Proposal Summary

Process Boiler #1 Stack Economizer And Stack Oxygen Concentration

Updated Friday, November 3, 2025

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Measure Description

This proposal would require boiler stack (non-condensing) economizers on process boilers with capacities at or above 10 MMBtu/hr. The requirement would apply to all new process boilers, including replacement boilers and boilers in additions to existing facilities, with the following exceptions:

- Boilers with stack temperatures below 340°F at their lowest firing rate without an economizer.
- Boilers that burn biofuels or hydrogen.
- Boilers employing other methods of stack heat recovery, such as a heat exchanger that serves an industrial heat pump or process drying application.

The Statewide CASE Team is evaluating one additional potential exemption for the requirement:

1. Sites where the retrofit building ceiling height or existing footprint shape results in insufficient room to install a standard boiler plus stack economizer combination.

In addition, this proposal would adjust the 2025 Title 24 Part 6 code language which calls for qualifying process boilers to maintain excess oxygen concentrations at 3.0 percent or lower over firing rates of 20 to 100 percent. The proposed code changes would update the code language to allow excess oxygen concentrations as follows:

- mesh burners: maximum 10% excess O2 at or above 25% of burner input capacity
- boilers equipped with Selective Catalytic Reduction (SCR) systems: maximum 4% excess O2 at or above 25% of burner input capacity
- all other process boilers: maximum 7% at or above 25% of burner input capacity

Boilers used in oilfield production and utility and municipal power generation are not expected to be within the scope of Title 24, Part 6. Table 1 summarizes the scope of the proposed code change.

Table 1: Scope of Proposed Code Change

An “X” indicates the proposed code change is relevant.

Building Type(s)		single family	**Construction Type(s)**	X	new construction
		multifamily		X	additions
	X	nonresidential		X	alterations
Type of Change	X	mandatory	**Updates to Compliance Software**	X	no updates
		prescriptive			update existing feature
		performance			add new feature
Third Party Verification	X	no changes to third party verification			
		update existing verification requirements			
		add new verification requirements			

Justification for Proposed Change

Most steam boilers lose 20% or more of their input fuel energy in the form of combustion exhaust. A stack economizer, which is an assembly of finned tubing placed in the boiler exhaust stream, can recover a significant fraction of this waste heat by pre-heating the boiler feedwater with the hot boiler flue gas. This reduces load and thermal stress on the boiler, lowers fuel consumption, and extends boiler useful life.

The use of boiler stack economizers has been listed in Department of Energy literature as a best practice since at least the early 2000s. Despite its cost-effectiveness, this measure often goes unimplemented because of its first cost and the general lack of owner and operator awareness of the energy benefits. In general, boiler system vendors and contractors are highly familiar with this technology, and it is widely available. Stack economizers can be installed in various configurations, including roof boxes, making them feasible in most facilities.

The use of a stack economizer is typically the highest-impact action that sites can take to reduce their boiler natural gas usage, saving 2-3% of fuel energy by preheating boiler feedwater. Preliminary statewide natural gas savings from a stack economizer requirement are estimated at 1.37 million therms per year. Preliminary savings

calculations and assumptions can be found in the stack economizer savings calculations document.

2025 Title 24 Part 6 requirements dictate that qualified boilers shall maintain stack-gas oxygen concentrations lower than or equal to 3.0 percent over firing rates of 20 to 100 percent. However, boilers that comply with California's local air quality district NOx emission rate limits, require higher amounts of excess oxygen than non-compliant, higher-Nox boilers—often above 3.0 percent. Updating Title 24 Part 6 requirements to allow for oxygen concentrations higher than 3.0 percent would allow for boilers to comply with California's local air quality district requirements. The proposed requirements would account for different boiler types that require different oxygen concentrations to maintain efficiency. Eliminating conflicting regulations through this proposal would improve ongoing code compliance. In addition, NOx monitoring often drives utilization of a control monitoring console, which enhances data utilization to improve decision-making and is synergetic with the monitoring requirements in this proposal.

Additional benefits of this proposed code change include job creation in the manufacturing and installation of stack economizers, as well as improved local air quality. Many industrial facilities are located near Low- and Moderate-Income (LMI) housing, which is disproportionately exposed to lower air quality. This proposal would reduce photochemical smog in these communities.

Data Needs / Information Requests

The Statewide CASE Team is seeking the following information to inform the code change proposal. Data may be provided anonymously. To participate or provide information, please email Emma Conroy, emmaconroy@2050partners.com directly and copy info@title24stakeholders.com.

- Typical annual operating hours and load factors for boilers in various industries
- Typical boiler lifetimes across different boiler sizes
- Labor and material costs of stack economizers across different boiler sizes
- Maintenance costs, the frequency of maintenance on stack economizers, lifetimes of stack economizers, and economizer retube costs
- Prevalence of boilers that have stack temperatures below 340°F
- Prevalence of inadequate overhead space, when a roof box cannot be added to accommodate a stack economizer in a boiler replacement
- Barriers to implementing non-condensing stack economizers on boilers
- Market prevalence of stack economizers by boiler capacity
- New construction and additions rate for process boilers

Draft Code Language

1.1 Guide to Marked Up Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2025 documents are marked with blue underlining (new language) and ~~strikethroughs~~ (deletions).

1.2 Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

1.3 Title 24, Part 6

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 100.1(b) – Definitions: Recommends new or revised definitions for the following terms:

BOILER STACK ECONOMIZER is a heat exchanger that recovers heat from boiler flue gas and transfers it to boiler feedwater or a combination of boiler feedwater and make-up water. Unless otherwise specified, this term refers to a non-condensing heat exchanger that does not condense water vapor from the boiler flue gas.

MESH BURNER is a type of burner constructed from fine metal mesh. In this system, combustion air is premixed with fuel before entering the burner. The premixed air-fuel mixture is directed through a steel tube into the mesh burner, where it passes through the fine mesh and enters the combustion chamber. Combustion occurs at the mesh surface, which acts as a flame arrestor, stabilizing and maintaining the flame.

SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM is a system used to reduce nitrogen oxide (NOx) emissions. In this system, aqueous ammonia is injected into the boiler stack, where it mixes with the combustion exhaust gases. This ammonia (NH_3) and exhaust gas mixture then passes through a catalyst. Within the catalyst, the ammonia reacts with the NOx to produce nitrogen (N_2) and water (H_2O). Urea can also be used as an alternative to ammonia; it is converted into ammonia in the hot stack before entering the catalyst.

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

SECTION 120.6 – MANDATORY REQUIRMENTS 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 percent by volume on a dry basis over firing rates of 20 to 100 percent~~ meet the following requirements:

A. Process boilers with mesh burners shall maintain stack-gas oxygen concentrations at less than or equal to 10.0 percent by volume on a dry basis at or above 25 percent of burner input capacity.
B. Process boilers equipped with Selective Catalytic Reduction (SCR) systems shall maintain stack-gas oxygen concentrations at less than or equal to 4.0 percent by volume on a dry basis at or above 25 percent of burner input capacity.
C. All other process boilers shall maintain stack-gas oxygen concentrations at less than or equal to 7.0 percent by volume on a dry basis at or above 25 percent of burner input capacity.

Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

Exception to Section 120.6(d)3: Boilers with steady state full-load combustion efficiency 90 percent or higher.

4. Stack economizer. Newly installed process boilers with an input capacity equal to or greater than 10 MMBtu/h (10,000,000 Btu/h) shall have a boiler stack economizer.

Exception 1 to Section 120.6(d)4: Boilers where the stack temperature measured at their lowest firing rate is below 340°F as documented in manufacturer performance data.

Exception 2 to Section 120.6(d)4: Boilers that burn biofuels or hydrogen.

Exception 3 to Section 120.6(d)4: Boilers employing other methods of stack heat recovery, such as a heat exchanger that serves an industrial heat pump or process drying application.

SECTION 141.1 – REQUIREMENTS FOR COVERED PROCESSES IN ADDITIONS, ALTERATIONS TO EXISTING NONRESIDENTIAL, AND HOTEL/MOTEL BUILDINGS

(d) Process boilers.

All newly installed process boilers at existing facilities shall meet the requirements of Section 120.6(d).

1.4 Reference Appendices

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

NA7.21 Process Boiler Acceptance Tests

NA7.21.1 Process Boiler Stack Economizer

Acceptance tests for process boilers in accordance with Section 120.6(d)4.

NA7.21.1.1 Construction Inspection

Verify and document the planned installation of a boiler stack economizer prior to functional testing in construction documentation.

NA7.21.1.2 Functional Testing

Acceptance testing, performed by field technician, shall be added to verify the following for newly installed process boilers with an input capacity equal to or greater than 10 MMBtu/h (10,000,000 Btu/h):

1. the stack economizer is operational and not bypassed at time of testing, or
2. the stack temperature at lowest fire is below 340°F for boilers that are pursuing the stack temperature exception, or

3. stack heat recovery equipment is operational for boilers that are pursuing the heat recovery exception.

Exact language for NA7.21.1.2 will be specified in the Final Process Boilers CASE Report.