. Without an understanding of whether the equipment can be retrofit to meet the low superficial velocity requirement, SCAQMD cannot demonstrate that the proposed BARCT endpoint is technically feasible

B. NEC's expert opinion was that the proposed BARCT endpoint would also require secondary ammonia injection grids (AIG) for downstream SCR catalyst bed(s). Neither the District nor

[8] NEC Report, page 44.
[9] FERCo South Coast Air Quality Management District Rule 1109.1 Study Final Report, November 2020, (FERCo Report).
[10] NEC Report, page 44.
[11] NEC Report, page 44.

FERCo has done a feasibility assessment for installation of secondary ammonia injection grids.

While District staff have previously suggested that multiple catalyst beds may be required to meet a 2 ppm endpoint, the NEC report was the first indication that multiple AIGs could also be needed. This design requirement effectively requires two SCR systems in series, which is significantly different design requirement than a single SCR with double the catalyst.

The FERCo report stated that refineries may be space-challenged to install SCR on some devices.[12] The report describes one FCCU in particular that has limited space which prevents a conventional SCR from being installed.[13] The report notes that achieving the high level of NOx removal necessary requires exceptionally good mixing of ammonia into the flue gas stream ahead of the catalyst, which could require two reactors.[14] While FERCo offered some ideas concerning the location of an AIG relative to the SCR grid(s), it appears that FERCo considered spatial requirements for only one FCCU, and did not consider the spatial needs to accommodate multiple AIG on the remaining FCCUs, which would likely be as complex and may require complete replacement of the unit.

In summary, the District has not addressed the technical feasibility of the proposed endpoint for FCCUs. Given the spatial limitations identified by FERCo, it seems likely there could be situations where the required space is simply unavailable.

C. FERCo proposed an alternative FCCU control technology consisting conversion of an ESP to a hot gas filtration system, similar to a control technology in use in the glass industry. FERCo's assigned scope did not include an assessment of potential control technologies. The assessment of potential control technologies was performed by NEC, who did not mention hot gas filtration in their review of available technologies for FCCUs. To our knowledge, the suggested technology has not been demonstrated as feasible for use in the refining industry, and there is no available data showing that FCCUs could meet the proposed BARCT endpoint of 2 ppm with this technology.

D. The NEC report states that an ammonia destruction catalyst will likely be needed to maintain low ammonia slip. It does not appear that SCAQMD has incorporated the impact of the ammonia destruction catalyst in the evaluation of technical feasibility.

The NEC report states that "a trade-off is required between low NH_3 slip and high NOx reduction."[15] In order to get to a 2 ppm BARCT endpoint, a large amount of ammonia must be introduced into the system. An ammonia destruction catalyst will oxidize a significant fraction of the ammonia slip to NOx. Ammonia oxidation mechanisms are shown below:

[12] FERCo Report, page 6-1.
[13] FERCo Report, page 5-9.
[14] FERCo Report, page 5-3.
[15] NEC Report, page 23.

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

$$4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O$$

Staff must consider the impact of an ammonia destruction bed on the technical feasibility of reaching the 2 ppm proposed BARCT endpoint.

In summary, the District has not addressed the issues identified by its third-party experts in its assessment of technical feasibility. The District must consider these issues when determining technical feasibility of a control technology.

2. Several issues identified by the District's third-party consultants appear to materially impact the cost-effectiveness of the proposed BARCT endpoints. These issues must be fully considered in the cost-effectiveness analysis.

As discussed above, NEC identified low space velocity, additional AIG and ammonia destruction beds as retrofit features needed to reach the proposed BARCT endpoint of 2 ppm NOx. The NEC report further states that a larger footprint will be required to achieve lower space velocity, which would essentially be "an entire replacement." [16] The District has not evaluated in their cost-effectiveness analysis the number of units that would require redesign to meet the low space velocity specification, nor the impact of potential FCCU replacement on the cost-effectiveness results. Further, the District has not included an evaluation of the spatial constraint impacts or associated cost for additional AIG and ammonia destruction beds in their cost-effectiveness analysis for FCCU.

The NEC and FERCo reports also identified items that would need to be considered in assessing the cost and cost-effectiveness of NO_X control technologies.

A. Higher costs for SCR catalyst

FERCo commented that the annualized cost to achieve the lowest NOx level is 60% greater than the projected cost by the EPA SCR Cost Model, and that the method for estimating catalyst volume could be altered to ensure that correct variable operating cost are used.[17] It is unclear whether this factor was considered in the District's analysis.

B. Additional costs for multibed SCR systems

While the District has mentioned the need for multiple catalyst beds during previous working group meetings, the quantity of catalyst appears to have been estimated by the District using EPA SCR Cost Model "default" values. The District presented in WGM #16 that costs were adjusted for catalyst volume but did not provide information on how such adjustments were made, or to which categories this cost adjustment applied. It is also unclear if or how the District included the cost of ammonia destruction beds in its cost analysis. NEC has repeatedly

[16] NEC Report, page 44.
[17] FERCo Report, page 4-5.

noted that such ammonia destruction beds would be needed to meet ammonia slip requirements with such a low NO_X limit.[18]

C. Additional costs for multiple AIGs

Both NEC and FERCo indicated that multiple AIG may be required to meet the proposed BARCT endpoint. The District has not indicated that costs for multiple AIG were considered in the cost-effectiveness analysis, and the EPA SCR Cost Model is not configured to provide costs for multi-AIG designs.

D. Additional costs for on-site electric power supplies

FERCo also noted that some facilities may need to upgrade the on-site electric power infrastructure to satisfy the additional power demand caused of SCR reactors.[19] It is unclear if or how the District considered this factor in its cost analysis.

E. Additional costs for existing subsurface conditions

FERCo also noted that there may be legacy underground barriers, such as process water or power lines, that would complicate installation of foundations.[20] FERCo stated that there could be substantial foundation work necessary due to the nature of the soil for refineries located at the coast.[21] It is unclear if or how the District considered this energy impact, as required pursuant to Health and Safety Code §40406, or whether this is considered in its cost analysis.

It short, it does not appear that the District has addressed the technical issues identified by its third-party experts in its assessment of technical feasibility or cost-effectiveness. These factors and associated costs must be incorporated into the BARCT analysis prior to arriving at a BARCT endpoint for the FCCU category.

WSPA appreciates the opportunity to provide these comments related to PR1109.1. We look forward to continued discussion of this important rulemaking. If you have any questions, please contact me at (310) 808-2144 or via e-mail at psenecal@wspa.org.

Sincerely,

Patty Senecal

Cc: Wayne Nastri, SCAQMD
Susan Nakamura, SCAQMD
Catherine Reheis-Boyd, WSPA

[18] NEC Report, page 44.
[19] FERCo Report, page 2-7.
[20] FERCo Report, page 2-8.
[21] FERCo Report, page 2-8.