



DENVER AMENDMENT PROPOSAL FORM FOR PROPOSALS TO THE 2019 DENVER BUILDING CODE AMENDMENTS AND THE 2021 INTERNATIONAL CODES

DENVER
THE MILE HIGH CITY

2021 CODE DEVELOPMENT CYCLE

1) **Name:** Courtney Anderson **Date:** 10/12/2021
Email: Courtney.Anderson@denvergov.org **Representing (organization or self):**
City Staff Proposal (check box):

2) One proposal per this document is to be provided with clear and concise information.

Is a separate graphic file provided ("X" to answer): ___ Yes or No

3) Highlight the code and acronym that applies to the proposal

<u>Acronym</u>	<u>Code Name</u>	<u>Acronym</u>	<u>Code Name</u>
DBC-AP	Denver Building Code–Administrative Provisions	IPC	International Plumbing Code
IBC	International Building Code	IRC	International Residential Code
IECC	International Energy Conservation Code	IFGC	International Fuel Gas Code
IEBC	International Existing Building Code	IMC	International Mechanical Code
IFC	International Fire Code	DGC	Denver Green Code

AMENDMENT PROPOSAL

Please provide all the following items in your amendment proposal.

Code Sections/Tables/Figures Proposed for Revision:

Instructions: If the proposal is for a new section, indicate (new), otherwise enter applicable code section.

R403.5

Add new definitions as follows:

DEMAND RESPONSE SIGNAL. A signal that indicates a price or a request to modify electricity consumption for a limited time period.

DEMAND RESPONSIVE CONTROL. A control capable of receiving and automatically responding to a demand response signal.

Add new section as follows:

R403.5.4 Demand Responsive Water Heating. Electric storage water heaters with rated water storage volume between 40 (150L) and 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with *demand responsive controls* that comply with ANSI/CTA-2045-B Level 1 and are also capable of initiating water heating to meet the temperature set point in response to a *demand response signal* or another equivalent *approved standard*.

Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code

3. Water heaters that use 3-phase electric power

Modify the table as follows:

**TABLE R405.2
REQUIREMENTS FOR TOTAL BUILDING PERFORMANCE**

SECTION	TITLE
	Mechanical
<u>R403.5.5</u>	<u>Demand responsive water heating</u>

Modify the table as follows:

**TABLE R406.2
REQUIREMENTS FOR ENERGY RATING INDEX**

SECTION	TITLE
	Mechanical
<u>R403.5.5</u>	<u>Demand responsive water heating</u>

Supporting Information (Required):

All proposals must include a written explanation and justification as to how they address physical, environmental, and/or customary characteristics that are specific to the City and County of Denver. The following questions must be answered for a proposal to be considered.

Purpose: What does your proposal achieve?

This proposal requires that all storage tank water heaters installed in residential buildings be compatible with the ANSI/CTA-2045-B grid flexibility / demand response protocol.

Reason: Why is your proposal necessary?

Grid flexibility is one of the four foundations of “Denver’s Net Zero Energy (NZE) New Buildings & Homes Implementation Plan.” With increasing penetrations of intermittent renewable energy, volatile wholesale power prices, and subsequent growth in dynamic rates/demand response programs, grid-interactive end uses present an opportunity to help homes manage their bills, participate in programs, and support efficient grid operations. Water heaters can provide many services to the grid, including generation, transmission, and distribution capacity, energy arbitrage, and ancillary services.

As electricity systems transform to include more variable wind and solar energy, demand flexibility becomes increasingly critical to both grid operation and further transformation. Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Water heaters offer an unparalleled opportunity for load shifting: tanks full of hot water are inherently energy storage devices. Including the controls necessary to take advantage of this opportunity is relatively simple and affordable in new construction. Compared to other energy storage technologies such as batteries, smart, grid-integrated water heater controls can deliver substantial dispatchable (that is, reliable to the grid operator) energy flexibility. The controls specified by ANSI/CTA-2045-B ensure negligible risk of occupant disruption (that is, the hot water will not run out). Water heaters provide a particularly attractive option as they

have inherent thermal storage that allows energy consumption to be shifted with little to no impact to the end user. This capability has been demonstrated in several contexts, most recently through regional demonstrations conducted by EPRI and BPA¹.

In their Grid-interactive and Efficient Buildings (GEBs) Roadmap, the US Department of Energy² estimates that approximately 15 GW of additional load flexibility is expected to be added to the system under reference case assumptions. Combined with energy efficiency, this is expected to provide \$13 billion/year of peak demand savings to the power system and its customers. Through a comprehensive literature review and interviewing dozens of national experts, the USDOE team found that one of the biggest barriers was the lack of interoperability. A key tool to solve this problem is building codes, which can help to ensure that interoperable devices and controls are installed at the time of construction. USDOE cited explicitly the use of codes and standards as one of its recommended pathways to enable greater adoption of GEBs technologies.

It is important to include the requirement for two-way communication (specifically, communication from the behind-the-meter control module back to the utility, grid operator, or other third-party entity) because this communication ensures that the controls capability can be fully deployed when needed. With legacy demand response systems, a signal is sent out but the ability to track and quantify the impacts of that signal is effectively nonexistent. This one-way communication paradigm is a key reason that the “firmness” or reliability of many flexibility-related demand side management strategies, particularly demand response, is often considered to be very low. However, a two-way communication paradigm enables much more reliable impact tracking. Buildings whose controls include two-way communication capability, that is, those with grid-interactive controls as defined here, will be better able to participate in the demand response programs of the future, and their owners will have improved financial prospects through enhanced ability to participate in potentially lucrative utility demand response programs.

ANSI/CTA-2045-B standardizes the socket, and communications protocol, for electric water heaters so they can communicate with the grid, and with demand response signal providers. In addition, 2045-B adds control and communications requirements for mixing valves in water heaters, which enable them to provide greater storage capacity to support increased load shifting while eliminating scalding risk.

Versions of this standard are included in codes or other requirements in California, Oregon, and Washington and are referenced explicitly by ENERGY STAR.

Substantiation: Why is your proposal valid? (i.e. technical justification)

This proposal requires that electric water heaters with integrated storage tanks have demand responsive controls. This functionality allows water heaters to “float” during periods of high demand and resume heating water after the high demand period is over or when water temperatures in the tank drop to the lower limit of acceptable temperature. ANSI/CTA-2045 is the industry standard for grid-flexible controls for water heaters, but the requirement allows for other protocols to be approved by the building official.

The requirement is limited to electric water heaters with integrated storage tanks. It also only applies to water heaters over 40 gallons and under 120 gallons in order to exclude small, point-of-use water heaters. Finally, it excludes “heavy duty” water heaters as defined by the ASME Boiler and Pressure Vessel Code or that use three-phase power; this ensures that these requirements do not apply to water heaters intended to support process loads for which DR controls are neither appropriate nor available.

CTA-2045-B is an updated version of CTA-2045-A. Level 2 in that standard provides robust grid interactivity. Level 1 corresponds to the older CTA-2045-A and provides only much simpler “load shedding” functionality. As manufacturers are still implementing CTA-2045-B Level 2, the proposal includes an exception that allows for compliance with the older standard as long as the water heater is also capable of the most critical feature of Level 2: “load up” (preheating before a load shed event). Currently, Rheem and AO Smith have models that

¹ BPA, CTA-2045 Water Heater Demonstration Report (2018) <https://www.bpa.gov/EE/Technology/demand-response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf>

EPRI, CEA-2045 Field Demonstrations Project Description (2014) <https://www.epri.com/research/products/000000003002004009>

² USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021) <https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf>

comply with CTA-2045-A and this additional functionality fall. The exception will bridge the gap between what is currently available on the market and the full adoption of -B by the market. As -B models become more widely available, the exception will not be necessary.

Since this requirement is part of the construction code, it will not require buildings to participate in any demand response programs. But it will ensure that buildings are capable of participating, so that Denver buildings will be able to help integrate building loads with available production.

The proposal also adds an additional line to Table R406.2, ensuring that this requirement is included in the ERI approach.

This proposal is identical to one that was recently voted for approval in the WA state commercial energy code process. It was developed through extensive negotiation with AHRI (American Heating and Refrigeration Institute, the manufacturer trade association) in order to remove their objections to the inclusion of these controls in the code.

Bibliography and Access to Materials (as needed when substantiating material is associated with the amendment proposal):

BPA, CTA-2045 Water Heater Demonstration Report (2018) <https://www.bpa.gov/EE/Technology/demand-response/Documents/Demand%20Response%20-%20FINAL%20REPORT%20110918.pdf>

EPRI, CEA-2045 Field Demonstrations Project Description (2014) <https://www.epri.com/research/products/000000003002004009>

USDOE, A National Roadmap for Grid-Interactive Efficient Buildings (2021) <https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20-%20Final.pdf>

Washington State Revised Code of Washington, Title 19, Chapter 19.260, Section 19.260.080, available at <https://app.leg.wa.gov/RCW/default.aspx?cite=19.260.080>

Oregon Department of Energy, Energy Efficiency Standards Rulemaking <https://www.oregon.gov/energy/Get-Involved/Pages/EE-Standards-Rulemaking.aspx>

U.S. EPA Energy Star Program, Connected Criteria for ENERGY STAR Products, https://www.energystar.gov/products/spec/connected_criteria_energy_star_products_pd

Other Regulations Proposed to be Affected

***For proposals to delete content from the 2019 Denver Green Code in conjunction with adding it to other mandatory Denver codes and/or regulations, only.**

Please identify which other mandatory codes or regulations are suggested to be updated (if any) to accept relocated content.

None

Referenced Standards:

List any new referenced standards that are proposed to be referenced in the code.

American National Standards Institute (ANSI)
25 West 43rd Street
New York, NY 20036, United States
1-212-642-4900; www.ansi.org

ANSI/CTA-2045-B - 2021 Modular Communications Interface for Energy Management 22

ASME
Two Park Avenue
New York, NY 10016-5990
(800) 843-2763; <https://www.asme.org>

ASME BPVC Boiler and Pressure Vessel Code IV, Part HLW;
X

Impact:

How will this proposal impact cost and restrictiveness of code? ("X" answer for each item below)

CTA-2045 controls are emerging as a standard feature of many heat pump water heaters. CTA-2045 models are sometimes less expensive than non-CTA-2045 models. As it will be difficult to meet the performance requirements of Denver's energy code with electric water heaters that are not Heat Pump models, the incremental cost of this requirement is effectively nothing.

As time-of-use rates and demand response or similar programs become more widespread and of higher magnitude, the customer cost savings associated with demand flexibility ability will grow substantially. For example, the New York utility ConEdison has a Residential Time of Use Rate whose summertime peak rate is \$0.2384/kWh and whose summertime offpeak rate is \$0.0168/kWh – a value differential of more than 14x. In winter the peak-time rate is \$0.0882/kWh, but the offpeak rate remains the same – a value differential of 5x. Water heaters able to shift load can empower customers to take advantage of these cost differentials to deliver substantial savings.

Cost of construction:	<input type="checkbox"/> Increase	<input type="checkbox"/> Decrease	<input checked="" type="checkbox"/> No Impact
Cost of design:	<input type="checkbox"/> Increase	<input type="checkbox"/> Decrease	<input checked="" type="checkbox"/> No Impact
Restrictiveness:	<input type="checkbox"/> Increase	<input type="checkbox"/> Decrease	<input checked="" type="checkbox"/> No Impact

Departmental Impact (City use only):

This amendment proposal increases/decreases/is neutral to the cost of plans review.

This amendment increases/decreases/is neutral to the cost of inspections.