

Process Boilers

CEC Staff Workshop

California Statewide Utility Codes and Standards Program

PECI
August 17, 2011

Process Boilers

Proposed code changes (mandatory)

- Combustion air positive shutoff
 - Combustion fan VFD
 - Parallel position control
 - Oxygen trim control
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Process Boilers

Proposed language

Definitions:

PROCESS is an activity or treatment that is not related to the space conditioning, lighting, service water heating, or ventilating of a building as it relates to human occupancy.

PROCESS LOAD is a load resulting from a process.

PROCESS BOILER is a boiler serving a process load.

Process Boilers

Proposed language: Flue damper

SECTION 127 – REGULATED PROCESS EQUIPMENT

127(a) Process Boilers.

1. Combustion air positive shut-off shall be provided on all natural draft and forced draft process boilers as follows:

A. All process boilers with an input capacity of 0.70 MMBtu/h (700,000 Btu/h) and above.

B. All process boilers where one stack serves two or more boilers with a total combined input capacity per stack of 0.70 MMBtu/h (700,000 Btu/h).

C. All process boilers when combustion air positive shut-off would significantly reduce air flow, and consequently boiler heat loss, during standby and shutdown periods.

Process Boilers

Proposed language: Fan VFD

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

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

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.

Process Boilers

Proposed language: Parallel position

3. Process boiler systems with input capacity 5 MMBtu/h (5,000,000 Btu/h) or larger shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5.0% by volume on a dry basis over the entire firing range. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.
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Process Boilers

Proposed language: O2 Trim

4. Process boiler systems with input capacity 10 MMBtu/h (10,000,000 Btu/h) or larger shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 3.0% by volume on a dry basis over the entire firing range. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.
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Process Boilers

Combustion air positive shutoff

- Energy Analysis
 - Combustion air positive shut off saves 30% of total standby losses
 - Standby losses are 2% of rated fuel input.
 - 2920 hrs/year boiler operation (8-hour shift x 365 days/year)
 - Fuel is natural gas at \$1.22/therm
 - LCCA payback threshold is 11.94 years
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Process Boilers

Combustion air positive shutoff

- **Incremental Installed Cost**
 - Cost data provided by a flue damper manufacturer
 - Incremental cost to a boiler manufacturer for a flue damper is \$750
 - Their mark-up to end user was conservatively estimated to be 100%
 - Total incremental installed cost of \$1500
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Process Boilers

Combustion air positive shutoff

- **Maintenance Cost**
 - \$50 controller replacement every 10 years with 1 hour labor at \$100/hr.
 - Present value maintenance cost of \$112 at 3% discount rate.
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Combustion air positive shutoff

- Life Cycle Cost Results
 - Input capacity 0.70 MMBtu/h

Incremental Installed Cost	\$1,500
Maintenance	\$150
PV of Maintenance (Year 10)	\$112
Total Incremental Cost	\$1,612
PV of Energy Savings	\$1,791
Lifecycle cost savings	\$179
Benefit/Cost Ratio	1.1

Process Boilers

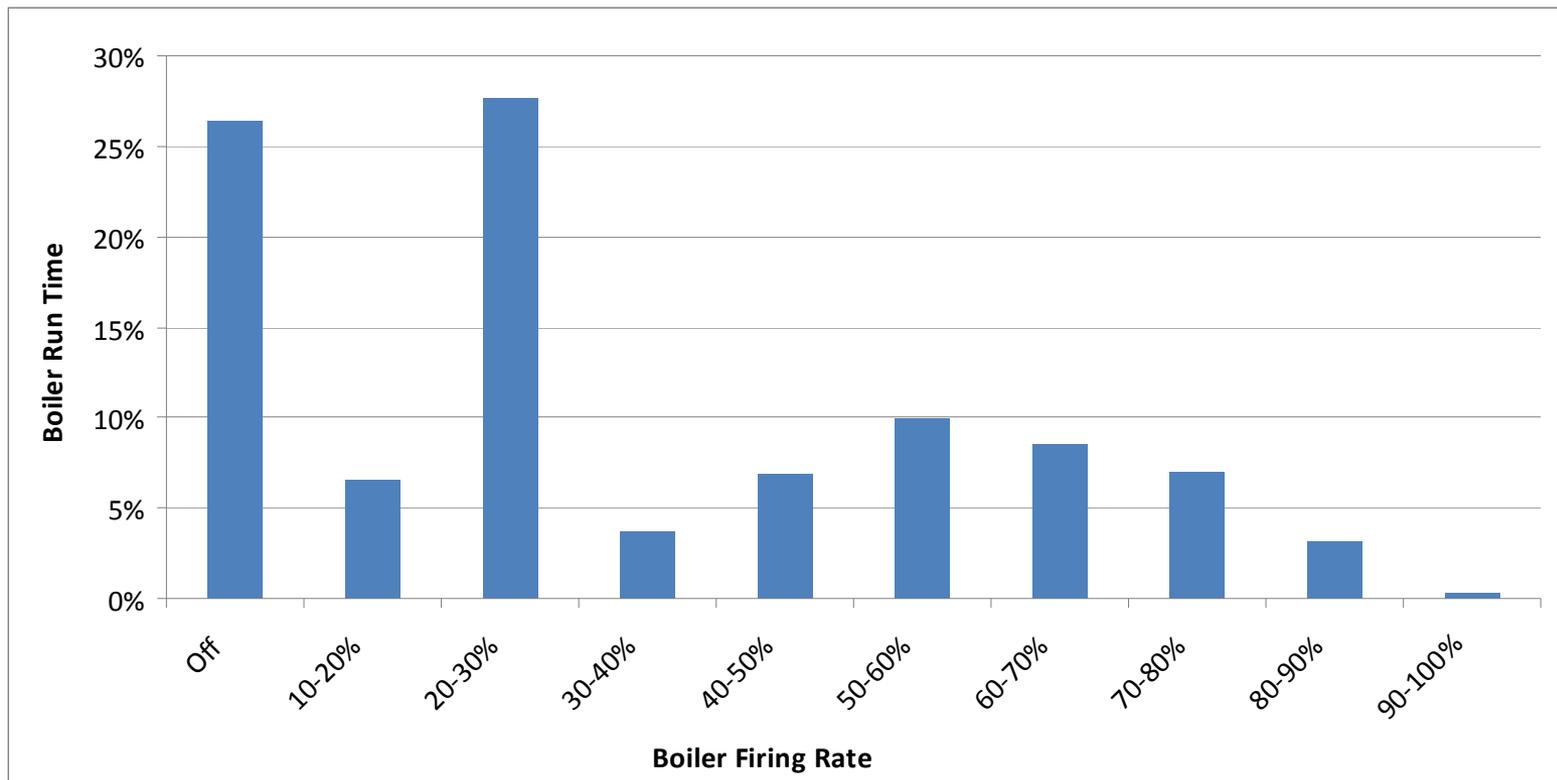
Combustion fan VFD

- Energy Analysis
 - 2920 hrs/year boiler operation
 - Motor load factor is 70%
 - Electricity cost is \$0.16/kWh
 - LCCA payback threshold is 11.94 years
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Process Boilers

Combustion fan VFD

- Energy Analysis
 - Boiler Run-Time Histogram



Process Boilers

Combustion fan VFD

- Incremental Installed Cost
 - Incremental cost data provided by RS Means and verified with cost data from PECL's California RCx program data

Size (hp)	2013 Equipment Cost	Controls Programming: 8 hrs	Incremental Installed Cost	Cost/HP
3	\$2,753	\$800	\$3,553	\$1,184
5	\$2,898	\$800	\$3,698	\$740
7.5	\$3,449	\$800	\$4,249	\$567
10	\$3,449	\$800	\$4,249	\$425
15	\$4,318	\$800	\$5,118	\$341
20	\$5,738	\$800	\$6,538	\$327
25	\$6,898	\$800	\$7,698	\$308
30	\$7,999	\$800	\$8,799	\$293
40	\$10,839	\$800	\$11,639	\$291
50	\$12,172	\$800	\$12,972	\$259

Process Boilers

Combustion fan VFD

- **Maintenance Cost**
 - Incremental maintenance cost is a conservative estimate of 0.5 hr/yr at a labor rate of \$100/hr.
 - PV of the annual maintenance discounted by 3% over 15 years is \$597.
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Process Boilers

Combustion fan VFD

- Life Cycle Cost Results
 - 10 HP motor

Incremental Installed Cost	\$4,249
Incremental Annual Maintenance	\$50
PV of Annual Maintenance	\$597
Total Incremental Cost	\$4,846
PV of Energy Savings	\$13,264
Lifecycle cost savings	\$8,418
Benefit/Cost Ratio	2.7

Process Boilers

Parallel position control

- **Energy Analysis**
 - Parallel positioning control is standard with low- and ultra-low NO_x burners
 - Base case is boiler with single-point control and without low- or ultra-low NO_x burner
 - Measure case is parallel positioning control and without low- or ultra-low NO_x burner
 - Base case excess air (oxygen) ranges from 40% (6.5%) at high fire to 80% (10%) at low fire
 - Measure case excess air (oxygen) is 28% (5%)
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Process Boilers

Parallel position control

- Energy Analysis
 - Net temperature difference (stack temp – intake temp) is 170°F
 - 2920 hrs/year boiler operation
 - Fuel is natural gas at \$1.22/therm
 - LCCA payback threshold is 11.94 years
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Process Boilers

Parallel position control

- **Incremental Installed Cost**
 - Incremental cost data was provided by 4 boiler controls reps
 - Total installed incremental costs from all 4 sources ranged from \$8,000 to \$9,000
 - Price does not vary with boiler capacity, at least between 50 HP (1.7 MMBtuh) and 1500 HP (50 MMBtuh)
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Process Boilers

Parallel position control

- **Maintenance Cost**

- A boiler's air/fuel ratio is adjusted during boiler tuning. This occurs for both the base case and the measure case but requires more time for the measure case.
 - The incremental maintenance cost is a conservative estimate of 4 hours per year at a labor rate of \$100/hr. The PV of the annual maintenance discounted by 3% over 15 years is \$4,775.
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Process Boilers

Parallel position control

- Life Cycle Cost Results
 - 150 HP (5 MMBtu/h) boiler:

Incremental Installed Cost	\$9,000
Incremental Annual Maintenance	\$400
PV of Annual Maintenance	\$4,775
Total Incremental Cost	\$13,775
PV of Energy Savings	\$24,756
Lifecycle cost savings	\$10,981
Benefit/Cost Ratio	1.8

Process Boilers

Oxygen trim control

- **Energy Analysis**
 - Parallel positioning control is standard with low- and ultra-low NO_x burners
 - Base case is boiler with single-point control and without low- or ultra-low NO_x burner
 - Measure case is parallel positioning control and without low- or ultra-low NO_x burner
 - Base case excess air (oxygen) ranges from 40% (6.5%) at high fire to 80% (10%) at low fire
 - Measure case excess air (oxygen) is 15% (3%)
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Process Boilers

Oxygen trim control

- Energy Analysis
 - Net temperature difference (stack temp – intake temp) is 170°F
 - 2722 hrs/year boiler operation
 - Fuel is natural gas at \$1.27/therm
 - LCCA payback threshold is 11.94 years
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Process Boilers

Oxygen trim control

- **Incremental Installed Cost**
 - Incremental cost data was provided by 3 boiler controls reps
 - Total installed incremental costs ranged from \$19,500 to \$27,000
 - Analysis uses \$27,000 for a conservative approach
 - Price does not vary with boiler capacity, at least between 50 HP (1.7 MMBtuh) and 1500 HP (50 MMBtuh)
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Process Boilers

Oxygen trim control

- **Maintenance Cost**

- A boiler's air/fuel ratio is adjusted during boiler tuning. This occurs for both the base case and the measure case but requires more time for the measure case.
 - The incremental maintenance cost is a conservative estimate of 8 hours per year at a labor rate of \$100/hr. The PV of the annual maintenance discounted by 3% over 15 years is \$9,550.
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Process Boilers

Oxygen trim control

- Life Cycle Cost Results

- 300 HP (10 MMBtu/h) boiler:

Incremental Installed Cost	\$27,000
Incremental Annual Maintenance	\$800
PV of Annual Maintenance	\$9,550
Total Incremental Cost	\$36,550
PV of Energy Savings	\$66,554
Lifecycle cost savings	\$30,004
Benefit/Cost Ratio	1.8

Process Boilers

Contact

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