Board of Building Standards

CODE COMMITTEE MEETING
AGENDA

DATE: NOVEMBER 18, 2021
TIME: 1:00 PM
LOCATION: TRAINING RM 3, 6606 TUSSING RD, REYNOLDSBURG, OHIO 43068

Call to Order

Approval of Minutes

MIN-1 October 21, 2021 Code Committee Meeting Minutes

Petitions

P-1 Petition #21-01 RCO 4401.2 - Duane Chubb/Dana Daughters of Gamechanger Fittings LLC

Recommendations of the Residential Construction Advisory Committee

Old Business

OB-1 Commercial Energy Code Update
OB-2 OBC Chapter 2 - Definition of Registered Design Professional - Landscape Architect
OB-3 Code Review Update
OB-4 2020 NEC E-notification Phase Stakeholder Comments

New Business

Adjourn

File Attachments for Item:

MIN-1 October 21, 2021 Code Committee Meeting Minutes

OHIO BOARD OF BUILDING STANDARDS
CODE COMMITTEE MINUTES
OCTOBER 21, 2021

The Code Committee met on October 21, 2021 with the following members present: Mr. Denk, Ms. Cromwell, Mr. Johnson, Mr. Miller, Mr. Pavlis, Mr. Samuelson, Mr. Stanbery, Mr. Tyler, and Mr. Yankie. Board Chairman, Tim Galvin, was also present.

The following staff members were present: Regina Hanshaw, Debbie Ohler, Jay Richards, and Rob Johnson.

Guests present: John Johnson, Ned Heminger, Len Sciarra, and Michael Myers

CALL TO ORDER

The meeting was called to order by Mr. Denk at 1:05 P.M.

APPROVAL OF MINUTES

Mr. Samuelson made the motion to approve the minutes of the Code Committee meeting held on June 24th. Mr. Tyler seconded the motion. The motion passed unanimously.

Mr. Tyler made the motion to approve the minutes of the Code Committee meeting held on September 17th. Mr. Samuelson seconded the motion. The motion passed unanimously.

PETITIONS

No items for consideration

RECOMMENDATIONS OF THE RESIDENTIAL CONSTRUCTION ADVISORY COMMITTEE

No items for consideration

OLD BUSINESS

No items for consideration

NEW BUSINESS

- ASHRAE members and guest presenters, Ned Heminger of HAWA, Michael Myer of PNNL, and Len Sciarra of Farr Associates, provided a presentation to the committee, via MS Teams, titled Overview of Changes to ASHRAE 90.1-2019. The presenters answered questions from the committee relating to modelling, cost effectiveness, rebates/incentives, equipment efficiencies, code enforcement challenges, and energy policy. No action was taken by the committee.
- OBC Section 105 - Annual Approvals. The BBS Executive Secretary was contacted by Geoff Eaton, the Superintendent of DIC, who requested an amendment to OBC Section 105.1.5, allowing for structural and building alterations, in addition to building services equipment alterations, to be performed under the annual approval process provided that the building owner has the related BBS-certified personnel on staff performing inspections and keeping records. Staff presented a proposed amendment for the committee's consideration and suggested that the remaining existing language could be improved to provide clarity. Mr. Tyler suggested that coordinating language should

also be added to the inspection section 108. The committee agreed in concept with Mr. Eaton's request to expand the scope of the annual approvals to include structural and building alterations. However, Mr. Miller made a motion to table the item while staff drafts language to clarify the intent of the annual approval process. Mr. Samuelson seconded the motion to table. The motion passed unanimously.

- OBC Ch 2 - definition of "Registered Design Professional". The BBS Executive Secretary was contacted by Doug Boyer of the Ohio Chapter of the American Society of Landscape Architects (ASLA). The ASLA membership is requesting amendments to OBC Section 106.2.1 and the definition of "Registered Design Professional" to clearly permit landscape architects to seal construction documents. Staff explained that the definition is used throughout the code, not just in Section 106.2.1, and that the definition already includes a reference to Revised Code 4703.36 which is specifically for landscape architects. Staff presented a proposed amendment to add the words "landscape architect" in the definition for clarification. Mr. Tyler suggested that this is an education issue, not a code issue. Mr. Pavlis moved to table the item and invite Mr. Boyer to attend the next meeting and explain what they are running into and why the need to change the code and definition when it already references the landscape architect statute. Ms. Cromwell seconded the motion. The motion to table passed unanimously.
- Ms. Cromwell mentioned that she was a speaker at the Structural Engineers of Ohio (SEO) conference. The members asked "What is the interpretation of "minor storage facilities" as used in OBC Table 1604.5? Staff suggested that the building official would make that interpretation. Additionally, someone indicated that the RCO Figure 301.2 (wind maps) are based upon old ASCE 7 maps, even though the code references a newer edition of ASCE 7. Staff found no ICC errata and will review code change proposals and get back with Ms. Cromwell. No action was taken.
- Mr. Pavlis asked about a gas utility requiring the gas lines to be painted yellow, even though that requirement is not in our code. Staff and Mr. Miller explained that some gas utility companies maintain authority throughout the building, even on the house side of the point of delivery. The owner agrees to the utility company policies when they sign the service agreement. If you want the gas, you will paint the pipe.

ADJOURN

Mr. Johnson made the motion to adjourn at 3:25 P.M. and Mr. Miller seconded the motion. The motion passed unanimously.

File Attachments for Item:

P-1 Petition #21-01 RCO 4401.2 - Duane Chubb/Dana Daughters of Gamechanger Fittings LLC

APPLICATION

FOR

RULE CHANGE

Pursuant to section 3781.12 of the Revised Code and rules adopted by the Board of Building Standards, application is herewith submitted to adopt, amend, or annul a rule adopted by the Board pursuant to section 3718.10 of the Revised Code.

BOARD OF BUILDING STANDARDS

6606 Tussing Road, P.O. Box 4009
Reynoldsburg, Ohio 43068-9009
(614) 644-2613
bbs@ohio.gov
www.com.state.oh.us/dico/bbs/default.aspx

For BBS use:	
Petition #:	21-01
Date Recv'd:	Oct. 25, 2021

Submitter: Dana Daughters (Contact Name) GameChanger Fittings, LLC (Organization/Company)

Address: 784 Timber Lane (Include Room Number, Suite, etc.)

Geneva (City) OH (State) 44041 (Zip)

Telephone Number: 440-474-2204 **Fax Number:**

Date: OCT 27, 2021 **E-mail Address:** dana@gamechangerfittings.com

Code Section: RCO 4401.2

General Explanation of Proposed Change (attach additional sheets if necessary):

Update Ohio Plumbing Code reference date from 11-1-2017 to 8-1-2018.

Explanation of Cost Impact of Proposed Code Change*: None

*Attach additional cost information as necessary to justify any statement of cost increase or cost decrease.

Information on Submittal (attach additional sheets if necessary):	
1. Sponsor:	Dana Daughters – GameChanger Fittings, LLC Organization sponsoring or requesting the rule change (if any)
2. Rule Title:	Update OPC reference date in RCO 4401.2 Title of rule change
3. Purpose/ Objective:	Incorporate amendments approved after 11-1-2017 Technical justification for the proposed rule change
4. Formatted Rule Language **(Using Strike-out for Deleted Text and Underline for Added Text)**	"4101:3-1 to 4101:3-15, codified and published as the 2017 Ohio Plumbing Code, effective ~~11-1-2017~~ 8-1-2018, and as modified in Section 2501.1.1" Use strike-out for deleted text and underline for added text
5. Notes:	1. To encourage uniformity among states using model codes, it is recommended that the submitter first submit any code change directly to ICC and participate in the national model code development process. 2. Please provide a copy of application and documentation. 3. Use a separate form for each code change proposal.

File Attachments for Item:

OB-1 Commercial Energy Code Update

Significant changes 2010-2013 ASHRAE 90.1 Commercial Provisions

(Sources: ASHRAE 90.1-2013 and PNNL-SA-107200)

Building Envelope

- Modifies daylighting and several other definitions
- Limits the size of vestibules and adds specific vestibule requirements for large spaces [5.4.3.4]
- Increased stringency requirements for roofs, walls, below grade walls, slab-on-grade floors [Tables 5.5-4 and 5.5-5]
- Lowers fenestration U-factors about 18% [Tables 5.5-4 and 5.5-5]
- Limits skylight area to 3%, except to 6% if daylighting criteria are met [5.5.4.2.2]

Mechanical

- Increased equipment efficiencies for air conditioners, condensing units, heat pumps, water-chillers, boilers, cooling towers, refrigerators, and freezers [6.4.1 & Tables 6.8.1]
- Reduces occupancy threshold for demand-controlled ventilation from 40 people/1000 sq ft to 25 people/1000 sq ft [6.4.3.8]
- Adds vestibule heating controls [6.4.3.9]
- Adds direct digital control (DDC) and graphical display requirements [6.4.3.10 & Table 6.4.3.10.1]
- Adds control requirements for preheat coils [6.5.2.5]
- Adds requirements for fan efficiency and controls [6.5.3]
- Adds requirements for boiler turndown ratio and efficiency [6.5.4.1]
- Reduces system size and outdoor air thresholds for energy recovery [6.5.6]
- Adds requirements for walk-in coolers, freezers and refrigerated display cases [6.4.5 & 6.5.11]
- Adds requirements for Computer room HVAC systems and introduces the Power usage Effectiveness (PUE) [6.6]

Service Water Heating

- Increases efficiency of water-heating equipment 7.5.3 & Table 7.8]

Power

- Increases the spaces where and reduces the threshold for when plug receptacle shutoff control is required [8.4.2]
- Requires electrical energy monitoring and reporting for total electrical, HVAC systems, lighting, and receptacles [8.4.3]
- Requires separate electrical energy monitoring for buildings with tenants [8.4.3.1]
- Adds specific control requirements for guestroom switched receptacles [9.4.1.3]

Lighting

- Requires the use of certain lighting controls in more space types [9.4.1]
- Increases and clarifies requirements for daylighting and daylighting controls [9.4.1.1]
- Updates and reduces the interior and exterior lighting power densities [Table 9.5.1]
- Adds specific requirements for guest room and task lighting controls [9.4.1.3]
- Adds functional testing requirements for occupant sensors, automatic time switches, and daylight controls [9.4.3]

Other Equipment

- Adds requirements for the efficiency of general-purpose motors having power rating greater than 200 hp, but no more than 500 hp [10.4.1]
- Adds power limitations for elevator cab lighting [10.4.3.1]

- Requires escalators and moving walks to slow to minimum permitted speed when not conveying passengers [10.4.4]
- Requires whole-building energy monitoring and reporting [10.4.5.1]

Energy Cost Budget Method (ECB)

- Allows credit for on-site renewable energy but limits the credit to 5% of the calculated energy cost budget [11.4.3.1]

Appendix C (Envelope tradeoff)

- Completely revamps the methodology for the building envelope trade-off option allowed in Section 5.6

Performance Rating Method (Appendix G)- an above code program

- Numerous clarifications are added for modeling

Significant changes 2012→2015 IECC Commercial Provisions

(Sources: PNNL-SA-107200 and ESL-TR-14-11-02 Texas A&M Energy Systems Laboratory)

Definitions

- Adds or modifies definitions of “Air Curtain”, “Alteration”, “Approved Agency”, “Boiler, Modulating”, “Boiler System”, “Bubble Point”, “Circulating Hot Water System”, “Computer Room”, “Condensing Unit”, “Conditioned Space”, “Continuous Insulation”, “Daylight Responsive Control”, “Daylight Zone”, “Fan Efficiency Grade”, “Fenestration”, “Floor Area, Net”, “General Purpose Electric Motor”, “Greenhouse”, “Hight Speed Door”, “Historic Building”, “Liner System” , “Low Sloped Roof”, “Low-voltage Dry-Type Distribution Transformer”, “Occupant Sensor Control”, “Opaque Door”, “Powered Roof/Wall Ventilator”, “Radiant Heating System”, “Refrigerant Dew Point”, “Refrigerated Warehouse Cooler”, “Refrigerated Warehouse Freezer”, “Refrigeration System”, “Repair”, “Reroofing”, “Roof Recover”, “Roof Replacement”, “Rooftop Monitor”, “Saturated Condensing Temperature”, “Small Electric Motor”, “Time-Switch Control”, “Variable Refrigerant Flow System”, “Walk-in Cooler”, “Walk-in Freezer”, “Wall, Above-grade”, “Wall, Below-Grade”, “Water Heater”

Building Envelope

- Adds an exception for greenhouses [C402.1.1]
- Increased stringency for roof insulation installed entirely above roof deck [Table C402.1.3]
- Increased stringency for SHGC of vertical fenestration [C402.4.3]
- Expanded requirements to calculate U-factors of walls with cold-formed steel, aged roof reflectance and provisions for rooms containing fuel burning appliances [C402.5]
- Mandatory skylight threshold reduced from 10K to 2.5K square feet [C402.4.2]

Mechanical

- Improved efficiency requirements for HVAC equipment performance [Table C403.2.3(1)-C403.2.3(10)]
- Added efficiency requirements for air-conditioning units serving computer rooms [Table C403.2.3(9)]
- Elaborated and added provisions for HVAC system controls which include: requirement for zone isolation [C403.2.4.4]; and requirement of economizer fault detection [C403.2.4.7]
- Added specifications for hot water boiler outdoor temperature setback control [C403.2.5]
- Updated provisions for energy recovery ventilation systems whose requirements are now based on the number of hour’s ventilations systems operate [C403.2.7]
- Introduced specifications for kitchen exhaust systems [C403.2.8]
- Updated requirements for duct and plenum insulation and sealing [C403.2.9]
- Introduced fan efficiency requirements [C403.2.12.3]
- Added specifications for commercial refrigeration equipment [C403.2.15 and C403.5]
- Updated provisions for air and water economizers, which include added requirements for the efficient operation of these systems [C403.3]
- Updated provisions for complex mechanical systems serving multiple zones, which include updated specifications for fan controls, heat rejection equipment and hot gas bypass limitations [C403.4]

Service Water Heating

- Added performance efficiencies for certain categories of service hot water systems [Table C404.2]
- Revises and clarifies the requirements for insulation of piping [C404.4]

- Added information for implementation of efficient heated water supply piping, heated water circulating and temperature maintenance system, demand recirculation controls, drain water heat recovery systems and energy requirements of portable spas [C404.5]
- Improved specifications for energy consumption of pools and permanent spas [C404.9]
- Added commissioning requirements for hot water systems [C404.11]

Lighting and Power

- Additional provisions for lighting controls, which include the added requirement of occupant sensor controls [C405.2.1]
- New exterior and warehouse lighting control requirements [C405.2.1.2]
- Revised daylighting zone controls [C405.2.3]
- New Hotel/motel sleeping and guest suite lighting controls [C405.2.4 #3]
- Updated lighting power densities for different building area types [Tables C405.4.2]
- Specifies non-tradable components of exterior lighting [C405.5.1]
- Requires a separate meter for each Group R-2 dwelling unit [C405.6]
- Adds federal minimum efficiency requirements for electric transformers [C405.7]
- Adds federal minimum efficiency requirements for electric motors [C405.8]
- Regulates elevator cab luminaires, ventilation fans, and controls [C405.9.1]
- Requires automatic speed control and a variable frequency regenerative drive for escalators [C405.9.2]

Other Equipment

Additional Efficiency Package Options

- Adds new options for more efficient HVAC equipment performance, for reduced lighting power densities, for enhanced digital lighting controls, for dedicated outdoor air systems, and for reduced energy use in service water systems [C406.1]

Total Building Performance

- No significant changes made to this section

Commissioning

- Adds commissioning requirements and documentation submittal requirements for lighting control systems including occupant sensor controls, time control switches, and daylight responsive controls [C408.3.1]

Existing Buildings

- Moved all existing building requirements from Chapter [CE] 1 to a new Chapter [CE] 5
- Historic buildings now partially covered [C501.6]
- Replacement fenestration covered [C401.2.1]
- Requires full upgrade of roofing insulation when re-roofing [C503.1]
- Roof replacement exempt from air barrier requirements [C503.1 Exception 6]

Significant changes 2015-2018 IECC Commercial Provisions

[Sources: IECC 2018 and PNNL-SA-127543]

- Made several editorial changes to eliminate the use of the word “Accessible” (if not associated with the IBC Chapter 11 meaning of “Accessible”).
- Clarifies that commissioning is mandatory for all mechanical and hot water heating systems
- Adds additional as-built energy code documentation and owner training requirements for all buildings (typically part of the commissioning documents) …these documents must be submitted to the owner within 90 days of receipt of the Certificate of Occupancy
- Enhanced the section for required energy code inspections

Definitions

- Adds or modifies definitions of “Access (to)”, “Air Barrier”, “Captive Key Override”, “Computer Room”, “Demand Recirculation Water System”, “Group R”, “IEC Design H Motor”, “IEC Design N Motor”, “Isolation Devices”, “Luminaire-level Lighting Controls”, “NEMA Design A Motor”, “NEMA Design B Motor”, “NEMA Design C Motor”, “Networked Guestroom Control System”, “Ready Access (to)”, and “Voltage Drop”

Building Envelope

- Increased stringency requirements for heated slabs [Tables C402.1.3 and C402.1.4]
- Adds maximum U-values for garage door glazing [Table C402.1.4]
- Requires 2 staggered layers of insulation board when continuous roof insulation is installed. Also provides a new exceptions for around roof drains [C402.2.1]
- Clarifies requirements for mass walls and mass floors [C402.2.2 and C402.2.3]
- Restores section on below-grade walls [C402.2.5]
- Adds a section on airspaces [C402.2.7]
- Decreases the SHGC for fenestration in Climates zones 4 and 5 [Table C402.4]
- Raises the allowable skylight area from 5% to 6% with daylight controls [C402.4.1.2]
- Clarified topics such as sliding doors [Table C402.5.2], rooms containing fuel-burning appliances [C402.5.3], loading dock weather seals [C402.5.6]

Mechanical

- Section 403 (Building Mechanical Systems) reorganized for ease of use
- Clarifies that HVAC equipment shall not be oversized [C403.3.1]
- Eliminates outdated federal equipment efficiencies for air conditioners, heat pumps, furnaces, boilers, chillers, cooling towers, and computer room AC [Tables C403.3.2(1) - C403.3.2(10)]
- Clarified that control must be “configured to” meet the requirements, not just be “capable of” meeting the requirements [throughout]
- Clarifies that many controls requirements are “Mandatory” [throughout]
- Adds HVAC control requirements for heated or cooled vestibules [C403.4.1.4]
- Adds pump flow control requirements for chilled and hot water hydronic piping distribution systems [C403.4.3.3.2 and C403.4.4]
- Adds exceptions to economizer requirements [C403.5]
- Adds a section requiring VAV with zone controls for multiple-zone systems [C403.6.1]
- Adds control requirements for parallel-flow fan-powered VAV air terminals [C403.6.7]
- Increases the threshold design airflow rate at which energy recovery is required [Table C403.7.4(2)]
- New HVAC set point and fan control requirements for hotel and motels (Group R-1) with greater than 50 guest rooms [C403.7.6]

- Provides an allowable hp exception for fans less than or equal to 5 hp [C403.8.1]
- Prescribes motor fan speed controls for heat-rejection devices [C403.9]
- Adds federal efficiency requirements for walk-in coolers and freezers to be in effect in 2020 [C403.10.2.1]

Service Water Heating

- Increased federal water heater efficiencies [Table C404.2]

Lighting

- Adds a section for "open plan office areas" and requires occupant sensor controls [C405.2.1.3]
- Adds exceptions for lighting controls for dwelling units [C405.2.4 #3] and patient rooms [C 405.2.4 #2]
- Interior and exterior lighting power allowance have been modified (reduced) to reflect new lighting levels in the IES lighting handbook and to recognize LED technology [Tables C405.3.2(1), C405.3.2(2), and C405.4.2(2)]
- Lighting control requirements have been modified to add additional controls in some space types and options to others to allow easier application of advanced controls [C405.2]
    - Reduce exterior lighting power by 30% during periods of inactivity or after business hours [C405.2.6.3]
- Adds a requirement that 90% of permanently installed dwelling unit lighting fixtures use high efficacy lamps [C405.1]

Power

- Limits the combined voltage drop of feeder conductors and branch circuits to 5% [C405.9]

Other Equipment

- Updates electric motor terminology, adds exceptions, and adds efficiency tables consistent with federal regulations [C405.7]
- Adds an exception to allow a variable voltage drive in lieu of automatic speed control for escalators that are not conveying passengers [C405.8.2]

Additional Efficiency Package Options

- Adds options for enhanced envelope performance as determined by UA analysis [C406.8]
- Adds options for reduced air infiltration as determined by whole building air leakage testing [C406.9]

Total Building Performance

- Limits the amount of credit allowed for on-site renewable energy [C407.3]
- Limits the amount of credit allowed for renewable energy purchased from off-site sources [C407.3]

Commissioning

- Requires that building operations and maintenance documents be provided to the owner
- Requires a completed "Commissioning Compliance Checklist" with the "Preliminary Commissioning Report"

Existing Buildings

- Provides exceptions for Changes in Space Conditioning and for Changes of Occupancy

Significant changes 2018-2021 IECC Commercial Provisions

[Sources: IECC 2021]

- Changes climate zone maps resulting in 15 Ohio counties moving from Climate Zone 5 to Climate Zone 4
- Requires an insulation certificate identifying the installed R-value of insulation when the insulation of the manufacturer is not readily observable upon inspection
- Requires that a Thermal Envelope Certificate be posted in an approved location
- Clarifies and relocates all "Mandatory" and "Prescriptive" labels to a table

Definitions

- Adds or modifies definitions of "Biogas", "Biomass", "Data Center", "Data Center Systems", "Direct Digital Control", "Enthalpy Recovery Ratio", "Embedded Fan", "Fan Array", "Fan Energy Index (FEI)", "Fan Nameplate Electrical Input Power", "Fan System Electrical Input Power", "Fault Detection and Diagnostics (FDD) System", "Information Technology Equipment (ITE)", "Internal Curtain System", "Large Diameter Ceiling Fan", "On-Site Renewable Energy", "Renewable Energy Resources", "Testing Unit Enclosure Area", "Thermal Distribution Efficiency (TDE)", "Vegetative Roof", "Visible Transmittance, Annual", and "Wall, Above-Grade"

Building Envelope

- Increased envelope stringency and clarity for conditioned greenhouses [C402.1.1.1]
- Allows certain electric equipment buildings up to 1200 ft^2 to be exempt from envelope requirements [C402.1.2]
- Recognizes and provides guidance for layered cavity insulation [C402.1.3]
- Increased stringency requirements for attic insulation, above-grade and below-grade walls, and unheated slabs [Tables C402.1.3 and C402.1.4]
- Clarifies U-factor and R-factor insulation requirements at roofs, particularly tapered above-deck insulation [C402.1.4.1 & C402.2.1]
- Adds limit of maximum of 25% glazing area for garage door [Table C402.1.4, note i]
- Increases stringency of U-values and SHGC for fenestration in CZ 4 and CZ 5 [Table C402.4]
- Clarifies skylight requirements [C402.4.2]
- Removes R-values for doors and prescribes maximum U-factors and glazing area for non-swinging doors [C402.4.5]
- Requires either air barrier inspection and commissioning or enclosure testing to verify envelope performance of buildings and provides testing methodologies [C402.5]
- Requires HVAC interlock with operable openings that are greater than 40 ft^2 and provides a few exceptions (separately zoned commercial kitchens, warehouses, and outside vestibule doors) [C402.5.11]

Mechanical

- Exempts data center systems from control and economizer requirements [C403.1]
- Requires that data center systems comply with ASHRAE 90.4 (with a few modifications) [C403.1.2]
- Requires large HVAC systems (serving $\geq$100,000 ft^2) in new buildings to provide a fault detection and diagnostics system [C403.2.3]
- Updates HVAC equipment efficiency tables (some efficiencies to go into effect on January 1, 2023) for air conditioners, heat pumps, furnaces, boilers, chillers, cooling towers, condensers, and computer room AC [Tables C403.3.2(1) - C403.3.2(16)]
- Clarifies heat pump control requirements [C403.4.1.1]

- Clarifies that automatic stop controls are also required for HVAC systems [C403.4.2.3]
- Requires two-position valve for hydronic heat pump systems to be automatic and interlocked [C403.4.3.3.3]
- Adds a Variable Refrigerant Flow (VRF) exception to economizer requirements [C403.5]
- Requires Demand Control Ventilation (DCV) whenever economizers are required [C403.7.1]
- Increases number of enclosed parking garages that will require detection and controls [C403.7.2]
- Prescribes specific enthalpy recovery ratios for dwelling unit energy recovery systems [C403.7.4.1]
- Differentiates control requirements for hotel and motels (Group R-1) based upon occupancy status of rooms and changes time-out time from 30 minutes to 20 minutes [C403.7.6]
- Requires fans and fan arrays to have a Fan Energy Index (FEI) certified IAW AMCA 208 [C403.8.3]
- Prescribes minimum efficiencies of low-capacity residential-type fans [C403.8.5]
- Recognizes Large-diameter ceiling fans [C403.9]
- Adds performance requirements for commercial refrigerators, freezers, walk-in coolers, walk-in refrigerators and refrigeration equipment [C403.11]
- Clarifies insulation requirements for underground ducts [C403.12.1]
- Prescribes control system operation for operable opening interlocks [C403.14]

Service Water Heating

- Increases minimum efficiency for large (1 M Btu/h input) individual water heating equipment to 92% [C404.2.1]

Lighting

- Clarifies what is meant by “general lighting” [C405.1]
- Requires corridor lighting to be reduced to minimum levels (no more than 50% full power) when unoccupied [C405.2.1.1 & C405.2.1.4]
- Adds a section for “warehouse storage areas” and requires occupant sensor controls [C405.2.1.2]
- Clarifies intent of light reduction control requirements [C405.2.3]
- Adds additional control requirements for the secondary side lit daylight zone [C405.2.4.2]
- Adds control requirements for parking lot luminaires [C405.2.7.3]
- Adds control requirements for parking garage lighting [C405.2.8]
- Clarifies lighting power allowance calculations, especially for projects that involve only a portion of a building and for exterior lighting [C405.3.2 & C405.5.2]]
- Interior and exterior lighting power allowance have been modified to reflect new lighting levels in the IES lighting handbook and to recognize LED technology [Tables C405.3.2(1), C405.3.2(2), and C405.4.2(2)]
- Recognizes the high energy use of plant growth lighting and requires 95% of permanent luminaires to have a minimum photon efficiency of 1.6 m mol/J [C405.4]

Power

- Limits the combined voltage drop of customer-owned service conductors, feeder conductors and branch circuits to 5% [C405.10]
- Requires automatic receptacle control of at least 50% of 125V, 15 and 20 amp receptacles in offices, conference rooms, copy/print rooms, breakrooms, classrooms, and modular workstations and 25% of branch circuit feeders for modular furniture not shown on plans [C405.11]
- Requires new buildings with $\geq$ 25,000 ft^2 to be provided with an energy monitoring system [C405.12]

Other Equipment

- Requires that escalators be designed to recover more electrical energy than is consumed when resisting overspeed in the down direction [C405.9.2.1]

Additional Efficiency Requirements [C406]

- Requires at least 10 credits by adding additional energy efficient features to the building. The credits are determined from newly added tables arranged by occupancy classification [C406.1]
- Modifies more efficient HVAC option [C406.2]
- Modifies reduced lighting power option [C406.3]
- Modifies the basic renewable energy option [C406.5]
- Adds options for energy monitoring systems, if not otherwise required [C406.10]
- Adds options for fault detection system, if not otherwise required [C406.11]
- Adds options for efficient kitchen equipment [C406.12]

Total Building Performance

- Provides a new table that outlines the code requirements that must be met when using the Total Building Performance method [Table C407.2]

Commissioning

- Allows an "approved agency" or a qualified commissioning professional to perform the commissioning activities [C408.3.1]

Existing Buildings

- Reorganizes and clarifies requirements
- Clarifies that commissioning is required for new lighting and power systems [C502.3.6]

Pacific Northwest
NATIONAL LABORATORY

PNNL-31524

Cost-Effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019 for Ohio

July 2021

M Tyler
Y Xie
E Poehlman
M Rosenberg

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
under Contract DE-AC05-76RL01830

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Cost-Effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019 for Ohio

July 2021

M Tyler
Y Xie
E Poehlman
M Rosenberg

Prepared for
the U.S. Department of Energy
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Pacific Northwest National Laboratory
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Acronyms and Abbreviations

AVERT	U.S. EPA AVoided Emissions and geneRation Tool
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BECP	Building Energy Codes Program
CH_4	Methane
CO_2	Carbon Dioxide
DOE	U.S. Department of Energy
E.O.	Executive Order
eGRID	EPA Emissions & Generation Resource Integrated Database
EIA	Energy Information Administration
EPA	Environmental Protection Agency
FEMP	Federal Energy Management Program
HVAC	Heating, Ventilating, and Air-Conditioning
LCC	Life-Cycle Cost
MMT	Million Metric Tons
N_2O	Nitrous Oxide
NOx	Nitrogen Oxides
NIST	National Institute of Standards and Technology
PNNL	Pacific Northwest National Laboratory
SOx	Sulfur Oxides
UPV	Uniform Present Value

1.0 Highlights

Moving to the ASHRAE Standard 90.1-2019 (ASHRAE 2019) edition from Standard 90.1-2016 (ASHRAE 2016) is cost-effective for Ohio. Standard 90.1-2019 will provide an annual energy cost savings of $0.054 per square foot on average across the state. It will reduce statewide CO_2 emissions by 9.2 MMT (30 years cumulative), equivalent to the CO_2 emissions of 2,009,000 cars driven for one year.

Updating the state energy code based on Standard 90.1-2019 will also stimulate the creation of high-quality jobs across the state. Standard 90.1-2019 is expected to result in buildings that are energy efficient, more affordable to own and operate, and based on current industry standards for health, comfort, and resilience.

The tables below show the expected impact of upgrading to Standard 90.1-2019 from a consumer perspective and statewide perspective. These results are weighted averages for all building types in all climate zones in the state, based on weightings shown in Table 4. The methodology used for this analysis is consistent with the methodology used in the national cost-effectiveness analysis.[1] Additional results and details on the methodology are presented in the following sections.

Consumer Impact	
Annual (first year) energy cost savings, $/ft^2	$0.054
Added construction cost, $/ft^2	-$1.225
Publicly-owned scenario LCC Savings, $/ft^2	4.02
Privately-owned scenario LCC Savings, $/ft^2	3.57

Statewide Impact - Emissions	**First Year**	**30 Years Cumulative**
Energy cost savings, 2020$	1,501,000	649,900,000
CO_2 emission reduction, Metric tons	13,250	9,239,000
CH_4 emissions reductions, Metric tons	1.35	938
N_2O emissions reductions, Metric tons	0.191	133
NOx emissions reductions, Metric tons	6.99	4,875
SOx emissions reductions, Metric tons	8.99	6,271

Statewide Impact - Jobs Created	**First Year**	**30 Years Cumulative**
Jobs Created Reduction in Utility Bills	134	4,230
Jobs Created Construction Related Activities	336	10,613

[1] National cost-effectiveness report:
https://www.energycodes.gov/development/commercial/cost_effectiveness

The report provides analysis of two LCC scenarios:

- **Scenario 1**, representing *publicly-owned* buildings, considers initial costs, energy costs, maintenance costs, and replacement costs—without borrowing or taxes.
- **Scenario 2**, representing *privately-owned* buildings, adds borrowing costs and tax impacts.

Figure 1 compares annual energy cost savings, first cost for the upgrade, and net annualized LCC savings. The net annualized LCC savings per square foot is the annual energy savings minus an allowance to pay for the added cost under scenario 1. Figure 2 shows overall state weighted net LCC results for both scenarios. When net LCC is positive, the updated code edition is considered cost-effective.

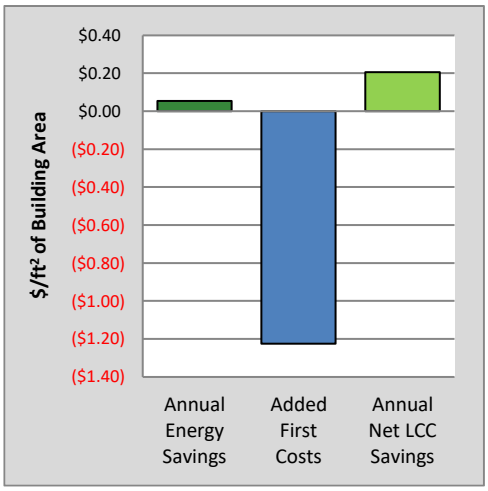

Figure 1. Statewide Weighted Costs and Savings

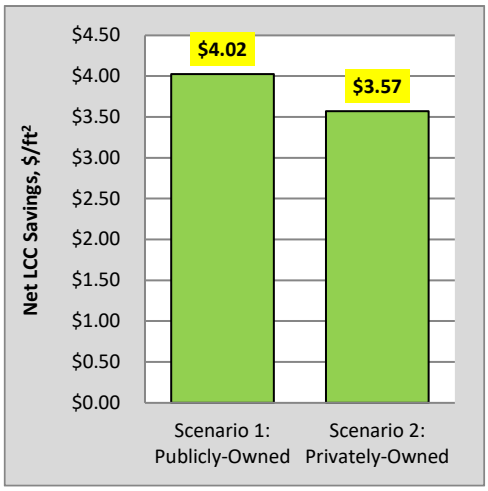

Figure 2. Overall Net Life-Cycle Cost Savings

2.0 Cost-Effectiveness Results for ASHRAE Standard 90.1-2019 in Ohio

This section summarizes the cost-effectiveness analysis results applicable to the building owner. Life Cycle Cost (LCC) savings is the primary measure established by the U.S. Department of Energy to assess the cost effectiveness and economic impact of building energy codes. Net LCC savings is the calculation of the present value of energy savings minus the present value of non-energy incremental costs over a 30-year period. The non-energy incremental costs include initial equipment and construction costs, and maintenance and replacement costs, less the residual value of components at the end of the 30-year period. When net LCC is positive, the updated code edition is considered cost-effective. Savings are computed for two scenarios:

- **Scenario 1:** represents *publicly-owned buildings*, includes costs for initial equipment and construction, energy, maintenance and replacement and does not include loans or taxes.
- **Scenario 2:** represents *privately-owned buildings*, includes the same costs as Scenario 1, with the initial investment financed through a loan amortized over 30 years and federal and state corporate income tax deductions for interest and depreciation.

Both scenarios include the residual value of equipment with remaining useful life at the end of the 30-year assessment period. Totals for building types, climate zones, and the state overall are averages based on Table 4 construction weights. Factors such as inflation and discount rates are different between the two scenarios, as described in the Cost-Effectiveness Methodology section.

LCC is affected by many variables, including the applicability of individual measures in the code, measure costs, measure lifetime, replacement costs, state cost adjustment, energy prices, and so on. In some cases, the LCC can be negative for a given building type or climate zone based on the interaction of these variables. However, the code is considered cost-effective if the weighted statewide LCC is positive.

Table 1 shows the present value of the net LCC savings over 30 years for buildings in scenario 1 averages $4.02 per square foot for Standard 90.1-2019.

Table 1. Net LCC Savings for Ohio, Scenario 1 ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	$3.78	$3.79	$3.99	$4.54	$12.83	$1.90	$3.76
5A	$3.73	$3.79	$4.06	$4.50	$12.79	$1.88	$4.22
State Average	$3.75	$3.79	$4.04	$4.51	$12.80	$1.89	**$4.02**

Table 2 shows the present value of the net LCC savings over 30 years averages $3.57 per square foot for scenario 2.

Table 2. Net LCC Savings for Ohio, Scenario 2 ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	$3.26	$3.21	$3.51	$3.91	$12.37	$1.73	$3.33
5A	$3.21	$3.21	$3.57	$3.88	$12.33	$1.72	$3.74
State Average	$3.23	$3.21	$3.55	$3.89	$12.34	$1.73	**$3.57**

2.1 Energy Cost Savings

Table 3 shows the economic impact of upgrading to Standard 90.1-2019 by building type and climate zone in terms of the annual energy cost savings in dollars per square foot. The annual energy cost savings across the state averages $0.054 per square foot.

Table 3. Annual Energy Cost Savings for Ohio ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	$0.039	$0.048	$0.077	$0.056	$0.069	$0.017	$0.049
5A	$0.038	$0.048	$0.078	$0.056	$0.067	$0.016	$0.057
State Average	$0.038	$0.048	$0.078	$0.056	$0.068	$0.017	**$0.054**

2.2 Construction Weighting of Results

Energy and economic impacts were determined and reported separately for each building type and climate zone. Cost-effectiveness results are also reported as averages for all prototypes and climate zones in the state. To determine these averages, results were combined across the different building types and climate zones using weighting factors shown in Table 4. These weighting factors are based on the floor area of new construction and major renovations for the six analyzed building prototypes in state-specific climate zones. The weighting factors were developed from construction start data from 2003 to 2018 (Dodge Data & Analytics) based on an approach documented in Lei, et al.

Table 4. Construction Weights by Building Type

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	4.3%	3.8%	13.2%	6.9%	1.6%	12.4%	42.1%
5A	7.7%	1.9%	24.7%	11.9%	2.9%	8.6%	57.9%
State Average	12.0%	5.8%	37.9%	18.8%	4.5%	21.0%	100.0%

2.3 Incremental Construction Cost

Cost estimates were developed for the differences between Standard 90.1-2016 and Standard 90.1-2019 as implemented in the six prototype models. Costs for the initial construction include material, labor, commissioning, construction equipment, overhead and profit. Costs were also estimated for replacing equipment or components at the end of the useful life. The costs were

developed at the national level for the national cost-effectiveness analysis and then adjusted for local conditions using a state construction cost index (Hart et al. 2019, Means 2020a,b).

Table 5 shows incremental initial cost for individual building types in state-specific climate zones and weighted average costs by climate zone and building type for moving to Standard 90.1-2019 from Standard 90.1-2016.

The added construction cost can be negative for some building types, which represents a reduction in first costs and a savings that is included in the net LCC savings. This is typically due to the interaction between measures and situations such as the following:

- Fewer light fixtures are required when the allowed lighting power is reduced. Also, changes from fluorescent to LED technology result in reduced lighting costs in many cases and longer lamp lives, requiring fewer lamp replacements.
- Smaller heating, ventilating, and air-conditioning (HVAC) equipment sizes can result from the lowering of heating and cooling loads due to other efficiency measures, such as better building envelopes. For example, Standard 90.1-2019 has more stringent fenestration U-factors for some climate zones. This results in smaller equipment and distribution systems, resulting in a negative first cost.

Table 5. Incremental Construction Cost for Ohio ($/ft^2)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	($1.722)	($1.967)	($1.266)	($1.990)	$0.646	($0.362)	($1.158)
5A	($1.701)	($1.975)	($1.297)	($1.973)	$0.651	($0.366)	($1.274)
State Average	($1.708)	($1.970)	($1.286)	($1.979)	$0.649	($0.364)	**($1.225)**

2.4 Simple Payback

Simple payback is the total incremental first cost divided by the annual savings, where the annual savings is the annual energy cost savings less any incremental annual maintenance cost. Simple payback is not used as a measure of cost-effectiveness as it does not account for the time value of money, the value of energy cost savings that occur after payback is achieved, or any replacement costs that occur after the initial investment. However, it is included in the analysis for states who wish to use this information. Table 6 shows simple payback results in years.

Table 6. Simple Payback for Ohio (Years)

Climate Zone	Small Office	Large Office	Stand-Alone Retail	Primary School	Small Hotel	Mid-Rise Apartment	All Building Types
4A	Immediate	Immediate	Immediate	Immediate	9.4	Immediate	Immediate
5A	Immediate	Immediate	Immediate	Immediate	9.7	Immediate	Immediate
State Average	Immediate	Immediate	Immediate	Immediate	9.6	Immediate	**Immediate**

3.0 Societal Benefits

3.1 Benefits of Energy Codes

It is estimated that by 2060, the world will add 2.5 trillion square feet of buildings, an area equal to the current building stock. As a building's operation and environmental impact is largely determined by upfront decisions, energy codes present a unique opportunity to assure savings through efficient building design, technologies, and construction practices. Once a building is constructed, it is significantly more expensive to achieve higher efficiency levels through later modifications and retrofits. Energy codes ensure that a building's energy use is included as a fundamental part of the design and construction process. Making this early investment in energy efficiency will pay dividends to residents of Ohio for years into the future.

3.2 Greenhouse Gas Emissions

The urban built environment is responsible for 75% of annual global greenhouse gas (GHG) emissions while buildings alone account for 39%.[2] While carbon dioxide emissions represent the largest share of greenhouse gas emissions, building electricity use and on-site fossil fuel consumption also contribute to other emissions, two of which, methane (CH_4) and nitrous oxide (N_2O), are significant greenhouse gases in their own right.

For natural gas combusted on site, emission metrics are developed using nationwide emission factors from U.S. Environmental Protection Agency publications for CO_2, NOx, SO_2, CH_4 and N_2O (EPA 2014).

For electricity, marginal carbon emission factors are provided by the U.S. Environmental Protection Agency (EPA) AVoided Emissions and geneRation Tool (AVERT) version 3.0 (EPA 2020). The AVERT tool forms the basis of the national marginal emission factors for electricity also published by EPA on its Greenhouse Gas Equivalencies Calculator website and are based on a portfolio of energy efficiency measures examined by EPA. AVERT is used here to provide marginal CO_2 emission factors at the State level.[3] AVERT also provides marginal emission factor estimates for gaseous pollutants associated with electricity production, including NOx and SO_2 emissions. While not considered significant greenhouse gases, these are EPA tracked pollutants. The current analysis uses AVERT to provide estimates of corresponding emission changes for NOx and SO_2 in physical units but does not monetize these.

AVERT does not develop associated marginal emissions factors for CH_4 or N_2O. To provide estimates for the associated emission reductions for CH_4 and N_2O, this report uses emission factors separately provided through the U.S. Environmental Protection Agency (EPA) Emissions

[2] Architecture 2030, https://architecture2030.org/2030_challenges/2030-challenge

[3] AVERT models avoided emissions in 14 geographic regions of the 48 contiguous United States and includes transmission and distribution losses. Where multiple AVERT regions overlap a state's boundaries, the emission factors are calculated based on apportionment of state electricity savings by generation across generation regions. The most recent AVERT 3.0 model uses EPA emissions data for generators from 2019. Note that AVERT estimates are based on marginal changes to demand and reflect current grid generation mix. Emission factors for electricity shown in Table 7 do not take into account long term policy or technological changes in the regional generation mix that can impact the marginal emission benefits from new building codes.

& Generation Resource Integrated Database (eGRID) dataset. eGRID is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States and the emission characteristics for electric power generation for each of the above emissions can also be found aggregated down to the state level in eGRID (EPA 2021a). The summary emission factor data provided by eGRID does not provide marginal emission factors, but instead summarizes emission factors in terms of total generation emission factors and non-baseload generation emission factors. Non-baseload emission factors established in eGRID are developed based on the annual load factors for the individual generators tracked by the EPA (EPA 2021b). Because changes in building codes are unlikely to significantly impact baseload electrical generators, the current analysis uses the 2019 non-baseload emission factors established in eGRID by state to estimate CH_4 or N_2O emission reductions due to changes in electric consumption.

Table 7 summarizes the marginal emission factors available from AVERT, eGRID and the EPA Greenhouse Gas Equivalencies Calculator.

Table 7. Greenhouse Gas Emission Factors by Fuel Type

GHG	Electricity lb/MWh	Natural Gas (lb/mmcf)
CO_2	1,567	120,000
SO_2	1.194	0.6
NO_X	0.774	96
N_2O	0.025	0.23
CH_4	0.175	2.3

Table 8 shows the annual first year and projected 30-year energy cost savings. This table also shows first year and projected 30-year greenhouse gas (CO_2, CH_4, and N_2O) emission reductions, in addition to NOx and SO_2 reductions.

Table 8. Societal Benefits of Standard 90.1-2019

Statewide Impact	First Year	30 Years Cumulative
Energy cost savings, 2020$	1,501,000	649,900,000
CO_2 emission reduction, Metric tons	13,250	9,239,000
CH_4 emissions reductions, Metric tons	1.35	938
N_2O emissions reductions, Metric tons	0.191	133
NOx emissions reductions, Metric tons	6.99	4,875
SOx emissions reductions, Metric tons	8.99	6,271

3.3 Jobs Creation through Energy Efficiency

Energy-efficient building codes impact job creation through two primary value streams:

1. Dollars returned to the economy through reduction in utility bills and resulting increase in disposable income, and;
2. An increase in construction-related activities associated with the incremental cost of construction that is required to produce a more energy efficient building.

When a building is built to a more stringent energy code, there is the long-term benefit of the ratepayer paying lower utility bills.

- This is partially offset by the increased cost of that efficiency, establishing a relationship between increased building energy efficiency and additional investments in construction activity.

- Since building codes are cost-effective, (i.e., the savings outweigh the investment), a real and permanent increase in wealth occurs that can be spent on other goods and services in the economy, just like any other income, generating economic benefits and creating additional employment opportunities.

Table 9 shows the number of jobs created because of efficiency gains in Standard 90.1-2019.

Table 9. Jobs Created from Standard 90.1-2019

Statewide Impact	First Year	30 Years Cumulative
Jobs Created Reduction in Utility Bills	134	4,230
Jobs Created Construction Related Activities	336	10,613

4.0 Overview of the Cost-Effectiveness Methodology

This analysis was conducted by Pacific Northwest National Laboratory (PNNL) in support of the DOE Building Energy Codes Program. DOE is directed by federal law to provide technical assistance supporting the development and implementation of residential and commercial building energy codes. The national model energy codes – the International Energy Conservation Code (IECC) and ANSI/ASHRAE/IES Standard 90.1 – help adopting states and localities establish minimum requirements for energy-efficient building design and construction, as well as mitigate environmental impacts and ensure residential and commercial buildings are constructed to modern industry standards.

The current analysis evaluates the cost-effectiveness of Standard 90.1-2019 relative to Standard 90.1-2016. The analysis covers six commercial building types. The analysis is based on the current prescriptive requirements of Standard 90.1. The simulated performance rating method is not in the scope of this analysis, as it is generally based on the core prescriptive requirements of Standard 90.1, and due to the unlimited range of building configurations that are allowed. Buildings complying via this path are generally considered to provide equal or better energy performance compared to the prescriptive requirements, as the intent of these paths is to provide additional design flexibility and cost optimization, as dictated by the builder, designer, and owner.

The current analysis is based on the methodology by DOE for assessing building energy codes (Hart and Liu 2015). The LCC analysis perspective described in the methodology appropriately balances upfront costs with longer term consumer costs and savings and is therefore the primary economic metric by which DOE evaluates the cost-effectiveness of building energy codes.

4.1 Cost-Effectiveness

DOE has established standard economic LCC cost-effectiveness analysis methods in comparing Standard 90.1-2019 and Standard 90.1-2016, which are described in *Methodology for Evaluating Cost-effectiveness of Commercial Energy Code Changes* (Hart and Liu 2015). Under this methodology, two metrics are used:

- **Net LCC Savings:** This is the calculation of the present value of energy savings minus the present value of non-energy incremental costs over a 30-year period. The costs include initial equipment and construction costs, maintenance and replacement costs, less the residual value of components at the end of the 30-year period. When net LCC is positive, the updated code edition is considered cost-effective.
- **Simple Payback:** While not a true cost-effectiveness metric, simple payback is also calculated. Simple payback is the number of years required for accumulated annual energy cost savings to exceed the incremental first costs of a new code.

Two cost scenarios are analyzed:

- **Scenario 1** represents publicly-owned buildings, considers initial costs, energy costs, maintenance costs, and replacement costs without borrowing or taxes.
- **Scenario 2** represents privately-owned buildings and includes the same costs as Scenario 1 plus financing of the incremental first costs through increased borrowing with tax impacts including mortgage interest and depreciation deductions. Corporate tax rates are applied.

The cost-effectiveness analysis compares the cost for new buildings meeting Standard 90.1-2019 versus new buildings meeting Standard 90.1-2016. The analysis includes energy savings estimates from building energy simulations and LCC and simple payback calculations using standard economic analysis parameters. The analysis builds on work documented in *Energy Savings Analysis: ANSI/ASHRAE/IES Standard 90.1-2019* (DOE 2021), and the national cost-effectiveness analysis documented in *National Cost-effectiveness of ANSI/ASHRAE/IES Standard 90.1-2019* (Tyler et al. 2021).

4.2 Building Prototypes and Energy Modeling

The cost-effectiveness analysis uses six building types represented by six prototype building energy models. These six models represent the energy impact of five of the eight commercial principal building activities that account for 74% of the new construction by floor area covered by the full suite of 16 prototypes. These models provide coverage of the significant changes in ASHRAE Standard 90.1 from 2016 to 2019 and are used to show the impacts of the changes on annual energy usage. The prototypes represent common construction practice and include the primary conventional HVAC systems most commonly used in commercial buildings.[4]

Each prototype building is analyzed for each of the climate zones found within the state. Using the U.S. DOE EnergyPlus software, the six building prototypes summarized in Table 10 are simulated with characteristics meeting the requirements of Standard 90.1-2016 and then modified to meet the requirements of the next edition of the code (Standard 90.1-2019). The energy use and energy cost are then compared between the two sets of models.

Table 10. Building Prototypes

Building Prototype	Floor Area (ft²)	Number of Floors
Small Office	5,500	1
Large Office	498,640	13
Stand-Alone Retail	24,690	1
Primary School	73,970	1
Small Hotel	43,210	4
Mid-Rise Apartment	33,740	4

4.3 Climate Zones

Climate zones are defined in ASHRAE Standard 169, as specified in ASHRAE Standard 90.1, and include eight primary climate zones in the United States, the hottest being climate zone 1 and the coldest being climate zone 8. Letters A, B, and C are applied in some cases to denote the level of moisture, with A indicating humid, B indicating dry, and C indicating marine. Figure 3 shows the national climate zones. For this state analysis, savings are analyzed for each climate zone in the state using weather data from a selected city within the climate zone and state, or where necessary, a city in an adjoining state with more robust weather data.

[4] More information on the prototype buildings and savings analysis can be found at www.energycodes.gov/development/commercial/90.1_models

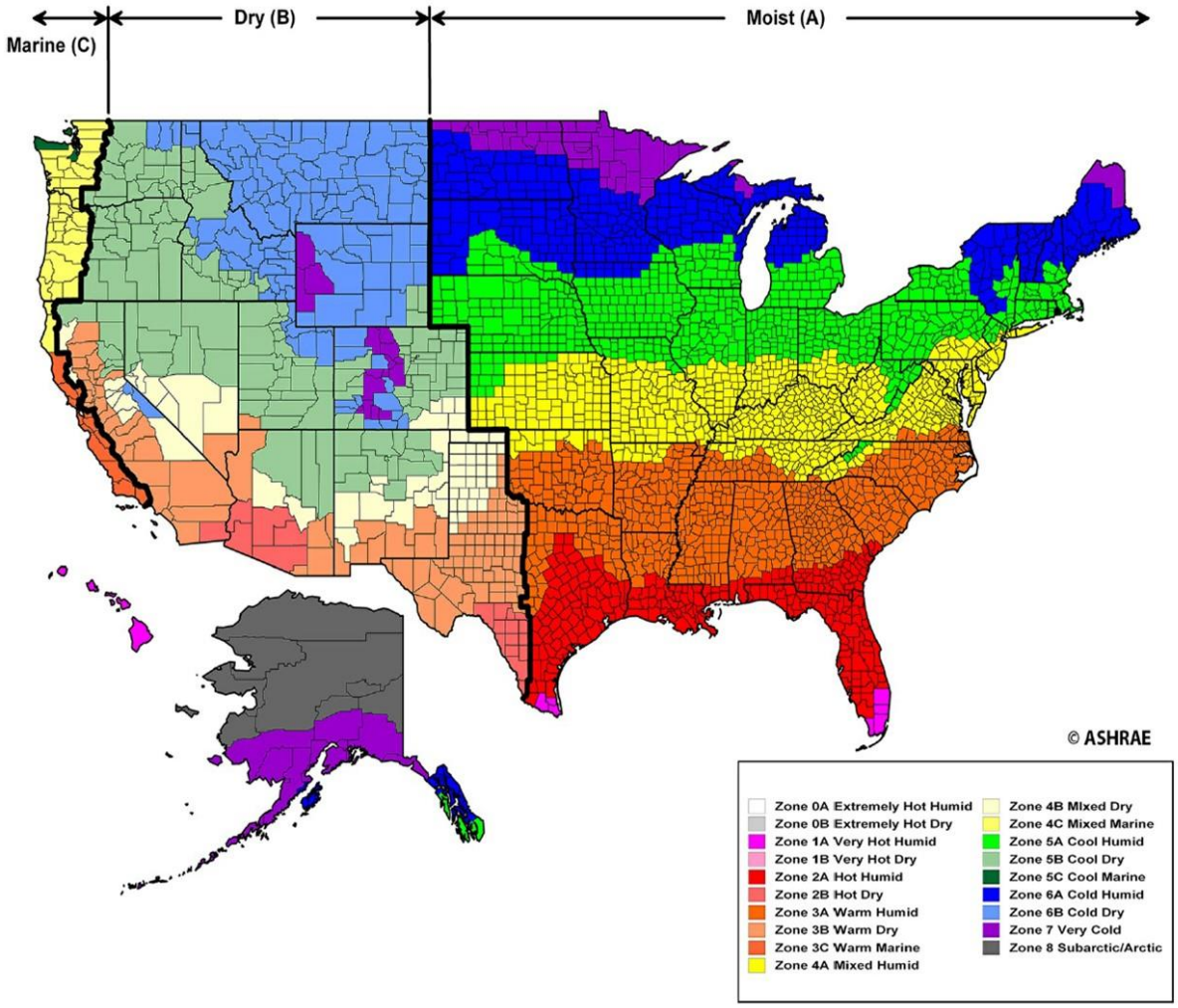

Figure 3. National Climate Zones

4.4 Cost-Effectiveness Method and Parameters

The DOE cost-effectiveness methodology accounts for the benefits of energy efficient building construction over a multi-year analysis period, balancing initial costs against longer term energy savings. DOE evaluates energy codes and code proposals based on LCC analysis over a multi-year study period, accounting for energy savings, incremental investment for energy efficiency measures, and other economic impacts. The value of future savings and costs are discounted to a present value, with improvements deemed cost-effective when the net LCC savings (present value of savings minus cost) is positive.

The U.S. DOE Building Energy Codes Program has established LCC analysis criteria similar to the method used for many federal building projects, as well as other public and private building projects (Fuller and Petersen 1995). The LCC analysis method consists of identifying costs (and revenues if any) and in what year they occur; then determining their value in today's dollars (known as the present value). This method uses economic relationships about the time value of money. Money in-hand today is normally worth more than money received in the future, which is why we pay interest on a loan and earn interest on savings. Future costs are discounted to the

present based on a discount rate. The discount rate may reflect the interest rate at which money can be borrowed for projects with the same level of risk or the interest rate that can be earned on other conventional investments with similar risk.

The LCC includes incremental initial costs, repairs, maintenance, and replacements. Scenario 2 also includes loan costs and tax impacts including mortgage interest and depreciation deductions. The residual value of equipment (or other component such as roof membrane) that has remaining useful life at the end of the 30-year study period is also included for both scenarios. The residual value is calculated by multiplying the initial cost of the component by the years of useful life remaining for the component at year 30 divided by the total useful life, a simplified approach included in the Federal Energy Management Program (FEMP) LCC method (Fuller and Petersen 1995). A component will have zero residual value at year 30 only if it has a 30-year life, or if it has a shorter than 30-year life that divides exactly into 30 years (for example, a 15-year life).

The financial and economic parameters used for the LCC calculations are shown in Table 11.

Table 11. LCC Economic Parameters

Economic Parameter	Scenario 1	Scenario 2
Study Period – Years[1]	30	30
Nominal Discount Rate[2]	3.10%	5.25%
Real Discount Rate[2]	3.00%	3.34%
Effective Inflation Rate[3]	0.10%	1.85%
Electricity Prices[4] (per kWh)	$0.0941	$0.0941
Natural Gas Prices[4] (per therm)	$0.5352	$0.5352
Energy Price Escalation Factors[5]	*Uniform present value factors*	*Uniform present value factors*
Electricity Price UPV[5]	19.17	17.37
Natural Gas Price UPV[5]	23.45	21.25
Loan Interest Rate[6]	NA	5.25%
Federal Corporate Tax Rate[7]	NA	21.00%
State Corporate Tax Rate[8]	NA	0.00%
Combined Income Tax Impact[9]	NA	21.00%
State and Average Local Sales Tax[10]	7.17%	7.17%
State Construction Cost Index[11]	0.925	0.925

[1] A 30-year study period captures most building components useful lives and is a commonly used study period for building project economic analysis. This period is consistent with previous and related national 90.1 cost-effectiveness analysis. It is also consistent with the cost-effectiveness analysis that was done for the residential energy code as described in multiple state reports and a summary report (Mendon et al. 2015). The federal building LCC method uses 25 years and the ASHRAE Standard 90.1 development process uses up to 40 years for building envelope code improvement analysis. Because of the time value of money, results are typically similar for any study periods of 20 years or more.

[2] The Scenario 1 real and nominal discount rates are from the National Institute of Standards and Technology (NIST) 2019 annual update in the *Report of the President's Economic Advisors, Analytical Perspectives* (referenced in the NIST 2019 annual supplement without citation) (Lavappa and Kneifel 2019). The Scenario 2 nominal discount rate is taken as the marginal cost of capital, which is set equal to the loan interest rate (see footnote 6). The real discount rate for Scenario 2 is calculated from the nominal discount rate and inflation.

[3] The Scenario 1 effective inflation rate is from the NIST 2019 annual update for the federal LCC method (Lavappa and Kneifel 2019). The Scenario 2 inflation rate is the 30-year average Producer Price Index for non-residential construction, June 1990 to June 2020 (Bureau of Labor Statistics 2021).

[4] Scenario 1 and 2 electricity and natural gas prices are state average annual prices for 2020 from the United States Energy Information Administration (EIA) *Electric Power Monthly* (EIA 2021a) and *Natural Gas Monthly* (EIA 2021b).

[5] Scenario 1 energy price escalation rates are from the NIST 2019 annual update for the FEMP LCC method (Lavappa and Kneifel 2019). The NIST uniform present value (UPV) factors are multiplied by the first-year annual energy cost to determine the present value of 30 years of energy costs and are based on a series of different annual escalation rates for 30 years. Scenario 2 UPV factors are based on NIST UPVs with an adjustment made for the scenario difference in discount rates.

[6] The loan interest rate is estimated from multiple online sources listed in the references (Commercial Loan Direct 2021; Realty Rates 2021).

[7] The highest federal marginal corporate income tax rate is applied.

[8] The highest marginal state corporate income tax rate is applied from the Federation of Tax Administrators (FTA 2021).

[9] The combined tax impact is based on state tax being a deduction for federal tax and is applied to depreciation and loan interest.

[10] The combined state and average local sales tax is included in material costs in the cost estimate (Tax Foundation 2020).

[11] The state construction cost index is based on weighted city indices from the state (Means 2020b).

5.0 Detailed Energy Use and Cost

On the following pages, specific detailed results for Ohio are included:

- Table 12 shows the average energy rates used.
- Table 13 shows the per square foot energy costs for Standard 90.1-2016 and Standard 90.1-2019 and the cost savings from Standard 90.1-2019.
- Table 14 shows the per square foot energy use for Standard 90.1-2016 and Standard 90.1-2019 and the energy use savings from Standard 90.1-2019.
- Tables 15.A and 15.B show the energy end use by energy type for each climate zone in the state.

Table 12. Energy Rates for Ohio, Average $ per unit

Electricity	$0.0941	kWh
Gas	$0.5352	Therm

Source: Energy Information Administration, annual average prices for 2020 (EIA 2021a,b)

Table 13. Energy Cost Saving Results in Ohio, $ per Square Foot

Climate Zone:	4A				5A			
Code:	90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings	
Small Office								
Electricity	$0.703	$0.663	$0.039	5.5%	$0.715	$0.676	$0.039	5.5%
Gas	$0.007	$0.008	$0.000	0.0%	$0.009	$0.010	-$0.001	-11.1%
Totals	$0.710	$0.671	$0.039	5.5%	$0.724	$0.686	$0.038	5.2%
Large Office								
Electricity	$1.409	$1.361	$0.048	3.4%	$1.414	$1.368	$0.047	3.3%
Gas	$0.016	$0.015	$0.001	6.3%	$0.019	$0.018	$0.001	5.3%
Totals	$1.425	$1.377	$0.048	3.4%	$1.434	$1.386	$0.048	3.3%
Stand-Alone Retail								
Electricity	$0.859	$0.776	$0.083	9.7%	$0.862	$0.778	$0.084	9.7%
Gas	$0.110	$0.116	-$0.006	-5.5%	$0.130	$0.136	-$0.006	-4.6%
Totals	$0.969	$0.892	$0.077	7.9%	$0.991	$0.914	$0.078	7.9%
Primary School								
Electricity	$0.840	$0.786	$0.055	6.5%	$0.839	$0.784	$0.054	6.4%
Gas	$0.065	$0.063	$0.002	3.1%	$0.073	$0.071	$0.002	2.7%
Totals	$0.905	$0.849	$0.056	6.2%	$0.912	$0.856	$0.056	6.1%
Small Hotel								
Electricity	$0.850	$0.782	$0.069	8.1%	$0.859	$0.792	$0.067	7.8%
Gas	$0.131	$0.131	$0.000	0.0%	$0.134	$0.134	$0.000	0.0%
Totals	$0.982	$0.913	$0.069	7.0%	$0.992	$0.926	$0.067	6.8%
Mid-Rise Apartment								
Electricity	$0.939	$0.920	$0.019	2.0%	$0.943	$0.925	$0.018	1.9%
Gas	$0.018	$0.020	-$0.002	-11.1%	$0.024	$0.027	-$0.003	-12.5%
Totals	$0.956	$0.940	$0.017	1.8%	$0.968	$0.952	$0.016	1.7%

Table 14. Energy Use Saving Results in Ohio, Energy Use per Square Foot

Climate Zone:	4A				5A			
Code:	90.1-2016	90.1-2019	Savings		90.1-2016	90.1-2019	Savings	
Small Office								
Electricity, kWh/ft^2	7.469	7.050	0.419	5.6%	7.601	7.188	0.413	5.4%
Gas, therm/ft^2	0.013	0.014	-0.001	-7.7%	0.017	0.018	-0.001	-5.9%
Totals, kBtu/ft^2	26.841	25.486	1.355	5.0%	27.634	26.327	1.307	4.7%
Large Office								
Electricity, kWh/ft^2	14.973	14.467	0.506	3.4%	15.030	14.533	0.497	3.3%
Gas, therm/ft^2	0.030	0.028	0.001	3.3%	0.036	0.034	0.002	5.6%
Totals, kBtu/ft^2	54.060	52.226	1.833	3.4%	54.887	53.036	1.851	3.4%
Stand-Alone Retail								
Electricity, kWh/ft^2	9.127	8.246	0.881	9.7%	9.157	8.266	0.891	9.7%
Gas, therm/ft^2	0.206	0.217	-0.011	-5.3%	0.242	0.254	-0.012	-5.0%
Totals, kBtu/ft^2	51.796	49.873	1.922	3.7%	55.490	53.634	1.856	3.3%
Primary School								
Electricity, kWh/ft^2	8.932	8.348	0.584	6.5%	8.914	8.335	0.579	6.5%
Gas, therm/ft^2	0.121	0.118	0.003	2.5%	0.136	0.133	0.003	2.2%
Totals, kBtu/ft^2	42.545	40.263	2.283	5.4%	44.053	41.773	2.280	5.2%
Small Hotel								
Electricity, kWh/ft^2	9.038	8.306	0.731	8.1%	9.124	8.416	0.707	7.7%
Gas, therm/ft^2	0.245	0.245	0.000	0.0%	0.250	0.250	0.001	0.4%
Totals, kBtu/ft^2	55.344	52.820	2.524	4.6%	56.162	53.692	2.470	4.4%
Mid-Rise Apartment								
Electricity, kWh/ft^2	9.977	9.776	0.200	2.0%	10.023	9.827	0.196	2.0%
Gas, therm/ft^2	0.033	0.037	-0.004	-12.1%	0.046	0.051	-0.005	-10.9%
Totals, kBtu/ft^2	37.325	37.079	0.246	0.7%	38.771	38.640	0.131	0.3%

Table 15.A. Annual Energy Usage for Buildings in Ohio in Climate Zone 4A

Energy End-Use	Small Office		Large Office		Stand-Alone Retail		Primary School		Small Hotel		Mid-Rise Apartment	
	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$
ASHRAE 90.1-2016												
Heating, Humidification	0.641	0.013	0.715	0.018	0.000	0.170	0.000	0.058	0.698	0.016	0.000	0.033
Cooling	0.682	0.000	1.648	0.000	1.400	0.000	1.327	0.000	1.575	0.000	0.750	0.000
Fans, Pumps, Heat Recovery	0.900	0.000	1.383	0.000	1.719	0.000	1.500	0.000	1.060	0.000	0.612	0.000
Lighting, Interior & Exterior	1.898	0.000	1.959	0.000	3.822	0.000	1.406	0.000	2.118	0.000	1.054	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.602	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.011	0.000	0.037	0.097	0.016	0.000	0.136	3.351	0.000
Total	7.469	0.013	14.973	0.030	9.127	0.206	8.932	0.121	9.038	0.245	9.977	0.033
ASHRAE 90.1-2019												
Heating, Humidification	0.649	0.014	0.714	0.017	0.000	0.181	0.000	0.056	0.789	0.016	0.000	0.037
Cooling	0.642	0.000	1.531	0.000	1.305	0.000	1.252	0.000	1.467	0.000	0.720	0.000
Fans, Pumps, Heat Recovery	0.826	0.000	1.324	0.000	1.648	0.000	1.383	0.000	1.003	0.000	0.595	0.000
Lighting, Interior & Exterior	1.585	0.000	1.630	0.000	3.107	0.000	1.158	0.000	1.461	0.000	0.900	0.000
Plugs, Refrigeration, Other	2.438	0.000	9.269	0.000	2.186	0.000	4.458	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.011	0.000	0.037	0.097	0.016	0.000	0.136	3.352	0.000
Total	7.050	0.014	14.467	0.028	8.246	0.217	8.348	0.118	8.306	0.245	9.776	0.037
Total Savings	0.419	-0.001	0.506	0.001	0.881	-0.011	0.584	0.003	0.731	0.000	0.200	-0.004

Table 15.B. Annual Energy Usage for Buildings in Ohio in Climate Zone 5A

Energy End-Use	Small Office		Large Office		Stand-Alone Retail		Primary School		Small Hotel		Mid-Rise Apartment	
	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$	Electric kWh/ $ft^2 \cdot yr$	Gas therms/ $ft^2 \cdot yr$
ASHRAE 90.1-2016												
Heating, Humidification	0.812	0.017	0.766	0.024	0.000	0.206	0.000	0.074	0.848	0.019	0.000	0.046
Cooling	0.671	0.000	1.650	0.000	1.374	0.000	1.290	0.000	1.517	0.000	0.741	0.000
Fans, Pumps, Heat Recovery	0.877	0.000	1.386	0.000	1.776	0.000	1.522	0.000	1.056	0.000	0.620	0.000
Lighting, Interior & Exterior	1.893	0.000	1.959	0.000	3.821	0.000	1.403	0.000	2.117	0.000	1.054	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.602	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.011	0.000	0.037	0.097	0.016	0.000	0.138	3.399	0.000
Total	7.601		15.030	0.036	9.157	0.242	8.914	0.136	9.124	0.250	10.023	0.046
ASHRAE 90.1-2019												
Heating, Humidification	0.819		0.766	0.023	0.000	0.217	0.000	0.071	0.955	0.019	0.000	0.051
Cooling	0.634	0.000	1.529	0.000	1.279	0.000	1.226	0.000	1.415	0.000	0.713	0.000
Fans, Pumps, Heat Recovery	0.805	0.000	1.339	0.000	1.694	0.000	1.395	0.000	1.000	0.000	0.605	0.000
Lighting, Interior & Exterior	1.582	0.000	1.631	0.000	3.106	0.000	1.158	0.000	1.460	0.000	0.900	0.000
Plugs, Refrigeration, Other	2.439	0.000	9.269	0.000	2.186	0.000	4.458	0.046	3.587	0.092	4.209	0.000
Service Water Heating (SWH)	0.910	0.000	0.000	0.011	0.000	0.037	0.097	0.016	0.000	0.138	3.400	0.000
Total	7.188		14.533	0.034	8.266	0.254	8.335	0.133	8.416	0.250	9.827	0.051
Total Savings	0.413	-0.001	0.497	0.002	0.891	-0.012	0.579	0.003	0.707	0.001	0.196	-0.005

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Significant changes 2013-2016 ASHRAE 90.1 Commercial Provisions

[Sources: ASHRAE 90.1-2016 and PNNL-SA-127543]

- Standard reformatted for ease of use
- New Climate maps (to align with ASHRAE 169) [5.1.4.1]
    - 16 Ohio counties will change from Zone 5A to Zone 4A [Annex 1]
- Adds a new path to demonstrate compliance – Performance Rating Method [4.2.1.1 (c) and Appendix G]

Building Envelope

- Air Leakage Verification requirements added [5.4.3.1.3 and 5.9.2.2]
    - Whole building pressurization test for air leakage
    - Continuous air barrier installation inspection and verification during construction
- Increased testing requirements for air leakage of overhead coiling doors [A7.1]
- Increased stringency requirements for fenestration and opaque doors [Table 5.5-4, Table 5.5-5, and 5.5.3.6]
- Clarified topics such as building orientation [5.5.4.5], default assumptions for the effective R-value of air spaces [A9.4.2], and calculation procedures for insulating metal building walls [A3.2.2, Table A3.2.3, A9.4.6]

Mechanical

- Increased equipment efficiencies for chillers, heat pumps, computer room AC, Dedicated Outdoor Air Systems (DOAS), Rooftop AC, Cooling Towers, and Variable Refrigerant Flow
- Clarified that control must be “configured to” meet the requirements, not just be “capable of” meeting the requirements [throughout]
- New HVAC set point and fan control requirements for hotel and motels with greater than 50 guest rooms [6.4.3.3.5]
- Adds HVAC control requirements for cooled vestibules [6.4.3.9]
- Large, electric-driven chilled-water plants are required to be monitored for electric energy use and efficiency [6.4.3.11]
- Air-cooled DX cooling units with economizers are required to have a Fault Detection and Diagnostics (FDD) monitoring system to determine that the air economizer is working properly [6.4.3.12]
- Adds control requirements for return and relief fans [6.5.3.2.4]
- Adds control requirements for parallel-flow fan-powered VAV air terminals [6.5.3.4]
- Dedicated outdoor air systems (DOAS) now include both efficiency and rating requirements for compliance [6.5.3.7]
- Adds pump flow control requirements for chilled and hot water hydronic piping distribution systems [6.5.4.2]
- Adds new requirements for the selection of chilled-water cooling coils [6.5.4.7]
- Prescribes motor fan speed controls for heat-rejection devices [6.5.5.2]
- Adds new requirements for transfer air delivered to a space having mechanical exhaust [6.5.7]

Service Water Heating

- Adds a new requirement for insulation of the first 8 ft of branch piping connections to recirculated, heat traced, or impedance heated service hot-water piping systems [7.4.3]

Power

- Limits the combined voltage drop of feeder conductors and branch circuits to 5% [8.4.1]
- Increased three-phase transformer efficiencies [Table 8.4.4]

Lighting

- Interior and exterior lighting power allowance have been modified (reduced) to reflect new lighting levels in the IES lighting handbook and to recognize LED technology [9.2.2.3 and 9.4.2]
- Lighting control requirements have been modified to add additional controls in some space types and options to others to allow easier application of advanced controls [9.4.1]
    - Reduce exterior lighting power by 50% (previously was 30%) during periods of inactivity or after business hours [9.4.1.4]
    - Certain outdoor parking areas required to reduce power by 50% during periods of inactivity [9.4.1.4]
- Adds a requirement that 75% of permanently installed dwelling unit lighting fixtures use high efficacy lamps [9.4.4]

Other Equipment

- Updates electric motor terminology, adds exceptions, and adds efficiency tables consistent with federal regulations [10.4.1]
- Elevator efficiency specifications are required to be provided on design documents, including both usage category and energy efficiency class. While a minimum threshold is not listed, the first step is taken toward including minimum elevator efficiency requirements in a future standard [10.4.3.4]

Energy Cost Budget Method (ECB)

No significant changes

Performance Rating Method (Appendix G)

- Appendix G now can be used as a path for compliance with the standard. Previously, Appendix G was used only to rate beyond-code performance of buildings
- The proposed design requires computation of a new metric, Performance Cost Index (PCI), and demonstration that it is less than that shown in Table 4.2.1.1, based on building type and climate zone
- The baseline design is now fixed at a certain level of performance, the stringency or baseline of which is expected not to change with subsequent versions of the standard. In this way, a building of any era can be rated using the same method
- Other modifications to Appendix G include changes to elevator, motor, and refrigeration baselines; changes to the baseline for existing building projects; and changes to specific opaque assemblies for the baseline envelope model. Modeling rule changes were made to heat pump auxiliary heat, economizer shutoff, lighting controls, humidification systems, cooling towers, and the simulation of preheat coils

ASHRAE 90.1-2019

The 2019 edition includes various modifications and clarifications to improve internal consistency and to standardize the structure and language of the document.

Significant changes to requirements include the following

Administration and Enforcement

- New commissioning requirements in accordance with ASHRAE/IES Standard 202 [4.2.5 and Appendix H]

Building Envelope

- Combined categories of “nonmetal framed” and “metal framed” products for vertical fenestration [Tables 5.5-0 through 5.5-8]
- Upgraded minimum criteria for SHGC and U-factor across all climate zones [Tables 5.5-0 through 5.5-8]
- Revised air leakage section to clarify compliance [5.4.3 and 5.9]
- Refined exceptions related to vestibules, added new option and associated criteria for using air curtains [5.4.3.3]

Mechanical

- New requirements to allow the option of using ASHRAE Standard 90.4 instead of ASHRAE Standard 90.1 in computer rooms that have an IT equipment load larger than 10 kW [6.6.1]
- Added pump definitions [3.2], requirements [10.4.7], and efficiency tables [10.8.6] to the standard for the first time
- New equipment efficiency requirement tables and changes to existing tables [Tables 6.8.1-1 to 6.8.1-20]
- Replaced fan efficiency grade (FEG) efficiency metric with fan energy index (FEI) [6.5.3.1.3]
- New requirements for reporting fan power for ceiling fans and updated requirements for fan motor selections to increase design options for load-matching variable-speed fan applications [6.5.3.1.2]
- New energy recovery requirements for high-rise residential building [3.2 and 6.5.6]
- New requirement for condenser heat recovery for acute care inpatient hospitals [6.5.6.3]

Lighting

- Modified lighting power allowances for Space-by-Space Method and the Building Area Method [Tables 9.6.1 and 9.5.1]
- New simplified method for lighting for contractors and designers of renovated office buildings and retail buildings up to 25,000 ft2 (2300 m2). [9.3 and Table 9.3.1-1]
- Updated lighting control requirements for parking garages to account for the use of LEDs [9.4.1.2]
- Updated daylight responsive requirements, added definition for “continuous dimming” based on NEMA LSD-64-2014 [3.2 and 9.4.1.1]
- Clarified side-lighting requirements and associated exceptions [9.4.1.1]

Energy Cost Budget (ECB) Method (Section 11)

- Numerous changes to ensure continuity
- Set baseline for on-site electricity generation systems [11.4.3.1 and 11.4.3.2]

Performance Rating Method (Appendix G)

- Clarified Appendix G rules and corresponding baseline efficiency requirement when combining multiple thermal zones into a single thermal block
- New explicit heating and cooling COPs without fan for baseline packaged cooling equipment
- New rules for modeling impact of automatic receptacle controls [Table G3.1 #12]
- Set more specific baseline rules for infiltration modeling
- Clarified how plant and coil sizing should be performed
- Updated building performance factors

Both Compliance Paths

- Clearer, more specific rules for treatment of renewables [G2.4.1]
- New updates to rules for lighting modeling

File Attachments for Item:

OB-2 OBC Chapter 2 - Definition of Registered Design Professional - Landscape Architect

REGISTERED DESIGN PROFESSIONAL. *Any architect holding a certificate issued under ~~sections~~ section 4703.10 ~~and~~ of the Revised Code, any landscape architect holding a certificate issued under section 4703.36 of the Revised Code, or any engineer holding a certificate issued under section 4733.14 of the Revised Code.*

File Attachments for Item:

OB-3 Code Review Update

Outstanding code issues after 2021 I-Code Review

2021 IBC					
Code Chapter	**Section**	**Topic**	**Work needed**	**Staff lead**	**Presented to Code Committee**
All Chapters	Throughout		Make sure that we have all previous Ohioizations carried forward	All	
All Chapters	Throughout		Make sure that we have incorporated AG 98 & 99 changes	All	
All Chapters	Throughout		Make sure that we have ICC errata included	All	
1	Throughout	Administration	Review ICC changes for possibly supplementing our administrative text with improved model code text	All	
1	Throughout	Administration	Add language and/ or exemption to provide flexibility to departments in pandemic or other emergency declared by Governor when under control of Army National Guard	All	
1	101.2	Exempt from approval vs. exempt from code	Coordinate with 102.10 exempt from approval (sheds, IUs, accessory structures, etc.)	All	
1	101.2 #7	Manufactured homes exemption	Update language	All	
1	101.2 #10 (coordinate with 1110.1 & 1110.4.8)	Scope – Amusement rides	Fix ORC reference to 993 (no longer 1711.50-1711.57)	All	
1	101.2 #11 & #17 (Coordinate with 102.11 #4)	Scope- Solar & distributed electrical generation not part of utility	Review and possibly provide exception with wind (study ORC, PUCO	All	

			rules, talk with PUCO & Chris Miller?)		
1	101.2	Underground storage tanks	Add an exception for UG storage tank regulated by the SFM BUSTR?	All	
1	101.2 #24	Scope – Floating buildings	Add an exemption for Floating buildings	All	
1	102.5	Referenced standards	Add "including the subsections of the referenced section"	All	
1	102.8 (Coordinate with 3103)	Temporary structures	Provide clarification and more flexibility	All	
1	102.10	Exempt from approval vs. exempt from code	Coordinate with 101.2 exceptions	All	
1	102.11	State building department jurisdiction at production and injection wells	Include buildings on site of Injection wells per DIC agreement with ODNR	All	
1	102.11 condition 5.4	Flexibility during pandemic or another emergency	Add new condition for pandemic time-limited hospitals, morgues	All	
1	104	Conduct of certified personnel	Create Code of Ethics	Certification Committee	
1	105	Approvals	Clarify	All	
1	105	Approvals	Short cut for identical building models located around state? Maybe like an IU approval?	All	
1	105.1.5	Annual approvals	Add structural? (Request from Geoff E) and clarify remaining existing text	All	
1	106.1.2 #2	Swimming pools	Clarify what ODH reviews vs what building department reviews	JR/All	
1	106.1.2 #3	Fireworks approvals	Clean up to reflect process (SFM & DIC) and use SFM terminology "preliminary authorization"	All	

1	106.1.2 #5 (coordinate with OBC 901.2.1.1	Fire department plan submittal	Clean up language regarding who gets drawings	All	
1	106.3	Amended construction docs	Coordinate with Ch 2 definition of "Existing building" and any proposed changes to 3403.1	All	
1	108.2.10	Other inspections	Clarify and use 114 terms	All	
1	108.2.11	Special inspections	Clarify and use 114 terms	All	
1	108.3	Inspection agencies	Clarify and use 114 terms "Inspection body"	All	
1	108.9	Fix reference	Should be 1602.2	All	
1	113	IU	Perhaps a separate certification rule in lieu of the OBC/RCO location?	JR	
1	113 & Ch 17	IU	Special inspections reqd for IU?	JR	
2	Definitions		Bring in 2018 & 2021 defs and Ohioizations	All	
2	Care Facility def	Last sentence should add on a 24-hour basis?	Fix for day care? (Type A or B Day care is in the home of provider, therefore exempt) As currently defined, Type A and B are not care facilities	All	
2	Existing building def	Change to clarify?	Coordinate with any proposed changes to 3403.1 and 106.3-Designer wants to build new building and addition at same time. Allows using a lesser type of construction on 1st bldg. (loophole, not intended) In my opinion, must have a full plan	All	

			approval to call it and propose change to existing building		
2	Special Inspector def	Fix reference and maybe coordinate with ORC for steel inspections	Should be 1704.2.1. May need to be limited to AWS certification for steel, depending upon meaning of ORC 3781.40	All	
2	Swimming Pool defs (coordinate with ODH, 106.1.2 #2, and 3109)	Swimming pools	Clarify what ODH reviews vs what building department reviews	JR	
3	305.2	Group E Day care facility	Change from “or” to “and” to include both supervision and personal care	JR	
3	Table 307.1	Fireworks bldg. classifications	Coordinate with ORC & OFC Ch 56 and ensure clarity of classifications (H-1 vs. H-2; or not H)	JR	
3	308.6	Group R Day care classifications	Clarify assistance?	JR	
3	308.6.1	Group R Day care classifications	Clarify that only the room with infants and toddlers need to be on LOED	JR	
3	310.4.4	Group R-3 Lodging House	Do not adopt ‘21 mod – leave with OH language.	JR	
3	310.5.5	Fix title to say, “Group R-3 alternative compliance option”?	Should be able to use option for one or more dwelling units such as a large congregate living?	JR	
3	312.1	Fences	Do not adopt ‘21 mod – leave fence height at 6 ft.	JR	
4	411.5	Puzzle rooms	Reverse # 2 & #3? CC intent is to get a variance to lock doors or Alternative engineered design per 106.5. If wasn’t	DO	

			to eliminate need for variance, need ICC #3		
4	415.10.5.2	Fireworks	Coordinate with OFC 5622.2.1.3	DO	
5	Table 504.4	Height & # of stories	Only allows 1 story Group I-2 for IIB, IIIA, IV, VA	ROB	
5	Tables 504 & 506	Height and area tables	Make sure unsprinklered Group I and Group R are addressed	ROB	
6	Table 601, Type IV nonbearing interior	Fire resistance of building elements	Fix reference…should be 602.4.8?	ROB	
9	901.2.1.1 (coordinate with OBC 106.1.2 #5	Fire department plan submittal	Clean up language regarding who gets drawings (is owner required to submit directly to FD or is BD required to send to FD?)	DO	
9	903.2.4.3 903.2.7.2 903.2.9.4	Upholstered furniture & mattresses	Revisit thresholds (ICC 2500 ft^2 & 5000 ft^2 vs. BBS 8000 ft^2)	DO	
9	903.2.6 ex 1 903.2.8.4 903.3.1	Sprinkler requirements for care facilities	Coordinate with H & A Tables, and egress tables for Groups I & R	DO	
9	903.2.4.2 903.2.9.3	Sprinkler requirements for breweries, wineries, distilleries	Coordinate with SFM & Liquor -check ICC IFC proposed changes in 2021 cycle	DO	
9	903.2.10 & 905.3.1	Sprinkler & standpipe requirements for parking garages	Revisit -talk with proponent to fully understand intent - check ICC IFC proposed changes in 2021 cycle -Coordinate with Ch 4	DO	
9	906.1	Warehouse fire extinguisher exception	Revisit – enforcement difficulty (Ohio used to have more exceptions – then we were	DO	

			petitioned to bring back model code text)		
9	907.2.1	Fire Alarm systems for bleachers	Bring in Ohio language	DO	
9	907.2.11	Smoke alarms	Bring in RCO requirement for both technologies	DO	
9	907.2.13.2 & 918	Fire Department communication/radios	Review OFC 510 requirements w CC	DO	
9	907.5.2.2.4		Add “the required” emergency… (per Greg N)	DO	
9	908	Emergency alarm systems	Coordinate with current 916- ensure that we have a clear reference to IFC Ch 53 for CO2 beverage dispensers & CO2 enrichment systems	DO	
9	916	Gas detection systems	Coordinate with current 908- ensure that we have a clear reference to IFC Ch 53 for CO2 beverage dispensers & CO2 enrichment systems	DO	
10	1006.2.2.4	Day care egress	Coordinate w Ch 3	ROB	
10	1008.2.1	Illumination under normal power	?	ROB	
10	1009.6.3	Area of refuge size increase to 52” x 30”	Need a CC decision- Consistent with A117.1-2017	ROB	
10	1009.8.1	Two-way communication requirement for area of refuge	OK with requirement…make sure the term “Telephone” is current?...seems like old technology Coordinate with NFPA 72: 24.8-24.10 and A117.1 to make sure terms are up to date	ROB	
10	1010.2.8	Locking arrangement in Group E	Make sure no conflict with Ohio TDLD text	ROB	

10	1010.2.13	Delayed egress	Coordinate with type of sprinkler system	ROB	
10	1011.16.1	Elevator ladder exception		ROB	
10	Table 1020.1 (Coordinate with Ch 5 height and area tables)	Corridor fire-resistance ratings	Ohio rework phase 2	ROB	
10	1025	Luminous Egress Path markings	Coordinate with SFM	ROB	
10	1030.6.3.1	Sprinklers required in enclosed areas of buildings having open-air assembly seating	See if makes sense	ROB	
11	Throughout	Accessibility	Decide if and to what extent to adopt the 2017 A117.1 standard	JR	
11	1105.1.1 (new)	Automatic door operators	Do not adopt '21 mods	JR	
11	1110.1 & 1110.4.8 (coordinate with 101.2 #10)	Scope – Amusement rides	Fix RC reference to 993	JR	
11	1111.1.1	Signs for accessible parking spaces	Fix RC reference in note	JR	
12	1204.1 (Similar to OMC 309) 1203.1 in '21 IBC	Minimum temperature	Add an exception for small kiosks, bars, etc. that are open to the outside during all times of occupancy.	JR	
13	1301.1.1	Exception to allow Multi-family Group R-3 to use ERI	Copy AG 99	DO	
13	1301.2	Equipment building exemption	Bring in 2015 IECC C402.1.2 and increase to at least 2000 ft^2 (Mike Regan request)	DO	
15	1507.18 through 18.7 (new)	Building integrated PV panels	See AG 98 – verify and include	JR	
16	1613.2.1	Mapped acceleration parameters – internet links	Verify valid link.	JR	
17	1704.2.5.1	Still references "Certificate of Compliance" from fabricator	Problem: we deleted 1704.5 & 1704.6	All	
17	1704.5 & 1704.6	Steel	Coordinate with RC 3781.40	All	

17	1705.2.2	Steel special inspections	Coordinate with RC 3781.40, maybe just reference to 1704.2.1	All	
17	1705.3.1	Steel special inspections	Coordinate with RC 3781.40, maybe just reference to 1704.2.1	All	
22	2204.1	Steel workmanship and welding qualifications	Coordinate with RC 3781.40 and perhaps modify	All	
22	2207.5	Certification	Bring back unless we verify why it was deleted in 2017 OBC	JR	
29	2902.1.2 (coordinate with OPC Ch 4)	Single-user toilet rooms (coordinate with IPC Ch 4)	Review	DO	
29	Table 2902.1 (coordinate with OPC Ch 4)	Plumbing fixtures	Need an exception for picnic shelters & swimming pools?	DO	
30	3002.2	Maximum number of cars in one hoistway	Clarify whether 4 cars (or 3 cars) in a hoistway?	DO	
30	3004.2	Clearance around ropes, cables, etc.	Bring back last sentence from 2011 OBC?	DO	
30	3006.2	Elevator opening protection	Clarify and create flowchart	DO	
31	3103 (coordinate with 102.8 & OFC 3105)	Temporary structures such as COVID pods	Provide clarification, guidance, and more flexibility to building official. Also fix OFC reference. Separate from tents & membrane structures	JR	
31	3103	Temporary Parklets	Provide better guidance for building official	JR	
31	3105.4	Canopy exception for detached 1 & 2 family dwellings	Perhaps delete? Or keep as a result of our Ch 1 exception that allows use of OBC	JR	

31	3109 (coordinate with ODH, 106.1.2 #2, and OBC & OPC Ch 2 defs)	Swimming pools	Clarify definitions and what ODH reviews vs what building department reviews	JR	
33	3303	Demolition	BBS staff to review role of bldg dept regarding demolition and clarify language as needed	JR	
33	3313	Water Supply for Fire Protection	Retain "practicable" provision	JR	
33	3313	Water Supply for Fire Protection	Coordinate any OH mods with SFM/OFC	JR	
34	Throughout	Existing buildings	Review & consider Dave Collins' comments	DO/All	
34	Throughout	Existing buildings	Use code academy FAQ to supplement Ch 34 Commentary	DO	
34	Throughout	Existing buildings	Study IEBC and consider bringing in clarifying text and definitions of repair, maintenance, alterations, etc. into the OBC	DO	
34	3403.1 (coordinate with 106.3 and def of existing building)	Existing building	Designer wants to build new building and addition at same time. Allows using a lesser type of construction on 1st bldg. (loophole, not intended) In my opinion, must have a full plan approval in order to call it and propose change to existing building	DO	
34	3403.6	CO alarms	Proposed new section to allow CO alarms to be battery operated in existing bldgs.?	DO	

34	3404.7	CO alarms	Proposed new section to allow to be battery operated in existing bldgs.?	DO	
34	3412	Drawings	Clarify that drawings or a sketch are required to verify compliance with assigned scores	DO	
34	3412.1	Scope of 3412 analysis	Seems to not allow use of Ch 33 to ensure safeguards during construction (Amit & Jim Decker)	DO	
34	3412.2.5	Change of Occupancy Accessibility	Shouldn't this be in 3412.2.1?	DO	
34	Table 3412.8	Mandatory Safety Scores	Why is Group B higher than Group R? (Amit)	DO	
35		Referenced standards	Update to latest version	All BBS	

2021 IMC					
Code Chapter	**Section**	**Topic**	**Work needed**	**Staff lead**	**Presented to Code Committee**
2	Commercial cooking appliance def		Possibly use 2018 def, but specify that appliance must be listed as a commercial appliance	DO	
3	309 (Similar to OBC 1204.1)	Minimum temperature	Add an exception for small kiosks, bars, etc. that are open to the outside during all times of occupancy.	DO	
6	603.8.2	Energy	Need to add ASHRAE option too		
15		Referenced standards	Update standards	All	

2021 IPC					
Code Chapter	**Section**	**Topic**	**Work needed**	**Staff lead**	**Staff Presented to Code Committee**
2	"Private", "public", "public utilization" defs (coordinate with 403.3 "unrestricted access"	Required public toilet facilities	"Unrestricted access" conflicts with our Ohioization to allow owner to control access- Coordinate defs	DO	
2	"Public swimming pool" (coordinate with ODH, 106.1.2 #2, and OBC Ch 2 defs)	Swimming pools	Clarify defs and what ODH reviews vs what building department reviews	JR	
2	"Swimming pool" def (coordinate with ODH, 106.1.2 #2, and OBC Ch 2 defs)	Swimming pools	Clarify defs and what ODH reviews vs what building department reviews	JR	
3	303.5		Possibly delete last sentence re 3rd party certifiers?	DO	
3	308.9 (coordinate with IPC 607.5 & IECC R403.5.3)	Bundled HW piping insulation	How much piping needs to be insulated (just where bundled, or beyond?) How much air space is needed without insulation?	DO	
3	312.10.2	Backflow gages	ASSE 1064 (different from 312, therefore, can't combine)	DO	
3	314.2.1.1	Lavs and sinks allow Y connections	Coordinate 1st and 3rd sentences	DO	
3	314.2.3.3	Condensate drain marking	Do not adopt	DO	

4	Table 403.1	Swimming pools Picnic shelters	Need count for picnic shelters and pools? Coordinate with ODH for pools. Should Ohio keep note j?	DO/JR	
4	403.2.1 (coordinate with OBC Ch 29)	Single-user toilet rooms	Review	DO	
4	403.3.1 (coordinate with defs of public, public utilization, private) (coordinate with OBC Ch 29)	Required public toilet facilities	"Unrestricted access" conflicts with our Ohioization to allow owner to control access- Coordinate defs	DO	
4	403.6	Service sink	Delete last sentence (404 already addresses accessibility)	DO	
4	405.3.4	Water closet compartment	IF multi-user toilet facilities permitted per 403, consider requiring/supplementing /clarifying that doors/partitions should be full height to ensure privacy	DO	
4	410	Drinking fountains	Coordinate Ohio language and clarify that operable pieces are required to be within reach range	DO	
6	602.3.1		Delete last 2 sentences or refer to ODH/OEPA rules	DO	
15		Referenced standards	Update standards	All	

RCO - To be reviewed by RCAC at a later date						
Code Chapter	**Section**	**Topic**	**Work needed**	**Staff lead**	**Presented to RCAC**	**Presented to Code Committee**
1	102.10	Exempt from approval	Clarify whether small garages are exempt	JR		

3	302.1 and Table 302.1	Fire separation distance – multiple zero lot line single family dwellings	What is a physically separated building? On the same lot? On an adjacent lot?	JR		
3	Figure 301.2(5)	Wind map - Ohio	Coordinate with ASCE 7-16	JR		
44	4401.2	Petition #21-01	Change date of OPC referenced from RCO to include Aug 2018 OPC updates	JR		

2021 IECC - Commercial					
Code Chapter	**Section**	**Topic**	**Work needed**	**Staff lead**	**Presented to Code Committee**
C4	C402.1.2	Equipment buildings	Adopt ASAP and increase from 1200 ft^2 to 2000 ft^2 (Mike Regan request)	DO	
C4	C402.5.1	Whole building air testing (still optional- either test or verification & commissioning)	Joe has concern in ASHRAE	DO	
C4	C405.12	Energy monitoring for new buildings $\geq$ 25,000 ft^2 (meters, data acquisition, storage & reports)	Joe has concern in ASHRAE	DO	
C4	C405.11	Automatic receptacle control for 50% of receptacles in offices, workstations,	Joe has concern in ASHRAE	DO	

		classrooms, breakrooms, copy rooms			
C4	C405.2	Lighting controls	Joe has concern in ASHRAE	DO	

Certification Rules – To be reviewed by certification committee			
Rule	Paragraph	Topic	Work needed
4101:7-2-01			Need grandfather date that existing township BD is permitted to remain if county gets certified
4101:7-3-01			RBO to BO: Must act as RBO, not just hold certificate
4101:7-3-01			BI to MI: need mechanical experience or BI that actually performed mech inspections
4101:7-3-01			BI to FPI: need fp experience or BI that actually performed fp inspections
			Change matrix exams for FP plan examiner (CP is only sprinklers- no FAS tests currently reqd)
New rule		Industrialized Units	Industrialized Unit rules – Move from OBC Section 113 to 4101:7-08