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PROCESS BOILERS: STACK OXYGEN CONCENTRATION

June 2026

California Energy Commission

Docket No. 25-BSTD-03

The California Statewide Codes and Standards Enhancement (CASE) initiative presents recommendations to support the California Energy Commission's (CEC's) efforts to update California's Energy Code (Title 24, Part 6), including revisions to simplify and clarify existing code requirements. Three California Investor-Owned Utilities (IOUs) — Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison — sponsored this effort as a group.

This letter recommends adjustments to the code language for process boiler stack oxygen concentration requirements to address stakeholder concerns, ensure consistent interpretation and application of the requirements, and support strong code compliance. This letter offers support for the proposed Energy Code change and was developed in collaboration with stakeholders. Changes suggested in this letter are editorial or provide information that may address a proposal made by another stakeholder in the public process. This letter does not recommend changes that will increase the stringency of existing requirements or recommend that existing requirements be applied more broadly.

1. Measure Description and Justification

1.1 Proposal Description

This proposed code alignment provision would adjust the 2025 Title 24, Part 6 code language in Section 904.1.3 that calls for qualifying process boilers to maintain excess oxygen concentrations at 3.0% or lower over firing rates of 20 to 100%. The proposed update would allow stack oxygen concentrations as follows, measured at 25% (or at the boiler's lowest firing rate, whichever is higher) to 100% of burner input capacity:

- Process boilers with mesh burners: maximum 8.0% by volume on a dry basis
- Process boilers equipped with Selective Catalytic Reduction (SCR) systems: maximum 4.0% by volume on a dry basis
- All other process boilers: maximum 6.0% by volume on a dry basis

In addition, the proposed code alignment provision would revise the exception language. The current code requirement exempts process boilers with a steady-state, full-load combustion efficiency of 90% or higher. The updated language clarifies that the combustion efficiency in this exception is inclusive of economizers.

This code change would apply to newly installed process boilers as specified in 2025 Title 24 Part 6, Section 904.1.3 as well as new process boilers installed during building additions or alterations as specified by Section 904.4.

1.2 Benefits of Proposed Change

The 2025 California Title 24, Part 6 code requires process boilers to maintain a stack oxygen concentration of 3 percent. The Statewide CASE Team received stakeholder feedback that maintaining a stack oxygen concentration at or below 3 percent is not achievable while simultaneously complying with nitrogen oxides (NOx) emissions limits for boilers in certain air districts.

The California Air Resources Board (CARB) and California's Air Quality Management Districts (AQMDs), such as the Bay Area AQMD, South Coast AQMD, and San Joaquin Valley Unified Air Pollution Control District (SJVAPCD), limit NOx emissions from boilers in their districts (Elliot 2007). To meet NOx requirements, boiler burners employ techniques such as flame shaping and flue-gas recirculation (FGR) to reduce flame temperature and thereby limit thermal NOx formation. These NOx-control strategies require higher stack oxygen levels to maintain flame stability.

Updating the Title 24, Part 6 requirements to allow for oxygen concentrations higher than 3.0% would allow boilers that are compliant with local AQMD NOx emissions requirements to also comply with Title 24, Part 6. Eliminating conflicting regulations through this proposal would improve ongoing code compliance. While removing the Title 24, Part 6 stack oxygen concentration requirements entirely would also address stakeholder feedback, the Statewide CASE Team recommends updating the maximum allowable stack oxygen concentrations to maintain energy savings.

Throughout the Statewide CASE Team's stakeholder engagement, boiler and burner manufacturers and owner/operators have supported this code update and confirmed the limitations of the existing code requirements. A summary of stakeholder engagement is detailed in the Stakeholder Engagement to Inform Proposal section.

1.2.1 Compliance

The proposed code alignment provision would update the current values for existing stack oxygen concentration requirements in Title 24, Part 6. There is currently no specified compliance process in place to verify stack oxygen concentrations or combustion efficiencies at boilers upon commissioning. For boilers that plan to qualify for the combustion efficiency exception, the Statewide CASE Team recommends that the professional engineer (PE) include the total boiler system combustion efficiency on the mechanical schedules. The Authority Having Jurisdiction (AHJ) plan checker would verify the efficiency submitted in the NRCC-PRCE-E form. To verify compliance with the stack oxygen concentration requirement, the Statewide CASE Team recommends that a field technician perform acceptance testing to verify and document the boiler's stack oxygen concentration at the three firing rates as specified in the Reference Appendices section. The existing Process System Certificate of Compliance form (NRCC-PRC-E, Section I: Process Boilers and Section T: Declaration of Required Certificates of Acceptance) and the existing Process System Certificate of Installation form (NRCI-PRC-E, Section G: Acceptance Tests and Field Verification) would be modified and a new form, (NRCA-PRC-XX-F, Nonresidential Certificates of Acceptance), would be created to demonstrate compliance with new acceptance testing requirements for process boilers. For more information on specific changes, see Compliance Forms.

1.2.2 Impact on building operations affordability and benefits to building owners, designers, developers

The proposed code alignment provision would not require changes to installed boiler equipment or changes in installation procedure. As such, the Statewide CASE Team does not expect the proposed code alignment provision to impact current design and construction practices or pose any design and construction challenges.

The proposed code alignment provision sets different maximum stack oxygen concentration values for boilers with mesh burners, boilers with SCR systems, and all boilers that do not use a mesh burner or SCR system. The Statewide CASE Team does not anticipate that different maximum values would influence the selection of burner types. Based on stakeholder feedback, each maximum value represents the minimum feasible stack oxygen concentration for that burner type at single-digit NOx emissions. In addition, the Statewide CASE Team does not expect building operations affordability to be affected by this change, since boilers are already tuned during normal operations to maintain proper combustion efficiency and regulatory emissions limits.

1.2.3 Other Considerations

There are no health and safety considerations pertaining to this measure.

The proposed code alignment provision may have both positive and negative environmental impacts. Compared to the current code requirements, higher stack oxygen concentration requirements would increase statewide energy consumption. However, if new acceptance testing procedures and higher stack oxygen concentration requirements improve code compliance, statewide energy consumption may decrease. Additionally, if higher allowable stack oxygen concentrations allowed for improved compliance with existing NOx emissions standards in some California AQMDs, the higher stack oxygen concentration would reduce local emissions and air pollution.

The Statewide CASE Team does not anticipate any energy equity and environmental justice impacts due to the proposed code alignment provision.

1.3 Background Information

1.3.1 Technology Summary

Manufacturers typically do not provide recommended boiler stack oxygen concentrations, as the ranges of feasible or desirable stack oxygen concentrations vary across applications and operating conditions. During boiler startup and commissioning, operators adjust air-fuel ratios at different firing rates to balance emissions, combustion stability, and efficiency. To comply with the stringent NOx emissions limits from many of California's AQMDs, boiler systems typically employ low-NOx burners or FGR. Low-NOx burners, designed to limit NOx emissions without FGR, require higher stack oxygen concentrations than other burners to ensure adequate flame stability. FGR is the process of mixing a portion of the exhaust gas with combustion air to lower the peak flame temperature and suppress the formation of thermal NOx. However, diluting the flame to reduce NOx makes the combustion process less stable, and therefore prone to incomplete combustion (Varga, Kizek and Lazic 2004). To counteract flame instability, operators increase oxygen concentrations to ensure complete combustion. Consequently, the excess air required to maintain low NOx emissions often pushes feasible stack oxygen concentrations above 3 percent.

Another way to limit NOx emissions is to use SCR, a post-combustion treatment that reduces NOx emissions by introducing ammonia-based catalysts to convert NOx to elemental nitrogen (Chudnovsky, et al. 2020). Since the treatment is applied after combustion, SCR does not rely on changes to the in-furnace combustion mechanics, and boiler systems employing SCR systems do not face the same tradeoff between NOx emissions and stack oxygen concentration. While boilers that use SCR systems to meet low-NOx emissions targets may operate with lower stack oxygen concentrations (around 4%) than boilers relying on other strategies (often above 6%), SCR systems are rarely a cost-effective solution for reducing fuel consumption because high upfront capital costs and ongoing costs for catalyst, reagents, and fan electricity often outweigh the energy cost savings from efficiency gains (Sorrels, et al. 2016, U.S. EPA 2003).

Therefore, boilers in air districts with more stringent NOx emissions limits typically cannot comply with both the emissions limits and the current Title 24, Part 6 requirement of 3 percent stack oxygen. The proposed code alignment provision aims to enable boilers to simultaneously comply with both requirements.

In order to meet local AQMD NOx emissions requirements across combustion system technologies while maintaining efficiency, the proposed code alignment provision sets distinct stack oxygen concentration maximums for boilers with mesh burners, boilers with SCR systems, and all other boilers.

The Statewide CASE Team gathered data from a statewide boiler permit inventory, boiler vendors, AQMDs, and other stakeholders to estimate the market share for each of these technologies in newly installed boilers. These market shares are summarized in Table 1 below.

Table 1: Estimated Market Share[1] of Boiler Types Among Newly Installed Boiler Capacity in California

Boiler Capacity (MMBtu/h)	Share of New Boiler Capacity: Boilers with Mesh Burners	Share of New Boiler Capacity: Boilers with SCR Systems	Share of New Boiler Capacity: All Other Boilers
5-10	20%	0%	80%
10-15	15%	20%	65%
15-25	10%	50%	40%
25-50	5%	75%	20%
50-100	0%	75%	25%

[1] These are exclusive groups, as boilers with mesh burners do not install SCR systems.

Boiler Capacity (MMBtu/h)	Share of New Boile r Capacity: Boilers with Mesh Burners	Share of New Boiler Capacity: Boilers with SCR Systems	Share of New Boiler Capacity: All Other Boilers
100-200	0%	75%	25%
200+	0%	75%	25%
Total (Weighted Avg.)	3%	67%	30%

The 2025 Title 24, Part 6 stack oxygen concentration requirement includes an exception for boilers with steady state full-load combustion efficiencies of 90 percent or higher. Based on field experience, the Statewide CASE Team believes that to achieve a steady state full-load combustion efficiency of 90 percent, steam boilers would need both a condensing economizer and a stack economizer[2].

Stack oxygen concentrations have a much smaller energy impact on steam boilers with condensing economizers and any changes to stack oxygen concentration requirements would have a negligible efficiency impact on these boilers. The Statewide CASE Team believes that the intent of this exception was to promote high-efficiency boilers. To maintain the intent of this exception, the Statewide CASE Team has interpreted that the exception should specify that the steady state full-load combustion efficiency should be measured downstream of all economizers (stack economizer, condensing economizer, etc.).

1.3.2 History of Stack Oxygen Concentration Requirements in Title 24, Part 6

Stack oxygen concentration requirements for process boilers were first introduced to Title 24, Part 6 in the 2013 code cycle (California Utilities Statewide Codes and Standards Team 2011). The following requirements were set to cost-effectively save energy through combustion optimization:

- Process boilers with a capacity of 5 to 10 MMBtu/h were required to maintain a stack oxygen concentration less than or equal to 5 percent.
- Process boilers with a capacity of more than 10 MMBtu/h were required to maintain a stack oxygen concentration less than or equal to 3 percent.

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[2] This belief is also stated in a docketed comment from Parker Boiler Co. (TN 266912 submitted 10/20/2025 to docket number 25-BSTD-03, 2028 Energy Code Pre-Rulemaking.)

Stack oxygen concentration requirements for process boilers in Title 24, Part 6 were updated to the 2025 code language in the 2022 code cycle to require a stack-gas oxygen concentration less than or equal to 3 percent for all process boilers with a capacity above 5 MMBtu/h after finding that oxygen trim technology, which enables operators to adjust stack oxygen concentrations, was cost-effective for boilers between 5 and 10 MMBtu/h (Energy Solutions 2020).

1.3.3 History of Process Boiler NOx Emissions Limits in California

Los Angeles established the first air quality alert levels in California in 1955. The first statewide air quality alert levels were enacted in 1959 and included alert levels for nitrogen dioxide, which is a common nitrogen oxide. CARB was created in 1967 and continued to set statewide ozone-related air quality targets through the next few decades (CARB n.d.).

Eighty percent of statewide process boiler capacity lies within the South Coast AQMD, Bay Area AQMD, and SJVAPCD district limits (Swanson and Staller 2025). In 1988, the South Coast AQMD created Rule 1146 to regulate the "emissions of oxides of nitrogen from industrial, institutional, and commercial boilers, steam generators, and process heaters", which has been amended multiple times since to improve stringency. By 2008, Rule 1146 set NOx limits at 30 to 40 parts per million (ppm), and from 2013-2018 the limits reached single digits (AQMD 2020). More recently, South Coast AQMD has pursued zero-NOx emissions for industrial boilers and water heaters using fossil fuel gas, with the intent of promoting industrial electrification (LPDD n.d.). Bay Area AQMD NOx limits for industrial boilers fall under 10 ppm for most boilers 20 MMBtu/h or greater. The SJVAPCD has the strictest requirements in place today, with NOx limits of 2.5 to 5 ppm for most industrial boilers (Nationwide Boiler Incorporated n.d., Anonymous 2026). Maximum allowable NOx emissions at AQMDs across the state have gradually decreased over time and the Statewide CASE Team anticipates that this trend will continue.

While process boilers face emissions limits for other pollutants, no other requirements present a direct technological conflict with the boiler stack oxygen concentrations.

1.3.4 Boiler Field and Stakeholder Data

The Statewide CASE Team used input from stakeholder interviews, data provided by the California AQMDs, and process boiler field data collected through Cascade Energy to determine the proposed stack oxygen concentration values for each boiler and technology type. The proposed stack oxygen concentration limits for each boiler type are intended to match each type's minimum feasible stack oxygen concentration.

Mesh burners provide more stable and shorter flames, allowing for higher turndown and a smaller boiler footprint. Mesh burners also require higher excess air to maintain flame stability, ensure safe operating temperatures, and prevent the mesh from oxidizing. Therefore, boilers with mesh burners have the highest proposed stack oxygen concentration maximum. Boilers with SCR systems can achieve lower stack oxygen concentrations than other boilers while operating safely and therefore have a lower proposed stack oxygen concentration maximum.

Table 2 summarizes the feasible stack oxygen ranges provided by five stakeholders for boilers with mesh burners, boilers with SCR, and boilers with non-mesh burners and without SCR.

Table 2: Feasible Stack O2 Concentrations at 25% Firing Rate from Stakeholders

Stakeholder	Boilers with Mesh Burners	Boilers with SCR Systems	All Other Boilers
Boiler Vendor 1	7% to 8%	-	5% to 6%
Boiler Vendor 2	8%	-	-
Boiler Vendor 3	8%	-	6% to 7%
Boiler Vendor 4	7.5% to 9%	-	Greater than 7%
Boiler Servicer 1	7.5% to 9%	5%	-
Boiler and SCR System Vendor 5	8%	4%	-
Proposed Maximum	8%	4%	6%

Table 3 and Table 4 present a summary of data provided by South Coast AQMD and San Joaquin Valley APCD.

Table 3: Boiler Field Data – California SCAQMD

Data	Value
Sample Size (Boiler Units)	32
Typical Stack Oxygen Range	4%-10%
Avg. Stack Oxygen: 5 Boilers with Known SCR Systems	4.1%
Avg. Stack Oxygen: 26 Boilers Without SCR Systems	7.8%

Table 4: Low-NOx Mesh Burner Boiler Field Data – California SJVAPCD

Site	Boiler Size (MMBtu/h)	Stack Oxygen Concentration
1	10.5	8.8%
2	17.5	8.5%
3	19.9	8.3%
4	24.5	9.8%
5	25.3	8.4%
6	33.6	7.9%
7	37.4	8.4%
8	39.9	9.8%
9	63.0	9.7%
10	73.0	9.4%
11	75.6	8.3%
12	97.0	10.4%
13	97.0	9.9%

Table 5 presents a summary of measured stack oxygen field data from ten operating boilers in California at low, medium, and high fire collected by Cascade Energy. The burner type and presence of SCR systems at these boilers is unknown. More detail on the boiler field data can be found in the **Error! Reference source not found.** section.

Table 5: Cascade Energy Field Data on Stack Oxygen Concentrations at Boilers in California

Measured Stack Oxygen Concentration	Data Point Count	Percentage of Data Points
Stack oxygen less than 5%	5	17%
Stack oxygen between 5% and 6%	2	7%
Stack oxygen greater than 6%	22	76%
Total	29	100%

The field data show that three quarters of the recorded stack oxygen values exceed 6 percent. Above six percent, the average oxygen concentration is 7.7 percent. Although vendors report that their equipment can be tuned to operate between 5 percent and 7 percent excess oxygen, they note that actual stack oxygen levels vary with boiler geometry and combustion air temperature[3]. As combustion air temperature increases, air density decreases, which can reduce stack oxygen and bring the boiler out of NOx-emission compliance. For this reason, boilers are often tuned to slightly higher oxygen levels than necessary at ideal conditions in order to maintain compliance under varying operating conditions.

1.3.5 Energy Impacts

1.3.5.1 Energy Impacts Estimations

The Statewide CASE Team learned through stakeholder input, boiler field data, and anecdotal industry experience that many operating process boilers do not comply with the current Title 24, Part 6 requirements for stack oxygen concentration.

The Statewide CASE Team therefore calculated the energy impacts of the proposed code alignment provision in two ways, comparing the proposed maximum stack oxygen concentrations both to 2025 Title 24, Part 6 requirements and to current boiler operating practices as follows:

1. Paper savings: The impact of qualifying boilers moving from following the current requirements in 2025 Title 24, Part 6 to following the proposed requirements (negative energy savings), and
2. Real-world savings: The impact of qualifying boilers moving from real-world stack oxygen concentrations to follow the proposed requirements (positive energy savings).

The negative (paper) energy impact was calculated based on the decreased boiler efficiency resulting from the increased stack oxygen for a boiler moving from the 2025 code requirement to the proposed code requirement. The positive (real-world) energy impact was calculated based on the increased boiler efficiency resulting from the decreased stack oxygen as a boiler goes from following typical operating practice to following the proposed stack oxygen concentration requirement levels.

The boiler efficiency was calculated using the ASME PTC 4- indirect Method: Stack Loss Method as follows:

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[3] The combustion air temperature is the temperature of the air supplied to the burner, which fluctuates with the outdoor air temperature.

$$Boiler\ Efficiency\ (\%) = 100\% - L_{DG} - H_{WG} - 1\%_{Other\ Loses}$$

$$DG = 14.7365 * (\frac{O_2\%}{21\% - O_2\%}) + 15.371$$

$$L_{DG}(\%) = 0.001044 * DG * (T_{Stack} - T_{ambient})$$

$$L_{WG}(\%) = 9.482 + 0.004351 * T_{Stack}$$

Energy savings were calculated based on the difference in fuel (gas) input required to meet the same boiler load, before and after the change in boiler efficiency.

1. Calculate boiler load based on gas consumption and boiler efficiency:

$$Boiler\ Load = \frac{Annual\ Gas\ Consumption_{Baseline}}{Boiler\ Efficiency_{Baseline}}$$

2. Calculate proposed boiler gas consumption based on boiler load and boiler efficiency:

$$Annual\ Gas\ Consumption_{Post} = \frac{Boiler\ Load}{Boiler\ Efficiency_{Post}}$$

3. Calculate difference in baseline and proposed gas consumption to get energy savings:

$$Savings = Annual\ Gas\ Consumption_{Baseline} - Annual\ Gas\ Consumption_{Post}$$

The Statewide CASE Team estimated current field operating stack oxygen concentrations based on process boiler field data from Cascade Energy, the South Coast AQMD, and the SJVAPCD.

Error! Reference source not found. includes the assumptions for the current code requirements, typical field operating practice, and proposed code requirement stack oxygen concentrations for each boiler type.

Table 6: Energy Savings Estimate Assumptions

Boiler Type	Case	Stack Oxygen Concentration	Data Source
Boilers with Mesh Burners	2025 Title 24 Code Requirement	3%	Title 24, Part 6, Section 904.1.3
Boilers with Mesh Burners	Operating Practice	8%	Boiler vendors and manufacturers, AQMD field data
Boilers with Mesh Burners	Proposed Code Requirement	8%	Boiler vendors and manufacturers
Boilers with SCR Systems	2025 Title 24 Code Requirement	3%	Title 24, Part 6, Section 904.1.3
Boilers with SCR Systems	Operating Practice	4%	10 sample tune-up reports, AQMD field data
Boilers with SCR Systems	Proposed Code Requirement	4%	Boiler vendors and manufacturers
All other boilers	2025 Title 24 Code Requirement	3%	Title 24, Part 6, Section 904.1.3
All other boilers	Operating Practice	8%	10 sample tune-up reports, AQMD field data
All other boilers	Proposed Code Requirement	6%	Boiler vendors and manufacturers

As process boilers with mesh burners and SCR systems typically operate at stack oxygen concentrations consistent with the proposed code maximums, the estimated real-world energy impact of the proposed code alignment provision on these boilers is zero.

Calculations for boilers operating annually assumed 6,500 operating hours per year at 40 percent load, while calculations for seasonal boilers assumed 2,400 operating hours per year (primarily July through October) at 80 percent load. The Statewide CASE Team based these assumptions for operating hours and load factor on analysis of data from 128 California steam-using sites sourced from the national Industrial Assessment Center (IAC) database (Swanson and Staller, Steam Trap Fault Detection & Diagnostics in Existing Industrial Applications 2025).

Table 7 and Table 8 below present the per-unit first year estimated natural gas impacts of the proposed code alignment provision compared to the current Title 24 requirements and current boiler operating practice.

Table 7: First Year Estimated Natural Gas Savings (kBtu) Per MMBtu/h of Boiler Capacity - Current Title 24, Part 6 Requirements (3%) vs. Proposed Requirements (8% for mesh, 6% for other, 4% for SCR)

Boiler Type	Estimated Percentage of New Statewide Boiler Capacity	First Year Natural Gas Savings (kBtu per MMBtu/h)
Year-Round Boilers with Mesh Burners	4.7%	-69,700
Year-Round Boilers with SCR Systems	52.8%	-10,400
Year-Round Boilers: All Other Boilers	31.5%	-35,800
Seasonal Boilers with Mesh Burners	0.0%	-55,800
Seasonal Boilers with SCR Systems	8.3%	-8,400
Seasonal Boilers: All Other Boilers	2.8%	-28,700

Table 8: First Year Estimated Natural Gas Savings (kBtu) Per MMBtu/h of Boiler Capacity - Operating Practice (8% mesh, 4% SCR, 8% all other) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Boiler Type	Estimated Percentage of New Statewide Boiler Capacity	First Year Natural Gas Savings (kBtu per MMBtu/h)
Year-Round Boilers with Mesh Burners	4.7%	0
Year-Round Boilers with SCR Systems	52.8%	0
Year-Round Boilers: All Other Boilers	31.5%	33,000
Seasonal Boilers with Mesh Burners	0.0%	0
Seasonal Boilers with SCR Systems	8.3%	0
Seasonal Boilers: All Other Boilers	2.8%	26,400

1.3.5.2 Assumptions for Statewide Energy Savings Estimations

To estimate statewide boiler capacities, the Statewide CASE Team leveraged statewide boiler inventory data developed as part of a Code Readiness project. This inventory is a nearly complete statewide boiler inventory that has over 9,000 equipment entries from local air quality management districts, which were collected and preprocessed by the Code Readiness project team in 2023 and 2024 (Swanson and Staller, Steam Trap Fault Detection & Diagnostics in Existing Industrial Applications 2025).

The Statewide CASE Team refined the statewide capacity to account for Title 24 purview and requirement exceptions, making the following changes to estimate the Existing Boiler Stock:

- Removed boilers with input capacities below 5 MMBtu/h.
- Removed oilfield and utility boilers, which are not in buildings and not subject to Title 24, Part 6 requirements.
- Removed estimated capacity anticipated to qualify for the exception. The percentage of capacity varies by boiler size and is shown in Table 9.

Table 9: Estimated Current Boiler Capacity in California with Steady State Full-Load Combustion Efficiency of 90% or Higher

Boiler Capacity (MMbtu/h)	Estimated Percentage of Boiler Capacity Qualifying for Exception
5-10	0%
10-15	0%
15-25	0%
25-50	1%
50-100	2%
100-200	4%
200+	8%

To estimate the capacity of new process boilers installed annually from new construction and additions, the Statewide CASE Team calculated two industrial production growth rates for boilers in California, one for year-round boilers and one for seasonal boilers. See the Process Boilers CASE Report for a detailed explanation on the development of each growth rate (Conroy, et al. 2026).

The calculated weighted average IPGRs were 1.65 percent for year-round boilers and 0.46 percent for seasonal facilities. The annual new construction and additions forecast is equivalent to the Existing Boiler Stock multiplied by the IPGR.

To estimate the capacity of new process boilers installed annually from alterations or replacements, the Statewide CASE Team calculated the replacement rate for boilers and applied it to Existing Boilers Stock. Boiler lifetimes range widely, with most estimates in the 25- to 40-year range (Van Wortswinkel and Nijs 2010). The boiler replacement rate is based on a 30-year boiler lifetime, which means that 3.3 percent of the Existing Boiler Stock is replaced each year. The alterations forecast is therefore equivalent to the Existing Boiler Stock multiplied by 3.3 percent.

The Statewide CASE Team then multiplied the per-unit measure savings by the annual new construction and additions forecast and by the alterations forecast to get statewide savings. All energy impacts would be consistent across climate zones and across boiler capacity added or replaced as part of new construction, additions, or alterations. The proposed code language updates would not incur any first or incremental costs for facilities.

The tables below present the first-year statewide energy and LSC savings from new construction and additions (Table 10 and Table 13) and alterations (Table 11 and Table 14) by climate zone for both current Title 24 requirements and standard practice. Table 12 and Table 15 present first-year statewide savings from new construction, additions, and alterations together. First-year natural gas savings between the current and proposed requirements would be -1.01 million therms, and first-year natural gas savings between estimated operating practice and the proposed requirements would be 0.52 million therms.

Table 10: Statewide Energy and LSC - Impacts New Construction and Additions – Current Title 24, Part 6 Requirements (3%) vs. Proposed Requirements (8% for mesh, 6% for other, 4% for SCR)

Climate Zone	Statewide NC and Additions Impacted by Proposed Change in 2029 (MMBtu/h of boiler capacity)	First-Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	5.98	0.00	-$0.09
2	18.41	0.00	-$0.39
3	121.66	-0.03	-$2.49
4	49.75	-0.01	-$1.05
5	9.57	0.00	-$0.21
6	76.59	-0.02	-$1.58
7	24.90	-0.01	-$0.63
8	117.05	-0.03	-$2.37
9	144.37	-0.04	-$2.93
10	98.97	-0.02	-$2.06
11	48.80	-0.01	-$0.84
12	316.83	-0.07	-$5.40
13	338.45	-0.06	-$5.31
14	47.83	-0.01	-$0.83

Climate Zone	Statewide NC and Additions Impacted by Proposed Change in 2029 (MMBtu/h of boiler capacity)	First-Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
15	24.03	-0.01	-$0.44
16	13.42	0.00	-$0.25
Total	**1,456.62**	**-0.32**	**-$26.88**

Table 11: Statewide Energy and LSC Impacts - Alterations– Current Title 24, Part 6 Requirements (3%) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2029 (MMBtu/h of boiler capacity)	First-Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	14.2	0.00	-$0.20
2	40.5	-0.01	-$0.82
3	264.5	-0.06	-$5.22
4	109.2	-0.03	-$2.20
5	19.5	-0.01	-$0.42
6	167.9	-0.04	-$3.31
7	50.6	-0.02	-$1.28
8	260.8	-0.06	-$5.03
9	320.2	-0.07	-$6.20
10	218.3	-0.05	-$4.35
11	114.5	-0.02	-$1.86
12	688.0	-0.14	-$11.38
13	727.2	-0.14	-$11.15
14	110.5	-0.02	-$1.81
15	54.7	-0.01	-$0.95
16	30.4	-0.01	-$0.54
Total	**3,191.1**	**-0.69**	**-$56.73**

Table 12: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations – Current Title 24, Part 6 Requirements (3%) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Construction Type	First -Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
New Construction & Additions	-0.32	-$26.88
Alterations	-0.69	-$56.73
Total	**-1.01**	**-$83.61**

Table 13: Statewide Energy and LSC Impacts – New Construction and Additions – Operating Practice (8% mesh, 4% SCR, 8% all other) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Climate Zone	Statewide NC and Additions Impacted by Proposed Change in 2029 (MMBtu/h of boiler capacity)	First-Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	1.60	0.00	$0.04
2	7.71	0.00	$0.21
3	49.30	0.02	$1.34
4	20.73	0.01	$0.56
5	3.94	0.00	$0.11
6	30.10	0.01	$0.83
7	12.75	0.00	$0.35
8	45.81	0.02	$1.26
9	56.37	0.02	$1.55
10	40.09	0.01	$1.10
11	16.34	0.01	$0.44
12	100.82	0.03	$2.74
13	96.65	0.03	$2.63
14	15.54	0.01	$0.42
15	8.36	0.00	$0.23
16	4.74	0.00	$0.13
Total	**510.85**	**0.17**	**$13.94**

Table 14: Statewide Energy and LSC Impacts – Alterations – Operating Practice (8% mesh, 4% SCR, 8% all other) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2029 (MMBtu/h of boiler capacity)	First-Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
1	3.77	0.00	$0.10
2	16.41	0.01	$0.44
3	104.23	0.03	$2.80
4	44.03	0.01	$1.18
5	8.01	0.00	$0.22
6	64.08	0.02	$1.73
7	25.83	0.01	$0.71
8	98.61	0.03	$2.66
9	120.98	0.04	$3.26
10	85.56	0.03	$2.31
11	36.98	0.01	$0.97
12	215.61	0.07	$5.76
13	206.11	0.07	$5.51
14	34.85	0.01	$0.92
15	18.43	0.01	$0.49
16	10.38	0.00	$0.28
Total	**1,093.87**	**0.36**	**$29.35**

Table 15: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations – Operating Practice (8% mesh, 4% SCR, 8% all other) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Construction Type	First -Year Natural Gas Savings (Million Therms)	30-Year Present Valued LSC Savings (Million 2029 PV$)
New Construction & Additions	0.17	$13.94
Alterations	0.36	$29.35
Total	**0.52**	**$43.30**

Table 16 and Table 17 present the estimated first-year impact to GHG emissions resulting from the proposed code alignment provision.

Table 16: First-Year Statewide GHG Emissions Impacts – Current Title 24, Part 6 Requirements (3%) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Construction Type	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Tons CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	-1,688.19	-1,688.19	-$207,896.65
Alterations	-3,584.03	-3,584.03	-$441,364.67
Total	**-5,272.22**	**-5,272.22**	**-$649,261.32**

Table 17: First-Year Statewide GHG Emissions Impacts – Operating Practice (8% mesh, 4% SCR, 8% all other) vs. Proposed Requirements (8% mesh, 4% SCR, 6% all other)

Construction Type	Reduced GHG Emissions from Natural Gas Savings (Metric Tons CO2e)	Total Reduced GHG Emissions (Metric Tons CO2e)	Total Monetary Value of Reduced GHG Emissions ($)
New Construction & Additions	875.60	875.60	$107,828.38
Alterations	1,853.29	1,853.29	$228,227.82
Total	**2,728.89**	**2,728.89**	**$336,056.20**

1.3.6 Material Impacts

The proposed code alignment provision would not result in water use or material impacts as the stack oxygen gas concentration does not impact water use at a boiler system or require any changes to equipment.

1.3.7 Other Entities

This proposal is limited to an existing code update. The Statewide CASE Team is unaware of any other entities pursuing proposals regarding process boiler stack-oxygen concentration limits. In February 2026, the CEC issued guidance regarding conflicts between the 2022 and 2025 Energy Codes and the federal Clean Air Act. The guidance states that the Clean Air Act takes precedence and enforcement officials should prioritize air district emission standards when it is not possible to simultaneously comply with both the Energy Code stack oxygen concentration requirements and air district standards (CEC 2026).

1.3.8 Grid Impacts

This proposal is limited to an existing code update to increase the stack oxygen concentration limits for process boilers to achievable ranges and would not have an impact on grid energy consumption. By proposing achievable stack oxygen concentration limits, this proposal encourages code compliance, which would lower process boiler natural gas consumption.

2. Stakeholder Engagement to Inform Proposal

Throughout the proposed code alignment provision development process, the Statewide CASE Team engaged a range of stakeholders to discuss the current and proposed stack oxygen concentration limits in Title 24, Part 6 via email and video call. Stakeholders included boiler and steam system manufacturers and vendors, burner and control system manufacturers, engineering consultants, and facility operators. Data from these stakeholder conversations are included in Table 2.

The Statewide CASE Team also met with representatives from the South Coast AQMD and SJVAPCD. The agencies provided data on the stack oxygen concentrations and the prevalence of SCR systems installed with new boilers in their respective jurisdictions. The Statewide CASE Team used this data to inform the proposed new limits and estimates of the distribution of qualifying boiler capacity with SCR systems.

Several industry representatives and stakeholders submitted public comments to docket 25-BSTD-03 to express concerns about the ability of current boilers to maintain stack oxygen concentrations of 3 percent or less while complying with NOx emissions requirements throughout the state. Table 18Table 18: Stakeholder Comments Regarding Stack Oxygen Concentrations includes details on the submitted comments regarding the stack oxygen concentrations as of April 2026.

Table 18: Stakeholder Comments Regarding Stack Oxygen Concentrations

Individual Name	Organization	TN #	Link to Comment
Daniel Robidoux	Carrier	266813	https://efiling.energy.ca.gov/GetDocument.aspx?tn=266813&DocumentContentId=103899
Greg Danenhauer	Parker Boiler	266909	https://efiling.energy.ca.gov/GetDocument.aspx?tn=266912&DocumentContentId=104092
Mike Alzona	Parker Boiler	266912	https://efiling.energy.ca.gov/GetDocument.aspx?tn=266935&DocumentContentId=104116
Philip Sondervan	Parker Boiler	266958	https://efiling.energy.ca.gov/GetDocument.aspx?tn=266958&DocumentContentId=104139
Steve Ocampo	San Jose Boiler	267006	https://efiling.energy.ca.gov/GetDocument.aspx?tn=267006&DocumentContentId=104174

Individual Name	Organization	TN #	Link to Comment
Mauro Donate	Unknown	267121	https://efiling.energy.ca.gov/GetDocument.aspx?tn=267121&DocumentContentId=104291
Anonymous	Industrial equipment supplier	N/A	Private email communication to CASE Team and email response to published Draft Process Boilers CASE Report.
Unknown	Power Flame Inc.	267173	https://efiling.energy.ca.gov/GetDocument.aspx?tn=267173&DocumentContentId=104334

The Statewide CASE Team also collected feedback from public stakeholders through an online survey fielded by TRC in late 2025. Five out of five respondents indicated that the current Title 24, Part 6 requirements regarding stack oxygen concentrations present a challenge when meeting local AQMD NOx requirements for low- or ultra-low NOx boilers. In general, respondents who left comments felt that the Title 24 stack oxygen concentrations should be removed or revised. One stakeholder noted that lower NOx comes at the expense of efficiency, while another stakeholder stated that they were unaware of available technologies that would allow boilers with capacities of 5 MMBtu/h or larger to achieve AQMD NOx requirements while maintaining stack oxygen concentrations of three percent.

Finally, the Statewide CASE Team presented this code change alignment provision at a public meeting on February 17, 2026 to solicit stakeholder feedback on the proposed changes. During the presentation, stakeholders were invited to answer polls and provide open ended feedback. No stakeholders raised concerns with the proposed provision.

Feedback gathered through stakeholder interviews, public meetings, and docket comments collectively informed the development of stack oxygen concentration limits that reflect achievable operating conditions for qualifying boilers.

3. Proposed Code Language

3.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

3.1.1 Energy Code (Title 24, Part 6)

SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 200.1– Definitions

No changes are proposed to Section 200.1.

SUBCHAPTER 9 – PROCESS SYSTEMS AND EQUIPMENT

SECTION 904 – PROCESS BOILERS (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)

904.1 *[Section 120.6(d)]* **Mandatory requirements (Newly Constructed, Additions, Alterations).**

904.1.1 *[Section 120.6(d)1]* **Combustion air positive shut-off.**

Combustion air positive shut-off shall be provided on all newly installed process boilers as follows:

A. All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.

B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

904.1.2 *[Section 120.6(d)2]* **Combustion air fans.**

Process boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

A. The fan motor shall be driven by a variable speed drive; or

B. The fan motor shall include controls that limit the fan motor demand to no more than 30% of the total design wattage at 50% of design air volume.

904.1.3 *[Section 120.6(d)3]* **Stack-gas oxygen.**

Newly installed process boilers with an input capacity greater than or equal to 5 MMBtu/h (5,000,000 Btu/h) shall ~~maintain stack-gas oxygen concentrations at less than or equal to 3.0% by volume on a dry basis over firing rates of 20 to 100%~~ meet the following requirements at 25% (or at the boiler's lowest firing rate, whichever is higher) to 100% of burner input capacity:

A. Process boilers with mesh burners shall maintain stack-gas oxygen concentrations at less than or equal to 8.0% by volume on a dry basis.

   i. A mesh burner is defined as a burner that uses a premixed air-fuel mixture, with combustion occurring at a fine mesh surface which acts as a flame arrestor, stabilizing and maintaining the flame.

B. Process boilers equipped with Selective Catalytic Reduction (SCR) systems shall maintain stack-gas oxygen concentrations at less than or equal to 4.0% by volume on a dry basis.

   i. A Selective Catalytic Reduction (SCR) system is defined as a boiler emissions control system that injects ammonia or urea into the flue gas over a catalyst to reduce NOx emissions.

C. All other qualifying process boilers shall maintain stack-gas oxygen concentrations at less than or equal to 6.0% by volume on a dry basis.

EXCEPTION to Section 904.1.3 *[Section 120.6(d)3]*: Boilers with steady state full-load combustion efficiency, inclusive of all economizers, 90 percent or higher.

904.4 *[Section 141.1]* **Additions and alterations to existing buildings.**

Covered processes in additions or alterations to existing buildings that will be nonresidential, hotel/motel, or multifamily occupancies shall comply with the applicable requirements of Section 904, and the applicable requirements of Section 400.5.1 *[Section 110.2(a)]* and Section 913 *[Section 120.3].*

All additions or alterations to existing buildings where process boilers are added or replaced shall comply with the applicable requirements of Section 904.1.

3.1.2 Reference Appendices

Appendix NA7 – Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes.

NA7.21 Process Boiler Installation and Acceptance Tests

NA7.21.1 Process Boiler Stack Oxygen Concentration

Acceptance tests for process boilers in accordance with Section 904.1.3.

NA7.21.1.1 Construction Inspection

No construction inspection is required for this measure.

NA7.21.1.2 Functional Testing

Additional acceptance testing, performed by field technician, shall be added to verify and document the following for newly installed process boilers with an input capacity equal to or greater than 5 MMBtu/h (5,000,000 Btu/h):

- Stack-gas oxygen concentrations at less than or equal to the percentage specified in 904.1.3 by volume on a dry basis at 25% (or at the boiler's lowest firing rate, whichever is higher) to 100% of burner input capacity.

Step 1: Installation Verification

1. Confirm the type of burner installed in the boiler:
    a. Standard manifold burner
    b. Mesh burner
2. Confirm if the boiler exhaust is equipped with an SCR system

Step 2: Visual Verification

3. Visually verify digital stack oxygen readings at the following rates to ensure the stack oxygen does not exceed the allowable maximum:
    a. 25% firing rate or the boiler's lowest firing rate, whichever is higher
    b. 100% firing rate
    c. Midpoint between a and b

Allowable maximums are:

   a. Boilers with a mesh burner: 8% O2 by volume on a dry basis
   b. Boilers equipped with an SCR: 4% O2 by volume on a dry basis
   c. All other boilers: 6% O2 by volume on a dry basis

3.1.3 Compliance Manuals

The Statewide CASE Team will provide CEC with recommended revisions to compliance manuals after the 45-Day Language is published.

3.1.4 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

3.1.5 Compliance Forms

NRCC-PRC-E and NRCI-PRC-E forms would be updated, and a new NRCA-PRC-XX-F compliance form would be added to reflect the proposed change. The Statewide CASE

Team can support the CEC in implementing these updates if the proposed change is adopted.

NRCC-PRC-E

In section I PROCESS BOILER table:

- In the Virtual Compliance Assistant, for “Which rated input capacity aligns with this process boiler?”
    - Update to the following dropdown options:
        - $<$ 2.5 MMBtu/h
        - $\geq$ 2.5 to $<$ 5 MMBtu/h
        - $\geq$ 5 to $<$ 10 MMBtu/h
        - $\geq$ 10 MMBtu/h
- If c or d is selected, add the following question:
    - Which type of technology is included in the design for this boiler?
    - Add the following dropdown options:
        - Mesh burner
        - SCR system
        - Other
- In the corresponding section for the stack-gas oxygen under the Process Boilers section of the Virtual Compliance Assistant, update the dropdown compliance question, “Does this process boiler maintain stack-gas oxygen concentrations at ≤ 3% by volume on a dry basis over firing rates of 20 -100% & control combustion air volume with respect to firing rate or measured flue gas oxygen concentration?” to say, “Is the process boiler system designed to maintain stack-gas oxygen concentrations at [autofill based on previous answer]?”
    - Autofill the question based on the answer selected in the previous question:
        - [If previous answer = Mesh Burner]: 8% O2 by volume on a dry basis
        - [If previous answer = SCR]: 4% O2 by volume on a dry basis
        - [If previous answer = Other]: 6% O2 by volume on a dry basis

In section T Declaration of Required Certifications of Acceptance table:

- Add a row for the stack oxygen acceptance test as follows: “NRCA-PRC-XX-F Stack Oxygen Concentration.”

NRCI-PRC-E

In section G Acceptance Tests and Field Declaration table:

- Add a row for the stack oxygen acceptance test as follows: "NRCA-PRC-XX-F - Must be Submitted for Stack Oxygen Concentration."

NRCA-PRC-XX (Stack-Gas Oxygen)-F

Create new NRCA-PRC form with the following:

- Functional Testing Table
    - Verify the boiler burner type (No Entry):
        - Mesh burner (Y/N)
    - Is the boiler equipped with an SCR system? (Y/N)
    - Observe the digital stack oxygen readings at the following conditions (No Entry):
        - 25% firing rate or the boiler's lowest firing rate during operations. (No Entry).
        - 100% firing rate (No Entry).
        - The midpoint between the lowest firing rate and 100% firing rate (No Entry).
            - Confirm the stack oxygen reading maximums were as follows (No Entry):
            - For boilers with mesh burners, 8% O_2 by volume on a dry basis. (P/F)
            - For boilers with SCR systems, 4% O_2 by volume on a dry basis. (P/F)
            - For all other boilers, 6% O_2 by volume on a dry basis. (P/F)

4. Appendix A - Boiler Capacity and Field Data

4.1 Boiler Capacity Bins

The Statewide CASE Team analyzed energy savings and cost effectiveness in six boiler capacity ranges to account for savings and cost differences for boilers with different capacities. Table 19 shows the boiler capacity bin ranges and the average capacity of the boilers within each bin, which was used to perform the calculations of cost effectiveness. The prototype is the average capacity boiler for each boiler capacity bin, as shown Table 19. Data on the capacity of installed boilers in California came from the statewide boiler inventory of local air district boiler permits developed as part of the Code Readiness program (Swanson and Staller 2025).

Table 19: Process Boiler Capacity Bins

Boiler Capacity Bin	Average Boiler Capacity Used for Calculations
10-15 MMBtu/h	12 MMBtu/h
15-25 MMBtu/h	19 MMBtu/h
25-50 MMBtu/h	33 MMBtu/h
50-100 MMBtu/h	71 MMBtu/h
100-200 MMBtu/h	143 MMBtu/h
200+ MMBtu/h	739 MMBtu/h

For this measure, boilers that operate infrequently throughout the year due to seasonal loads will experience smaller savings. Due to this variance, the Statewide CASE Team also developed prototypes and calculated annual energy savings and cost effectiveness for boilers with seasonal loads separately from the more typical annual loads. Calculations for boilers operating annually assumed 6,500 operating hours per year at 40 percent load, and calculations for seasonal boilers assumed 2,400 operating hours per year (primarily July through October) at 80 percent load. To calculate statewide capacity, seasonal boilers were all boilers in canneries. Boilers used in all other industries were assumed to be year-round boilers.

Review finds no anticipated differences between new process boilers that are installed during the new construction, addition, or alteration of a building, so the same prototypes were used for new construction, additions, and alterations.

For this measure, two baseline cases are considered: the existing code requirements and current standard practice.

The baseline case representing existing code requirements assumes compliance with the 2025 Title 24, Part 6 standards, which apply to process boilers in new construction, additions, and alterations. These requirements include: 1) combustion air positive shut-off for all process boilers with an input capacity of 2.5 MMBtu/h and above, 2) variable speed drive for process boiler combustion air fans with motors 10 horsepower and greater, and 3) stack oxygen concentrations at less than or equal to 3.0 percent by volume on a dry basis over firing rates of 20 to 100 percent for process boilers with an input capacity greater than 5.0 MMBtu/h. This baseline informs the combustion efficiency assumptions used in savings calculations.

The standard practice baseline case reflects data collected by the Statewide CASE Team from multiple sources to estimate current stack oxygen concentrations in practice, which represent typical operating conditions used to maintain compliance with AQMD NOx requirements.

Table 20, Table 21, and Table 22 below include process boiler field data from 10 sites collected through Cascade Energy's work at the sites. These data were used to inform boiler stack oxygen content assumptions.

Table 20: Boiler Field Data - Low Fire

Site Number	Stack Oxygen Concentration	Stack Temperature (°F)	NOx (ppmv)	Combustion Efficiency
1	7.0%	381	5.4	80.60%
2	4.8%	370	3.8	81.83%
3	7.8%	377	6.8	80.29%
4	8.3%	376	6.7	80.03%
5	8.0%	363	6.9	80.59%
6	8.1%	367	7.5	80.41%
7	8.0%	345	7.5	81.13%
8	7.7%	351	7.7	81.10%
9	[no data]	[no data]	[no data]	90.72%
10	6.7%	386	7	80.61%

Table 21. Boiler Field Data - Mid Fire

Site	Stack Oxygen Concentration	Stack Temperature (°F)	NOx (ppmv)	Combustion Efficiency
1	5.5%	399	7.5	80.81%
2	4.5%	374	4.5	81.84%
3	7.6%	410	6.4	79.44%
4	8.0%	421	6.4	78.86%
5	8.1%	375	6.28	80.17%
6	7.8%	380	7.5	80.20%
7	7.9%	365	7.7	80.59%

Site	Stack Oxygen Concentration	Stack Temperature (°F)	NOx (ppmv)	Combustion Efficiency
8	8.0%	360	7.1	80.68%
9	6.8%	392	26.1	80.39%
10	4.1%	427	6.4	80.70%

Table 22: Boiler Field Data – High Fire

Site	Stack Oxygen Concentration	Stack Temperature (°F)	NOx (ppmv)	Combustion Efficiency
1	7.5%	394	5.7	79.96%
2	4.5%	378	4.5	81.74%
3	7.4%	451	6.4	78.37%
4	7.8%	444	6.4	78.31%
5	8.1%	389	6.14	79.75%
6	7.7%	396	7.31	79.78%
7	7.8%	384	7.8	80.08%
8	7.8%	370	7.7	80.49%
9	5.2%	450	25.1	79.64%
10	3.5%	500	7.1	79.21%

5. Appendix B - Markup of Non-Restructured 2025 Title 24, Part 6 Code Language

5.1 Proposed Code Language

Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes to the 2025 documents should be marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

Administrative Code (Title 24, Part 1)

No changes are proposed to Title 24, Part 1.

Energy Code (Title 24, Part 6)

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 100.1 (b) – Definitions

No changes are proposed to Section 100.1.

SUBCHAPTER 3 – NONRESIDENTIAL, HIGH-RISE RESIDENTIAL, HOTEL/MOTEL OCCUPANCIES, AND COVERED PROCESSES–MANDATORY REQUIREMENTS

Section 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

120.6(d) Mandatory requirements for process boilers.

1. Combustion air positive shut-off shall be provided on all newly installed process boilers as follows:

A. All process boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.

B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

2. Process boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

A. The fan motor shall be driven by a variable speed drive; or

B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

3. Newly installed process boilers with an input capacity greater than or equal to 5 MMBtu/h (5,000,000 Btu/h) shall ~~maintain stack-gas oxygen concentrations at less than or equal to 3.0% by volume on a dry basis over firing rates of 20 to 100%~~ meet the following requirements at 25% (or at the boiler's lowest firing rate, whichever is higher) to 100% of burner input capacity:

A. Process boilers with mesh burners shall maintain stack-gas oxygen concentrations at less than or equal to 8.0% by volume on a dry basis.

   i. A mesh burner is defined as a burner that uses a premixed air-fuel mixture, with combustion occurring at a fine mesh surface which acts as a flame arrestor, stabilizing and maintaining the flame.

B. Process boilers equipped with Selective Catalytic Reduction (SCR) systems shall maintain stack-gas oxygen concentrations at less than or equal to 4.0% by volume on a dry basis.

   i. A Selective Catalytic Reduction (SCR) system is defined as a boiler emissions control system that injects ammonia or urea into the flue gas over a catalyst to reduce NOx emissions.

C. All other qualifying process boilers shall maintain stack-gas oxygen concentrations at less than or equal to 6.0% by volume on a dry basis.

EXCEPTION to Section 120.6(d)3: Boilers with steady state full-load combustion efficiency, inclusive of all economizers, 90 percent or higher.

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