TITLE 24, PART 6 | 2028 CODE CYCLE

Process Steam #1: Flash Steam Recovery

Codes and Standards Enhancement (CASE) Proposal

Ryan Swanson
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CALIFORNIA ENERGY CODES & STANDARDS
A STATEWIDE UTILITY PROGRAM

Proposal Description

- Code Change Proposal
- Benefits
- Background Information

Proposed Code Change: New Construction

For new construction of **process steam systems** that have (a) one or more connected boilers with an input rating (capacity) of 10 MMBtu/h or greater, (b) a pressurized deaerator, and (c) a boiler design condition pressures of 100 psig or greater, **require at least 50% [TBD] of flash steam to be recovered or reduced** using one or more methods such as the following:

1. Recover and reuse flash steam from high-pressure condensate and boiler blowdown for use at:
   - Low-pressure steam loads
   - Steam-to-hot-water heat exchangers
   - Deaerator heating
2. Recover flash steam and boost pressure via thermal vapor recompression (TVR) or mechanical vapor recompression (MVR) for use at intermediate-pressure loads.
3. Implement a pressurized condensate return system.

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

Poll

What percentage of flash steam recovery/reduction would be viable across all steam systems that have pressurized deaerators and boiler operating pressures above 100 psig?

a. 1% – 10%
b. 11% – 20%
c. 21% – 30%
d. 31% – 40%
e. 41% - 50%
f. 51% - 60%
g. 61% - 70%
h. 71% - 80%
i. 81% - 90%
j. 91% - 100%
k. Don't know

Proposed Code Change: Additions and Alterations

50% or more of flash steam must be recovered or reduced **at new, non-replacement process steam loads at existing facilities** that:

- are connected to a system with a pressurized deaerator
- are served by a header that has a design condition pressure of 100 psig or greater
- meet the conditions in Table 120.6-F:

Table 120.6 F
Steam Load Addition Code Trigger Criteria for Existing Facilities

Steam Flow (lb/h)	Linear Length* (ft) less than
<5,000	Exempt
>5,000, <7,500	150
>7,500, <10,000	350
>10,000, <15,000	500
>15,000	1,000

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

Note: Existing systems and existing equipment replacements that do not add new or additional steam loads are exempt.

*Linear distance from the load to the nearest boiler plant deaerator, measured across both horizontal and vertical dimensions. Calculation of linear length will be described in Reference Appendix.

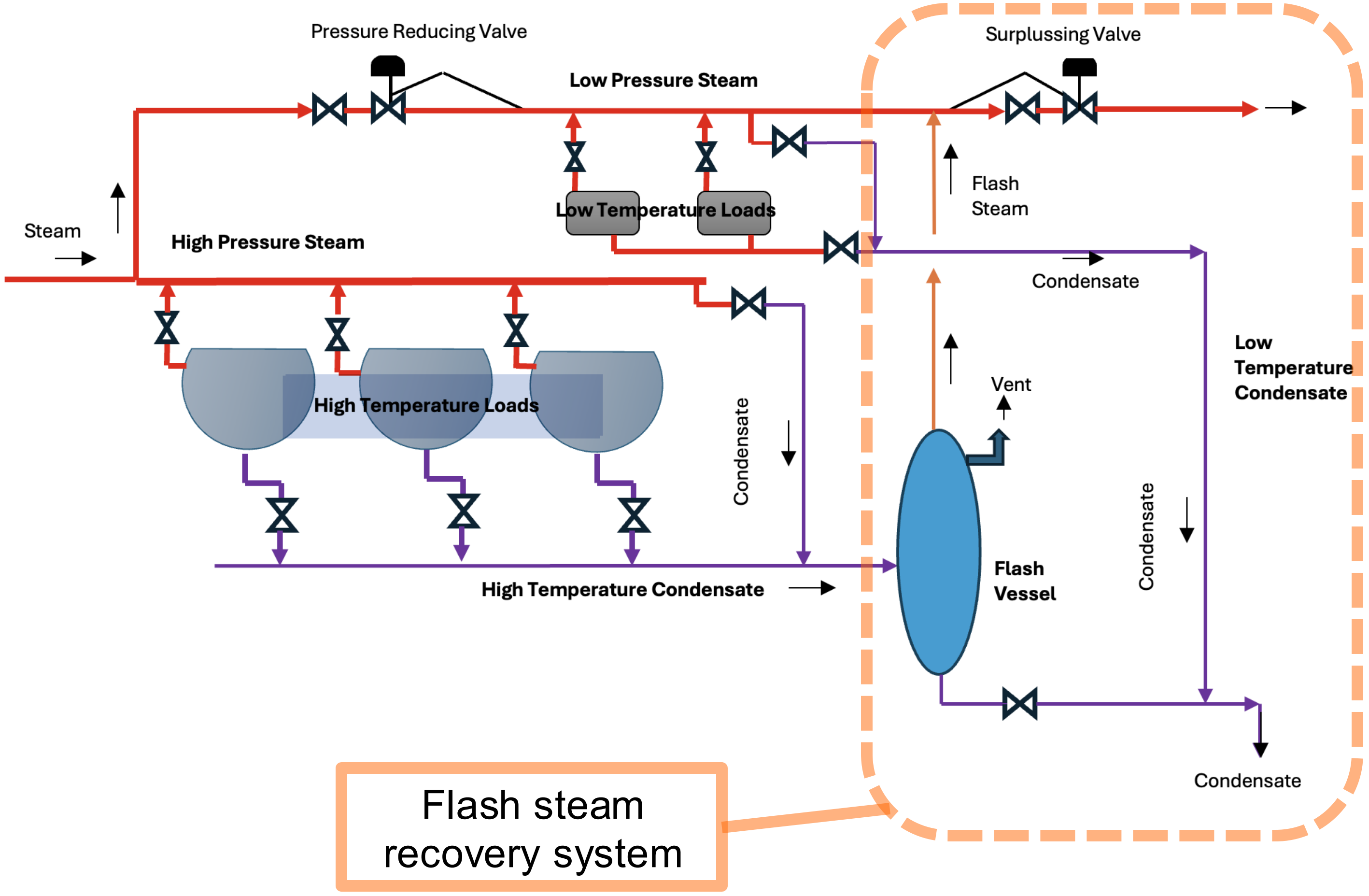
Poll

How can this proposed requirement consider sites without viable low-pressure loads? What could a possible exception pathway look like?

Open ended response

Benefits of the Proposed Change

- **<u>Fuel</u>**. Saves 1-5% or more of baseline boiler system fuel use by using flash steam to serve lower-pressure loads instead of down-regulating live boiler steam.
- **<u>Water</u>**. Reduces water and sewer use, as the flash steam is no longer vented to the atmosphere and its condensate can be returned to the boiler plant.
- **<u>Chemicals</u>**. Conserves boiler system water that has already been chemically treated, avoiding cost to treat makeup water.



Background Information

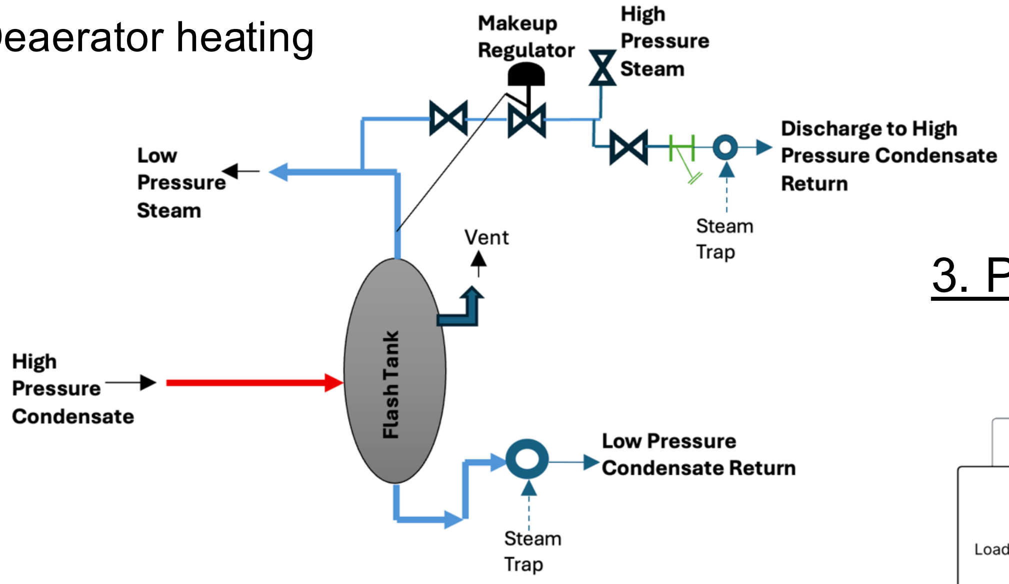
- Flash steam is created when steam condensate is dropped to a pressure lower than its saturation pressure (boiling-point pressure).
- Flash steam is typically vented to the atmosphere, wasting fuel, water, and chemicals.
- Flash steam can be **recovered and repurposed** for useful heating to serve low-pressure loads, instead of using high-pressure live boiler steam for the same purpose.
- Flash steam can also be **reduced** by using a pressurized condensate return system.
- Existing process steam requirements in Title 24 Part 6 cover steam traps and do not address flash steam recovery.
- 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

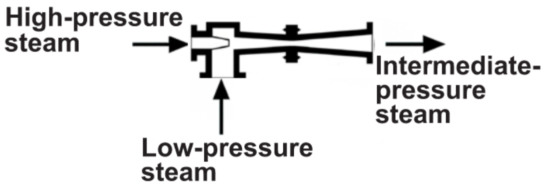
Background Information-Flash Steam Applications

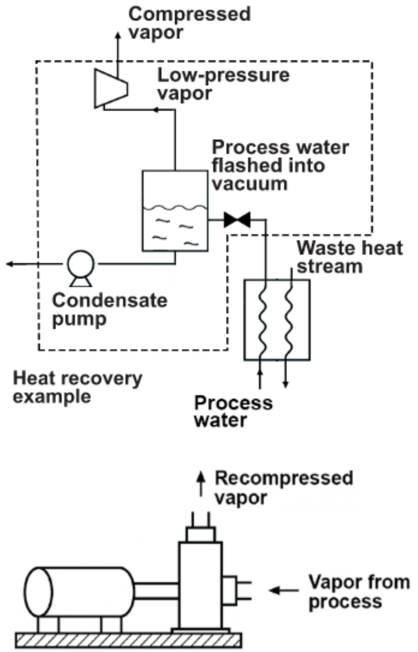
1. Low-pressure Loads

Process hot water
Process steam
Deaerator heating

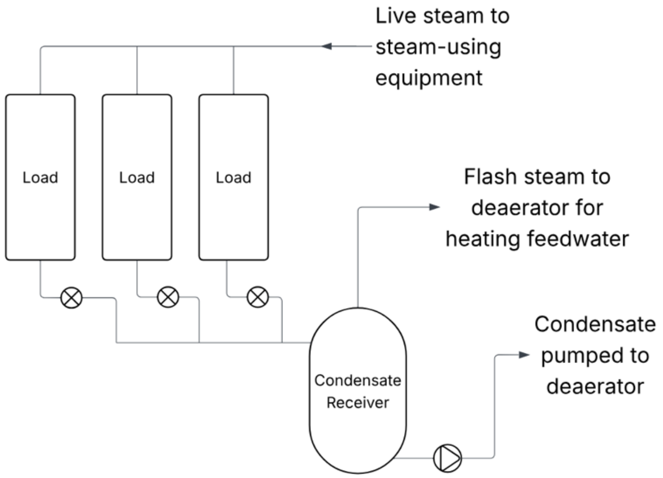


2. Thermal/Mechanical Vapor Recompression





3. Pressurized Condensate Return



Poll

Are there additional flash steam recovery methods or applications that should be included?

Open ended response

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1	Title 24, Part 6	Reference Appendices
▪ No changes.	▪ 100.1(b) Definitions ▪ 120.6(I) Mandatory requirements for process steam systems (new) ▪ 141.1(x) Requirements for covered processes in additions, alterations to existing nonresidential and hotel/ motel buildings	▪ Nonresidential Appendix 9 – Process Steam System Qualification Requirements ▪ NA9.2 Flash Steam Calculations (new)

Market and Technical Considerations

- Current Conditions and Trends
- Potential Barriers and Solutions
- Technical feasibility

Current Market Conditions

- Flash steam recovery is a **well-accepted best practice** in the design and operation and design of steam systems.
  - There is a history of documentation in **DOE** and **ASHRAE**.
  - The components used are highly standard and **widely available.**
  - **Multiple steam equipment manufacturers** have application guides for flash steam recovery.
- Anecdotally, flash steam recovery is not common. Recovery of flash steam from boiler blowdown tends to be the most common application.
- California has known installations of TVR and MVR.
- The CASE Team will continue to gather information from stakeholders on existing flash steam recovery applications.

DOE Steam Tip Sheets (#10, #11, #12, #13, #29): https://www.energy.gov/eere/iedo/tip-sheets-system
ASHRAE: Handbook- HVAC Systems and Equipment (2020 ed., Chapter 11); Fundamentals of Steam System Design (2006 ed., Chapter 6)

Market Barriers and Solutions

Market Barriers	Potential Solutions
1. High upfront cost and longer payback periods than typical industrial investments.	1. To ensure cost-effectiveness at existing sites with high upfront costs, only trigger this requirement for sites with reasonable upfront costs via the code trigger criteria table.
2. Some sites may lack lower-pressure loads at which to use recovered flash steam and reduce energy use.	2. Only apply the code requirement to sites that have a pressurized deaerator, ensuring a use for low-pressure steam.
3. Low awareness of flash steam recovery cost-effectiveness.	3. Develop Compliance Manual content with best practices on ways to use recovered flash steam. Perform outreach to present potential applications and successful case studies in various use cases.

Poll

Using your best estimate, what percentage of newly added steam loads have flash steam recovery?

a. 1% – 10%
b. 11% – 20%
c. 21% – 30%
d. 31% – 40%
e. 41% - 50%
f. 51% - 60%
g. 61% - 70%
h. 71% - 80%
i. 81% - 90%
j. 91% - 100%
k. Don't know

Poll

For existing sites <u>with flash steam recovery</u>, what percentage of flash steam is recovered?

a. 1% – 10%
b. 11% – 20%
c. 21% – 30%
d. 31% – 40%
e. 41% - 50%
f. 51% - 60%
g. 61% - 70%
h. 71% - 80%
i. 81% - 90%
j. 91% - 100%
k. Don’t know

Current Estimated Market Share: Flash Steam Recovery

Market share: percentage of process steam systems that already recover or reduce 50% of their flash steam.

Current Market Share

New Construction	20%
Additions and Alterations	10%

Engineering judgement. Expected to vary by facility and industry size.

Technical Considerations

The components for a flash steam recovery system are standardized and widely available.

The components include a tank and piping.

Installation Considerations

- Pipe length: the physical distance between flash steam supply and demand
- Pipe sizing: lower-pressure steam requires larger piping

Operational Considerations

- Stability of flash steam supply
- Stability of flash steam demand

Technical Barriers and Solutions

Technical Barriers	Potential Solutions
1. Distance of new pipe runs between recovery and use can vary greatly at existing sites. 2. Recovered flash steam application may be limited without adequate low-pressure steam loads.	1. Use pipe length code trigger table to ensure practicality of code compliance for additions and alterations. 2. Proposed measure allows either flash steam reduction or recovery, as well as applications such makeup water preheating, deaerator heating, and hot water production. The use of a pressurized deaerator ensures a use for low-pressure steam at each site.

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs

Energy and Energy Cost Savings Methodology

Savings Principle

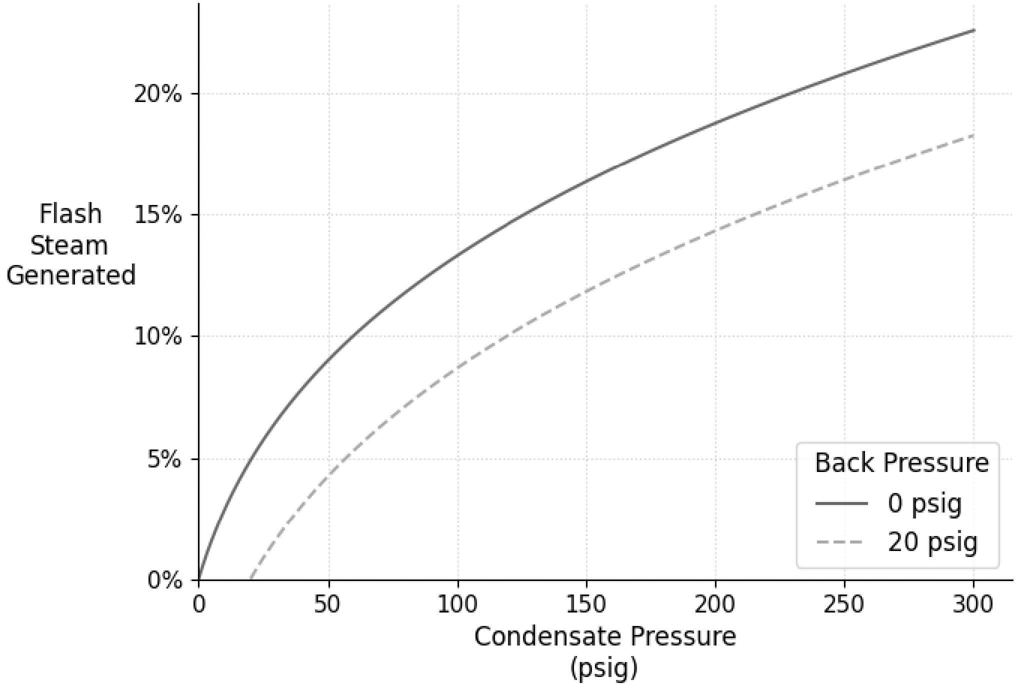
- Flash steam recovery reduces the use of live steam at lower-pressure loads.
- Recovery of flash steam reduces the need to down-regulate high-pressure live steam for low pressure loads.
    - Boiler fuel use is proportional to live steam use.

Savings Methodology

- The amount of flash steam **generated** is a function of the following:
    - Condensate temperature and pressure
    - Flash steam pressure
- The amount of **recoverable** flash steam is a function of the supply and demand stability.
- Specific equations are provided in a reference slide and savings are estimated for use cases that send flash steam to lower-pressure loads.

Steam Types

Type	Source	Pressure
Live steam	Boiler	High
Flash steam	System	Lower than boiler pressure



Key Assumptions

The key assumptions below are for the average savings design. The CASE Team is performing a sensitivity analysis for edge cases, such as seasonal facilities.

Baseline Design
No recovery of flash steam.

1. Flash Steam Recovered: **0%**
2. Boiler Efficiency: 79.5 %
3. Boiler Load: 40%
4. Operating Hours per Year: 6,500 (typical year-round boilers), 2,400 (seasonal)
5. Makeup Water Temperature: 65°F
6. High-Pressure Load Pressures: 100 - 400 psig
7. Low-Pressure Load Pressures: 0 - 50 psig
8. % High-Pressure Steam Loads: 20% - 80%

Proposed Design.
50% of flash steam recovered.

1. Flash Steam Recovered: **50%**
2. All other assumptions remain the same.

Estimate of Natural Gas Savings - Sensitivity Analysis

The CASE Team will perform additional **sensitivity analyses** and **edge case** savings estimates for:

- Varying annual operating hours.
- Steam load and pressure distributions.
- Implementation difficulty.
- Seasonal canneries with low operating hours.
- Applications with long pipe runs between flash steam generation and use.
- Sites with a low percentage of low-pressure steam loads.

Incremental Cost Framework

Baseline:

No recovery of flash steam.

First Cost

1. None

30-Year Maintenance Costs

1. N/A

Proposed:

50% of flash steam recovered.

First Cost

1. System Design
2. Equipment (flash vessel, piping, steam traps, ancillary components)
3. Installation
4. Startup & Commissioning

30-Year Maintenance Costs

1. Equipment Replacement (steam traps)
2. Regular Maintenance (steam traps)
3. Piping insulation repair

Approach for Gathering Costs

The CASE Team plans to:

- Review Code Readiness Steam Trap Fault Detection & Diagnostics (FDD) project data.
- Survey vendor quotes for required equipment.
- Review anonymized pricing data from recent flash steam recovery projects in California.
- Interview stakeholders (vendors, owners, operators, manufacturers) equipment first costs, installation costs, lifetime, maintenance costs, type and frequency.
- Evaluate equipment lifetime data from CPUC DEER Database.
- Review RSMeans Mechanical Cost Data for hardware and labor costs.

Poll

If your steam system has some form of flash steam recovery, what kind is it?

If your steam system does not recover flash steam, why not?

[OPEN END]

Compliance Verification

- Key Aspects of Compliance Verification
- Barriers and Solutions
- Revisions to Compliance Software

Key Aspects of Compliance Verification

- **Design Document Review** by AHJ plan checker to verify:
  - Planned installation of a flash steam recovery tank and labeled piping in construction documents.
  - Include calculations that show the percentage of flash steam recovered and/or reduced in design documents (will be described in Reference Appendix NA9).
- **Updates to NRCC-PRC-E Process Systems Certificate of Compliance**
  - Document the following in accordance with the Reference Appendix NA9 Flash Steam Calculations:
    - The amount of flash steam generated by the added steam load.
    - The amount of flash steam reduced or recovered.
- **Updates to NRCI-PRC-E Process Systems Certificate of Installation**
  - Document key installed equipment specifications.
- **No Third-Party Verification Requirements**
- **No Updates to Compliance Software**

Compliance Barriers and Solutions

Compliance Verification Barriers

1. AHJ plan checkers and field technician must be comfortable checking for flash steam system design and installation.

Potential Solutions

1. Forms and plans would be signed by licensed Professional Engineers (PE). A Compliance Manual section 120.6(I) will be developed to improve understanding of condensate return compliance. A new Reference Appendix section NA9 and the NRCC-PRC forms will provide additional guidance for AHJ plan checker system review.

Compliance Software Updates

No compliance software updates are expected as there is no compliance software of any kind for this measure.

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We want to hear from you!

Ryan Swanson
Enesfere
ryan@enesfere.com

Emma Conroy
2050 Partners
emmaconroy@2050partners.com

Please copy: info@title24stakeholders.com

More information on
CEC's 2028 proceeding website.

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