BAY AREA AIR QUALITY MANAGEMENT DISTRICT

FINAL STAFF REPORT

PROPOSED AMENDMENTS TO BUILDING APPLIANCE RULES – REGULATION 9, RULE 4: NITROGEN OXIDES FROM FAN TYPE RESIDENTIAL CENTRAL FURNACES AND RULE 6: NITROGEN OXIDES EMISSIONS FROM NATURAL GAS-FIRED BOILERS AND WATER HEATERS

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I. EXECUTIVE SUMMARY

The Bay Area Air Quality Management District ("BAAQMD" or the "Air District") staff is proposing amendments to two Air District rules: Regulation 9, Rule 4: *Nitrogen Oxides from Fan Type Residential Central Furnaces* ("Rule 9-4") and Regulation 9, Rule 6: *Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters* ("Rule 9-6") to support improvements to regional ambient air quality and health outcomes. Rule 9-4 currently applies to the natural gas-fired space-heating furnaces commonly found in single-family homes and Rule 9-6 applies to natural gas-fired water heaters commonly found in residential and commercial applications. These sources generate a substantial portion of nitrogen oxides (NOx) emissions from sources in the Bay Area.

Exposure to NOx and their atmospheric reaction products can greatly impact health. Breathing air with a high concentration of NOx can irritate airways in the human respiratory system. Such exposures over short periods can aggravate respiratory diseases, particularly asthma, leading to respiratory symptoms (such as coughing, wheezing or difficulty breathing), hospital admissions and visits to emergency rooms. Longer exposures to elevated concentrations of NOx may contribute to the development of asthma and potentially increase susceptibility to respiratory infections. People with asthma, as well as children and the elderly are generally at greater risk for the health effects of NOx.

Nitrogen oxides react with other chemicals in the air to form both fine particulate matter ($PM_{2.5}$) and ozone (O_3). Both of these pollutants are harmful when inhaled. The Bay Area does not currently attain all state and national ambient air quality standards for particulate matter, and further reductions of particulate matter emissions are needed for attainment and maintenance of the standards. The District-wide health benefits of attaining and maintaining compliance with the $PM_{2.5}$ ambient air standards are significant. $PM_{2.5}$ has been linked to a broad range of health effects, including premature mortality, adverse respiratory health effects, cardiovascular diseases, impacts to cognitive function, and cancer.[1] The Air District's Advisory Council has determined that PM is "the most important health risk driver in Bay Area air quality," and that reductions in PM levels are needed to achieve further clean air and public health benefits.[2]

The $PM_{2.5}$ from gas-fired building appliances that impacts human health is composed of both directly emitted $PM_{2.5}$ ("primary $PM_{2.5}$") and $PM_{2.5}$ that later forms in the atmosphere from chemical reactions with NOx ("secondary $PM_{2.5}$"). Reducing emissions of NOx from these sources would specifically reduce total exposures to the secondary $PM_{2.5}$ component. Replacement of these sources with electric appliances (see below) would also reduce total exposures to the primary component. Modeling indicates that both components disproportionately impact residents of color throughout the nine Bay Area counties. Reducing emissions of NOx from these sources will reduce the formation of and exposure to secondary PM, thus improving health and saving lives, especially those most impacted by air pollution.

The proposed amendments to Rules 9-4 and 9-6 include the introduction of a zero NOx emissions standard for natural gas-fired furnaces and water heaters sold and installed in the Bay Area. Zero NOx space and water heating technologies currently exist, but they are limited in availability and can be expensive to install in existing buildings. Equipment availability is projected to increase, and costs are expected to decrease in the coming years. As such, staff is proposing a longer-term compliance date of 2027 to 2031, dependent on equipment type, use and size.

Other updates to the proposed rule amendments include the introduction of an ultra-low NOx standard to Rule 9-4 starting in 2024 as well as additional updates to definitions, testing and certification requirements and other clarifications. Both Rules 9-4 and 9-6 currently apply only to new devices and only to natural gas-fired devices, and Air District staff is not proposing to change these provisions of the rules. The proposed ultra-low and zero NOx standards would apply to appliance retailers, wholesalers and installers and would affect Bay Area consumers at the point in time when they install a new appliance or replace their existing furnaces and water heaters. The proposed amendments include a commitment from District staff to re-evaluate the availability and accessibility of zero NOx solutions in closer proximity to the compliance date through an interim reporting process. The interim reports are intended to update the Air District Board of Directors on relevant market changes and ensure equitable outcomes in the implementation of the proposed standards.

District staff intends for this proposed future-effective rule standard to provide manufacturers, suppliers, and consumers with a sufficient planning horizon for the proliferation of zero NOx appliances into the market while realizing emissions reductions and positive health outcomes as soon as practicable. While the proposed rule amendments do not specify emission control

[1] US EPA, 2019. Integrated Science Assessment (ISA) for particulate matter (final report, Dec 2019). US Environmental Protection Agency, Washington, DC. Publication No: EPA/600/R-19/188.
[2] BAAQMD, 2020. Advisory Council Particulate Matter Reduction Strategy Report. December. See also: BAAQMD, 2017. Final 2017 Clean Air Plan: Spare the Air – Cool the Climate. April.

methods to meet the zero NOx standards, the appliances currently available on the market that do not emit NOx largely use electric heat pump technology. Natural gas-fired appliances could also be designed to emit zero NOx in compliance with the proposed rules. However, because electric heat pump technology is the only currently available technology that emits zero NOx in alignment with the proposed rules, staff assumes for purposes of the analysis presented in this Report that if the proposed rules are adopted, consumers will replace natural gas-fired appliances with electric appliances upon rule implementation. The emissions benefits, costs and potential environmental impacts analyzed throughout this Staff Report assume appliance replacement with electric heat pump technology except where otherwise noted. Generally, this assumption provides a "worst case" conservative estimate of emissions reductions, costs, and environmental impacts of the proposed amendments for the Board and public's consideration.

The proposed rule amendments are expected to have significant emissions benefits. This includes NOx reductions, which are a direct impact of the proposed amendments to emission standards, as well as a variety of co-benefits including reducing peak ozone levels, secondary particulate matter formation, greenhouse gas emission reduction and health benefits from reductions in secondary and primary particulate matter. Potential net NOx emissions reductions that could result from full implementation of the proposed rule amendments are estimated to be 3,236 tons NOx per year.

In terms of health benefits, the proposed amendments will result in reductions in NOx emissions and reductions in secondary $PM_{2.5}$ across the Bay Area. These reductions in secondary $PM_{2.5}$ avoid an estimated 23 to 52 deaths per year and about 71 new cases of asthma per year. Reductions in total $PM_{2.5}$ attributable to the targeted appliances, including reductions in primary $PM_{2.5}$ from adoption of electric appliances, would avoid an estimated 37 to 85 premature deaths per year and about 110 new cases of asthma each year. The valuations of the health impacts from total $PM_{2.5}$ were estimated to be between 400 to 890 million U.S. dollars annually.

The proposed rule amendments may result in potentially significant environmental impacts. There may be a significant impact on utility resources due to potential increases in electricity demand from uptake of electric appliances in response to the proposed zero NOx emissions standard, based on currently available zero NOx technology. The significance of these potential impacts to electric generation and delivery demands were evaluated based on two reference scenarios; the impacts vary depending on what actions the State takes to meet its climate goals. Operation of electric appliances may also cause a significant noise impact in certain areas of the Bay Area, as electric heat pump technology may require outdoor installation of condensing units that make noise similar to air conditioning units. These potential impacts are discussed in the Draft Environmental Impact Report associated with this Staff Report.

The proposed amendments may also result in socioeconomic impacts due to increased consumer appliance replacement costs and resultant shifted spending patterns. The cost effectiveness associated with the proposed rule amendments ranges from $54,100 per ton of NOx reduced to $594,000 per ton of NOx reduced as multiple emissions standards are included in the proposed rule amendments.

As discussed above and throughout this Report, the proposed amendments to Rule 9-4 and Rule 9-6 are needed to ensure attainment and maintenance of ambient air quality standards for ozone and particulate matter in the Bay Area. These emissions also result in PM exposures in communities throughout the Bay Area, which can contribute to a number of adverse health outcomes, including premature deaths. In addition, the health impact modeling described in this report indicates that exposures associated with emissions from building appliances are not

distributed equally amongst different communities and race/ethnicity groups. The proposed amendments to Rule 9-4 and Rule 9-6 would achieve these needed reductions in emissions and pollutant exposures throughout the Bay Area and would yield substantial health benefits in these communities and throughout the jurisdiction of the Air District.

Based on evidence presented in this Staff Report, Air District staff believes that the proposed amendments are necessary for achieving its goal to create a healthy breathing environment for every Bay Area resident while protecting and improving public health, air quality and the global climate. This Report presents potential impacts, including potentially significant environmental impacts, for the Board of Director's consideration in adoption of the amendments. Staff believes that the air quality and public health benefits presented demonstrate the value and necessity of the proposed rule amendments despite these potential impacts.

Air District staff recommends adoption of the proposed amendments to Rule 9-4 and Rule 9-6 and certification of the Final Environmental Impacts Report, and adoption of the accompanying CEQA Findings and a Statement of Overriding Considerations. Air District staff released this Staff Report and proposed amendments to Rules 9-4 and 9-6 for public review and comment on December 20, 2022. This release opened a public comment period that ended on February 6. 2023, during which staff received over 500 comment letters representing a wide range of perspectives. Over 400 of the correspondence expressed strong support for the adoption of the proposed amendments. Other comments raised concerns including, but not limited to, the cost of compliance, environmental impacts of the proposal, electric grid capacity and reliability, and the possibility for emergency replacements.

Staff will present a final proposal to the Air District Board of Directors for their consideration at a Public Hearing. At the Public Hearing, the Air District Board of Directors will consider the final proposal and receive public input before taking action.

II. BACKGROUND

The proposed rule amendments would be the first of their kind, introducing zero NOx requirements for furnaces and water heaters installed in buildings. The appliances covered by the proposed standards currently emit more NOx emissions than passenger vehicles in the Bay Area. Through NOx reductions, the Bay Area will also see ozone and secondary particulate matter formation reductions, which will assist in achieving ambient air quality standards and vital health benefits. If electric appliances are installed upon implementation of the proposed rule amendments, the proposal would indirectly achieve greenhouse gas and primary particulate matter reductions as co-benefits.

Nitrogen oxides are compounds that are considered "criteria air pollutants"[3] and which contribute to the formation of other air pollutants such as fine particulate matter ($PM_{2.5}$) and ozone (O_3). Nitrogen oxides are formed during combustion processes. Nitrogen and oxygen present in the ambient air react at the high temperatures of combustion to form nitric oxide (NO) and nitrogen dioxide (NO_2), collectively referred to as NOx. These compounds can further react

[3] Criteria pollutants are particulate matter, photochemical oxidants (including ozone), carbon monoxide, sulfur oxides, nitrogen oxides and lead. US EPA calls these pollutants "criteria" air pollutants because it sets national ambient air quality standard (NAAQS) for them based on the criteria, which are characterizations of the latest scientific information regarding their effects on health or welfare.

in the ambient air with other compounds in the presence of sunlight to form other air pollutants. Nitrogen oxides can form fine particulate matter ($PM_{2.5}$) when reacting with either ammonia to form ammonium nitrate (NH_4NO_3) or with sulfur dioxide to form ammonium sulfate ($(NH_4)_2SO_4$). Nitrogen oxides can also react with reactive organic gases (ROG) in the atmosphere to form ozone.

Rule 9-4 currently imposes a NOx emission limit on centralized natural gas-fired furnaces that are typically used in single-family homes and some multi-unit dwellings. Rule 9-6 currently sets NOx emission standards for small boilers and water heaters, with existing standards varying based on size and equipment application. Note that larger boilers used in industrial, institutional, and large commercial scenarios are generally subject to Regulation 9, Rule 7: *Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters* ("Rule 9-7"). Equipment subject to Rule 9-7 is not impacted by this proposed rule amendment package.

A. Industry Description

Proposed amendments to Rules 9-4 and 9-6 would impact natural gas-fired space and water heating appliances. These include furnaces and water heaters used in single family homes, multifamily residences such as apartment buildings, and commercial spaces such as retail and office buildings. The Air District regulates these sources on an appliance point-of-sale basis, requiring that equipment manufactured after the compliance date and sold or installed within the geographical jurisdiction of the Air District meets the standards contained in the Rules. The proposed amendments would apply to applicable appliances regardless of the type or age of the building in which it will be used.

Appliances covered under the proposed rule amendments are manufactured by a large number of corporations. Some of these companies focus on either space or water heating, while some manufacture appliances for a variety of uses. Similarly, some manufacturers focus on one fuel type, such as natural gas, while many manufacture both natural gas and electric-powered devices. No manufacturing operations for space and water heating appliances take place in the Bay Area. Manufacturers who wish to sell their appliances in the Bay Area must submit compliance certifications for their appliances to the Air District under the current rules and the proposed rule amendments.

Space and water heating appliances are obtained by property owners through either retail locations or distributors that contract directly with construction firms or other installers. Compliance with existing Rule 9-4 and 9-6 is, and will continue to be, enforced through compliance visits at retail and other distribution locations to ensure that all appliances being offered for sale within the Air District meet the standards of the Rules.

B. Regulatory History

The Air District has regulated NOx emissions from space and water heating appliances for several decades. Rule 9-4 for furnaces was first adopted in 1983, with this version of the rule still in place. Rule 9-6 was first adopted in 1992 and was most recently updated with more stringent NOx emissions standards for certain equipment in 2007. All versions of these rules have included a NOx emissions standard expressed as nanograms (ng) of NOx per joule of useful heat delivered by the appliance. The Air District's 2017 Clean Air Plan identifies the importance of nitrogen oxide emission reductions from residential space heating appliances in measure SS30.

Additionally, the South Coast Air Quality Management District (SCAQMD) and the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD) have adopted their own regulations that are similar in structure to Rules 9-4 and 9-6. SCAQMD Rule 1111 and SJVUAPCD Rule 4905, which are similar in applicability to Rule 9-4 for furnaces, have been updated within the last 10 years and currently require a NOx emissions standard of 14 ng/J, the same near-term standard that is included in the proposed amendments. Rule 9-6 for water heaters and small boilers currently contain NOx emissions standards equivalent to those in SCAQMD Rules 1146.2 and 1121 and SJVUAPCD Rules 4308 and 4902 for similar equipment.

Outside of California Air Districts, local jurisdictions across the country have implemented similar regulation of NOx emissions from building appliances. For example, the Texas Commission on Environmental Quality implemented water heater NOx limits in 2000,[4] and the Utah Department of Environmental Quality introduced them in 2015.[5]

C. Active Rule Development

In addition to historical rule development efforts, Air District staff has been tracking active rule development efforts related to building appliances. In 2022, both the California Air Resources Board (CARB) and SCAQMD have signaled their intent to initiate rule development efforts to impose regulatory standards for building appliances.

In the SCAQMD Draft 2022 Air Quality Management Plan, the SCAQMD describes its intent to initiate rule amendments (or possibly new rules) to introduce zero NOx emissions standards for space and water heating appliances and potentially other classes of appliances.[6]

CARB is focused on regulating greenhouse gas emissions under its authority granted by Assembly Bill 32. CARB is planning to phase out natural gas-fired appliances entirely, as a way to reduce greenhouse gas emissions from these appliances. In the Draft 2022 Scoping Plan Update, CARB lays out a plan for phasing out the installation of natural gas-fired appliances in new buildings by 2029, existing residential buildings by 2035 and existing commercial buildings by 2045.[7] Although these regulations do not address NOx emissions directly, they will have a NOx-reduction co-benefit by eliminating natural gas combustion as they move the state to all-electric appliances.

Numerous municipalities in the Bay Area are instituting “reach codes” under which new construction must be all electric or electric-ready. State building codes, effective in 2023, that encourage the proliferation of zero emissions solutions, were passed by the California Energy Commission in the summer of 2021. These standards have greatly increased the proliferation of zero NOx electric solutions over the past five years, a trend that is only expected to accelerate.

Despite the differences in timelines and in regulatory focus of these efforts being explored by SCAQMD, CARB and elsewhere, Air District staff sees these efforts as complementary to the proposed rule amendments, particularly with District goals around affordability and accessibility

[4] 30 Tex. Admin. Code § 117.3200 to .3215
[5] Utah Admin. Code R307-230-5
[6] Draft 2022 Air Quality Management Plan. South Coast Air Quality Management District. http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/combined-residential-and-commercial-buildings-appliance.pdf?sfvrsn=8
[7] Draft 2022 Scoping Plan Update. May 10, 2022. https://ww2.arb.ca.gov/sites/default/files/2022-05/2022-draft-sp.pdf

of zero NOx appliances to all consumers. Air District staff will continue to communicate with other agencies on issues related to the proposed rule amendments. The interim reporting process proposed as part of the rule amendments also allows Air District staff to continue to track the progress of these projects and suggest any alignment strategies, as appropriate, for consideration by the Air District's the Board of Directors. See Section III.C for more information on the proposed interim reporting requirements and Section IX.C for more information on the implementation working group.

III. PROPOSED RULE AMENDMENTS

Air District staff is presenting proposed amendments to Rules 9-4 and 9-6 in this Staff Report that staff believes best represents significant achievable NOx emissions reductions from the largest sources within the building sector. These proposed amendments include, for Rule 9-4, introducing an "ultra-low" NOx standard with a compliance date in 2024, and for both Rules 9-4 and 9-6, setting a zero NOx standard with compliance dates ranging from 2027 to 2031 based on equipment type, use and size. The details of these amendments are discussed below.

A. Proposed Amendments to Rule 9-4

Proposed amendments to Rule 9-4 are included in this report as Appendix A. The key changes are summarized below.

1. Rule Title and Equipment Scope

Rule 9-4 is currently titled "Nitrogen Oxides from Fan-Type Residential Central Furnaces." To expand the applicability of this rule to a larger breadth of space heating appliances, the proposed amendments would change the name to "Nitrogen Oxides from Natural Gas-Fired Furnaces." Existing requirements for residential fan-type furnaces will remain and additional units not historically covered by the rule are only intended to be subject to the zero NO_X emission standard in proposed new Section 9-4-301.3. Staff differentiates this through the addition of a definition for "Natural Gas-Fired Fan Type Central Furnace" and specifying where the standards are more broadly applicable to space heating equipment that does not meet the fan type central specifications. The proposed rule amendments also include a new applicability section to clarify that the rule applies only to natural gas-fired furnaces.

2. Applicability

The proposed amendments include a section that addresses to whom this rule would apply. Section 9-4-102 clarifies that the emissions standards of the rule would apply to any person who sells, offers for sale, or installs natural gas-fired furnace in the Air District. The rule also has requirements for manufacturers who intend to sell or distribute for sale or installation a natural gas-fired furnace for use within the Air District. These manufacturers would be subject to certification requirements that would demonstrate the furnaces for use within the Air District meet the emissions standards in Section 9-4-301.

3. Definitions

For clarity and enforceability, proposed amendments include the addition of definitions for British Thermal Unit (BTU), Heat Input, Natural Gas, Natural Gas-Fired Fan Type Central Furnace, Natural Gas-Fired Furnace, and Nitrogen Oxides.

4. Standards

The proposed amendments to Section 9-4-301 would clarify emissions standards, including existing requirements for residential fan-type central furnaces in the current version of the Rule (§ 9-4-301.1). Section 9-4-301.2 is added to introduce the "ultra-low NOx" requirement (14 ng/J) on January 1, 2024, to align with SCAQMD and SJVUAPCD emissions standards and would begin to achieve NOx reductions and health benefits shortly after rule adoption. As proposed, this requirement would only be applicable to fan-type central furnaces historically covered by Rule 9-4, as defined in the proposed amendments.

The proposed rule amendments include the addition of new Section 9-4-301.3 to introduce the zero NOx standard and expand the types of equipment subject to the standard. As proposed, the zero NOx standard is proposed to take effect on January 1, 2029, and would apply to all residential and commercial space heating appliances that meet the definition of a "Natural Gas-Fired Furnace" under proposed Section 9-4-206. This includes wall heating and other direct-vent units. This requirement would not be applicable to furnaces used in mobile homes. The proposed standard is intended to result in significant regional NOx (and therefore ozone and secondary PM) emission reductions in the long term. The standard is proposed to take effect in 2029 based on staff's current understanding of available technology, accessibility, and affordability of zero NOx units and planned industry technology development to reduce these current barriers to an immediate effective date, as discussed in more detail in Section IV.D. The standard would apply when appliances are replaced upon burnout; only appliances that meet the new standard could be sold and installed in the Bay Area upon implementation.

5. Administrative Requirements

The proposed amendments include updates and clarifications to certification and calculation methods. Staff intends for dual-fuel units that can demonstrate compliance with the applicable NOx standard, on average, to be able to meet the standards and certification requirements of these rule amendments. Rule 9-4 additionally requires the completion of a compliance statement for recordkeeping purposes and the proposed amendments would add a provision to this section to allow for the submission of compliance statements issued by SCAQMD for equivalent emission standards.

The proposed amendments include the addition of an interim report to be brought to the Board of Directors by the Air Pollution Control Officer (APCO) two years prior to the compliance date for the zero NOx standard. Staff intends for this report to provide information to the Board and the public about the accessibility of zero NOx appliances to Bay Area residents and to allow the Board of Directors an opportunity to take any necessary action in response to this information. Contents of this report would include information on technology development, market availability of zero NOx space heating appliances, potential costs of compliance, infrastructure readiness, and availability of incentive programs to decrease these costs.

6. Manual of Procedures

The proposed amendments include the addition of a Manual of Procedures (MOP) section to add further clarity around equipment certification and determination of emissions through source tests conducted in accordance with Environmental Protection Agency (EPA) reference methods.

B. *Proposed Amendments to Rule 9-6*

Proposed amendments to Rule 9-6 are included in this report as Appendix B. The key changes are summarized below.

1. Rule Applicability

The proposed amendments include a section that addresses to whom this rule would apply. Section 9-6-102 clarifies that the rule would apply to any person who sells, offers for sale, or installs natural gas-fired water heaters in the Air District. The rule also has requirements for manufacturers who intend to sell or distribute for sale or installation a natural gas-fired water heater for use within the Air District. These manufacturers would be subject to certification requirements that would demonstrate the water heaters for use within the Air District meet the emissions standards found in Section 9-6-301.

2. Standards

The proposed amendments to Rule 9-6 include the introduction of a zero NOx standard for natural gas-fired residential and commercial water heaters and boilers. The proposed compliance dates for these appliances are dependent on equipment size. Units under 75,000 BTU/hour (typically single-family residential) would be required to comply by 2027 and larger units up to 2 million BTU/hour (typically used in multifamily and commercial buildings) would have a 2031 compliance date as proposed. Based on staff's current understanding of available zero NOx technologies and market development, staff anticipates that zero NOx solutions for single-family residential applications will be available and affordable on a shorter timeframe than larger boilers used in multifamily and commercial applications, as discussed in more detail in Section IV.D. This includes the development of lower voltage heat-pump water heaters that will lower cost barriers associated with potentially necessary electric upgrades. The standard would apply when appliances are replaced upon burnout; only appliances that meet the new standard could be sold and installed in the Bay Area upon implementation.

The proposed rule amendments also include updates throughout the standards section intended to clarify and streamline the requirements as well as align with similar requirements in rules issued by other air districts and those currently incorporated into to the State Implementation Plan. This includes clarifications to how the equipment size standards are framed as well as a focus on weight-based emissions of NOx over parts per million.

3. Administrative Requirements

Section 9-4-402 of the proposed amendments has been updated to simplify the certification requirements and decrease the amount of APCO discretion allowed in the issuance of a certification under the rule. The new language is intended to align more closely with that in Rule 9-4 and to allow for a more streamlined process of a manufacturer certified compliance statement over an application.

As in Rule 9-4, proposed amendments to Rule 9-6 include an Interim Report to be brought to the Board by the APCO at least two years prior to each of the compliance dates for the zero NO_X standards. Staff intends for these reports to provide information to the Board and the public about the accessibility of zero NOx appliances to Bay Area residents and to allow the Board of Directors an opportunity to take any necessary action in response to this information. Contents of this report would include information on technology development, market availability of zero

NOx water heating appliances, potential costs of compliance, infrastructure readiness, and availability of incentive programs to decrease these costs.

4. Manual of Procedures

For clarity and consistency with the Air District's Manual of Procedures, references to Test Method ST-13B have been removed from Section 9-6-601.2. As in Rule 9-4, EPA Reference Method 7 should be used to measure emissions of nitrogen oxides from applicable equipment. In order to align with rules present in the State Implementation Plan, reference to South Coast's 1995 protocol has been removed in favor of approved EPA testing methodologies.

C. Interim Report and Implementation Working Group

As described above, the proposed amendments to Rules 9-4 and 9-6 include a requirement for staff to report back to the Air District Board of Directors on key factors associated with accessibility of technologies that are compliant with or do not conflict with the zero NOx standards. These reports are required to take place no later than two years before compliance dates. Therefore, the proposed schedule of zero NOx compliance and associated interim reporting is shown in Table 3-1 below.

Table 3-1
Zero NOx Compliance and Interim Reporting Schedule

Rule	Applicable Equipment	Ultra-low NOx compliance Date	Zero NOx Compliance Date	Interim Report Deadline
9-4	Natural gas-fired fan type central furnaces	Jan. 1, 2024	*N/A*	*N/A*
9-6	Water heaters and boilers below 75,000 BTU/hr	*N/A*	Jan. 1, 2027	Jan. 1, 2025
9-4	All natural gas-fired furnaces (heat input rate less than 175,000 BTU/hr)	*N/A*	Jan. 1, 2029	Jan. 1, 2027
9-6	Water heaters and boilers between 75,000 and 2 million BTU/hr	*N/A*	Jan. 1, 2031	Jan. 1, 2029

The content of the interim reports will additionally be informed by an Implementation Working Group of external stakeholders that will be convened and led by Air District staff and facilitated by a third-party consultant. The membership, intent and scope of the Implementation Working Group and their contributions to the interim reporting process is discussed further in Section IX.C.

IV. TECHNOLOGY EVALUATION

As described above, the interim reporting process and Implementation Working Group provides a mechanism for Air District Staff to report back to the Board on technology available to consumers that aligns with the proposed rule amendments. This section serves to provide information on the current state of technology availability, at the time of this report, as a baseline. Other accessibility factors to be addressed in the Interim Reports are also addressed

here including economic impacts (Section VI and Appendix C) and potential infrastructure impacts (Appendix D).

A. Zero NOx Natural Gas Systems

No zero NOx natural gas furnace or water heater systems are currently available, and no residential/commercial systems are being developed, to the knowledge of Air District staff. This assumption and any technology development will be updated through the interim reporting process to the Board of Directors and the Implementation Working Group. While not currently utilized in residential and commercial building appliances, zero NOx burners have been achieved in industrial settings using catalytic heat[8] and flameless, high air flow burners,[9] both of which realize zero NOx results by keeping the temperature of the combustion chamber below that at which NOx is formed. Additionally, oxy-combustion in industrial natural gas turbines can achieve zero NOx results by performing combustion without excess air.[10]

B. Zero NOx 240 Volt Electric Systems

There are currently a wide variety of zero NOx electric heat pump water heaters[11] and heat pump space conditioning (heating and cooling) systems[12] available on the market that operate on a 240-volt circuit. These units begin at low capacities for small apartments and low water usage but are widely commercially available at sizes equivalent to existing natural gas systems on the market for installation in residential and commercial spaces. These appliances can also be supplemented by additional equipment such as circuit sharing devices, smart panels, residential solar,[13] and thermal heat sharing devices[14] to optimize operation with limited amperage impact or during power outages. The potential costs associated with installing these units, including potential costs associated with electric service upgrades are addressed in the socioeconomic report for the proposed rule amendments, Appendix C.

C. Zero NOx Low Voltage Electric Systems

A key accessibility factor for installation of zero NOx furnaces and water heaters is the ability to install a new appliance without the need for significant additional work. For example, the installation of a 240V heat pump appliance may require electric service upgrades in older homes. Market availability of 120V heat pump systems provides consumers the ability to install heat pump appliances without this additional extra work and expense.

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[8]Bruest Natural Gas Line Heaters. June 2020. https://bruestcatalyticheaters.com/wp-content/uploads/2020/07/Bruest_Brochure_HOTCAT-Natural-Gas-Line-Heaters_6-16-20.pdf

[9] Patent Number 9562683. Accessed October 2022. https://patents.justia.com/patent/9562683

[10] Oxy-Fuel Turbines. Accessed November 2022. https://www.cleanenergysystems.com/oxy-fuel-turbines

[11] Energy Star Certified Water Heaters. Accessed November 2022. https://www.energystar.gov/productfinder/product/certified-water-heaters/results

[12] Energy Star Certified Central Heat Pumps. Accessed November 2022. https://www.energystar.gov/productfinder/product/certified-central-heat-pumps/results

[13] Peninsula Clean Energy. Design Guidelines for Home Electrification. Accessed March 2023. https://www.peninsulacleanenergy.com/wp-content/uploads/2023/02/Design-guidelines-for-home-electrification-v021023.pdf

[14] Harvest Thermal. Product. Accessed March 2023. https://www.harvest-thermal.com/product

Table 4-1, below, contains a subset of commercially available heat pump mini-split systems that operate on a 120-volt or 15-amp circuit, which is common in older homes. Mini split systems that are commonly operable on 120V circuits are sized between 9,000 and 12,000 BTU/hour, which are designed to heat and cool up to 600 square feet. In larger spaces with limited electric circuit capacity, it is typical to install multiple units and run them as needed when different spaces are occupied. These smaller solutions also allow for temporary use while a larger system is being permitted or installed, or, if desired by the building owner, while electric service is being upgraded to the building to accommodate other new electric uses such as onsite solar panels or electric vehicle charging.

Table 4-1
120V Heat Pump Mini Split Systems

Manufacturers	Model	Status
Pioneer	WYT012ALFI19RL, WYT009ALFI19RL (and others)	Commercially available
Hessaire	H12E1	Commercially available
LG	LS120HXV2, LS090HXV2	Commercially available
Mitsubishi	MZ-JP12WA, MZ-JP09WA	Commercially available
Fujitsu	9RL2, 12RL2	Commercially available
General Electric	AS09CRA, AS12CRA	Commercially available
Senville	LETO series	Commercially available
MRCOOL	DIY-12-HP-115B	Commercially available
LBG Products	LBH12ATO, LBH09ATO	Commercially available
AUX	Inverter series	Commercially available
Daizuki	DXTH12C416-20	Commercially available

Low voltage heat pump water heaters are also currently under development, with 4 companies participating in a field study through the Advanced Water Heating Initiative 120-Volt Heat Pump Water Heater Technology Validation and Commercialization program.[15] The 120V heat pump water heater represents a solution for appliance installation in existing buildings without need for other upgrades, which is especially important in emergency water heater replacement scenarios. The Advanced Water Heating Initiative's field study aims to provide data to manufacturers and electricity providers to understand the operation of these units in practice and build confidence in consumer satisfaction with their operation.

The first of these units recently became available on the consumer market, the Rheem ProTerra Plug-In. This unit is a standard footprint tank water heater and requires minimal clearance or additional venting. Nyle Water Heating Systems is also beginning to roll out consumer literature on their E8 unit. The E8 is a split heat pump water heater meaning that it is a separate heating unit that can be hooked up to an existing water heater tank, including tanks that were previously heated by gas. Both units operate on a 120V or 15-amp circuit and include connectivity features to assist in energy savings associated with time-of-use energy rates and other demand

[15] Advanced Water Heating Initiative 120V Field Study, Accessed November 2022. https://www.advancedwaterheatinginitiative.org/120v-field-study

response services. Table 4-2 below summarizes the 120V heat pump water heater systems included in the field study.

Table 4-2
Units in Advanced Water Heating Initiative 120V Field Study

Manufacturers	Model	Status
A.O. Smith	TBD	Active development/Field study (Announced May 2021)
General Electric	TBD	Active development/Field study (Announced May 2021)
Nyle Water Heating Systems	E8	Soon to be released/Field study complete
Rheem	ProTerra (Plug-In)	Commercially available beginning September 2022

With the field study ongoing as well as additional regulatory activity, incentive funding and market development in this space, Air District staff anticipates further development of compliant options prior to the first zero NOx compliance date on January 1, 2027. This development will be reported on in the first interim report to the Board of Directors by January 1, 2025.

D. Compliance Dates

Table 4-3 below outlines the zero NOx compliance dates included in the proposed rule amendments.

Table 4-3
Proposed Zero NOx Compliance Dates

Date	Rule	Applicable Equipment
Jan. 1, 2027	Rule 9-6	Water heaters and boilers below 75,000 BTU/hr
Jan. 1, 2029	Rule 9-4	All commercial and residential furnaces
Jan. 1, 2031	Rule 9-6	Water heaters and boilers between 75,000 and 2 million BTU/hr

Generally, while technology currently exists on the market that aligns with the proposed zero NOx standards today, Air District staff has provided additional time before the proposed compliance dates in order to increase accessibility and decrease costs of newly installed appliances for consumers. Additional time allows for further technology development, market saturation of zero NOx appliances and development of funding mechanisms such as those provided through the Inflation Reduction Act. A larger discussion of these factors can be found in Section VI.D (Economic Impacts: Funding and Incentives).

Water heaters and boilers sized 75,000 BTU/hr and below are typically installed in single family residential and small commercial environments. As outlined above, there are a variety of zero NOx appliances currently available on the market for this type of equipment, including the Rheem 120V ProTerra model and other low voltage options that are concluding field testing. For this reason, Air District staff reasonably expects that additional low voltage solutions will reach the consumer market with sufficient supply for those customers that require them by January 1, 2027.

While low voltage systems exist for space heating on the market currently, they serve mostly very small units or individual rooms. Additionally, unlike water heaters which can frequently be replaced in the footprint of an existing natural gas appliance, heat pump space conditioning equipment may require installation of a condenser or other equipment outdoors. In order to provide the opportunity for development of additional or improved low voltage solutions as well as to allow for local jurisdictions such as cities to consider adjusting their setback and permitting requirements for outdoor installations, Air District staff has proposed a compliance date of January 1, 2029, for zero NOx furnaces. Air District staff also plans to convene an ongoing Implementation Working Group to further investigate a number of implementation topics, including the status of technology development and availability, as well as actions/activities of local jurisdictions that may pertain to the implementation of the proposed amendments (further details on the Implementation Working Group can be found in Section IX.C. of this report).

Larger water heaters and boilers (75,000 to 2 million BTU/hr) have a proposed zero NOx compliance date of January 1, 2031. This is due to the complexities of installations in multifamily and larger commercial buildings typically served by these units. To the knowledge of Air District staff, there is still technology development and field testing needed to bring compliant appliances of this size to market. With initial rule drafts published in 2021 and anticipated rule adoption in 2023, Air District staff believes that there is sufficient time for this technology development to occur before 2031 while continuing to prioritize the emission reductions that will be achieved from enacting the proposed rule amendments.

Through the interim reporting process included in Sections 9-4-405 and 9-6-404 of the proposed amendments, Air District staff will report to the Board on technology developments and availability. Staff expects that availability of zero NOx units will increase and that costs will decrease over time. Should there be a gap in the market for any of the technology categories above such that sufficient zero NOx technologies are no longer projected to be available to meet the needs of the Bay Area, the Air District's Board of Directors may choose to consider amending any of the compliance dates through a public rulemaking process.

V. EMISSIONS AND EMISSION REDUCTIONS

The following section describes the emissions and expected emission reductions associated with the proposed rule amendments. First, the existing emissions context, based on the 2018 Air District emissions inventory, is presented. Next, the impacts of NOx emissions, including ozone and secondary PM formation are discussed, followed by the emission control methods expected to be used in response to the proposed rule amendments. Beginning in Section V.F, emission reductions are discussed, beginning with NOx emission reductions, then potential greenhouse gas co-benefits. This is followed by a discussion of particulate matter emission reductions and the health benefits associated with these reductions.

A. Emissions Context

Table 5-1 below shows the total emissions from all-natural gas combustion in residential and commercial buildings in the Bay Area, as 2018 annual emissions of carbon monoxide, nitrogen oxides, sulfur oxides, reactive organic gases, and fine particulate matter. The rows in bold indicate the equipment covered by the proposed amendments.

Table 5-1
Bay Area Emissions from Commercial and Residential Natural Gas Combustion

Description	2018 Annual Emissions (tons per year)				
	CO	NO_x	SO_x	ROG	$PM_{2.5}$
Commercial – space heating	**237.8**	**552.8**	**3.6**	**28.8**	**45.2**
Commercial – water heating	**291.5**	**475.7**	**4.4**	**35.3**	**55.4**
Commercial – other	237.8	552.8	3.6	28.8	45.2
Commercial subtotal	*767.0*	*1,581.3*	*11.5*	*92.8*	*145.7*
Residential – space heating	**1,036.6**	**2,410.0**	**15.5**	**125.4**	**196.9**
Residential – water heating	**847.3**	**828.3**	**12.7**	**102.5**	**161.0**
Residential – cooking	92.0	213.9	1.4	11.1	17.5
Residential – other	83.2	193.5	1.2	10.1	15.8
Residential subtotal	*2,059.1*	*3,645.7*	*30.9*	*249.2*	*391.2*
Grand Total[a]	*2,826.1*	*5,266.9*	*42.4*	*342.0*	*536.9*

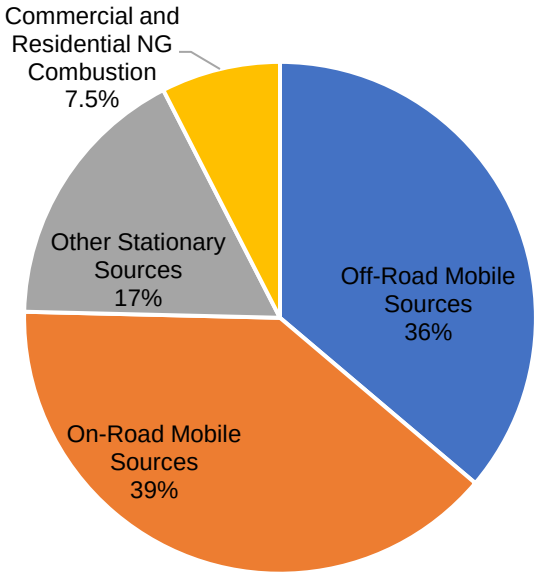
[a] The grand total in each case may not match the column summation due to rounding.

Emissions from building appliances in the Bay Area are estimated based on aggregated natural gas usage data from the California Energy Commission and appliance usage data from Pacific Gas and Electric. These data, combined with data and assumptions regarding the age of buildings and their equipment, are used to calculate emissions associated with the building sector.

Note that for 2018, NOx emissions from these targeted appliances totaled 4,267 tons; however, it is estimated that full implementation of existing Rule 9-6 will reduce NOx emissions from commercial and residential water heating by 576 tons relative to 2018. That leaves 3,690 tons of NOx emissions to be addressed by the proposed rule amendments, which is used as the baseline for emission reduction calculations in Section V.F. Additional details on emissions reduction estimates and how emissions were treated in the modeling analyses are provided in Appendix E.

For comparison, Figure 5-1 below shows the total 2018 emissions of nitrogen oxides from natural gas combustion in residential and commercial buildings (5,267 tons) in context with other sources of emissions of nitrogen oxides in the Bay Area.

Figure 5-1
Source Contributions to Total 2018 NOx emissions in the Bay Area

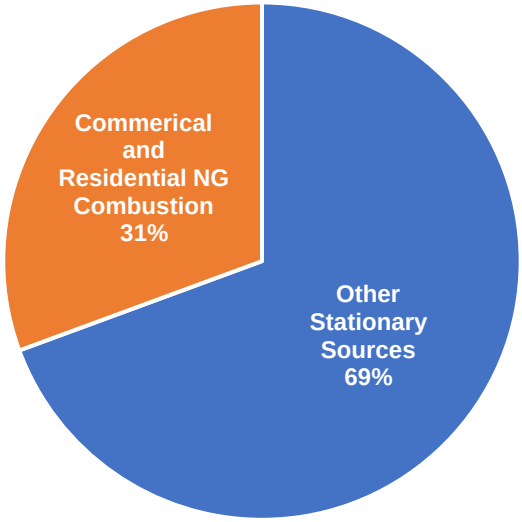


As seen above and in Figure 5-2 below, emissions of nitrogen oxides from commercial and residential natural gas combustion account for roughly one third of nitrogen oxides emissions from stationary sources in the Bay Area. As one of the largest single contributors to District-wide NOx emissions from stationary sources, Air District staff sees the further regulation of emissions from this sector as a key opportunity to minimize criteria pollutant emissions and achieve related air quality and health benefits across the Bay Area. As stated in the California Air Resources Board 2022 State Strategy for the State Implementation Plan (State SIP), "controlling ozone precursors, in particular oxides of nitrogen (NOx), is key to attaining the federal ozone standards".[16] NOx reductions are also critical for reducing PM, which is discussed in more detail in Section V.H.

Figure 5-2 below shows the breakdown of the total 2018 emissions of NOx solely from stationary sources. While commercial and residential natural gas combustion accounted for 7.5 percent of overall NOx emissions in the Bay Area in 2018, this source category accounted for 31 percent of total NOx emissions from stationary sources which are within the Air District's regulatory authority.

[16] California Air Resources Board. Proposed 2022 State Strategy for the State Implementation Plan Strategy. https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

Figure 5-2
Total 2018 NOx Contributions from Stationary Sources in the Bay Area

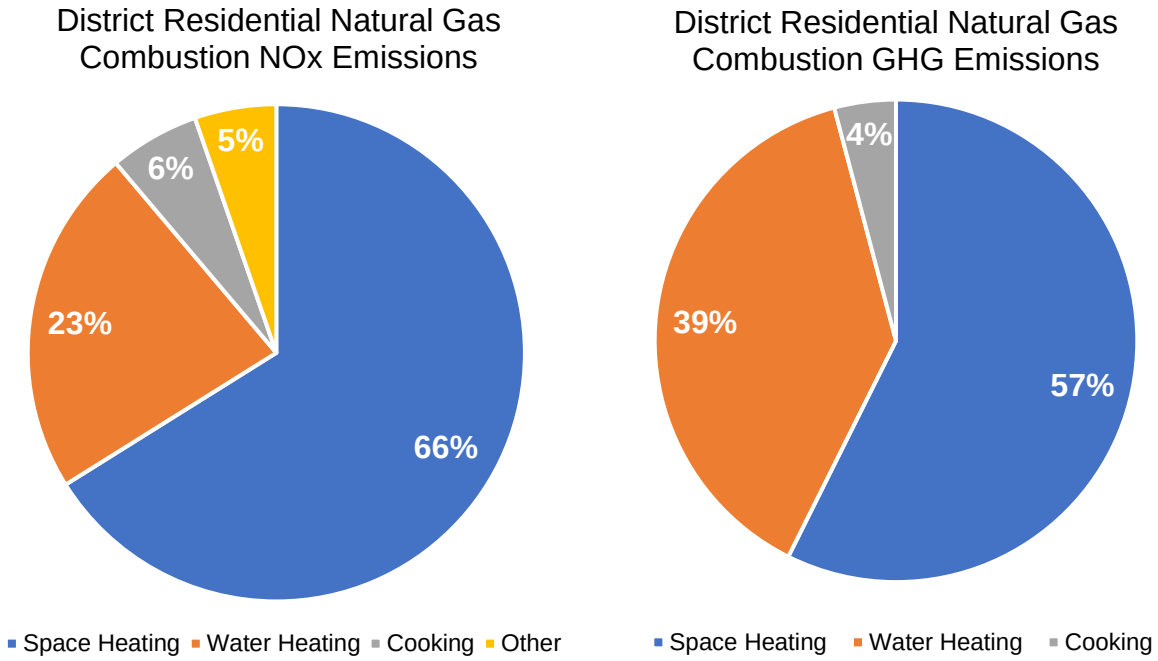


The buildings sector was identified as a significant Bay Area source of emissions in the Air District's 2017 Clean Air Plan, with space and water heating appliances representing roughly 90 percent of the emissions from this sector. The Clean Air Plan identifies all feasible measures that the Air District can take to achieve the ambient air quality standards, in furtherance of the goal set forth in Health and Safety Code section 40914, and all feasible measures that the Air District can take to mitigate the impact of pollution sources within the Bay Area on downwind jurisdictions, as required by Health and Safety Code section 40912. Emissions from building appliances were highlighted in measures SS30 (reduce NOx and carbon monoxide from residential and commercial furnaces) and BL2 (explore potential Air District rulemaking options to reduce all emissions from fossil fuel-based space and water heating systems for both residential and commercial use). This rulemaking proposal is the first to address the 2017 Clean Air Plan's measures SS30 and BL2.

The proposed rule amendments focus on emissions from natural gas-fired space and water heating appliances in buildings. While space and water heating are not the only natural gas consuming appliances in buildings, they do represent the vast majority of natural gas consumption and therefore NOx emissions from the buildings sector. Space and water heaters vent outdoors into the ambient air, impacting the local and regional air quality of the Bay Area, which is the focus of the Air District. For comparative purposes, staff also considered greenhouse gas (GHG) emissions associated with the relevant appliances and potential co-benefit of GHG emission reductions. Figure 5-3, below, shows the emissions share by appliance type for residential natural gas combustion.[17] Represented by the blue and orange sections of the charts, space and water heating represent roughly 90 percent of emissions from residential natural gas combustion for both NOx and greenhouse gases as carbon dioxide equivalent.

[17] Bay Area Air Quality Management District. 2019 Criteria Pollutant inventories.

Figure 5-3
Residential Natural Gas Combustion Emissions by Equipment Type in 2019



B. Nitrogen Oxide Emissions

The proposed rule amendments seek to significantly reduce NOx emissions from space and water heating appliances. As shown above in Table 5-1, these appliances emitted 2,410 and 828 tons of NOx per year, respectively, at residential buildings in the Bay Area in 2018.

Nitrogen oxides are a key criteria pollutant as a precursor to ozone and secondary particulate matter (PM) formation.[18] Secondary PM is formed from the conversion of NOx to ammonium nitrate through atmospheric chemical reactions with ammonia. Particulate matter, a diverse mixture of suspended particles and liquid droplets, is the air pollutant most harmful to the health of Bay Area residents. The Bay Area is currently classified as non-attainment for $PM_{2.5}$ under California Ambient Air Quality Standards (CAAQS) and non-attainment (24-hour standard) and unclassifiable (annual standard) under National Ambient Air Quality Standards (NAAQS) and must strive to meet these standards as soon as possible. Exposure to fine PM, on either a short-term or long-term basis, can cause a wide range of respiratory and cardiovascular health effects, including strokes, heart attacks, and premature deaths. Because NOx compounds in the atmosphere contribute to the formation of secondary PM, any NOx emissions reduction would also result in $PM_{2.5}$ reductions. Particulate matter emissions are discussed further in Sections V.H and V.I of this report. Although most NOx emissions are quickly broken down in the atmosphere, emissions of nitrogen oxides can be impactful in their own right, with the Agency

[18] *See* 40 C.F.R. Part 50 (ambient air quality standards for ozone, carbon monoxide, and PM2.5). EPA treats NOx as both an ozone and PM2.5 precursor

for Toxic Substances and Disease Registry finding that "[e]xposure to high levels of nitrogen oxides can damage the respiratory airways."[19]

C. Ozone Formation

Ozone is a regional pollutant for which the Bay Area is also currently in non-attainment under NAAQS and CAAQS. The Air District must strive to meet these standards as soon as possible. Emissions of reactive organic gases (ROG) and NO_X throughout the Bay Area contribute to ozone formation in downwind areas. Therefore, reductions in emissions of ROG and NO_X are needed throughout the region in order to decrease ozone levels. As the air temperature rises, ground-level ozone forms at an accelerated rate. Ozone levels are usually highest on hot, windless summer afternoons, especially in inland valleys. Exceedances of state or national ozone standards in the Bay Area only occur on hot, relatively stagnant days. Because weather conditions have a strong impact on ozone formation, ozone levels can vary significantly from day-to-day or from one summer to the next. Longer and more severe heat waves expected as a result of climate change may cause more ozone formation, resulting in more frequent exceedances of ozone standards. Ozone, also a key ingredient in smog, is additionally linked to direct health effects such as irritation and damage to lung tissue, worsening asthma, reduced lung function, and worsening of chronic illnesses such as obstructive pulmonary disease.[20]

The atmospheric chemistry of ozone formation depends on a large number of factors including the concentration of multiple precursor pollutants (including nitrogen oxides) as well as weather patterns. Thus, ozone concentrations and can vary widely on a local scale as well as a daily scale. However, overall reductions of nitrogen oxides contribute to long term ozone reductions, both in the Bay Area as well as in neighboring air basins. The California Air Resources Board states in its 2022 State Implementation Plan (SIP) Strategy, adopted in September 2022, that they are "exploring and proposing an unprecedented variety of new measures to reduce emissions [to support attainment of the 70 ppb ozone standard] …using all mechanisms available. This level of action is needed to ensure federal air quality standards are attained and to deliver on our commitments to protect public health…Controlling ozone precursors, in particular oxides of nitrogen (NOx), is key to attaining the federal ozone standards."[21] The implementation of the proposed rule amendments is necessary to achieve and maintain the ozone NAAQS and CAAQS standards in the region as well as necessary to support similar state-wide emissions reduction efforts and to support attainment in areas downwind of the Bay Area air basin. Staff has estimated that the proposed amendments would result in a mean modeled decrease in 8-hour ozone of -0.021 ppb on peak ozone days in the Bay Area, as detailed in Appendix E. The amendments may have further benefits on downwind air basins. Staff recommends that the Air District submit the proposed amendments to the SIP if they are adopted by the Board.

D. Ultra-low NOx Emission Control Methods

Emission control methods to meet the proposed 14 ng/J standard for Rule 9-4 are well established and currently required by SCAQMD Rule 1111 and SJVUAPCD Rule 4905. These ultra-low NOx burners reduce excess air in combustion by pre-mixing the fuel and air and burning the mixture at a lower temperature than older equipment, thus reducing NOx emissions.

[19] ASTDR, Nitrogen Oxides. https://www.atsdr.cdc.gov/toxfaqs/tfacts175.pdf
[20] U.S. EPA (2019b). Policy Assessment for the Review of the National Ambient Air Quality Standards for Particulate Matter, External Review Draft
[21] California Air Resources Board. Proposed 2022 State Strategy for the State Implementation Plan. https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

Potential complications identified in other jurisdictions, such as high altitude and cold weather scenarios, are not applicable in the Bay Area. Staff intends for dual-fuel systems that are able to demonstrate compliance with this new proposed standard to be eligible for certification.

E. Zero NOx Technologies for Space and Water Heating

Current emission control methods that align with the zero NOx emissions standard available on the market consist mainly of electric resistance and electric heat pump systems. Air District staff does not intend to mandate specific zero NOx technology solutions, but for the purpose of this report, including emissions and cost estimates, currently available electric solutions are used to form estimates and projections. While not currently available on the market, other natural gas technologies, such as those with combustion occurring in the absence of nitrogen, may also be able to meet the proposed standards and proposed certification requirements. The use of electric appliances serves as a conservative estimate for NOx reductions due to the additional NOx from natural gas-fired power plants for electricity generation taken into account for estimates as described below.

F. Nitrogen Oxides Emissions Reductions

As the applicable rules function as appliance point-of-sale requirements, emission reductions associated with the proposed rule amendments would occur over time in relation to the lifespan of currently installed equipment. Staff estimated emissions reductions from the proposed amendments as newer equipment is phased in over time due to equipment replacements. To model these predicted emission reductions, staff made the following assumptions:

- While the proposed regulatory amendments would allow for natural gas-fired zero NOx appliances, based on currently available technology, staff assumed that, upon burnout, natural gas-fired appliances would be replaced with electric solutions when the proposed zero NOx standards are in effect. As noted above, this results in a conservative analysis of NOx reductions because other technologies that may be developed could avoid the additional NOx from electricity generation.
- For electric replacements, it is assumed that the electricity provided is from the community choice aggregator local to the customer, or direct from Pacific Gas and Electric. The emissions associated with each of these electricity sources as well as their contribution to projected Bay Area electric load is shown below in Table 5-2. The resulting weighted average is 85 percent carbon and NOx-free electricity generation.

Table 5-2
Bay Area Electricity Generation Resources

	Solar, Wind & Geothermal	Hydro	Nuclear	Biomass	System Power	Bay Area Usage[22]
Marin Clean Energy[23]	53%	38%	1%	6%	2%	14%
Sonoma Clean Power[24]	38%	41%	1%	11%	9%	6%
East Bay Community Energy[25]	42%	16%	0%	1%	40%	17%
Peninsula Clean Energy[26]	40%	51%	0%	9%	0%	9%
Silicon Valley Clean Energy[27]	36%	64%	0%	0%	0%	9%
SF Clean Power[28]	54%	39%	0%	0%	7%	8%
San Jose Clean Energy[29]	50%	23%	23%	3%	1%	10%
PG&E[30]	43%	6%	39%	4%	8%	27%

- Electricity generated from natural gas-fired power plants is assumed to result in NOx emissions of 5 ppm by dry volume at 15% oxygen. This emission limit represents best available control technology (BACT) for simple-cycle gas turbine power plants over 50 megawatts.[31] This is a conservative estimate, as most Bay Area power plants are required by Air District permit to meet a 2.5 ppm NOx limit.
- While some Bay Area residents are choosing to install zero NOx solutions at this time, and this is expected to continue and increase over time, modeled emissions reductions do not assume any voluntary uptake of zero NOx technology prior to the proposed compliance dates because voluntary uptake is not expected to be significant.

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[22] Values calculated via data from California Public Utilities Commission, Integrated Resource Plan. https://www.cpuc.ca.gov/irp/

[23] Marin Clean Energy, Light Green Plan. https://www.mcecleanenergy.org/60-renewable/. Accessed November 2022.

[24] Sonoma Clean Power, CleanStart Plan. https://sonomacleanpower.org/uploads/documents/Power-Content-Label-2021-Web.pdf

[25] East Bay Community Energy, Bright Choice Plan. https://ebce.org/our-power-mix/ .Accessed November 2022.

[26] Peninsula Clean Energy, ECOplus Plan. https://www.peninsulacleanenergy.com/power-mix/. Accessed November 2022.

[27] Silicon Valley Clean Energy, SVP Residential Plan. https://www.siliconvalleypower.com/svp-and-community/about-svp/power-content-label. Accessed November 2022.

[28] SF Clean Power, Green Plan. https://static1.squarespace.com/static/5a79fded4c326db242490272/t/632e3e4c508cf816fc26e5d8/1663974989563/CleanPowerSF_Product+Content+Label+2022_Green_All+Languages.pdfhttps://static1.squarespace.com/static/5a79fded4c326db242490272/t/632e3e4c508cf816fc26e5d8/1663974989563/CleanPowerSF_Product+Content+Label+2022_Green_All+Languages.pdf

[29] San Jose Clean Energy, GreenSource Plan. https://sanjosecleanenergy.org/wp-content/uploads/2022/09/SJCE_2021-Power-Content-Label.pdf

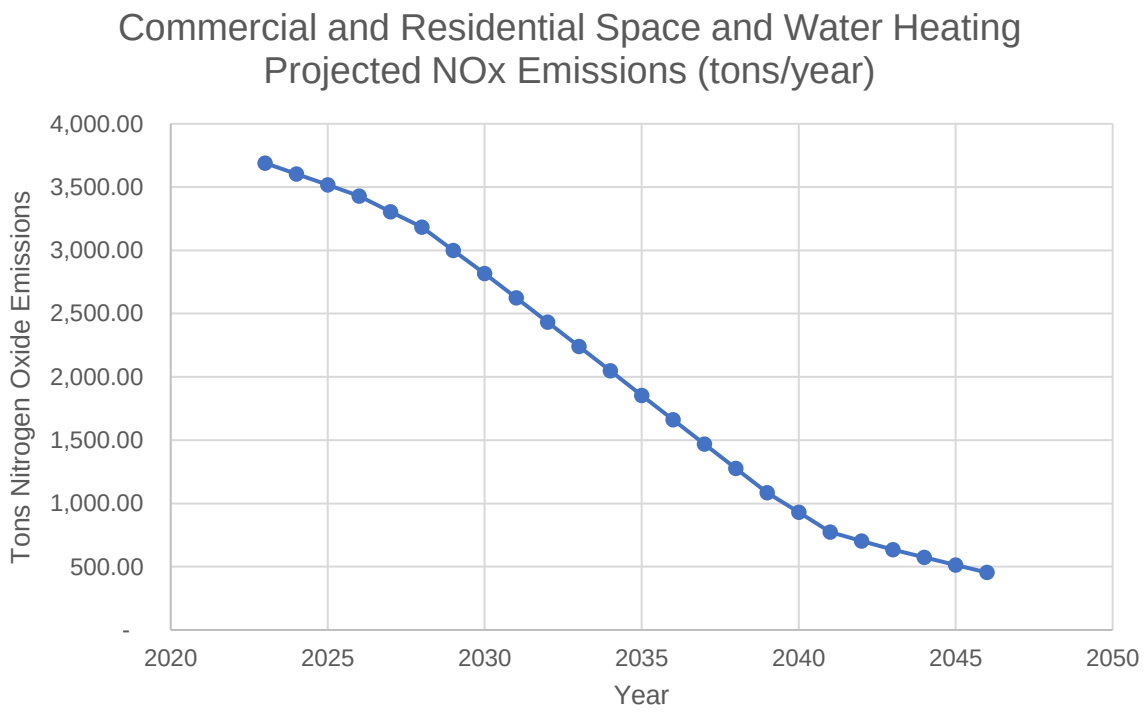
[30] Pacific Gas and Electric Power Mix via East Bay Community Energy. https://ebce.org/our-power-mix/. Accessed November 2022.

[31] California Air Resources Board, Stationary Source Division. Report to the Legislature: Gas-Fired Power Plant NOx Emission Controls and Related Environmental Impacts. May 2004. https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/reports/l2069.pdf.

- Commercial space and water heating is frequently achieved through the use of larger boilers that are covered under the Air District's Regulation 9, Rule 7. Based on available inventories, staff assumed that 50 percent of commercial space and water heating baseline emissions would not be impacted by the proposed amendments to Rule 9-4 and Rule 9-6.
- As the proposed rule amendments would impact only direct emissions from two types of building appliances and do not impact natural gas distribution, staff did not assume any upstream emission reductions along the natural gas infrastructure. Although reduced use of natural gas may result in less methane leakage, this reduced leakage is not guaranteed because the technologies used to meet the proposed standards may rely on the natural gas grid for energy and the proposed amendments do not impact the existing natural gas distribution system.
- Water heaters were assumed to have an average lifespan of 13 years and space heating equipment are assumed to have an average lifespan of 18 years.[32]

Figure 5-3, below, shows the projected NOx emissions over time based on the assumptions described above and the proposed amendments to Rules 9-4 and 9-6. The 2018 Air District emissions inventory provides the baseline for this projection. Further detail on the development of the emissions inventory can be found in the Draft EIR (Appendix G).

Figure 5-4
Projected NOx Emissions from Proposed Rule Amendments



Initial reductions would be achieved by the introduction of the ultra-low NO_X requirements (14 ng/J) for residential furnaces. For replacements under this standard between 2024 and 2029,

[32] Environmental Energy and Economics. April 2019. "Residential Building Electrification In California: Consumer economics, greenhouse gases and grid impacts". Page 41.

staff estimates a 65 percent reduction in NO_X emissions on a per unit basis compared to existing standards. Additional significant emission reductions would be achieved starting in 2027 with the zero NO_X compliance date for small water heaters, and additionally in 2029 with the zero NOx compliance date for all new space heating units.

Yearly emissions reductions would continue, including as zero NOx technology is introduced for large water heaters in 2031 and units, including ultra-low NOx space heating units, are changed out over the course of the average assumed appliance lifetimes.

Table 5-3, below, provides values for projected yearly emissions and projected reductions versus the baseline emissions inventory for selected years as represented by the graph in Figure 5-4.

Table 5-3
Projected NOx Emissions upon Implementation of Proposed Rule Amendments

Year	Projected Yearly NOx Emissions (tons/year)	Projected NOx Reduction vs. Baseline (tons/year)
Baseline	3,690	-
2025	3,516	174
2030	2,816	874
2035	1,855	1,835
2040	930	2,761
2045	515	3,176
2046	454	3,236

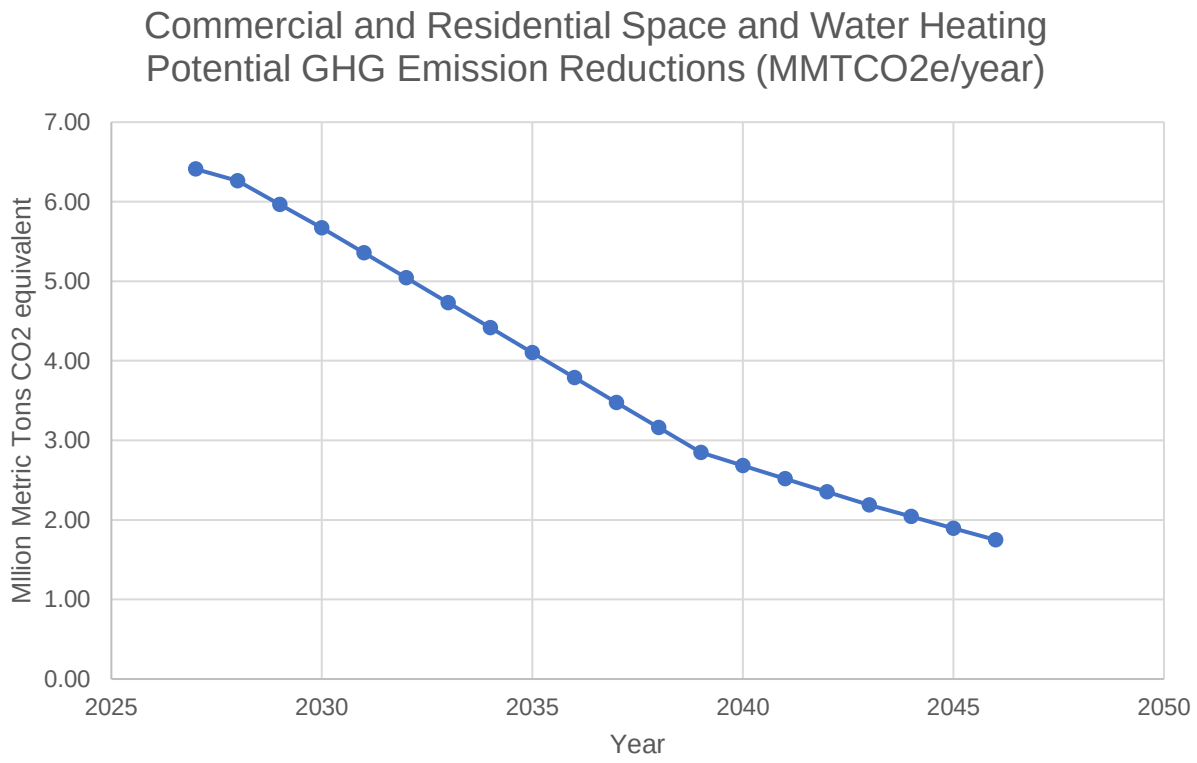
These NOx emission reductions over time are significant, with an 88 percent reduction of emissions from the baseline by the projected date of complete equipment changeout in 2046. This date could be realized sooner with voluntary uptake and replacements before burnout both prior to and throughout the compliance period. NOx emissions are a criteria pollutant of concern for the Bay Area and impact overall regional air quality and ozone formation, as well as secondary particulate matter (PM) formation. The significant NOx reduction expected from the proposed amendments to the rules would result in meaningful local health benefits through reduced PM formation. These reductions are discussed in Section V.G of this report as well as Appendix E.

G. Greenhouse Gas Emissions Reductions

Staff additionally estimated potential greenhouse gas emission co-benefits that may result from the proposed rule amendments. Figure 5-5, below, shows the potential GHG emissions reductions over time based on the same set of assumptions listed at the beginning of this section. These assumptions include the proliferation of electric technologies in the absence of other new technology development but do not include potential greenhouse gas savings along the natural gas infrastructure that could result from widespread electric appliance usage. Should zero NOx natural gas-fired technologies be developed and adopted, consumers would have the opportunity to choose between newly designed natural-gas fired and electric appliances, and the projected greenhouse gas savings depicted below would overestimate

potential GHG reduction co-benefits from the amendments. These estimates should thus be seen as maximum potential co-benefit emissions reductions. For greenhouse gases, 2019 District emissions data serves as the baseline.

Figure 5-5
Potential GHG Emissions under Proposed Rule Amendments



GHG co-benefits are achieved in a fashion similar to the emission reductions described for NOx. Projected greenhouse gas co-benefits are based largely on the assumption of in-kind electric replacements and low-carbon content power provided by Pacific Gas and Electric and the community choice aggregators in the Bay Area as shown in Table 5-2 above. For natural gas generated electricity, a correction factor is applied to account for GHG emission differences between natural gas appliance and turbine combustion. Further details on and examples of this calculation are provided in Appendix G.

Table 5-4, below, provides values for projected yearly emissions and potential reductions versus the baseline emissions inventory for selected years as represented by the graph in Figure 5-5.

Table 5-4
Potential GHG emissions under Proposed Rule Amendments

Year	Projected Yearly GHG Emissions ($MMTCO_2e/yr$)	Potential Reduction vs. Baseline ($MMTCO_2e/yr$)
Baseline	6.56	-
2030	5.67	0.89
2035	4.10	2.46
2040	2.68	3.88
2046	1.75	4.81

H. Particulate Matter Emissions

Emissions of total fine particulate matter from residential and commercial natural gas combustion is represented above in Table 5-1, with a total of 536.9 tons per year emitted in 2018. Fine particulate matter, or $PM_{2.5}$, can be categorized as "primary" or "secondary" particulates. Primary $PM_{2.5}$ is directly emitted to the atmosphere, while secondary $PM_{2.5}$ is a byproduct of chemical reactions of gaseous pollutants such as NO_x and ammonia (NH_3) in the atmosphere. Secondary particulate matter formation is of significant relevance to these proposed rule amendments due to the significant emissions of nitrogen oxides from this sector, as discussed above. Secondary particulate matter emissions from this source are expected to be reduced in line with NOx reductions achieved by the proposed rule amendments. Primary particulate matter reductions are a potential co-benefit that would be achieved with consumer installation of electric appliances, which aligns with but is not required by the proposed rule amendments. Further analysis of particulate matter exposure and health impacts associated with these sources is discussed in Section V.I below.

The Bay Area is currently designated as a non-attainment area for the annual $PM_{2.5}$ and 24-hour PM_{10} CAAQS and as unclassifiable under the annual $PM_{2.5}$ NAAQS and non-attainment for the 24-hour $PM_{2.5}$ NAAQS. The EPA is currently considering a new, more stringent $PM_{2.5}$ ambient air quality standard. Air District staff anticipates the need to submit a PM attainment plan in response to this new standard once it is finalized. These proposed amendments will reduce $PM_{2.5}$ in the Bay Area and help move the Air District towards attainment of both the CAAQS and NAAQS. Staff has estimated through modeling that the amendments may result in a mean modeled decrease in 24-hour $PM_{2.5}$ of -0.68 $\mu g/m^3$ when observations indicated 24-hour $PM_{2.5}$ was at least 30 $\mu g/m^3$, as detailed in Appendix E. The importance of zero NOx appliance standards has been recognized by EPA. On October 5, 2022, citing this Bay Area rule development proposal, EPA found that zero NOx appliance rules must be evaluated by the San Joaquin Valley Air Pollution Control District in order to show full consideration of all methods of emissions reductions for fine particulate matter. Air District staff thus recommends that the Air District submit the proposed rule amendments to EPA for inclusion in the State Implementation Plan. Staff plans to recommend submittal of all new rules or rule amendments passed by the Board of Directors that reduce PM to be a part of the SIP moving forward, beginning with the proposed rule amendments discussed in this report.

I. Exposure and Health Impacts

The Air District evaluated ambient air quality and health impacts from natural gas fired furnaces and water heaters in commercial and residential buildings in support of the proposed amendments to Rules 9-4 and 9-6. Staff estimated contributions to ambient NOx levels from the above sources, as well as the contributions to levels of particulate matter and ozone. Staff also estimated the health impacts of simulated fine particulate matter. The results of this analysis are summarized in this section but can be found in more detail in Appendix E.

The modeling analysis included two annual simulations for 2018:

- A base case simulation that included the Air District's latest natural gas combustion emissions estimates, and
- A control case simulation that removed emissions from commercial and residential natural gas combustion emissions associated with space heating and water heating that are covered by the proposed rule amendments. The emissions removed are represented by those in bold in Table 5-1.

Differences between these two simulations provided an estimate of the air quality impacts of this source sector. It is important to note, however, that the current version of Rule 9-6 is expected to reduce 2018 NOx emissions from commercial and residential water heaters by 576 tons, with proposed rule amendments targeting the remaining emissions from these appliances, as well as all emissions from commercial and residential space heating. Impacts from the expected emissions reductions from the current version of Rule 9-6 (576 tons) were excluded from the health benefits analysis to ensure that the modeling-estimated health benefits account only for NOx emission reductions associated with the proposed rule amendments (3,690 tons). (See Appendix E for details.)

It is important to clarify the bounds of this analysis and assumptions made as compared to other emission estimates and impact findings throughout this report. The health modeling shows the health impact associated with currently designed natural gas-fired space and water heating appliances located in commercial and residential buildings that are covered by the proposed rule amendments. Due to the nature of the rule amendments, with enforcement of the standards at the point of sale of the equipment, the emission reductions and related health benefits will be realized over the course of time as old equipment is replaced by new equipment that meets the emissions standards in the amendments.

The study population of this analysis includes residents of the portions of the nine-county Bay Area that are under the jurisdiction of the Air District (Figure 5-5). This population was estimated to be approximately 7.7 million residents. A breakdown by county and race/ethnicity, using categories supplied by BenMAP/PopGrid, is given in Table 5-5.

Table 5-5
Modeled residential population

	Asian	Hispanic	Black	White	(all)
Alameda	32.6%	24.3%	11.0%	32.1%	*1,668,306*
Contra Costa	18.5%	28.7%	9.2%	43.6%	*1,180,605*
Marin	7.4%	18.3%	3.2%	71.1%	*266,439*
Napa	8.5%	36.8%	2.3%	52.5%	*147,553*
San Francisco	34.6%	15.1%	5.2%	45.1%	*866,833*
San Mateo	31.5%	26.6%	2.7%	39.1%	*797,428*
Santa Clara	38.3%	27.7%	2.8%	31.2%	*1,991,116*
Solano	21.7%	27.8%	17.3%	33.2%	*311,782*
Sonoma	5.6%	30.5%	2.2%	61.7%	*461,976*
(all)	*28.6%*	*25.6%*	*6.4%*	*39.4%*	*7,692,039*

Note: Percentages are row-wise; they indicate shares of that county's population.
Basis: BenMAP/PopGrid projection from 2010 to 2020.

The key findings of this analysis are that NOx emissions from the sources in question caused production of secondary $PM_{2.5}$ across most residential areas of the Bay Area with an annual average contribution between about 0.04 microgram per cubic meter (µg/m^3) to 0.18 µg/m^3. Emissions from this source sector also include primary, or directly emitted, $PM_{2.5}$. The total annual average contribution to $PM_{2.5}$, including both primary and secondary $PM_{2.5}$, across most residential areas of the Bay Area varied between 0.10 µg/m^3 and 0.42 µg/m^3. Maps of emissions reductions in NOx and primary $PM_{2.5}$ can be seen in Figures 5-6 and 5-7 below.

Figure 5-6
Map of the NOx emissions difference between the modeled control and base cases

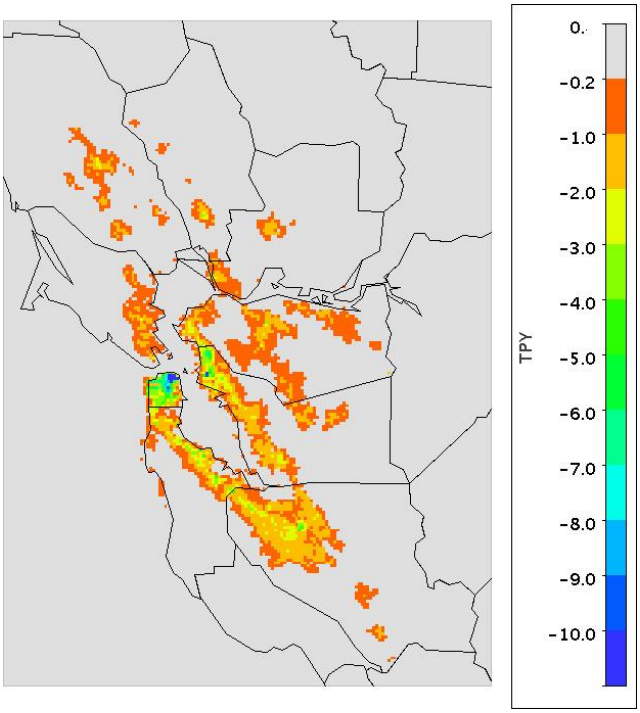
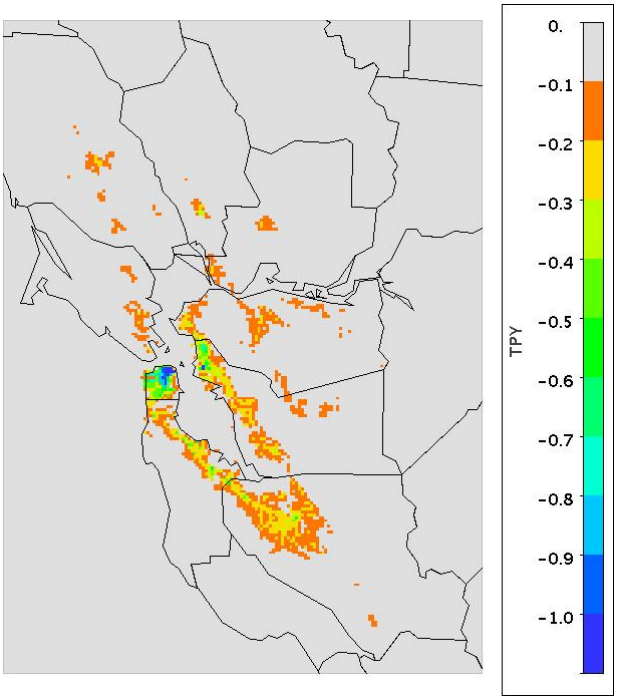


Figure 5-7
Map of the $PM_{2.5}$ emissions difference between the modeled control and base cases



The health benefits from reduced $PM_{2.5}$ achieved by eliminating emissions from the natural gas-fired appliances covered under the proposed rule amendments were estimated using the U.S. EPA's May 2021 version of the Environmental Benefits Mapping and Analysis Program – Community Edition (BenMAP-CE), paired with three additional sets of health impact functions deemed appropriate for use in the Bay Area. Further information about the methodology used and constraints of this modeling can be found in Appendix E. Due to the nature of commercial and residential buildings, these health benefits would be realized across the region, with increased benefits in densely populated areas.

Table 5-6 provides a breakdown of these exposure assessments by the four racial/ethnic groups listed in Table 5-5.

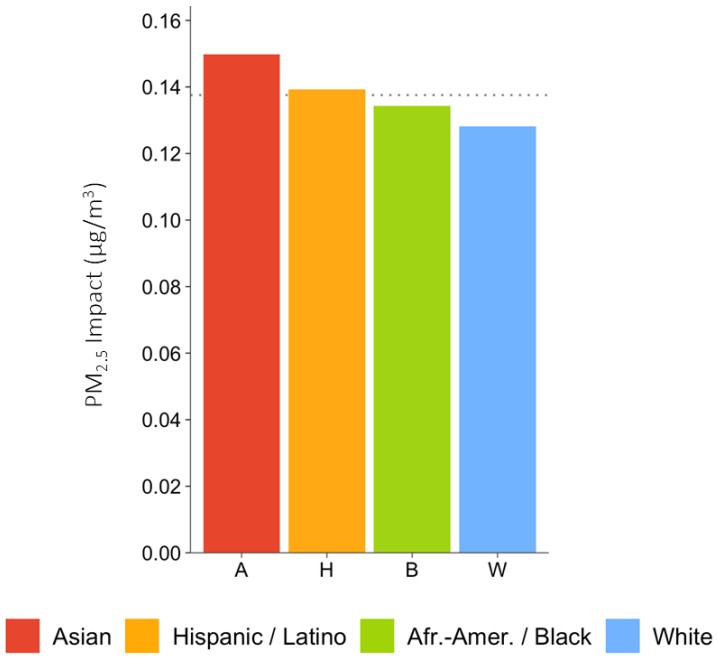
Table 5-6
Modeled exposures (outdoor concentrations, weighted by 2020 Bay Area residential population) under baseline and control scenarios

	Baseline	Control	Reduction
Total $PM_{2.5}$ ($\mu g/m^3$)			
Asian/Pacific Islander	8.817	8.667	0.150 (1.7%)
Hispanic/Latino	8.826	8.687	0.139 (1.6%)
African-American/Black	8.670	8.536	0.134 (1.5%)
White	8.116	7.988	0.128 (1.6%)
(average)	*8.534*	*8.397*	*0.138 (1.6%)*
Primary $PM_{2.5}$ ($\mu g/m^3$)			
Asian/Pacific Islander	4.496	4.437	0.059 (1.3%)
Hispanic/Latino	4.558	4.505	0.054 (1.2%)
African-American/Black	4.491	4.436	0.055 (1.2%)
White	4.140	4.091	0.050 (1.2%)
(average)	*4.371*	*4.318*	*0.054 (1.2%)*
Secondary $PM_{2.5}$ ($\mu g/m^3$)			
Asian/Pacific Islander	4.321	4.230	0.091 (2.1%)
Hispanic/Latino	4.268	4.182	0.086 (2.0%)
African-American/Black	4.179	4.099	0.079 (1.9%)
White	3.976	3.898	0.079 (2.0%)
(average)	*4.163*	*4.079*	*0.084 (2.0%)*
NO_x (ppb)			
Asian/Pacific Islander	10.079	9.324	0.755 (7.5%)
Hispanic/Latino	9.958	9.268	0.690 (6.9%)
African-American/Black	10.930	10.212	0.718 (6.6%)
White	8.113	7.470	0.643 (7.9%)
(average)	*9.328*	*8.636*	*0.692 (7.4%)*

Note: Reductions are expressed relative to baseline exposures.

As depicted in Figure 5-8, if both NOx and primary $PM_{2.5}$ emissions from the combustion of natural gas by residential and commercial space and water heating appliances were eliminated, modeling indicates that the largest reductions in $PM_{2.5}$ exposure would accrue to the Bay Area's Asian/Pacific Islander population. This would be true in both absolute and relative terms (see Table 5-6, column "Reduction"). Within individual counties (not shown; see Appendix F) the greatest modeled reductions in $PM_{2.5}$ exposure from the proposed rule amendments would accrue either to Hispanic/Latino, African-American/Black, or Asian/Pacific Islander residents, depending on the county.

Figure 5-8
Modeled Total $PM_{2.5}$ Impacts (annual average outdoor concentrations, weighted by residential population) attributed to targeted emissions from space and water heating appliances.



Note: Consistent with Table 5-6, this $PM_{2.5}$ (Total) is the sum of $PM_{2.5}$ (Primary) and $PM_{2.5}$ (Secondary).

The total $PM_{2.5}$ emissions from this sector result in an estimated 37 to 85 premature deaths per year, with 23-52 attributable to secondary $PM_{2.5}$ emissions (which are directly tied to NOx emissions). These results can be seen in Table 5-7 below.

Table 5-7
Estimated benefits resulting from decreased $PM_{2.5}$ levels due to an assumed case that eliminates space and water heating natural gas combustion emissions in the Bay Area

Health Impact[a]	Avoided Incidence, Per Year	
	Secondary $PM_{2.5}$	Total $PM_{2.5}$
Premature mortality		
All causes[b]	23–52	37–85
Chronic/severe illness		
Non-fatal acute myocardial infarction (heart attack)	2.6–24	4.2–39
Hospital admission, neurological[c]	7.7	13
Incidence, out of hospital cardiac arrest	0.45	0.73
Incidence, stroke	1.5	2.4
Incidence, lung cancer	1.9	3.1
Hospital admissions[d]		

Health Impact[a]	Avoided Incidence, Per Year	
	Secondary $PM_{2.5}$	Total $PM_{2.5}$
Respiratory[e]	2.4	3.9
Cardiovascular[f]	3.0	4.9
ER visits		
Respiratory[g]	13	20
Cardiovascular[h]	6.2	10
Other effects		
Restricted activity days	24,000	39,000
Work loss days	4,100	6,700
Hay fever/allergic rhinitis	440	710
Asthma-related effects		
Asthma symptoms/albuterol use	9,200	15,000
Onset of asthma	71	110

[a] Each health impact is associated with one or more unique International Classification of Diseases-9-Clinical Modification (ICD-9-CM) code(s) (Medicode, 1996).
[b] Includes all ICD-9 codes.
[c] First hospital admission (cause-specific, to indicate onset of the chronic disease) for dementia, Alzheimer's disease, or Parkinson's disease (ICD-9 codes 290, 331.0, or 332, respectively), and other neurological morbidities.
[d] Hospital admissions due to acute exposure to air pollution are assumed to pass through the emergency room; however, the calculated value of hospital admissions does not account for the cost incurred in the emergency room visit. This strategy avoids double-counting.
[e] Includes all respiratory diseases (ICD-9 codes 460–519).
[f] Includes cardio-, cerebro-, and peripheral vascular diseases (ICD-9 codes 410, omitting 410.x2; 410–414; 426–427; 428; 429; 430–438; 440–448).
[g] Includes respiratory diseases (ICD-9 codes 480–486, 491, 492, 496, 460–465, 466, 477, 493, 786.07).
[h] Includes all cardiac outcomes (ICD-9 codes 390–549).

It is important to note that the secondary $PM_{2.5}$ benefits represented above in the center column would be achieved as a result of NOx emissions reductions. Therefore, the secondary $PM_{2.5}$ benefits captured in this modeling represent the potential direct benefits of the emissions standards set forth in the proposed rule amendments. The righthand column of Table 5-7 represents benefits from total $PM_{2.5}$ emission reductions and therefore includes primary $PM_{2.5}$ emissions from space and water heating appliances. While it is expected that, based on current appliance availability, the amendments will lead to the proliferation of electric space and water heating appliances, the development of natural gas-fired appliances that meet the proposed standards is possible. If zero NOx natural gas-fired appliances are developed, these appliances may, or may not, be designed to eliminate primary PM emissions. Thus, there still may be primary $PM_{2.5}$ emissions from these appliances and the additional benefits represented in the Total $PM_{2.5}$ column of Table 5-7 would not be fully realized, depending on how many consumers choose electric versus natural gas-fired zero NOx appliances.

As discussed in Section VIII: Environmental Impacts and Appendix D, it is expected that all incremental power generation needs will be met with renewable generation resources.

VI. ECONOMIC IMPACTS

A. Cost Effectiveness

In this section staff presents cost effectiveness information for the Board and public's consideration. Cost effectiveness is calculated by dividing the annualized costs (amortized capital costs and operating costs) by the total number of tons of emission reductions expected each year:

$$Cost\ effectiveness = \frac{Annualized\ Cost}{Annual\ Emission\ Reduction}$$

Air District staff reviewed available data on costs and cost estimation tools and methodologies and developed cost estimates associated with compliance under the proposed amendments. Based on these cost estimates, Air District staff estimated cost effectiveness for the proposed amendments. Staff assumes replacement of currently designed natural gas-fired space and water heating appliances with currently available electric heat pumps for purposes of this analysis. Costs of potential natural gas-fired zero NOx appliances are unknown at this time. Estimates of the net annual costs (including annualized equipment costs, rate savings, and panel upgrades), annual emission reductions and cost effectiveness are shown on a per equipment unit basis in Table 6-1.

Table 6-1
Per Unit Compliance Cost and Cost Effectiveness for Proposed Amendments

	Equipment Cost ($)	Net Equipment Compliance Cost ($)[a]	Panel Upgrade Cost ($)	Annualized Equipment Compliance Cost ($/year)[b]	Annual Rate Savings ($/year)	Annualized Panel Upgrade Cost ($/year)[c]	Annual NOx Reductions (tons/year)	Cost Effectiveness ($/ton)[d]
Rule 9-4 Amendments for Space Heating								
Ultra-low NOx Standard	$5,650	$550	$0	$45	$0	$0	0.0008	$54,100
Zero NOx Standard	$8,030	$2,900	$2,630	$241	($150)	$161	0.0013	$72,100 - $199,800
Rule 9-6 Amendments for Water Heating								
Zero NOx Standard	$2,820	$850	$960	$88	($45)	$59	0.0002	$250,400 - $594,000

Notes:
[a] Net equipment compliance cost is estimated by calculating the difference in capital cost between equipment meeting the current standard and equipment meeting the applicable proposed standard.
[b] Annualized equipment compliance cost is estimated by amortizing the net equipment compliance cost over the lifetime of the equipment.
[c] Annualized panel upgrade cost is estimated by amortizing the panel upgrade cost over the lifetime of the panel upgrade.
[d] Ranges of cost effectiveness shown for the space heating and water heating zero-NOx standards represent the cost effectiveness for an equipment installation that does not require a panel upgrade (low end of range) and an equipment installation that does require a panel upgrade (high end of range).

Further information and details on the development of the cost estimates are provided in the following Section VI.C. The calculation of the NOx reductions is described in Section V.F. and shown in Figure 5-4 and Table 5-3 of this Report. Further details on the calculation of annualized net costs can be found in Appendix C. Note that cost estimates presented here are

in 2019 and 2018 year dollars, and do not account for potential cost changes since that time due to recent inflation or other factors. Staff notes that between 2019 and 2022, the national construction cost index has increased 7.9%.[33] Staff expects that equipment and construction costs associated with the proposed amendments will continue to change over time, with equipment costs expected to decrease. It is speculative to extend the short-term trends of 2019-2022 out to the compliance dates which begin in 2027. Changes to associated costs and therefore cost-effectiveness of the proposed amendments will be evaluated over time through the Implementation Working Group (see Section IX.C) if the proposed rule amendments are adopted. Staff does not believe it is appropriate to inflate the 2018-2019 cost data to current dollars due to uncertainty related the representativeness and applicability of recent inflation trends, particularly given the long-term compliance timelines under the proposed amendments.

For the zero NOx standards for space heating and water heating, a range of cost effectiveness values are shown in Table 6-1 to reflect installations that may or may not require an electrical panel upgrade; the low end of the range represents equipment installations where a panel upgrade would not be required, while the high end of the range represents equipment installations where a panel upgrade would be required. As shown in Table 6-1, the cost effectiveness can vary widely depending on the need for electrical panel upgrades. As discussed in the Technology Evaluation in Section IV of this report, staff anticipates that the availability and continued development of low voltage zero NOx solutions for space heating and water heating systems will be a key factor in the ability to install zero NOx equipment without electric panel upgrades. In addition, staff plans to convene an ongoing Implementation Working Group to investigate a number of implementation topics, including the accessibility and costs of zero NOx technology (further details on the Implementation Working Group can be found in Section IX.C. of this report). Staff anticipates that topics related to implementation costs will be a focus of the group as the status of low voltage technology development and availability, as well as financing and incentive programs, continues to evolve.

B. Incremental Cost Effectiveness

In this section, Staff presents incremental cost effectiveness information on other potential regulatory options for the Board and public's consideration. Incremental cost effectiveness is calculated by 1) calculating the incremental difference in cost between the different regulatory options, and 2) dividing the incremental difference in cost by the incremental difference in emission reductions between each progressively more stringent regulation:

$$Incremental\ cost\ effectiveness = \frac{Annual\ cost\ (B) - Annual\ cost\ (A)}{Emission\ reduction\ (B) - Emission\ reduction\ (A)}$$

1. Proposed Amendments to Rule 9-4

Air District staff identified a potential regulatory option for comparison that is less stringent than the proposed zero NOx standard for space heating equipment. This potential regulatory option would be to only adopt an ultra-low NOx standard of 14 ng/J instead of a zero NOx standard. (Note that the currently proposed amendments include the implementation of both an ultra-low NOx standard in 2024 and a zero NOx standard in 2029; the purpose of this incremental cost effectiveness analysis is to evaluate an ultra-low NOx standard as a less stringent regulatory option for comparison with the proposed zero NOx standard.)

[33] Engineering News Record 20 City Construction Cost Index. Annual averages 2019-2022. Accessed February 2023.

Air District staff estimated the incremental cost effectiveness of the proposed zero NOx standard compared to this ultra-low NOx option. Estimates of the net annual costs (including annualized equipment costs, rate savings, and panel upgrades), annual emission reductions, and cost effectiveness are shown for both the zero NOx and ultra-low NOx standards in Table 6-1 above. Based on these values, the incremental cost effectiveness of the zero NOx standard compared to the ultra-low NOx standard is estimated to range from $106,900 to $480,900 per ton of additional NOx reduction. This range of incremental cost effectiveness is a result of the range in costs associated with the zero NOx standard as described above and in Table 6-1.

2. Proposed Amendments to Rule 9-6

Air District staff did not identify a potential regulatory option for comparison that is less stringent than the proposed zero NOx standard for water heating equipment. As discussed in Section II.B., the existing NOx emission standards in Rule 9-6 are equivalent to those in SCAQMD Rules 1146.2 and 1121 and SJVUAPCD Rules 4308 and 4902 for similar equipment, and there have not been any lower, non-zero NOx emissions limits identified. Staff recognizes that discussions and considerations regarding the potential for other lower NOx emission levels and limits are ongoing, including considerations by the South Coast Air Quality Management District in the development of its 2022 Air Quality Management Plan;[34] however, the achievability, feasibility, and costs associated with these emissions levels and types of devices are not currently known and cannot be accurately estimated within the scope of the staff's analysis at this time.

C. Socioeconomic Impacts

The Air District is required to assess and consider potential socioeconomic impacts when adopting or amending regulations.[35] Air District staff contracted with an independent consultant, Applied Development Economics (ADE), to develop estimates of potential socioeconomic impacts for the proposed amendments to Rule 9-4 and Rule 9-6. The analysis and findings are summarized in this section, and the full report of the socioeconomic impact analysis is available in Appendix C.

Because the proposed amendments to Rule 9-4 and Rule 9-6 will likely have the greatest potential economic impact on residential consumers, the analysis is focused on consumer spending behavior and how the potential added expenses from appliance upgrades might factor into those spending patterns. In cases such as this, where the cost of compliance is borne by individual property owners, equity considerations must be kept at the forefront. The impact of these rule amendments on interest groups such as renters, affordable housing administrators, and others must also be adequately considered. Staff has discussed equity and cost concerns with stakeholders throughout the rule development process. Assuming no zero-NOx natural gas-fired solutions are developed and/or consumers choose to switch to electric appliances, significant additional costs beyond the capital cost of equipment such as electric service or panel updates could occur. However, improvements in available technology may lessen the cost of equipment as well as related electric service upgrades. For example, heat pump water

[34] South Coast AQMD. 2022 Air Quality Management Plan – Policy Brief – Residential and Commercial Building Appliances. https://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/combined-residential-and-commercial-buildings-appliance.pdf?sfvrsn=8

[35] California Health and Safety Code, Section 40728.5

heaters that are compatible with 120-volt electric systems are currently entering the market, removing the need for upgrading electric service in older homes. While improvements in technology availability and costs may continue to occur in the future, ADE's analysis of consumer costs is based on pricing and data for currently available technologies and equipment. As described in Section IX.C of this report, potential socioeconomic impacts may be further informed in the future by the Implementation Working Group and presented to the Board through staff's interim reporting process. However, this current socioeconomic impact analysis represents the most current and best available information at the time of its preparation.

ADE began its analysis by looking at the income distribution patterns in the Bay Area to see how the proposed rule amendments might impact households based on their income, poverty status, and whether they are homeowners or renters. In order to identify household characteristics and accompanying spending patterns, ADE used data from the U.S. Census American Community Survey (ACS) and the Bureau of Labor Statistics Consumer Expenditure Survey (CES). The ACS is an annual survey of households that is used to identify socioeconomic characteristics by geographic area, and how they change on an annual basis. Because the analysis focused on the nine Bay Area counties served by the Air District, all of the data comes from the combined county-level data.

The CES data is an ongoing household survey of consumer spending administered by the Bureau of Labor Statistics in order to calculate the Consumer Price Index (inflation rate). This data includes spending information by category, including housing, transportation, retail goods, services, and investments. For the socioeconomic analysis, the CES data is used to identify the proportion of household spending that goes towards major appliance and household equipment purchases. The data is cross-tabulated based on income range, homeownership status, and other household characteristics. This provides a useful benchmark for comparing existing household spending patterns with the potential cost of compliance for the Rule 9-4 and Rule 9-6 amendments. Note that when analyzing the degree to which socioeconomic impacts are significant or not significant, the Air District has previously used thresholds related to the percent change in return on equity (ROE) for an impacted industry (e.g., a threshold of costs exceeding ten percent of a business' return on equity). This type of threshold is not directly applicable to the impacts on residential consumers, but a discussion comparing the compliance costs and existing household spending patterns is provided below.

ADE's report includes a comparable review of the incremental cost differences between existing gas-fired appliances and electric units that, based on current market availability, are expected to be the most common zero NOx appliance installation. For proposed Rule 9-4 amendments, an incremental cost difference of $2,931 was used (installed costs of $8,027 compared to $5,096). For proposed Rule 9-6 amendments, an incremental cost difference of $852 was used (installed costs of $2,824 compared to $1,972). Additionally, installation costs for electrical panel upgrades that may be necessary were estimated to be $4,256 for single family homes and $2,744 for low-rise multi-family homes. The incremental installed cost and panel upgrade costs were amortized over the equipment lifetime and combined with estimates of annual rate savings to develop total annual net costs (as shown previously in Table 6-1). Further details on the calculation of annualized net costs can be found in Appendix C.

It should be noted that these comparisons are based on existing costs using current technologies and volumes of scale. The analysis does not make any assumptions about future cost reductions, nor any rebate programs that often provide incentives for consumers to upgrade to more efficient appliances. Potential future sources of funding and incentive programs are discussed below. These issues are intended to be further evaluated as the

market changes prior to the proposed zero NOx implementation dates through the Implementation Working Group and interim reporting process, which are discussed in Section IX.C of this report.

Detailed socioeconomic impacts of the proposed amendments can be found in the full report as Appendix C. Overall, the level of potential impact will vary considerably by income range. Existing household expenditures on major appliances and other household equipment accounts for 1.1 percent to 5.7 percent of annual income, depending on the income range. The proposed Rule 9-4 and Rule 9-6 amendments will potentially increase this by up to 1.0 percentage points ($252 per year) for space heaters and 0.4 percentage points ($102 per year) for water heaters for the lowest income households. Additionally, shifts in consumer expenditures toward higher appliance costs and away from other retail goods and services could result in potential job losses in these sectors. During the highest impact implementation period (when both water heaters and space heaters would be replaced), shifts in consumer spending could result in potential annual losses of approximately 0.02 percent of jobs within the trade and services sectors regionwide (286 losses annually compared to 1.5 million total trade and services jobs).

D. Funding and Incentives

There are a variety of funding and incentive sources that are currently available to Bay Area residents who wish to install zero NOx emission heat pump furnace and water heater systems in their homes and businesses. As discussed above, the socioeconomic impacts for the proposed rule amendments were calculated without taking into account cost mitigations that may be available from financing, rebate, or other incentive programs. This is because these programs are currently small and are not consistently available to all consumers in the region. Through federal and state legislation and budget planning processes, there are also plans to greatly expand the funds and financing available and accessible over the course of the next decade. Air District staff, along with the Implementation Working Group as discussed in Section IX.C, intends to track the development of these programs and work with administrators and other stakeholders to increase consumer awareness of and access to incentive funds. Table 6-2 summarizes significant funding sources that have recently been available to Bay Area residents. Note that these funding sources may be limited to fully zero emission (electric) appliances and may not provide funding for zero NOx emission natural gas-fired appliances if they are developed.

Table 6-2
Existing Funding Sources

Name of Funding Source	Amount	Agency/ Funder	Area	Type of applications
TECH (Technology and Equipment for Clean Heating)[36]	$120 million	CEC	California	Jumpstart market for low emissions space and water heating technology/heat pumps (over 4 years)
BUILD (Building Initiative for Low Emissions Development)[37]	$80 million	CEC	California	All electric new housing (new construction) (over 4 years)
Equitable Building Decarbonization - low-income installations[38]	$622.4 million	CEC	California	Direct-install building retrofit program
Equitable Building Decarbonization - consumer rebates[39]	$300 million	CEC	California	Rebates for upgrades and replacement of fossil fuel equipment with electric
Self-Generation Incentive Program (SGIP)[40]	$84.7 million	CPUC	California	Demand-response focused HPWH installations. Half of funds reserved for low-income customers
LIFT (Low-income Tenants and Families) Program 2.0[41]	$10.6 million	CPUC / Marin Clean Energy	Marin	Whole building multifamily program - energy efficiency and fuel substitution in low-income properties

[36]Borgeson, Merrian. CA Launches $200M in Programs to Reduce Building Emissions. https://www.nrdc.org/experts/merrian-borgeson/ca-launches-200m-programs-reduce-building-emissions
[37] *Ibid.*
[38] California State Budget 2022-2023. Accessed August 2022. https://www.ebudget.ca.gov/2022-23/pdf/BudgetSummary/ClimateChange.pdf
[39] *Ibid.*
[40] California Public Utilities Commission. CPUC Provides Additional Incentives and Framework for Electric Heat Pump Water Heater Program. https://www.cpuc.ca.gov/news-and-updates/all-news/cpuc-provides-additional-incentives-and-framework-for-electric-heat-pump-water-heater-program
[41] California Public Utilities Commission. Fact Sheet: Heat Pump Water Heater Incentive Programs. https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/building-decarb/cpuc-hpwh-and-electrification-fact-sheet_q22020.pdf

Name of Funding Source	Amount	Agency/ Funder	Area	Type of applications
Energy Efficiency and Fuel Substitution Measures[42]	$31 million	CPUC	California	Funds distributed for local installations of heat pump water heaters, space conditioning and dryers and induction stoves
Energy Savings Assistance (ESA) Program[43]	$735 million	CPUC	PG&E Territory	Appliance replacements and other energy savings for single family and mobile homes (2021-2026)
Energy Savings Assistance (ESA) Program[44]	$263 million	CPUC	PG&E Territory	Appliance replacements and other energy savings for multifamily (2021-2026)
Energy Savings Assistance (ESA) Program[45]	$49 million	CPUC	PG&E Territory	Studies, training, workforce education and training, marketing education and outreach (2021-2026)
Wood Smoke Program	$2 million	BAAQMD	Bay Area	Change out ~322 wood burning devices to heat pumps

Some of the funding identified above, such as the TECH and BUILD programs have exhausted their funding available in Pacific Gas and Electric territory, and therefore the Bay Area. Air District staff anticipates the further expansion of these programs including more distributed administration of these programs across all areas within the Air District's jurisdiction.

In August 2022, the federal government finalized the Inflation Reduction Act (IRA) which designates significant funds for a variety of programs related to reducing emissions related with building appliances. Programs initiated in the IRA include direct rebate programs that will be administrated through states as well as federal tax credits that are available now and will continue through 2032. The IRA includes multiple programs that apply to space and water heating appliances and other sources of energy usage in buildings. One significant program is the allocation of $4.275 billion over 10 years for point-of-sale rebates to income-qualified entities. These rebates allow for a maximum of $14,000 for the installation of new electric space and water heating equipment and ancillary costs. This program is focused on low- and middle-income entities in both single and multifamily residences, with 100 percent of project costs covered where annual income is less than 80 percent of the area median income (AMI). Fifty percent of project costs are covered when annual income is 80-150 percent of the AMI. The IRA also extends and increases a blanket tax credit for the installation of compliant appliances for all owners of their primary residence. Previously capped at $500, this tax credit

[42] *Ibid.*
[43] California Public Utilities Commission. Decision 21-06-015. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M387/K107/387107687.PDF
[44] *Ibid.*
[45] *Ibid.*

will provide $2,000 per eligible homeowner annually through 2032. State administrative agencies have up to two years to submit programmatic plans in order to receive IRA funds, at which time more details on process and access will become available.

Through the Implementation Working Group and the interim reporting process, Air District staff will continue to track and facilitate accessibility to funds, such as those described in this section, to Bay Area residents. Air District staff will work to ensure necessary and relevant working group membership, including staff from agencies responsible for disbursing state and federal funds. Due to the continuing growth and interest in this space, staff expects the landscape of funding and incentive programs to grow significantly over the next five to ten years and will assess the impact of this growth on costs of compliance in interim reports to the Board of Directors.

E. Valuation of Health Impacts

As previously discussed in Section V.I (Emissions and Emission Reductions; Exposure and Health Impacts), Air District staff modeled the health impacts associated with current NOx emissions from all space and water heating in residential and commercial buildings. The annual avoided incidences of health impacts listed in Table 5-7 are further analyzed below in Table 6-3, showing the potential valuation of these avoided incidences.

Table 6-3
Valuations of reductions in annual average $PM_{2.5}$ concentrations due to an assumed case that eliminates space and water heating natural gas combustion emissions in the Bay Area

Health Impact[a]	Total Valuation in 2020 U.S. Dollars, Million Dollars Per Year	
	Secondary $PM_{2.5}$	Total $PM_{2.5}$
Premature mortality		
All causes[b]	230–530	380–870
Chronic/severe illness		
Non-fatal acute myocardial infarction (heart attack)	0.23–2.1	0.38–3.5
Hospital admission, neurological[c]	0.11	0.19
Incidence, out of hospital cardiac arrest	0.019	0.03
Incidence, stroke	0.059	0.096
Incidence, lung cancer	0.056	0.091
Hospital admissions[d]		
Respiratory[e]	0.028	0.045
Cardiovascular[f]	0.055	0.090
ER visits		
Respiratory[g]	0.013	0.021
Cardiovascular[h]	0.0084	0.014
Other effects		
Restricted activity days	1.9	3.2
Work loss days	1.1	1.8
Hay fever/allergic rhinitis	0.31	0.52

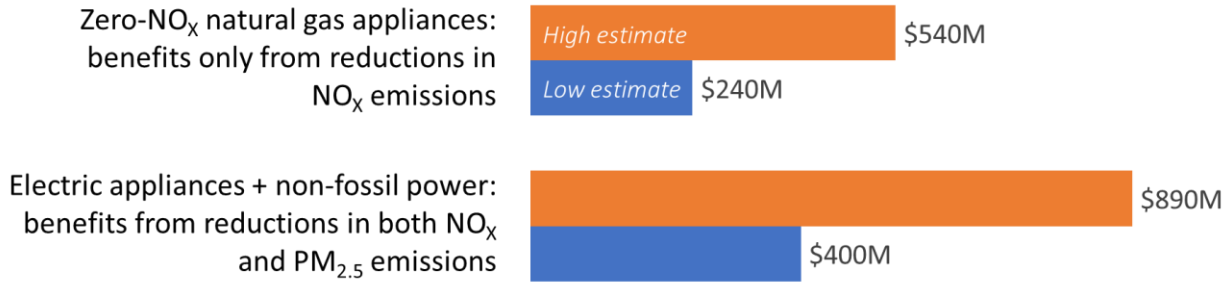
Health Impact[a]	Total Valuation in 2020 U.S. Dollars, Million Dollars Per Year	
	Secondary $PM_{2.5}$	Total $PM_{2.5}$
Asthma-related effects		
Asthma symptoms/albuterol use	0.0037	0.0059
Onset of asthma	3.6	5.8
Sum		
All health impacts included	240–540	400–890

[a] Each health impact is associated with one or more unique International Classification of Diseases-9-Clinical Modification (ICD-9-CM) code(s) (Medicode, 1996).
[b] Includes all ICD-9 codes.
[c] First hospital admission (cause-specific, to indicate onset of the chronic disease) for dementia, Alzheimer's disease, or Parkinson's disease (ICD-9 codes 290, 331.0, or 332, respectively), and other neurological morbidities.
[d] Hospital admissions due to acute exposure to air pollution are assumed to pass through the emergency room; however, the calculated value of hospital admissions does not account for the cost incurred in the emergency room visit. This strategy avoids double-counting.
[e] Includes all respiratory diseases (ICD-9 codes 460–519).
[f] Includes cardio-, cerebro-, and peripheral vascular diseases (ICD-9 codes 410, omitting 410.x2; 410–414; 426–427; 428; 429; 430–438; 440–448).
[g] Includes respiratory diseases (ICD-9 codes 480–486, 491, 492, 496, 460–465, 466, 477, 493, 786.07).
[h] Includes all cardiac outcomes (ICD-9 codes 390–549).

These valuations were determined using EPA's May 2021 version BenMAP-CE paired with three sets of health impact functions deemed appropriate for use in the Bay Area. Further information about the methodology used and constraints of this modeling can be found in Appendix E. BenMAP-CE was designed to estimate changes in human health due to changes in air pollution levels and to estimate conventional valuations of these impacts (in 2020 U.S. dollars). The valuation process considers the direct and indirect costs of illnesses as well as the willingness to pay to avoid premature death. Direct costs include actual medical costs and lost worker hours, while indirect costs reflect willingness to pay to avoid pain and suffering.

As previously discussed, the valuation of secondary $PM_{2.5}$ reductions represented above in the center column is associated with NOx emissions reductions. Therefore, the valuation of secondary $PM_{2.5}$ reductions captured in this modeling represent the potential direct benefits of the emissions standards set forth in the proposed rule amendments. The righthand column of Table 6-3 represents the valuation of total $PM_{2.5}$ reductions and therefore includes primary $PM_{2.5}$ emissions from space and water heating appliances. While it is expected that, based on currently available zero NOx appliances, the amendments will result in the proliferation of electric space and water heating appliances, the development of natural gas-fired appliances that meet the proposed standards are possible. In that case, there still may be primary $PM_{2.5}$ emissions from these appliances, depending on how they are designed, and the additional savings represented in the Total $PM_{2.5}$ column of Table 6-3 would not be fully realized. Figure 6-1 below summarizes the health valuations shown in Table 6-3.

Figure 6-1
Summary of Health Valuations



These health outcomes were also attributed to potential valuations, which are reported below in Section VI.E (Economic Impacts; Valuation of Health Impacts) as well as in the full emissions modeling analysis, Appendix E.

F. Air District Impacts

Staff anticipates that the proposed amendments to Rules 9-4 and 9-6 will require additional staff time and resources.

The enforcement of the zero NOx standard is anticipated to result in increased staffing needs for the Compliance and Enforcement Division. While inspections to ensure continued compliance are ongoing, general compliance with the existing requirements of Rule 9-4 and 9-6 has been established throughout the region. This is supported by the longevity of the existing requirements as well as similar requirements throughout the state. As such, review of certifications has been streamlined and point-of-sale enforcement is not currently resource-intensive for the Air District.

In order to process certifications for compliant equipment and ensure point of sale compliance with the proposed ultra-low NOx requirement in Section 9-4-301.2, staff anticipates the need to allocate 0.5 FTE time to support the proposed rule amendments from January 1, 2024, through January 1, 2027. This time also includes potential compliance and enforcement involvement in the Implementation Working Group, addressing questions from retailers, distributors and other stakeholders and pre-processing applications for appliances that are compliant with the zero NOx standard.

Starting on January 1, 2027, which is the first zero NOx implementation date for small water heaters, staff anticipates an ongoing need for one additional FTE in the Compliance and Enforcement Division to ensure compliance with the requirements of Sections 9-6-301.3, 9-6-301.5 and 9-6-303.5. This includes processing certifications for compliant equipment as well as performing regular inspections at retailers and other appliance distribution locations.

Additionally, implementation of the proposed rule amendments will require ongoing support from Rules and Strategic Policy and Planning and Climate Protection Divisions staff to facilitate and participate in the Implementation Working Group as well as to draft and submit to the Board the Interim Reports as required in Sections 9-4-405 and 9-6-404. Staff anticipates that the

combined workload between these two divisions will amount annually to one FTE from January 1, 2023, to January 1, 2029.

There are no impacts to the Engineering Division of the Air District as equipment covered by Rules 9-4 and 9-6 does not require an Air District permit to operate.

VII. REGULATORY IMPACTS

Section 40727.2 of the California Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and air district air pollution control requirements for the equipment or source type affected by a proposed change in air district rules. The air district must then note any differences between these existing requirements and the requirements imposed by the proposed changes.

The proposed rule amendments impose changes to the pollution control requirements for equipment historically subject to Rules 9-4 and 9-6. Air District staff is proposing a lower NOx emission limit of 14 ng/joule in the near term for natural gas-fired fan type central furnaces. The proposed rule amendments also include a zero NOx requirement with compliance dates ranging from 2027 to 2031 for all-natural gas-fired furnaces and water heaters that are subject to the rules.

Additionally, proposed amendments to Rule 9-4 would result in an expanded set of sources being subject to these pollution control requirements. The proposed amendments expand the applicability of the rule to devices used in non-residential settings as well as devices that are not considered "fan-type central furnaces," including wall furnaces, direct vent units and other natural gas-fired space heating units.

There are currently no state or federal regulations addressing emissions of nitrogen oxides from space and water heating appliances. In August 2022, the Sierra Club petitioned EPA to regulate space and water heating appliances under section 111 of the federal Clean Air Act.[46] That petition is currently pending EPA's consideration. In the 2022 State SIP Strategy, the California Air Resources Board signaled its intention to develop zero emission building appliance rules with a draft 2030 implementation date. No draft rulemaking has yet been proposed. The Air District's proposed rule amendments specifically regulate NOx emissions from furnaces and water heaters, while CARB has indicated that it will pursue zero emission requirements for the same or similar sources. Air District staff sees the proposed rule amendments as complementary to the plan laid out in the CARB SIP Strategy. With the state showing its intent to regulate these sources in a similar manner, Air District staff expects market growth, and therefore accessibility of zero NOx appliances, to accelerate.

[46] Sierra Club, et al. Petition for Rulemaking to List Heating Appliances as a Source Category Under Section 111(b)(1)(A) of the Clean Air Act and to Issue New Source Performance Standards for that Category under Section 111(b)(1)(B). https://www.sierraclub.org/sites/default/files/Sierra%20Club%20Heating%20Appliance%20Rulemaking%20Petition.pdf

VIII. ENVIRONMENTAL IMPACTS

The California Environmental Quality Act (CEQA), Public Resources Code Section 21000 et seq., require a government agency that undertakes or approves a discretionary project to consider the potential impacts of that project on all environmental media. The Air District contracts with an independent consultant to conduct a CEQA analysis of potential environmental impacts for rule making projects.

A. Notice of Preparation and Initial Study

The Air District prepared a Notice of Preparation and Initial Study (NOP/IS) in anticipation of a Draft Environmental Impact Report (DEIR) for proposed amendments to Rule 9-4 and Rule 9-6 and the NOP/IS was distributed to responsible agencies and interested parties for a 30-day review on May 19, 2022. A notice of availability of this document was distributed and was published on the Air District's website and in newspapers throughout the area of the Air District's jurisdiction. A CEQA scoping meeting was conducted on June 9, 2022, to solicit public comment regarding the scope and content of the information to be included in the DEIR. The NOP/IS initially identified the following environmental resources as being potentially significant, requiring further analysis in the DEIR:

- Utilities and Service Systems,
- Air Quality, and
- Greenhouse Gas Emissions

Staff received eight written comments in response to this release, which are posted to the Air District website. No verbal or written comments requested that the Air District expand the scope of the planned DEIR.

B. Draft Environmental Impact Report

The Air District prepared a DEIR, which is included as Appendix G of this report, to address the potential environmental impacts associated with the proposed amendments.

Impacts to air quality as well as greenhouse gas emissions and climate change were found to be less than significant and beneficial. The potential emission reductions associated with the proposed rule amendments are discussed in Section V of this Report as well as in the DEIR.

Impacts to utilities and service systems were found to be potentially significant. Air District staff contracted with Energy and Environmental Economics (E3) to perform modeling to determine potential additional electrical need associated with the proposed rule amendments. E3's report is incorporated here in Appendix D. E3 assumed, for purposes of determining the "worst case" potential impact on the electric grid, that upon implementation of the proposed amendments all currently installed natural gas-fired space and water heating appliances in the Bay Area would be replaced with electric appliances upon burnout. E3 considered two potential baselines: a more likely "High Policy" case pursuant to which California moves forward with rules and regulations to meet its climate goals, including required heat pump adoption, and a "Low Policy" case that represents business as usual, with no major policy changes supporting building electrification and heat pump adoption other than currently existing incentives. Under the more conservative Low Policy Reference Scenario evaluated by E3, the proposed rule amendments would, over the long term, result in increased energy demand beyond the planned electric grid capacity growth represented in this scenario. E3 estimated that the proposed zero NOx

standards could result in 6.2 terrawatt-hours per year of additional electric load growth by 2050, which would represent 2.2 percent of the total statewide electrical load by 2020 standards. The E3 study estimates that this level of demand could be met by the development of approximately 2,180 MW of incremental utility-scale solar capacity, corresponding to 19,500 acres of direct land use impacts. Almost all of this energy production is anticipated to occur outside of the Bay Area, and a portion will likely be developed outside of California. Development of these potential new energy resources is not part of the current project under review, but rather a potential indirect impact of implementation of the proposed amendments. Selection, location, development, review, and approval of any new energy resources is outside of BAAQMD's jurisdiction and would be completed by other agencies. It is not possible to determine any particular energy resource that would be developed to meet growing demand; that determination is outside of BAAQMD's jurisdiction and is unknown and speculative at this time. However, based on E3's report, almost all of this energy production is anticipated to occur outside of the Bay Area, and a portion of it will likely be developed outside California. The potential construction and operational impacts associated with these energy facilities could be potentially significant.

Following the release of the NOP and IS, Air District staff also determined that impacts related to aesthetics and noise should also be further evaluated in the DEIR. As described in Appendix G, aesthetics impacts were found to be less than significant, while noise impacts were found to be potentially significant. The proposed amendments would result in the installation of appliances and equipment, such as heat pump units, inside and outside of existing buildings. While noise from these new appliances would vary depending on size, model, location, and use type, this impact analysis conservatively evaluated the potential noise impacts from some of the loudest commercial equipment that might be installed and found that these impacts may be potentially significant. Lesser impacts may occur with smaller residential units and other installation features, such as equipment enclosures or screenings, but it is likely that some appliances would still exceed applicable standards in some locations and result in potentially significant impacts.

Alternatives considered in the environmental analysis include a no project alternative (where the proposed rule amendments are not adopted), an alternative with expedited compliance dates, and an alternative with delayed compliance dates. The CEQA alternatives analysis is intended to identify the alternative to minimize or avoid a project's impact; as such, the alternative with delayed compliance dates was identified as the "environmentally superior alternative" due to the slight reduction of impacts on utilities and service systems compared to the proposed project. It is important to note that this finding under CEQA is based on the minimization and avoidance of environmental impacts, and the proposed project would result in a greater beneficial effect related to air quality and climate change impacts due to emissions reductions occurring sooner.

C. Final Environmental Impact Report

Thirteen comment letters were received during the comment period that address issues raised in the DEIR, and responses to those comments are included in the proposed Final EIR. No revisions have been made to the content of the DEIR.

Prior to making a decision on the adoption of the proposed amendments to Rule 9-4 and Rule 9-6, the Air District's Board of Directors must review and certify the Final EIR as providing adequate information on the potential adverse environmental impacts of these actions. The proposed Final EIR concludes that there are potentially significant impacts associated with

utilities and service systems (energy resources) as relocation or construction of new or expanded electric facilities may occur in response to the proposed rule amendments. These facilities could result in adverse environmental impacts. The proposed Final EIR also concludes that equipment used to comply with the proposed rule amendments could result in potentially significant noise impacts from long-term operational noise. Because impacts to noise and utilities and service systems remain potentially significant, the Board of Directors must also adopt a Statement of Overriding Considerations in order to move forward with the adoption of the proposed amendments to Rule 9-4 and Rule 9-6. While the potential utility resources and noise impacts warrant close and careful consideration by the Board, Staff believes the air pollution control and public health benefits of the proposed amendments described throughout this Staff Report outweigh the potential adverse impacts related to utility systems and noise.

IX. RULE DEVELOPMENT / PUBLIC PARTICIPATION PROCESS

A. Public Participation during Rule Development Process

Air District staff initially received feedback from the public and the Air District Board of Directors on approaches to addressing emissions from building appliances at a November 2020 presentation to the Climate Protection Committee. Staff presented initial rule development concepts to the Stationary Source and Climate Impacts Committee and public stakeholders in April 2021. The Board and public both expressed general support for staff's proposed concepts and emphasized the need for swift action in this space but also noted the importance of balancing complicating factors, such as equity and the availability of funding mechanisms for incentives and subsidies.

Air District staff has reached out to and met with regulatory, community and industry experts in the space and water heating and building sectors. This includes manufacturers, advocates, community organizers, research organizations, utilities, labor representatives, community choice aggregators, and other regulatory bodies such as Bay Area cities, SCAQMD, the California Air Resources Board and the California Energy Commission. Staff has presented as requested at existing industry working groups convened by groups such as the Building Decarbonization Coalition and Stop Waste.

In addition, staff convened a stakeholder working group to discuss specific issues relating to Rules 9-4 and 9-6 and drafting amendments. This working group included community and environmental advocates, equipment manufacturers, local city staff and representatives from the SCAQMD, the California Air Resources Board, the California Energy Commission and Pacific Gas and Electric, among others. Air District staff has convened four meetings of this group in Q2 and Q3 of 2021. These meetings consisted of:

- A "kickoff" meeting to discuss general direction of the rule amendments and equity concerns;
- Two meetings to discuss technical issues specifically related to space and water heating issues, respectively;
- An equity focused working group meeting.

All meetings of the group were held as interactive webinars including discussion questions for stakeholder response and use of Google Jamboards. Depending on interest in the specific topic, these meetings were attended by approximately 20-40 stakeholders.

On September 30, 2021, staff released draft amendments to Rules 9-4 and 9-6 as well as a workshop report for public review. Staff then held a virtual public workshop on the evening of October 7, 2021, to discuss and receive feedback on the draft amendments. The workshop was attended by over 40 stakeholders and members of the public and staff received valuable feedback for consideration. Staff additionally presented to the Stationary Source and Climate Impacts committee on October 18, 2021, to discuss the draft amendments. The committee directed staff to continue in the current direction of rulemaking, with additional considerations for community and stakeholder involvement following potential rule amendment adoption. Staff updated the Stationary Source and Climate Impacts Committee on November 15, 2021, on public comments received and proposed an alternate schedule to allow for additional stakeholder engagement, environmental review, and cost analysis. Staff presented to the committee in April 2022 and provided updates on project timelines and recent work on this effort.

Staff released the CEQA Notice of Preparation (NOP) of an Environmental Impact Report (EIR) and Initial Study (IS) and held a scoping meeting in May 2022. Staff received eight written comments in response to this release, which are posted to the Air District website. No commenters requested that the Air District expand the scope of the planned DEIR. Staff additionally updated to the Board of Directors and the public on the status and makeup of the implementation working group and presented the health impacts modeling included in this Staff Report, at the October 17, 2022, Stationary Source and Climate Impacts Committee meeting. On February 15, 2023, the Air District Board of Directors discussed funding options for retrofitting low-income homes with cleaner appliances with an emphasis on ensuring accessibility for all consumers.

On December 20, 2022, Air District staff released an initial Staff Report, proposed amendments to Rule 9-4 and Rule 9-6 and a draft Environmental Impact Report for public review and comment. Staff accepted and responded to written comments and will present a final proposal to the Air District Board of Directors for its consideration at a Public Hearing on March 15, 2023. At the Public Hearing, the Air District Board of Directors will consider the final proposal and receive public input before taking any action on the proposed amendments to Rule 9-4 and Rule 9-6.

B. Considerations to Ensure Equitable Outcomes

The proposed rule amendments for both Rules 9-4 and 9-6 include the requirement that interim reports be brought to the Board of Directors by the APCO no later than two years prior to the three compliance dates for the zero NO_X standards. During the 2021 working group meetings, Air District staff discussed guiding principles and factors that should be included in this analysis with stakeholders throughout the rule development process as well as specifically during the most recent stakeholder working group meeting. The following guiding questions have served Air District staff throughout the course of this rule amendment process:

- Who stands to benefit most from the implementation of this policy? Who may be disproportionately burdened by this policy?
- Who is missing from this process and how can we ensure their concerns are represented and addressed?
- What unintended consequences could result from these proposed amendments if they were adopted as envisioned/intended? What steps can be taken to mitigate these adverse impacts?

- What additional barriers might prevent individuals in certain racial/ethnic/socioeconomic groups from benefitting fully from this policy? Are their further ways to maximize equitable outcomes?
- How will impacts and performance be documented and evaluated? What methodologies will be used? How will results be used?

Staff will continue to consider these questions throughout the time frame between rule adoption and the future effective date of the zero NO_X standards. These questions will additionally serve to guide the interim report included in the proposed amendments. Further, staff will report on the status of the following factors at the time of the interim reports:

- Access to economic benefits, including robust market availability and affordability;
- Ease of installation and coordination with local requirements;
- Assurance that policy promotes affordable housing and anti-displacement outcomes;
- Access to health and safety benefits, including resiliency during climate events;
- Potential infrastructure impacts associated with rule compliance.

C. Implementation Working Group

Staff plans to convene a formalized ongoing Implementation Working Group (IWG) to support the proposed rule amendments after potential adoption and leading up to the proposed zero NOx compliance dates. Air District staff have been working to form this implementation working group along with a third-party facilitator.

The IWG, once formed, is intended to be an information-gathering body and to provide a forum to discuss technical and community/equity aspects and issues pertaining to building appliance rule amendments the Air District adopts. Although the IWG will not be a decision-making body, IWG input will be considered in the implementation process, and feedback may be incorporated into interim reporting materials as deemed appropriate by the Air District. The Air District will retain its independent decision-making role in the interim reporting process.

The IWG is intended to consist of a variety of stakeholders with different areas of expertise in reference to the implementation of the rule amendments. This may include community-based organizations, environmental justice groups, advocacy, and subject matter expert organizations, building technology experts, affordable and market rate housing developers and managers, local and state government staff, funding and financing agencies, equipment manufacturers and distributors, tenant representation organizations and labor organizations. The anticipated makeup and specific organizations represented will be presented at the public hearing for adoption of the proposed rule amendments. Implementation Working Group members will have access to stipends for their work which will be administered, as appropriate, through the Air District's third-party facilitator.

Topics included in the scope of the IWG and that will be investigated through the course of their work include the market availability of compliant technology, projected costs of purchasing and installing compliant technology, incentive programs and other funding and financing available to Bay Area residents, and potential challenges and opportunities for facilitating an equitable implementation. Accessibility of compliant technology as well as funding and financing programs to low-income residents and small businesses will be a focus of the Implementation Working Group.

The IWG will provide critical input and information to staff that staff will consider when preparing interim reports for the Board. This input may include the following:

- Costs, technology/appliance availability, impacts to different stakeholder groups (e.g., renters, homeowners, small businesses, industry, local governments);
- Suggestions on new/enhanced funding/financing streams for lower income households;
- Status of zero NOx technology/appliance development, costs, and economic incentives;
- Potential barriers, including affordability for residents, and interventions needed to meet the compliance deadlines in Air District Rules; and
- Potential adjustments or guardrails to the Rule implementation timeline so that technology readiness, infrastructure readiness, available financing/investments, and cost feasibility are aligned.

The IWG process will consist of a dual focused approach, which will allow the IWG to ensure that both technical considerations as well as equity-based considerations are addressed. This will be achieved through the creation of a technical subcommittee as well as a community/equity subcommittee. The technical subcommittee will focus on appliance development and availability, costs of implementation, and existing economic incentives. The community/equity subcommittee will focus on affordability, equity, and incentives to address the needs and challenges associated with the implementation of these rule amendments.

D. Overview of Comments Received

During the written comment period (December 20, 2022 through February 6, 2023), Air District staff received letters from 565 commenters that represent a variety of stakeholders commenting on the regulatory package. Commenters included a public utility, the California Air Resources Board, local governments, equipment manufacturers, industry groups, environmental groups, community organizations, and individual members of the public. 404 of the correspondence expressed strong support for the adoption of the proposed amendments. Comments received covered a wide range of topics, including support for the proposals, along with concerns including, but not limited to, the cost of compliance, environmental impacts of the proposal, electric grid capacity and reliability, possibility for emergency replacements, and the cost and timeline associated with potentially needed electric panel upgrades.

The Response to Comments document in Appendix H provides a detailed listing of the comments received, the commenters, and the Air District staff's response to the comments received, including comments on the DEIR.

X. CONCLUSION/RECOMMENDATIONS

Pursuant to the California Health and Safety Code Section 40727, before adopting, amending, or repealing a rule the Board of Directors must make findings of necessity, authority, clarity, consistency, non-duplication, and reference. This section addresses each of these findings.

A. Necessity

As stated in California Health and Safety Code Section 40727(b)(1), "'Necessity' means that a need exists for the regulation, or for its amendment or repeal, as demonstrated by the record of the rulemaking authority."

The San Francisco Bay Area does not currently attain all state and national ambient air quality standards for ozone or particulate matter, and further reductions of ozone precursor and particulate matter emissions are needed for attainment and maintenance of the standards. The proposed amendments to Rule 9-4 and Rule 9-6 would reduce nitrogen oxide and secondary particulate matter emissions from space and water heating appliances which are a large area source of these pollutants in the Bay Area. The proposed amendments to Rule 9-4 and Rule 9-6 are needed to ensure attainment and maintenance of these ambient air quality standards and to provide clean air and public health benefits.

Space and water heating appliances generate a substantial portion of NOx emissions from all sources (including mobile) in the Bay Area, and these emissions contribute to the formation of secondary particulate matter. These emissions result in PM exposures in communities throughout the Bay Area, which can contribute to a number of adverse health outcomes, including premature deaths. In addition, the health impact modeling described in this report indicates that these exposures are not distributed equally amongst different communities and race/ethnicity groups. The proposed amendments to Rule 9-4 and Rule 9-6 are needed to achieve these reductions in emissions and pollutant exposures throughout the Bay Area and would yield substantial health benefits in these communities and throughout the jurisdiction of the Air District.

B. Authority

The California Health and Safety Code Section 40727(b)(2) states that "'Authority' means that a provision of law or of a state or federal regulation permits or requires the regional agency to adopt, amend, or repeal the regulation."

The Air District has the authority to adopt these rule amendments under Sections 40000, 40001, 40702, and 40725 through 40728.5 of the California Health and Safety Code.

C. Clarity

The California Health and Safety Code Section 40727(b)(3) states that "'Clarity' means that the regulation is written or displayed so that its meaning can be easily understood by the persons directly affected by it."

The proposed amendments to Rule 9-4 and 9-6 are written so that their meaning can be easily understood by the persons directly affected by them. Further details in the Staff Report clarify the proposals, delineate the affected industry, compliance options, and administrative requirements for the industries and persons subject to this rule.

D. Consistency

The California Health and Safety Code Section 40727(b)(4) states that "'Consistency' means that the regulation is in harmony with, and not in conflict with or contradictory to, existing statutes, court decisions, or state or federal regulations."

The proposed amendments to Rule 9-4 and Rule 9-6 are consistent with other Air District rules and not in conflict with state or federal law.

E. Non-Duplication

The California Health and Safety Code Section 40727(b)(5) states that "'Nonduplication' means that a regulation does not impose the same requirements as an existing state or federal regulation unless a district finds that the requirements are necessary or proper to execute the powers and duties granted to, and imposed upon, a district."

The proposed amendments to Rule 9-4 and Rule 9-6 are non-duplicative of other statutes, rules, or regulations.

F. Reference

The California Health and Safety Code Section 40727(b)(6) states that "'Reference' means the statute, court decision, or other provision of law that the district implements, interprets, or makes specific by adopting, amending, or repealing a regulation."

By adopting the proposed amendments to Rule 9-4 and Rule 9-6, the Air District Board of Directors will be implementing, interpreting or making specific the provisions of California Health and Safety Code Sections 40000, 40001, 40702 and 40727.

The proposed amendments to Rule 9-4 and Rule 9-6 have met all legal noticing requirements, have been discussed with the regulated community and other interested parties, and reflect consideration of the input and comments of many affected and interested stakeholders.

G. Recommendations

Staff prepared a Final EIR and Response to Comments for the Board's consideration after consideration of comments on the proposed amendments, DEIR, and the initial Staff Report. Following a review of public comments, Air District staff recommends that the Air District Board of Directors (1) certify the Final EIR and adopt of Statement of Overriding Considerations due to the potentially significant noise and utility systems impacts of the proposed amendments; and (2) adopt the proposed amendments to Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Regulation 9, Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters.

Staff also recommends that the Air District submit the proposed rule amendments to EPA for inclusion in the State Implementation Plan. This action will be brought before the Board of Directors separately, if the Board adopts the proposed rule amendments.