Domestic Hot Water Recirculation

Control Methods, Code Requirements, and energy savings

Session 4B

ACEEE Hot Water Forum

Nashville, TN

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Domestic Hot Water Recirculation

Why am I talking to you about controls on DHW Recirculation loops

NEEA's Extended Motor Products Initiative

- Aimed at improving the efficiency of pumps and pump systems in the Pacific Northwest
- The Regional Technical Forum (RTF) has developed "**Planning Measures"** for C&I Pumps and Circulators
  - They will expire if they are not validated
  - NEEA is pursuing research, with assistance from PG&E, to verify and improve the savings estimates and convert them to Proven measures
- The Energy Savings associated with DHW Circulators is heavily dependent on the control strategy that is employed
- We are research control strategies, and incorporating previous research into the sample

Note: the Regional Technical Forum is a regional body in the PNW that reviews and approves energy efficiency savings on behalf of the region. For more info, see: https://rtf.nwcouncil.org

Agenda

- Control Methods for DHW Circulation
- Review Code requirements for these systems
  - Focused on On-Demand control
- Discuss the Energy Savings that previous studies have seen by employing these controls
- The effectiveness of these controls

DHW Recirculation Control Strategies

- No Control
- Timer Control
- Temperature Control
- Learning Mode
- On Demand Control
- Temperature Modulation

DHW Recirculation Control Strategies

- No Control
  - 24/7 Pump operation
  - No change in temperature setpoint
- Least energy efficient option
  - Pump operating 24/7
  - Water heater has to make up for loop losses 24/7
  - Constantly loosing energy to the building, HVAC System is compensating
- Not Allowed by code in many area

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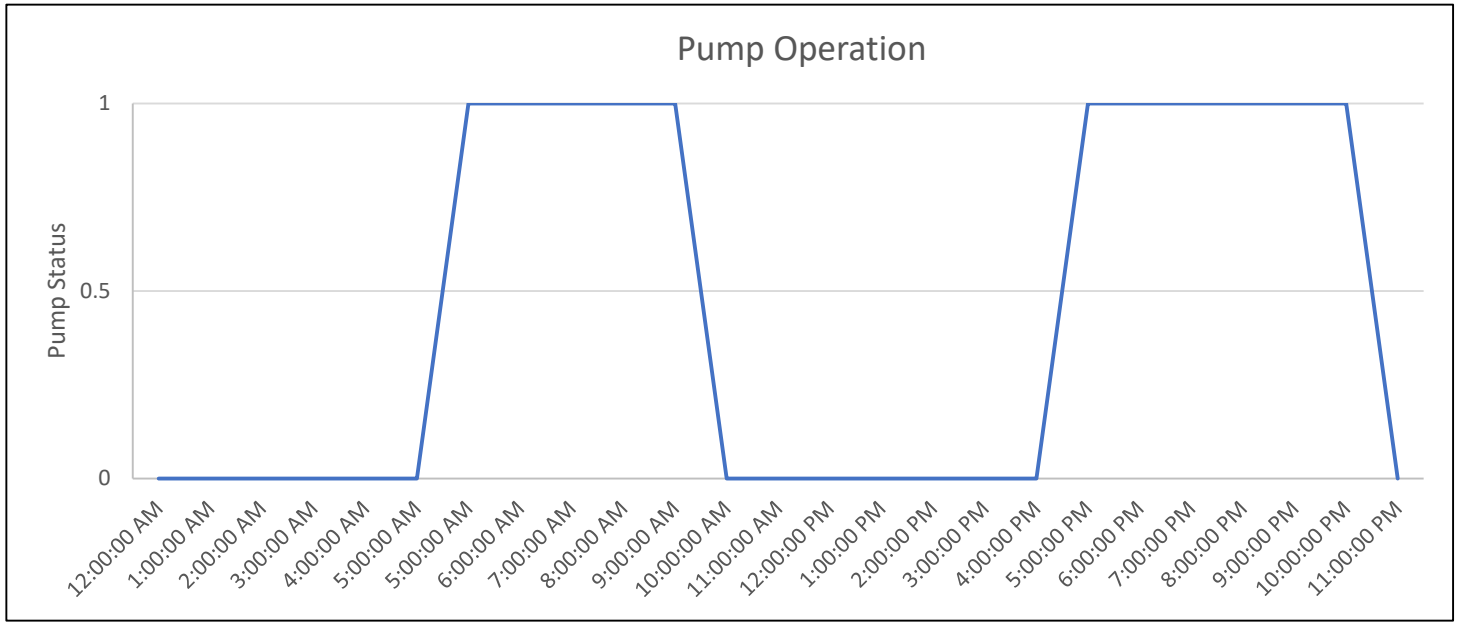
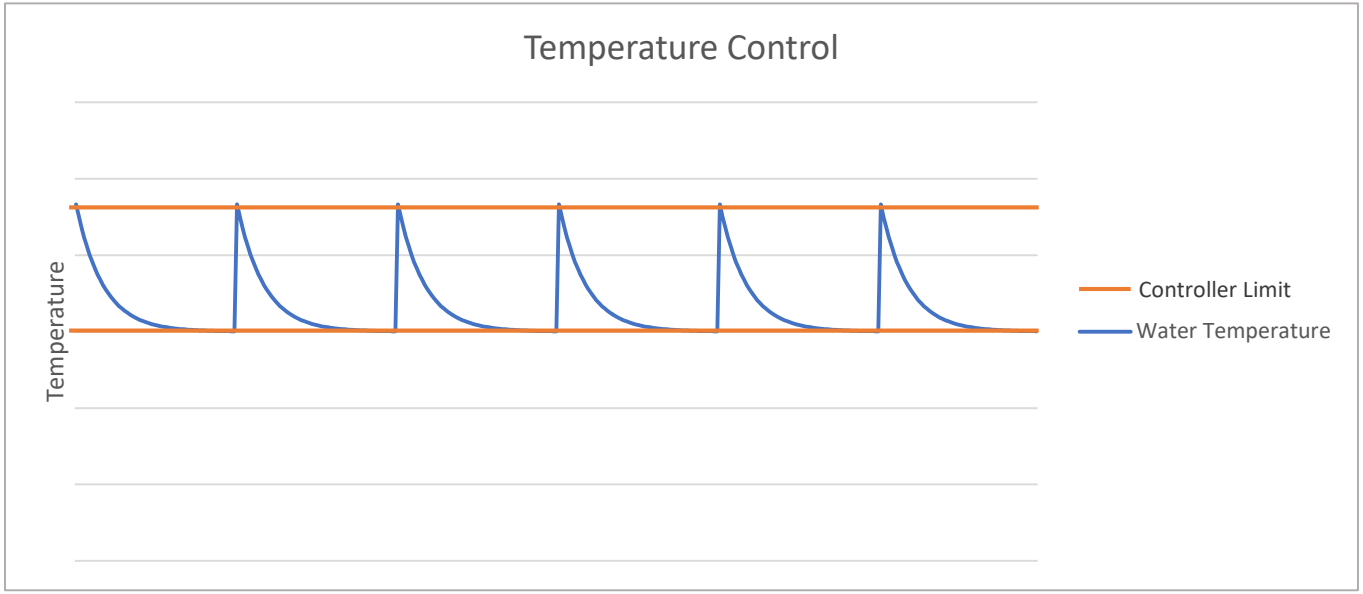
DHW Recirculation Control Strategies

- Timer Control
  - Schedule the recirc pump to operate when most of the instances of water use occur



DHW Recirculation Control Strategies

- Temperature control
  - When the temperature of the water in the line drops below a certain set-point the pump turns on until the temperature in the line reaches an upper set point.



DHW Recirculation Control Strategies

- Learning Mode
  - A period of time is taken to monitor the use patterns of the occupants and then the pump schedule is set to operate across these time periods

DHW Recirculation Control Strategies

- Temperature Modulation
  - The temperature of the Hot Water is varied based on occupancy patterns in the building (increase the temperature during the highest use periods, decrease the temperature during the lowest use periods)
  - Pump operates 24/7 in this instance

DHW Recirculation Control Strategies

- Combination Controls
  - Utilizing multiple control schemes, like On-Demand Control + Temperature modulation can prove to be an effective way to decrease energy consumption
  - Temperature control + Timer

DHW Recirculation Control Strategies

- On-Demand Control
  - This control method is required by code in many areas
  - This control strategy uses a demand for water/call for water to start the recirculation pump.
  - What qualifies as a call for water
    - Physically pushing a button to call for water
    - Motion sensor detecting presence at the water fixture
    - Change in Make-up water flow rate, indicating water use

DHW Recirculation Control Strategies

- No Control
- Timer Control
- Temperature Control
- Learning Mode
- On Demand Control
- Temperature Modulation

Code Requirements

Code Definition for Circulation Systems

- Circulating Hot Water System

  International Plumbing Code

  - "A specifically designed water distribution system where one or more pumps are operated in the service hot water piping to circulate heated water from the water-heating equipment to fixture supply and back to the water-heating equipment"

Code Requirements

Code Definition for Demand Control Recirculation Systems

- Demand Recirculation Water System

  International Plumbing Code

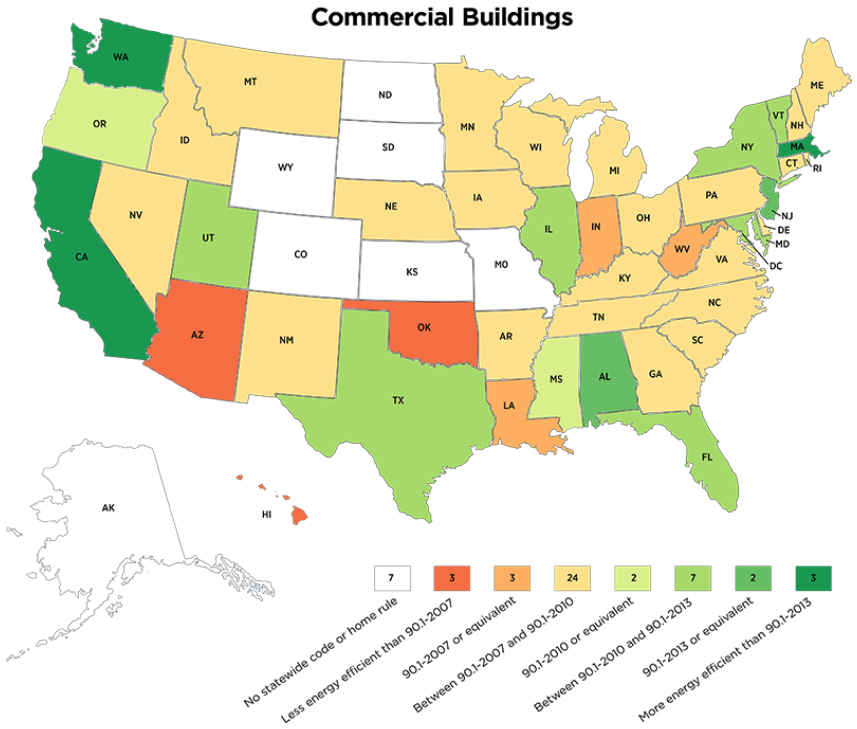
  - "A water distribution system where one or more pumps prime the service hot water piping with heated water upon a demand for hot water"

  IECC

  - "A water distribution system having one or more recirculation pumps that pump water from a heated water supply pipe back to the heated water source through a *cold water supply pipe*"

Code Requirements for DWH Controls

Different versions of the energy code have different requirements for DHW Recirculation



* All Energy Codes lump Multi-family in with Commercial

Code Requirements for DWH Controls

IECC has different requirements depending on the version

IECC 2009

"Automatic-Circulating Hot Water System Pumps…shall be arranged to be conveniently turned off automatically or manually when hot water system is not in use"

- Doesn't require a pump on a recirculation system
- Can be turned off automatically *or* manually
- "Conveniently turned off"

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Code Requirements for DWH Controls

IECC has different requirements depending on the version

IECC 2012

"Circulating hot water system pumps…shall be arranged to be turned off either automatically or manually when there is limited hot water demand. Ready access shall be provided to the operating controls"

- Doesn't require a pump on a recirculation system
- "Limited hot water demand"
- Can be turned off automatically *or* manually
- Requires "Ready access" to controls

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Code Requirements for DWH Controls

IECC has different requirements depending on the version

IECC 2015

"Circulation systems shall be provided with a circulation pump….Controls for circulating system pumps shall start the pump based on the identification of a demand for hot water…. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and there is no demand for hot water "

- Requires a pump on a circulation system
- Demand-start required
- Automatic pump stop required
  - When the circulation loop is "at the desired temperature *and* there is no demand for hot water"

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DEMAND RECIRCULATION WATER SYSTEM. A water distribution system where pumps prime the service hot water piping with heated

Code Requirements for DWH Controls

IECC has different requirements depending on the version

IECC 2009

"Automatic-Circulating Hot Water System Pumps…shall be arranged to be conveniently turned off automatically or manually when hot water system is not in use"

IECC 2012

"Circulating hot water system pumps…shall be arranged to be turned off either automatically or manually when there is limited hot water demand. Ready access shall be provided to the operating controls"

IECC 2015

"Circulation systems shall be provided with a circulation pump….Controls for circulating system pumps shall start the pump based on the identification of a demand for hot water…. The controls shall automatically turn off the pump when the water in the circulation loop is at the desired temperature and there is no demand for hot water "

Code becomes more explicit

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Code Requirements for DWH Controls

California, Washington, and Massachusetts have state-specific requirements

California

"…hot water systems with circulating pumps or with electrical heat trace shall be capable of automatically turning off the system

Washington

"Heated water circulation systems shall be provided with a circulation pump…. Controls for circulating hot water pumps shall start the pump based on identification of a demand for hot water….The controls shall automatically turn off the pump when the water in the circulating loop is at the desired temperature and when there is no demand for hot water"

Massachusetts

Refers to IECC 2009

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Demand Controls, as defined by Code

Our general understanding of the Code definition of Demand Control

The control shall start the pump upon receiving a signal from the action of a user or a fixture or appliance, sensing the presence of a user or a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.

- Meaning
  - Push-Button Demand Control
  - Motion Sensing Demand control (integrated into lighting-motion sensors? Nest Thermostats?)
  - Indication of flow, installed on recirculation loop
    - Include different examples of such (not necessarily “flow”)
- Doesn’t include
  - ???

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What Strategies work best in MF/Commercial Buildings

Most current research in the commercial and multifamily sectors focus on 1 or 2 control strategies

- Research on Demand Control dominates the current body of work
- The coupling of controls (Demand+Temp Modulation) is common
- Learning controls are not prevalent in the current research

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Demonstrated Savings

Energy Savings seen in research from DHW Recirculation Controls

Organization	Buildings Type	Control Method	Pump Savings	Water Heater Savings
The Levy Partnership	Multifamily	Demand	1,708-2,602 kWh/year	6-12%
		Temperature Modulation	NA	2-8%
		Demand+TM	1,708-2,602 kWh/year	12-15%
Heshong Mahone Group	Multifamily	Demand Control	Average of 11%	
		Timer Control	Average of 1%	
		Temperature Modulation	Average of 7%	
MN Center for Energy and Environment	Office	Demand	88%	20.30%
	Hospitality	Demand	70-93%	9.9-15.9%
	Education	Demand	96.20%	11.40%
Benningfield Group	Multifamily	Demand	Average of 1,236 kWh/year	Average 1,526 therms/building
Oracle America, Inc	Commercial	Timer	43%*	27%
Enovative Case Study	Multifamily	Demand	78%	30%

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Effectiveness of DHW Recirculation Controls

- Make sure the controls fit the Application
  - You wont get savings if End Users aren't getting hot water and override the controls
    - For large loops the controls have to keep the loop warm
      - Temperature-based controls
    - Schedule based controls work if you can confidently predict the water usage schedule

Thank you

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How can we better implement occupancy based controls in MF/Commercial

- Focusing on one control method as a “Silver Bullet” for the *entire* MF/Commercial sectors is not going to work

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Legionnaires Disease and DHW Recirculation

The language in the OSHA Code referring to Constant Recirculation is a recommendation, and better methods of managing Legionella growth are available in Multifamily and Commercial Buildings

- OSHA General Safety and Health Provisions *recommend* constant recirculation of DHW. (29 CFR 1926.32)
  - This is to prevent the proliferation of Legionella in the water system.
- DHW Systems in Commercial Buildings rarely sit idle long enough for growth to occur in the trunk lines. Major issues are dead legs and underused portions of the system.
- Developing and implementing a comprehensive Water Safety Plan is a more effective way to prevent LD.
  - Is building and site specific, looks at the piping layout, the mechanical system, and operational habits

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