



TITLE 24, PART 6

2028 CODE CYCLE



Process Steam #1: Flash Steam Recovery



Codes and Standards Enhancement (CASE) Proposal



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Flash Steam Background Information

- Flash steam forms when steam condensate is dropped to a pressure lower than its saturation pressure (boiling-point pressure).
- Flash steam is typically vented to the atmosphere, wasting fuel, water, and chemicals.
- Flash steam can be **recovered and repurposed** for useful heating to serve low-pressure loads like a deaerator.
- Repurposed flash steam **saves boiler system fuel use** by displacing live boiler steam to serve heating loads, as well as lowering water and sewer use.
- Flash steam recovery is an established industry best practice: ASHRAE has design guidance for flash steam recovery and DOE has five tip sheets on flash steam recovery.

DOE Steam Tip Sheets (#10, #11, #12, #13, #29): <https://www.energy.gov/eere/iedo/tip-sheets-system>

Flash Steam Proposed Code Change

This measure would require any **newly installed process steam boilers** with capacities at or above 10 MMBtu/h that are served by a pressurized deaerator to **recover and route flash steam from blowdown to the deaerator or another steam load**.

Exception 1: Boiler systems where high-pressure condensate is returned to the deaerator without being flashed (dropped to atmospheric pressure).

Exception 2: Boiler systems where the linear length* from the boiler to the serving deaerator is greater than or equal to 100 feet.

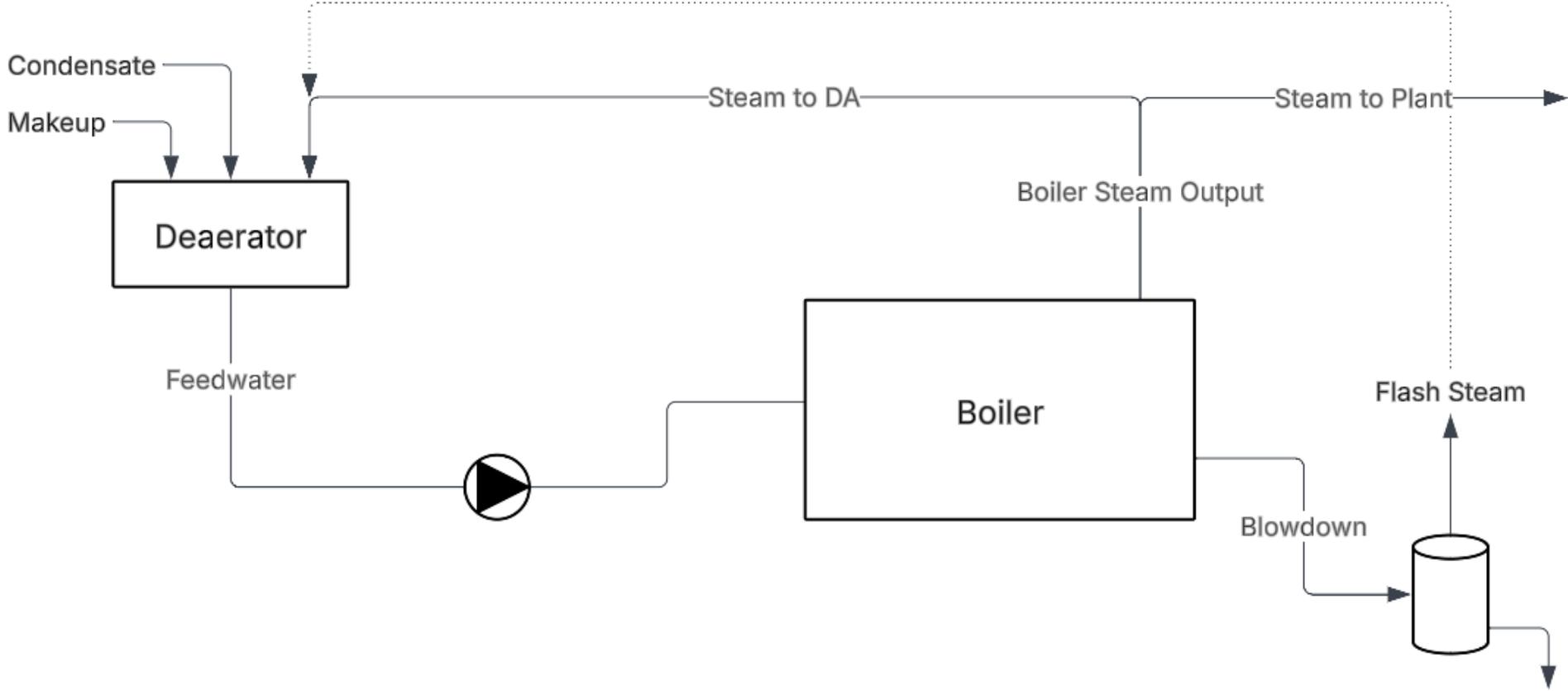
Estimated Boiler Pressure
(used to calculate savings for all boiler sizes):

100
psig

- What percentage of statewide steam boilers do you think would qualify for these exceptions?
- Are there any needed exception modifications or additional exceptions?
- Is 100 psig a fair representation of boiler pressure?

*The linear length shall include the sum of all horizontal and vertical pipe runs. Elbows and pipe fittings, including reducers, shall be excluded from the distance calculation.

Blowdown Flash Steam Recovery



Flash Steam Current Market

- Flash steam recovery is a **well-accepted best practice**. The components used are highly standard and **widely available**.
- Despite being a long-standing best practice, flash steam recovery is **not commonly implemented** due to additional design considerations, upfront cost, perceived complexity, and a lack of awareness of the benefits and cost-effectiveness.
- Rerouting flash steam from boiler blowdown for deaerator heating is the **most common application** of flash steam recovery because it's the simplest and cheapest.

Current Estimated Flash Steam Recovery Market Share

Percentage of new boiler capacity that recovers flash steam from boiler blowdown):

10%

Qualification Estimate

Percentage of new boiler capacity without a pressurized deaerator or where high-pressure condensate is returned to the deaerator without being flashed:

5%

Questions for the audience:

What would be your estimate for **current market share**?

Flash Steam Cost Estimates

First Cost: design, equipment, installation, startup and commissioning costs of flash steam recovery equipment, including flash vessels, piping (100 ft), and any ancillary components.

- Pipe diameter increases as boiler capacity increases, which scales first costs with capacity.
- Pipe length is fixed at 100 feet.

Boiler Capacity (median from bin)	Flash Steam Recovery System First Cost Estimate
12 MMBtu/h	\$15,713
19 MMBtu/h	\$18,900
32 MMBtu/h	\$18,900
71 MMBtu/h	\$22,970
143 MMBtu/h	\$25,731
739 MMBtu/h	\$51,871

30-Year Maintenance Costs

1. 10% piping insulation replacement every 10 years

Any feedback on or concerns with these cost estimates?

Flash Steam Cost Breakdown: 32.6 MMBtu/h Boiler

Item	Cost Explanation	Item Cost
Flash vessels	Linear extrapolation by load size of costs from a vendor stakeholder conversation in October 2024	\$5,000
Schedule 40 pipe (labor & materials)	2-inch diameter at \$51.78/linear foot for 100 feet	\$5,178
Pipe insulation w/ all service jacket (labor & materials)	RSMeans data, fiberglass insulation with all service jacket: \$45.36/LF	\$4,536
Additional valves, strainers, and fittings (materials only)	20% of total piping cost per engineering judgement	\$1,036
Additional labor	20% of total project cost, including oversight, coordination, installation, startup, and compliance and commissioning per engineering judgement	\$3,150
Total measure first cost		\$18,900

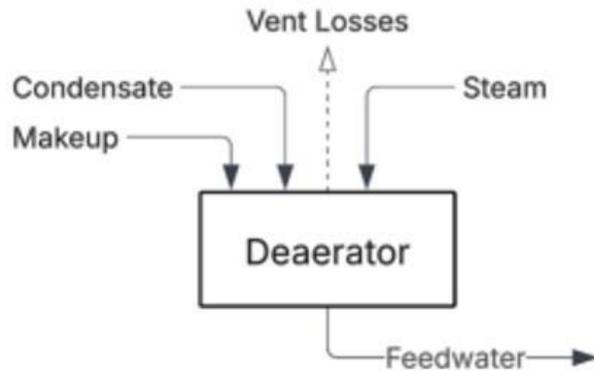
Flash Steam Savings Calculation Steps

Baseline: Model all mass and energy flows for a boiler system, where all blowdown is lowered to atmospheric pressure and *flash steam is vented*.

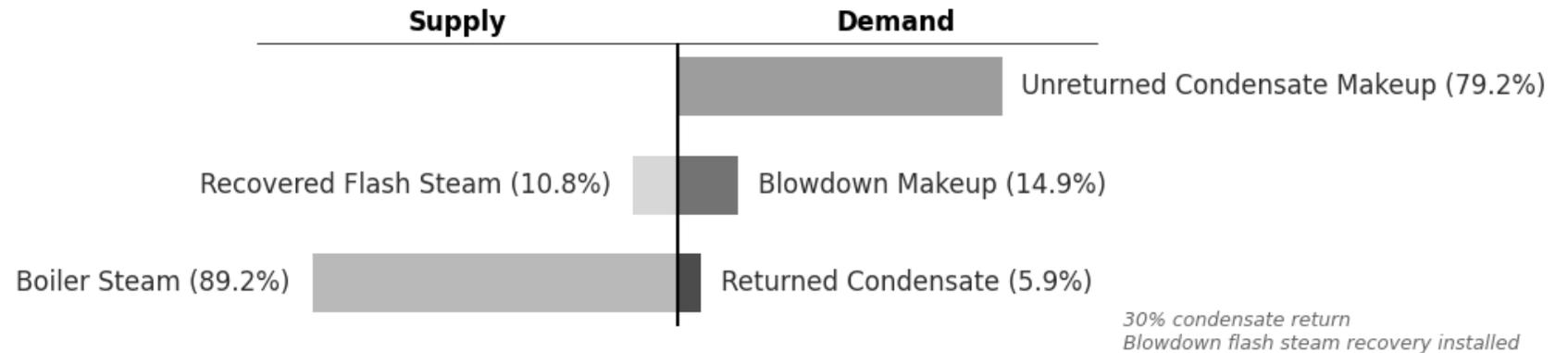
Proposed: Model all mass and energy flows for a boiler system, where *flash steam is recovered and routed to the deaerator*.

Savings: The energy savings and water savings are taken as the *differences in energy use and water use* between the baseline and proposed scenarios.

Deaerator Mass Flows



Deaerator Heat Balance



Flash Steam Recovery LSC Savings, Costs, and BCR Per Unit

Prototype	Benefits LSC Savings (2029 PV\$ Per MMBtu/h)	Costs Total Incremental PV Costs (2029 PV\$ Per MMBtu/h)	Benefit-to-Cost Ratio
Year-Round Boiler 10-15 MMBtu/h	\$25,765	\$2,071	12.4
Year-Round Boiler 15-25 MMBtu/h	\$25,762	\$1,274	20.2
Year-Round Boiler 25-50 MMBtu/h	\$25,739	\$911	28.2
Year-Round Boiler 50-100 MMBtu/h	\$25,627	\$467	54.9
Year-Round Boiler 100-200 MMBtu/h	\$25,683	\$273	94.0
Year-Round Boiler 200+ MMBtu/h	\$25,823	\$116	222.3
Seasonal Boiler 10-15 MMBtu/h	\$16,775	\$2,071	8.1
Seasonal Boiler 15-25 MMBtu/h	\$16,775	\$1,274	13.2
Seasonal Boiler 25-50 MMBtu/h	\$16,773	\$911	18.4
Seasonal Boiler 50-100 MMBtu/h	\$16,765	\$467	35.9
Seasonal Boiler 100-200 MMBtu/h	\$16,769	\$273	61.4
Seasonal Boiler 200+ MMBtu/h	\$16,780	\$116	144.4

Long-term System Cost (LSC) is the present value of costs to California's energy system over a period of 30 years. LSC does not represent a prediction of individual utility bills.

Poll

What else should we know? Do you have any feedback on any of the assumptions or estimates made regarding this measure?

Open ended response



TITLE 24, PART 6

2028 CODE CYCLE



Process Steam #2: Condensate Return

Codes and Standards Enhancement (CASE) Proposal



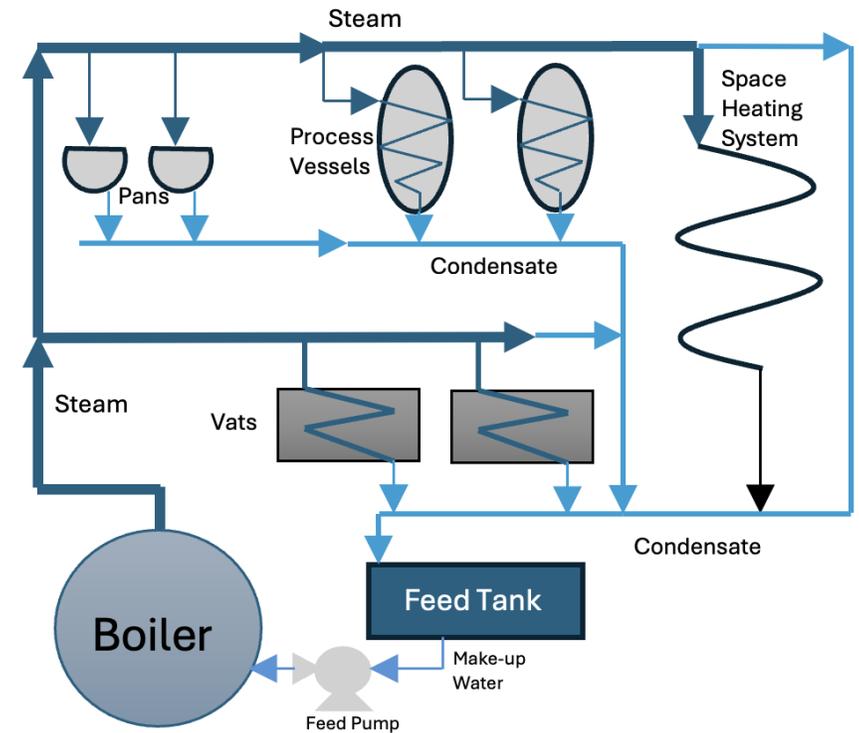
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Condensate Return Background Information

- After steam is used in process loads, hot condensate remains. Condensate is hot treated water, requiring no chemical treatment.
- Condensate can be dumped to drain or returned to the boiler for reuse.
- Condensate that is drained must be replaced with makeup water, which requires chemical treatment and heating.
- Sources of savings:
 - Reduce need for makeup water preheating.
 - Reduce blowdown.

A Typical Steam Circuit



DOE Tip Sheet: https://www.energy.gov/sites/prod/files/2014/05/f16/steam8_boiler.pdf

Proposed Code Change: Condensate Return

- **Require newly constructed process steam systems and newly added process steam loads** that use indirect-contact heat exchangers **to return all uncontaminated steam condensate** to the boiler for reuse.
 - This requirement would only apply to steam systems that meet a set of criteria for **load size** and **condensate return piping length**.
 - Condensate from associated drip legs must also be returned.
 - Condensate return from direct steam injection (that comes in direct contact with the process) is outside of the proposed code change.

See Title24stakeholders.com
for proposal description,
justification, draft code
language, and requested data

Code Trigger Table Addresses Cost Effectiveness Concerns

To ensure measure cost-effectiveness, process steam systems are only subject to the condensate return requirement **if the distance between the new steam load and the nearest condensate tank or the serving boiler is less than the maximum linear length*** values in the table below.

Steam Flow (lb/h)	Linear Length (ft) Less Than
<1,000	Exempt
≥1,000, <2,000	400
≥2,000, <3,000	600
≥3,000, <4,000	800
≥4,000, <6,000	1,100
≥6,000	1,300

Is this table clear?

*Linear length from the steam trap serving the load to the nearest condensate return tank or the deaerator serving the steam boiler, whichever is closer. The linear length shall include the sum of all horizontal and vertical pipe runs. Elbows and pipe fittings, including reducers, shall be excluded from the length calculation.

Current Market Conditions

The CASE Team assumes the following:

- The market for condensate return equipment is robust.
- The majority of facilities **return some condensate** but fall short of best practice targets.

**Estimated Percentage of Condensate Returned Across Total Steam Flow From
Total Statewide Qualifying Boiler Capacity:**

30%

Are you aware of any data on the typical percentage of condensate returned at steam loads in California?

Savings Assumptions

To calculate per-unit energy savings, the CASE Team assumes the following:

Base case:

Percentage of total steam flow that is returned as condensate in the baseline case:

30%

With requirement:

Percentage of total steam flow that will be returned at newly installed steam loads qualifying for the requirement:

75%*

Any feedback on or concerns with these assumptions?

Would year-round and seasonal (likely food processing) boilers achieve significantly different levels of condensate return?

*25% of loads estimated as direct injection and DA steam supply.

Condensate Return System Costs

First Cost: Purchase and installation of condensate return piping, piping insulation, condensate tank, and condensate pump.

First costs scale significantly with boiler size due to larger capacities requiring both larger pipes and longer pipe runs.

Boiler Capacity (median from bin)	Condensate Return System First Cost
12 MMBtu/h	\$145,264
19 MMBtu/h	\$253,362
32 MMBtu/h	\$380,043
71 MMBtu/h	\$896,345
143 MMBtu/h	\$1,692,933
739 MMBtu/h	\$4,931,741

30-Year Maintenance Costs

1. Pump replacement every 10 years
2. 10% insulation replacement every 10 years
3. Tank replacement after 20 years

Condensate Return Cost Assumptions

Boiler Capacity (median from bin)	Number of Steam Loads	Pipe Length (ft)	Pipe Diameter (in)
12 MMBtu/h	2	300	1.5
19 MMBtu/h	2	450	2.0
32 MMBtu/h	3	450	2.0
71 MMBtu/h	4	825	2.0
143 MMBtu/h	5	975	2.5
739 MMBtu/h	12	975	3.5

Condensate Return System Cost Breakdown: 12 MMBtu/h

Item	Cost Explanation	Item Cost
Pipe Cost	RSMeans data, 2025 Q2 for Vallejo, Calif for (\$53.68/LF) at: <ul style="list-style-type: none"> • 300ft (75% of max cost-effective trigger table length 400ft for steam load) • 1.5in piping (calculated at pressure drop <0.1psig/100LF for steam load) 	\$16,104
Fittings, Elbows, Tanks and Valves	Equivalent to piping costs. Tank costs are estimated at 50% of the total cost of fittings, elbows, tanks, and valves.	\$16,104
Total Labor Costs	Est1.5 times the piping cost, based on costs from a recent Cascade Energy project in California	\$24,156
Pump Cost	Linear extrapolation of RSMeans data, 2025 Q2 for Vallejo, Calif. The 12 MMBtu/h boiler requires pumps based on steam load size.	\$10,001 per pump
Insulation Costs	RSMeans, fiberglass insulation with all service jacket (\$20.89/LF) for 2-inch insulation (1.5-inch pipe at 200°F)	\$6,267
Total Project Cost per Load	Cost for one load at 75% of max trigger table length (300 LF)	\$72,632
Total Project Cost	Cost for two loads	\$145,264

Any feedback on or concerns with these cost estimates?

Condensate Return Savings Components

Energy savings from this condensate return measure were calculated in two components:

- 1. Deaerator preheating savings.** Replacing cold make-up water with (warm/hot) returned condensate reduces the energy required to heat the deaerator.
 - Returned condensate is typically at 200°F, while cold make-up water is around 65°F.
- 2. Blowdown reduction.** Replacing make-up water (containing dissolved solids) with condensate (effectively distilled water) reduces blowdown.
 - Reduction in energy: Blowdown for a 100psig boiler is at 338°F prior to discharge, and reducing blowdown reduces energy losses.
 - Reduction in water use: Excess blowdown requires fresh makeup water, increasing the total amount of water a site must purchase from a utility.

Condensate Return LSC Savings, Costs, and BCR Per Unit

Prototype	Benefits LSC Savings (2029 PV\$ Per MMBtu/h)	Costs Total Incremental PV Costs (2029 PV\$ Per MMBtu/h)	Benefit-to-Cost Ratio
Year-Round Boiler 10-15 MMBtu/h	\$155,338	\$15,155	10.3
Year-Round Boiler 15-25 MMBtu/h	\$155,325	\$15,366	10.1
Year-Round Boiler 25-50 MMBtu/h	\$155,184	\$13,725	11.3
Year-Round Boiler 50-100 MMBtu/h	\$154,505	\$14,383	10.7
Year-Round Boiler 100-200 MMBtu/h	\$154,846	\$13,263	11.7
Year-Round Boiler 200+ MMBtu/h	\$155,691	\$7,436	20.9
Seasonal Boiler 10-15 MMBtu/h	\$101,461	\$15,155	6.7
Seasonal Boiler 15-25 MMBtu/h	\$101,460	\$15,366	6.6
Seasonal Boiler 25-50 MMBtu/h	\$101,449	\$13,725	7.4
Seasonal Boiler 50-100 MMBtu/h	\$101,398	\$14,383	7.1
Seasonal Boiler 100-200 MMBtu/h	\$101,424	\$13,263	7.7
Seasonal Boiler 200+ MMBtu/h	\$101,487	\$7,436	13.7

Long-term System Cost (LSC) is the present value of costs to California's energy system over a period of 30 years. LSC does not represent a prediction of individual utility bills.

Poll

What else should we know? Are there market or technical barriers or solutions we should consider?

Open ended response

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More information on
[CEC's 2028 proceeding website](#)

We want to hear from you!