



TITLE 24, PART 6

2028 CODE CYCLE

Circulator Pump Controls

Codes and Standards Enhancement (CASE) Proposal

Richard Fatu
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Proposal Description

- Code Change Proposal
- Benefits
- Background Information



Proposed Code Change

For nonresidential applications:

Electronic Commutating Motor (ECM) Pumps with increased controls functionality:

- **New prescriptive requirement** for **advanced controls** for circulator pumps in service hot water systems
 - Onboard or remote sensors to provide input signal for pump motor control
 - Validated controls (pump-integrated):
 - Constant return temperature
 - Differential or Constant pressure with balancing valve
 - Validated controls (add on, remote to pump):
 - Demand control
 - Non-validated controls:
 - Adaptive or smart controls

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

Proposed Code Change (Useful Terms)

- **Basic controls:**
 - Current base case method
 - Includes: repeat cycle timers, timeclocks, and aquastats
 - Lack lockout options, ability to retain settings during power outages, remote monitoring, and alerts
- **Advanced controls:**
 - Integrated:
 - Differential pressure
 - Constant return temperature
 - External:
 - Demand control
 - Energy Management System
 - Offer lockout option, retention of settings during power outages, remote monitoring and alerts via network connectivity.

See Title24stakeholders.com
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language, and requested data

Benefits of the Proposed Change

- Reduce heat loss in pipes, reducing water heater energy use
- Utilize advanced pump controls to reduce circulator pump energy consumption
- Reduce risk of water tank destratification, to mitigate HW runouts and improve heat pump COP
- More consistent HW supply and return temperature



Background Information

1. Currently on/off mandatory requirements for nonresidential central service hot water systems in Section 110.3
 - Primarily via timeclock, some designers also include an aquastat
2. NREL¹, NEEA², CARD³ research suggests adding advanced controls to pumps has significant energy savings
 - NREL research only evaluated pump savings, not savings from water heater
 - Savings are from reduction in pump full load operating hours, via part load operation and switch off hours
3. Ongoing code readiness studies to investigate pump control performance⁴



1. [High-Performance Circulator Pump Demonstration \(2018\)](#)
2. [Extended Motor Products Savings Validation Research on Clean Water Pumps and Circulators \(2019\)](#)
3. [Evaluation of New DHW System Controls in Hospitality and Commercial Buildings \(2018\)](#)
4. [Circulator Pump Controls Field Study \(2026\)](#)

Marked-up Code Language

See Title24stakeholders.com for marked-up code language

Title 24, Part 1

- No changes

Title 24, Part 6

- SECTION 140.5(d) Circulator pump controls
- SECTION 141.0(b)2.N
ADDITIONS, ALTERATIONS,
AND REPAIRS

Reference Appendices

- No Changes



Market and Technical Considerations

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

Current Market Conditions

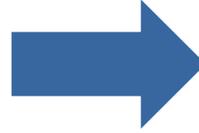
- Current market offerings are focused on controls in circulation pumps for hydronic space heating systems
- Example of pumps w/integrated advanced controls suitable for service hot water systems:
 - Bell & Gossett, ecocirc XL (pictured)
 - Taco, 00e
 - Grundfos, MAGNA3



Market Barriers and Solutions

Market Barriers

1. ECM pump with advanced controls not common industry practice
2. Lack of design & installation experience
3. Limited product availability beyond basic pump controls in service hot water system recirculation



Potential Solutions

1. Raise awareness on benefits of circulation pumps with advanced controls
2. Training and best practices for designers and installers
3. Educate pump manufacturers on the need for advanced pump controls products for service hot water systems to increase product availability.

Poll

What else should we know? Are there market or technical barriers or solutions that should be considered?

Open ended response

Poll

Are there any other integrated or add-on pump controls that are not listed that you have seen or utilize?

Open ended response

Technical Considerations

- Advanced controls have several benefits compared to basic controls:
 - Basic controls are often circumvented:
 - Installed controls may never be turned on
 - Can be set in the "always on" position
 - Basic timers offer 7-day time options but are harder to set up
 - Lack of fault detection and diagnostic (FDD) and connectivity
- Riser distribution systems (i.e., multiple pipe loops) have poor compatibility with non-continuous recirculation controls
- For smaller nonresidential buildings, continuous and non-continuous controls are viable



Poll

Which controls functionality tends to be the most / least reliable for hot water systems? Are controls bypassed or manually turned off? If so, which ones?

Open ended response

Poll

We are proposing 125F max return temperature. Are there any specific applications or building types where higher than 125F is needed, if so what building types and what is an appropriate temperature?

Open ended response

Per Unit Energy and Cost Impacts

Methodology and Assumptions

- Energy and Energy Cost Savings
- Incremental Costs



Energy Savings Methodology

- Since CBECC does not model distribution systems for NR, the Statewide CASE Team used a recirculation heat loss spreadsheet calculator to estimate distribution heat loss for selected prototypes
- The calculator uses pipe heat loss calculation methods defined in existing 2025 MF ACM Reference Manual
- The calculator handles detailed recirculation pipe designs, installation conditions, and recirculation flow rates
- Energy savings are calculated for gas, electric resistance, and HPWH systems

Reference: [2025_T24_CASE-Report-_MF-DHW-Final-1.pdf](#)

Energy and Energy Cost Savings Methodology

- Energy savings calculations assume a constant return temperature control strategy
- Baseline assumption is circulator pump with ECM and single speed operation (assumption is lowest of three speeds to maintain the temperature differential)
- Nonresidential building types analyzed
 - Office (large, medium, small), School (large, small), Laboratory, Restaurant, Grocery, Assembly, Retail (large, medium)

Assumptions for Statewide Savings Estimates

The Statewide CASE Team estimated the percentage of statewide NR sq ft that will have central SHW with recirculation for each prototype based on plans review and engineering judgement for both new construction and alterations

Prototype	Percentage of statewide NR sq ft that have central SHW with recirculation	
	New Construction	Alteration
OfficeLarge	95%	95%
OfficeMedium	95%	95%
OfficeMediumLab	95%	95%
OfficeSmall	75%	75%
RestaurantFastFood	95%	30%
SchoolSmall	95%	95%
SchoolLarge	95%	95%
Assembly	60%	50%
RetailLarge	75%	75%
RetailMixedUse	75%	75%
RetailMedium	75%	75%
RetailStripMall	75%	75%
Warehouse	75%	75%
Grocery	75%	65%
RefWarehouse	75%	75%
Horticulture	75%	75%
VehicleService	75%	75%

Preliminary Savings Estimates

ECM Circulator Pump with Controls	First Year Statewide Electricity Savings (GWh)	First Year Statewide Natural Gas Savings (Million Therms)	Confidence Level (low, medium, high)
New Construction	1.65	0.06	Medium
Alterations	3.09	0.08	Medium

Cost Effectiveness Results New Construction

Climate Zone	Benefits <i>30-year Energy Cost Savings + Other PV Savings</i> (2029 PV\$)	Costs <i>Total Incremental PV Costs</i> (2029 PV\$)	Benefit-to-Cost Ratio
1	1.98	0.62	3.22
2	0.90	0.46	1.95
3	0.61	0.23	2.67
4	0.64	0.24	2.68
5	1.48	0.48	3.06
6	0.90	0.33	2.71
7	1.45	0.48	3.01
8	0.89	0.33	2.67
9	0.88	0.32	2.76
10	1.03	0.44	2.35
11	1.40	0.45	3.09
12	0.62	0.28	2.19
13	1.49	0.49	3.02
14	1.50	0.51	2.95
15	0.87	0.39	2.26
16	0.92	0.38	2.46

Results vary by prototypical building

Cost Effectiveness Results Alterations

Climate Zone	Benefits <i>30-year Energy Cost Savings + Other PV Savings</i> (2029 PV\$)	Costs <i>Total Incremental PV Costs</i> (2029 PV\$)	Benefit-to-Cost Ratio
1	0.96	0.40	2.37
2	0.50	0.35	1.41
3	0.33	0.16	2.03
4	0.35	0.17	2.05
5	0.73	0.34	2.16
6	0.43	0.22	1.97
7	0.71	0.32	2.23
8	0.42	0.22	1.93
9	0.41	0.20	2.02
10	0.50	0.30	1.66
11	0.69	0.32	2.16
12	0.34	0.22	1.59
13	0.73	0.33	2.22
14	0.72	0.33	2.18
15	0.43	0.28	1.56
16	0.46	0.27	1.75

Results vary by prototypical building

Energy Modeling Assumptions

- Energy savings are based on distribution system heat losses, pump power reductions and associated minor increases in heating plant load, and heating plant efficiency

Prototypical Buildings

- Office (large, medium, small)
- School (large, small)
- Laboratory
- Restaurant (Fast Food)
- Assembly
- Retail (Large, Mixed Use, Medium, Strip Mall)
- Warehouse (standard and refrigerated)
- Grocery
- Horticulture
- Vehicle Service

- Simulated using the following prototypical buildings and climate zones
- Includes new construction and existing buildings

Climate Zones

- CA Climate Zones 1 to 16

Key Modeling Assumptions

Prototype: Each Prototypical Building



Standard Design

1. ECM circulator pump with 3-speed controls
2. Includes prototype specific scheduled off periods
3. Target recirculation temperature drop of 5°F for prototypes with small loops and 10°F for prototypes with large loops
4. Pump speed selected to meet or exceed return temperature target



Proposed Design

1. ECM circulator pump with constant return temperature controls
2. Includes prototype specific scheduled off periods
3. Recirculation temperature drop of 5°F or 10°F based on size of prototype distribution system
4. Pump speed selected to exactly meet return temperature target

Incremental Cost Framework

Prototype: Each Prototypical Building



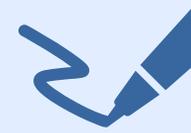
Baseline

First Cost

1. Installation of system
2. Startup

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular maintenance of system



Proposed

First Cost

1. Installation of system
 - including a pump with advanced controls
2. Startup including basic unit programming

30-Year Maintenance Costs

1. Equipment Replacement
2. Regular maintenance of system

Approach for Gathering Costs

- Develop Prototype Plumbing Designs and obtain cost data for baseline and measure case
 - Collect cost data from an experienced plumbing contractor
 - Review published studies



Compliance Verification

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

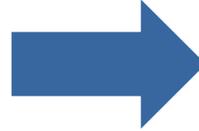
Key Aspects of Compliance Verification

- Verification would be via self-attestation on the design/compliance (NRCC) and installation (NRCI) forms, and (LMCC) and installation (LMCI) forms, for buildings when a non-residential occupancy is part of a mixed-use low-rise residential building
 - Add a statement and single check box to NRCC-PLB-E Table H and LMCC-PLB-E Table H
 - Add a line item to NRCI-PLB-E Table F and LMCI-PLB-01-E Tables B and C

Compliance Barriers and Solutions

Compliance Verification Barriers

1. Added workload on form owners and plan checkers to understand, review, and verify additional details



Potential Solutions

1. Explaining simple changes to check boxes and tables on compliance forms.

Compliance Software Updates

- The Statewide CASE Team has reviewed modifications needed in the compliance software to account for the new prescriptive requirements
 - Addition of user inputs to indicate the selected pump control method
 - Updates to the performance software to calculate the energy impact of the selected control method - *precise requirements still to be confirmed*
 - Adding pipe heat loss values based on proposed case
 - Projects that trade off this proposed requirement will incur a 3% penalty
 - Updates to the software to support compliance reporting via the NRCC-PRF-E form

Richard Fatu

TRC

rfatu@trccompanies.com

Please copy: info@title24stakeholders.com

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

**We want to
hear from you!**