A Review of the California Regional Haze State Implementation Plan

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National Parks Conservation Association
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June 2022

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1 Introduction

This is a report that analyzes the California Regional Haze State Implementation Plan (SIP).[1] Emissions and controls information for all EGUs were downloaded from EPA's Air Markets Program Data (AMPD) website.[2] Emissions for non-EGUs were requested via a public records request but were not provided in time to be included in the review. Title V operating permits for a number of units were also reviewed.

2 California's SIP Has Basic Documentation and Analytical Flaws

In a number of cases discussed throughout this report, CARB has failed to provide proper documentation for fundamental technical aspects of its SIP.

2.1 California's SIP Lacks Basic Emissions and Control Data

In preparing for this report, fundamental information necessary in order to properly review the SIP was requested from CARB. This included unit-level emissions from all non-EGU sources and information on how those units are presently controlled.[3] In addition, because the SIP indicates that Assembly Bill (AB) 617 is being used as a reasonable progress control, or as a reason not to subject sources to four-factor analyses (discussed later in the report), it was inquired whether any of the emission reductions that result from AB 617 were made federally enforceable in the SIP.

As indicated later in this report, despite the literally thousands of individual unit-level sources throughout California, CARB exempts every single one from a four-factor analysis, except those from one facility. Without access to unit-level emissions from these sources and their present states of control, CARB's decision to exempt these sources cannot be investigated. In addition, this same information is necessary in order to investigate whether the existing controls on these can be upgraded/optimized. Without this information, it is impossible for a reviewer, or indeed anyone from the public, to follow and understand CARB's reasoning for not reviewing these sources. As of the date of this report, CARB has not provided the requested emission data. Thus, the public has been deprived of the opportunity to properly review the California Regional Haze SIP.

In response to the controls currently installed on those unit sources, CARB replied that the authority to regulate stationary facilities is delegated to local air pollution control districts, and that there is no centralized database that contains all air permits across the State, and that such information would have to be obtained from the 35 individual local air pollution control districts. It can only be assumed that if CARB itself possessed this information, which again is necessary

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[1] Draft California's Regional Haze Plan for the Second Implementation Period, Draft Release Date: May 13, 2022, available here: https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans/statewide-efforts/regional-haze

[2] See https://ampd.epa.gov/ampd/. This information is compiled and assessed in a spreadsheet that is included in this analysis.

[3] Unit level emissions and control information is readily available for EGUs from EPA's AMPD website, so this information was not requested.

to properly conduct four-factor analyses, it would supply it when requested. Therefore, it can only be concluded that CARB itself, despite being the assembler of California's Regional Haze SIP, indeed all state SIPs, has apparently not judged it necessary to review the existing controls on any of the sources it has exempted from four-factor analyses. Instead, as discussed below, it has merely accepted various general statements from the air districts that the sources in question are adequately controlled.

In response to the inquiry of whether any of the emissions from AB 617 were made federally enforceable in the SIP, CARB responded that emission reductions resulting from AB 617 will not be reflected in this Regional Haze SIP. CARB stated that emission reductions resulting from AB 617 due to rule or permit revisions will be integrated into its emission inventory and will be part of the baseline inventory included in the Regional Haze SIP prepared for submission in 2033. Thus, despite a great deal of evidence, which is summarized below, that CARB is in fact using speculative emission reductions from AB 617 to exempt sources from four-factor analyses, CARB claims that AB 617 is not a part of the SIP. As demonstrated later in this report, CARB's assertion that it is not relying on emission reductions from AB 617 is incorrect and CARB must therefore revise its SIP accordingly.

2.2 CARB Failed to Verify Data and Statements from the Air Districts

In its discussion of its exemption of sources from four-factor analyses in Appendix G, CARB organized the sources by air district. For each facility exempted, CARB provides a paragraph or so discussion of its reasoning. In many cases, CARB's reasoning consists of echoing statements from air districts that it uses to justify exempting all the sources in an entire facility from four-factor analyses, with no indication that it has verified the information and finds it acceptable. For example, on page 172 of Appendix G, CARB states regarding the Cal Portland Mojave Plant: "The district concluded that the existing rules regulating NOx emissions from the facility are at BARCT stringency. Based on this information, this facility will be excluded from further consideration because a full four-factor analysis would likely result in the conclusion that, for the purposes of the regional haze program, no further controls are reasonable." Another example is on page 174, regarding Mitsubishi Cement: "District staff indicate that the most reasonable available controls are in place at the facility. Based on this information, this facility will be excluded from further consideration because a full four-factor analysis would likely result in the conclusion that, for the purposes of the regional haze program, no further controls are necessary." Many other examples exist. CARB does not indicate in any of these cases that it has in fact reviewed the information and verified the air district's determination, nor does CARB present any of the necessary information the air district would have had to use to make its determination. CARB's failure to verify and provide documentation to support the various air districts' conclusions does not comply with the Regional Haze Rule. CARB is the final decisionmaker. Therefore, it must provide the information the air districts have relied upon, and make reasonable demonstrations that the various air districts' conclusions were valid and that a four-factor analysis would not result in a greater level of control. As indicated below, for many units it is in fact highly unlikely that actual four-factor analyses would not uncover cost-effective controls or upgrades/optimizations to existing controls.

2.3 Documentation is a Fundamental Requirement of the Regional Haze Rule

In its 2017 revision to the Regional Haze Rule, EPA specifically emphasized the need for this type of documentation:[4]

> We are changing proposed 40 CFR 51.308(f)(2)(iv), regarding documentation requirements, ... to "document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, on which the State is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory Class I area it affects." The purpose of this provision is to require states to document all of the information on which they rely to develop their long-term strategies, which will primarily be information used to conduct the four-factor analysis. Therefore, in addition to modeling, monitoring and emissions information, we are making it explicit that states must also submit the cost and engineering information on which they are relying to evaluate the costs of compliance, the time necessary for compliance, the energy and non-air quality impacts of compliance and the remaining useful lives of sources.

The Regional Haze Guidance reinforces this point:[5]

> As part of meeting the requirement of the Regional Haze Rule for the state to document the cost and engineering information on which the State is relying to determine the emission reduction measures that are necessary to make reasonable progress (40 CFR 51.308(f)(2)(iii)), every source-specific cost estimate used to support an analysis of control measures must be documented in the SIP. If information about a source has been asserted to be confidential, we recommend the state consult with its EPA Regional office regarding whether such confidentiality is appropriate and allowed under the CAA and if so how it can be reconciled with the need for adequate documentation of the basis for the SIP.

In summary, due to CARB's failure to provide basic emissions and control documentation and its failure to verify the control claims of the individual air districts, the California SIP does not adhere to the basic documentation requirements of the Regional Haze Rule. CARB must therefore correct these fundamental failures in documentation in its SIP. Unless these issues are addressed, CARB cannot satisfy Section 51.308(f) which requires "supporting documentation for all required analyses" or Section 51.308(f)(2)(iii) which requires that CARB "must document the technical basis, including modeling, monitoring, cost, engineering, and emissions information, on which the State is relying to determine the emission reduction measures that are necessary to make reasonable progress in each mandatory Class I Federal area it affects."

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[4] See 82 FR 3096 (January 10, 2017).

[5] See Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, EPA-457/B-19-003 August 2019. Hereafter referred to as "Regional Haze Guidance," or "the Guidance.". Page 32.

3 CARB's Source Selection Process is Highly Flawed and Must be Revised

Despite having literally thousands of stationary sources that emit visibility impairing pollution, CARB has required that only one facility's source undergo a four-factor analysis, and has declined to control that one source—Collins Pine. One of the reasons for this poor performance—CARB's failure to verify claims made by the air districts—has been discussed above.

In addition, CARB relied on unsecured and speculative emissions from Best Available Control Retrofit Technologies (BARCT) in general, and AB 617, which expanded BARCT. The California Clean Air Act (CCAA) of 1988 established requirements for local air districts to incorporate BARCT. BARCT is defined in California Health and Safety Code Section 40406, which CARB reproduces on page 78:

> [A]s an air emission limit that applies to existing sources and is the maximum degree reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source.

On page 79, CARB explained its reliance on BARCT and AB 617:

> Specifically, AB 617 required air districts to review emission control technologies installed at industrial facilities subject to the State's Cap-and-Trade Program for greenhouse gas emissions. Air districts were required to adopt an expedited BARCT implementation schedule by January 1, 2019 detailing the rules or rule revisions that will be developed for any source categories for which BARCT is not in place. Industrial facilities subject to this AB 617 requirement must have BARCT in place by December 31, 2023 . . . California views the implementation of BARCT level controls as equivalent to reasonable controls for regional haze planning purposes.

While CARB "views" implementation of "BARCT level controls" equivalent to reasonable controls for reasonable controls for regional haze planning purposes, for the reasons discussed below, CARB's reliance on BARCT and AB 617 does not comply with the Regional Haze Rule. Indeed, neither BARCT nor AB 617 are equivalent to the four-factor analysis and regional haze statutory and regulatory requirements. Moreover, the district's rules are not included in this proposed SIP and there are no plans that they be made federally enforceable.

3.1 CARB Cannot Use Unsecured and Speculative Emission Reductions from BARCT and/or AB 617 to Exempt Sources from Four-Factor Analyses

On page 79, CARB states that BARCT is the state version of the federal Reasonable Available Control Technologies (RACT) requirement, but the stringency is generally more akin to that of the federal Best Available Control Technologies (BACT) requirement. According to CARB, that implementation of BARCT at stationary sources is required under certain conditions in California air districts designated as having moderate, serious, severe, or extreme air pollution. On page 79, without providing any detailed analysis supporting its assertion, CARB equates the

imposition of BARCT to a four-factor analysis when it states, "California views the implementation of BARCT level controls as equivalent to reasonable controls for regional haze planning purposes." In fact, CARB exempted sources from four-factor analyses if they are subject to BARCT either presently, or if they will be subject to the expansion of BARCT through AB 617current or future AB 617 state-only requirements.

Despite CARB's claim to the contrary, most of the non-airport sources that are excluded from the regional haze SIP appear to have been done so at least partly based on AB 617.[6] AB 617 is cited to in most if not all of CARB's exemptions and is a key basis for CARB exempting these sources. A typical example is CARB's exemption of Searles Valley Mineral on page 175 of Appendix G:

> The smallest boiler complies with a BACT emission limit of 9 ppmv. All the boilers are subject to Rule 1157.1 BARCT Requirements for Boilers and Process Heaters Outside the FONA, which was adopted in 2019 to meet the AB 617 expedited BARCT requirements. The three larger boilers are required to be in compliance with this new rule by 2023. Based on this information, this facility will be excluded from further consideration because a full four-factor analysis would likely result in the conclusion that, for the purposes of the regional haze program, no further controls are necessary.

CARB in fact admits that it used AB 617 to exempt sources from four-factor analyses in response to FLM comments on page 250 of Appendix I:

> CARB did not bring forward stationary sources subject to California's AB 617 for four factor analysis in this SIP because, under the expedited BARCT requirement they will be required to install more effective emission controls, if they are not already installed, prior to the end of the period covered by this SIP (2028). Initiating parallel and competing analyses of control options would have been an inefficient and costly step that would have potentially hindered steps being taken at the local level to address emissions from these sources.

CARB cannot use BARCT or AB 617 in order to exclude source from four-factor analyses for three reasons:

First, a regional haze SIP must evaluate the sources it has selected according to the four factors as required by Section 51.308(f)(2)(i), not BARCT and/or AB 617:

> The State must evaluate and determine the emission reduction measures that are necessary to make reasonable progress by considering the costs of compliance, the time necessary for compliance, the energy and non-air quality environmental impacts of compliance, and the remaining useful life of any potentially affected anthropogenic source of visibility impairment.

[6] See https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180AB617.

Second, those evaluations must be a part of the state's SIP so that they are federally enforceable, as required by Section 51.308(f)(2): "The long-term strategy must include the enforceable emissions limitations, compliance schedules, and other measures that are necessary to make reasonable progress, as determined pursuant to (f)(2)(i) through (iv)." The Regional Haze Guidance for the Second Planning Period provides additional clarity:[7]

> If a state determines that an in-place emission control at a source is a measure that is necessary to make reasonable progress and there is not already an enforceable emission limit corresponding to that control in the SIP, the state is required to adopt emission limits based on those controls as part of its LTS in the SIP via the regional haze second implementation period plan submission. The LTS can be said to include those controls only if the SIP includes emission limits or other measures (with associated averaging periods and other compliance program elements) that effectively require the use of the controls. If the current SIP includes emission limits and other measures that would not ensure the continued use of that technology with good operating practices, then the limits and compliance program elements in the LTS must be revised via the regional haze second implementation period plan submission. Inclusion in the SIP makes the emission limits permanent (meaning they cannot be subsequently revised without an EPA approved SIP revision) and federally enforceable.

Neither BARCT in general nor the expansion of BARCT under AB 617 are equivalent to the Act's four-factor analysis regional haze requirements, and therefore cannot be used in lieu of those requirements.

Third, CARB has not presented any indication of what emission reductions will actually occur under BARCT and/or AB 617. In fact, many of the sources covered under CARB's blanket AB 617 exclusion have not even undergone a formal review under AB 617, so the results are speculative. Indeed, not all districts have adopted regulations to implement AB 617, which CARB admits on page 79: "Local districts are in the process of developing rules and rule revisions to meet the expedited BARCT requirements of AB 617." This is similar to the situation in which a state wrongly assumes speculative future operating parameters in its four-factor analysis. Again, the Guidance addresses this issue:[8]

> In the situation of an enforceable requirement for the source to cease operation before the end of the useful life of the controls under consideration, a state may use the enforceable shutdown date as the end of the remaining useful life. To the extent such a requirement is being relied upon for a reasonable progress determination, the measure would need to be included in the SIP and/or be federally enforceable. See 40 CFR 51.308(f)(2).

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[7] See Guidance on Regional Haze State Implementation Plans for the Second Implementation Period, EPA-457/B-19-003 August 2019. Hereafter referred to as "Regional Haze Guidance," or "the Guidance.". Page 43.
[8] Ibid., page 34.

Thus, CARB cannot use BARCT and/or AB 617 as a substitute for four-factor analyses and it must revise its SIP to properly evaluate all sources according to Section 51.308(f)(2)(i).

3.2 CARB Cannot Rely on CEQA NOPs to Exclude Sources from Four-Factor Analyses

In several cases, CARB notes that facilities have submitted a California Environmental Quality Act (CEQA) Notice of Preparation (NOP), which it wrongly uses as a reason to exclude these sources from four-factor analysis. Under California law, an NOP is a preparatory step in requesting state agency approval of various changes in operations.[9] For instance, on page 159 of Appendix G, CARB notes that the former Tesoro refinery, sold to Marathon in 2018 has suspended operations and submitted a CEQA NOP requesting approval of a project proposal to convert the refinery to a renewable fuels facility. CARB excluded this entire facility from any four-factor analyses on that basis. Similarly, on page 168 of Appendix G, CARB states that it excluded the entire Phillips 66 carbon plant and refinery from four-factor analyses, based on a NOP to implement the Rodeo Renewed Project. That project would include the decommissioning and potential demolition of the Carbon Plant as well as surrendering the existing air permits. As with AB 617, an NOP is no guarantee of any future action. And just to be clear, the purpose of CEQA is to alert decision-makers to the environmental impacts of state projects for which they have approval authority. It is not a substantive statute on which CARB can base its failure to fully implement the federal Regional Haze Rule.

In addition, concerning the absolute necessity to review individual unit emissions and controls, even wholesale facility changes like the ones summarized here do not necessarily mean that the individual units (e.g., boilers, furnaces, FCCU, etc.) that would have received four-factor analyses would be dismantled. It is quite possible—even likely— these individual units would simply be repurposed, which would not change their status with regard to a regional haze four-factor analysis. If permits have indeed been surrendered and enforceable commitments can be included in the SIP to guarantee an applicable unit-level source is not operating or will not operate, then those guarantees must be included in California's SIP and the source in question can be excluded. Otherwise, these sources must be treated like any other source and be subject to four-factor analyses.

3.3 CARB Must Consider SO_2 in the SIP

On page 154 of Appendix G, CARB describes how it screened sources for four-factor analyses using a Q/d strategy. However, unlike most if not all other states that have used this strategy, CARB only considers NOx when totaling the emissions, Q. CARB presents information in the main body of its SIP to support its decision to only focus on NOx for this planning period.

However, the National Park Service (NPS) provided a great deal of detailed information in its comments to refute CARB's NOx-only approach. For instance, the NPS states, "IMPROVE data show that the impact of ammonium sulfate (yellow highlights) exceeds the impact of ammonium nitrate (orange highlights) at 13 of the 17 monitoring sites representing California Class I areas in recent years. This demonstrates that SO_2, a precursor emission that leads to ammonium

[9] See https://www.law.cornell.edu/regulations/california/14-CCR-Sec-15082.

sulfate formation, is one of the most significant contributors to visibility impairment in the California NPS Class I areas.[10] The NPS goes on to point out the following key points:

- Sulfate is a significant contributor to visibility impairment in the California Class I areas.

- California is a contributor to sulfate impairment within the state and is upwind of the WRAP region.

- Modeling results underpredict sulfate impacts in the NPS California Class I areas.

- EPA's Clarification Memo states "Consistent with the first planning period, EPA generally expects that each state will analyze sulfur dioxide (SO_2) and nitrogen oxide (NOx) in selecting sources and determining control measures. In nearly all Class I areas, the largest particulate matter (PM) components of anthropogenic visibility impairment are sulfate and nitrate, caused primarily by PM precursors SO_2 and NOx, respectively. A state that chooses not to consider at least these two pollutants in the second planning period should show why such consideration would be unreasonable, especially if the state considered both these pollutants in the first planning period."[11]

- California industrial point sources (non-EGUs) make the most significant contribution to predicted 2028 anthropogenic sulfate impairment of all U.S. anthropogenic source categories in Zion, Bryce Canyon, and Grand Canyon National Parks.

- There are significant stationary sources of SO_2 in California that significantly contribute to this impairment and for which CARB should have addressed.

CARB's main point in its response to the NPS is that it shas focused on NOx emissions from mobile sources, as these account for 80% all NOx. However, as indicated in this report, all of the measures considered by CARB in its NOx mobile source four-factor analyses are already being implemented or are planned to be adopted for reasons independent of t he regional haze program. CARB's only stationary source four-factor analysis resulted in a no control determination. Thus, the California Regional Haze SIP erroneously concluded that no new controls are warranted to address regional haze.

4 Many Sources Excluded by CARB Have Additional Controls Available

As indicated above, CARB has wrongly excluded a number of facilities from four-factor reviews on the basis of speculative and unsecured controls from the imposition of AB 617 and CEQA NOPs. As also indicated above, CARB further wrongly excluded a number of sources because of general unsupported statements from the air districts, such as claims that the most reasonable controls are installed (even if available information indicates no controls are installed), or that the units in question already comply with applicable rules and regulations. It appears from the

[10] See the National Park Service comments beginning on pdf page 264 of Appendix I.
[11] See EPA July 2021 Clarification Memo, Section 2.2.

information presented that CARB has merely accepted these statements absent verification, choosing instead to skip independent evaluations of these sources—certainly not four-factor analyses. As is discussed below, a number of these sources have demonstrable controls that must be evaluated under a four-factor review. Some of these are noted below. As indicated earlier in this report, CARB's failure to provide unit-specific emissions and controls data prevents a much thorough review of the facilities it declined to require undergo four-factor analyses. The facilities reviewed here are those with easily identifiable high-emitting units that either lacked controls or could have their existing controls upgraded or optimized. Undoubtedly, many other examples exist.

For a number of additional cases not individually reviewed (e.g., Sierra Pacific Industries, Wheelabrator Shasta) existing SNCR controls should have been examined to determine if they could be optimized or cost-effectively upgraded to SCR systems. In other cases (e.g., Chevron Richmond, Shell Martinez, Valero Refining, California Steel, Chevron El Segundo, New Indy Ontario, Phillips 66 Carson and Wilmington, Tesoro, and Torrance) it is impossible to provide a meaningful review of CARB's exclusion due to the complexity of the facilities coupled with a complete lack of data and information concerning the multitude of potential sources. CARB does not even provide a complete listing of the individual units, their historical emissions and how they are currently controlled. It is extremely unlikely that all of these dozens of units are presently being controlled optimally.

Lastly, the mere fact that a source is fitted with the most stringent type of control, for instance SCR, is no guarantee that source is in fact operating that control optimally. In a number of cases (e.g., furnaces and turbines at Chevron Richmond; a turbine/boiler at Shell Martinez; turbines, furnaces or boilers at Valero, etc.), CARB merely notes the presence of these controls and wrongly concludes no further review to determine if cost-effective upgrades and/or optimizations are available is required. Experience in reviewing a number of SIPs has demonstrated that frequently, optimal performance of these top tier control systems is not attained due to lax permitting limits and/or the failure of the permitting agency to requires performance testing.

In short, it is completely unreasonable for CARB to assert that of the dozens of excluded facilities comprising hundreds of individual sources, *none* have any available cost-effective controls or upgrades/optimizations to their existing controls. CARB has wrongly excluded all of these facilities and must provide either (1) much better documentation for its assertions on a unit-by-unit basis or (2) complete four-factor analyses for all of them.

4.1 Desert View Power

On page 163 of Appendix G, CARB states that the 47 MW Desert View Power Plant is located within the South Coast AQMD, which includes the South Coast Air Basin and the Coachella Valley, which includes areas that are designated as extreme and severe nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the boilers are equipped with ammonia injection to control NOx. More information concerning this facility is required for three reasons. First, because this facility does not report its emissions to EPA's Air Markets Programs Data,[12]

[12] See https://ampd.epa.gov/ampd/.

CARB must include its historical emissions in its SIP so they can be properly evaluated. Without this data, the public cannot assess CARB's determination.

Second, CARB must investigate potential upgrades and/or optimizations to this existing NOx control. EPA has long indicated that upgrades to existing controls can be expected to be very cost-effective. For instance, although concerned with scrubber upgrades, the BART Rule went into extensive detail into the subject, as did the Texas FIP.[13] More recently, EPA's Clarification Memo provided the following admonition to states:

> The four factors are used to assess and choose between emission reduction measures for sources of visibility impairing pollutants. A reasonable four-factor analysis will consider the full range of potentially reasonable options for reducing emissions. The August 2019 Guidance lists examples of different types of control measures that states may consider in their four-factor analyses for sources.[14] In addition to add-on controls and other retrofits, the Guidance also lists emission reductions through improved work practices; upgrades or replacements for existing, less effective controls; and year-round operation of existing controls.

Thus, CARB must assess upgrades and/or optimizations to this control. It is assumed this facility's ammonia injection is similar to SNCR and is therefore highly site specific. That site-specific information must be made a part of the SIP.

Third, assuming the ammonia injection is similar to SNCR and not SCR, CARB must investigate the replacement of this control with SCR. Anticipating that CARB's objection to SCR on a wood-fired fired boiler would be similar to what it presented with regard to the Collins Pine Company (misplaced concern over alkali metals catalyst poisoning), CARB is referred to that discussion later in this report.

Sierra Pacific Industries and Wheelabrator Shasta have similar wood-fired boilers fitted with SNCR and must likewise be properly reviewed for cost-effective upgrades/optimization opportunities to their SNCR systems or replacement with SCR systems.

4.2 Lehigh Southwest Cement Company

On page 168 of Appendix G, CARB indicates that the Lehigh Southwest Cement Company is located within the Bay Area AQMD, and controls the facility NOx emissions through the use of SNCR and excludes it from consideration "because a full four-factor analysis would likely result in the conclusion that, for the purposes of the regional haze program, no further reasonable controls are necessary." CARB must review this source for the installation of SCR.

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[13] See 70 FR 39171 (July 6, 2005). Also see the Texas BART FIP proposal, which conducted extensive cost determinations for scrubber upgrades, at 82 FR 930 and 938.

[14] Original citation to the Guidance from the Clarification Memo: "See August 2019 Guidance at 29-30."

SCR has been technically proven and available for installation on cement kilns for at least 25 years.[15] In its BART review memo, the PA DEP concluded that SCR was technically feasible for the Evansville Kilns 1 and 2.[16] According to the U.S. EPA's Air Pollution Control Cost Manual, SCR is technically feasible for cement kilns:[17]

> Today, SCR has been successfully implemented at seven European cement plants in Solnhofer, Germany (operated from 2001 until 2006), Bergamo, Italy (2006), Sarchi, Italy (2007), Mergelstetten, Germany (2010), Rohrdorf, Germany (2011), Mannersdorf, Austria (2012), and Rezatto, Italy (2015).

SCR has in fact been installed on a number of cement kilns. For example, SCR was required by a consent decree at the Lafarge Joppa plant in Illinois.[18] As Lafarge itself noted in its 2014 annual report, SCR "installed at Joppa plant reduced NOx by up to 80%."[19] The Lafarge Holcim[20] cement plant in Midlothian, TX also installed SCR with a reported efficiency of at least 70%.[21] Also, the Texas Commission on Environmental Quality issued a report concerning the application of SCR systems at a number of cement kilns.[22] Thus, CARB has no basis to conclude without presenting any analysis, that a four-factor analysis would likely result in the conclusion that no further controls are necessary. CARB must require that the Lehigh Southwest Cement Company perform a four-factor analysis for the installation of SCR.

4.3 Cal Portland Mojave Plant

On page 172 of Appendix G, CARB indicates that the Cal Portland Mojave Plant is located within the Eastern Kern Air Pollution Control District, which includes areas that are designated

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[15] See "NOx Control Technologies for the Cement Industry Final Report, EPA-457/R-00-002, September 2000" available here: https://www3.epa.gov/airquality/ctg_act/200009_nox_epa457_r-00-002_cement_industry.pdf. Also see Assessment of NOx Emissions Reduction Strategies for Cement Kilns - Ellis County Final Report, July 14, 2006, available here: https://www.tceq.texas.gov/assets/public/implementation/air/sip/agreements/BSA/CEMENT_FINAL_REPORT_70514_final.pdf

[16] See page 9 of the Lehigh Evansville Cement plant BART review memo, here: http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=1483512&DocName=14%20-%20APPENDIX%20C2%20-%20PADEP%20BART%20REVIEW%20MEMO%20LEHIGH%20EVANSVILLE.PDF%20%20%3Cspan%20style%3D%22color%3Agreen%3B%22%3E%3C%2Fspan%3E%20%3Cspan%20style%3D%22color%3Ablue%3B%22%3E%3C%2Fspan%3E

[17] Control Cost Manual, Section 4 - NOx Controls, Chapter 2 Selective Catalytic Reduction, June 2019, pdf page 6.

[18] See https://www.epa.gov/enforcement/lafarge-north-america-inc-clean-air-act-settlement.

[19] See the Annual Report, Registration Document, Lafarge 2014, page 141. https://www.lafargeholcim.com/sites/lafargeholcim.com/files/atoms/files/03232015-press_publication-2014_annual_report-uk.pdf

[20] Lafarge and Holcim have recently merged.

[21] See https://www.midlothianmirror.com/news/20170718/holcim-makes-environmental-improvements-with-new-regulation-updates.

[22] Assessment Of NOx Emissions Reduction Strategies For Cement Kilns - Ellis County Final Report, TCEQ Contract No. 582-04-65589 Work Order No.05-06, Prepared by: ERG, Inc., Prepared for: Texas Commission on Environmental Quality, July 14, 2006. Available here: https://www.tceq.texas.gov/assets/public/implementation/air/sip/agreements/BSA/CEMENT_FINAL_REPORT_70514_final.pdf.

as severe and moderate nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the kiln is fitted with SNCR. CARB states that the district's Rule 425.3: Portland Cement Kilns (Oxides of Nitrogen) and concludes that the SNCR is BARCT-level stringency. As with the Lehigh Southwest Cement Company, SCR is technically feasible, demonstrated, and must be considered in a four-factor analysis.

Also, CARB's blanket position that SNCR on cement kilns is BARCT conflicts with the California Clean Air Act's definition of BARCT, which CARB reproduces on page 78:

> BARCT is defined in California Health and Safety Code Section 40406: …as an air emission limit that applies to existing sources and is the maximum degree reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source.

Because SCR is a more efficient level of control than SNCR, it and not SNCR, is "the maximum degree reduction achievable." Because CARB has not formally considered SCR, it has not actually taken into account the "environmental, energy, and economic impacts by each class or category of source." Although this evaluation (somewhat similar to a four-factor analysis but not equivalent) is specific to each source, CARB cannot make such pro forma declarations considering that SCR has in fact been installed on other cement kilns.

4.4 Cemex Black Mountain Quarry

On page 173 of Appendix G, CARB indicates that the Cemex Black Mountain Plant is located within the Mojave Desert AQMD, which includes areas that are designated as severe nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the facility has two coal-fired kilns and is subject to the expedited BARCT requirements of AB 617 and a 2009 U.S. EPA consent decree, the latter requiring a NOx limit of 1.95 lbs/ton of clinker which was the 2008 best available control technology (BACT)/lowest achievable emission rate (LAER) limit. The consent decree CARB references but does not cite, does not in fact specify the technology that must be installed to achieve that NOx limit.[23] CARB does not state what NOx control technology is even installed, but a review of the facility's Title V permit indicates it is SNCR.[24] Thus, like the Lehigh Southwest and Cal Portland facilities, CARB must require that a four-factor analysis be performed that includes consideration of SCR.

4.5 Mitsubishi Cement

On page 173 of Appendix G, CARB indicates that the Mitsubishi Cement Plant is located within the Mojave Desert AQMD, which includes areas that are designated as severe nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the kiln is subject to Rule 1161 – Portland Cement Kilns, and that "District staff indicate that the most reasonable available controls are in place at the facility." On that basis, CARB concludes Mitsubishi Cement should be excluded from further consideration because a full four-factor analysis would likely result in the

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[23] See https://www.epa.gov/sites/production/files/documents/cemexca-cd_0.pdf
[24] See https://www.mdaqmd.ca.gov/home/showdocument?id=2612.

conclusion that no further controls are necessary. CARB does not indicate what controls are in fact fitted to the kiln. It is not evident from an examination of the facility's Title V permit and a 2019 Preliminary Determination/Decision - Statement of Basis that any retrofit NOx controls have been installed.[25] Thus, CARB has no basis to conclude that a four-factor analysis would likely result in the conclusion that no further controls are necessary. Again, like the Lehigh Southwest, Cal Portland, and Cemex Black Mountain facilities, CARB must require that a four-factor analysis be performed that includes consideration of SCR, and in this case, SNCR as well.

4.6 Cal Portland Oro Grande

On page 174 of Appendix G, CARB indicates that the Cal Portland Oro Grande Cement Plant is located within the Mojave Desert AQMD, which includes areas that are designated as severe nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the kiln is subject to Rule 1161 – Portland Cement Kilns, and that "[p]er district staff, this facility has the most reasonable controls already in place." On that basis, CARB concludes that the Cal Portland Oro Grande facility should be excluded from further consideration because a full four-factor analysis would likely result in the conclusion that no further controls are necessary. CARB does not indicate what controls are in fact fitted to the kiln. It is not evident from an examination of the facility's Title V permit and a 2018 Preliminary Determination/Decision - Statement of Basis that any retrofit NOx controls have been installed.[26] Thus, CARB has no basis to conclude that a four-factor analysis would likely result in the conclusion that no further controls are necessary. Again, like the Lehigh Southwest, Cal Portland, Cemex Black Mountain, and Mitsubishi facilities, CARB must require that a four-factor analysis be performed that includes consideration of SCR, and in this case, SNCR as well.

4.7 Searles Valley Mineral

On page 174 of Appendix G, CARB indicates that the Searles Valley Mineral Plant is located within the Mojave Desert AQMD, which includes areas that are designated as severe nonattainment for the 2008 and 2015 Ozone NAAQS. CARB states that the facility operates two coal-fired steam boilers (each with a 1,025 MMBtu/hr heat output rating), one natural gas-fired steam boiler (418 MMBtu/hr heat output rating), and one natural gas-fired package steam boiler (126.58 MMBtu/hr heat output rating). The boilers account for about 80 percent of NOx emissions at the facility. CARB states that the smallest boiler complies with a BACT emission limit of 9 ppmv and that all the boilers are subject to Rule 1157.1 BARCT Requirements for Boilers and Process Heaters Outside the FONA, which was adopted in 2019 to meet the AB 617 expedited BARCT requirements. CARB notes that the three larger boilers are required to be in compliance with this new rule by 2023. Based on this information, CARB excludes Searles Valley Mineral from further consideration because a full four-factor analysis would likely result in the conclusion that no further controls are necessary. Again, CARB does not state what

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[25] See https://www.mdaqmd.ca.gov/home/showpublisheddocument/9248/637816568612000000, and https://www.mdaqmd.ca.gov/Home/Components/Calendar/Event/1359/48?selsta=1&sortn=EName&sortd=desc&toggle=all&smview=cate&alpha=E.

[26] See http://mdaqmd.ca.gov/home/showdocument?id=2628, and https://www.mdaqmd.ca.gov/Home/Components/Calendar/Event/1235/205?sortn=EDate&npage=3&toggle=all.

retrofit controls, if any, are present on these boilers. An examination of the facility's Title V permit appears to indicate that none of the boilers have any type of post combustion NOx controls.[27] Industrial boilers are commonly fitted with SNCR or SCR NOx controls. Thus, CARB has no basis to conclude that a four-factor analysis would likely result in the conclusion that no further controls are necessary. CARB must require that a four-factor analysis be performed that includes consideration of SCR and SNCR for these boilers.

5 Review of the Collins Pine Company Four-Factor Analysis.

CARB presents its summary of the four-factor analysis for the Collins Pine Company beginning on page 105. Additional information, including a report is included in Appendix H.[28] As CARB indicates on page 105, the Collins Pine Company operates a wood products and cogeneration facility in Plumas County.

Clean lumber, clean hogged fuel, wood fuel, and yard waste are burned in the Keeler cogeneration boiler to produce steam and generate electricity to power the sawmill operations. The boiler typically operates year-round and has a heat input capacity of 242 MMBtu/hr. The boiler is the source of all NOx emissions at the facility. The boiler does not currently have any post-combustion NOx emission controls in place. The facility is located only 12 km from the Caribou Wilderness Area.

5.1 The Collins Company Wrongly Excluded Technically Feasible Controls

5.1.1 CARB Must Require Consideration of FGR

On page 5 of its report, the Collins Company excluded Flue Gas Recirculation (FGR) because it claims it is difficult to retrofit on existing boilers and would only result in 15% to 20% NOx reduction during the summer when the wood moisture content is the lowest, and could be expected to perform poorer during other parts of the year when the wood moisture content is higher. Controls should only be excluded on the basis of technical feasibility and these issues do not relate to technical feasibility. Rather, they relate to the cost-effectiveness ($/ton) of the control and are properly considered in that portion of the four-factor analysis. In fact, in Appendix A, Collins' expert states, "The Chester boiler is suitable for flue gas recirculation."[29] Therefore, CARB must require that Collins properly consider this technology.

5.1.2 CARB Wrongly Excluded Consideration of SCR

On page 108 of the SIP, CARB echoes some of Collins' arguments against the installation of SCR on wood-fired boilers, including (1) its assertion that alkali metals can poison catalyst and (2) that the temperature of the exhaust existing the PM control device is too low. CARB's concern that alkali and/or alkaline earth metals will poison SCR catalyst and thus render that

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[27] http://www.mdaqmd.ca.gov/home/showdocument?id=854.

[28] Regional Haze Four Factor Analysis, Collins Pine Company—Chester Facility, Prepared for Collins Pine Company, September 16, 2021, by Maul Foster & Alongi, Inc. Hereafter referred to as the "Collins Report."

[29] See Appendix A of the Collins Report, pdf page 239.

technology infeasible is without merit. There is nothing in the SIP record, or indeed any record, that supports such a conclusion. A recent report explores this issue in detail as it relates to North Dakota lignite EGUs, and includes citations to many successful examples of SCR on sources that burn fuels that contain alkali and/or alkaline earth metals, including wood-fired boilers.[30] In particular, the California DTE Stockton EGU, which burns biomass, has been fitted with an SCR system for many years and consistently controls NOx to a level below 0.04 lbs/MMBtu on an annual average basis. Therefore, to the extent that alkali and/or alkaline earth metals do poison SCR catalyst, this is not a technical feasibility issue, but rather a maintenance issue and should be included in the SCR cost-effectiveness calculation as such.

CARB's concern that the exhaust temperature is too low for successful SCR operation is also undocumented, and in fact unfounded. First, Collins must provide documentation that the temperature of the exhaust after exiting its ESP is in fact 417 degrees F as claimed. Second, low temperature catalyst is available and exhaust gas reheat is a proven option and is discussed in the Control Cost Manual.[31] Again, this is not a technical feasibility issue, but in this case a capital and operational cost issue and should be included in the SCR cost-effectiveness calculation as such.

5.2 The Collins Company's SNCR Efficiency Estimate is Too Low

Regarding SNCR performance, Collins claims that a residence time in the boiler of 0.3 to 0.5 seconds is required for effective control. Collins states that the required time is not available in the Keeler boiler, as the flue gas velocity in the upper furnace is 19 feet per second and distance between the top of the flame and the beginning of the bull nose where the flue gas velocity increases is about 4 feet, resulting in a residence time of approximately 0.2 seconds. Collins concludes the following:

> The short residence time would require an excessive amount of reducing agent to achieve any significant NOx control. The increased reagent application and high heat absorption in the upper furnace from the radiant super heater would rapidly cool the flue gas resulting in high levels of ammonia slip. For this reason, we expect that the levels of ammonia slip would exceed the standard 20 ppm limit.

An examination of Appendix A to the Collins Report yields the actual statement from Collins' expert that reveals significant subtleties:

> A reaction zone with up to .5 seconds residence time is ideal but residence time on the order of .3 + seconds is required for effective control. The required time is not available at Chester, the flue gas velocity in the upper furnace is 19 feet per

[30] A Review of the Record Concerning the Technical Feasibility of Selective Catalytic Reduction on North Dakota Lignite Electric Generating Units, prepared by Joe Kordzi and Ranajit Sahu, Consultants, on behalf of National Parks Conservation Association and Sierra Club, October 2020.

[31] See Control Cost Manual, Section 4 - NOx Controls, Chapter 2 Selective Catalytic Reduction, June 2019, pdf page 34.

> second and distance between the top of the flame and the beginning of the bull nose where the flue gas velocity increases is about 4 feet, resulting in a time of about .2 seconds.
>
> In addition to the reaction efficiency between the reducing agent and NO, SNCR design must be effective and control slip of ammonia. The short residence time would require a higher than normal amount of reducing agent for significant NOx control.

This report cannot verify the above calculations. However, it does appear that Collins' resident time calculation is simplistic and does not consider all relevant parameters. For instance, the Electrical Power Research Institute (EPRI) SNCR Technical Report states that "[t]he flue gas residence time between each boiler elevation is a function of the boiler volumetric flow rate, average flue gas temperature over the defined control volume, and the boiler dimensions at the HVT measurement locations." Collins' expert does not consider those parameters. EPRI provides a calculation for boiler residence time as part of its SNCR design approach: [32]

> Residence Time (s) = Boiler Depth at Injector Elevation (ft) * Boiler Width (ft) * Height Between Two HVT Measurement Elevations (ft) * (3600 s / hr) / [Flue Gas Flow Rate (wscf/ hr) * (T avg (F) + 460) / (528 R)]

Consequently, there is some doubt as to the accuracy of Collins' residence time claim and CARB must seek verification.

Regardless of Collins' claim on residence time, there is no disagreement that ideal SNCR efficiency results from times approaching 0.5 seconds. In fact, the Control Cost Manual echoes this advice when it states, "the gain in performance for residence times greater than 0.5 seconds is generally minimal, and *performance degradation is observed for residence times less than 0.2 seconds* [emphasis added]."[33] The key issue, however, is that Collins' expert does not state that SNCR will not function with a residence time of 0.2 seconds. Rather, he indicates that the effectiveness will be suboptimal. As indicated above, the Control Cost Manual does not indicate performance degradation until the residence time drops below 0.2 seconds. In fact, the Control Cost Manual references the Electrical Power Research Institute SNCR Technical Report cited to above which states, "Performance degradation demonstrated if available residence time within process temperature window is less than 200 msec (e.g., lower NOx removal and higher NH_3 slip)."[34]

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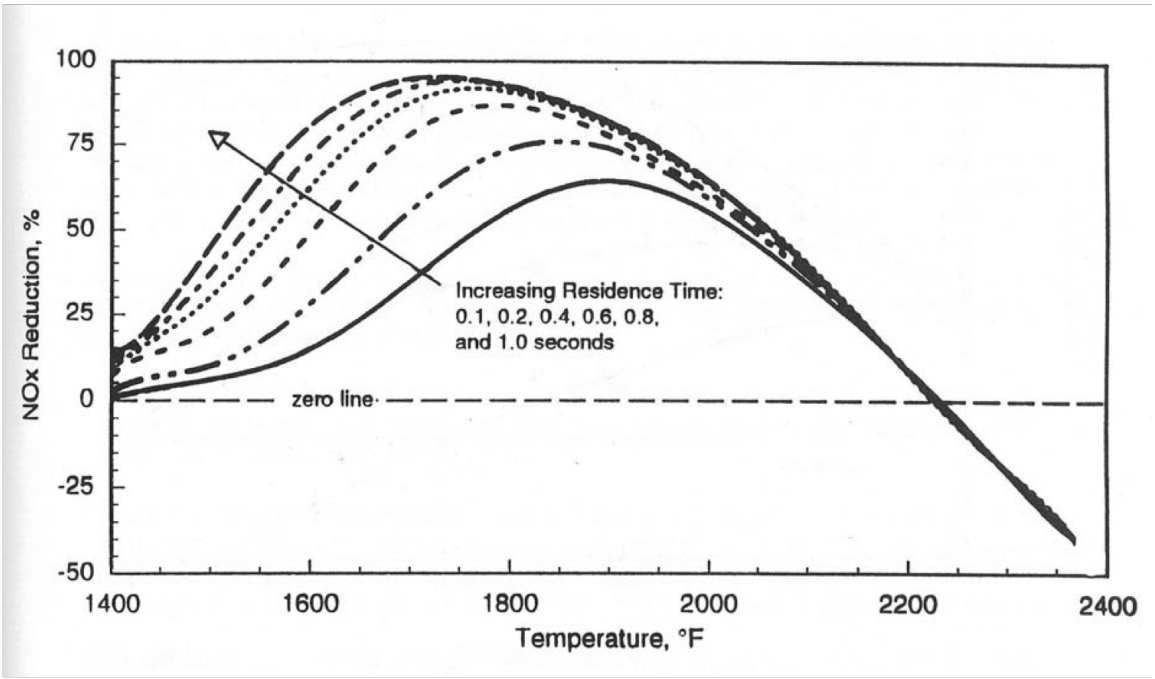
[32] EPRI, SNCR Guidelines Update, Technical Report, 100474, November 2004. Page 4-11. Available here: https://www.epri.com/research/products/000000000001004727

[33] Control Cost Manual, Section 4 - NOx Controls, Chapter 1 Selective Noncatalytic Reduction, Revised 4/25/2019, page 1-15.

[34] EPRI, SNCR Guidelines Update, Technical Report, 100474, November 2004. Page 2-5. Available here: https://www.epri.com/research/products/000000000001004727. Note that 200 msec is 200 milliseconds, which is equal to 0.2 seconds.

In fact, it has been well established for decades that significant SNCR performance will still result when the residence time is 0.2 seconds. For instance, the above cited EPRI report offers the following graph:

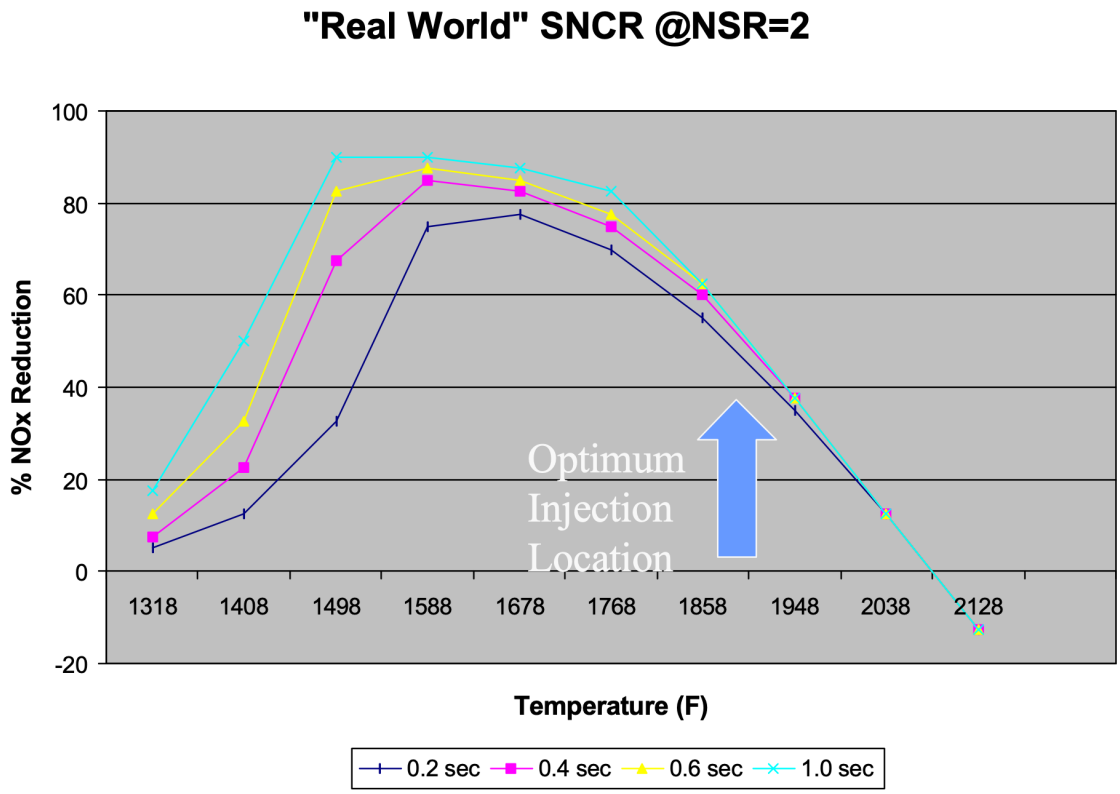
Figure 1. EPRI Figure 2-1, Calculated Effects of Residence Time and Temperature on NOx Reduction with Urea Injection



As this graph indicates, significant SNCR performance will still occur with a residence time of 0.2 seconds. Similarly, De-NOx Technologies presented the following at a DOE NETL conference, in 2002:[35]

[35] SNCR System Design, Installation, and Operating Experience, David Wojichowski, Principal De-NOx Technologies, LLC, 6/21/02, DOE NETL Pittsburgh 2002. Available here: http://lexissecuritiesmosaic.com/gateway/FedReg/scr-sncr_wojichowski-1.pdf.

Figure 2. De-NOx Technologies SNCR Performance for Various Residence Times



Again, significant SNCR performance will still occur with a residence time of 0.2 seconds. In fact, in the above report, De-NOx characterized "closest to perfect" conditions as:

- Waste Incinerators, *Wood/Bark Boilers* [the Collins' boiler], CFB's, some PC Boilers.
- All are characterized by reasonable furnace plan dimensions, well defined gas profiles, and adequate residence time prior to first convective surface.
- Common performance is 50% reduction at NSR = 1.0 and ammonia slip L.T. 10 ppm.

Collins uses an SNCR removal efficiency of 25% in its cost-effectiveness calculation. However, this appears low. Collins supports this conclusion with information on pdf page 238, where Collins' expert indicates that the expected furnace temperature ranges from approximately 1,800 to 1,900 degrees F, depending on the moisture content of the wood being burned. Note that in the above SNCR performance graphs, this temperature range at a residence time of 0.2 seconds corresponds to an SNCR efficiency range of approximately 70% according to EPRI and

approximately 50% to 65% for the DeNOx data. This is in agreement with various values the Control Cost Manual reports for pulp and paper boilers.[36]

In summary, Collins' SNCR residence time calculation does not appear to consider all relevant parameters and is therefore suspect. Even if its assertion of a 0.2 second residence time is accurate, SNCR industry experience indicates significant NOx control. Collins' estimate of a NOx control of 25% in its SNCR cost-effectiveness calculation is unreasonably low and a value of 40% appears to be a more reasonable, but still conservative estimate. Use of a higher SNCR efficiency could be possible but considering the NOx inlet, would further increase the Normalized Stoichiometric Ratio (NSR) and potentially cause excessive ammonia slip. This point must be investigated in a proper four-factor analysis.

Using a 40% SNCR efficiency would reduce Collins' NOx inlet from 0.124 lbs/MMBtu to 0.074 lbs/MMBtu. The latter figure is not unusual, at least in comparison to SNCR performance of coal-fired boilers as the following table indicates:[37]

Table 1. Examples of Coal-Fired Boiler SNCR Performance

Facility Name	Unit ID	Year	Operating Time	No. of Months Reported	Avg. NOx Rate (lb/MMBtu)
Northside	2A	2021	7101.1	12	0.0338
Northside	2A	2018	4308.23	12	0.0421
Northside	2A	2020	4759.72	12	0.053
Northside	1A	2017	4762.04	12	0.0557
Northside	2A	2017	3239.46	12	0.0557
St. Nicholas Cogeneration Project	1	2018	8304.01	12	0.0566
St. Nicholas Cogeneration Project	1	2020	8289.87	12	0.0569
St. Nicholas Cogeneration Project	1	2019	7836.7	12	0.0582
St. Nicholas Cogeneration Project	1	2017	7942	12	0.0582
Archer Daniels Midland Co.	FBC9	2017	8369.08	12	0.0587
Archer Daniels Midland Co.	FBC9	2019	8367.42	12	0.0595
Archer Daniels Midland Co.	FBC9	2018	8086.04	12	0.0599
Northeastern Power Company	31	2017	4196.33	12	0.06
St. Nicholas Cogeneration Project	1	2021	8166.87	12	0.0602

[36] Control Cost Manual, Section 4 - NOx Controls, Chapter 1 Selective Noncatalytic Reduction, Revised 4/25/2019, Tables 1.1, 1.2, and Figure 1.1b.
[37] Data from https://ampd.epa.gov/ampd/.

Archer Daniels Midland Co.	FBC9	2021	6728.75	12	0.0604
H L Spurlock	3	2021	7495.25	12	0.0621
H L Spurlock	4	2021	7769.5	12	0.0621
Virginia City Hybrid Energy Center	2	2017	6409.18	12	0.0621
H L Spurlock	4	2020	5893.71	12	0.0623
Mt. Carmel Cogeneration	SG-101	2017	8296.57	12	0.0627
Mt. Carmel Cogeneration	SG-101	2020	1430.91	12	0.0628
Northside	1A	2018	7824.6	12	0.0628
Virginia City Hybrid Energy Center	1	2021	2774.21	12	0.0633
Virginia City Hybrid Energy Center	1	2017	6382.78	12	0.0633
Virginia City Hybrid Energy Center	2	2021	1848.04	12	0.0642
H L Spurlock	4	2018	6329.45	12	0.0649
Mt. Carmel Cogeneration	SG-101	2018	7461.39	12	0.0652
Archer Daniels Midland Co.	FBC9	2020	7994.83	12	0.0653
H L Spurlock	4	2019	5796.25	12	0.0656
H L Spurlock	3	2020	7275.85	12	0.0657
Northside	1A	2021	1514.8	12	0.0659
H L Spurlock	4	2017	5906.07	12	0.066
H L Spurlock	3	2018	7265.19	12	0.0661
Northside	2A	2019	1789.78	12	0.0662
H L Spurlock	3	2017	6960.65	12	0.067
Virginia City Hybrid Energy Center	1	2018	5640.95	12	0.0678
Northside	1A	2020	7419.66	12	0.0684
Virginia City Hybrid Energy Center	2	2018	5601.93	12	0.0685
Northside	1A	2019	8007.02	12	0.0686
Sandow Station	5A	2017	7897.16	12	0.0699
H L Spurlock	3	2019	6107.93	12	0.0703
Sandow Station	5B	2017	7756.6	12	0.0709
Mt. Carmel Cogeneration	SG-101	2019	2627.95	12	0.0731
Marion	123	2019	7994.04	12	0.0744
Virginia City Hybrid Energy Center	2	2019	3832.07	12	0.0757

Marion	123	2018	7929.87	12	0.0767
Virginia City Hybrid Energy Center	1	2020	1590.71	12	0.0769
Ebensburg Power Company	31	2020	7356.42	12	0.0775
Virginia City Hybrid Energy Center	1	2019	2047.15	12	0.0779
Herbert A Wagner	2	2017	1551.12	12	0.0782
Ebensburg Power Company	31	2021	5228.27	12	0.0784
Spiritwood Station	1	2020	8208.4	12	0.0785
Northeastern Power Company	31	2018	4448.34	12	0.0786
Virginia City Hybrid Energy Center	2	2020	3557.88	12	0.0805
River Valley	1A	2017	7945.28	12	0.0812
River Valley	1B	2017	7764.56	12	0.0814
River Valley	2B	2017	7378.13	12	0.0816
Marion	123	2017	7780.48	12	0.083
River Valley	2A	2017	7582.3	12	0.0837
Kimberly-Clark Tissue Company	35	2017	7820.25	12	0.0848
Indian River	4	2019	836.27	12	0.0855
Indian River	4	2017	1842.29	12	0.0874
Kimberly-Clark Tissue Company	35	2018	8357.75	12	0.0875
Marion	123	2020	5819.69	12	0.0899

The above summary only considers units that list coal as the sole primary fuel, and are equipped with NOx combustion controls (which initially lower the NOx inlet) and an SNCR system. As can be seen, there are many examples of coal-fired boilers fitted with SNCR systems that consistently achieve a low NOx floor and there is no reason to believe that the Collins' boiler would not be able to perform similarly.

5.3 Collins' SNCR Cost-Effectiveness Figure is Inflated

In addition to Collins' unreasonable low SNCR efficiency, a number of other factors combine to cause its SNCR cost-effectiveness calculation of $11,149/ton to be inflated or otherwise unsupported. These issues are covered below.

5.3.1 Collins' Capital Cost Assumption is Inappropriate

On pdf page 232 of Appendix H, Collins provides its capital cost figure. Footnotes to this cost item indicates that it is based on a figure of $1,700/MMBtu/hr which Collins indicates is derived from the EPA Air Pollution Control Technology Fact Sheet (EPA-452/F-03-031) for SNCR, issued July 15, 2003. Collins states it assumed the average capital cost in the range of costs provided in that publication. There are three reasons why Collins' approach is unacceptable.

First, the cost it references is from 1999, which Collins escalated to 2019 using the Chemical Engineering Plant Cost Index (CEPCI). The CEPCI is indeed the correct escalation to use in regional haze cost-effectiveness calculations, but as the Control Cost Manual indicates, it is not appropriate to escalate costs from 1999 using the CEPCI or any other index, as that time period is far outside the time window suitable for escalation, which is usually regarded as five years.[38] Thus, CARB must require that Collins obtain a new cost figure, preferably from a vendor or other documentable source.

Second, even if the data were more recent, it is not of the quality suitable for a cost-effectiveness calculation, as it is provided for general information and doesn't consider fundamental considerations such as the inlet NOx, the efficiency of the system, sizing of reagent storage and distribution system, etc. For instance, the capital cost figures cited range widely from $900/MMBtu/hr to $2,500/MMBtu/hr. Collins' figure of $1,700/MMBtu/hr was selected by averaging these figures. However, merely selecting the lower end of the range would have almost halved the cost. It is possible the low, middle or high end of this range would be appropriate, but there is no way to determine that.

Third, as Collins is undoubtedly aware since it has repeatedly referenced the Control Cost Manual, the Manual provides a spreadsheet that can be used to calculate the cost-effectiveness of SNCR for industrial boilers.[39] This spreadsheet uses the same equations Collins references and employs in its cost-effectiveness calculation (except for its use of the outdated capital cost, as discussed above), beginning on pdf page 232 of Chapter H. Again, use of a vendor provided cost estimate is preferable, since this spreadsheet assumes coal or natural gas as the fuel but it can be modified in order to adapt it to wood as the fuel. These adaptations are discussed below.

5.3.2 Revision of the Collins SNCR Cost-Effectiveness Calculation

As discussed above, Collins improperly used a SNCR capital cost from 1999. Use of the Control Cost Manual SNCR spreadsheet inherently generates an SNCR capital cost figure, which is in fact much higher that what Collins employed. Despite this, due to a number of other improper inputs, use of the Control Cost Manual SNCR cost-effectiveness spreadsheet results in a lower cost-effectiveness figure than Collins' estimate of $11,149/ton.

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[38] See Control Cost Manual Section 1 Chapter 2, Cost Estimation: Concepts and Methodology, November 2017: "Escalation with a time horizon of more than five years is typically not considered appropriate as such escalation does not yield a reasonably accurate estimate." Also see Vatavuk, W., Updating the CE Plant Cost Index, Chem. Eng., pp. 62-70, January 2002.

[39] See https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution, Section 4 – NOx Controls, "SNCR Cost Calculation Spreadsheet."

5.3.2.1 Collins Uses Some Improper SNCR Inputs

- Collins uses a NOx inlet of 0.190 lbs/MMBtu, which it states in Note 2 on pdf page 233 is from a "[p]erformance test dated September 15 & 16, 2020 by Environmental Technical Services, Inc." However, this figure does not agree with its figure of annual NOx emissions of 129 tpy and its hours of operation of 8,592, which would result in an annual NOx average of 0.124 lbs/MMBtu.[40] These figures must be in agreement as they are both used in the cost-effectiveness calculation. Use of the lower NOx inlet actually has the effect of increasing (higher $/ton) the cost-effectiveness, but it was nevertheless included in the revised cost-effectiveness calculation.

- Collins assumed a 20-year equipment life. A number of EGU contractors have been assuming a 20-year equipment life for SNCR systems, by reference to the Control Cost Manual. The 4/25/2019 SNCR update of the Control Cost Manual does state on page 1-53, "Thus, an equipment lifetime of 20 years is assumed for the SNCR system in this analysis."[41] However, this is a calculation example and does not indicate that EPA universally considers the equipment life for all SNCR systems installed on EGUs to be twenty years. Just prior to this statement, EPA notes, "[a]s mentioned earlier in this chapter, SNCR control systems began to be installed in Japan the late 1980's. Based on data EPA collected from electric utility manufacturers, at least 11 of approximately 190 SNCR systems on utility boilers in the U.S. were installed before January 1993. In responses to another Institute of Coal Research (ICR), petroleum refiners estimated SNCR life at between 15 and 25 years." Therefore, based on a 1993 SNCR installation date, these SNCR systems are at least twenty-eight years old, which all other considerations aside, strongly argues for a 30-year equipment life. Furthermore, an SNCR system is much less complicated than a SCR system, for which EPA clearly indicates the life should be thirty years. In an SNCR system, the only parts exposed to the exhaust stream are lances with replaceable nozzles. The injection lances must be regularly checked and serviced, but this can be done relatively quickly, if necessary, is relatively inexpensive, and should be considered a maintenance item. In this regard, the lances are analogous to SCR catalyst, which is not considered when estimating equipment life. All other items, which comprise the vast majority of the SNCR system capital costs, are outside the exhaust stream and should be considered to last the life of the facility or longer. Thus, a 30-year equipment life is assumed in the revised analysis.

- Collins assumes an interest rate of 3.25%, which was the Bank Prime Rate at the time of its analysis. The Bank Prime Rate has since increased to 4.0%, which is used in the revised analysis.[42] Use of the higher interest rate has the effect of increasing (higher $/ton) the cost-effectiveness, but it was nevertheless included in the revised cost-effectiveness calculation.

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[40] (129 tons NOx/yr) x (2,000 lbs/ton) x (yr/8,592 hr) x (hr/242 MMBtu) = 0.124 lbs NOx/MMBtu. Note that Collins assumes the 8,592 hours/year run time, as opposed to 8,760 hours in a full year.
[41] Section 4, Chapter 1, Selective Noncatalytic Reduction, April 2019, page 1-53.
[42] See https://www.federalreserve.gov/releases/h15/.

- Collins includes capital charges for the reagent storage tank and its construction/installation. Use of a reagent storage tank and costs for its construction is common to all SNCR systems. Therefore, Collins' inclusion of these additional charges is likely double counting, since they should be a part of the SNCR capital cost figure (noted issues with that figure aside) it assumed. The revised cost-effectiveness calculation, which uses the Control Cost Manual's SNCR spreadsheet, also inherently assumes these charges so they are not separately included.

- Collins assumes an additional annual electricity charge to heat the urea tank. As this charge is not a part of the Control Cost Manual SNCR spreadsheet it was deleted.

- Collins' did not consider the plant elevation. The Control Cost Manual SNCR spreadsheet does consider the plant elevation, which considering the Collins Pine approximate elevation of 4,561 feet (obtained from Google Earth Pro), multiplies the capital cost by a factor of 1.18.[43]

- Lastly, as discussed above, Collins' assumed SNCR efficiency of 25% was changed to 40%.

5.3.2.2 Revised SNCR Cost-Effectiveness Calculations

As discussed above, the Control Cost Manual SNCR spreadsheet was used to calculate a revised SNCR cost-effectiveness calculation. Because this spreadsheet is based on the use of coal, fuel oil, or natural gas, the following adaptations and assumptions were employed for the use of wood fuel:

- Assume lignite as the fuel, but adjust to wood heating characteristics. Of the choices for coal (bituminous, subbituminous, lignite), lignite results in the highest cost-effectiveness figure, which is again a conservative choice.

    - Use the calculated HHV of 8,740 Btu/lb for the wood burned, based on Collins' figures.[44]

    - Estimate the actual annual fuel consumed (which Collins' does not disclose) based on the spreadsheet's calculation of the max annual fuel consumption (which assumes the boiler's heat input and the HHV) multiplied by the ratio of the number of hours the boiler runs/yr to 8,760 hours.

    - Make the ash disposal cost rate (which assumes costs for coal ash) zero.

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[43] See Control Cost Manual, Section 4 - NOx Controls, Chapter 1 Selective Noncatalytic Reduction, Revised 4/25/2019, Equation 1.29.

[44] Collins stated the HHV of the wood is 17.48 MMBtu/ton: (17.48 MMBtu/ton) x (ton/2,000 lbs) x (1,000,000 Btu/MMBtu) = 8.740 Btu/lb.

- Use the same inputs Collins used (with the corrections noted above), along with a calculated NSR based on equation 1.17 of the SNCR portion of Control Cost Manual.

The following is a summary of the revised urea-based SNCR cost-effectiveness calculation for Collins Pine:

Table 2. Revised Collins Pine SNCR Urea-Based Cost-Effectiveness Calculation

Fuel type	Coal	
Retrofit factor	1	
MW rating	242	MW
HHV	8,740	Btu/lb
Annual MWh output	242,553,776	MWh
Net plant heat input rate (NPHR)	10	MMBtu/MW
Desired SNCR efficiency	40	Percent
NOx inlet	0.124	lb/MMBtu
NOx outlet	0.0744	lb/MMBtu
Reagent	Urea	
Plant elevation	4,561	feet
Desired dollar-year	2020	
Interest rate	4	Percent
Equipment life	30	years
Total Capital Investment (TCI)	$3,282,361	
Direct Annual Costs (DAC)	$253,117	
Indirect Annual Costs (IDAC)	$191,198	
Total Annual Costs (TAC) = DAC + IDAC	$444,314	
NOx removed	53	tons/year
Cost-effectiveness	**$8,451**	**$/ton**

As can be seen from the above, Collins' SNCR cost-effectiveness estimate of $11,149/ton, is inflated.

EPA's Control Cost Manual SNCR spreadsheet can also be used to calculate the cost-effectiveness of an ammonia-based SNCR system, which is inherently more cost-effective, as the following indicates:

Table 3. Revised Collins Pine SNCR Ammonia-Based Cost-Effectiveness Calculation

Fuel type	Coal	
Retrofit factor	1	
MW rating	242	MW
HHV	8,740	Btu/lb

Annual MWh output	242,553,776	MWh
Net plant heat input rate (NPHR)	10	MMBtu/MW
Desired SNCR efficiency	40	Percent
NOx inlet	0.124	lb/MMBtu
NOx outlet	0.0744	lb/MMBtu
Reagent	Ammonia	
Plant elevation	4,561	feet
Desired dollar-year	2020	
Interest rate	4	Percent
Equipment life	30	years
Total Capital Investment (TCI)	$3,282,361	
Direct Annual Costs (DAC)	$102,622	
Indirect Annual Costs (IDAC)	$191,198	
Total Annual Costs (TAC) = DAC + IDAC	$293,819	
NOx removed	53	tons/year
Cost-effectiveness	**$5,589**	**$/ton**

The only change made to the previous SNCR cost-effectiveness calculation was to switch the reagent from urea to ammonia. As can be seen from the above, using the same input parameters used by Collins, with some reasonable corrections, results in an SNCR cost-effectiveness figure that is about half of that calculated by Collins Pine.

6 A Review of CARB's Four-Factor Analyses of Mobile Sources

California has a long history of adopting mobile source rules that are more stringent than federal standards.[45] As CARB notes on page 81, "California's focus is on NOx emissions from mobile sources. Mobile sources account for nearly 80 percent of NOx emissions in the State." Thus, CARB's failure to consider SO_2 aside, it rightly places a great deal of emphasis on reducing NOx from mobile sources. CARB examines both on-road and off-road mobile source categories in its four-factor analyses, which is comprised of five mobile source groups consisting of heavy-duty trucks, light and medium-duty passenger vehicles, off-road equipment, trains, and ocean-going vessels. CARB states on page 82 that these mobile source groups considered accounted for 60 percent of NOx emissions in 2017.

In Appendix H, CARB describes its four-factor analyses of the NOx portions of on-road and off-road controls. These measures are summarized in the tables that follow this section. As a preliminary qualifier to these analyses, it should be noted that by necessity, CARB's four-factor analyses poses unique challenges and requires departures from conventional stationary source four-factor analyses. These include the following:

[45] See EPA's listing of its authorizations to these rules: https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations.

- NOx reductions are by the nature of the regulations difficult to project, variable due to market forces, and therefore somewhat uncertain. In some cases, NOx reductions vary with time due to the phasing of different aspects of the regulation in question.
- As opposed to facility owners in a stationary source analysis, costs are borne by manufacturers; individuals, and companies that purchase and maintain the vehicles, lawn equipment, and locomotives; and at-berth infrastructure costs for port authorities, vessel operators, and terminal operators.
- The equipment life appears to depend on the individual regulation, or is otherwise assumed for calculational purposes. Also, the regulations are too broad and the impacts too complex to calculate annualized costs in the conventional manner, resulting in cost-effectiveness calculation methodologies that are not internally consistent. Hence calculation of cost-effectiveness is not comparable to that for a conventional stationary source.
- CARB states that some of the increased manufacturers' costs are offset by increased sales, and consumer costs will be offset by lengthened warranties and savings associated with longer warranty periods, longer useful lives of vehicles, improved durability, and in some cases lower cost of ownership.
- Consideration of the remaining three factors (time necessary for compliance, energy and non-air quality impacts, and remaining useful life) are, similar to conventional stationary source considerations, non-determinative and overall positive (additional societal benefits).

Below are summaries of CARB's on-road and off-road four-factor analyses:

Table 4. Summary of CARB's On-Road Four-Factor Analyses of Mobile Source Rules

On-Road		Summary of NOx Portion of Control	Projection of NOx Reductions (tons)	Cost	Cost-Effectiveness ($/ton)
Heavy-Duty Trucks	Heavy-Duty Omnibus	Applies to diesel or otto-cycle engines in vehicles with a gross vehicle weight greater than 10,000 lbs (Class 3-8). 2024 – 2026 model years must meet an in-use standard of 0.05 g/bhp-hr (federal test procedure and ramped modal cycles) and 0.20 g/bhp-hr (low load cycle), and an idling standard of 10 g/hr. 2027 and later model years must meet an in-use standard of 0.02 g/bhp-hr (federal test procedure and ramped modal cycles) and 0.05 g/bhp-hr (low load cycle), and an idling standard of 5 g/hr. Other measures include more comprehensive certification procedures and extended warranty requirements.	28,617 (total from 2022 - 2032)	$1.11B (total from 2022 - 2032)	$38,788 (total for 2022 - 2032)
	Heavy-Duty Inspection and Maintenance	SB 210 (2019) requires the implementation of a heavy-duty inspection and maintenance program within 2 yrs following a pilot program, and requires the CA DMV to confirm that a heavy-duty vehicle is compliant prior to initial registration, transfer of ownership, or renewal of registration. CARB initiated the pilot program in 2020 and expects greater than 1M vehicles to be covered.	11,060 in 2024	$350,331,000 in 2024	$31,676
			26,134 in 2027	$149,119,000 in 2017	$5,706
			29,675 in 2031	$136,135,000 in 2031	$4,588[46]

[46] Note that on page 190 of Appendix H, CARB uses its 2024, 2027, and 2031 emissions in conjunction with its 2024, 2031, and 2037 costs to calculate cost-effectiveness figures of $31,677/ton in 2024, $5,209/ton in 2031, and $4,428/ton in 2037. Consequently, there is an unaccountable error between this calculation and that from CARB.

	Advanced Clean Trucks	Requires that zero-emission vehicles make up an increasing share of manufacturer's medium and heavy-duty sales, and that large entities report information that can be used to develop strategies to further accelerate transition to zero-emission vehicles.	1,825 in 2031, increasing to 6,205 in 2040	$2.4M in 2020, increasing to $60M in 2028, then decreasing to -$161M (cost savings) in 2031	Variable depending on time period
Light-Duty Vehicles		Currently developing Advanced Clean Cars (ACC) II regulations intended to affect model year 2025 and later vehicles. Draft regulation. Would maintain the fleet average emissions standard of 0.03 g/mile of smog forming pollutants but phase out the inclusion of ZEVs in that calculation. Additional emission limits for aggressive driving and cold starts would be established. Would include requirements for ZEVs to make up an increasing share of manufacturers' light-duty vehicle sales *so that by 2035, all light-duty vehicles sold in California would be ZEVs.*	215 in 2026, increasing to 10,205 in 2040	Costs gradually decreasing to become a cost savings in 2033	Variable depending on time period

Table 5. Summary of CARB's Off-Road Four-Factor Analyses of Mobile Source Rules

Off-Road	**Summary of NOx Portion of Control**	**Projection of NOx Reductions (tons)**	**Cost**	**Cost-Effectiveness ($/ton)**
Transport Refrigeration Units	Proposed 2021 amendments to the TRU ATM.[47] Requires certain TRUs to meet a 0.02 g/bhp-hr PM standard beginning with model year 2023. Establishes reporting requirements for facility owners and TRU owners. Assesses operating fees for TRU owners. Requires TRU owners to affix CARB compliance labels on TRUs operating in California. Requires TRU owners to transition at least 15 percent of their TRU fleet to zero emission technologies each year for seven years. Requires all truck TRUs operating in California to be zero-emission by the end of 2029.	312 by 2028, leveling off to approx. 450 soon thereafter	$129.7M[48]	$415,705
		3,515 total 2022 - 2034	$1.027B total 2022 - 2034	$292,176 (total for 2022 – 2034)
Small Off-Road Engines (SOREs)	Proposed amendments to require most SOREs sold after MY 2024 to have zero emissions. Generators must meet reduced emission limits for MY 2024 to 2027, after which generators must be zero emission.	Gradually increasing to approx. 4,563 by 2043	Net costs gradually decreasing from $736.39M in 2024 to become a cost savings by 2037	Variable depending on time period
Locomotives	Proposed In-Use Locomotive Regulation that	Not well developed		

[47] Airborne Toxic Control Measure for In-Use Diesel-Fueled TRUs and TRU Generator Sets and Facilities where TRUs Operate (TRU ATCM).
[48] On page 200 of Appendix H, CARB indicates the cost-effectiveness is $483,653/ton, based on a gross cost of $150.9M. This figure is what CARB lists as the net cost, which includes some cost savings.

	would establish spending accounts for locomotive operators, establish a useful life limit for locomotives operating in CA, and adopt federal idling limits (so CARB can enforce them).			
Ocean-Going Vessels	Proposed amendments to the 2007 at-berth regulation to expand the scope to include additional vessel types and ports.	20,000 between 2021 and 2032.	Gradually increasing from $37.2M in 2020 to $283M in 2032	$117,471 (total for 2021 - 2032)

6.1 Discussion of CARB's Four-Factor Analyses of Mobile Sources

At this point in the regional haze process, it appears that California is the only state to meaningfully assess mobile sources in its regional haze SIP and it should be lauded for that.[49] It should be noted, however, that California intends to adopt all of the measures it has assessed. Therefore, all of these measures are already on the books or planned to be adopted, irrespective of the regional haze program.

On page 89, CARB states that it determined that the four on-road mobile source controls discussed above "are reasonable and necessary to meet 2028 reasonable progress goals for visibility in Class I areas impacted by emissions from California." However, on page 105, CARB states that the off-road controls "are not reasonable for the purposes of regional haze planning." No further discussion was provided to justify either of these decisions. Again, considering that California intends to adopt all of these measures anyway, this decision appears arbitrary. Consequently, CARB must expand its discussion regarding these decisions and provide a meaningful explanation as to why the off-road controls are not going to be adopted into the regional haze SIP.

Regardless, by specifically adopting the on-road measures into its reasonable progress goal, California would make them federally enforceable under the regional haze program. As indicated in the summary tables above, one of the measures CARB proposes to adopt into its SIP, the Light Duty Vehicles measure, appears to be in the draft or planning stage, as of the date of this report.[50] Therefore, it is unclear whether that measure will be finalized in time for its SIP submittal to EPA.

Under Section 177 of the Clean Air Act, any state can adopt emission control standards for motor vehicles if (1) such standards are identical to the California standards for which a waiver has been granted for such model year, and (2) California and such state adopt such standards at least two years before commencement of such model year.[51] Many states have long followed California's lead and in fact adopted portions of its mobile source rules, most notably various iterations of CARB's Low Emission Vehicle (LEV) program.[52] This report encourages states to specifically assess mobile source emissions in their regional haze SIPs.

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[49] Note that many other states have mobile source emission control programs or have adopted parts of California's mobile source strategy. However, it does not appear that any of these states have meaningfully assessed mobile source controls in their regional haze SIPs.

[50] See https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2022/accii/isor.pdf. Note that a public hearing is planned for June 9, 2022.

[51] See https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partD-subpart1-sec7507.htm.

[52] See https://ww2.arb.ca.gov/resources/documents/states-have-adopted-californias-vehicle-standards-under-section-177-federal. A broad history of state adoption of California mobile source rules can be found here: https://www.mjbradley.com/sites/default/files/MJBA_California_Transportation_Policy_Leadership_October2018.pdf.