

# Process Boilers



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# Executive Summary

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This proposal presents updates to process boiler requirements for consideration in the 2028 California Energy Code (Title 24, Part 6 or Energy Code). The proposals were developed by the Statewide Codes and Standards Enhancement (CASE) Team to improve process steam boiler system performance, reduce natural gas consumption, support water savings where applicable, and advance California's long-term energy efficiency and greenhouse gas (GHG) reduction goals. The CASE Report evaluates two measures applicable to nonresidential process boiler systems: a) Stack Economizer and b) Automatic Blowdown and Deaerator Pressure.

The Statewide CASE Team developed these proposed measures for submission to the California Energy Commission (CEC) for potential inclusion in the 2028 update to Title 24, Part 6. To be adopted, each measure must be technically feasible and cost effective. The proposed measures focus on cost-effective boiler stack heat recovery, improved boiler blowdown control, and reduced deaerator losses for large process steam boiler systems.

Stakeholder feedback informed the proposed code changes, associated analyses and assumptions, and compliance and enforcement approach. The Statewide CASE Team worked with or gathered feedback from boiler manufacturers, sales representatives, maintenance and installation providers, consulting firms, the South Coast Air Quality Management District, the San Joaquin Valley Air Pollution Control District, and others involved in the code compliance process. The team also held two public stakeholder workshops on September 23, 2025 and February 17, 2026, interviewed five boiler representatives from three organizations, received feedback from three additional representatives via email, and refined measure exceptions, assumptions, estimates, and code language in response.

The Statewide CASE Team recognizes ongoing systemic inequities in environmental and social justice (ESJ) communities and evaluated potential unintended impacts.

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## Stack Economizer

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### Proposed Code Change

This proposed code change would require boiler stack (non-condensing) economizers for feedwater preheating on process steam boilers with capacities of 10 million British thermal units per hour (MMBtu/h) or greater. The stack economizer would need to be designed for a stack temperature drop of 60°F or more at design condition.

The requirement would apply to all new process steam boilers, including replacement boilers and boilers in additions to existing facilities. Exceptions would apply for boilers with low stack temperatures, biomass-fired boiler systems, boilers using other forms of stack heat recovery, and certain indoor replacement boilers with limited roof clearance.

## **Benefits of Proposed Change**

Steam boilers lose a substantial share of input fuel energy as combustion exhaust heat. A stack economizer would recover a portion of this waste heat, reduce fuel consumption, lower boiler thermal stress, and support longer boiler useful life.

In addition, the proposed measure could reduce natural gas use and associated GHG emissions, and reduced fuel combustion can reduce local photochemical smog.

## **Compliance and Enforcement**

Compliance with this measure would be confirmed during permit application, installation, and inspection by the Authority Having Jurisdiction (AHJ) or building department alongside compliance confirmation of existing requirements for process boilers. To the knowledge of the Statewide CASE Team, the proposed compliance and enforcement steps for this measure are feasible and would not present a significant burden when training and education are provided to responsible parties.

New fields would be added to the Process Systems Certificate of Compliance form NRCC-PRC-E and Process System Certificate of Installation form NRCI-PRC-E, both of which already include fields for process boilers. No third-party verification is recommended, and no compliance software updates are identified.

## **Market Assessment**

The market for stack economizers is mature, with multiple manufacturers and suppliers providing a wide range of purchasing options. Boiler system manufacturers and vendors are familiar with the technology and confirmed the technical feasibility of the measure.

Based on interviews with boiler system vendors and field experience at industrial sites, the Statewide CASE Team estimates that natural market adoption of stack economizers for new process boilers in California increases with boiler size, ranging from 25 percent of the smallest qualifying boilers to 90 percent of the largest boilers. Exceptions are proposed for situations where feasibility or cost effectiveness may be reduced.

## Cost Effectiveness

The proposed code change is highly cost effective across applicable California climate zones and boiler sizes. Benefit-to-cost ratios<sup>1</sup> range from 3.4 to 23.1 depending on climate zone, boiler size, and annual operating hours.

Incremental first costs include purchase, design, installation, and compliance verification. Maintenance assumptions include a stack economizer replacement in year 15 and partial retubings in years 7 and 23.

While the use of a stack economizer would slightly increase the electricity usage of the boiler's combustion fan, the reduced cost and GHG emissions from natural gas savings vastly outweigh those from increased electricity.

## First-Year Statewide Impacts

Table 1: Summary of Statewide Impacts – Stack Economizers

Metric <sup>a</sup>	New Construction & Additions	Alterations	Total
Annual Electricity Savings (GWh)	-0.006	-0.016	-0.022
Peak Demand Reduction (MW)	-0.001	-0.002	-0.003
Annual Natural Gas Savings (Million Therms)	0.43	0.86	1.29
Annual Source Energy Savings (Million kBtu)	37.00	73.98	110.98
30-Year Long-term System Cost Savings (Million 2029 PV\$)	\$35.74	\$70.96	\$106.70
Annual Avoided GHG Emissions (Metric Tons CO <sub>2</sub> e/yr)	2,250	4,498	6,747

a. Values represent impacts from buildings permitted during the first year the code is in effect. Positive values indicate savings or reductions.

## Measure 2: Automatic Blowdown and Deaerator Pressure

### Proposed Code Change

This measure would add two requirements for newly installed process steam boilers with input capacities at or above 10 MMBtu/h. First, qualifying boilers would need an automatic surface blowdown controller programmed to operate based on conductivity. Second, for systems that use the boiler steam header to pressurize the deaerator, the steam supply line pressure regulator serving the deaerator would need to be set at or

<sup>1</sup> The benefit-to-cost ratio (BCR) compares benefits or cost savings to costs over the 30-year period of analysis. Proposed code changes with a BCR of 1.0 or greater are cost effective.

below 5 pounds per square inch gauge (psig), and between 2 and 5 psig for boilers with tubes not rated for oxidizing conditions.

The automatic blowdown requirement would include exceptions for boiler systems with returned condensate comprising more than 90 percent of feedwater flow, make-up water treated by reverse osmosis, and systems with blowdown heat recovery. The deaerator pressure requirement would include an exception for sites with make-up water swings equal to or above 20 percent of feedwater flow, as determined by the steam system designer.

## **Benefits of the Proposed Change**

Manual boiler blowdown can discharge more hot water than needed to remove solids from boiler water, resulting in unnecessary water, chemical, and energy losses. Automatic blowdown systems monitor conductivity and control blowdown more precisely, reducing excess blowdown, lowering make-up water needs, and helping maintain boiler efficiency over time.

The deaerator pressure requirement would address unnecessary steam venting from over-pressurization. Proper deaerator pressurization saves energy without requiring added equipment for end users. Together, the automatic blowdown and deaerator pressure requirements would reduce natural gas use, water use, GHG emissions, and local combustion-related air pollution.

## **Compliance and Enforcement**

Newly installed process boilers undergo plan review, installation verification, and inspection as part of the compliance process for existing boiler requirements. Compliance for this measure would also include plan review, installation verification, and inspection, and would introduce acceptance testing by a field technician. To support the proposed requirements, new fields would be needed in NRCC-PRC-E and NRCI-PRC-E forms, and a new Process Boilers NRCA-PRC-XX-F form would document the new acceptance tests.

The field technician would verify boiler blowdown controls and steam supply line pressure regulator settings. To the knowledge of the Statewide CASE Team, the proposed compliance and enforcement steps for this measure are feasible and would not present a significant burden when training and education are provided to responsible parties. No third-party verification is recommended.

## **Market Assessment**

Designers commonly include automatic blowdown systems in standard boiler system designs, and deaerators and steam supply line pressure regulators are standard boiler

system components. Automatic blowdown systems are widely available from multiple manufacturers and suppliers.

Based on interviews with boiler system stakeholders and field experience at industrial sites, the Statewide CASE Team estimates that automatic blowdown system adoption for new process boilers in California increases with boiler size, ranging from 25 percent of the smallest qualifying process boilers to 75 percent of the largest boilers. The deaerator pressure submeasure does not require equipment additions and is not expected to impact, or be impacted by market conditions.

## Cost Effectiveness

The proposed code change is cost effective across all applicable California climate zones. Benefit-to-cost ratios range from 5.5 to 228 for the automatic blowdown system submeasure and from 110 to 930 for the deaerator pressure submeasure, depending on climate zone, boiler size, and annual operating hours.

Automatic blowdown first costs include the costs of the controller, valve, conductivity probe, system installation, and acceptance testing. The only incremental cost of the deaerator pressure requirement is acceptance-testing labor, estimated at \$200, or one labor hour, per boiler.

## Statewide Impacts

**Table 2: Summary of Statewide Impacts – Automatic Blowdown and Deaerator Pressure**

Metric <sup>a</sup>	Automatic Blowdown	Deaerator Pressure	Total
<b>Annual Electricity Savings (GWh)</b>	-	-	-
<b>Peak Demand Reduction (MW)</b>	-	-	-
<b>Annual Natural Gas Savings (Million Therms)</b>	0.41	0.02	0.43
<b>Annual Source Energy Savings (Million kBtu)</b>	35.23	1.36	36.60
<b>30-Year Long-term System Cost Savings (Million 2029 PV\$)</b>	\$33.97	\$1.32	\$35.29
<b>Annual Avoided GHG (Metric Tons CO<sub>2</sub>e/yr)</b>	2,143	83	2,226

a. Values represent impacts from buildings permitted during the first year the code is in effect. Positive values indicate savings or reductions.

The automatic blowdown and deaerator pressure measure would also avoid 14,439,500 gallons of water use per year.

# Acronyms

Table 3 presents a list of acronyms used in this report. Title24stakeholders.com also maintains a [glossary of terms](#).

**Table 3: List of Acronyms**

Acronym	Definition
<b>ACM</b>	Alternative Calculation Method
<b>ADA</b>	Americans with Disabilities Act
<b>AHJ</b>	Authority Having Jurisdiction
<b>APCD</b>	Air Pollution Control District
<b>AQMD</b>	Air Quality Management District
<b>ASHRAE</b>	American Society of Heating, Refrigeration, and Air-Conditioning Engineers
<b>ASME</b>	American Society of Mechanical Engineers
<b>ATT</b>	Acceptance Test Technician
<b>BCR</b>	Benefit-to-cost Ratio
<b>BEA</b>	Bureau of Economic Analysis
<b>BEM</b>	Building Energy Modeling
<b>Btu</b>	British Thermal Units
<b>CALGreen</b>	California Green Building Standards Code
<b>Cal/OSHA</b>	California Division of Occupational Safety and Health
<b>CARB</b>	California Air Resources Board
<b>CASE</b>	Codes and Standards Enhancement
<b>CBSC</b>	California Building Standards Commission
<b>CBECC</b>	California Building Energy Code Compliance Software
<b>CBECC-Res</b>	California Building Energy Code Compliance for Residential Buildings Software
<b>CEC</b>	California Energy Commission
<b>CEQA</b>	California Environmental Quality Act
<b>CBO</b>	Community-Based Organization
<b>CO<sub>2</sub>e</b>	Carbon Dioxide Equivalent
<b>CPUC</b>	California Public Utilities Commission
<b>CSE</b>	California Simulation Engine
<b>CTF</b>	Conduction Transfer Functions
<b>CZ</b>	Climate Zone
<b>DAC</b>	Disadvantaged Community
<b>DGS</b>	California Department of General Services

Acronym	Definition
<b>DOAS</b>	Dedicated Outdoor Air System
<b>DOE</b>	Department of Energy
<b>DOSH</b>	Division of Occupational Safety and Health
<b>ECC</b>	Energy Code Compliance
<b>EIR</b>	Environmental Impact Report
<b>EPIC</b>	Electric Program Investment Charge
<b>ESJ</b>	Environmental and Social Justice
<b>EUL</b>	Effective Useful Life
<b>FGR</b>	Flue Gas Recirculation
<b>FRED</b>	Federal Reserve Economic Data
<b>FSOR</b>	Final Statement of Reasons
<b>GDP</b>	Gross Domestic Product
<b>GHG</b>	Greenhouse Gas
<b>GWh</b>	Gigawatt-Hour
<b>HVAC</b>	Heating, Ventilation, and Air Conditioning
<b>IAC</b>	Industrial Assessment Center
<b>IDF</b>	Input Data File
<b>IECC</b>	International Energy Conservation Code
<b>IOU</b>	Investor-Owned Utility
<b>IPGR</b>	Industrial Product Growth Rate
<b>ISOR</b>	Initial Statement of Reasons
<b>kBtu/yr</b>	Thousand British Thermal Units Per Year
<b>Kg/s</b>	Kilograms per Second
<b>kWh</b>	Kilowatt-Hour
<b>kWh/year</b>	Kilowatt-Hour Per Year
<b>LED</b>	Light Emitting Diode
<b>LMI</b>	Low- and Moderate-Income
<b>LPD</b>	Lighting Power Density
<b>LSC</b>	Long-term System Cost
<b>MeasureSET</b>	CASE Measure Savings Estimation Template
<b>MG</b>	Million Gallons of Water
<b>MMBtu</b>	Million British Thermal Units
<b>MMBtu/h</b>	Million British Thermal Units Per Hour
<b>NAICS</b>	North American Industry Classification System
<b>NOx</b>	Nitrogen Oxides
<b>NPDI</b>	Net Private Domestic Investment

<b>Acronym</b>	<b>Definition</b>
<b>NR</b>	Nonresidential
<b>NRCA</b>	Nonresidential Certificate of Acceptance
<b>NRCC</b>	Nonresidential Certificate of Compliance
<b>NRCI</b>	Nonresidential Certificate of Installation
<b>OEM</b>	Original Equipment Manufacturer
<b>PEP</b>	Public Engagement Plan
<b>ppmv</b>	Parts Per Million by Volume
<b>psig</b>	Pounds Per Square Inch Gauge
<b>PV</b>	Present Value
<b>RO</b>	Reverse Osmosis
<b>SCR</b>	Selective Catalytic Reduction
<b>SDD</b>	Standards Data Dictionary
<b>SOC</b>	Standard Occupational Classification
<b>SPMS</b>	Saturation Pressure Measurement Sensors
<b>SRIA</b>	Standardized Regulatory Impact Assessment
<b>TDS</b>	Total Dissolved Solids
<b>UL</b>	Underwriters Laboratories
<b>W</b>	Watt

# 1. Introduction

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## 1.1 Report Context

This proposal describes specific energy efficiency code changes (referred to as “measures”) aimed at reducing wasteful, uneconomic, inefficient, or unnecessary consumption of energy in California. These measures are submitted to the California Energy Commission (CEC) for consideration and potential inclusion in California’s Energy Code (Title 24, Part 6), which sets statewide energy efficiency requirements for newly constructed buildings and for additions and alterations to existing buildings. Measures may also be considered for inclusion in CALGreen (Title 24, Part 11) as voluntary energy efficiency standards, which would take effect only if adopted by a local jurisdiction seeking to exceed the minimum requirements of the Energy Code. Measures submitted to the CEC will be reviewed, may be modified, and may be incorporated into a broader regulatory package proposed and adopted by the CEC. To be included in the Energy Code, proposed measures must be both cost effective and technically feasible.

## 1.2 Proposal Sponsors

Three California Investor-Owned Utilities (IOUs)—Pacific Gas & Electric Company, San Diego Gas & Electric, and Southern California Edison jointly sponsored this effort. Where the term “Statewide CASE Team” is used in this report, it refers to the authors and State Building Codes Advocacy activities supported through the Codes and Standards program.

## 1.3 Stakeholder Engagement to Inform Proposal

When developing the code change proposal and associated technical information presented in this report, the Statewide CASE Team worked with or gathered feedback from many industry stakeholders including boiler manufacturers, sales representatives, maintenance and installation providers, consulting firms, the South Coast Air Quality Management District (AQMD), the San Joaquin Valley Air Pollution Control District, and others involved in the code compliance process. The proposal incorporates feedback received during two public stakeholder workshops that the Statewide CASE Team held on September 23, 2025 and February 17, 2026. Materials from the workshops are available at [Title24stakeholders.com](https://www.title24stakeholders.com) (Amoni, et al., Process Boiler #1: Non-Condensing Stack Economizer Requirement, 2025; Amoni, et al., Process Boiler #2: Conductivity-Based Blowdown & Deaerator Settings, 2025; Amoni, Presentation Slides, 2026).

The Statewide CASE Team engaged with multiple boiler manufacturers and representatives to learn more about current industry trends and practices across all the proposed measures. The Statewide CASE Team formally interviewed five boiler representatives from three organizations and received feedback from three additional representatives via email. Topics covered in the interviews included boiler lifespan and efficiency, and current industry practices related to blowdown, deaerator pressure, and stack economizers. Insights from these interviews were used to inform estimates for the current market share, incremental costs, and barriers to adoption of the proposed measures. The Statewide CASE Team shared specific details of the proposed measures, including planned measure exceptions and requirement thresholds, and received feedback from interviewees that was incorporated into the proposed code language. See Appendix E for details on the Statewide CASE Team’s stakeholder engagement.

## 1.4 Addressing Energy Equity and Environmental Justice

The Statewide CASE Team recognizes, acknowledges, and accounts for a history of prejudice and inequality in environmental and social justice (ESJ) communities.<sup>2</sup> These issues persist today. To minimize the risk of perpetuating inequity, code change proposals were developed with intentional consideration of the unintended consequences on ESJ communities.

When analyzing impacts for nonresidential buildings, the Statewide CASE Team reviewed each nonresidential building type through the lens of the four criteria: cost, health, resiliency, and comfort. The Statewide CASE Team examined which building types are used by ESJ communities most frequently and evaluated the allocation of impacts related to the following areas among all populations. Some building types have unique environmental justice concerns due to their common uses, location, or other factors.

The Statewide CASE Team will continue to build relationships with CBOs and other stakeholders to improve the identification of potential impacts for future code cycles and is open to additional resources that can contribute to this effort.

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<sup>2</sup> The CPUC refers to ESJ communities as “low-income or communities of color that have been underrepresented in the policy setting or decision-making process, are subject to a disproportionate impact from one or more environmental hazards, and likely to experience disparate implementation of environmental regulations and socio-economic investments in their communities” (CPUC 2022). ESJ communities also include the CPUC definition for Disadvantaged Communities, which comprises “(1) Census tracts receiving the highest 25 percent of overall scores in CalEnviroScreen 4.0 (1,984 tracts); (2) Census tracts lacking overall scores in CalEnviroScreen 4.0 due to data gaps, but receiving the highest 5 percent of CalEnviroScreen 4.0 cumulative pollution burden scores (19 tracts); (3) Census tracts identified in the 2017 DAC designation as disadvantaged, regardless of their scores in CalEnviroScreen 4.0 (307 tracts); and (4) Lands under the control of federally recognized Tribes (OEHHA 2022).

## 2. Stack Economizer

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### 2.1 Stack Economizer – Measure Description

#### 2.1.1 Proposed Code Change

A process boiler is a type of boiler with a capacity (rated maximum input) of 300,000 Btu per hour (Btu/h) or more that serves loads other than space conditioning and service water heating related to human occupancy. A 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.

This proposed code change would require boiler stack (non-condensing) economizers, designed for a stack temperature drop of 60°F or more across the boiler stack economizer at design condition, on process boilers with capacities of 10 million British thermal units per hour (MMBtu/h) or greater. Boiler feedwater must flow from the deaerator to the stack economizer and the stack economizer must not be bypassed. 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, at outlet of boiler or outlet of SCR system if present and connected to the boiler.
- Boiler systems designed to burn biomass<sup>3</sup> from facility processes or biomass produced from waste material produced at the facility, such as woody biomass, digester gas, landfill gas, and animal fat.
- Boilers that employ other forms of stack heat recovery, such as a heat exchanger that serves an industrial heat pump or process drying application.
- Indoor replacement boilers at existing facilities with roof clearances (distance between the boiler outlet connection to the stack and the ceiling or between the outlet of the SCR duct and the ceiling if the boiler is equipped with an SCR system) of less than:
  - 88 inches for boilers with an input capacity at or below 25 MMBtu/h.
  - 116 inches for boilers with an input capacity above 25 MMBtu/h.

This requirement is not expected to impact hotel/motel or nonresidential buildings with Group R occupancies because these building types will not house process steam boilers of qualifying size. Boilers used in oilfield production and municipal power

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<sup>3</sup> Has a dedicated line to the burner for biomass as specified. This does not include utility-supplied fuel that includes biomass.

generation are often not in buildings and therefore not expected to be within the scope of Title 24, Part 6. Table 4 summarizes the scope of the proposed code change.

**Table 4: Scope of Proposed Code Change.**

A  indicates the proposed code change is relevant.

Building Type(s)		Construction Type(s)		Type of Change	
<input type="checkbox"/> Single Family		<input checked="" type="checkbox"/> New Construction		<input checked="" type="checkbox"/> Mandatory	
<input type="checkbox"/> Multifamily		<input checked="" type="checkbox"/> Additions		<input type="checkbox"/> Prescriptive	
<input checked="" type="checkbox"/> Nonresidential (excluding Occupancy R uses)		<input checked="" type="checkbox"/> Alterations		<input type="checkbox"/> Performance	
Application Climate Zones	Energy Code Sections	Compliance Forms		Sections of ACM Reference Manuals	
Climate Zones 1-16	Part 6, Section 201 [Section 100.1(b)] and Section 904.1 [Section 120.6(d)]	NRCC-PRC-E, NRCI-PRC-E		N/A	
Third Party Verification			Updates to Compliance Software		
<input checked="" type="checkbox"/> No changes to third party verification			<input checked="" type="checkbox"/> No updates		
<input type="checkbox"/> Update existing verification requirements			<input type="checkbox"/> Update existing feature		
<input type="checkbox"/> Add new verification requirements			<input type="checkbox"/> Add new feature		

### 2.1.2 Benefits of Proposed Change

Most steam boilers lose 20 percent or more of their input fuel energy in the form of heat of the combustion exhaust (Rahman, 2011). A stack economizer can recover a significant fraction of this waste heat, reducing load and thermal stress on the boiler, lowering fuel consumption, and extending boiler useful life. The use of a stack economizer is typically the highest-impact action that sites can take to reduce their boiler natural gas usage, saving two to four percent of fuel energy by preheating boiler feedwater (Kramer, Masanet, Tengfang, & Worrell, 2009). A 2012 Department of Energy (DOE) steam tip sheet estimated that an economizer can reduce fuel requirements by five to ten percent and pay for itself in less than two years (Office of Industrial Technologies, Energy Efficiency and Renewable Energy, US Department of Energy, 1999).

This proposed code change can also achieve benefits, including job creation in the manufacturing and installation of stack economizers, as well as improved local air quality from reduction in burned fuel, which is typically natural gas. Many industrial facilities are located near Low- and Moderate-Income (LMI) housing, which

disproportionately experiences lower air quality. This proposal would also reduce photochemical smog in these communities.

### **2.1.3 Background Information**

A boiler stack economizer is an air-to-water heat exchanger consisting of tubes placed in the boiler exhaust stream. Boiler feedwater is run through the tubes and the hot boiler flue gas then pre-heats the boiler feedwater. Since the water enters the boiler at a higher temperature, the boiler requires much less fuel to heat the water to the desired temperature and pressure, increasing overall efficiency.

The use of boiler stack economizers has been listed in DOE literature as a best practice since at least 1999 (Office of Industrial Technologies, Energy Efficiency and Renewable Energy, US Department of Energy, 1999). Despite its cost-effectiveness, building owners and operators too often fail to implement the practice because of its initial cost and the general lack of awareness of the energy benefits. That said, boiler system vendors and contractors are familiar with this technology, and they ensure it is widely available. Further, stack economizers can be installed in various configurations, making them feasible in most facilities.

Title 24, Part 6 first adopted requirements for process boilers in 2013. To the knowledge of the Statewide CASE Team, boiler stack economizer requirements have not been proposed in previous code cycles. Multiple utilities in the United States offer incentives for boiler stack economizers, including SoCalGas in California (SoCalGas, 2025; Consumers Energy, 2025).

A design requirement for the stack economizer ensures that the installed stack economizer is cost-effective and saves energy. The Statewide CASE Team determined that a stack temperature drop of 60°F across the boiler stack economizer at design condition would be the minimum cost-effective stack temperature drop for qualifying boilers.

### **2.1.4 Modifications to Energy Code Documents**

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 2.6 of this report for detailed revisions to code language.

#### **2.1.4.1 Energy Code Change Summary**

##### **SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION**

**Subsection 201 [100.1(b)]:** The proposed measure would add new definitions for 1) boiler stack economizer, 2) biomass, and 3) selective catalytic reduction (SCR) system.

## **SECTION 900 – NONRESIDENTIAL, HOTEL/MOTEL, AND MULTIFAMILY OCCUPANCIES (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)**

### **SECTION 904 [Section 120.6] PROCESS BOILERS (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)**

#### **904.1 Mandatory requirements (Newly Constructed, Additions, Alterations).**

**904.1.4 [New section]:** The proposed measure would add a non-condensing stack economizer requirement for newly installed process boilers with an input capacity greater than 10 MMBtu/h (10,000,000 Btu/h), with exceptions for boilers with stack temperatures below 340°F at their lowest firing rate without an economizer, boilers that burn biomass, boilers employing other methods of stack heat recovery, and indoor replacement boilers with low roof clearance. This requirement would specify that the economizer shall be designed for a stack temperature drop of 60°F or more across the boiler stack economizer at design condition to cost-effectively increase the stringency of the Energy Code. To ensure savings are captured, this requirement would also specify that boiler feedwater must flow from the deaerator to the stack economizer. By minimizing the energy use of covered processes, the requirement would improve the state's economic and environmental health.

#### ***2.1.4.2 Reference Appendices Change Summary***

The proposed measure will not modify the reference appendices because there is no functional testing required for compliance verification.

#### ***2.1.4.3 Compliance Manuals Change Summary***

The proposed changes would include updates to Section 10.9.2 of the Nonresidential Compliance Manual, which outlines mandatory requirements for process boilers. A new section, 10.9.2.5, would be created to explain the stack economizer requirement and verification.

#### ***2.1.4.4 Alternative Calculation Method Reference Manual Change Summary***

The proposed measure will not modify Alternative Calculation Method (ACM) Reference Manuals because the proposed measure requires no associated software updates.

#### ***2.1.4.5 Compliance Forms Change Summary***

The existing Process System Certificate of Compliance form (NRCC-PRC-E, Section I: Process Boilers) would need updated input fields to capture the boiler capacity rating and compliance with the stack economizer requirement or any applicable exception. The Process System Certificate of Installation form (NRCI-PRC-E, Process Boilers) would need new input fields added to ensure that qualified boilers meet the stack

economizer requirement as described in the NRCC-PRC-E, and to record the stack economizer serial and model number.

## 2.1.5 Measure Context

### 2.1.5.1 *Comparable Model Codes or Standards*

Review found no relevant and comparable model codes or standards for context.

### 2.1.5.2 *Interactions with Other Regulations*

Review found no known existing federal, state, or local regulatory requirements that address process boiler stack economizers. Current Title 24, Part 6 requirements for process boilers cover combustion air positive shut-off, combustion air fans, and stack-gas oxygen concentrations. The proposed non-condensing stack economizer requirement discussed in this document would have no impact on these existing requirements.

Review finds no anticipated conflicts between these proposed requirements and the other proposed submeasures for process boilers, discussed in Section 3, which would require conductivity-based blowdown and steam supply line pressure regulator setpoints at or below 5 pounds per square inch of gauge pressure (psig).

## 2.2 Stack Economizer – Compliance and Enforcement

### 2.2.1 Compliance Considerations

When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and to mitigate negative or reduce negative impacts on the market actors involved in the process. The Statewide CASE Team believes that compliance and enforcement of the proposed measure are feasible and would not add a significant compliance or enforcement burden to those responsible for ensuring compliance with the building code.

To ensure compliance with the proposed stack economizer requirement, confirmation steps would need to be taken during permit application (plans review), installation, and inspection by the Authority Having Jurisdiction (AHJ) or building department. New fields in the Process Systems Certificate of Compliance Form NRCC-PRC-E and the Process System Certificate of Installation form NRCI-PRC-E would need to be completed.

**Designers.** Designers would need to be aware that requirements for process boilers in section 904.1 [120.6] have been expanded, enabling design compliant process boiler systems. They would need to fill out an updated NRCC-PRC-E form and to submit design documents indicating a compliant design, including planned installation of a stack economizer designed for a stack temperature drop of at least 60°F across the

boiler stack economizer at design condition and piping for boiler feedwater to reach the economizer or information indicating qualification for at least one requirement exception. For boilers pursuing an exception based on stack temperature, designers should coordinate with the boiler manufacturer to document the expected stack temperature at the boiler's lowest fire rate in the construction drawings. If a site plans to pursue an exemption for the use of biomass, the fuel line needs to be depicted and labeled in the construction documents. To qualify for the heat recovery exemption, the designer would need to ensure that the stack heat recovery equipment is included in the construction documents. For replacement boilers at existing facilities, the NRCC-PRC-E form may be completed by the plant engineering department or another party and must include the existing roof clearance at the boiler (distance between the boiler outlet connection to the stack and the ceiling or between the outlet of the SCR duct and the ceiling if the boiler is equipped with an SCR system). For replacement boilers to qualify for the stack temperature exception, biomass exemption, or heat recovery exemption, the same documentation requirements apply as for new installations. Specifically, designers must document the expected stack temperature at the boiler's lowest firing rate per the manufacturer in the construction documents, depict and label the biomass fuel line where applicable, and include stack heat recovery equipment in the construction documents. All applicable information must also be included in the NRCC-PRC-E.

**AHJ plan checkers.** During the permit application phase, AHJ plan checkers would review the submitted NRCC-PRC-E form and design documents to confirm that the design either includes a stack economizer in the design or qualifies for a claimed exception based on stack temperature, biomass use, alternative methods of heat recovery, or low roof clearance.

**Installation contractors.** Installation contractors would be required to correctly install stack economizers in accordance with design and manufacturing specifications, which their normal operating procedures already require. The installation contractors will document the installation in the NRCI-PRC-E form unless done by another party. When the installation contractor fills in the Certificate of Installation form, they would need to include the model and serial number for the stack economizer in addition to information on the process boiler that is already required.

**Field technicians.** Field technicians are typically the installers or technicians configuring the boiler system controls and are not certified Acceptance Testing Technicians (ATT). Field technicians may complete the stack economizer fields in the process boilers section of the NRCI-PRC-E form if the installation contractors do not complete them. For sites not claiming an exemption, field technicians should confirm that a stack economizer was installed, that the stack economizer is not bypassed, and that feedwater flows from the deaerator to the stack economizer.

**AHJ building inspectors.** In addition to the process boiler inspection items already required for a new boiler installation, the AHJ building inspector would need to verify in the NRCI-PRC-E form that a stack economizer was installed and is not bypassed, and that feedwater flows from the deaerator to the stack economizer.

Review finds that all definitions added for the new proposed code language do not conflict with any existing definitions in other parts of Title 24.

## 2.2.2 Impact on Market Actors

Table 5 summarizes actors and suggests outreach and education that might be helpful to support market actors as they prepare for the effective date of the requirements.

**Table 5: Impacts on Market Actors and Suggested Training and Education Opportunities**

Market Actor	Impact(s)	Suggested Outreach and Education
<b>Owner/ Operator<sup>a</sup></b>	<p>Be aware that stack economizers are required and plan for additional costs.</p> <p>Expect higher upfront cost and reduced energy bills.</p> <p>Expect to maintain the stack economizer when maintaining the boiler.</p> <p>May need to complete the NRCC-PRC-E form for replacement boilers at existing facilities.</p>	<p>Conduct outreach to owners to improve understanding of the benefits of stack economizers and address concerns.</p> <p>Additional training could reinforce the importance of water quality maintenance and stack economizer maintenance.</p>
<b>Design Professional<sup>b</sup></b>	<p>Be aware of new requirements, code triggers, and exceptions when designing process boiler systems.</p> <p>Include correctly-sized stack economizers in all process boilers system designs where required and include relevant specifications in design documents.</p> <p>Where an exception is claimed, ensure that all applicable supporting information is clearly documented in the construction documents and reflected in the NRCC-PRC-E.</p> <p>Complete new fields of NRCC-PRC-E Process Boilers section in addition to existing fields.</p>	<p>Provide industrial boiler equipment design firms with training on the energy code including compliance requirements and compliance documentation.</p>
<b>Construction Team<sup>c</sup></b>	<p>Install stack economizer as specified in the approved design documents, consistent with standard practice.</p> <p>Complete a new field in the process boilers section of NRCI-PRC-E.</p>	<p>Provide stack economizer/boiler system installers with training on the energy code updates and supporting documentation, compliance requirements, and compliance documentation.</p>

Market Actor	Impact(s)	Suggested Outreach and Education
<b>Building Department<sup>d</sup></b>	Plan reviewers would confirm that the NRCC-PRC-E and design documents include documentation on stack economizer installation or exception qualification as required and reflect compliance with the proposed requirements. Building inspectors would verify completion of the NRCI-PRC-E and compliant installation of the stack economizer in addition to existing process boilers requirements.	Provide education and training to local building department plans examiners to familiarize them with new code language.
<b>Verification Tester<sup>e</sup></b>	Because verification testing is performed by a field technician, see Construction Team.	N/A
<b>Manufacturers and Distributors</b>	Additional sales of stack economizers.	Additional training likely unnecessary.
<b>Air Quality Management Districts</b>	No anticipated impacts based on conversations with major AQMDs.	Provide information to California AQMDs to familiarize them with new code language.

- a. Owner/Operator is funding the project and is the primary decision maker.
- b. Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
- c. Construction team includes general contractors, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople.
- d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians, and third-party plan review and inspection.
- e. Verification testers include commissioning agents, Energy Code Compliance Raters, and Acceptance Test Technicians.

The [2028 CASE Methodology Report](#) includes more information on how changes to the California building code impact builders, building designers, and energy consultants. While the analysis in the methodology report is not specific to the code changes presented in this report, this measure focuses on industrial facility owners and operators, design and installation professionals, and building department representatives, since these market actors are expected to experience the most direct impacts from a requirement for stack economizers. This section provides a qualitative description of how this specific code change affects various market actors and additional quantitative analyses of its potential impacts on building industry subsectors.

**Building owners.** The proposed code change would have incremental costs and would reduce building owners' utility bills throughout the measure lifetime. See the [2028 CASE Methodology Report](#) for a description of how LSC savings relate to utility bill savings.

**Builders.** The proposed change would likely affect industrial builders; however, it would likely not impact firms focused on the construction or retrofitting of residential buildings, utility systems, or public infrastructure. The proposed change would not affect all firms and workers in the commercial and industrial building industries equally; instead, it would primarily affect specific subsectors within the industries. Table 6 shows the construction subsectors the Statewide CASE Team expects will be impacted by the changes proposed in this measure.

**Table 6: Specific Subsectors of the California Commercial and Industrial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)**

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions)
Industrial Building Construction	278	4,095	\$0.5
Nonresidential Structural Steel Contractors	365	11,899	\$1.1
Nonresidential Plumbing & HVAC Contractors	2,270	55,182	\$5.8
Other Nonresidential Equipment Contractors	580	9,749	\$1.1
Nonresidential Site Preparation Contractors	1,147	19,273	\$1.9
All Other Nonresidential Trade Contractors	948	17,084	\$1.7

Source: (State of California, n.d.)

\*An establishment is a single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods. <https://www.bls.gov/opub/hom/cew/concepts.htm>

**Manufacturers.** As discussed in Section 2.3.1, multiple manufacturers and installers of stack economizers are based in California, and these businesses would sell and install additional stack economizers. Refer to Section 2.3.4 for more information on the resultant impact on California jobs.

### 2.2.3 Compliance Software Updates

Review finds no compliance software updates required for this measure proposal.

### 2.2.4 Cost of Enforcement

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report is an evaluation of specific measures, and the collective

impact of all proposed changes for the 2028 Title 24, Part 6 may represent an increase in training and/or workload for enforcement personnel.

Enforcement costs will include costs to deliver training for enforcement officials to enable them to adequately enforce the proposed measure. This training can leverage current education programs to minimize expenses. Local governments will need to retrain building department staff; however, this practice aligns with the regular triennial code update cycle and is supported by resources such as Energy Code Ace.

The incremental cost of enforcement requirement additions is small, as Title 24, Part 6 already includes a plan review and inspection for the installation of new process boilers. During plan review, a plan checker would review the design and construction documents and the NRCC-PRC-E form to confirm that the stack economizer requirement is met or that a qualifying exception is properly documented. In doing so, the plan checker would ensure that the energy features and performance specifications, materials, components, and manufactured devices for the system design identified on the form conform to the requirements of Title 24, Part 1 and Part 6 of the California Code of Regulations and are consistent with the drawings and specifications.

During the construction inspection, a building inspector would review the NRCI-PRC-E form and ensure that the information on the form is consistent with the approved NRCC-PRC-E form and with what is actually installed.

## **2.3 Stack Economizer – Market and Economic Analysis**

### **2.3.1 Market Structure and Availability**

#### ***2.3.1.1 Current Market Structure and Availability***

The stack economizer market is composed of manufacturers, designers and engineers, suppliers and distributors, installers and contractors, and field technicians.

Manufacturers provide base designs for stack economizers integrated with boilers or sold separately. Designers and engineers work with manufacturers to select a correctly sized base stack economizer design and customize selections for specific site needs as necessary.

Suppliers and distributors provide parts and facilitate sales and logistics. They maintain an inventory of standard models and spare parts, manage procurement, and handle deliveries to the facility.

Installers and contractors install the physical equipment, work with field technicians to commission boiler systems, and tune the boiler operating setpoints so its performance meets design specifications, site requirements, and any regulatory requirements. Field technicians also complete required forms.

The market for stack economizers is mature, with multiple manufacturers and suppliers providing designers and contractors many options for purchase. Table 7 lists manufacturers, installers, and vendors that the Statewide CASE Team identified as major market actors.

**Table 7: Major Stack Economizer Manufacturers, Installers, and Vendors**

Company	Market Actor Type	Product Offering	Headquartered in California?
<b>Cain Industries</b>	Manufacturer	Stack economizers and integrated boiler and stack economizers	No
<b>California Boiler</b>	Manufacturer	Stack economizers and integrated boiler and stack economizers	Yes
<b>Cleaver-Brooks</b>	Manufacturer	Stack economizers and integrated boiler and stack economizers	No
<b>Energex Venting Design Solutions</b>	Vendor	Stack economizers	No
<b>Parker Boiler</b>	Manufacturer, Installer	Stack economizers and integrated boiler and stack economizers	Yes
<b>R.F. MacDonald</b>	Vendor	Stack economizers and integrated boiler and stack economizers	Yes

Boiler system manufacturers and vendors are familiar with stack economizer technology. Current market adoption rates are limited by a combination of initial capital cost and customer concerns about complexity. When purchasing a new boiler (or a replacement), many industrial buyers focus on minimizing the initial capital expenditure and fail to perform long-term cost analyses. Even when energy savings have relatively quick payback periods, industry still often prioritizes first costs (Energy Efficiency Movement, 2025). Some sites and their managers may be concerned about maintenance requirements for stack economizers or potential maintenance of additional components required to route feedwater through the stack economizer. Further, many system owners and operators may lack a deep understanding of the true fuel-saving potential and efficiency gains that stack economizers offer.

Site managers with larger boilers are more likely to include a stack economizer in their design strategy, as fuel savings potential increases with boiler capacity. In an interview with the Statewide CASE Team, one boiler vendor stated that economizers are economically justified for any boiler rated for several hundred horsepower or more.

Table 8 details the estimated current market adoption of stack economizers on newly installed boilers in California separated by boiler capacity. These market adoption

estimates were informed by stakeholder interviewees and a statewide boiler inventory of local AQMD boiler permits (Swanson & Staller, 2025). Larger boilers generally experience higher adoption rates due to the greater opportunity for fuel savings, which further improves cost-effectiveness of the stack economizer. The Statewide CASE Team anticipates that current market adoption will not change significantly without adoption of this measure but will slowly increase. One boiler manufacturer representative confirmed that adoption rates may be increasing as the fraction of newly sold boilers with integrated stack economizers is higher than they currently see in the field.

**Table 8: Estimated Current Stack Economizer Market Adoption in California**

Boiler Capacity	Estimated Stack Economizer Market Adoption
10-15 <sup>4</sup> MMBtu/h	25%
15-25 MMBtu/h	30%
25-50 MMBtu/h	40%
50-100 MMBtu/h	45%
100-200 MMBtu/h	50%
200+ MMBtu/h	90%

### 2.3.1.2 Market Challenges and Solutions

The stack economizer market is well-established, with dozens of vendors and suppliers with decades of experience procuring and installing stack economizers. The Statewide CASE Team reviewed several manufacturer websites to confirm the availability of stack economizers in the current market.

The Statewide CASE Team identified potential market adoption barriers to be 1) stack economizer first cost and 2) boiler fuel type. The incorporation of stack economizers in boiler design increases the first cost of a boiler system. In stakeholder interviews with boiler manufacturers and vendors, interviewees described that industrial sites look for payback periods as low as 18 months to justify an investment, so even measures with a three-year payback can be passed over on purely a cost basis. Many system owners and operators are also unaware of the energy-savings benefits associated with stack economizers and the extended boiler lifetime due to reduced thermal load, both of which justify the added cost of a stack economizer. The Statewide CASE Team recognizes that suppliers typically understand these benefits and expects these stakeholders to assist with the education of facility owners and the promotion of regulatory compliance. The Statewide CASE Team also identified that boilers that burn

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<sup>4</sup> All boiler capacity bins use an inclusive lower bound. For example, the 10-15 MMBtu/h bin means  $10 \leq \text{boiler capacity} < 15$ .

wood processing byproducts or other biomass would experience increased maintenance costs from stack economizers due to external fouling and residue these fuels deposit on the outside of economizer tubes. As such, the Statewide CASE Team has included a requirement exemption for these boilers. See Section 2.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

## **2.3.2 Design and Construction Practices**

### ***2.3.2.1 Current Design and Construction Practices***

Manufacturers provide two main types of stack economizers: condensing and non-condensing. Condensing economizers are more efficient because they condense water vapors in flue gas and capture both latent and sensible heat of combustion (Waldron R. , 2021). However, they are also more expensive, as the condensed water vapor is often acidic and requires economizers to be made of expensive, corrosion-resistant alloys (Waldron R. , 2021). Additional equipment is also required to manage the accumulation of the condensed water vapors.

Non-condensing economizers only recover sensible heat and do not condense any liquids in the flue gas. Therefore, manufacturers typically use carbon steel for both the tubes and fins (Jouhara, et al., 2018). While non-condensing economizers are not as efficient as condensing economizers, this proposed code change would require only non-condensing economizers to ensure the measure is cost-effective for all types of facilities, including smaller facilities and seasonal producers. Facility owners may choose to install a condensing economizer, and in doing so would qualify for Exception 3 to the proposed non-condensing stack economizer requirement.

The design and selection of a non-condensing stack economizer is driven by efficiency goals, feedwater conditions, and corrosion prevention. The most common design for maximizing heat transfer surface in a compact space is a finned-tube heat exchanger (also known as gilled-tube), but shell-and-tube heat exchangers are also used (Moynihan & Barringer, 2017). Shell-and-tube heat exchangers typically utilize a rectangular or cylindrical casing installed directly into the exhaust stack ducting. The cylindrical economizer is more compact and can thus be used on smaller boilers. The rectangular stack economizer can be installed in a horizontal or vertical orientation and is commonly used for larger boilers. Typically, the compact design of the cylindrical economizer requires the tubes to be welded in, whereas the rectangular economizer has replaceable tubes that can be more easily maintained (Nationwide Boiler Incorporated, 2019). As non-condensing economizers do not require corrosion-resistant materials, they must be sized and controlled to ensure that the flue gas temperature remains above the acid dew point—around 250°F for natural gas fuels—to prevent

acidic condensation (Reddy, Naidu, & Rangaiah, 2013). The economizer heats the boiler feedwater and is designed for pressurized operation to raise the water temperature toward the saturation point without flashing to steam.

A stack economizer should be sized for the maximum feedwater flow rate and designed to handle the system's pressure. Installation must ensure that the water pressure at the economizer outlet sufficiently prevents the water from flashing to steam within the tubes, which can cause flow instability and thermal stress. To comply with the proposed requirement, the installed stack economizers must be designed for a stack temperature drop of at least 60°F across the boiler stack economizer at design condition. As stack economizers are typically designed for 80°F to 100°F stack temperature drops, this component of compliance should not interfere with typical design practices. Best practices for installation include locating the economizer directly above the boiler's stack outlet when possible. When stack economizers are installed at boilers with SCR systems, the stack economizer should be installed downstream of the SCR system. Stack economizer designs usually include bypass valves to enable isolation of the economizer for emergencies. Stack economizers are not intended to be bypassed during normal operation, but temporary bypass or isolation may be necessary for maintenance, tube leaks, safety, or emergency conditions (Cain Industries, n.d.). Stack economizer data sheets include rated boiler capacities and full economizer dimensions.

The proposed requirement would not impact construction best practices, as respective market actors are accustomed to the technology and its various installations and applications. In new construction, the proposed requirement may necessitate larger overall boiler house footprints or increased stack height clearances. For replacement boilers in existing facilities, limited space in the boiler room may require custom and smaller-footprint designs or the use of cylindrical economizers that fit into the stack. The added pressure drop in the flue gas may necessitate a larger forced-draft or induced-draft fan to overcome the resistance of the economizer.

### **2.3.2.2 Health and Safety Considerations**

The proposed code change does not impact any existing regulations pertaining to health and safety. Compliance with this code change would reduce local photochemical smog and improve air quality by reducing boiler fuel consumption and emissions. Reduced stack exhaust temperatures could lower the boiler's plume loft, which mainly consists of CO<sub>2</sub> and water vapor. However, the impact will be minimal for most

qualifying boilers<sup>5</sup> and the dispersed concentrations are not anticipated to directly impact the health or safety of local residents. An interviewee from a major California AQMD told the Statewide CASE Team that they were not aware of any issues arising from stack temperatures affecting plume dynamics. In addition, the Statewide CASE Team has extensive field engineering and utility program experience with steam boiler systems in California and has not encountered issues of insufficient plume dispersion due to installation of stack economizers.

### **2.3.2.3 Design and Construction Challenges and Solutions**

See Table 5 in Section 2.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

The Statewide CASE Team has identified two main design and construction challenges: 1) stack economizer tube fouling and 2) facility space constraints.

Non-condensing stack economizers are typically low maintenance as they have no moving parts. However, poor water quality management causes stack economizer fouling through the same mechanisms as boiler tube fouling, where scale deposits occur when dissolved solids react to form a continuous layer of material on the waterside of the heat exchange tubes. Scale typically has a thermal conductivity that is an order of magnitude lower than that of bare steel, so even thin layers of scale reduce heat transfer (US Department of Energy, 2012). Proper water quality management practices would minimize stack economizer and boiler degradation, maintain boiler efficiency, minimize unplanned downtime, and avoid the cost of boiler and economizer full tube replacements. Although stack economizers degrade at a slower rate than boilers, fouling rates can be significant and facilities managers need to address them during planned maintenance outages for boilers. Facilities occasionally neglect stack economizer maintenance due to a lack of planning or an overall desire to reduce maintenance cost and downtime. In such cases, the operator would likely bypass the stack economizer and render it inactive. This practice leads to a reduction in boiler efficiency and an increase in fuel consumption, as recoverable heat is expelled through the stack. To address this challenge, facilities would need to plan effectively for stack economizer maintenance cost and downtime. Maintenance costs and downtime may be minimized by scheduling cleaning and retubing of the boiler and stack economizer simultaneously.

Additional conditions that increase the risk of stack economizer fouling and failure include boilers with low stack temperatures and boilers burning biomass. To maintain a

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<sup>5</sup> Using the FAA plume turbulence risk assessment guidebook and equations, the Statewide CASE Team calculated changes to plume loft at a boiler with an estimated minimum stack outlet temperature of 250°F and found that the plume loft should still avoid impacting local air quality across typical ambient air temperatures.

temperature above a condensation or acid dewpoint, the boiler stack temperature should be at or above 250°F downstream of the economizer. The Statewide CASE Team estimated a stack economizer temperature drop of 80 to 100 degrees, depending on the boiler capacity. Therefore, the Statewide CASE Team selected 340°F as a safe minimum stack temperature at lowest fire to eliminate water vapor and acid condensation in the stack. While a smaller stack economizer with a lower temperature drop may be installed at stack temperatures of 340°F or below, the installation has a higher risk of condensation and lower cost-effectiveness.

While most process boilers burn natural gas, some facilities may choose to use alternative fuel sources, such as wood processing byproducts or other biomass. The ash generated when burning many of these fuels builds up on the flue gas side of the stack economizer tubes and requires additional, frequent maintenance to address and maintain heat transfer.

For these reasons, the Statewide CASE Team included measure exceptions for boilers with stack temperatures below 340°F at their lowest firing rate without an economizer, and for boiler systems designed to burn biomass<sup>6</sup> from facility processes or biomass produced from waste material produced at the facility.

Facilities may also experience space constraints when required to install an economizer when replacing a boiler that previously did not have a stack economizer or when adding a boiler at an existing facility. As described in Section 2.3.2, manufacturers offer multiple economizer designs that can be installed in different orientations to address this challenge. Facilities can work with designers to determine the best solution for their space constraints while complying with the proposed requirement. In certain cases, facilities may not have the required amount of space for a stack economizer installation in the boiler room and would therefore be required to install the stack economizer on the roof. Roof installations may require structural work to support the additional weight, which can significantly increase installation costs. To ensure measure cost-effectiveness, the Statewide CASE Team included an exception to the proposed measure requirement for boilers at sites that would likely require roof installation. To determine the clearance required for stack economizer installation, the Statewide CASE Team spoke to a prominent stack economizer manufacturer about stack economizer dimensions and space requirements for installation. The manufacturer described that they typically need the clearance between the bottom of the stack and the roof to be at least one foot greater than the height of the economizer. As a conservative assumption, the Statewide CASE Team added three feet to the estimated stack economizer heights for large and small boilers and used that clearance to set a minimum roof clearance for requirement qualification. Boilers with planned SCR systems should measure the roof

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<sup>6</sup> Has a dedicated line to the burner for biomass as specified. This does not include utility-supplied fuel that includes biomass.

clearance required for a stack economizer as the distance between the outlet of the SCR duct and the ceiling.

The Statewide CASE Team considered including an exception for boilers that are designated as low use through AQMD permitting. After discussions with representatives from two AQMDs, the Statewide CASE Team decided not to include a low use exception, as this designation is rarely used and is reserved for pre-existing boilers and not newly installed boilers. Additionally, low-use boiler exception to the proposed stack economizer requirement could enable boilers to be initially permitted as low-use and later re-permitted for regular operation without triggering the Title 24 compliance process, which would complicate verification.

### **2.3.3 Energy Equity and Environmental Justice**

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the [2028 CASE Methodology Report](#).

The Statewide CASE Team does not expect any impact on the health and safety of ESJ communities, or on their disaster preparedness. The comfort of ESJ communities is unlikely to be impacted by the proposed code changes.

The use of stack economizers in boiler systems would reduce boiler fuel consumption and avoid the associated emissions from burning fuel. The value of improved air quality from the proposed code changes is augmented by the fact that industrial facilities are disproportionately located near ESJ communities and Low- and Moderate-Income (LMI) housing. As a result, the Statewide CASE Team expects that ESJ communities may experience a disproportionate air quality improvement from this proposed measure.

### **2.3.4 Impacts on Jobs and Businesses**

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy from this proposed measure. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team anticipates that the proposed change would directly and indirectly affect statewide employment and economic output through its impact on builders, designers, energy consultants, and building inspectors. Table 9, Table 10, and Table 11 outline the statewide implications for these job categories. For more information on the Statewide CASE Team's economic impacts methodology, see the [2028 CASE Methodology Report](#).

The Statewide CASE Team does not anticipate that the proposed changes would lead to the creation of new types of jobs or the elimination of existing types of jobs. In other words, the Statewide CASE Team's proposed change would not result in economic

disruption to any sector of the California economy. Rather, it would lead to modest changes in the employment of existing jobs.

**Table 9: Estimated Impact that Adoption of the Proposed Measure would have on the California Nonresidential Construction Sector**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by Commercial Builders)</b>	53.3	\$4,238,696	\$6,381,783	\$13,808,235
<b>Indirect Effect (Additional spending by firms supporting Commercial Builders)</b>	31.1	\$2,450,155	\$4,206,375	\$7,364,187
<b>Total Economic Impacts</b>	<b>84.4</b>	<b>\$6,688,851</b>	<b>\$10,588,157</b>	<b>\$21,172,422</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.<sup>7</sup>

**Table 10: Estimated Impact that Adoption of Proposed Measure would have on California Building Designers and Energy Consultant Sectors**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by building designers and energy consultants)</b>	0.14	\$15,530	\$15,375	\$24,301
<b>Indirect Effect (Additional spending by firms supporting building designers and energy consultants)</b>	0.06	\$4,624	\$6,427	\$10,345
<b>Total Economic Impacts</b>	<b>0.20</b>	<b>\$20,154</b>	<b>\$21,801</b>	<b>\$34,647</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

**Table 11: Estimated Impact that Adoption of the Proposed Measure would have on California Building Inspectors**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by building inspectors)</b>	0.015	\$1,687	\$2,000	\$2,430

<sup>7</sup> IMPLAN® model, 2020 Data, IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 [www.IMPLAN.com](http://www.IMPLAN.com)

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Indirect Effect (Additional spending by firms supporting building inspectors)</b>	0.002	\$156	\$243	\$424
<b>Total Economic Impacts</b>	<b>0.017</b>	<b>\$1,843</b>	<b>\$2,243</b>	<b>\$2,854</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment, which is not expected to excessively burden or competitively disadvantage California businesses, nor is it expected to lead to a competitive advantage for California businesses. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state.<sup>8</sup> Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have advantageous or an adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on business income. The Statewide CASE Team’s IMPLAN modeling resulted in an estimated \$1,460,423 increase in California business income due to the proposed code change. The Statewide CASE Team assumed that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.<sup>9</sup>

To estimate the portion of business income that will be allocated to net investment, the Statewide CASE Team analyzed national data on corporate profits and capital investment by businesses that expand a firm’s capital stock (referred to as net private domestic investment, or NPDI).<sup>10</sup> As Table 12 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID-19 pandemic, to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the

<sup>8</sup> Gov. Code, §§ 11346.3(c)(1)(C), 11346.3(a)(2); 1 CCR § 2003(a)(3) Competitive advantages or disadvantages for California businesses currently doing business in the state.

<sup>9</sup> 23 percent of proprietor income was assumed to be allocated to net business investment; see Table 12.

<sup>10</sup> Net private domestic investment is the total amount of investment in capital by the business sector that is used to expand the capital stock, rather than maintain or replace due to depreciation. Corporate profit is the money left after a corporation pays its expenses.

proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of incremental income that business owners would reinvest into expanding their capital stock.

**Table 12: Net Private Domestic Investment and Corporate Profits, U.S.**

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	\$389	\$2,212	18%
2021	\$545	\$2,888	19%
2022	\$825	\$2,951	28%
2023	\$836	\$3,069	27%
2024	\$885	\$3,441	26%
<b>5-Year Average</b>	-	-	<b>23%</b>

Source: (Federal Reserve Economic Data (FRED) n.d.)

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in a \$342,818 increase in net private investment by California businesses.

### **2.3.5 Economic and Fiscal Impacts**

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California’s economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team’s economic and fiscal impacts methodology, see the [2028 CASE Methodology Report](#).

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by or on industrial contractors, energy consultants, and building inspectors. The Statewide CASE Team does not anticipate that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

#### **2.3.5.1 Effects on the State General Fund, State Special Funds, and Local Governments**

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California’s General Fund, any state special funds, or local government funds.

**Cost to State:** The state government already has a budget for code development, education, and compliance enforcement. While the state government would be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. State buildings do not typically operate process boilers of qualifying size and so would not be directly impacted by this proposed measure.

**Cost to Local Governments:** All proposed code changes to Title 24, Part 6 would result in changes to compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2028 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining every time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training, and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in Section 3, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

#### ***2.3.5.2 Mandates on Local Agencies or School Districts***

There are no relevant mandates to local agencies or school districts because local agencies and schools do not typically operate process boilers of qualifying size.

#### ***2.3.5.3 Costs to Local Agencies or School Districts***

There are no costs to local agencies or school districts because local agencies and schools do not typically operate process boilers of qualifying size.

#### ***2.3.5.4 Costs or Savings to Any State Agency***

There are no costs or savings to any state agencies because local agencies do not typically operate process boilers of qualifying size.

#### ***2.3.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies***

There are no added non-discretionary costs or savings to local agencies because local agencies do not typically operate process boilers of qualifying size.

### **2.3.5.6 Costs or Savings in Federal Funding to the State**

The Statewide CASE Team did not identify any costs or savings to federal funding provided to the state.

## **2.4 Stack Economizer – Cost Effectiveness**

### **2.4.1 Cost Effectiveness Methodology**

The Statewide CASE Team collaborated with CEC staff to confirm that the cost-effectiveness methodology aligns with CEC guidelines, including cost-inclusion parameters. The [2028 CASE Methodology Report](#) and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its Benefit-Cost Ratio (BCR) is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on Long-term System Cost (LSC), which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, with peak-demand hours are valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. The CEC develops and publishes LSC hourly conversion factors for each code cycle.

Evaluation of costs includes both initial costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code.

### **2.4.2 Energy and Energy Cost Savings Results**

The Statewide CASE Team completed an energy savings analysis for the proposed stack economizer requirement, calculating the difference in energy consumption between the baseline (a boiler without a stack economizer) and measure (a boiler with a non-condensing stack economizer) case. Savings result from improved boiler combustion efficiency due to the economizer using recovered heat to increase the temperature of boiler feedwater, and were calculated using the following steps:

1. Calculate the measure case boiler combustion efficiency using the American Society of Mechanical Engineers (ASME) PTC-4 Indirect Method: Stack Loss Method.<sup>11</sup>

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<sup>11</sup> An explanation of the ASME PTC-4 Indirect Method: Stack Loss Method can be found at: [ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/boiler\\_efficiency\\_calc.pdf](http://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/boiler_efficiency_calc.pdf)

2. Calculate annual boiler load from baseline annual gas consumption and baseline boiler efficiency.
3. Given that the annual boiler load is the same for the baseline and measure cases, calculate the measure case annual boiler gas consumption from the annual boiler load and the measure case boiler efficiency.
4. Calculate the difference between the baseline and measure case gas consumption to arrive at the measure's energy savings.

Natural gas savings from this measure will increase as boiler capacity and stack economizer size increase. This correlation occurs because more heat traveling through the boiler stack leads to greater heat recovery, offsetting feedwater heating energy. The longer the boiler is operated, the greater the savings. As such, boilers that operate infrequently throughout the year due to seasonal loads will experience lower savings. Due to this variance, the Statewide CASE Team calculated annual energy savings and cost-effectiveness for boilers with seasonal loads separately from boilers with more typical annual loads. 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 & Staller, 2025). Industrial boilers may operate more than 6,500 annual hours, making the collective prototypes a conservative representation of boiler operating hours.

To calculate energy savings, the Statewide CASE Team estimated an 80°F stack economizer temperature drop in the stack exhaust for boilers between 10 and 25 MMBtu/h and a 100°F temperature drop for boilers at or above 25 MMBtu/h. The Statewide CASE Team believes that both the estimated temperature drops of 80°F for smaller process boilers and 100°F for larger process boilers are slightly conservative based on field experience.

The Statewide CASE Team calculated energy savings separately for boilers equipped with SCR systems and those without, which operate with different stack oxygen concentrations. Estimates of new process boiler capacity in California expected to be installed with SCR systems were based on data from California's San Joaquin Valley Air Pollution Control District and are shown in Table 13. The Statewide CASE Team then applied a weighted average of the savings associated with each boiler type to determine the overall per-unit energy savings for each boiler capacity bin. More detail on the assumptions used to estimate energy savings are outlined in Appendix A.

**Table 13. Estimated SCR System Market Adoption in Newly Installed Process Boiler Capacities in California**

<b>Boiler Capacity</b>	<b>Estimated SCR System Market Adoption</b>
<b>10-15 MMBtu/h</b>	20%
<b>15-25 MMBtu/h</b>	50%
<b>25-50 MMBtu/h</b>	75%
<b>50-100 MMBtu/h</b>	75%
<b>100-200 MMBtu/h</b>	75%
<b>200+ MMBtu/h</b>	75%

The persistence of energy savings depends on occupant behavior. Energy savings will diminish gradually over time as the stack economizer fouls, and the fouling rate increases with poor water treatment practices. The Statewide CASE Team accounted for economizer retubing costs halfway through the stack economizer lifetime, which should eliminate the impact of previous fouling and maintain savings throughout the 15-year stack economizer lifetime. When the stack economizer fouls, boiler operators may elect to bypass the stack economizer rather than retubing it. If the stack economizer is bypassed, the energy savings would drop to zero at that time. However, the cost-effectiveness of the measure would not be impacted because a stack economizer replacement in year 15 is included in the cost-effectiveness analysis.

While a stack economizer has no dedicated pump or fan, use of a stack economizer would slightly increase the energy usage of the combustion fan, which would have to run at a higher speed to overcome the pressure drop of the economizer. As feedwater pumps use valves to control the boiler feedwater level, the economizer would have a negligible impact on feedwater pump energy usage.

The Statewide CASE Team used these calculated savings to arrive at the savings per MMBtu/h of boiler capacity for each boiler size bin. As shown in Table 14, per-unit savings for the stack economizer measure in the first year range from 64,900 to 75,900 thousand British thermal units (kBtu) per MMBtu/h of boiler capacity for boilers operated year-round and 48,300 to 56,500 kBtu per MMBtu/h of boiler capacity for boilers operated seasonally. Table 15 shows the first-year per-unit increase in electricity consumption associated with stack economizers, which ranges from 5 to 74 kilowatt-hours (kWh) across year-round and seasonal boilers in the various size bins. The per-unit energy impacts of this measure do not differ by climate zone and remain the same for new construction, additions, and alterations. Although the first-year savings are independent of climate zone, the LSC factors vary by climate zone. Table 16 presents total per-unit energy cost savings for newly added boilers in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV\$) for year-round and seasonal boilers in the various size bins by climate zone.

**Table 14: First Year Natural Gas Savings (kBtu) Per MMBtu/h of Boiler Capacity -- Stack Economizer**

<b>Boiler Category</b>	<b>First Year Natural Gas Savings (kBtu)</b>
Year-Round 10-15 MMBtu/h	69,400
Year-Round 15-25 MMBtu/h	64,900
Year-Round 25-50 MMBtu/h	75,900
Year-Round 50-100 MMBtu/h	75,900
Year-Round 100-200 MMBtu/h	75,900
Year-Round 200+ MMBtu/h	75,900
Seasonal 10-15 MMBtu/h	51,700
Seasonal 15-25 MMBtu/h	48,300
Seasonal 25-50 MMBtu/h	56,500
Seasonal 50-100 MMBtu/h	56,500
Seasonal 100-200 MMBtu/h	56,500
Seasonal 200+ MMBtu/h	56,500

**Table 15. First Year Electricity Savings (kWh) Per MMBtu/h of Boiler Capacity – Stack Economizer**

<b>Boiler Category</b>	<b>First Year Electricity Savings (kWh)</b>
Year-Round 10-15 MMBtu/h	-5
Year-Round 15-25 MMBtu/h	-5
Year-Round 25-50 MMBtu/h	-9
Year-Round 50-100 MMBtu/h	-9
Year-Round 100-200 MMBtu/h	-13
Year-Round 200+ MMBtu/h	-13
Seasonal 10-15 MMBtu/h	-28
Seasonal 15-25 MMBtu/h	-26
Seasonal 25-50 MMBtu/h	-49
Seasonal 50-100 MMBtu/h	-49
Seasonal 100-200 MMBtu/h	-74
Seasonal 200+ MMBtu/h	-74

**Table 16: Total 30-Year LSC Savings (2029 PV\$) Per MMBtu/h of Boiler Capacity – Stack Economizer**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	57,482	57,482	57,482	57,482	57,482	58,178	58,007	58,178	58,179	58,178	57,482	57,482	57,482	58,178	58,179	58,179
<b>Year-Round 15-25 MMBtu/h</b>	53,755	53,755	53,755	53,755	53,755	54,407	54,246	54,407	54,407	54,407	53,755	53,755	53,755	54,407	54,407	54,407
<b>Year-Round 25-50 MMBtu/h</b>	62,836	62,836	62,836	62,836	62,836	63,598	63,411	63,598	63,599	63,598	62,836	62,836	62,836	63,598	63,598	63,599
<b>Year-Round 50-100 MMBtu/h</b>	62,836	62,836	62,836	62,836	62,836	63,598	63,411	63,598	63,599	63,598	62,836	62,836	62,836	63,598	63,598	63,599
<b>Year-Round 100-200 MMBtu/h</b>	62,797	62,798	62,798	62,797	62,798	63,560	63,372	63,560	63,560	63,560	62,798	62,797	62,798	63,559	63,560	63,560
<b>Year-Round 200+ MMBtu/h</b>	62,797	62,798	62,798	62,797	62,798	63,560	63,372	63,560	63,560	63,560	62,798	62,797	62,798	63,559	63,560	63,560
<b>Seasonal 10-15 MMBtu/h</b>	37,746	37,744	37,752	37,737	37,734	37,789	37,774	37,774	37,772	37,771	37,734	37,731	37,731	37,769	37,786	37,779
<b>Seasonal 15-25 MMBtu/h</b>	35,264	35,263	35,270	35,256	35,253	35,304	35,290	35,291	35,289	35,287	35,253	35,250	35,250	35,285	35,302	35,295
<b>Seasonal 25-50 MMBtu/h</b>	41,076	41,072	41,086	41,059	41,055	41,116	41,095	41,090	41,086	41,083	41,054	41,049	41,049	41,080	41,110	41,099
<b>Seasonal 50-100 MMBtu/h</b>	41,076	41,072	41,086	41,059	41,055	41,116	41,095	41,090	41,086	41,083	41,054	41,049	41,049	41,080	41,110	41,099
<b>Seasonal 100-200 MMBtu/h</b>	40,842	40,837	40,857	40,818	40,811	40,874	40,849	40,835	40,830	40,825	40,811	40,803	40,802	40,820	40,866	40,848
<b>Seasonal 200+ MMBtu/h</b>	40,842	40,837	40,857	40,818	40,811	40,874	40,849	40,835	40,830	40,825	40,811	40,803	40,802	40,820	40,866	40,848

### **2.4.3 Incremental First Cost**

The Statewide CASE Team evaluated the incremental cost for stack economizers using a boiler without a stack economizer as a baseline. The incremental first cost for this measure includes the purchase of the stack economizer and the cost of its design, installation, and compliance verification. Stack economizers at small process boilers do not require additional design labor, but installations at large boilers may slightly increase design time to account for additional ductwork. Stack economizer installation costs can vary widely depending on where the stack economizer is installed. Indoor installations are much costlier than outdoor installations, and their specific cost and complexity depends on the unique dimensions of the indoor space. The proposed measure includes an exception for newly installed indoor replacement boilers at existing facilities without much space between boiler stack outlet and the ceiling, as the cost of stack economizer installations at these sites may be too high to ensure measure cost-effectiveness.

Given the high variance of installation costs, the Statewide CASE Team estimated total incremental first costs by boiler capacity without separating equipment, installation, and commissioning costs. The total incremental first costs were estimated based on anonymized data from four sites that completed work with Cascade Energy, which included stack economizer purchase and installation costs from December 2023 through November 2024. The labor costs of stack economizer installation ranged from 33 percent to 60 percent of the total cost. In addition, two large boiler vendors provided estimates for the total cost of stack economizer installation, inclusive of labor and materials, in June 2025 and April 2026. In September 2025, a boiler vendor confirmed that the Statewide CASE Team's total cost estimates were reasonable, and no stakeholders raised concerns with the total first costs when they were presented at a public meeting or included in the Draft CASE Report. The additional costs of commissioning and design are included in the labor estimates and are typically less than one percent of the total measure cost.

Costs of stack economizer equipment and installation increase with boiler capacity. Stack economizer incremental costs are not expected to change significantly over time. The incremental first costs for equipment and installation are shown in Table 17.

**Table 17: Process Boiler Non-Condensing Stack Economizer Incremental First Costs by Boiler Capacity**

<b>Boiler Capacity</b>	<b>Stack Economizer Total First Cost</b>
<b>10-15 MMBtu/h</b>	\$68,000
<b>15-25 MMBtu/h</b>	\$98,000
<b>25-50 MMBtu/h</b>	\$150,000
<b>50-100 MMBtu/h</b>	\$242,000
<b>100-200 MMBtu/h</b>	\$443,000
<b>200+ MMBtu/h</b>	\$1,191,000

#### **2.4.4 Incremental Maintenance and Replacement Costs**

Incremental maintenance costs include the incremental cost of replacing the equipment or parts of the equipment, as well as periodic maintenance required to keep the equipment operating relative to current practices over the 30-year period of analysis. A description of the incremental maintenance and replacement costs and estimation of present value of maintenance and replacement costs are provided in the [2028 CASE Methodology Report](#).

The maintenance cost for stack economizers includes a full economizer replacement in year 15 and a partial tube replacement in year 7 and year 23. The stack economizer effective useful lifetime of 15 years was obtained from the California Electronic Technical Resource Manual guidance for Industrial Steam Boiler Economizers (California Electronic Technical Resource Manual, 2024). The stack economizer full replacement cost was estimated to equal the first cost, whereas partial tube replacement cost was estimated at 20 percent of the first cost. A boiler vendor provided guidance on the average frequency and cost of stack-economizer tube replacements in September 2025. Because the practices for stack economizer tube replacement are similar to practices for boiler tube replacements, the same technicians would conduct both.

Failure to replace fouled or failed stack economizer tubes would reduce boiler system efficiency by requiring higher firing rates, and therefore higher gas consumption, to maintain the same steam output. This practice would thus adversely impact measure energy savings. Proper commissioning practices need to be used to ensure the stack economizer is placed back in service after maintenance and not left in bypass. Appropriate water-quality management practices would significantly improve energy savings between maintenance periods for stack-economizer and boiler tubes.

## 2.4.5 Cost Effectiveness

As described in Section 2.4.3, to validate stack economizer costs, the Statewide CASE Team requested and received an estimate for the equipment and installation costs of a specific size of stack economizer from a large boiler vendor in June 2025. In addition, the vendor separately confirmed in September 2025 that the cost estimates used in preliminary stack economizer simple payback calculations were reasonable.

The Statewide CASE Team evaluated per-unit cost-effectiveness for both year-round operation and seasonal boilers at six boiler capacities to ensure cost-effectiveness of the proposed requirement for boilers with lower annual operating hours and across the size range covered by the proposed measure. Table 18 shows the boiler capacity bin ranges and the average capacity of the boilers within each bin which were used to perform the cost-effectiveness calculations. 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 & Staller, 2025) and described in more detail in Appendix C. Boilers not subject to Title 24 or the proposed measure were removed prior to determining the average capacity as described in more detail in Section 2.5.1.

Interviewed stakeholders reiterated that the payback of boiler stack economizers varies significantly with boiler capacity, and installing stack economizers on small boilers likely will not be cost effective. In response to this information and after running initial cost-effectiveness calculations, the Statewide CASE Team raised the minimum boiler capacity for the proposed requirement from 5 MMBtu/h to 10 MMBtu/h.

**Table 18: Process Boiler Capacity Bins**

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

The Statewide CASE Team also evaluated the proposed measure's cost-effectiveness when the boiler steam header pressure was set to 15 psig rather than 100 psig to account for sites with lower steam header pressures. With the lower pressure, savings decreased by 13.2 percent and the measure remained cost effective.

As neither costs nor savings differ between new construction, additions, and alterations, cost effectiveness was not evaluated by project type.

Results of the per-unit cost-effectiveness analyses are presented in Table 19 and Table 20. The proposed measure saves money over the 30-year period of analysis relative to the existing conditions and is cost effective for both annual and seasonal boilers in each capacity bin and climate zone.

In Table 19 below, all values are presented in 2029 present value dollars (2029 PV\$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if the proposed residual value is greater than current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the BCR is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is considered infinite. A BCR of “NA” indicates that there is no boiler capacity in that climate zone that would be impacted by the proposed requirement.

**Table 19: 30-Year Cost-Effectiveness Summary Per MMBtu/h of Boiler Capacity -- Stack Economizer**

<b>Boiler Category</b>	<b>Benefits LSC Savings + Other PV Savings (2029 PV\$)</b>	<b>Costs Total Incremental PV Costs (2029 PV\$)</b>	<b>Benefit- to-Cost Ratio</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	\$57,834	\$10,800	5.4
<b>Year-Round Boiler 15-25 MMBtu/h</b>	\$54,080	\$9,830	5.5
<b>Year-Round Boiler 25-50 MMBtu/h</b>	\$63,159	\$8,769	7.2
<b>Year-Round Boiler 50-100 MMBtu/h</b>	\$62,880	\$6,495	9.7
<b>Year-Round Boiler 100-200 MMBtu/h</b>	\$62,981	\$5,904	10.7
<b>Year-Round Boiler 200+ MMBtu/h</b>	\$63,328	\$3,070	20.6
<b>Seasonal Boiler 10-15 MMBtu/h</b>	\$37,757	\$10,800	3.5
<b>Seasonal Boiler 15-25 MMBtu/h</b>	\$35,273	\$9,830	3.6
<b>Seasonal Boiler 25-50 MMBtu/h</b>	\$41,072	\$8,769	4.7
<b>Seasonal Boiler 50-100 MMBtu/h</b>	\$41,054	\$6,495	6.3
<b>Seasonal Boiler 100-200 MMBtu/h</b>	\$40,818	\$5,904	6.9
<b>Seasonal Boiler 200+ MMBtu/h</b>	\$40,832	\$3,070	13.3

**Table 20: Benefit-to-Cost Ratio – Stack Economizer**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	5.32	5.32	5.32	5.32	5.32	5.39	5.37	5.39	5.39	5.39	5.32	5.32	5.32	5.39	5.39	5.39
<b>Year-Round 15-25 MMBtu/h</b>	N/A	5.47	5.47	5.47	5.47	5.53	5.52	5.53	5.53	5.53	5.47	5.47	5.47	5.53	5.53	5.53
<b>Year-Round 25-50 MMBtu/h</b>	7.17	7.17	7.17	7.17	7.17	7.25	7.23	7.25	7.25	7.25	7.17	7.17	7.17	7.25	7.25	7.25
<b>Year-Round 50-100 MMBtu/h</b>	N/A	9.67	9.67	9.67	9.67	9.79	9.76	9.79	9.79	9.79	9.67	9.67	9.67	9.79	9.79	9.79
<b>Year-Round 100-200 MMBtu/h</b>	N/A	10.64	10.64	10.64	N/A	10.77	N/A	10.77	10.77	10.77	10.64	10.64	10.64	10.77	10.77	10.77
<b>Year-Round 200+ MMBtu/h</b>	20.45	20.45	20.45	20.45	N/A	20.70	N/A	20.70	20.70	20.70	20.45	20.45	20.45	20.70	20.70	20.70
<b>Seasonal 10-15 MMBtu/h</b>	3.50	3.49	3.50	3.49	3.49	3.50	3.50	3.50	3.50	3.50	3.49	3.49	3.49	3.50	3.50	3.50
<b>Seasonal 15-25 MMBtu/h</b>	N/A	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59	3.59
<b>Seasonal 25-50 MMBtu/h</b>	4.68	4.68	4.69	4.68	4.68	4.69	4.69	4.69	4.69	4.69	4.68	4.68	4.68	4.68	4.69	4.69
<b>Seasonal 50-100 MMBtu/h</b>	N/A	6.32	6.33	6.32	6.32	6.33	6.33	6.33	6.33	6.32	6.32	6.32	6.32	6.32	6.33	6.33
<b>Seasonal 100-200 MMBtu/h</b>	N/A	6.92	6.92	6.91	N/A	6.92	N/A	6.92	6.92	6.91	6.91	6.91	6.91	6.91	6.92	6.92
<b>Seasonal 200+ MMBtu/h</b>	13.30	13.30	13.31	13.29	N/A	13.31	N/A	13.30	13.30	13.30	13.29	13.29	13.29	13.29	13.31	13.30

## 2.5 Stack Economizer – Statewide Impacts

### 2.5.1 Statewide Energy and Energy Cost Savings

The Statewide CASE Team took the following steps to determine statewide savings from the proposed stack economizer measure.

First, the Statewide CASE Team used a statewide boiler inventory of local AQMD boiler permits (Swanson & Staller, 2025) to estimate statewide boiler capacities and total quantity of installations by boiler capacity bins. More information on the data can be found in : Assumptions for Statewide Savings Estimates.

The Statewide CASE Team refined the statewide capacity in each capacity bin to account for equipment within the purview of Title 24, Part 6 and the proposed stack economizer exceptions, making the following changes:

- Removed boilers with input capacities under 10 MMBtu/h and any units that were indicated to be hot water boilers or hot water heaters in the permit data.
- Removed oilfield and utility boilers, which are not in buildings and not subject to Title 24, Part 6 requirements.
- Removed boilers in the lumber industry, which likely use biomass as fuel and qualify for an exception from the stack economizer requirement.
- Removed ten percent of boiler capacity to account for boilers operating with a stack temperature below 340°F, which qualify for an exception from the stack economizer requirement.
- Removed 20 percent of alteration capacity under 25 MMBtu/h as the estimated statewide capacity that would qualify for the roof clearance exception.
- Separated seasonal boilers from annual boilers by classifying boilers at major tomato and canned fruit and vegetable processors as seasonal boilers.

The statewide capacity after these changes represents the Existing Boilers Stock. Boilers at or above 10 MMBtu/h in the manufacturing, non-cannery food, education, refinery, and ‘all other’ sectors were included in the statewide capacity totals.

To estimate the capacity of new process boilers installed annually through new construction and additions, the Statewide CASE Team calculated two Industrial Product Growth Rates (IPGRs) for California, one for year-round boilers and one for seasonal boilers. See : Assumptions for Statewide Savings Estimates for details on how the Statewide CASE Team calculated the IPGRs. 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 & 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 and by the alterations forecasted units of boiler capacity to get first-year statewide savings, not accounting for natural market adoption. To estimate the share of new boilers that would have stack economizers installed without the requirement in place, the Statewide CASE Team leaned on input from boiler manufacturers and vendors during stakeholder interviews and an analysis of IAC audit data from 64 boilers at 32 steam-using industrial plants from 2010 to 2022. The Statewide CASE Team applied these market share percentages to the statewide savings for each boiler capacity bin to arrive at the final statewide savings estimate.

Total 30-year statewide energy savings in the field may be lower than estimated in this report due to imperfect stack economizer retubing and replacement rates. For more details on the methodology and context of estimating the statewide energy and energy cost savings, see the [2028 CASE Methodology Report](#).

The tables below present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 21) and alterations (Table 22) by climate zone.

Table 23 presents first-year statewide savings from new construction, additions, and alterations.

**Table 21: Statewide Energy and LSC Impacts – New Construction and Additions**

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2029 (Million Btu/h of boiler capacity)	First-Year Electricity Savings (Gigawatthours, GWh)	First-Year Peak Electrical Demand Reduction (Megawatts, MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	1.1	0.0000	0.0000	0.00	0.07	\$0.07
2	6.8	-0.0001	0.0000	0.00	0.42	\$0.40
3	47.3	-0.0005	-0.0001	0.03	2.94	\$2.83
4	18.5	-0.0002	0.0000	0.01	1.14	\$1.10
5	4.8	0.0000	0.0000	0.00	0.30	\$0.28
6	27.6	-0.0002	0.0000	0.02	1.67	\$1.64
7	11.2	-0.0001	0.0000	0.01	0.68	\$0.66
8	37.2	-0.0003	0.0000	0.03	2.24	\$2.19
9	47.6	-0.0004	0.0000	0.03	2.88	\$2.82
10	32.9	-0.0003	0.0000	0.02	1.99	\$1.94
11	9.9	-0.0001	0.0000	0.01	0.61	\$0.59
12	149.8	-0.0015	-0.0002	0.11	9.46	\$9.09
13	170.5	-0.0017	-0.0002	0.13	10.84	\$10.41
14	16.0	-0.0002	0.0000	0.01	0.99	\$0.97
15	8.0	-0.0001	0.0000	0.01	0.48	\$0.47
16	4.6	-0.0001	0.0000	0.00	0.29	\$0.28
<b>Total</b>	<b>593.9</b>	<b>-0.0057</b>	<b>-0.0006</b>	<b>0.43</b>	<b>37.00</b>	<b>\$35.74</b>

Table 22: Statewide Energy and LSC Impacts – Alterations

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2029 (Million Btu/h of boiler capacity)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	2.3	0.0000	0.0000	0.00	0.15	\$0.14
2	13.7	-0.0002	0.0000	0.01	0.83	\$0.79
3	95.5	-0.0014	-0.0002	0.07	5.88	\$5.60
4	37.1	-0.0006	-0.0001	0.03	2.27	\$2.16
5	8.8	-0.0001	0.0000	0.01	0.54	\$0.52
6	52.5	-0.0006	-0.0001	0.04	3.17	\$3.08
7	20.0	-0.0001	0.0000	0.01	1.21	\$1.18
8	70.9	-0.0009	-0.0001	0.05	4.25	\$4.13
9	91.0	-0.0011	-0.0001	0.06	5.47	\$5.32
10	62.2	-0.0007	-0.0001	0.04	3.73	\$3.63
11	21.0	-0.0004	0.0000	0.01	1.27	\$1.20
12	310.4	-0.0044	-0.0005	0.23	19.37	\$18.47
13	353.7	-0.0047	-0.0005	0.26	22.24	\$21.24
14	34.4	-0.0007	-0.0001	0.02	2.08	\$2.00
15	16.0	-0.0003	0.0000	0.01	0.96	\$0.92
16	9.6	-0.0002	0.0000	0.01	0.58	\$0.56
<b>Total</b>	<b>1,198.9</b>	<b>-0.0164</b>	<b>-0.0019</b>	<b>0.86</b>	<b>73.98</b>	<b>\$70.96</b>

**Table 23: Statewide Energy and LSC Impacts – New Construction, Additions, and Alterations**

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
<b>New Construction &amp; Additions</b>	-0.006	-0.001	0.43	37.00	\$35.74
<b>Alterations</b>	-0.016	-0.002	0.86	73.98	\$70.96
<b>Total</b>	<b>-0.022</b>	<b>-0.003</b>	<b>1.29</b>	<b>110.98</b>	<b>\$106.70</b>

### 2.5.2 Statewide Greenhouse Gas Emissions Reductions

Table 24 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 6,747 metric tons of carbon dioxide equivalent (CO<sub>2</sub>e) emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of California Building Energy Code Compliance Software (CBECC), as well as data from the CEC’s 2028 Metrics Report. See the [2028 CASE Methodology Report](#) for additional information.

**Table 24: First-Year Statewide GHG Emissions Impacts**

Construction Type	Avoided GHG Emissions from Electricity Savings (Metric Tons CO <sub>2</sub> e)	Avoided GHG Emissions from Natural Gas Savings (Metric Tons CO <sub>2</sub> e)	Total Avoided GHG Emissions (Metric Tons CO <sub>2</sub> e)	Total Monetary Value of Avoided GHG Emissions (\$)
<b>New Construction &amp; Additions</b>	-0.51	2,250.34	2,249.83	\$365,507.83
<b>Alterations</b>	-1.46	4,499.08	4,497.63	\$730,684.35
<b>Total</b>	<b>-1.97</b>	<b>6,749.42</b>	<b>6,747.46</b>	<b>\$1,096,192.17</b>

### 2.5.3 Statewide Water Use Impacts

The proposed code change will not result in water use impacts as the stack economizer recovers heat from the boiler stack and has no impact on water use in the boiler system.

## 2.5.4 Statewide Material Impacts

The proposed code change would require the addition of non-condensing stack economizers to newly installed process boiler systems. Non-condensing stack economizers are typically made of carbon steel (Jouhara, et al., 2018). The proposed requirement would increase the demand for steel at industrial sites. The Statewide CASE Team used vendor data sheets to estimate the mass of steel in stack economizers for boiler capacities up to 50 MMBtu/h and derived a linear regression equation to estimate the pounds of steel per unit of boiler capacity using a least squares approach (Clever-Brooks, n.d.). This linear regression equation was used to estimate the additional steel used per unit of boiler capacity, as shown in Table 25. For more information on the Statewide CASE Team’s methodology and assumptions used to calculate statewide material impacts, see the [2028 CASE Methodology Report](#).

**Table 25: First-Year Statewide Impacts on Material Use: Stack Economizer**

Material	Impact	Per-Unit Impacts (Pounds per MMBtu/h)	First-Year Statewide Impacts (Pounds)	Embodied GHG Emissions saved (Metric Tons CO <sub>2</sub> e)
<b>Mercury</b>	No Change	0	0	0
<b>Lead</b>	No Change	0	0	0
<b>Copper</b>	No Change	0	0	0
<b>Steel</b>	Increase	173	310,749	-171
<b>Plastic</b>	No Change	0	0	0
<b>TOTAL</b>	<b>Increase</b>	<b>173</b>	<b>310,749</b>	<b>-171</b>

## 2.5.5 Environmental Impacts

Requiring the use of stack economizers will decrease the energy required to operate a boiler, thereby reducing GHG emissions from the reduced need to produce that energy, typically by burning natural gas (Chen, Omotesho, & Johnson, 2025). Direct benefits are fully discussed in Sections 2.5.1 and 2.5.2, above.

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine that this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternative would achieve the same impact on reduced energy consumption from process boilers.

## 2.5.6 Other Non-Energy Impacts

The use of a stack economizer for boiler-feedwater preheating would reduce boiler fuel consumption and emissions, thereby reducing photochemical smog and improving local air quality.

## 2.6 Stack Economizer – Proposed Code Language

### 2.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes follow the restructured 2025 Building Energy Efficiency Standards and are marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

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). New to the 2028 energy code is to italicize defined terms when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included with greyed highlight and italics.

Markups are provided to the restructured 2025 Energy Code that the CEC developed in response to feedback that aligning the structure of Title 24, Part 6 with other parts of the California Building Standards Code (Title 24) would improve readability, usability, and navigation.<sup>8</sup> New section numbers are shown as bold followed square brackets that document the section in the 2025 Title 24, Part 6 section numbers prior to the restructuring. For example, “**Section 601.1** [Section 130.0(a)] **General**” contains the content that is in the current Section 130.0(a).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

### 2.6.2 Administrative Code (Title 24, Part 1)

No changes are proposed to Title 24, Part 1.

## 2.6.3 Energy Code (Title 24, Part 6)

### SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION

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**Section 201** [Section 100.1(b)] – **Definitions – Recommends new or revised definitions for the following terms:**

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- **BOILER STACK ECONOMIZER** (also known as a feedwater 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.
- **BIOMASS** is non-fossilized and biodegradable organic material originating from plants, animals or micro-organisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.
- **SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM** is a system used to reduce nitrogen oxide (NOx) emissions by injecting ammonia into the combustion exhaust gases.

### SUBCHAPTER 9 – PROCESS SYSTEMS AND EQUIPMENT

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

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**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 percent of the total design wattage at 50 percent 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 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.

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 904.1.3 [Section 120.6(d)3]:** Boilers with steady state full-load combustion efficiency 90 percent or higher.

**904.1.4 [New section] Stack economizers.**

Newly installed process steam boilers with an input capacity equal to or greater than 10 MMBtu/h (10,000,000 Btu/h) shall have a boiler stack economizer designed for a stack temperature drop of 60°F or more across the boiler stack economizer at design condition. The stack economizer shall not be bypassed during normal operation, and piping shall route boiler feedwater from the deaerator to the stack economizer.

**Exception 1 to Section 904.1.4:** Boilers where the stack temperature at their lowest firing rate is below 340°F at outlet of boiler or outlet of SCR system if present and connected to the boiler.

**Exception 2 to Section 904.1.4:** Boiler systems designed to burn biomass<sup>12</sup> from facility processes or biomass produced from waste material produced at the facility, such as woody biomass, digester gas, landfill gas, and animal fat.

**Exception 3 to Section 904.1.4:** Boilers employing other methods of stack heat recovery, such as a heat exchanger serving a load other than boiler feedwater.

**Exception 4 to Section 904.1.4:** Indoor replacement boilers at existing facilities with roof clearance (distance from the boiler stack outlet to the ceiling or distance from the outlet of the SCR duct to the ceiling if the boiler is equipped with an SCR system) less than 88 inches for boilers with an input capacity at or below 25 MMBtu/h and less than 116 inches for boilers with an input capacity above 25 MMBtu/h.

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

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<sup>12</sup> Has a dedicated line to the burner for biomass as specified. This does not include utility-supplied fuel that includes biomass.

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 steam boilers are added or replaced shall comply with the applicable requirements of Section 904.1.

## 2.6.4 Reference Appendices

No changes are proposed to the Reference Appendices.

## 2.6.5 Compliance Manuals

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

## 2.6.6 ACM Reference Manual

No changes are proposed to the ACM Reference Manual.

## 2.6.7 Compliance Forms

As discussed in Section 2.1.4, the NRCC-PRC-E and NRCI-PRC-E compliance forms would be updated 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

To section I PROCESS BOILER table:

- In the Virtual Compliance Assistant, add the following dropdown options:
  - Rated input capacity for one or more connected boilers to include:  $\geq 10\text{MMBtu/h}$
  - Rated input capacity for one or more connected boilers to include:  $\geq 5$  to  $<10\text{MMBtu/h}$
- Add a column for Stack Economizer
  - To the corresponding section for the form in the Virtual Compliance Assistant, add:
  - Does this process boiler have a stack economizer connected to the stack that is not bypassed and has feedwater piping from the deaerator or feedwater tank passing through the economizer before entering the boiler?
    - ♣ Question response dropdown options:
      - Yes

- This doesn't apply because the process boiler has a rated capacity less than 10 MMBtu/h.
- This doesn't apply because the stack temperature is below 340°F at its lowest firing rate.
- This doesn't apply because the boiler system is designed to burn biomass.
- This doesn't apply because there is an alternative heat exchanger connected to the stack that is operational and heating another process.
- This doesn't apply because the clearance at the site is lower than the clearance listed in the exception language for this boiler capacity.

**NRCI-PRC-E**

To the Process Boilers Table, add:

- Column for Stack Economizer
  - Verify that the boiler's maximum capacity is greater than or equal to 10 MMBtu/h. (T/F)
  - Verify that an economizer (air-to-water heat exchanger) is connected to the stack. (P/F)
  - Ensure the feedwater piping from the deaerator or feedwater tank passes through the economizer. (P/F)
  - Confirm the economizer is not bypassed. (P/F)
- Column for Stack Economizer Serial and Model #

## 3. Automatic Blowdown and Deaerator Pressure

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### 3.1 Automatic Blowdown and Deaerator Pressure – Measure Description

#### 3.1.1 Proposed Code Change

This proposal would add the following requirements for all newly installed process steam boilers with input capacities at or above 10 MMBtu/h:

- 1) The boilers shall have an automatic surface blowdown controller that is programmed to be controlled by conductivity, and
- 2) For systems that use the boiler steam header to pressurize the deaerator, the steam supply line pressure regulator serving the deaerator shall be set at or under 5 psig and between (and inclusive of) 2 and 5 psig for boilers with tubes not rated for oxidizing conditions.

The requirements would apply to all sites with new process steam boilers, including replacement boilers and boilers in additions to existing facilities, with the following exceptions:

#### Exceptions for the automatic blowdown requirement

- Boiler systems with returned condensate comprising more than 90 percent of the feedwater flow,
- Boilers with make-up water treated by a reverse osmosis system, and
- Boilers with a heat exchanger that recovers energy from the blowdown to heat make-up water or another process stream, with or without a flash tank (blowdown heat recovery).

#### Exception for the steam supply line pressure regulator requirement

- Boiler systems with swings in make-up water equal to or above 20 percent of feedwater flow as determined by the steam system designer.

This proposal would require updates to compliance document review and a verification of controls and the steam supply line pressure regulator setpoint by a field technician.

This requirement is not expected to impact hotel/motel or nonresidential buildings with Group R occupancies because these building types will not house process steam boilers of qualifying size. Boilers used in oilfield production and municipal power generation are not expected to be within the scope of Title 24, Part 6. Table 26 summarizes the scope of the proposed code change.

**Table 26: Scope of Proposed Code Change**

A  indicates the proposed code change is relevant

Building Type(s)		Construction Type(s)	Type of Change	
<input type="checkbox"/> Single Family		<input checked="" type="checkbox"/> New Construction	<input checked="" type="checkbox"/> Mandatory	
<input type="checkbox"/> Multifamily		<input checked="" type="checkbox"/> Additions	<input type="checkbox"/> Prescriptive	
<input checked="" type="checkbox"/> Nonresidential (excluding Occupancy R uses)		<input checked="" type="checkbox"/> Alterations	<input type="checkbox"/> Performance	
Application Climate Zones	Energy Code Sections	Compliance Forms	Sections of ACM Reference Manuals	
Climate Zones 1-16	Part 6, Sections 201 and 904.1, Nonresidential Reference Appendix Section 7	NRCC-PRC NRCI-PRC NRCA-PRC-XX-F	N/A	
Third Party Verification		Updates to Compliance Software		
<input checked="" type="checkbox"/> No changes to third party verification		<input checked="" type="checkbox"/> No updates		
<input type="checkbox"/> Update existing verification requirements		<input type="checkbox"/> Update existing feature		
<input type="checkbox"/> Add new verification requirements		<input type="checkbox"/> Add new feature		

### 3.1.2 Benefits of Proposed Changes

Manual boiler blowdown typically discharges more hot water than is needed to remove suspended and dissolved solids from the boiler water, resulting in unnecessary water and chemical losses. Reducing blowdown saves both water and energy because less cold make-up water enters the system; therefore, less energy is needed at the deaerator and at the boiler to maintain system temperatures. Automatic blowdown systems continuously monitor surface conductivity and control a blowdown valve according to measured conductivity levels, avoiding excessive blowdown by eliminating the need for operators to make manual valve adjustments. Improved conductivity control using an automatic blowdown system can also extend the boiler’s useful life and slow the efficiency degradation of the boiler.

Deaerators may be operated at higher-than-necessary pressures. Over-pressurization leads to excess venting, while under-pressurization can result in insufficient air removal, potentially leading to oxygen pitting and corrosion on contact surfaces. Ensuring proper deaerator pressurization through the steam supply line regulator saves energy and has no additional cost for facilities.

In addition to the energy benefits, these practices would reduce emissions that can impact local air quality. The value of improved air quality at industrial sites is amplified

by the consideration that many industrial facilities are located near LMI housing, which typically gets disproportionately exposed to lower air quality.

In addition to the energy benefits, these practices would reduce air emissions that can contribute local air quality impacts (as measured by the Air Quality Index). The value of improved air quality in these areas is amplified by the consideration that many industrial facilities are located near LMI housing, which typically gets disproportionately exposed to lower air quality.

### **3.1.3 Background Information**

High boiler water conductivity indicates high mineral content, which leads to fouling of the boiler heat exchanger tubes, increased thermal stress, lower boiler efficiency, and ultimately accelerated system wear and tear. High dissolved solids concentrations can also lead to foaming and the carryover of boiler water into the steam, which can foul downstream components, trigger water hammer<sup>13</sup>, and accelerate system wear and tear.

To limit the levels of suspended and dissolved solids in steam boilers, water is periodically or continuously discharged or blown down. This surface blowdown removes dissolved solids that accumulate near the surface of the boiler water. When boiler operators complete blowdown manually, they commonly do so on a set schedule, testing the conductivity level once per shift and performing surface blowdown based on their reading. The ideal conductivity levels are largely a function of boiler type, operating pressure, and feedwater quality, and boiler operators typically follow manufacturer recommendations for conductivity setpoints. As many site changes can affect feedwater conductivity values and therefore require a change in blowdown, maintaining correct conductivity levels manually is very difficult and can lead to excessive or insufficient blowdown. To ensure that dissolved solid concentrations stay below acceptable limits with periodic testing, operators may conservatively blow down more than needed to provide a safety factor. Given that any water blown down must ultimately be replaced, blowdown beyond what is necessary to remove dissolved solids ends up wasting water, chemical treatments, and energy required to replace it. Automatic surface blowdown systems avoid excessive blowdown by automatically monitoring and maintaining water conductivity. These systems use a conductivity probe to continuously measure surface conductivity, an indicator of the level of dissolved solids in the water. When conductivity rises above the setpoint, the system modulates a control valve to discharge the minimum amount of water necessary to bring conductivity back into its acceptable range.

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<sup>13</sup> Water hammer, or hydraulic shock, occurs when a sudden change in water flow direction or velocity creates a pressure surge within plumbing.

Automatic boiler blowdown control was patented in the early 1980s and has been in DOE tip sheets since 2001 (Office of Industrial Technologies, Energy Efficiency and Renewable Energy, US Department of Energy, 2001; United States of America Patent No. US3908605A, 1974). IAC audits often recommend the practice (McLaughlin, Choi, & Kissock, 2022), addressing the standard IAC audit recommendation to “reduce excessive boiler blowdown” (Michael Muller, 2019). The Statewide CASE Team estimates that 20 to 30 percent of existing qualifying boiler capacity in California is equipped with automatic blowdown systems, with the prevalence of these systems increasing with boiler size. Without a code requirement, the Statewide CASE Team estimates that the current market share will remain relatively stable, as boiler operators have already had ample time and opportunity to transition to automatic blowdown systems if they preferred to do so. The market share may increase slowly as the benefits of automatic blowdown become more widely understood, but the rate of adoption would not be expected to increase substantially. Utility incentive programs for automatic blowdown exist in other states, such as Consumers Energy offering customers in Michigan a financial incentive for automatic boiler blowdown (Consumers Energy, 2025).

Boiler systems with returned condensate comprising more than 90 percent of feedwater flow would qualify for an exemption from the proposed automatic blowdown system requirement. Condensate is essentially pure, distilled water with almost no dissolved solids, so systems where feedwater is largely condensate need less frequent blowdown to maintain total dissolved solids below manufacturer recommendations. Because these systems would experience lower energy savings from automatic blowdown, an investment in an automatic blowdown system is unlikely to be cost-effective.

The reverse osmosis process removes over 90 percent of the dissolved solids and impurities from boiler make-up water. As such, boilers with make-up water treated by reverse osmosis also require less frequent blowdown and would experience lower energy savings from automatic blowdown. Therefore, automatic blowdown systems are unlikely to be cost effective for these boilers and the Statewide CASE Team recommends that they are exempt from the proposed requirement.

Boilers recovering heat from their blowdown water also qualify for an exception, as they would also achieve lower energy savings from switching from manual blowdown to an automatic blowdown system, reducing cost-effectiveness.

Deaerators are sold with all large steam boiler systems. A deaerator is a pressurized vessel that heats a boiler’s feedwater to temperatures that release the dissolved gases (mainly oxygen and carbon dioxide) from the water. Removing the dissolved gases from the feedwater protects the system from corrosion. As the pressurization of the deaerator increases, the saturation temperature of the pressurized water also increases, which means a higher deaerator pressure setpoint heats the feedwater to higher

temperatures. Almost all dissolved gases are removed at a temperature of 212°F. A steam supply line pressure regulator controls the pressure (and therefore the temperature) of the steam delivered to the deaerator. Setting the steam supply line pressure regulator, and correspondingly the deaerator pressure, to 5 psig (equivalent to 227°F) provides a 15°F margin in case of fluctuations in cold make-up water that can swing the deaerator temperature lower. Setting the pressure higher than 5 psig leads to higher amounts of steam venting out of the system without providing benefits, which wastes energy and water. Most facilities use a 5 psig setpoint, but a small percentage of facilities instead set their steam supply line pressure regulator and deaerator to a higher pressure out of an abundance of caution. This over-pressurization leads to excess steam venting and wasted energy. On the other hand, while uncommon, under-pressurization of the deaerator can cause insufficient dissolved gas removal, which can lead to oxygen pitting and corrosion on contact surfaces.

In addition to steam from the steam supply line, some facilities may also direct condensate return to feed their deaerator. Boiler systems with high-pressure (above 5 psig) and high-temperature (above 227°F) condensate return may operate with a deaerator pressure higher than 5 psig due to the influx of high-pressure condensate. By implementing a setpoint requirement at the steam supply line pressure regulator instead of the deaerator itself, systems that feed the deaerator with high-pressure condensate may still comply with the 5 psig setpoint requirement for their steam supply line pressure regulator and avoid energy losses from deregulating the returned condensate.

Discussions with industry stakeholders demonstrated that a steam supply line pressure regulator limit of 5 psig is impractical when large amounts of make-up water serve the boiler feedwater. In these cases, the steam supply line must be at a higher pressure to compensate for the reduced energy of the incoming boiler feedwater. To account for sites that may use make-up water to serve the boiler feedwater, the Statewide CASE Team added an exception for sites with swings in make-up water equal to or above 20 percent of feedwater flow. Qualification for this exception will be determined by the professional engineer during the design process and indicated on the design documents.

Title 24, Part 6, first adopted requirements for process boilers in 2013. Based on research conducted by the Statewide CASE Team, neither automatic blowdown nor deaerator or steam supply line regulator pressure requirements have been proposed in previous code cycles.

### **3.1.4 Modifications to Energy Code Documents**

This section provides descriptions of how the proposed code change will affect each Energy Code document. See Section 3.6 of this report for detailed revisions to code language.

### **3.1.4.1 Energy Code Change Summary**

#### **SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION**

**Subsection 201:** The proposed measure would add new definitions for a boiler blowdown valve, automatic boiler blowdown controller, boiler deaerator, and blowdown heat recovery.

#### **SECTION 900 – NONRESIDENTIAL, HOTEL/MOTEL, AND MULTIFAMILY OCCUPANCIES (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)**

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

##### **904.1 Mandatory requirements (Newly Constructed, Additions, Alterations).**

**904.1.5:** The proposed regulations would add an automatic surface blowdown system requirement for all newly installed process boilers with an input capacity greater than 10 MMBtu/h (10,000,000 Btu/h), with exceptions for boilers with condensate return above 90 percent, boilers with make-up water treated by a reverse osmosis (RO) system, and boilers employing blowdown heat recovery.

**904.1.6:** The proposed regulations would add a requirement for all newly installed process boilers with an input capacity greater than 10 MMBtu/h (10,000,000 Btu/h) that use the boiler steam header to pressurize the deaerator that the steam supply line pressure regulator serving the deaerator shall be set at or under 5 psig. For boilers with tubes that are not rated for oxidizing conditions, the proposal would require that the steam supply line pressure regulator setpoint be within 2 to 5 psig. There would be one exception for boiler systems with large swings in make-up water as a percentage of feedwater flow.

### **3.1.4.2 Reference Appendices Change Summary**

**Appendix NA7 – Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes Process Boiler Acceptance Tests:** The proposed changes would expand this appendix to include information on new process boiler acceptance tests that verify compliance with the proposed blowdown and deaerator pressure requirements.

### **3.1.4.3 Compliance Manuals Change Summary**

Section 10.9.2 of the Nonresidential Compliance Manual, which outlines mandatory requirements for process boilers, would be updated. Two new sections, 10.9.2.x and 10.9.2.y, would be created to explain the automatic surface blowdown and deaerator pressure requirements and verification.

#### **3.1.4.4 Alternative Calculation Method Reference Manual Change Summary**

The proposed measure will not modify ACM Reference Manuals because no software updates are associated with the proposed measure.

#### **3.1.4.5 Compliance Forms Change Summary**

The existing Process System Certificate of Compliance form (NRCC-PRC-E, Section I: Process Boilers) would require updated input fields to capture boiler capacity ratings that trigger compliance requirements. In addition, two new input fields would be added, one for automatic blowdown and one for steam supply line pressure regulator setpoint, to confirm code compliance and document any applicable exceptions. The Process System Certificate of Installation form (NRCI-PRC-E, Process Boilers) would be updated with corresponding input fields for the automatic blowdown and deaerator pressure requirements, including a space for the make and model number of the automatic blowdown controller and confirmation of the presence of a pressure gauge on the deaerator, as specified in the NRCC-PRC-E. Two new NRCA-PRC-XX-F forms would be developed for the automatic blowdown and steam supply line pressure regulator requirements. Documentation of the automatic blowdown acceptance test on the NRCA-PRC-XX-F would verify that the controller operates the blowdown valve based on the conductivity setpoint, as specified in the NRCC-PRC-E. Documentation of the deaerator pressure acceptance test would confirm that the steam supply line pressure regulator setpoint does not exceed 5 psig, as specified in the NRCC-PRC-E. Both acceptance tests would be performed by a field technician.

### **3.1.5 Measure Context**

#### **3.1.5.1 Comparable Model Codes or Standards**

Boiler blowdown is referenced in Appendix L (Sustainable Practices) of Title 24, Part 5 (California's Plumbing Code). L 507.0 (Heat Recovery from Steam Boiler Blowdown) stipulates that where heat recovery can be used beneficially to heat boiler makeup water or for other purposes, boiler blowdown from steam boilers exceeding 15 psi and 3,400,000 MMBtu/h shall be directed to a heat recovery system that reduces the temperature of the blowdown discharge to below 140°F without using tempering water. Provisions in Appendix L are not mandatory. The proposed code change for Title 24, Part 6 would lessen the energy savings from the provision in Title 24, Part 5, Appendix L for individual boilers, but a boiler that met the proposed requirement for Title 24, Part 6 would save more energy overall than a boiler that employed blowdown heat recovery as described in Title 24, Part 5, Appendix L.

### **3.1.5.2 Interactions with Other Regulations**

Review has found no known existing federal, state, or local regulatory requirements that require conductivity-based blowdown in process boilers. Current Title 24, Part 6 requirements for process boilers cover combustion air positive shut-off, combustion air fans, and stack-gas oxygen concentrations. The proposed requirements for automatic (conductivity-based) blowdown and the steam supply line pressure regulator setpoints would have no impact on these existing requirements. Additionally, review finds no anticipated conflicts between these proposed requirements and the proposed Title 24, Part 6 measure that would require stack economizers.

## **3.2 Automatic Blowdown and Deaerator Pressure – Compliance and Enforcement**

### **3.2.1 Compliance Considerations**

When developing this proposal, the Statewide CASE Team considered methods to streamline the compliance and enforcement process and to mitigate or reduce negative impacts on market actors involved in the process. The Statewide CASE Team believes that compliance and enforcement of the proposed measure is feasible and would not add significant compliance and enforcement burdens to those responsible for ensuring compliance with the building code.

To ensure compliance with the proposed automatic blowdown and steam supply line pressure regulator setpoint requirements, verification steps would need to be taken during the permit application (such as reviewing plans), during installation (including acceptance testing by a field technician), and during inspection. New fields would need to be completed in the NRCC-PRC-E and NRCI-PRC-E forms. Two new acceptance test forms (NRCA-PRC-XX-F) would need to be created to document new acceptance tests performed by field technicians for the automatic blowdown system and steam supply line pressure regulator setpoint requirements.

**Designers.** Designers would need to be aware that the requirements for process boilers in section 904.1 have been expanded, enabling them to design compliant process boiler systems. They would need to complete an updated NRCC-PRC-E form and submit design documents indicating a compliant design with an automatic surface blowdown control system or qualification for an exception to the requirement. If a site plans to pursue an exemption based on returned condensate composing more than 90 percent of boiler feedwater, the plans should indicate the planned installation of condensate return infrastructure sized to meet more than 90 percent of the boiler feedwater volume. Designers would need to do a simple calculation using the design flow rates and loads in the plans to confirm qualification for the exception. In existing systems, conductivity logs could be used to verify qualification for the exception if plans are not available. If a

site plans to pursue an exemption based on RO treatment of make-up water, the plans should indicate planned installation of an RO system. If a site plans to pursue an exemption based on the use of blowdown heat recovery, the plans should indicate planned installation of blowdown heat recovery equipment. Exception qualification for boiler replacements may include documentation of installed and operational RO systems, blowdown heat recovery equipment, or condensate return infrastructure.

Designers would need to be aware of new pressure requirements for the deaerator steam supply line pressure regulator in Section 904.1 to ensure that the system is designed to meet the applicable pressure limits or qualifies for the exception. The specified steam line supply pressure regulator setpoint used to demonstrate compliance must be included in the construction documents and reflected in the NRCC-PRC-E. In addition, the design should include a pressure gauge on the deaerator to allow for field confirmation of pressure requirement. If a new or existing site plans to pursue the exception to the requirement based on the make-up water swings as a percentage of feedwater flow, designers would need to indicate the target steam supply line pressure regulator pressure setpoint on the design documents, along with a statement of justification confirming that the site experiences make-up water swings of 20 percent or more.

**AHJ plan checkers.** During the permit application phase, AHJ plan checkers would review the submitted NRCC-PRC-E form and design documents to confirm that the design either includes an automatic surface blowdown system or qualifies for a claimed exception as determined by the designer and outlined on the plans. For the steam supply line pressure regulator setpoint requirement, plan checkers would confirm that the information in the design documents and NRCC-PRC-E specify the steam supply line pressure regulator setpoint and demonstrate compliance with the requirement. Plan checkers should also confirm that the construction documents include a pressure gauge on the deaerator. If the site plans to claim the requirement exception, the plan checker should confirm that the construction documents include the specified setpoint and a statement of justification indicating that the boiler feedwater may experience make-up water swings equal to or above 20 percent of its flow.

**Installation contractors.** Installation contractors would be required to correctly install automatic surface blowdown systems in accordance with design and manufacturing specifications, which is their normal operating procedure. They would also install a pressure gauge on the deaerator in accordance with approved design documents. When the installation contractor fills in the NRCI form, they would need to include the make and model of the automatic surface blowdown controller and confirm that the deaerator system and pressure gauge have been installed in accordance with the approved design in addition to the information already required on the form for process boilers.

**Field technicians.** Field technicians, who are typically the installers or technicians configuring the boiler system controls, would set the setpoints for automatic blowdown conductivity and the steam supply line pressure regulator serving the deaerator during boiler startup and commissioning. They would also complete the automatic blowdown system and deaerator system pressure acceptance tests and record results on the new NRCA-PRC-XX-F forms. If no exemption is claimed, the acceptance test would include confirmation that the blowdown system is programmed to be controlled by conductivity and confirmation that the steam supply line pressure regulator setpoint is at or under 5 psig, or within (and inclusive of) 2 to 5 psig for boilers with tubes that are not rated for oxidizing conditions.

Sites seeking to reduce compliance burdens can require the commissioning technicians who tune the equipment prior to AQMD-required stack testing also to conduct acceptance testing of the automatic surface blowdown system and steam supply line pressure.

**AHJ building inspectors.** The AHJ building inspector would need to confirm, through visual inspection, the installation of the automatic blowdown system (including each of the valve, controller, and conductivity probe). For the deaerator measure, they would also need to verify the presence of a pressure gauge on the deaerator. The inspector would also verify completion of the NRCI-PRC-E form fields related to automatic blowdown and the deaerator pressure gauge, as well as NRCA-PRC-XX-F forms for the automatic blowdown system and deaerator system pressure requirements in addition to the other process boiler inspection items already required for a new boiler installation.

Definitions added for the new proposed code language do not conflict with any existing definitions in other parts of Title 24.

### **3.2.2 Impact on Market Actors**

Table 27 summarizes impacts on market actors and suggests outreach and education to support market actors as they prepare for the effective date of the requirements.

**Table 27: Impacts on Market Actors and Suggested Training and Education Opportunities**

Market Actor	Impact(s)	Suggested Outreach and Education
<b>Owner/ Operator<sup>a</sup></b>	<p>Be aware of requirements for automatic blowdown systems and steam supply line pressure regulator setpoint limits.</p> <p>May need to complete the NRCC-PRC-E form for replacement boilers at existing facilities.</p> <p>Ensure that the field technician performs acceptance testing and completes the NRCA-PRC-XX-F forms.</p> <p>Expect a slight increase to boiler first cost, but with reduced energy bills and, in some cases, reduced maintenance needs.</p>	<p>Outreach to owners and operations personnel could improve understanding of the benefits of automatic blowdown and address any concerns.</p>
<b>Design Professional<sup>b</sup></b>	<p>Be aware of new requirements, code triggers, and exceptions when designing process boiler systems.</p> <p>Include automatic blowdown systems in all process boilers system designs where required and include relevant specifications in design documents.</p> <p>Include the deaerator operating pressure setpoint and pressure gauge in the construction documents. Where an exception is claimed, include all required supporting information in the construction documents and in the NRCC-PRC-E.</p> <p>Complete new fields of NRCC-PRC-E Process Boilers section in addition to existing fields.</p>	<p>Provide training to industrial boiler and steam system design firms on the energy code update and compliance documentation.</p>
<b>Construction Team<sup>c</sup></b>	<p>Install automatic blowdown systems and deaerator pressure gauges as specified in the approved design documents, consistent with standard practice.</p> <p>Complete new fields in the process boilers section of NRCC-PRC-E for the automatic blowdown and steam supply line pressure regulator requirements.</p> <p>Installing technicians will need to conduct acceptance testing in accordance with NA7 and complete new NRCA-PRC-XX-F forms.</p>	<p>Provide training to automatic blowdown system installers on the energy code update, compliance requirements, acceptance testing, and documentation.</p>
<b>Building Department<sup>d</sup></b>	<p>Plan reviewers must confirm that the NRCC-PRC-E and design documents include required automatic blowdown and deaerator system information and reflect compliance with the proposed requirements.</p> <p>Building inspectors must confirm completion of the NRCC-PRC-E, completion of the NRCA-PRC-XX-F, and compliant installation of the</p>	<p>Provide education and training to local building department plans examiners to familiarize them with new code language and new acceptance tests.</p>

Market Actor	Impact(s)	Suggested Outreach and Education
	automatic blowdown and deaerator systems in addition to existing process boilers requirements.	
<b>Verification Tester<sup>e</sup></b>	Because verification testing is performed by installing technician, see Construction Team.	N/A
<b>Manufacturers and Distributors</b>	Expect additional sales of automatic blowdown systems.	Additional training likely unnecessary.

- a. Owner/Operator is funding the project and is the primary decision-maker.
- b. Design professionals include architects, engineers (mechanical, electrical, plumbing, structural), specification writers, cost estimators, commissioning agents, lighting designers, and energy consultants.
- c. Construction team includes general contractors, home builders, design-build contractors, installation contractors (e.g., HVAC, plumbing, electrical), commissioning agents, and tradespeople
- d. Building departments include plans reviewers, building inspectors, specialty inspectors, permit counter technicians and third-party plan review and inspection.
- e. Verification testers include commissioning agents, ECC Raters, and Acceptance Test Technicians.

The [2028 CASE Methodology Report](#) includes more detail on how changes to the California building code can impact builders, building designers, energy consultants, facility owners, and occupants. While the analysis in the methodology report is not specific to the code changes presented in this report, this measure focuses on industrial building owners and operators, design and installation professionals, and building department representatives, since these market actors are expected to experience the most direct impacts from this proposed measure. The following section provides a qualitative description of how this specific code change would affect various market actors and additional quantitative analyses of its potential impacts on building-industry subsectors.

**Building owners.** The proposed code change would have incremental costs and would reduce building owners’ utility bills throughout the measure lifetime. See the [2028 CASE Methodology Report](#) for a description of how LSC savings relate to utility bill savings. Building owners will also need to ensure that new acceptance tests are completed by a field technician, that the testing is documented in the NRCA forms, and that the forms are provided to the building inspector. No regulations previously required acceptance tests for process boilers, so this change represents a minor adjustment in their workflow. An installation or controls technician that the builder already coordinates with can complete this test to minimize impacts.

**Builders.** The proposed change would likely have a very minor impact on firms engaged in the construction or retrofitting of industrial buildings, utility systems, public infrastructure, or other heavy construction. The proposed change would not affect all firms and workers in the commercial and industrial building industries. Instead, the change would primarily affect specific subsectors within the industries. Table 28 shows the commercial and industrial building subsectors that the Statewide CASE Team expects to be impacted by the changes proposed in this report.

**Table 28: Specific Subsectors of the California Commercial and Industrial Building Industry Impacted by Proposed Change to Code/Standard by Subsector in 2025 (Estimated)**

Construction Subsector	Establishments*	Employment	Annual Payroll (Billions \$)
Industrial Building Construction	278	4,095	\$0.5
Other Nonresidential Equipment Contractors	580	9,749	\$1.1
All Other Nonresidential Trade Contractors	948	17,084	\$1.7

Source: (State of California, n.d.)

\*An establishment is a single economic unit, typically at one physical location, that engages in one, or predominantly one, type of economic activity for which a single industrial classification may be applied. Many businesses are composed of multiple establishments. US Bureau of Labor Statistics, Handbook of Methods.

<https://www.bls.gov/opub/hom/cew/concepts.htm>

**Manufacturers.** As discussed in Section 3.3.1, at least two manufacturers of automatic blowdown systems are headquartered in California, along with several vendors. Refer to Section 3.3.4 for more information on the projected impact on California jobs.

### 3.2.3 Compliance Software Updates

Review finds no expected compliance software updates to be required for this measure proposal.

### **3.2.4 Cost of Enforcement**

The Statewide CASE Team acknowledges that changes to the code will impact enforcement costs. This report evaluates specific measures, and the collective impact of all proposed changes to the 2028 Title 24, Part 6, which may increase training and/or workload for enforcement personnel.

The Statewide CASE Team does not anticipate significant additional state costs resulting from this measure. The cost of enforcement would include the cost of plan review and inspection. Plans examiners are expected to spend less than 30 additional minutes on plan reviews, and building inspectors are expected to spend up to 60 additional minutes on inspections. The plan review function would include review of the NRCC-PRC-E to ensure that it meets the new code requirement and is consistent with the drawings and specifications. Inspection would include review of the NRCI-PRC-E and NRCA-PRC-XX-F forms to ensure that the information on the forms is consistent with the approved NRCC-PRC-E forms and with what is actually installed. Specifically, AHJ plan reviewers must confirm that the plans and NRCC-PRC-E include the use of an automatic blowdown control system. For the deaerator measure, plan reviewers must confirm that the construction documents and NRCC-PRC-E identify the steam supply line pressure regulator setpoint and indicate a pressure gauge on the deaerator. Plan reviewers must also ensure that any claimed exception is supported with the required documentation. Building inspectors would need to check for the completion of acceptance testing for automatic blowdown and deaerator systems in the new NRCA forms and verify field installation of the automatic blowdown system and deaerator pressure gauge. The proposed acceptance testing is performed by a field technician and not enforcement officials.

The costs of enforcement will include labor costs for plan examiners and building inspectors and costs to deliver training to enforcement officials to enable them to adequately enforce the proposed measure described in Section 3.2.2. Overall, the incremental enforcement requirements are small, as Title 24, Part 6 already includes requirements for process boilers, and plans reviews and inspections already take place when new process boilers are installed.

## **3.3 Automatic Blowdown and Deaerator Pressure – Market and Economic Analysis**

### **3.3.1 Market Structure and Availability**

#### **3.3.1.1 Current Market Structure and Availability**

The automatic blowdown market includes boiler system designers, component manufacturers, original equipment manufacturer (OEM) suppliers, boiler manufacturers,

manufacturer representatives, distributors, mechanical contractors, boiler technicians, and water treatment companies. Designers specify the boilers and automatic blowdown systems that meet project needs and comply with regulations. Component manufacturers and OEMs design, manufacture, and supply the system components, including conductivity probes, controllers, and modulating valves, which are often sold as packaged systems. Boiler manufacturers often provide automatic blowdown systems as an optional accessory or a fully integrated package with a new boiler installation. Manufacturer representatives and distributors act as the local sales and distribution channel for the component manufacturers and specialized boiler accessory companies. Mechanical contractors handle the physical installation of the system, including piping, wiring, and integration with the boiler’s main controls. Boiler technicians install and commission automatic blowdown systems and, under the proposed change, would complete acceptance testing and complete acceptance forms in most cases. Water treatment companies often advise clients on the correct blowdown setpoints based on their water quality and may recommend the control equipment.

The market for automatic blowdown systems is mature, with multiple manufacturers and suppliers providing designers and contractors with many options for purchasing. Table 29 lists companies that the Statewide CASE Team has identified as major market actors.

**Table 29. Major Automatic Blowdown System Component Manufacturers and Vendors**

Company	Market Actor Type	Product Offering	Headquartered in California
<b>Electro-Chemical Devices</b>	Manufacturer	Controller, probe	Yes
<b>Lakewood Instruments</b>	Manufacturer	Controller, probe, valve	No
<b>Rite Boilers</b>	Manufacturer	Controller, probe, valve	Yes
<b>Spirax Sarco</b>	Manufacturer	Controller, probe, valve	No
<b>R. F. MacDonald</b>	Vendor	Automatic blowdown systems	Yes
<b>Nationwide Boiler Incorporated</b>	Vendor	Automatic blowdown systems	Yes

Designers commonly include automatic blowdown systems in standard boiler system designs. The Statewide CASE Team believes that boiler system designers are familiar with these systems but would require minimal training on code updates to ensure designs meet the proposed code requirements.

Manufacturers and vendors have a comprehensive understanding of the benefits of automatic blowdown in boiler systems. During a stakeholder interview with the

Statewide CASE Team, one boiler manufacturer noted that they recommend an automatic blowdown system for all steam systems over 3.3 MMBtu/h.

Table 30 includes the estimated current market adoption of automatic blowdown systems on newly installed boilers in California by boiler capacity. Market adoption estimates were based on stakeholder interviews and a statewide boiler inventory of local AQMD boiler permits (Swanson & Staller, 2025). The prevalence of automatic blowdown systems is estimated to increase with boiler capacity, driven by improved cost-effectiveness with increasing boiler capacity.

The Statewide CASE Team does not foresee this proposed requirement having negative impacts on technology adoption.

**Table 30: Estimated Current Automatic Blowdown Market Adoption in California**

<b>Boiler Capacity</b>	<b>Estimated Automatic Blowdown Market Adoption</b>
<b>10-15 MMBtu/h</b>	25%
<b>15-25 MMBtu/h</b>	30%
<b>25-50 MMBtu/h</b>	35%
<b>50-100 MMBtu/h</b>	40%
<b>100-200 MMBtu/h</b>	45%
<b>200+ MMBtu/h</b>	75%

The deaerator market is well established, and deaerators and steam supply line pressure regulators are both standard components of boiler systems. The proposed code change specifies a set pressure range for the steam supply line pressure regulator to avoid excess energy loss to high deaerator pressurization. This code change would not affect current market structure or product availability.

The Statewide CASE Team estimates that 20 percent of process boiler systems in California have steam supply line pressure regulators and deaerators set above 5 psig based on anecdotal industry experience and conversations with facility operators.

### **3.3.1.2 Market Challenges and Solutions**

See Section 3.2 for a description of workforce trainings that may be needed to ensure effective design, installation, and commissioning.

The market for automatic blowdown systems is well-established, with multiple vendors and suppliers offering decades of experience in designing and installing them. Given the current market availability, the Statewide CASE Team does not anticipate any market challenges related to product availability.

Despite the clear fuel, chemical, and water savings provided by automatic blowdown systems, many industrial process facilities continue to use manual or fixed-rate blowdown due to a combination of factors. Primarily, these facilities focus on the higher upfront cost of automatic blowdown systems, which require a specialized conductivity probe for each boiler, a dedicated controller, and a modulating (automated) blowdown valve, all of which add to the initial cost compared with a basic manual valve setup. Facility owners often prefer to save the immediate capital expense and operate with a high barrier for capital expenditure on auxiliary equipment, even if the payback period from operational savings is short (Energy Efficiency Movement, 2025). An automatic blowdown system has a payback period up to about 4-5 years. The Statewide CASE Team recognizes most facilities consider the upper range of that payback period as being slightly longer than they typically consider for investments, which may dissuade facilities from purchasing automatic blowdown systems without a code requirement. Conducting market education and creating supporting guidelines would improve awareness of the benefits of automatic blowdown systems, helping facilities justify and accept longer payback periods.

Some facility owners and operators may not be fully aware of the measurable energy, water, and chemical savings that an optimized automatic blowdown system provides. In facilities with experienced, stable operators and a consistent boiler load, management may feel that a manual system they regularly monitor and adjust provides sufficiently for their needs so the additional cost and perceived complexity of adding automation are not worthwhile. Further, automatic systems introduce new electronic and mechanical components that require maintenance and calibration, which some facilities may prefer to avoid. The most common failure points in automatic blowdown systems are the blowdown valve and the conductivity probe. The Statewide CASE Team included the cost of blowdown valve and conductivity probe replacement in the measure costs. See Section 3.4.4 for a full description of maintenance costs.

Some facilities have highly variable steam demand. While an automatic system can handle variable loads, operators may prefer to manually over-blowdown during peak usage rather than relying on the automated system's responsiveness. As described in section 3.2.2, owners and operators would benefit from education on the impact of automatic blowdown systems and personal outreach to address any concerns they may have with moving to an automatic blowdown system. To address a lack of awareness among various market actors, the Statewide CASE Team plans to include information on automatic blowdown system operation in the Nonresidential & Multifamily Compliance Manual and Nonresidential Appendices.

Deaerators and steam supply line pressure regulators are standard boiler system components. The proposed code change would require facilities to set the steam supply

line pressure regulator to a value between 2 and 5 psig, which may be lower than pressures used today. The Statewide CASE Team identified operational risk minimization practices and existing manufacturer setpoint ranges as potential market challenges. Facilities may opt to set steam supply line regulator pressures at higher setpoints to minimize the potential for oxygen carryover, thereby ensuring dissolved oxygen removal but increasing steam and energy use. The Statewide CASE Team plans to include information on deaerators and supply line pressure regulators in the Compliance Manual and Nonresidential Appendix to support the proposed code update.

### **3.3.2 Design and Construction Practices**

#### ***3.3.2.1 Current Design and Construction Practices***

The proposed automatic blowdown submeasure would not impact current design or construction best practices for process boilers. Automatic blowdown systems are common in boiler controls design and have been listed as a best practice in DOE literature for over 20 years, including an Energy Steam Tip Sheet that discusses the advantages of an automatic blowdown system (DOE, 2012). Additionally, patents for these systems date back to the 1980s (Gasper, 1987). These systems consist of three main components: a blowdown valve, a valve controller, and a conductivity probe. The conductivity probe measures the conductivity of hot boiler water. If the conductivity exceeds a predetermined maximum value, the controller will open the blowdown valve, allowing blowdown water to pass through and restoring conductivity to the predetermined allowable range.

The market features two types of automatic blowdown systems: continuous and timed. Continuous automatic blowdown systems are used for larger boiler systems and require a constant small stream of boiler water to be passed through the probe for monitoring. Timed automatic blowdown systems are used for smaller systems and send hot boiler water across the conductivity probe on a preset schedule (Yamatho, 2017). Automatic blowdown systems require a negligible amount of electricity to operate the controller and control valve.

Removing dissolved gases from boiler water is crucial to boiler systems because dissolved gases, such as oxygen and carbon dioxide, cause aggressive corrosion and equipment failure (Lawley, 2023). To address this issue, boiler systems are installed with atmospheric feedwater tanks or pressurized deaerator systems (Chem Aqua, n.d.). Atmospheric feedwater systems are cheaper and operate at atmospheric pressure and lower temperature ranges (less than 212°F). However, they remove less dissolved gases than pressurized deaerators and boiler systems with atmospheric feedwater systems often require additional chemical water treatment to reach desired levels of dissolved gases (Chem Aqua, n.d.). Pressurized deaerators commonly operate at

higher pressures (2 to 15 psig), higher temperatures (219 to 250°F), and achieve higher levels of dissolved gas removal than atmospheric feedwater systems, providing increased protection from corrosion (Chem Aqua, n.d.). Both atmospheric feedwater systems and pressurized deaerators preheat feedwater and prevent thermal shock to the boiler, extending boiler lifetime (Chem Aqua, n.d.). This proposed measure only applies to boiler systems with pressurized deaerators.

Deaerators remove dissolved gases from feedwater by using steam to heat the feedwater to its saturation (that is, its boiling point), breaking the surface water tension through turbulent conditions and allowing sufficient time for the steam to scrub the gases out of the water (Waldron R. , 2022). The steam and dissolved gases then exit through the deaerator vent (American Boilers Manufacturing Association, 2011). The saturation temperature at which the feedwater boils is dependent on the pressure in the deaerator, which is set by the pressure regulator on the incoming steam supply line (Lawley, 2023). The higher the pressure of the incoming steam, the more energy will be required to heat the water to a boil, and the more steam will be vented through the top of the deaerator, thereby resulting in additional energy losses.

In deaerator systems, maintaining proper incoming steam pressure is essential to ensure complete removal of dissolved oxygen and to prevent excess energy consumption associated with overheating feedwater due to elevated steam pressure. This proposed measure would require the steam supply line pressure regulator to be set at 2 to 5 psig to avoid under- and over- pressurization. Common design and construction practice includes installation of a pressure gauge on the deaerator to ensure that system is maintaining the correct pressure. Because steam supply line regulator setpoints do not impact the equipment itself and deaerator pressure gauges are a common design practice, no impacts are expected to current design and construction best practices.

### **3.3.2.2 Health and Safety Considerations**

The proposed code change does not impact any existing regulations pertaining to health and safety. If a facility typically conducts manual boiler blowdown, compliance with the proposed automatic blowdown requirement would reduce the amount of time boiler operators are exposed to hot, high-pressure equipment and boiler exhaust fumes. Review finds no health and safety considerations pertaining to the proposed steam supply line pressure regulator requirement. Additionally, both proposed submeasures would reduce local photochemical smog and improve air quality by decreasing boiler fuel consumption.

### **3.3.2.3 Design and Construction Challenges and Solutions**

See Table 27 in Section 3.2.2 for a description of workforce trainings that could support effective design, installation, and commissioning.

The Statewide CASE Team identified automatic blowdown system component malfunction as a potential challenge. If the controller is not working correctly or the conductivity probe or blowdown valve has failed, a facility would need to fix or replace these components to maintain proper boiler water quality. To address this challenge, the Statewide CASE Team has included the cost of replacement for the system and its individual components in the calculations of cost effectiveness.

The Statewide CASE Team does not anticipate any design and construction challenges for the proposed steam supply line pressure regulator, where pressure adjustments are standard practice in the field.

### **3.3.3 Energy Equity and Environmental Justice**

Each measure in this CASE Report was evaluated for ESJ impacts using 4 criteria: cost, health, resiliency, and comfort. The details of that evaluation can be found in Section 1.4 and the [2028 CASE Methodology Report](#).

The Statewide CASE Team does not expect any impact on the health and safety of ESJ communities, or on their disaster preparedness. The comfort of ESJ communities is unlikely to be impacted by the proposed code changes.

Use of an automatic boiler blowdown system and an appropriately low setpoint for the steam supply line pressure regulator would lower boiler fuel consumption. This fuel reduction will reduce GHG emissions and improve local air quality. The value of improved air quality from the proposed code changes is amplified by the fact that industrial facilities are disproportionately located near ESJ and LMI communities. As a result, the Statewide CASE Team expects that ESJ communities may experience a disproportionate air quality improvement from this proposed measure.

### **3.3.4 Impacts on Jobs and Businesses**

The Statewide CASE Team does not anticipate significant employment or financial impacts on any particular sector of the California economy. However, the proposed change may have modest impacts on employment in California. The Statewide CASE Team estimates that the proposed change would directly and indirectly affect statewide employment and economic output through its impact on builders, designers, energy consultants, and building inspectors. Table 31, Table 32, and Table 33 outline the statewide implications for these job categories. For more information on the Statewide CASE Team's economic impacts methodology, see the [2028 CASE Methodology Report](#).

The Statewide CASE Team does not anticipate that the proposed changes would lead to the creation of new types of jobs or the elimination of existing types of jobs. In other words, the Statewide CASE Team’s proposed change would not result in economic disruption to any sector of the California economy. Rather, it would lead to modest increases in the employment of existing jobs.

**Table 31: Estimated Impact that Adoption of the Proposed Measure would have on the California Nonresidential Construction Sector**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by Commercial Builders)</b>	6.4	\$508,350	\$765,373	\$1,656,033
<b>Indirect Effect (Additional spending by firms supporting Commercial Builders)</b>	3.7	\$293,849	\$504,474	\$883,193
<b>Total Economic Impacts</b>	<b>10.1</b>	<b>\$802,200</b>	<b>\$1,269,846</b>	<b>\$2,539,227</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.<sup>14</sup>

**Table 32: Estimated Impact that Adoption of Proposed Measure would have on California Building Designers and Energy Consultant Sectors**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by building designers and energy consultants)</b>	0.04	\$4,592	\$4,546	\$7,185
<b>Indirect Effect (Additional spending by firms supporting building designers and energy consultants)</b>	0.02	\$1,367	\$1,900	\$3,059
<b>Total Economic Impacts</b>	<b>0.06</b>	<b>\$5,959</b>	<b>\$6,446</b>	<b>\$10,244</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

<sup>14</sup> IMPLAN® model, 2020 Data, IMPLAN Group LLC, IMPLAN System (data and software), 16905 Northcross Dr., Suite 120, Huntersville, NC 28078 [www.IMPLAN.com](http://www.IMPLAN.com)

**Table 33: Estimated Impact that Adoption of the Proposed Measure would have on California Building Inspectors**

Type of Economic Impact	Employment (Jobs)	Labor Income	Total Value Added	Output
<b>Direct Effects (Additional spending by building inspectors)</b>	0.022	\$2,493	\$2,957	\$3,593
<b>Indirect Effect (Additional spending by firms supporting building inspectors)</b>	0.003	\$231	\$360	\$626
<b>Total Economic Impacts</b>	<b>0.025</b>	<b>\$2,724</b>	<b>\$3,317</b>	<b>\$4,220</b>

Source: Statewide CASE Team analysis of data from the IMPLAN modeling software.

The proposed change represents a modest adjustment to industrial boiler operation that would not excessively burden or competitively disadvantage California businesses, nor is it expected to lead to a competitive advantage. Therefore, the Statewide CASE Team does not expect the proposed code changes to result in the creation of new businesses or the elimination of existing ones.

The proposed code changes would apply to all businesses operating in California, regardless of whether the business is incorporated inside or outside of the state.<sup>15</sup> Therefore, the Statewide CASE Team does not anticipate that the proposed changes would have advantageous or an adverse effect on the competitiveness of California businesses.

The Statewide CASE Team derived a reasonable estimate of the change in investment by California businesses based on the estimated change in economic activity associated with the proposed measure and its expected effect on proprietor income. The Statewide CASE Team’s IMPLAN modeling resulted in an estimated \$175,827 increase in California business income due to the proposed code change. The Statewide CASE Team assumes that net business investment is positively correlated with business income and that a portion of business income will be allocated to net business investment.

To estimate the portion of business income that will be allocated to net investment, the Statewide CASE Team analyzed national data on corporate profits and net capital investment by businesses that expand a firm’s capital stock (referred to as net private

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<sup>15</sup> 2 Gov. Code, §§ 11346.3(c)(1)(C), 11346.3(a)(2); 1 CCR § 2003(a)(3) Competitive advantages or disadvantages for California businesses currently doing business in the state.

domestic investment, or NPDI).<sup>16</sup> As Table 34 shows, between 2020 and 2024, NPDI as a percentage of corporate profits ranged from a low of 18 percent in 2020 due to the worldwide economic slowdowns associated with the COVID 19 pandemic to a high of 28 percent in 2022, with an average of 23 percent. While only an approximation of the proportion of business income used for net capital investment, it provides a reasonable estimate of the proportion of incremental income that business owners would reinvest into expanding their capital stock.

**Table 34: Net Domestic Private Investment and Corporate Profits, U.S.**

Year	Net Domestic Private Investment by Businesses, Billions of Dollars	Corporate Profits After Taxes, Billions of Dollars	Ratio of Net Private Investment to Corporate Profits (Percent)
2020	\$389	\$2,212	18%
2021	\$545	\$2,888	19%
2022	\$825	\$2,951	28%
2023	\$836	\$3,069	27%
2024	\$885	\$3,441	26%
<b>5-Year Average</b>	-	-	<b>23%</b>

Source: (Federal Reserve Economic Data (FRED) n.d.)

Given the estimated total increase in California business income and net business investment ratio described above, the Statewide CASE Team estimates the proposed code change would result in a \$41,273 increase in net private investment by California businesses.

### 3.3.5 Economic and Fiscal Impacts

The Statewide CASE Team does not anticipate that the economic impacts associated with the proposed measure would lead to a significant change (increase or decrease) in investment, directly or indirectly, in any affected sectors of California’s economy. The proposed change would not result in economic disruption to any sector of the California economy. For more information on the Statewide CASE Team’s economic and fiscal impacts methodology, see the [2028 CASE Methodology Report](#).

Adoption of this code change proposal would result in relatively modest economic impacts through additional direct spending by or on industrial contractors, energy consultants, and building inspectors. The Statewide CASE Team does not anticipate

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<sup>16</sup> Net private domestic investment is the total amount of investment in capital by the business sector that is used to expand the capital stock, rather than maintain or replace due to depreciation. Corporate profit is the money left after a corporation pays its expenses.

that money saved by businesses or other organizations affected by the proposed 2028 code cycle regulations would result in additional spending by those businesses.

### **3.3.5.1 3.3.5.1 Effects on the State General Fund, State Special Funds, and Local Governments**

The Statewide CASE Team does not expect the proposed code changes to have a measurable impact on California's General Fund, any state special funds, or local government funds.

**Cost to state:** The state government already has a budget for code development, education, and compliance enforcement. While the state government would be allocating resources to update the Title 24, Part 6 Standards, including updating education and compliance materials and responding to questions about the revised requirements, these activities are already covered by existing state budgets. The costs for the state government are small when compared to the overall cost savings and policy benefits associated with the code change proposals. State buildings do not commonly operate process boilers of qualifying size and so would not be directly impacted by the measure.

**Cost to local governments:** All proposed code changes to Title 24, Part 6 would affect compliance determinations. Local governments would need to train building department staff on the revised Title 24, Part 6 Standards. While this retraining is an expense to local governments, it is not a new cost associated with the 2028 code change cycle. The building code is updated on a triennial basis, and local governments plan and budget for retraining each time the code is updated. There are numerous resources available to local governments to support compliance training that can help mitigate the cost of retraining, including tools, training, and resources provided by the IOU Codes and Standards program (such as Energy Code Ace). As noted in Section 3, the Statewide CASE Team considered how the proposed code change might impact various market actors involved in the compliance and enforcement process and aimed to minimize negative impacts on local governments.

### **3.3.5.2 Mandates on Local Agencies or School Districts**

There are no relevant mandates to local agencies or school districts because local agencies and schools do not typically operate process boilers of qualifying size.

### **3.3.5.3 Costs to Local Agencies or School Districts**

There are no costs to local agencies or school districts because local agencies and schools do not typically operate process boilers of qualifying size.

### **3.3.5.4 Costs or Savings to Any State Agency**

There are no costs or savings to any state agencies because these agencies do not typically operate process boilers of qualifying size.

### **3.3.5.5 Other Non-Discretionary Cost or Savings Imposed on Local Agencies**

There are no added non-discretionary costs or savings to local agencies because local agencies do not typically operate process boilers of qualifying size.

### **3.3.5.6 Costs or Savings in Federal Funding to the State**

The Statewide CASE Team did not identify any costs or savings to federal funding to the state.

## **3.4 Automatic Blowdown and Deaerator Pressure – Cost Effectiveness**

### **3.4.1 Cost Effectiveness Methodology**

The Statewide CASE Team collaborated with CEC staff to confirm that the cost effectiveness methodology aligns with CEC guidelines, including cost-inclusion parameters. The [2028 CASE Methodology Report](#) and Appendix A provide reproducibility details.

Per California Law (Public Resources Code 25000), a measure is considered cost effective if its BCR is 1.0 or greater, amortized over the economic life of the structure. The Statewide CASE Team calculates BCR by dividing total dollar benefits by total dollar costs over a 30-year analysis period.

Benefits are based on LSC, which assigns an hourly dollar value to energy use. LSC hourly factors weigh the long-term value of each hour differently, with peak demand hours valued more than off-peak hours. These factors are not utility rates, forecasts, or bill estimates. Instead, the CEC develops and publishes LSC hourly conversion factors for each code cycle.

Measure costs include first costs and ongoing maintenance costs assessed over the 30-year period. Benefits and costs are evaluated incrementally, relative to the most recently adopted Energy Code.

### **3.4.2 Energy and Energy Cost Savings Results**

Per-unit energy savings analyses of per-unit energy savings were conducted independently for the automatic blowdown and deaerator system pressure requirements. Review finds no anticipated interactive effects between automatic blowdown and deaerator system pressure setpoints.

For the automatic blowdown requirement, the baseline case is a boiler maintained with manual blowdown, and the proposed case is a boiler with an automatic blowdown system. Savings result from the reduction in hot water removed from the boiler when conducting less blowdown, calculated by subtracting the boiler's annual energy lost to blowdown with automatic blowdown from the boiler's annual energy lost to blowdown with manual blowdown.

Natural gas savings increase as the boiler capacity increases because a larger total volume of water is blown down. The percentage of water savings scales based on the boiler capacity, so the greater the water savings, the greater the energy saved from avoided make-up water heating.

The main driver of savings from automatic blowdown is the difference in the boiler water conductivity between the baseline and the proposed measure cases. A larger difference indicates greater fluctuation in conductivity under manual blowdown and more excessive manual blowdown. The assumed difference of 500  $\mu\text{S}$  used for the calculation was selected as a conservative value, as both reference sites experienced a conductivity difference exceeding 1,000  $\mu\text{S}$ .

The longer the boiler is operated, the greater the resultant savings. As such, boilers that operate infrequently throughout the year due to seasonal loads will experience lower savings. Due to this variance, the Statewide CASE Team calculated annual energy savings and cost effectiveness for boilers with seasonal loads separately from boilers with more typical annual loads. 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 in July through October) at 80 percent load. The Statewide CASE Team based the operating-hours and load-factor assumptions on field data from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).

Savings from an automatic blowdown system should stay constant over the measured lifetime. Boiler operators could choose not to use an installed automatic blowdown system, which would decrease the energy savings from the measure.

Per-unit savings for the first year for the automatic blowdown measure are expected to be about 21,500 kBtu/yr per MMBtu/h boiler capacity for year-round boiler operation, and about 15,900 kBtu/yr per MMBtu/h boiler capacity for seasonal boiler operation, as shown in Table 35. There are no electric savings or demand reductions associated with this measure. The per-unit energy savings of this measure are not impacted by climate zone and are the same for new construction, additions, and alterations.

Table 36 presents total per unit energy cost savings for the automatic blowdown measure for newly added boilers in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV\$) for the boilers in each size bin.

**Table 35: First Year Natural Gas Savings (kBtu) Per MMBtu/h of Boiler Capacity -- Automatic Blowdown**

<b>Boiler Category</b>	<b>First Year Natural Gas Savings (kBtu)</b>
<b>Year-Round 10-15 MMBtu/h</b>	21,700
<b>Year-Round 15-25 MMBtu/h</b>	21,600
<b>Year-Round 25-50 MMBtu/h</b>	21,500
<b>Year-Round 50-100 MMBtu/h</b>	21,800
<b>Year-Round 100-200 MMBtu/h</b>	21,600
<b>Year-Round 200+ MMBtu/h</b>	21,500
<b>Seasonal 10-15 MMBtu/h</b>	15,900
<b>Seasonal 15-25 MMBtu/h</b>	15,900
<b>Seasonal 25-50 MMBtu/h</b>	15,900
<b>Seasonal 50-100 MMBtu/h</b>	15,900
<b>Seasonal 100-200 MMBtu/h</b>	15,900
<b>Seasonal 200+ MMBtu/h</b>	15,900

**Table 36: Total 30-Year LSC Savings (2029 PV\$) Per MMBtu/h of Boiler Capacity – Automatic Blowdown**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	17,987	17,987	17,987	17,987	17,987	18,205	18,151	18,205	18,205	18,205	17,987	17,987	17,987	18,205	18,205	18,205
<b>Year-Round 15-25 MMBtu/h</b>	17,904	17,904	17,904	17,904	17,904	18,121	18,068	18,121	18,121	18,121	17,904	17,904	17,904	18,121	18,121	18,121
<b>Year-Round 25-50 MMBtu/h</b>	17,821	17,821	17,821	17,821	17,821	18,037	17,984	18,037	18,037	18,037	17,821	17,821	17,821	18,037	18,037	18,037
<b>Year-Round 50-100 MMBtu/h</b>	18,070	18,070	18,070	18,070	18,070	18,289	18,235	18,289	18,289	18,289	18,070	18,070	18,070	18,289	18,289	18,289
<b>Year-Round 100-200 MMBtu/h</b>	17,904	17,904	17,904	17,904	17,904	18,121	18,068	18,121	18,121	18,121	17,904	17,904	17,904	18,121	18,121	18,121
<b>Year-Round 200+ MMBtu/h</b>	17,821	17,821	17,821	17,821	17,821	18,037	17,984	18,037	18,037	18,037	17,821	17,821	17,821	18,037	18,037	18,037
<b>Seasonal 10-15 MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707
<b>Seasonal 15-25 MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707
<b>Seasonal 25-50 MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707
<b>Seasonal 50-100 MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707
<b>Seasonal 100-200 MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707
<b>Seasonal 200+ MMBtu/h</b>	11,691	11,691	11,691	11,691	11,691	11,707	11,704	11,707	11,707	11,707	11,691	11,691	11,691	11,707	11,707	11,707

For the deaerator pressure requirement, the baseline case is a boiler with its steam supply line pressure regulator and deaerator set to 8 psig and the proposed case is a boiler with its steam supply line pressure regulator and deaerator set to 5 psig. Savings result from the decreased energy loss when less steam is vented due to over-pressurization of the deaerator.

To estimate the natural gas savings from improved deaerator control, the Statewide CASE Team calculated the mass flow of steam lost to over-pressurization in lbs/h when the deaerator setpoint is 8 psig. The Statewide CASE Team used a Cascade Energy tool to calculate the amount of steam vented and then calculated the therms required to make up for the volume of excess steam vented.

Natural gas savings are higher for the largest boiler size because the deaerator and vent valve are larger. The estimates are neither conservative nor ambitious, though they may be conservative for larger boilers. While the savings are modest, they are not offset by any costs. The savings due to deaerator pressure should stay constant over the measure lifetime. The savings would change if a boiler operator chose to change the steam supply line pressure regulator or deaerator pressure setpoints.

The longer the boiler is operated, the greater the savings. As such, boilers that operate infrequently throughout the year due to seasonal loads will experience lower savings. Due to this variance, the Statewide CASE Team calculated annual energy savings and cost-effectiveness for boilers with seasonal loads separately from boilers with more typical annual loads. 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 IAC database (Swanson & Staller, 2025).

First-year per-unit savings for the deaerator pressure submeasure are expected to range from 300 to 5,800 kBtu/yr per MMBtu/h boiler capacity for year-round boiler operation and from 100 to 2,500 kBtu/yr per MMBtu/h boiler capacity for seasonal boiler operation, as shown in Table 37. No electric savings or demand reductions are assumed to be associated with this measure. The per-unit energy savings of this measure are not affected by climate zone and are consistent across new construction, additions, and alterations.

Table 38 presents total per-unit energy cost savings for the deaerator pressure submeasure in terms of LSC savings realized over a 30-year period, in 2029 present value dollars (2029 PV\$) for the boilers in each size bin.

**Table 37: First Year Natural Gas Savings (kBtu) Per MMBtu/h of Boiler Capacity -- Deaerator Pressure**

<b>Boiler Category</b>	<b>First Year Natural Gas Savings (kBtu)</b>
<b>Year-Round 10-15 MMBtu/h</b>	5,800
<b>Year-Round 15-25 MMBtu/h</b>	3,600
<b>Year-Round 25-50 MMBtu/h</b>	2,100
<b>Year-Round 50-100 MMBtu/h</b>	2,000
<b>Year-Round 100-200 MMBtu/h</b>	1,000
<b>Year-Round 200+ MMBtu/h</b>	300
<b>Seasonal 10-15 MMBtu/h</b>	2,500
<b>Seasonal 15-25 MMBtu/h</b>	1,500
<b>Seasonal 25-50 MMBtu/h</b>	900
<b>Seasonal 50-100 MMBtu/h</b>	800
<b>Seasonal 100-200 MMBtu/h</b>	400
<b>Seasonal 200+ MMBtu/h</b>	100

**Table 38: Total 30-Year LSC Savings (2029 PV\$) Per MMBtu/h of Boiler Capacity – Deaerator Pressure**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	4,808	4,808	4,808	4,808	4,808	4,866	4,852	4,866	4,866	4,866	4,808	4,808	4,808	4,866	4,866	4,866
<b>Year-Round 15-25 MMBtu/h</b>	2,984	2,984	2,984	2,984	2,984	3,020	3,011	3,020	3,020	3,020	2,984	2,984	2,984	3,020	3,020	3,020
<b>Year-Round 25-50 MMBtu/h</b>	1,741	1,741	1,741	1,741	1,741	1,762	1,757	1,762	1,762	1,762	1,741	1,741	1,741	1,762	1,762	1,762
<b>Year-Round 50-100 MMBtu/h</b>	1,658	1,658	1,658	1,658	1,658	1,678	1,673	1,678	1,678	1,678	1,658	1,658	1,658	1,678	1,678	1,678
<b>Year-Round 100-200 MMBtu/h</b>	829	829	829	829	829	839	836	839	839	839	829	829	829	839	839	839
<b>Year-Round 200+ MMBtu/h</b>	249	249	249	249	249	252	251	252	252	252	249	249	249	252	252	252
<b>Seasonal 10-15 MMBtu/h</b>	1,838	1,838	1,838	1,838	1,838	1,841	1,840	1,841	1,841	1,841	1,838	1,838	1,838	1,841	1,841	1,841
<b>Seasonal 15-25 MMBtu/h</b>	1,103	1,103	1,103	1,103	1,103	1,104	1,104	1,104	1,104	1,104	1,103	1,103	1,103	1,104	1,104	1,104
<b>Seasonal 25-50 MMBtu/h</b>	662	662	662	662	662	663	662	663	663	663	662	662	662	663	663	663
<b>Seasonal 50-100 MMBtu/h</b>	588	588	588	588	588	589	589	589	589	589	588	588	588	589	589	589
<b>Seasonal 100-200 MMBtu/h</b>	294	294	294	294	294	295	294	295	295	295	294	294	294	295	295	295
<b>Seasonal 200+ MMBtu/h</b>	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74	74

### 3.4.3 Incremental First Cost

The baseline case for evaluating the incremental costs of this sub measure consists of a boiler system with a manual throttling valve and no automatic blowdown system. Boilers with automatic blowdown systems typically also have a manual throttling valve. The incremental first cost of an automatic blowdown system includes the hardware and installation costs of a controller, a valve with an actuator controlled by the controller, and a conductivity probe.

During stakeholder interviews in August and September 2025, multiple boiler vendors quoted approximately \$5,000 as the general cost of an automatic blowdown system. The Statewide CASE Team conservatively estimated the blowdown system installation costs to be roughly equivalent to the equipment costs, including system startup and commissioning (setting conductivity parameters), and completion of required acceptance testing. Overall, the Statewide CASE Team estimates the incremental first costs of an automatic blowdown system to be \$10,000 for boilers rated 50 MMBtu/h and smaller, \$15,000 for boilers from 50 to 100 MMBtu/h, \$20,000 for boilers from 100 to 200 MMBtu/h, and \$30,000 for boilers 200 MMBtu/h or larger. The Statewide CASE Team estimates acceptance testing costs for this submeasure to amount to one hour of field technician labor at \$200 per hour.

The Statewide CASE Team does not expect the incremental first costs to vary significantly between new and replacement systems or to change significantly over time.

Adjusting the supply line pressure regulator setpoint has no associated equipment cost. The only incremental cost for the deaerator pressure requirement is the cost of the labor for the acceptance test performed by a field technician to confirm that the regulator pressure is set in accordance with the requirement. The Statewide CASE Team estimates acceptance testing costs for this submeasure to amount to about one hour of field technician labor at \$200 per hour. The Statewide CASE Team expects that in most cases, the same field technician would verify settings for and fill out the NRCA-PRC-XX-F acceptance test form to verify compliance with both the automatic blowdown and deaerator pressure requirements.

### 3.4.4 Incremental Maintenance and Replacement Costs

Descriptions of incremental maintenance and replacement costs, as well as estimations of the present value of maintenance and replacement costs, are provided in the [2028 CASE Methodology Report](#).

Incremental maintenance for automatic blowdown systems includes replacing the blowdown valve and conductivity probe every three years. Full system replacement is anticipated every 15 years. Replacement costs for the valve (\$1,000) and probe (\$500) were assumed to be equivalent to their first costs, which were obtained from vendor

product data in 2025. These component replacements are much less expensive than the total system cost because most of the system cost comes from the controller, which must be replaced only every 15 years. The Statewide CASE Team estimated valve replacement cost in the baseline case to be negligible, given the extremely low first cost of the manual valve and reduced need for replacement, as the automatic blowdown valves are actuated more frequently. The Statewide CASE Team assumed that facility operators would replace the valves and conductivity probes simultaneously.

The proposed deaerator pressure requirement only involves changing the setpoint on an existing piece of equipment and has no incremental maintenance costs.

### 3.4.5 Cost Effectiveness

As described in Section 3.4.3, the Statewide CASE Team used 2025 cost estimates from a boiler manufacturer and a boiler vendor to estimate the incremental costs of an automatic blowdown system.

The Statewide CASE Team evaluated per-unit cost effectiveness for both year-round operation and seasonal boilers at six different capacities to ensure the proposed requirement for boilers with lower annual operating hours and is cost-effective across the size range covered by the proposed measure.

The Statewide CASE Team also evaluated the proposed measure’s cost-effectiveness when the boiler steam header pressure was set to 15 psig rather than 100 psig to account for sites with lower steam header pressures. With lower pressure, energy savings decreased by 29 percent, and the measure remained cost-effective.

Table 39 shows the boiler capacity bin ranges and the average capacity of the boilers within each bin, which were used to calculate cost effectiveness. Data on the capacity of installed boilers in California came from the statewide boiler inventory of local AQMD permits, as described in more detail in Appendix C. Boilers not subject to Title 24 or the proposed measure were removed prior to determining the average capacity, as described in more detail in Section 3.5.1.

**Table 39. 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

Results of the per-unit cost-effectiveness analyses are presented in Table 40 and

Table 41 for year-round and seasonal boilers, respectively, for the automatic blowdown measure, and in Table 43 and Table 44 for year-round and seasonal boilers, respectively, for the deaerator pressure measure. Table 42 and Table 45 display the BCR values for each prototype by climate zone. The proposed measure saves money over the 30-year period of analysis relative to the existing conditions and is cost effective for both annual and seasonal boilers in each capacity bin.

In the tables below, all values are presented in 2029 present value dollars (2029 PV\$). Benefits represent 30-year LSC savings and other savings, including incremental first-cost savings if the proposed first cost is less than the current first cost, incremental maintenance cost savings if the proposed maintenance costs are less than the current maintenance costs, and incremental residual value if the proposed residual value is greater than the current residual value at the end of the 30-year period of analysis. Costs represent the total incremental PV cost, including incremental equipment, replacement, and maintenance costs over the period of analysis. The analysis treats a negative incremental maintenance cost as a positive benefit. If total incremental costs are zero, the BCR is considered infinite. Costs and other savings are discounted at a real (inflation-adjusted) three percent rate. If there are no total incremental PV costs, the BCR is infinite. A BCR of “NA” indicates that there is no boiler capacity in that climate zone that the proposed requirement would impact.

**Table 40: 30-Year Automatic Blowdown Cost-Effectiveness Summary Per MMBtu/h – Year-Round Boilers**

<b>Boiler Category</b>	<b>Benefits LSC Savings + Other PV Savings (2029 PV\$)</b>	<b>Costs Total Incremental PV Costs (2029 PV\$)</b>	<b>Benefit-to- Cost Ratio</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	\$18,097.34	\$2,127.83	8.51
<b>Year-Round Boiler 15-25 MMBtu/h</b>	\$18,012.41	\$1,343.89	13.40
<b>Year-Round Boiler 25-50 MMBtu/h</b>	\$17,912.62	\$783.25	22.87
<b>Year-Round Boiler 50-100 MMBtu/h</b>	\$18,082.64	\$475.26	38.05
<b>Year-Round Boiler 100-200 MMBtu/h</b>	\$17,956.55	\$293.37	61.21
<b>Year-Round Boiler 200+ MMBtu/h</b>	\$17,971.60	\$78.97	227.59

**Table 41: 30-Year Automatic Blowdown Cost-Effectiveness Summary Per MMBtu/h – Seasonal Boilers**

<b>Boiler Category</b>	<b>Benefits LSC Savings + Other PV Savings (2029 PV\$)</b>	<b>Costs Total Incremental PV Costs (2029 PV\$)</b>	<b>Benefit-to- Cost Ratio</b>
<b>Seasonal Boiler 10-15 MMBtu/h</b>	\$11,698.74	\$2,127.83	5.50
<b>Seasonal Boiler 15-25 MMBtu/h</b>	\$11,698.63	\$1,343.89	8.71
<b>Seasonal Boiler 25-50 MMBtu/h</b>	\$11,697.40	\$783.25	14.93
<b>Seasonal Boiler 50-100 MMBtu/h</b>	\$11,691.47	\$475.26	24.60
<b>Seasonal Boiler 100-200 MMBtu/h</b>	\$11,694.43	\$293.37	39.86
<b>Seasonal Boiler 200+ MMBtu/h</b>	\$11,701.79	\$78.97	148.19

**Table 42: Benefit-to-Cost Ratio – Automatic Blowdown**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	8.5	8.5	8.5	8.5	8.5	8.6	8.5	8.6	8.6	8.6	8.5	8.5	8.5	8.6	8.6	8.6
<b>Year-Round 15-25 MMBtu/h</b>	N/A	13.3	13.3	13.3	13.3	13.5	13.4	13.5	13.5	13.5	13.3	13.3	13.3	13.5	13.5	13.5
<b>Year-Round 25-50 MMBtu/h</b>	22.8	22.8	22.8	22.8	22.8	23.0	23.0	23.0	23.0	23.0	22.8	22.8	22.8	23.0	23.0	23.0
<b>Year-Round 50-100 MMBtu/h</b>	N/A	38.0	38.0	38.0	38.0	38.5	38.4	38.5	38.5	38.5	38.0	38.0	38.0	38.5	38.5	38.5
<b>Year-Round 100-200 MMBtu/h</b>	N/A	61.0	61.0	61.0	N/A	61.8	N/A	61.8	61.8	61.8	61.0	61.0	61.0	61.8	61.8	61.8
<b>Year-Round 200+ MMBtu/h</b>	225.7	225.7	225.7	225.7	N/A	228.4	N/A	228.4	228.4	228.4	225.7	225.7	225.7	228.4	228.4	228.4
<b>Seasonal 10-15 MMBtu/h</b>	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
<b>Seasonal 15-25 MMBtu/h</b>	N/A	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7	8.7
<b>Seasonal 25-50 MMBtu/h</b>	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9	14.9
<b>Seasonal 50-100 MMBtu/h</b>	N/A	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6	24.6
<b>Seasonal 100-200 MMBtu/h</b>	N/A	39.8	39.8	39.8	N/A	39.9	N/A	39.9	39.9	39.9	39.8	39.8	39.8	39.9	39.9	39.9
<b>Seasonal 200+ MMBtu/h</b>	148.0	148.0	148.0	148.0	N/A	148.3	N/A	148.3	148.3	148.3	148.0	148.0	148.0	148.3	148.3	148.3

**Table 43: 30-Year Deaerator Pressure Cost-Effectiveness Summary Per MMBtu/h – Year-Round Boilers**

<b>Boiler Category</b>	<b>Benefits LSC Savings + Other PV Savings (2029 PV\$)</b>	<b>Costs Total Incremental PV Costs (2029 PV\$)</b>	<b>Benefit-to-Cost Ratio</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	\$4,837.08	\$16.67	290.22
<b>Year-Round Boiler 15-25 MMBtu/h</b>	\$3,002.07	\$10.53	285.20
<b>Year-Round Boiler 25-50 MMBtu/h</b>	\$1,749.60	\$6.13	285.19
<b>Year-Round Boiler 50-100 MMBtu/h</b>	\$1,658.96	\$2.82	588.93
<b>Year-Round Boiler 100-200 MMBtu/h</b>	\$831.32	\$1.40	594.39
<b>Year-Round Boiler 200+ MMBtu/h</b>	\$250.77	\$0.27	926.83

**Table 44: 30-Year Deaerator Pressure Cost-Effectiveness Summary Per MMBtu/h – Seasonal Boilers**

<b>Boiler Category</b>	<b>Benefits LSC Savings + Other PV Savings (2029 PV\$)</b>	<b>Costs Total Incremental PV Costs (2029 PV\$)</b>	<b>Benefit-to-Cost Ratio</b>
<b>Seasonal Boiler 10-15 MMBtu/h</b>	\$1,839.43	\$16.67	110.37
<b>Seasonal Boiler 15-25 MMBtu/h</b>	\$1,103.64	\$10.53	104.85
<b>Seasonal Boiler 25-50 MMBtu/h</b>	\$662.12	\$6.13	107.93
<b>Seasonal Boiler 50-100 MMBtu/h</b>	\$588.25	\$2.82	208.83
<b>Seasonal Boiler 100-200 MMBtu/h</b>	\$294.20	\$1.40	210.35
<b>Seasonal Boiler 200+ MMBtu/h</b>	\$73.60	\$0.27	272.01

**Table 45: Benefit-to-Cost Ratio – Deaerator Pressure**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>
<b>Year-Round 10-15 MMBtu/h</b>	288.5	288.5	288.5	288.5	288.5	292.0	291.1	292.0	292.0	292.0	288.5	288.5	288.5	292.0	292.0	292.0
<b>Year-Round 15-25 MMBtu/h</b>	N/A	283.5	283.5	283.5	283.5	286.9	286.1	286.9	286.9	286.9	283.5	283.5	283.5	286.9	286.9	286.9
<b>Year-Round 25-50 MMBtu/h</b>	283.7	283.7	283.7	283.7	283.7	287.2	286.3	287.2	287.2	287.2	283.7	283.7	283.7	287.2	287.2	287.2
<b>Year-Round 50-100 MMBtu/h</b>	N/A	588.5	588.5	588.5	588.5	595.6	593.9	595.6	595.6	595.6	588.5	588.5	588.5	595.6	595.6	595.6
<b>Year-Round 100-200 MMBtu/h</b>	N/A	592.7	592.7	592.7	N/A	599.8	N/A	599.8	599.8	599.8	592.7	592.7	592.7	599.8	599.8	599.8
<b>Year-Round 200+ MMBtu/h</b>	919.1	919.1	919.1	919.1	N/A	930.2	N/A	930.2	930.2	930.2	919.1	919.1	919.1	930.2	930.2	930.2
<b>Seasonal 10-15 MMBtu/h</b>	110.3	110.3	110.3	110.3	110.3	110.4	110.4	110.4	110.4	110.4	110.3	110.3	110.3	110.4	110.4	110.4
<b>Seasonal 15-25 MMBtu/h</b>	N/A	104.8	104.8	104.8	104.8	104.9	104.9	104.9	104.9	104.9	104.8	104.8	104.8	104.9	104.9	104.9
<b>Seasonal 25-50 MMBtu/h</b>	107.9	107.9	107.9	107.9	107.9	108.0	108.0	108.0	108.0	108.0	107.9	107.9	107.9	108.0	108.0	108.0
<b>Seasonal 50-100 MMBtu/h</b>	N/A	208.8	208.8	208.8	208.8	209.1	209.0	209.1	209.1	209.1	208.8	208.8	208.8	209.1	209.1	209.1
<b>Seasonal 100-200 MMBtu/h</b>	N/A	210.3	210.3	210.3	N/A	210.6	N/A	210.6	210.6	210.6	210.3	210.3	210.3	210.6	210.6	210.6
<b>Seasonal 200+ MMBtu/h</b>	271.7	271.7	271.7	271.7	N/A	272.1	N/A	272.1	272.1	272.1	271.7	271.7	271.7	272.1	272.1	272.1

## 3.5 Automatic Blowdown and Deaerator Pressure – Statewide Impacts

### 3.5.1 Statewide Energy and Energy Cost Savings

The Statewide CASE Team took the following steps to determine statewide savings from the proposed automatic blowdown and deaerator pressure measure.

The Statewide CASE Team used a statewide boiler inventory with 9,000 equipment entries from local air quality management districts to estimate current installed boiler capacity and boiler counts in California, developed as part of a Code Readiness project (Swanson & Staller, 2025). The Statewide CASE Team split this inventory into bins by boiler capacity.

The Statewide CASE Team refined the statewide capacity in each capacity bin to account for equipment within the purview of Title 24, Part 6, and proposed exceptions, making the following changes:

- Removed boilers with input capacities under 10 MMBtu/h and any units that were indicated to be hot water boilers or hot water heaters in the permit data.
- Removed oilfield and utility boiler capacity, as these boilers are not in buildings and are thus not subject to Title 24, Part 6 requirements.
- For the automatic blowdown submeasure only: Removed additional boiler capacity to represent the total proportion of boilers estimated to qualify for at least one measure exception, including boiler systems with returned condensate comprising more than 90 percent of feedwater flow, boilers with make-up water treated by a reverse osmosis system, and boilers employing blowdown heat recovery. The Statewide CASE Team chose to aggregate estimates of boiler exception qualification because of overlapping applicability, where boilers may simultaneously qualify for more than one exception. Table 46 includes the percentages of boiler capacity that were removed from the statewide capacity by boiler capacity bin. Larger boilers are more likely to qualify for these exceptions.
- For the deaerator pressure submeasure only: Removed 7.5 percent of boiler capacity to account for sites that serve the deaerator with high-pressure, high-temperature condensate and sites that may qualify for the exception. Sites with high-pressure, high-temperature condensate may comply with the proposed requirement that the steam supply line pressure regulator setpoint to be 5 psig, but the deaerator will operate at a higher pressure, and they will not realize direct energy savings from the proposed requirement.
- Separated seasonal boilers from annual boilers by classifying boilers at major tomato and canned fruit and vegetable processors as seasonal boilers.

**Table 46. Boilers Qualifying for Blowdown Requirement Exception by Boiler Capacity**

Boiler Capacity Bin	Estimated Percentage of Boilers Qualifying for Automatic Blowdown Requirement Exceptions
10-15 MMBtu/h	5%
15-25 MMBtu/h	7%
25-50 MMBtu/h	10%
50-100 MMBtu/h	25%
100-200 MMBtu/h	30%
200+ MMBtu/h	30%

Following these refinements, the statewide capacity represents the Existing Boilers Stock. Boilers at or above 10 MMBtu/h in the healthcare, education, non-cannery food, lumber, refinery, and ‘all other’ sectors were included in the statewide capacity totals.

To estimate the capacity of new process boilers installed annually in new construction and additions, the Statewide CASE Team calculated two IPGRs for California, one for year-round boilers and one for seasonal boilers. See Appendix C for details on how the Statewide CASE Team calculated the IPGRs. The annual new construction and additions forecast is equivalent to the Existing Boiler Stock multiplied by the IPGRs.

To estimate the capacity of new process boilers installed annually from alterations, which are typically boiler 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 & 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 annual alterations forecast is therefore calculated as the Existing Boiler Stock multiplied by 3.3 percent. See the [2028 CASE Methodology Report](#) for details on how statewide savings are calculated.

The Statewide CASE Team then multiplied the per-unit measure savings (the sum of the automatic blowdown savings and the deaerator pressure savings) by the annual new construction and additions forecast and by the alterations forecast to get first-year statewide savings, not accounting for natural market adoption.

To estimate the share of new boilers that would have automatic blowdown systems installed without the requirement in place, the Statewide CASE Team leaned on input from boiler manufacturers and vendors during stakeholder interviews and an analysis of IAC audit data from 64 boilers in 32 steam-using industrial plants from 2010 to 2022 (Swanson & Staller, 2025). The estimated market adoption is outlined in Table 47.

**Table 47: Estimated Current Automatic Blowdown Market Adoption in California**

Boiler Capacity	Estimated Automatic Blowdown Market Adoption
10-15 MMBtu/h	25%
15-25 MMBtu/h	30%
25-50 MMBtu/h	35%
50-100 MMBtu/h	40%
100-200 MMBtu/h	45%
200+ MMBtu/h	75%

The Statewide CASE Team applied these market share percentages to the statewide savings for each boiler capacity bin to arrive at the final statewide savings estimate. Appendix C Table 50 presents the assumptions on the percentage of the total construction forecast that the proposed measure would impact. For more details on the methodology and context about estimating the current market share rate, as well as statewide energy and energy cost savings, see the [2028 CASE Methodology Report](#).

Table 48 presents the statewide energy and LSC impacts for both submeasures. The following tables present the first-year statewide energy and LSC savings from newly constructed buildings and additions (Table 49 and Table 52) and alterations (Table 50 and Table 53) by climate zone for each submeasure. Table 51 presents first-year statewide savings from new construction, additions, and alterations for the automatic blowdown submeasure and Table 54 presents first-year statewide savings from new construction, additions, and alterations for the deaerator pressure submeasure.

**Table 48: Statewide Energy and LSC Impacts – Automatic Blowdown and Deaerator Pressure**

Submeasure	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
<b>Automatic Blowdown</b>	-	-	0.41	35.23	\$33.97
<b>Deaerator Pressure</b>	-	-	0.02	1.36	\$1.32
<b>Total</b>	-	-	<b>0.43</b>	<b>36.60</b>	<b>\$35.29</b>

**Table 49: Statewide Energy and LSC Impacts Automatic Blowdown – New Construction and Additions**

<b>Climate Zone</b>	<b>Statewide New Construction &amp; Additions Impacted by Proposed Change in 2029 (MMBtu/h)</b>	<b>First-Year Electricity Savings (GWh)</b>	<b>First-Year Peak Electrical Demand Reduction</b>	<b>First-Year Natural Gas Savings (Million Therms)</b>	<b>First-Year Source Energy Savings (Million kBtu)</b>	<b>30-Year Present Valued LSC Savings (Million 2029 PV\$)</b>
<b>1</b>	1.65	-	-	0.000	0.03	\$0.03
<b>2</b>	7.13	-	-	0.002	0.13	\$0.13
<b>3</b>	48.27	-	-	0.010	0.89	\$0.86
<b>4</b>	19.41	-	-	0.004	0.36	\$0.34
<b>5</b>	5.06	-	-	0.001	0.09	\$0.09
<b>6</b>	31.16	-	-	0.007	0.57	\$0.56
<b>7</b>	11.77	-	-	0.003	0.22	\$0.21
<b>8</b>	43.23	-	-	0.009	0.79	\$0.78
<b>9</b>	54.81	-	-	0.012	1.00	\$0.98
<b>10</b>	37.71	-	-	0.008	0.69	\$0.68
<b>11</b>	13.39	-	-	0.003	0.25	\$0.24
<b>12</b>	145.72	-	-	0.031	2.70	\$2.60
<b>13</b>	162.27	-	-	0.035	3.01	\$2.90
<b>14</b>	17.47	-	-	0.004	0.32	\$0.31
<b>15</b>	9.07	-	-	0.002	0.17	\$0.16
<b>16</b>	5.09	-	-	0.001	0.09	\$0.09
<b>Total</b>	<b>613.20</b>	-	-	<b>0.132</b>	<b>11.32</b>	<b>\$10.95</b>

**Table 50: Statewide Energy and LSC Impacts Automatic Blowdown – Alterations**

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2029 (MMBtu/h)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	3.74	-	-	0.001	0.07	\$0.06
2	15.49	-	-	0.003	0.28	\$0.27
3	103.95	-	-	0.022	1.89	\$1.81
4	42.04	-	-	0.009	0.76	\$0.73
5	10.31	-	-	0.002	0.19	\$0.18
6	66.25	-	-	0.014	1.20	\$1.17
7	23.97	-	-	0.005	0.44	\$0.43
8	93.04	-	-	0.020	1.68	\$1.63
9	117.60	-	-	0.025	2.12	\$2.07
10	80.55	-	-	0.017	1.46	\$1.42
11	30.55	-	-	0.006	0.54	\$0.52
12	313.19	-	-	0.066	5.71	\$5.46
13	345.97	-	-	0.074	6.33	\$6.06
14	39.39	-	-	0.008	0.70	\$0.68
15	19.93	-	-	0.004	0.36	\$0.35
16	11.23	-	-	0.002	0.20	\$0.19
<b>Total</b>	<b>1,317.22</b>	-	-	<b>0.279</b>	<b>23.92</b>	<b>\$23.02</b>

**Table 51: Statewide Energy and LSC Impacts Automatic Blowdown – New Construction, Additions, and Alterations**

<b>Construction Type</b>	<b>First-Year Electricity Savings (GWh)</b>	<b>First-Year Peak Electrical Demand Reduction (MW)</b>	<b>First -Year Natural Gas Savings (Million Therms)</b>	<b>First-Year Source Energy Savings (Million kBtu)</b>	<b>30-Year Present Valued LSC Savings (Million 2029 PV\$)</b>
<b>New Construction &amp; Additions</b>	-	-	0.13	11.32	\$10.95
<b>Alterations</b>	-	-	0.28	23.92	\$23.02
<b>Total</b>	-	-	<b>0.41</b>	<b>35.23</b>	<b>\$33.97</b>

**Table 52: Statewide Energy and LSC Impacts Deaerator Pressure – New Construction and Additions**

Climate Zone	Statewide New Construction & Additions Impacted by Proposed Change in 2029 (MMBtu/h)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	1.37	-	-	0.0000	0.00	\$0.00
2	3.14	-	-	0.0001	0.01	\$0.01
3	20.63	-	-	0.0004	0.04	\$0.04
4	8.45	-	-	0.0002	0.01	\$0.01
5	1.56	-	-	0.0000	0.00	\$0.00
6	13.99	-	-	0.0003	0.02	\$0.02
7	3.51	-	-	0.0001	0.01	\$0.01
8	21.90	-	-	0.0004	0.03	\$0.03
9	26.80	-	-	0.0005	0.04	\$0.04
10	18.00	-	-	0.0003	0.03	\$0.03
11	10.23	-	-	0.0001	0.01	\$0.01
12	60.97	-	-	0.0012	0.11	\$0.10
13	67.01	-	-	0.0014	0.12	\$0.11
14	9.88	-	-	0.0001	0.01	\$0.01
15	4.90	-	-	0.0001	0.01	\$0.01
16	2.61	-	-	0.0000	0.00	\$0.00
<b>Total</b>	<b>274.94</b>	-	-	<b>0.0053</b>	<b>0.45</b>	<b>\$0.44</b>

**Table 53: Statewide Energy and LSC Impacts Deaerator Pressure – Alterations**

Climate Zone	Statewide Alterations Impacted by Proposed Change in 2029 (MMBtu/h)	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction	First-Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
1	2.75	-	-	0.000	0.00	\$0.00
2	6.33	-	-	0.000	0.01	\$0.01
3	41.57	-	-	0.001	0.07	\$0.07
4	17.03	-	-	0.000	0.03	\$0.03
5	3.14	-	-	0.000	0.01	\$0.01
6	28.19	-	-	0.001	0.05	\$0.05
7	7.07	-	-	0.000	0.02	\$0.02
8	44.13	-	-	0.001	0.07	\$0.06
9	54.02	-	-	0.001	0.08	\$0.08
10	36.27	-	-	0.001	0.06	\$0.06
11	20.62	-	-	0.000	0.02	\$0.02
12	122.88	-	-	0.002	0.21	\$0.20
13	135.04	-	-	0.003	0.24	\$0.23
14	19.91	-	-	0.000	0.02	\$0.02
15	9.88	-	-	0.000	0.01	\$0.01
16	5.25	-	-	0.000	0.01	\$0.01
<b>Total</b>	<b>554.08</b>	-	-	<b>0.011</b>	<b>0.91</b>	<b>\$0.88</b>

**Table 54: Statewide Energy and LSC Impacts Deaerator Pressure – New Construction, Additions, and Alterations**

Construction Type	First-Year Electricity Savings (GWh)	First-Year Peak Electrical Demand Reduction (MW)	First -Year Natural Gas Savings (Million Therms)	First-Year Source Energy Savings (Million kBtu)	30-Year Present Valued LSC Savings (Million 2029 PV\$)
<b>New Construction &amp; Additions</b>	-	-	0.005	0.45	\$0.44
<b>Alterations</b>	-	-	0.011	0.91	\$0.88
<b>Total</b>	-	-	<b>0.016</b>	<b>1.36</b>	<b>\$1.32</b>

### 3.5.2 Statewide Greenhouse Gas Emissions Reductions

Table 55 and Table 56 presents the estimated first-year reduction in GHG emissions resulting from the proposed code change. In this initial year, the Statewide CASE Team expects to avoid 2,226 metric tons of CO<sub>2</sub>e emissions. These reductions, along with their associated monetary value, were calculated using hourly GHG emissions factors published alongside the LSC hourly factors and source energy hourly factors in the research versions of CBECC, as well as data from the CEC’s 2028 Metrics Report. See the [2028 CASE Methodology Report](#) for additional information.

**Table 55: First-Year Statewide GHG Emissions Impacts – Automatic Blowdown**

Construction Type	Avoided GHG Emissions from Electricity Savings (Metric Tons CO <sub>2</sub> e)	Avoided GHG Emissions from Natural Gas Savings (Metric Tons CO <sub>2</sub> e)	Total Avoided GHG Emissions (Metric Ton CO <sub>2</sub> e)	Total Monetary Value of Avoided GHG Emissions (\$)
<b>New Construction &amp; Additions</b>	0.0	688	688	\$111,813
<b>Alterations</b>	0.0	1,455	1,455	\$236,316
<b>Total</b>	<b>0.0</b>	<b>2,143</b>	<b>2,143</b>	<b>\$348,128</b>

**Table 56: First-Year Statewide GHG Emissions Impacts – Deaerator Pressure**

Construction Type	Avoided GHG Emissions from Electricity Savings (Metric Tons CO <sub>2</sub> e)	Avoided GHG Emissions from Natural Gas Savings (Metric Tons CO <sub>2</sub> e)	Total Avoided GHG Emissions (Metric Ton CO <sub>2</sub> e)	Total Monetary Value of Avoided GHG Emissions (\$)
<b>New Construction &amp; Additions</b>	0.0	27	27	\$4,466
<b>Alterations</b>	0.0	55	55	\$9,001
<b>Total</b>	<b>0.0</b>	<b>83</b>	<b>83</b>	<b>\$13,468</b>

### 3.5.3 Statewide Water Use Impacts

The Statewide CASE Team used boiler steam production, feedwater conductivity, and boiler water conductivity setpoint assumptions to calculate the blowdown flow rate in pounds per hour for each boiler capacity bin. The blowdown flow rate was converted to gallons per year and summed across boiler capacity bins to estimate the total annual water savings from the automatic blowdown measure in gallons per year. See Appendix C for more details on calculation assumptions.

Table 57 and Table 58 present the impact on water use. See the [2028 CASE Methodology Report](#) for additional information on the embedded electricity savings estimates, which assume embedded energy factors of 5,440 kWh per million gallons of water for indoor use and 3,280 kWh per million gallons of water for outdoor water use (SBW Consulting, Inc. 2022).

To comply with Section 810.1 of the California Plumbing Code, which limits water discharged from the facility to the public sewer to below 140°F, water from boiler blowdown is commonly tempered with cold water to cool the blowdown. Initial analyses of water savings do not consider savings from reduced use of tempering water, making the water-use impact a conservative estimation. If a heat recovery system is not used, the amount of cooling water often equals the amount of blowdown water.

**Table 57: Impacts on Water Use and Embedded Electricity in Water – Automatic Blowdown**

Impact	On-Site Indoor Water Savings (Gallons/Year)	On-site Outdoor Water Savings (Gallons/Year)	Embedded Electricity Savings (kWh/Year)
<b>Average Per-MMBtu/h Impacts</b>	7,410	-	40
<b>First-Year Statewide Impacts for New Construction and Additions</b>	4,593,936	-	24,991
<b>First-Year Statewide Impacts for Alterations</b>	9,710,014	-	52,822
<b>Total First-Year Statewide Impacts</b>	<b>14,303,950</b>	-	<b>77,813</b>

**Table 58. Impacts on Water Use and Embedded Electricity in Water – Deaerator Pressure**

Impact	On-Site Indoor Water Savings (Gallons/Year)	On-site Outdoor Water Savings (Gallons/Year)	Embedded Electricity Savings (kWh/Year)
<b>Average Per-MMBtu/h Impacts</b>	164	-	1
<b>First-Year Statewide Impacts for New Construction and Additions</b>	44,954	-	245
<b>First-Year Statewide Impacts for Alterations</b>	90,596	-	493
<b>Total First-Year Statewide Impacts</b>	<b>135,550</b>	-	<b>737</b>

### 3.5.4 Statewide Material Impacts

Automatic blowdown systems require the installation of a blowdown valve, controller, and conductivity probe. Material impacts from automatic blowdown systems are

expected to be the same across different boiler sizes, as component sizing does not increase significantly with boiler size. Because blowdown valves are required for both manual and automatic blowdown systems (representing the baseline and measure case), they will not have any incremental impact on material use.

Conductivity controller materials typically include plastic (for the casing and the circuit board) and copper (on the circuit board and for the wires). Based on a datasheet from Myron L Company, a large manufacturer of water quality management instruments, a standard 750 Series II controller weighs 2.0 pounds (Myron L Company, n.d.). The Statewide CASE Team assumed that 1.5 pounds are from the plastic casing and circuit board, and 0.5 pounds are from the copper. Conductivity probes are typically made of stainless steel. After examining vendor datasheets that listed conductivity probe weights ranging from 0.5 to 1.0 pound, the Statewide CASE Team used one pound as a conservative value for conductivity probe weight (Sensorex, n.d.; Cannon Water Technology Inc, n.d.)

The materials for automatic blowdown systems are consistent across boiler capacity. Therefore, the Statewide CASE Team took the total qualifying statewide boiler capacity construction forecast for new construction, additions, and alterations and divided that total by the statewide average boiler capacity to estimate the construction forecast in number of boilers. That value was multiplied by the material impacts per boiler to calculate the first-year statewide impacts. For more information on the Statewide CASE Team’s methodology and assumptions used to calculate embodied GHG emissions, see the [2028 CASE Methodology Report](#).

The materials impacts and embodied GHG-emissions impacts from the increase in material use for automatic blowdown systems are summarized in Table 59.

**Table 59: First-Year Statewide Impacts on Material Use: Automatic Blowdown**

Material	Impact	Per-Unit Impacts (Pounds Per Boiler)	First-Year Statewide Impacts (Pounds)	Embodied GHG emissions saved (Metric Tons CO <sub>2</sub> e)
<b>Mercury</b>	No change	-	-	-
<b>Lead</b>	No change	-	-	-
<b>Copper</b>	Increase	0.02	30	-0.04
<b>Steel</b>	Increase	0.03	61	-0.03
<b>Plastic</b>	Increase	0.05	91	-0.08
<b>TOTAL</b>	<b>Increase</b>	<b>0.10</b>	<b>182</b>	<b>-0.15</b>

The deaerator pressure submeasure specifies operating setpoints and does not have any impacts on material use.

### **3.5.5 Environmental Impacts**

Requiring the use of automatic blowdown systems prevents releasing more water than is necessary, as is common with manual blowdown. This practice saves energy by reducing the need to heat make-up water. The higher the pressure setpoint the higher the boiling point of water, and the more energy is needed to boil the water. As such, unnecessarily high setpoints result in unnecessary consumption of energy, while lowering setpoints will save energy. These direct benefits are fully discussed in Sections 3.5.1, 3.5.2, and 3.5.3 above.

Automatic blowdown controls can reduce boiler fouling, extend system lifetimes, and reduce wastewater by avoiding purging more water than is necessary. Deaerator controls can also extend system lifetimes by reducing oxygen pitting and corrosion. Reducing fouling and corrosion will, in turn, reduce the need for water treatment chemicals intended to protect equipment from these impacts. Making equipment replacement more infrequent would reduce the embodied carbon emissions produced during the manufacture and transportation of the equipment.

The reduced energy consumption from these measures would also indirectly lead to improvements in local air quality. Combustion of natural gas produces NO<sub>x</sub>, a chemical precursor to ozone. Reducing the consumption of natural gas will therefore indirectly lead to reduced ozone (Chen, Omotesho, & Johnson, 2025).

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine that this measure would result in significant direct or indirect adverse environmental impacts and, therefore, did not develop any mitigation measures.

### **3.5.6 Other Non-Energy Impacts**

Automatic blowdown systems reduce the use of water and the chemicals used to treat that water. In addition to water and chemical savings, the reduction in fuel usage to heat fresh water to replace excess blowdown results in lower boiler NO<sub>x</sub> emissions. This would reduce local photochemical smog and improve air quality.

The lower supply line pressure regulator setpoints specified in this proposed measure require less boiler fire, leading to lower boiler emissions and improved local air quality.

## 3.6 Automatic Blowdown and Deaerator Pressure - Proposed Code Language

### 3.6.1 Guide to Markup Language

The proposed changes to the standards, Reference Appendices, and the ACM Reference Manuals are provided below. Changes follow the restructured 2025 Building Energy Efficiency Standards and are marked with dark blue underlining (new language) and ~~strikethroughs~~ (deletions).

New to the 2028 energy code is to *italicize defined terms* when the terms are being used in its defined context. In-line comments that are not part of the proposed code language but are used to help describe the purpose of what is proposed are included *with greyed highlight and italics*.

Markups are provided to the restructured 2025 Energy Code that the CEC developed in response to feedback that aligning the structure of Title 24, Part 6 with other parts of the California Building Standards Code (Title 24) would improve readability, usability, and navigation.<sup>8</sup> New section numbers are shown as bold followed square brackets that document the section in the 2025 Title 24, Part 6 section numbers prior to the restructuring. For example, “**Section 601.1** [Section 130.0(a)] **General**” contains the content that is in the current Section 130.0(a).

Posting the proposed code language in this format is useful as it helps describe how the Energy Code changes proposed for nonresidential occupancies are isolated from the requirements for residential occupancies which are prohibited from being changed until the 2031 code cycle by Assembly Bill 130.

### 3.6.2 Administrative Code (Title 24, Part 1)

No changes are proposed to Title 24, Part 1.

### 3.6.3 Energy Code (Title 24, Part 6)

## SECTION 200 – DEFINITIONS AND RULES OF CONSTRUCTION

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**Section 201** [Section 100.1(b)] – **Definitions – Recommends new or revised definitions for the following terms:**

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**BOILER BLOWDOWN VALVE** is a valve used for discharging water from a boiler to maintain the desired concentration of solids and chemicals to deter scale buildup, corrosion and carryover of impurities in the boiler water.

**AUTOMATIC BOILER SURFACE BLOWDOWN CONTROLLER** is an automated system that optimizes surface-blowdown rates by regulating the volume of water discharged from the boiler in relation to the concentration of dissolved solids present.

**BOILER DEAERATOR** is a system that is used for the removal of oxygen and other dissolved gases from the feedwater to steam generating boilers. Dissolved gases in boiler feedwater cause corrosion damage in steam systems by attaching to metallic components and forming oxides, or rust.

**BLOWDOWN HEAT RECOVERY** is a heat exchanger that recovers energy from the blowdown to heat make-up water or another process stream, with or without a flash tank.

## **SUBCHAPTER 9 – PROCESS SYSTEMS AND EQUIPMENT**

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### **SECTION 900 – NONRESIDENTIAL, HOTEL/MOTEL, AND MULTIFAMILY OCCUPANCIES (NEWLY CONSTRUCTED, ADDITIONS, ALTERATIONS)**

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

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##### **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 percent of the total design wattage at 50 percent 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 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. 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 904.1.3** [Section 120.6(d)3]: Boilers with steady state full-load combustion efficiency 90 percent or higher.

904.1.4. Stack economizer.

[Placeholder for Stack Economizer code]

#### **904.1.5. Automatic blowdown.**

Newly installed process steam boilers with an input capacity greater than or equal to 10 MMBtu/h (10,000,000 Btu/h) shall have an automatic boiler surface blowdown controller that is programmed to be controlled by conductivity.

**Exception 1 to Section 904.1.5:** Boiler systems with returned condensate composing more than 90 percent of feedwater flow.

**Exception 2 to Section 904.1.5:** Boilers with make-up water treated by a reverse osmosis (RO) system.

**Exception 3 to Section 904.1.5:** Boilers employing *blowdown heat recovery*.

#### **904.1.6 Steam supply line regulator pressure control.**

For systems that use the boiler steam header to pressurize the deaerator, the steam supply line pressure regulator serving the *deaerator* shall be set at or under 5 psig for all newly installed process steam boilers with an input capacity greater than or equal to 10 MMBtu/h (10,000,000 Btu/h). For boilers with tubes that are not rated for oxidizing conditions, the steam supply line pressure regulator setpoint shall be within 2 to 5 psig. A pressure gauge shall be installed on the deaerator.

**Exception to Section 904.1.6:** Boiler systems with swings in make-up water equal to or above 20 percent of feedwater flow. Design documents shall include a statement of justification indicating that swings in make-up water flow are anticipated to be 20 percent or more of feedwater flow. The construction documents shall also identify the target deaerator steam supply line pressure regulator setpoint for the system.

#### **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 steam boilers are added or replaced shall comply with the applicable requirements of Section 904.1.

### **3.6.4 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 Automatic Blowdown**

Acceptance tests for process boilers in accordance with Section 904.1.5.

##### **NA7.21.1.1 Construction Inspection**

Verify and document the installation of a boiler blowdown valve, valve controller, and conductivity probe (automatic blowdown system) prior to functional testing.

##### **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 10 MMBtu/h (10,000,000 Btu/h):

- automatic blowdown is programmed to be controlled by conductivity.

##### **Step 1: Installation Verification**

1. Confirm that an automatic blowdown controller is installed in the surface blowdown line.

##### **Step 2: Setpoint Verification**

2. Visually verify the current conductivity setpoint configured on the controller.

##### **Step 3: Operational Cycle Observation**

1. Observe the controller as it completes one full cycle: The controller should sample the boiler water conductivity and display a reading.
  - a. Based on the reading:
    - i. **If the conductivity is above the setpoint:** The controller should automatically open the blowdown valve to reduce TDS.
    - ii. **If the conductivity is below the setpoint:** The blowdown valve should remain closed.

##### **Step 4: Functional Test (if conductivity is below setpoint)**

2. To verify system functionality even when blowdown is not triggered under current conditions:
  - a. Temporarily lower the blowdown setpoint below the current conductivity value.
  - b. Observe one full cycle and confirm that the blowdown valve opens as expected.
  - c. Restore the conductivity setpoint to its original value after testing.

### **NA7.21.2 Process Boiler Deaerator Pressure**

Acceptance tests for process boilers in accordance with Section 904.1.6.

#### **NA7.21.2.1 Construction Inspection**

Verify and document the presence of a pressure gauge on the deaerator.

#### **NA7.21.2.2 Functional Testing**

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 10 MMBtu/h (10,000,000 Btu/h): that the steam supply line pressure regulator setpoint is at or under 5 psig and within 2 to 5 psig for boilers with tubes that are not rated for oxidizing conditions.

#### **Step 1: Boiler Pressure Confirmation**

1. Ensure the boiler is at its design condition operating pressure.

#### **Step 2: Deaerator Pressure Verification**

2. Visually confirm that the pressure gauge on the deaerator reads 5 psig or under or between 2 psig and 5 psig.

#### **Step 3: High Pressure Check (if deaerator pressure is greater than 5 psig)**

3. If the deaerator pressure is above 5 psig, take one of the following steps:
  - a. Confirm that the pressure of the returning condensate matches the pressure at the deaerator. If the condensate return pressure is lower than the deaerator pressure, reduce the supply line pressure regulator setpoint.
  - b. Confirm that the temperature of the returning condensate matches the temperature at the deaerator. If the condensate return temperature is lower than the deaerator temperature, reduce the supply line pressure regulator setpoint.
  - c. Confirm that the condensate return system does not utilize a flash vessel.

### 3.6.5 Compliance Manuals

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

### 3.6.6 ACM Reference Manual

There are no proposed changes to the ACM Reference Manual.

### 3.6.7 Compliance Forms

As discussed in Section 3.1.4, the NRCC-PRC-E and NRCI-PRC-E forms and a new NRCA-PRC-XX-F compliance form would be updated or 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

To section I PROCESS BOILER table:

- In the Virtual Compliance Assistant, add the following dropdown options:
  - Rated input capacity for one or more connected boilers to include:  
≥ 10MMBtu/h
  - Rated input capacity for one or more connected boilers to include: ≥ 5  
to <10MMBtu/h
- Add a selection in the dropdown for rated input capacity to include: ≥ 10MMBtu/h
- Add a column for Automatic Blowdown
  - To the corresponding section for the form in the Virtual Compliance Assistant, add:
    - Does this process boiler have an automatic surface blowdown controller that is that is programmed to be controlled by a conductivity setpoint?
      - Question response dropdown options:
        - Yes
        - This doesn't apply because the system has returned condensate composing more than 90 percent of feedwater flow.
        - This doesn't apply because this boiler has make-up water treated by a reverse osmosis (RO) system.
        - This doesn't apply because this process boiler employs blowdown heat recovery.
- Add column for Deaerator System Pressure
  - To the corresponding section for the form in the Virtual Compliance Assistant, add:

- Does this process boiler have the steam supply line pressure regulator serving the deaerator set at 5 psig or under, OR the steam supply line pressure regulator set at 2-5 psig if the boiler does not have tubes rated for oxidizing conditions?
  - Question response dropdown options:
    - Yes
    - This doesn't apply because the boiler steam header is not used to pressurize the deaerator.
    - This does not apply because the system has swings in make-up water equal to or above 20% of feedwater flow.

In section T Declaration of Required Certifications of Acceptance table:

- Add a row for the acceptance test as follows: "NRCA-PRC-XX-F Automatic Blowdown Controls."
- Add a row for the acceptance test as follows: "NRCA-PRC-XX-F Deaerator System Pressure."

### **NRCI-PRCC-E**

To the Process Boilers Table, add:

- Column for Automatic Blowdown Compliance. (P/F)
  - Confirm the installation of the automatic blowdown control system (including each of the valve, controller, and conductivity probe).
- Column for Automatic Blowdown Controller.
  - Enter the controller make and model number.
- Column for Deaerator Pressure Compliance. (P/F)
  - Confirm that a pressure gauge is installed on the deaerator.

In section G Acceptance Tests and Field Declaration table:

- Add a row for the acceptance test as follows: "NRCA-PRC-XX-F - Must be Submitted for Automatic Blowdown Controls."
- Add a row for the acceptance test as follows: "NRCA-PRC-XX-F - Must be Submitted for Deaerator Pressure."

### **NRCA-PRC-XX (Automatic Blowdown)-F**

Create new NRCA-PRC form with the following:

- Construction Inspection Table
  - Verify maximum boiler capacity is greater than or equal to 10 MMBtu/h. (T/F)

- Document the automatic blowdown conductivity controller make and model.
- Functional Testing Table
  - Verify the current conductivity setpoint configured on the controller. (P/F)
  - Observe the controller as it completes one full cycle. Verify the following (No Entry):
    - If the conductivity is above the setpoint, the controller automatically opens the blowdown valve. If the conductivity is below the setpoint, the blowdown valve should remain closed. (P/F)
    - If the conductivity is below the setpoint, temporarily lower the blowdown setpoint below the current conductivity value. Observe the controller for one full cycle. Verify the following (No Entry):
      - Blowdown valve opens. (P/F)
      - Return system to original operating conditions. (P/F)

#### **NRCA-PRC-XX (Deaerator)-F**

Create a new NRCA-PRC form with the following:

- Construction Inspection Table
  - Verify maximum capacity is greater than or equal to 10 MMBtu/h. (T/F)
  - Verify the deaerator is pressurized by a boiler steam header. (T/F)
  - Verify the boiler is at its design condition operating pressure. (No Entry)
- Functional Testing
  - Verify that the pressure gauge on the deaerator reads less than 5 psig or 2-5 psig for boilers with non-oxidizing tubes. (P/F)
  - If the deaerator is above 5 psig, verify the following (No Entry):
    - Confirm that returning condensate enters the deaerator at a pressure greater than 5 psig and matches the pressure measured inside the deaerator. (P/F)
    - Ensure the deaerator steam supply line pressure regulator setpoint is below 5 psig or 2-5 psig for boilers with non-oxidizing tubes. (P/F)

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# Appendix A: Assumptions for Cost-effectiveness Analysis

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## Key Assumptions for Energy Savings Analysis

### Stack Economizer

For the proposed stack economizer requirement, the baseline case is a boiler without a stack economizer, and the proposed case is a boiler with a non-condensing stack economizer.

Boilers with SCR systems operate with lower stack oxygen percentages than boilers without SCR systems. Based on an interview with a representative from the SJVAPCD we learned that most new boiler capacity in the state will likely be installed with SCR systems. Therefore, the Statewide CASE Team calculated energy savings separately for boilers with (67% of statewide boiler capacity) and without SCR systems (33% of statewide boiler capacity) using the stack oxygen concentrations outlined in the assumptions below.

Savings calculation assumptions for both the baseline and proposed cases include the following:

- a. Boiler operation (year-round boilers): 6,500 hours per year, based on a survey of 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).
- b. Boiler operation (seasonal boilers): 2,400 hours per year, based on data from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).
- c. Shell losses: 1.0 percent, based on industry standard rule of thumb.
- d. Combustion air temperature: 75°F, based on outdoor air temperatures in California.
- e. Stack oxygen content: 4 percent for boilers with SCR systems and 8 percent for all other boilers, based on field data from 10 sites that conducted fieldwork with Cascade Energy and data from AQMDs. See Boiler Field Data for full information.

Savings calculation assumptions and outputs for the baseline case include the following:

- a. Annual boiler gas consumption: calculated at 40 percent load for year-round boilers and 80 percent load for seasonal boilers.
- b. Stack exhaust temperature: 382°F at 40 percent boiler load and 100 psig, based on field data from 10 sites.

- c. Combustion efficiency, based on field data from Cascade Energy and AQMDs:
  - a. 81.8 percent for year-round boilers with SCR systems.
  - b. 81.3 percent for seasonal boilers with SCR systems.
  - c. 80.0 percent for all other year-round boilers.
  - d. 79.3 percent for all other seasonal boilers.
- d. Boiler efficiency, equivalent to the combustion efficiency minus shell losses:
  - a. 80.8 percent for year-round boilers with SCR systems.
  - b. 80.3 percent for seasonal boilers with SCR systems.
  - c. 79.0 percent for all other year-round boilers.
  - d. 78.3 percent for all other seasonal boilers.

Savings calculation assumptions and outputs for the proposed measure case include the following:

- a. Combustion efficiency is calculated using the ASME PTC-4 Indirect Method: Stack Loss Method.
- b. Boiler efficiency is equivalent to the combustion efficiency minus shell losses.
- c. Stack exhaust temperature: 282°F to 302°F, based on an 80°F temperature drop due to the stack economizer for boilers 10-25 MMBtu/h and a 100°F temperature drop due to the stack economizer for boilers 25 MMBtu/h or greater.
- d. Stack economizer heat transfer effectiveness: 95.0 percent, accounting for heat loss to the atmosphere.

Stack economizers are standardized products, and the Statewide CASE Team assumes consistent performance across makes and models. The Statewide CASE Team applied the climate-zone-specific LSC hourly factors when calculating energy cost impacts.

### **Automatic Blowdown**

For the automatic blowdown requirement, the baseline case is a boiler maintained with manual blowdown and the proposed case is a boiler with an automatic blowdown system.

Savings calculation assumptions for both the baseline and proposed cases include the following:

- a. Boiler operation (year-round boilers): 6,500 hours per year, based on a survey from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).
- b. Boiler operation (seasonal boilers): 2,400 hours per year, based on a survey of from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).

- c. Steam header pressure: 100 psig, informed by average industry steam header pressure.
- d. Condensate conductivity: 20  $\mu\text{S}$ , based on field data from two industrial sites from prior work with Cascade Energy.
- e. Make-up water conductivity: 440  $\mu\text{S}$ , based on field data from two industrial sites from prior work with Cascade Energy.
- f. Feed water conductivity: 345  $\mu\text{S}$ , based on field data from two industrial sites from prior work with Cascade Energy.
- g. Feedwater enthalpy: 194.5 Btu/lb, from steam tables.
- h. Steam enthalpy: 1,190.8 Btu/lb, from steam tables.
- i. Enthalpy of boiler water: 309.2 Btu/lb, from steam tables at 100 psig.
- j. Make-up water enthalpy: 33 Btu/lb, calculated based on make-up water temperature of 65°F.
- k. Steam flow: 3,752 lbs/h, calculated for a 12 MMBtu/h boiler at 40 percent load.
- l. Boiler water conductivity setpoint: 3,000  $\mu\text{S}$ .

No unique assumptions apply to the baseline case. Savings calculation assumptions unique to the proposed case include the following:

- a. Boiler water conductivity: 500  $\mu\text{S}$  less than in the baseline case.

Automatic blowdown systems are standardized products, and the Statewide CASE Team assumes consistent performance across makes and models. The Statewide CASE Team applied the climate-zone-specific LSC hourly factors when calculating energy cost impacts.

### **Deaerator System Pressure**

For the deaerator pressure requirement, the baseline case is a boiler with its steam supply line pressure regulator and deaerator set to 8 psig and the proposed case is a boiler with its steam supply line pressure regulator and deaerator set to 5 psig.

Savings calculation assumptions for both the baseline and proposed cases include the following:

- a. Boiler operation (year-round boilers): 6,500 hours per year, based on a survey of from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).
- b. Boiler operation (seasonal boilers): 2,400 hours per year, based on a survey of from 128 California steam-using sites sourced from the national IAC database (Swanson & Staller, 2025).
- c. Valve flow coefficient ( $C_v$ ): 1, from steam tables.

- d. Pressure differential ratio factor: 0.72, calculated value.

Savings calculation assumptions unique to the baseline case include the following:

- a. Deaerator pressure: 8 psig, based on industry experience and estimated to apply to about 20 percent of sites statewide.
- b. Feedwater temperature: 234.6°F, based on a deaerator pressure of 8 psig.
- c. Steam flow rate: 35 lbs/h, calculated value.

Savings calculation assumptions unique to the proposed case include the following:

- a. Deaerator pressure: 5 psig, based on industry experience.
- b. Feedwater temperature: 226°F, based on a deaerator pressure of 5 psig.
- c. Steam flow rate: 27 lbs/h, calculated value.

## Energy Savings Methodology

### *Prototype Development - Stack Economizer and Automatic Blowdown and Deaerator Pressure*

The Statewide CASE Team analyzed energy savings and cost-effectiveness across six boiler capacity ranges to account for savings and differences for boilers with different capacities. Table 60 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 in Table 60. 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 & Staller, 2025).

**Table 60: 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 both measures, boilers that operate infrequently throughout the year due to seasonal loads will experience lower 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, separate 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 installed during new construction, additions, or alterations of a building, so the same prototypes were used for all.

Existing Title 24, Part 6 requirements already cover process boilers and apply to new construction, additions, and alterations, so the Standard Design (baseline case) is minimally compliant with the 2025 Title 24 requirements and informs the baseline combustion efficiency estimate used in savings calculations. These requirements include combustion air positive shut-off for all process boilers with an input capacity of 2.5 MMBtu/h and above, variable speed drive for process boiler combustion air fans with motors 10 horsepower and greater, and 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.

The [2028 CASE Methodology Report](#) provides details on estimating energy savings per prototypical building and per unit.

## **Energy Savings Calculations**

### **Stack Economizer**

The Proposed Design (measure case) was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Specifically, the proposed conditions assume installation of a non-condensing stack economizer on the boiler stack.

Savings result from improved boiler combustion efficiency due to the economizer using recovered heat to increase the temperature of boiler feedwater. Energy savings were calculated for a 12 MMBtu/h boiler using the following steps:

1. Calculate the measure case boiler combustion efficiency using the ASME PTC-4 Indirect Method: Stack Loss Method.<sup>17</sup>
2. Calculate annual boiler load from baseline annual gas consumption and baseline boiler efficiency, where:

a. 
$$\mathbf{Boiler\ Load} = \frac{\mathbf{Annual\ Gas\ Consumption}_{Baseline}}{\mathbf{Boiler\ Efficiency}_{Baseline}}$$

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<sup>17</sup> An explanation of the ASME PTC-4 Indirect Method: Stack Loss Method can be found at: [ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/boiler\\_efficiency\\_calc.pdf](http://ww2.arb.ca.gov/sites/default/files/cap-and-trade/allowanceallocation/boiler_efficiency_calc.pdf)

3. The annual boiler load is the same for the baseline and measure cases. Calculate the measure case annual boiler gas consumption from the annual boiler load and the measure case boiler efficiency, where:

- a. 
$$\text{Annual Gas Consumption}_{Post} = \frac{\text{Boiler Load}}{\text{Boiler Efficiency}_{Post}}$$

4. Calculate the difference between the baseline and measure case gas consumption to arrive at the measure's energy savings, where:

- a. 
$$\text{Savings} = \text{Annual Gas Consumption}_{Baseline} - \text{Annual Gas Consumption}_{Post}$$

### Automatic Blowdown

The Proposed Design was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Specifically, the proposed conditions assume installation and use of an automatic blowdown system in place of manual blowdown.

Savings result from the reduction in hot water removed from the boiler when conducting less blowdown and were calculated by subtracting the boiler's annual energy lost to blowdown with automatic blowdown from the boiler's annual energy lost to blowdown with manual blowdown.

The annual energy lost to blowdown is equal to the average blowdown energy in Btu/h \* (hours of operation / 100,000 / Boiler Efficiency), where

$$\text{Blowdown Energy} = \dot{m}_{bdn} * (H_{bw} - H_{mw})$$

$\dot{m}_{bdn}$  = blowdown flow rate in (lbs/h)

$H_{bw}$  = Enthalpy of boiler water

$H_{mw}$  = Enthalpy of make-up water

$$\dot{m}_{bdn} = \frac{\text{Steam flow}}{(COC - 1)}$$

$$COC = \frac{C_b}{C_{fw}}$$

COC = Cycles of Concentration

$C_b$  = average conductivity of boiler water

$C_{fw}$  = conductivity of feedwater

## Deaerator Pressure

The Proposed Design was identical to the Standard Design in all ways except for the revisions that represent the proposed changes to the code. Specifically, the proposed conditions assume boiler operation with steam supply line regulator and deaerator setpoints at 5 psig instead of 8 psig. Savings result from the decreased energy loss when less steam is vented due to over-pressurization of the deaerator.

To estimate the natural gas savings from improved deaerator control, the Statewide CASE Team calculated the mass flow of steam lost to over-pressurization in lbs/h when the deaerator setpoint is 8 psig. The Statewide CASE Team used a Cascade Energy tool to calculate the amount of steam vented and then calculated the therms required to make up for the volume of excess steam vented, using the following equations:

$$\frac{(p_1 - p_2)}{p_1} < F_Y * x_T \rightarrow m_s = 63.3 * C_v * \left( 1 - \frac{p_1 - p_2}{3 * F_Y * x_T} \right) * \sqrt{(p_1 - p_2) * \rho}$$

$$\frac{(p_1 - p_2)}{p_1} \geq F_Y * x_T \rightarrow m_s = 0.66 * 63.3 * C_v * \sqrt{F_Y * x_T * p_1 * \rho}$$

$p_1$ : Primary Pressure (psia)

$p_2$ : Secondary Pressure (psia)

$C_v$ : Valve Cv Value (Cv (US))

$m_s$ : Steam Flow Rate (lb/h)

$\rho$ : Density of steam (lb/ft<sup>3</sup>)

$F_Y$ : Specific heat ratio factor

$x_T$ : Pressure differential ratio factor

Energy benefits for deaerators set inadvertently under 2 psig were not calculated, as such values typically only occur after installation and sites with deaerators set inadvertently under 2 psig are estimated to make up a very small percentage of newly installed boiler systems.

## Boiler Field Data

Table 61, Table 62, and Table 63 include process boiler field data from 10 sites collected through Cascade Energy's work at the sites. Table 64 and Table 65 include boiler field data provided by California's South Coast AQMD and San Joaquin Valley Air Pollution Control District. Together, these data were used to inform the assumptions for boiler stack oxygen content, stack exhaust temperature, and combustion efficiency that

were used in the per-unit energy savings calculations. Table 66 includes process boiler field data from four sites collected through Cascade Energy. These data were used to inform the assumptions for boiler conductivity.

**Table 61: 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 62: 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%
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 63: 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%

**Table 64: Boiler Field Data – California South Coast AQMD**

<b>Data</b>	<b>Value</b>
<b>Sample Size (Boiler Units)</b>	20-30
<b>Median Stack Oxygen</b>	7.2%
<b>Typical Stack Oxygen Range</b>	4%-10%
<b>Avg. Stack Oxygen: Boilers with SCR</b>	4.1%

**Table 65: Ultra Low-NOx Burner Boiler Field Data – California SJVAPCD**

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

**Table 66. Boiler Field Data – Conductivity**

Site	Boiler Makeup Conductivity ( $\mu\Omega$ )	Boiler Feedwater Conductivity ( $\mu\Omega$ )	Boiler Blowdown Conductivity ( $\mu\Omega$ )	Condensate Conductivity ( $\mu\Omega$ )	% Blowdown	Cycles of Concentration	% Makeup	% Condensate Return
A	575	409	2,574	91	16%	6	66%	34%
B	355	259	3,265	10	8%	13	72%	28%
C	552	43	1,359	39	3%	32	1%	99%
D	229	145	3,942	3	4%	27	63%	37%

# Appendix B: Purpose and Necessity of Proposed Code Changes

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## Introduction

The section below provides the purpose and necessity of proposed changes to Title 24, Part 1; Title 24, Part 6; and the reference appendices, with the intent of providing the CEC with information needed for the Initial Statement of Reasons.

See Sections 2.6 and 3.6 of this report for markup for updated code language.

## Stack Economizer

### Purpose and Necessity of Changes to Title 24, Part 1

No changes are proposed to Title 24, Part 1.

### Purpose and Necessity of Changes to Title 24, Part 6

**Section:** 201

**Purpose:** The purpose of this change is to aid in the interpretation and implementation of new requirements for process boilers in Title 24, Part 6, Section 904 by adding several new definitions.

**Necessity:** This change adds definitions for Boiler Stack Economizer, Biomass, and Selective Catalytic Reduction (SCR) System. These definitions ensure clarity of the proposed process boiler requirements for the use of economizers.

**Section:** 904.1.4

**Purpose:** The purpose of this change is to add a new requirement for boiler stack economizers. Requiring the use of stack economizers will result in energy savings by recovering energy from exhaust that is otherwise wasted.

**Necessity:** These changes intend to reduce the energy consumed by process boilers. These adjustments align with the mandated cost-effective building design standards outlined in the California Public Resources Code, specifically Sections 25213 and 25402.

### Purpose and Necessity of Changes to the Reference Appendices

There are no required updates to the reference appendices as a result of this measure

## Automatic Blowdown and Deaerator Pressure

### Purpose and Necessity of Changes to Title 24, Part 1

No changes are proposed to Title 24, Part 1.

### Purpose and Necessity of Changes to Title 24, Part 6

**Section:** 201

**Purpose:** The purpose of this change is to aid in the interpretation and implementation of proposed new requirements for process boilers in Title 24, Part 6, Section 904 by adding several new definitions.

**Necessity:** This change adds definitions for Boiler Blowdown Valve, Automatic Boiler Surface Blowdown Controller, Boiler Deaerator, and Blowdown Heat Recovery. These definitions provide necessary clarity for the proposed additions to Title 24, Part 6, Section 904 that require new process boilers to use automatic blowdown systems and comply with specified steam supply line pressure regulator setpoints.

**Section:** 904.1.5,6

**Purpose:** The purpose of these changes is to require new process boilers to use automatic blowdown systems and to limit the pressure of steam supply line pressure regulators, which will result in energy savings.

**Necessity:** These changes are intended to reduce process boiler energy consumption. These adjustments align with the mandated cost-effective building design standards outlined in the California Public Resources Code, specifically Sections 25213 and 25402.

### Purpose and Necessity of Changes to the Reference Appendices

**Section:** NA7

**Purpose:** The purpose of this change is to add process boiler acceptance testing to ensure compliance with automatic blowdown and deaerator system pressure requirements.

**Necessity:** This change is necessary in order to implement and enforce the proposed requirements for process boilers.

# Appendix C: Assumptions for Statewide Savings Estimates

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## Stack Economizer and Automatic Blowdown and Deaerator Pressure

The Statewide CASE Team took the following steps to determine statewide savings from the proposed stack economizer and automatic blowdown and deaerator pressure measures.

To estimate statewide boiler capacities and counts by boiler capacity bins, 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 with over 9,000 equipment entries from local air quality management districts, collected and preprocessed by the Code Readiness project team in 2023 and 2024 (Swanson & Staller, 2025).

The Statewide CASE Team refined the statewide capacity for each capacity bin to account for Title 24 purview and requirement exceptions, making the following changes:

- Removed boilers with input capacities under 10 MMBtu/h and any units that were indicated to be hot water boilers or water heaters in the permit data.
- Removed oilfield and utility boilers, which are not in buildings and not subject to Title 24, Part 6 requirements.
- For the stack economizer measure only: Removed boilers in the lumber industry, which typically use biomass as fuel and thus qualify for an exception from the stack economizer requirement.
- For the stack economizer measure only: Removed ten percent to account for boiler capacity operating with a stack temperature below 340°F, which qualifies for an exception from the stack economizer requirement.
- For the stack economizer measure only: Removed 20 percent of alteration capacity under 25 MMBtu/h estimated to qualify for the roof clearance exception.
- For the automatic blowdown submeasure only: Removed an additional percentage of boiler capacity to represent the total proportion of boilers estimated to qualify for a measure exception, including boiler systems with returned condensate composing more than 90 percent of feedwater flow, boilers with make-up water treated by a reverse osmosis system, and boilers employing blowdown heat recovery. The Statewide CASE Team chose to aggregate estimates of boiler exception qualification because of overlapping applicability, where sites may qualify for the exception in more than one way. Table 44

presents the percentages of boiler capacity removed from the statewide capacity by boiler capacity bin.

- For the deaerator system pressure submeasure only: Removed 7.5 percent of boiler capacity to account for sites that serve the deaerator with high-pressure, high-temperature condensate and sites that may qualify for the exception. Sites with high-pressure, high-temperature condensate may comply with the proposed requirement that the steam supply line pressure regulator setpoint to be 5 psig, but the deaerator will operate at a higher pressure, and they will not realize direct energy savings from the proposed requirement.
- Separated seasonal boilers from annual boilers by classifying boilers at major tomato and canned fruit and vegetable processors as seasonal boilers.
  - The cannery capacity includes the capacity from major tomato and canned fruit and vegetable processors in the state. The Statewide CASE Team is not aware of other major facility types in California that would typically operate boilers seasonally.

The statewide capacity after these changes were made represents the Existing Boilers Stock. Boilers at or above 10 MMBtu/h in healthcare, education, non-cannery food, refinery, and 'all other' sectors were included in the statewide capacity totals.

To estimate the capacity of new process boilers installed annually from new construction and additions, the Statewide CASE Team calculated two IPGRs for California, one for annual boilers and one for seasonal boilers.

The Statewide CASE Team analyzed both national and state data to develop an IPGR for California. The IPGR from the 2022 Steam Trap Monitoring CASE Report was calculated using an average of the 10-year and 30-year compound annual growth rate (CAGR) of INDPRO, the national Federal Industrial Production Index (Johnson, Heinrichs, & Coakley, 2020). However, the Statewide CASE Team determined that national trends would not provide an accurate representation of the California industrial production market. While California is the largest contributor to the U.S. manufacturing industry in terms of output and employment, it accounts for 14.5 percent of U.S. manufacturing output (Profozich, 2022). A study conducted by Beacon Economics for the California Manufacturing Network confirmed that California's manufacturing sector has grown faster rate than the U.S. (Economics, n.d.).

To more accurately estimate California's IPGR, the Statewide CASE Team met with Beacon Economics to discuss the availability of California-specific data on industrial production growth and the differences between California's manufacturing sector and the U.S. manufacturing sector as a whole. Beacon Economics provided a 2025 study demonstrating that California's manufacturing growth was not only faster than the rest of the United States, but California's manufacturing is also more productive (Beacon

Economics, 2025). The Statewide CASE Team investigated California real Gross Domestic Product (GDP) data from the U.S. Bureau of Economic Analysis (BEA) and California Federal Reserve Bank of St. Louis' Federal Reserve Economic Data (FRED) for industries classified as manufacturing per 2017 NAICS (U.S. Bureau of Economic Analysis, 2025; FRED, 2025).

The Statewide CASE Team calculated the average of the 7-year CAGR and 10-year CAGR from both sources through 2024. The California real GDP manufacturing growth rate from BEA and FRED was similar at 2.25 percent and 2.74 percent, respectively. The data from BEA provided a more conservative growth rate and were selected for California IPGR calculations.

To further tailor this data to the proposed Process Boilers measures, the Statewide CASE Team applied weights based on the proportion of boiler capacity in each of the main industry subsectors (i.e., food and beverage manufacturing, wood manufacturing, and total other manufacturing which is defined as all other manufacturing that was not food and beverage, wood, lumber, petroleum/refining, or other subsectors that burn byproduct waste), calculated from the statewide boiler inventory based on AQMD data to subsector-specific California real GDP BEA data. Boiler capacity from canneries was excluded from the weighted average for year-round boilers. The calculated weighted average IPGR for year-round boilers was 1.65 percent.

The growth rate for the seasonal facilities is best represented by the Food and Beverage Manufacturing IPGR of 0.46 percent, which was calculated from BEA real GDP data in 2017 chained dollars.

Statewide savings estimates were calculated using an IPGR of 1.65 percent for year-round boilers and 0.46 percent for seasonal boilers. 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 & 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, not accounting for natural market adoption.

The final statewide savings and cost estimates take the current market adoption rate into account by removing the market adoption estimation for each measure from the boiler capacity used for the statewide savings estimate. The Statewide CASE Team

estimated a current market share rate for both proposed measures based on boiler capacity. The market share is expected to be lower for the retrofit market than the new construction market. The current market share rates were estimated based on interviews with well-informed boiler manufacturers and vendors and data from an analysis of IAC audit data from 64 boilers in 32 steam-using industrial plants from 2010 to 2022. The current market adoption rates are shown in Table 67 and Table 68 for stack economizers and automatic blowdown, respectively.

The Statewide CASE Team estimated that 20 percent of current process boiler capacity operates with steam supply line regulators and deaerator setpoints above 5 psig, based on anecdotal industry experience and conversations with facility operators. Therefore, the per-unit savings were applied to only 20 percent of statewide new boiler capacity to reach the statewide savings.

**Table 67: Estimated Current Stack Economizer Market Adoption in California**

Boiler Capacity Bin	Estimated Stack Economizer Market Adoption
10-15 MMBtu/h	25%
15-25 MMBtu/h	30%
25-50 MMBtu/h	40%
50-100 MMBtu/h	45%
100-200 MMBtu/h	50%
200+ MMBtu/h	90%

**Table 68: Estimated Current Automatic Blowdown Market Adoption in California**

Boiler Capacity	Estimated Automatic Blowdown Market Adoption
10-15 MMBtu/h	25%
15-25 MMBtu/h	30%
25-50 MMBtu/h	35%
50-100 MMBtu/h	40%
100-200 MMBtu/h	45%
200+ MMBtu/h	75%

The Statewide CASE Team applied these market share percentages to the statewide savings for each boiler capacity bin to arrive at the final statewide savings estimate.

The energy impacts of the proposed code change do not vary by climate zone. The measure is not climate-dependent because the impact of the outdoor air temperature on the boiler's and stack economizer's operation is minimal and does not materially impact estimated measure savings. Since savings do not vary by climate zone, the Statewide

CASE Team used the statewide LSC hourly factors when calculating energy and LSC impacts.

Table 69, Table 70, and Table 71 show the percentages of statewide boiler capacity with input capacities over 10 MMBtu/h that would be impacted by the proposed code changes in 2029. These percentage capacities exclude industries not impacted by Title 24, Part 6; the capacity expected to qualify for exceptions for each measure; and the share of the potentially affected capacity that is expected to adopt the proposed requirement voluntarily. No differences are found in affected boiler capacity across climate zones.

**Table 69: Percentage of Statewide Capacity Impacted by Proposed Code Change in 2029, by Boiler Capacity – Stack Economizer**

<b>Boiler Category</b>	<b>New Construction Impacted (Percent Capacity)</b>	<b>Existing Boiler Capacity (Alterations) Impacted (Percent Capacity)</b>
Year-Round Boiler 10-15 MMBtu/h	67.0%	1.7%
Year-Round Boiler 15-25 MMBtu/h	61.6%	1.6%
Year-Round Boiler 25-50 MMBtu/h	51.5%	1.7%
Year-Round Boiler 50-100 MMBtu/h	24.1%	0.8%
Year-Round Boiler 100-200 MMBtu/h	43.5%	1.4%
Year-Round Boiler 200+ MMBtu/h	2.1%	0.1%
Seasonal Boiler 10-15 MMBtu/h	67.5%	1.7%
Seasonal Boiler 15-25 MMBtu/h	63.0%	1.6%
Seasonal Boiler 25-50 MMBtu/h	54.0%	1.8%
Seasonal Boiler 50-100 MMBtu/h	49.5%	1.6%
Seasonal Boiler 100-200 MMBtu/h	45.0%	1.5%
Seasonal Boiler 200+ MMBtu/h	9.0%	0.3%

**Table 70: Percentage of Statewide Capacity Impacted by Proposed Code Change in 2029, by Boiler Capacity – Automatic Blowdown**

<b>Boiler Category</b>	<b>New Construction Impacted (Percent Capacity)</b>	<b>Existing Boiler Capacity (Alterations) Impacted (Percent Capacity)</b>
Year-Round Boiler 10-15 MMBtu/h	70.7%	2.4%
Year-Round Boiler 15-25 MMBtu/h	63.8%	2.1%
Year-Round Boiler 25-50 MMBtu/h	56.7%	1.9%
Year-Round Boiler 50-100 MMBtu/h	22.0%	0.7%
Year-Round Boiler 100-200 MMBtu/h	38.5%	1.3%
Year-Round Boiler 200+ MMBtu/h	5.1%	0.2%
Seasonal Boiler 10-15 MMBtu/h	71.3%	2.4%
Seasonal Boiler 15-25 MMBtu/h	65.1%	2.2%
Seasonal Boiler 25-50 MMBtu/h	58.5%	1.9%
Seasonal Boiler 50-100 MMBtu/h	45.0%	1.5%
Seasonal Boiler 100-200 MMBtu/h	38.5%	1.3%
Seasonal Boiler 200+ MMBtu/h	17.5%	0.6%

**Table 71: Percentage of Statewide Capacity Impacted by Proposed Code Change in 2029, by Boiler Capacity – Deaerator Pressure**

<b>Boiler Category</b>	<b>New Construction Impacted (Percent Capacity)</b>	<b>Existing Boiler Capacity (Alterations) Impacted (Percent Capacity)</b>
Year-Round Boiler 10-15 MMBtu/h	18%	0.61%
Year-Round Boiler 15-25 MMBtu/h	18%	0.60%
Year-Round Boiler 25-50 MMBtu/h	18%	0.60%
Year-Round Boiler 50-100 MMBtu/h	9%	0.30%
Year-Round Boiler 100-200 MMBtu/h	19%	0.62%
Year-Round Boiler 200+ MMBtu/h	5%	0.18%
Seasonal Boiler 10-15 MMBtu/h	19%	0.62%
Seasonal Boiler 15-25 MMBtu/h	19%	0.62%
Seasonal Boiler 25-50 MMBtu/h	19%	0.62%
Seasonal Boiler 50-100 MMBtu/h	19%	0.62%
Seasonal Boiler 100-200 MMBtu/h	19%	0.62%
Seasonal Boiler 200+ MMBtu/h	19%	0.62%

Table 72, Table 74, and Table 76 present the projected process boilers new construction that the proposed stack economizer, automatic blowdown, and deaerator code changes would respectively impact in 2029. Table 73, Table 75, and Table 77 show the projected existing statewide boiler stock that the proposed stack economizer, automatic blowdown, and deaerator code change would respectively affect through alterations in 2029. The Statewide CASE Team developed these estimates using the methods described in this section.

The [2028 CASE Methodology Report](#) includes additional information about the methodology and assumptions used to calculate statewide energy impacts.

**Table 72: Estimated New Process Boiler Capacity Impacted by Proposed Stack Economizer Code Change in 2029, by Climate Zone, Boiler Capacity and Year-Round vs. Seasonal Operation (Million Btu/h)**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>	<b>All</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	0.13	1.55	8.88	4.08	1.12	6.97	4.61	9.76	12.12	9.39	1.96	14.97	10.65	1.72	1.50	0.63	90.05
<b>Year-Round Boiler 15-25 MMBtu/h</b>	0.00	1.28	7.53	3.41	1.34	7.55	2.56	10.76	13.21	9.22	1.53	16.75	16.64	2.88	2.30	1.03	98.01
<b>Year-Round Boiler 25-50 MMBtu/h</b>	0.59	1.40	8.35	4.15	1.77	7.97	2.86	8.15	11.99	7.39	1.67	21.67	17.91	2.77	1.12	1.11	100.85
<b>Year-Round Boiler 50-100 MMBtu/h</b>	0.00	0.79	12.68	2.22	0.57	1.18	1.17	1.89	2.16	1.95	0.82	68.88	102.44	2.22	0.89	0.40	200.26
<b>Year-Round Boiler 100-200 MMBtu/h</b>	0.00	1.36	7.58	3.54	0.00	1.97	0.00	2.79	3.68	2.09	1.38	22.45	18.50	4.59	1.29	1.03	72.23
<b>Year-Round Boiler 200+ MMBtu/h</b>	0.31	0.20	0.95	0.51	0.00	1.50	0.00	2.99	3.42	2.24	2.09	0.94	0.29	1.10	0.64	0.27	17.45
<b>Seasonal Boiler 10-15 MMBtu/h</b>	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.12
<b>Seasonal Boiler 15-25 MMBtu/h</b>	0.00	0.00	0.02	0.01	0.00	0.02	0.01	0.02	0.03	0.02	0.00	0.03	0.03	0.01	0.00	0.00	0.20
<b>Seasonal Boiler 25-50 MMBtu/h</b>	0.00	0.01	0.05	0.02	0.01	0.05	0.02	0.05	0.07	0.04	0.01	0.13	0.10	0.02	0.01	0.01	0.59
<b>Seasonal Boiler 50-100 MMBtu/h</b>	0.00	0.01	0.20	0.04	0.01	0.02	0.02	0.03	0.03	0.03	0.01	1.10	1.63	0.04	0.01	0.01	3.19
<b>Seasonal Boiler 100-200 MMBtu/h</b>	0.00	0.16	0.91	0.43	0.00	0.24	0.00	0.34	0.44	0.25	0.17	2.70	2.22	0.55	0.15	0.12	8.68
<b>Seasonal Boiler 200+ MMBtu/h</b>	0.04	0.02	0.12	0.06	0.00	0.19	0.00	0.38	0.43	0.28	0.26	0.12	0.04	0.14	0.08	0.03	2.19
<b>TOTAL</b>	<b>1.07</b>	<b>6.79</b>	<b>47.27</b>	<b>18.48</b>	<b>4.82</b>	<b>27.65</b>	<b>11.24</b>	<b>37.17</b>	<b>47.60</b>	<b>32.93</b>	<b>9.92</b>	<b>149.75</b>	<b>170.48</b>	<b>16.03</b>	<b>8.01</b>	<b>4.64</b>	<b>593.85</b>

**Table 73: Estimated Existing Process Boiler Capacity Impacted by Proposed Stack Economizer Code Change in 2029 (Alterations), by Climate Zone and Boiler Capacity and Year-Round vs. Seasonal Operation (Million Btu/h)**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>	<b>All</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	0.21	2.51	14.32	6.58	1.81	11.24	7.43	15.74	19.54	15.14	3.16	24.14	17.18	2.77	2.42	1.02	145.19
<b>Year-Round Boiler 15-25 MMBtu/h</b>	0.00	2.07	12.13	5.50	2.16	12.18	4.13	17.35	21.30	14.87	2.47	27.01	26.82	4.65	3.72	1.66	158.02
<b>Year-Round Boiler 25-50 MMBtu/h</b>	1.18	2.82	16.82	8.37	3.56	16.05	5.76	16.42	24.17	14.90	3.37	43.67	36.09	5.59	2.25	2.23	203.25
<b>Year-Round Boiler 50-100 MMBtu/h</b>	0.00	1.59	25.56	4.47	1.14	2.38	2.36	3.81	4.36	3.92	1.66	138.81	206.44	4.48	1.80	0.81	403.60
<b>Year-Round Boiler 100-200 MMBtu/h</b>	0.00	2.74	15.27	7.13	0.00	3.96	0.00	5.63	7.41	4.22	2.78	45.24	37.28	9.25	2.59	2.07	145.57
<b>Year-Round Boiler 200+ MMBtu/h</b>	0.63	0.40	1.91	1.03	0.00	3.01	0.00	6.03	6.89	4.52	4.22	1.90	0.59	2.21	1.29	0.54	35.17
<b>Seasonal Boiler 10-15 MMBtu/h</b>	0.00	0.01	0.07	0.03	0.01	0.06	0.04	0.08	0.10	0.07	0.02	0.12	0.08	0.01	0.01	0.01	0.71
<b>Seasonal Boiler 15-25 MMBtu/h</b>	0.00	0.02	0.09	0.04	0.02	0.09	0.03	0.13	0.16	0.11	0.02	0.20	0.20	0.03	0.03	0.01	1.18
<b>Seasonal Boiler 25-50 MMBtu/h</b>	0.02	0.06	0.35	0.17	0.07	0.34	0.12	0.34	0.51	0.31	0.07	0.91	0.75	0.12	0.05	0.05	4.25
<b>Seasonal Boiler 50-100 MMBtu/h</b>	0.00	0.09	1.47	0.26	0.07	0.14	0.14	0.22	0.25	0.22	0.09	7.96	11.83	0.26	0.10	0.05	23.13
<b>Seasonal Boiler 100-200 MMBtu/h</b>	0.00	1.19	6.60	3.08	0.00	1.71	0.00	2.43	3.20	1.82	1.20	19.55	16.11	4.00	1.12	0.89	62.92
<b>Seasonal Boiler 200+ MMBtu/h</b>	0.29	0.18	0.86	0.47	0.00	1.36	0.00	2.72	3.11	2.04	1.90	0.86	0.27	1.00	0.58	0.24	15.88
<b>TOTAL</b>	<b>2.33</b>	<b>13.66</b>	<b>95.46</b>	<b>37.14</b>	<b>8.84</b>	<b>52.51</b>	<b>20.00</b>	<b>70.90</b>	<b>90.99</b>	<b>62.16</b>	<b>20.97</b>	<b>310.36</b>	<b>353.66</b>	<b>34.35</b>	<b>15.96</b>	<b>9.59</b>	<b>1,198.88</b>

**Table 74: Estimated New Process Boiler Capacity Impacted by Automatic Blowdown Code Change in 2029, by Climate Zone, Boiler Capacity, and Year-Round vs. Seasonal Operation (Million Btu/h)**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>	<b>All</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	0.13	1.64	9.37	4.31	1.19	7.36	4.86	10.30	12.79	9.91	2.07	15.80	11.25	1.81	1.59	0.67	95.06
<b>Year-Round Boiler 15-25 MMBtu/h</b>	0.00	1.33	7.79	3.53	1.39	7.82	2.65	11.14	13.67	9.55	1.59	17.34	17.22	2.98	2.39	1.07	101.46
<b>Year-Round Boiler 25-50 MMBtu/h</b>	0.65	1.54	9.18	4.57	1.94	8.76	3.14	8.96	13.19	8.13	1.84	23.83	19.70	3.05	1.23	1.22	110.94
<b>Year-Round Boiler 50-100 MMBtu/h</b>	0.00	0.72	11.56	2.02	0.52	1.07	1.07	1.72	1.97	1.77	0.75	62.78	93.36	2.03	0.82	0.37	182.52
<b>Year-Round Boiler 100-200 MMBtu/h</b>	0.00	1.21	6.71	3.13	0.00	1.74	0.00	2.47	3.26	1.85	1.22	19.87	16.38	4.06	1.14	0.91	63.96
<b>Year-Round Boiler 200+ MMBtu/h</b>	0.79	0.49	2.38	1.28	0.00	3.74	0.00	7.49	8.56	5.62	5.24	2.36	0.74	2.74	1.60	0.67	43.69
<b>Seasonal Boiler 10-15 MMBtu/h</b>	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.02	0.02	0.00	0.00	0.00	0.13
<b>Seasonal Boiler 15-25 MMBtu/h</b>	0.00	0.00	0.02	0.01	0.00	0.02	0.01	0.02	0.03	0.02	0.00	0.04	0.04	0.01	0.00	0.00	0.21
<b>Seasonal Boiler 25-50 MMBtu/h</b>	0.00	0.01	0.05	0.03	0.01	0.05	0.02	0.05	0.08	0.05	0.01	0.14	0.11	0.02	0.01	0.01	0.64
<b>Seasonal Boiler 50-100 MMBtu/h</b>	0.00	0.01	0.18	0.03	0.01	0.02	0.02	0.03	0.03	0.03	0.01	1.00	1.48	0.03	0.01	0.01	2.90
<b>Seasonal Boiler 100-200 MMBtu/h</b>	0.00	0.14	0.78	0.36	0.00	0.20	0.00	0.29	0.38	0.22	0.14	2.31	1.90	0.47	0.13	0.11	7.43
<b>Seasonal Boiler 200+ MMBtu/h</b>	0.08	0.05	0.23	0.12	0.00	0.37	0.00	0.73	0.83	0.55	0.51	0.23	0.07	0.27	0.16	0.07	4.26
<b>TOTAL</b>	<b>1.65</b>	<b>7.13</b>	<b>48.27</b>	<b>19.41</b>	<b>5.06</b>	<b>31.16</b>	<b>11.77</b>	<b>43.23</b>	<b>54.81</b>	<b>37.71</b>	<b>13.39</b>	<b>145.72</b>	<b>162.27</b>	<b>17.47</b>	<b>9.07</b>	<b>5.09</b>	<b>613.20</b>

**Table 75: Estimated Existing Process Boiler Capacity Impacted by Automatic Blowdown Code Change in 2029, by Climate Zone, Boiler Capacity, and Year-Round vs. Seasonal Operation (Million Btu/h)**

Boiler Category	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8	CZ 9	CZ 10	CZ 11	CZ 12	CZ 13	CZ 14	CZ 15	CZ 16	All
Year-Round Boiler 10-15 MMBtu/h	0.27	3.31	18.89	8.69	2.39	14.83	9.80	20.76	25.78	19.98	4.17	31.85	22.66	3.65	3.20	1.35	191.57
Year-Round Boiler 15-25 MMBtu/h	0.00	2.68	15.70	7.12	2.80	15.76	5.34	22.45	27.56	19.24	3.20	34.95	34.71	6.01	4.81	2.15	204.48
Year-Round Boiler 25-50 MMBtu/h	1.30	3.10	18.51	9.20	3.91	17.66	6.34	18.06	26.59	16.39	3.71	48.03	39.70	6.14	2.48	2.46	223.58
Year-Round Boiler 50-100 MMBtu/h	0.00	1.45	23.29	4.07	1.04	2.16	2.15	3.48	3.97	3.57	1.51	126.52	188.16	4.08	1.64	0.74	367.84
Year-Round Boiler 100-200 MMBtu/h	0.00	2.43	13.52	6.31	0.00	3.51	0.00	4.98	6.56	3.74	2.46	40.05	33.01	8.19	2.29	1.83	128.89
Year-Round Boiler 200+ MMBtu/h	1.59	0.99	4.79	2.58	0.00	7.55	0.00	15.09	17.25	11.32	10.56	4.76	1.48	5.53	3.22	1.34	88.06
Seasonal Boiler 10-15 MMBtu/h	0.00	0.02	0.09	0.04	0.01	0.07	0.05	0.10	0.13	0.10	0.02	0.16	0.11	0.02	0.02	0.01	0.94
Seasonal Boiler 15-25 MMBtu/h	0.00	0.02	0.12	0.05	0.02	0.12	0.04	0.17	0.21	0.14	0.02	0.26	0.26	0.04	0.04	0.02	1.53
Seasonal Boiler 25-50 MMBtu/h	0.03	0.06	0.38	0.19	0.08	0.36	0.13	0.37	0.55	0.34	0.08	0.99	0.82	0.13	0.05	0.05	4.60
Seasonal Boiler 50-100 MMBtu/h	0.00	0.08	1.33	0.23	0.06	0.12	0.12	0.20	0.23	0.20	0.09	7.23	10.76	0.23	0.09	0.04	21.03
Seasonal Boiler 100-200 MMBtu/h	0.00	1.01	5.65	2.64	0.00	1.47	0.00	2.08	2.74	1.56	1.03	16.73	13.79	3.42	0.96	0.77	53.83
Seasonal Boiler 200+ MMBtu/h	0.56	0.35	1.68	0.90	0.00	2.65	0.00	5.29	6.05	3.97	3.70	1.67	0.52	1.94	1.13	0.47	30.87
<b>Total</b>	<b>3.74</b>	<b>15.49</b>	<b>103.95</b>	<b>42.04</b>	<b>10.31</b>	<b>66.25</b>	<b>23.97</b>	<b>93.04</b>	<b>117.60</b>	<b>80.55</b>	<b>30.55</b>	<b>313.19</b>	<b>345.97</b>	<b>39.39</b>	<b>19.93</b>	<b>11.23</b>	<b>1,317.22</b>

**Table 76: Estimated New Process Boiler Capacity Impacted by Proposed Deaerator Pressure Code Change in 2029, by Climate Zone, Boiler Capacity, and Year-Round vs. Seasonal Operation (Million Btu/h)**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>	<b>All</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	0.03	0.43	2.43	1.12	0.31	1.91	1.26	2.68	3.32	2.57	0.54	4.10	2.92	0.47	0.41	0.17	24.68
<b>Year-Round Boiler 15-25 MMBtu/h</b>	0.00	0.38	2.21	1.00	0.39	2.22	0.75	3.17	3.89	2.71	0.45	4.93	4.89	0.85	0.68	0.30	28.83
<b>Year-Round Boiler 25-50 MMBtu/h</b>	0.20	0.49	2.90	1.44	0.61	2.77	0.99	2.83	4.17	2.57	0.58	7.54	6.23	0.96	0.39	0.39	35.08
<b>Year-Round Boiler 50-100 MMBtu/h</b>	0.00	0.30	4.75	0.83	0.21	0.44	0.44	0.71	0.81	0.73	0.31	25.81	38.38	0.83	0.34	0.15	75.04
<b>Year-Round Boiler 100-200 MMBtu/h</b>	0.00	0.58	3.22	1.51	0.00	0.84	0.00	1.19	1.56	0.89	0.59	9.55	7.87	1.95	0.55	0.44	30.73
<b>Year-Round Boiler 200+ MMBtu/h</b>	0.83	0.52	2.51	1.35	0.00	3.96	0.00	7.92	9.05	5.94	5.54	2.50	0.78	2.90	1.69	0.71	46.19
<b>Seasonal Boiler 10-15 MMBtu/h</b>	0.00	0.00	0.01	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.12
<b>Seasonal Boiler 15-25 MMBtu/h</b>	0.00	0.00	0.02	0.01	0.00	0.02	0.01	0.02	0.03	0.02	0.00	0.04	0.04	0.01	0.01	0.00	0.22
<b>Seasonal Boiler 25-50 MMBtu/h</b>	0.00	0.01	0.06	0.03	0.01	0.06	0.02	0.06	0.09	0.05	0.01	0.16	0.13	0.02	0.01	0.01	0.72
<b>Seasonal Boiler 50-100 MMBtu/h</b>	0.00	0.02	0.27	0.05	0.01	0.03	0.03	0.04	0.05	0.04	0.02	1.48	2.19	0.05	0.02	0.01	4.29
<b>Seasonal Boiler 100-200 MMBtu/h</b>	0.00	0.24	1.35	0.63	0.00	0.35	0.00	0.50	0.65	0.37	0.25	3.99	3.29	0.82	0.23	0.18	12.83
<b>Seasonal Boiler 200+ MMBtu/h</b>	0.29	0.18	0.88	0.47	0.00	1.39	0.00	2.78	3.17	2.08	1.94	0.87	0.27	1.02	0.59	0.25	16.19
<b>TOTAL</b>	<b>1.37</b>	<b>3.14</b>	<b>20.63</b>	<b>8.45</b>	<b>1.56</b>	<b>13.99</b>	<b>3.51</b>	<b>21.90</b>	<b>26.80</b>	<b>18.00</b>	<b>10.23</b>	<b>60.97</b>	<b>67.01</b>	<b>9.88</b>	<b>4.90</b>	<b>2.61</b>	<b>274.94</b>

**Table 77: Estimated Existing Boiler Capacity Impacted by Proposed Deaerator Pressure Code Change in 2029, by Climate Zone, Boiler Capacity, and Year-Round vs. Seasonal Operation (Million Btu/h)**

<b>Boiler Category</b>	<b>CZ 1</b>	<b>CZ 2</b>	<b>CZ 3</b>	<b>CZ 4</b>	<b>CZ 5</b>	<b>CZ 6</b>	<b>CZ 7</b>	<b>CZ 8</b>	<b>CZ 9</b>	<b>CZ 10</b>	<b>CZ 11</b>	<b>CZ 12</b>	<b>CZ 13</b>	<b>CZ 14</b>	<b>CZ 15</b>	<b>CZ 16</b>	<b>All</b>
<b>Year-Round Boiler 10-15 MMBtu/h</b>	0.07	0.86	4.91	2.26	0.62	3.85	2.54	5.39	6.69	5.19	1.08	8.27	5.88	0.95	0.83	0.35	49.74
<b>Year-Round Boiler 15-25 MMBtu/h</b>	0.00	0.76	4.46	2.02	0.79	4.48	1.52	6.38	7.83	5.47	0.91	9.93	9.86	1.71	1.37	0.61	58.11
<b>Year-Round Boiler 25-50 MMBtu/h</b>	0.41	0.98	5.85	2.91	1.24	5.58	2.00	5.71	8.41	5.18	1.17	15.19	12.55	1.94	0.78	0.78	70.70
<b>Year-Round Boiler 50-100 MMBtu/h</b>	0.00	0.59	9.58	1.67	0.43	0.89	0.88	1.43	1.63	1.47	0.62	52.01	77.35	1.68	0.68	0.30	151.22
<b>Year-Round Boiler 100-200 MMBtu/h</b>	0.00	1.17	6.50	3.03	0.00	1.69	0.00	2.39	3.15	1.80	1.18	19.25	15.86	3.93	1.10	0.88	61.94
<b>Year-Round Boiler 200+ MMBtu/h</b>	1.68	1.05	5.07	2.73	0.00	7.98	0.00	15.95	18.23	11.97	11.17	5.03	1.57	5.85	3.40	1.42	93.09
<b>Seasonal Boiler 10-15 MMBtu/h</b>	0.00	0.00	0.02	0.01	0.00	0.02	0.01	0.03	0.03	0.03	0.01	0.04	0.03	0.00	0.00	0.00	0.24
<b>Seasonal Boiler 15-25 MMBtu/h</b>	0.00	0.01	0.03	0.02	0.01	0.03	0.01	0.05	0.06	0.04	0.01	0.07	0.07	0.01	0.01	0.00	0.43
<b>Seasonal Boiler 25-50 MMBtu/h</b>	0.01	0.02	0.12	0.06	0.03	0.11	0.04	0.12	0.17	0.11	0.02	0.31	0.26	0.04	0.02	0.02	1.46
<b>Seasonal Boiler 50-100 MMBtu/h</b>	0.00	0.03	0.55	0.10	0.02	0.05	0.05	0.08	0.09	0.08	0.04	2.97	4.42	0.10	0.04	0.02	8.65
<b>Seasonal Boiler 100-200 MMBtu/h</b>	0.00	0.49	2.71	1.27	0.00	0.70	0.00	1.00	1.32	0.75	0.49	8.04	6.62	1.64	0.46	0.37	25.87
<b>Seasonal Boiler 200+ MMBtu/h</b>	0.59	0.37	1.78	0.96	0.00	2.80	0.00	5.59	6.39	4.19	3.91	1.76	0.55	2.05	1.19	0.50	32.63
<b>TOTAL</b>	<b>2.75</b>	<b>6.33</b>	<b>41.57</b>	<b>17.03</b>	<b>3.14</b>	<b>28.19</b>	<b>7.07</b>	<b>44.13</b>	<b>54.02</b>	<b>36.27</b>	<b>20.62</b>	<b>122.88</b>	<b>135.04</b>	<b>19.91</b>	<b>9.88</b>	<b>5.25</b>	<b>554.08</b>

# Appendix D: Environmental Analysis

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## Stack Economizer

### Potential Significant Environmental Effect of Proposal

The Statewide CASE Team has considered the environmental benefits and adverse impacts of its proposal, including but not limited to an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064, and has determined that the proposal will not result in a significant effect on the environment.

### Direct Environmental Impacts

#### *Direct Environmental Benefits*

Requiring the use of stack economizers would decrease the energy required to operate a boiler, which in turn would reduce GHG emissions from the reduced need to produce that energy, typically by burning natural gas. The direct environmental benefits of this proposal are demonstrated by the estimated energy reductions.

The data demonstrating energy benefits are discussed in Section 2.5.1. The data demonstrating GHG benefits are discussed in Section 2.5.2.

#### *Direct Adverse Environmental Impacts*

The Statewide CASE Team has not identified direct adverse environmental impacts.

### Indirect Environmental Impacts

#### *Indirect Environmental Benefits*

The Statewide CASE Team has not identified any indirect environmental benefits.

#### *Indirect Adverse Environmental Impacts*

The Statewide CASE Team has not identified any indirect adverse environmental impacts.

### Mitigation Measures

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

## **Reasonable Alternatives to Proposal**

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternate proposals would achieve the same impact of reduced energy consumption from process boilers.

## **Water Use and Water Quality Impacts Methodology**

The Statewide CASE Team has not identified any impacts to water quality or water use that would result from adopting the proposed changes.

## **Automatic Blowdown and Deaerator Pressure**

### **Potential Significant Environmental Effect of Proposal**

The Statewide CASE Team considered the environmental benefits and adverse impacts of its proposal, including but not limited to an evaluation of factors contained in the California Code of Regulations, Title 14, section 15064, and determined that the proposal will not result in a significant effect on the environment.

### **Direct Environmental Impacts**

#### ***Direct Environmental Benefits***

Requiring the use of automatic blowdown systems prevents releasing more water than necessary, as is common with manual blowdowns. This practice saves energy by reducing the need to heat make-up water.

Higher deaerator pressure setpoints lead to a higher boiling point of water, and thus an increased amount of energy is needed to boil the water. As such, unnecessarily high setpoints for the steam supply line header that feeds the deaerator will result in unnecessary energy consumption. The proposed code change would ensure that steam supply line header setpoints are not unnecessarily high.

The data demonstrating energy benefits are discussed in Section 3.5.1. The data demonstrating GHG benefits are discussed in Section 3.5.2. The data demonstrating water use benefits are discussed in Section 3.5.3.

#### ***Direct Adverse Environmental Impacts***

The Statewide CASE Team has not identified any direct adverse environmental impacts that would result from the proposed changes.

### **Indirect Environmental Impacts**

#### ***Indirect Environmental Benefits***

Automatic blowdown controls can reduce fouling and extend system lifetimes while reducing wastewater by avoiding unnecessary purging. Deaerator controls can also

extend system lifetimes by reducing oxygen pitting and corrosion. Reducing fouling and corrosion will also reduce the need for water treatment chemicals intended to protect equipment from these impacts. Making equipment replacement less frequent would reduce the embodied carbon emissions from its manufacture and transportation.

The reduced energy consumption from these measures will also indirectly improve in local air quality. Combustion of natural gas produces NO<sub>x</sub>, a chemical precursor to ozone. Reducing natural gas consumption will therefore indirectly lead to lower ozone levels (Environmental Defense Fund, 2025).

### ***Indirect Adverse Environmental Impacts***

The Statewide CASE Team has not identified any indirect adverse environmental impacts.

### **Mitigation Measures**

The Statewide CASE Team has considered opportunities to minimize the environmental impact of the proposal, including an evaluation of “specific economic, environmental, legal, social, and technological factors” (Cal. Code Regs., tit. 14, § 15021). The Statewide CASE Team did not determine this measure would result in significant direct or indirect adverse environmental impacts and therefore did not develop any mitigation measures.

### **Reasonable Alternatives to Proposal**

The Statewide CASE Team has considered alternatives to the proposal and determined that no alternate proposals would achieve the same impact of reduced boiler energy consumption.

### **Water Use and Water Quality Impacts Methodology**

Reducing excessive blowdown and avoiding unnecessary steam venting due to deaerator over-pressurization will reduce water consumption by reducing the amount of water that needs to be replaced in the boiler system. The quantity of water saved will vary depending on a site’s practices in the absence of the proposed requirements.

# Appendix E: Summary of Stakeholder Engagement

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## Introduction to Stakeholder Engagement

Collaborating with stakeholders who may be affected by proposed code changes is a core component of the Statewide CASE Team's process. The Statewide CASE Team engages interested parties to identify and address issues related to the proposals, to submit recommendations to the CEC that reflect broad support. Public stakeholders provide valuable feedback on draft analyses and help identify and address adoption challenges, including cost effectiveness, market and technical barriers, compliance and enforcement, and potential impacts on human health or the environment. Some stakeholders also provide data that the Statewide CASE Team uses to support analyses.

This appendix summarizes the stakeholder engagement conducted by the Statewide CASE Team during the development and refinement of the report's recommendations.

## Stack Economizer and Automatic Blowdown and Deaerator Pressure

### Utility-Sponsored Stakeholder Meetings

Utility-sponsored stakeholder meetings provide an opportunity to learn about the Statewide CASE Team's role in the advocacy effort and to hear about specific code change proposals that the Statewide CASE Team is pursuing for the 2028 code cycle. The goal of these meetings is to solicit early stakeholder input on proposals, ensuring the proposals and the supporting analyses are vetted and have as few outstanding issues as possible. To promote transparency in the development of code change proposals, the Statewide CASE Team uses stakeholder meetings to solicit feedback on the following:

- Proposed code changes,
- Draft code language,
- Draft assumptions and results of analyses,
- Data to support assumptions,
- Compliance and enforcement, and
- Technical and market feasibility.

The Statewide CASE Team hosted two stakeholder meetings for the proposed process boilers measures via webinar, as described in Table 78. Dates and links to event pages are listed and updated at [Title24Stakeholders.com](https://Title24Stakeholders.com). Materials from each meeting, such as slide presentations, proposal summaries with code language, and meeting notes, are

included in the bibliography section of this report (CA Statewide Utility Codes and Standards Team, 2025).

**Table 78: Utility-Sponsored Stakeholder Meetings**

Meeting Name and Link to Materials	Meeting Date	Summary of Items Discussed
First Round of Process Boiler Utility-Sponsored Stakeholder Meetings	Tuesday, September 23, 2025	<ul style="list-style-type: none"> <li>• Proposal description</li> <li>• Market and technical considerations</li> <li>• Energy savings methodology and cost assumptions</li> <li>• Compliance verification</li> </ul>
Second Round of Process Boiler Utility-Sponsored Stakeholder Meetings	Tuesday, February 17, 2026	<ul style="list-style-type: none"> <li>• Stack economizer measure assumptions</li> <li>• Blowdown measure assumptions</li> <li>• Deaerator measure assumptions</li> </ul>

The first round of utility-sponsored stakeholder meetings began in September 2025 and served as an early forum to promote transparency and gather stakeholder feedback on measures under consideration by the Statewide CASE Team.

The objectives of the first round of stakeholder meetings were to solicit input on the scope of the 2028 code cycle proposals; request data and feedback on the specific approaches, assumptions, and methodologies for the energy impacts and cost-effectiveness analyses; and understand potential technical and market barriers. The initial draft code language was posted on [Title24Stakeholders.com](https://www.title24stakeholders.com) for public stakeholder review.

The second round of utility-sponsored stakeholder meetings was held on February 17, 2026, to provide updated details on proposed code changes. This meeting introduced and solicited feedback on early results of energy savings, market adoption, and incremental cost analyses.

Utility-sponsored stakeholder meetings were open to the public. For each stakeholder meeting, two promotional emails were distributed from [info@title24stakeholders.com](mailto:info@title24stakeholders.com). One email was sent to the full Title 24 Stakeholders listserv, which includes over 3,000 individuals. A second email targeted specific recipients based on their subscription preferences.

The Title 24 Stakeholders listserv is an opt-in service that includes participants from diverse industries and trades, such as manufacturers, advocacy groups, local government, and building and energy professionals. Each meeting was announced on the Title 24 Stakeholders LinkedIn page and cross-promoted on the CEC LinkedIn page approximately two weeks in advance to engage individuals, organizations, and broader channels beyond the listserv. The Statewide CASE Team conducted extensive personal outreach to stakeholders identified in initial work plans who had not yet opted in to the

listserv. Exported webinar meeting data captured attendance numbers, individual comments, and results from live attendee polls to help evaluate stakeholder participation and support.

At the second stakeholder meeting, various stakeholders expressed concerns about stack economizer measure savings persistence, stack economizer installation, verification of the deaerator pressure exception, and the characterization of manual boiler blowdown as “excessive.” The Statewide CASE Team addressed these concerns verbally at each meeting and reached out to individual stakeholders afterward to better understand and address them. In some cases, this stakeholder feedback directly informed changes in the report language or assumptions.

### Statewide CASE Team Communications

The Statewide CASE Team held personal communications over email and phone with numerous stakeholders when developing this report, listed in Table 79. Most stakeholders preferred to be anonymous.

**Table 79: Engaged Stakeholders**

Organization Name	Market Role	Date of Engagement	Mentioned in CASE Report Sections
<b>Anonymous Stakeholder 1</b>	Boiler systems manufacturer	September 2025	2.1.2 Benefits of Proposed Change 2.3.1.1 Current Market Structure and Availability 2.4.3 Incremental First Cost 2.4.5 Cost Effectiveness 2.5.1 Statewide Energy and Energy Costs Savings 3.1.1.1 Current Market Structure and Availability 3.4.3 Incremental First Cost 3.5.1 Statewide Energy Costs and Savings Appendix C: Assumptions for Statewide Savings Estimates
<b>Anonymous Stakeholder 2</b>	Boiler systems manufacturer	August-November 2025	2.1.2 Benefits of Proposed Change 2.3.1.1 Current Market Structure and Availability 3.3.1.1 Current Market Share and Structure Availability 3.4.3 Incremental First Cost 3.5.1 Statewide Energy Costs and Savings Appendix C: Assumptions for Statewide Savings

Organization Name	Market Role	Date of Engagement	Mentioned in CASE Report Sections
<b>Anonymous Stakeholder 3</b>	Boiler and stack economizer representative	July-November 2025	2.3.1.1 Current Market Structure and Availability 3.1.1.1 Current Market Structure and Availability 3.5.1 Statewide Energy Costs and Savings Appendix C: Assumptions for Statewide Savings Estimates
<b>Anonymous Stakeholder 4</b>	Boiler servicer (maintenance and installation)		Did not inform specific assumptions.
<b>Anonymous Stakeholder 5</b>	Stack economizer and stack heat recovery equipment manufacturer	July 2025	Did not inform specific assumptions.
<b>Anonymous Stakeholder 6</b>	Boiler servicer (maintenance and installation)		Did not inform specific assumptions.
<b>Anonymous Stakeholder 7</b>	Industrial energy benchmarking representative	September 2025	Did not inform specific assumptions.
<b>Anonymous Stakeholder 8</b>	Boiler engineering consultant		Did not inform specific assumptions
<b>Beacon Economics</b>	Economic research and consulting firm	August 2025	Appendix C: Assumptions for Statewide Savings Estimates
<b>San Joaquin Valley APCD</b>	Air Quality Management District	April 2026	2.1.1 Proposed Code Change
<b>South Coast AQMD</b>	Air Quality Management District	March 2026	2.5.1 Statewide Energy and Energy Cost Savings
<b>Anonymous Stakeholder 9</b>	Boiler Owner/Operator	October 2026	2.4.2 Energy and Energy Cost Savings 3.4.2 Energy and Energy Cost Savings Appendix A: Assumptions for Cost-Effectiveness
<b>Anonymous Stakeholder 10</b>	Steam Solutions Manufacturer	March 2026	Appendix C: Assumptions for Statewide Savings

## Engagement with ESJ communities

The Statewide CASE Team did not conduct stakeholder outreach specifically targeted towards ESJ communities for this proposed code change. The proposed measures

would have no direct impact on residential communities in California, and the only indirect anticipated impact is decreased exposure to air pollution due to reduced natural gas combustion at nearby industrial facilities.

### **Mass Email Cold Outreach**

The Statewide CASE Team leveraged a list of organizations and emails from the California Directory of Manufacturers to send cold outreach email to about 600 organizations believed to have process boilers. The email invited respondents to participate in a conversational interview about or otherwise provide feedback on the proposed measures. Many of the email addresses were outdated at the time of sending, and the Statewide CASE Team did not receive responses from any stakeholders who wished to contribute to the process.

# Appendix F: Code Language Markup (Non-restructured)

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The language below is in the non-restructured 2025 Title 24 Part 6 Code Language.

## Stack Economizer

### 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

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

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- **BOILER STACK ECONOMIZER** (also known as a feedwater 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.
- **BIOMASS** is non-fossilized and biodegradable organic material originating from plants, animals or micro-organisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the non-fossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of non-fossilized and biodegradable organic material.
- **SELECTIVE CATALYTIC REDUCTION (SCR) SYSTEM** is a system used to reduce nitrogen oxide (NOx) emissions by injecting ammonia into the combustion exhaust gases.

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

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### SECTION 120.6 – MANDATORY REQUIREMENTS FOR COVERED PROCESSES

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#### 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 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.

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. 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 designed for a stack temperature drop of 60°F or more across the boiler stack economizer at design condition. The stack economizer shall not be bypassed during normal operation and piping shall route boiler feedwater through the stack economizer to the deaerator.

Exception 1 to Section 120.6(d)4: Boilers where the stack temperature measured at their lowest firing rate is below 340°F at outlet of boiler or outlet of SCR system if present and connected to the boiler.

**Exception 2 to Section 120.6(d)4:** Boiler systems designed to burn biomass<sup>18</sup> from facility processes or biomass produced from waste material produced at the facility, such as woody biomass, digester gas, landfill gas, and animal fat.

**Exception 3 to Section 120.6(d)4:** Boilers employing other methods of stack heat recovery, such as a heat exchanger serving a load other than boiler feedwater.

**Exception 4 to Section 120.6(d)4:** Indoor replacement boilers at existing facilities with roof clearance (distance from the boiler stack outlet to the ceiling or distance from the outlet of the SCR duct to the ceiling if the boiler is equipped with an SCR system) less than 88 inches for boilers with an input capacity at or below 25 MMBtu/h and less than 116 inches for boilers with an input capacity above 25 MMBtu/h.

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

Covered processes in additions or alterations to existing buildings that will be nonresidential, and hotel/motel occupancies shall comply with the applicable subsections of section 120.6 and 140.9.

## **Automatic Blowdown and Deaerator Pressure**

### **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**

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

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**BOILER BLOWDOWN VALVE** is a valve used for discharging water from a boiler to maintain the desired concentration of solids and chemicals to deter scale buildup, corrosion and carryover of impurities in the boiler water.

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<sup>18</sup> Has a dedicated line to the burner for biomass as specified. This does not include utility-supplied fuel that includes biomass.

**AUTOMATIC BOILER SURFACE BLOWDOWN CONTROLLER** is an automated system that optimizes surface-blowdown rates by regulating the volume of water discharged from the boiler in relation to the concentration of dissolved solids present.

**BOILER DEAERATOR** is a system that is used for the removal of oxygen and other dissolved gases from the feedwater to steam generating boilers. Dissolved gases in boiler feedwater cause corrosion damage in steam systems by attaching to metallic components and forming oxides, or rust.

**BLOWDOWN HEAT RECOVERY** is a heat exchanger that recovers energy from the blowdown to heat make-up water or another process stream, with or without a flash tank.

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

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### **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 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.

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. [Placeholder for Stack Economizer code]

5. Newly installed process steam boilers with an input capacity greater than or equal to 10 MMBtu/h (10,000,000 Btu/h) shall have an automatic boiler surface blowdown controller that is programmed to be controlled by conductivity.

**Exception 1 to Section 120.6(d)5:** Systems with returned condensate composing more than 90 percent of feedwater flow.

**Exception 2 to Section 120.6(d)5:** Boilers with make-up water treated by a reverse osmosis (RO) system.

**Exception 3 to Section 120.6(d)5:** Boilers employing blowdown heat recovery.

6. At newly installed process steam boiler systems that use the boiler steam header to pressurize the deaerator, the steam supply line pressure regulator serving the deaerator shall be set at or under 5 psig for all newly installed process steam boilers with an input capacity greater than or equal to 10 MMBtu/h (10,000,000 Btu/h). For boilers with tubes that are not rated for oxidizing conditions, the steam supply line pressure regulator setpoint shall be within 2 to 5 psig.

**Exception to Section 120.6(d)6:** Boiler systems with swings in make-up water equal to or above 20 percent of feedwater flow.

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

Covered processes in additions or alterations to existing buildings that will be nonresidential, and hotel/motel occupancies shall comply with the applicable subsections of section 120.6 and 140.9.