2020 Baseline Document: Energy Code Base Case Overview

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The Baseline Document defines base case (or baseline) parameters for projects pursuing energy savings and incentives under the Program Administrators' (PA) New Construction program(s). This document is intended to inform assumptions for New Construction applications as well as "end of life" replacements. In this case, "end of life" is defined as either failed or retired equipment, or a specific age of existing equipment that has been established by the PA's in cooperation with state regulators. This document is applicable to commercial buildings and systems in these buildings.

In general, the base case for a given system or piece of equipment is defined by one of two primary methods:

State Energy Code: For equipment and systems whose performance is explicitly governed by the applicable state's building energy code, the baseline for that equipment is generally based on the minimum allowable performance in the energy code (for MA as of 2020, code follows either ASHRAE 90.1-2016 or IECC 2018 plus specific MA amendments outlined in state code 780 CMR).

Standard Practice/Industry Standard: For equipment and systems that are not governed by energy code, the baseline is defined based on the minimum performance option that is still considered to be industry standard or standard practice within the given industry.

Note: In select cases, there are performance requirements in energy code that are not as strict as the current industry standard, as determined by the PAs. For those cases, the PAs have set the baseline requirements within this document to reflect the current industry standard. These apply for energy conservation measure (ECM) applications regardless of their inclusion or exclusion from the national model codes and state amendments. Those cases are identified in this document with a note that the baseline is different from the energy code requirement.

Guide for Energy Code Baselines

Energy code requirements vary by state. The Massachusetts energy code as of February 7, 2020 is based on one of two national code standards options, which are used to define the MA program baselines:

i. International Energy Conservation Code – IECC 2018
ii. ASHRAE 90.1-2016

The Baseline Document is intended to highlight the key criteria within these codes that set the baseline for code-governed equipment and systems; however, it does not provide every detail of the code criteria or all potential exemptions to code requirements. Where additional information or details are required, the state specific code documents/standards should be referenced for clarification.

a. IECC vs. ASHRAE code selection

In MA, state code allows new buildings to use either IECC or ASHRAE 90.1, coupled with the state amendments, as the primary standard for energy code compliance. The selection should be made and documented by the design team. The designed building must comply with the selected standard in its entirety.

The baseline for incentives for a given New Construction project must follow whichever standard is used for that particular project as the basis of code compliance, in its entirety **(i.e. cannot use IECC for some sections and ASHRAE for others)**. It is essential that the code choice followed be clearly documented in any reports submitted along with an application for an incentive.

b. State Amendments

Each state energy code can include amendments to either increase or decrease the stringency of the national code standards (IECC and ASHRAE). In general, the baseline for incentives in any given state should reflect any and all amendments included in that state's energy code. For information on state amendments, see the following:

iii. MA: Board of Building Regulations and Standards link at www.mass.gov

c. IECC C406 - Additional Efficiency Package Options

IECC includes a section (C406) that outlines eight Additional Efficiency Package options that go above and beyond the requirements in Sections C402-C405.

State energy codes/amendments may require one or more of the C406 options for energy code compliance; however, for Mass Save, the baseline for new building projects (including additions and gut-rehab of existing buildings) does not require any C406 options. Energy savings can be claimed for C406 options that are implemented into the design (even if required by energy code). Note that this is a divergence from the MA energy code, which requires new buildings to comply with at least three of the eight C406 Additional Efficiency Package options.

Note: This is true for projects under the updated code but not for projects carried out under the previous version of the code (prior to 11 07 2020 when the concurrency period ends).

d. Performance Paths for Energy Code Compliance Not Acceptable for Mass Save Baseline

The energy code gives the design team the option of following a Prescriptive path (not to be confused with Mass Save prescriptive incentive programs) or a Performance path (energy modeling vs. a "baseline" building as defined by a separate section of the code standard) for complying with the code. While these are viable options for energy code compliance, the Performance path options are not acceptable for defining the baseline for Mass Save.

For Mass Save, the following methods are NOT acceptable baseline modeling methods:

1. ASHRAE 90.1 Appendix G
2. ASHRAE 90.1 Chapter 11 (Energy Cost Budget Method)
3. IECC Section C407

Mass Save custom energy savings must be evaluated through discrete individual ECMs where the proposed high performance practice is compared to the applicable base case definition as defined in this Baseline Document.

For incentive studies based on designs that have used one of the Performance paths for code compliance, high performance design features that exceed the applicable base case definition in this Baseline Document can be included as ECMs. However, any design tradeoffs used where systems do not meet the applicable base case definition in this Baseline Document must also be accounted for with an energy penalty and included in the project's interactive savings.

e. *Stretch Energy Codes*

States may adopt a stretch energy code ("stretch code") to be more stringent than the "base code" it has adopted with its state amendments. Where a state has adopted the stretch code, municipalities may elect to make the stretch code mandatory for certain building types, sizes, classes of owners, building functions or for public buildings. It varies by the version of the code adopted and by the State or municipal regulations.

Stretch codes do NOT define the baseline for Mass Save incentive programs. For projects in municipalities where stretch code is enforced, the baseline for incentive purposes shall still follow the State's "base code" with amendments, or industry standard practice, as outlined in this document. Energy savings can be claimed and incentives may be offered for equipment/systems meeting stretch code that exceed the requirements outlined in this document.

f. *Energy Code/Baseline Document Interpretations*

In cases where the baseline definitions in this document or the specific energy codes have gaps or questions on interpretations, one of the following groups should be consulted for assistance in defining baselines. Any rulings by these groups should be communicated to the PAs so that this document can be updated as needed.

i. New Construction Baseline Committee
ii. Statewide C&I Impact Evaluation team' Baseline Advisory Group

g. *Prescriptive Program Baselines Relative to Energy Codes*

Due to the protocols for reporting savings for Mass Save Prescriptive incentives, it is not possible to take into account all of the possible paths that a design team may take for code compliance. As such, Mass Save has settled on a particular base case for these projects. This in no way is intended to set a common standard for Custom projects. The base case for Custom applications must be determined for each individual project and documented in the application.

h. *Federal Exemption from State Energy codes*

Federal Buildings are exempt from State Energy codes; however, for incentive purposes the same base case shall be applied to these buildings as any other building.

i. *Useful Links*

The below links can be used to access useful reference information.

i. IECC 2018 electronic copy link at: https://codes.iccsafe.org/content/IECC2018P3

ii. Massachusetts Amendments to the International Building Code link at: https://www.mass.gov/massachusetts-state-building-code-780-cmr

Line #	Div.	2020 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
1	**A**	***IECC C406 Requirements***	The baseline building for Mass Save shall not include any Section C406 enhanced efficiency options. This does not align with the MA energy code, which requires implementation of select C406 options.		
	B	***IECC vs. ASHRAE***	Either IECC 2018 or ASHRAE 90.1 2016 can be used to define the baseline. Whichever standard is used must be followed in its entirety for the given project/study (cannot use IECC for some sections and ASHRAE for others).		
	C	***Acceptable Baseline Modeling Methods***	For Mass Save, the only acceptable baseline definition/modeling method is the Prescriptive path for the applicable standard (either IECC or ASHRAE). Although viable paths to demonstrate code compliance, the following methods are not acceptable baseline modeling methods for the MA programs: ASHRAE 90.1-2016 Appendix G, ASHRAE 90-1 2016 Chapter 11 (Energy Cost Budget Method), and IECC 2018 Section C407 Note: The "Mandatory for Code Compliance regardless of path" column is provided for reference only		
2	**Architectural**	***Opaque Assemblies***	***IECC ≠ ASHRAE** Opaque thermal envelope insulation requirements meeting table C402.1.3 / ASHRAE Table 5.5-5 (Climate Zone 5). Comply with either R-value or U-value method. The baseline construction type category shall be the same as the design construction type.	-	Opaque wall insulation with higher thermal resistance. Efficient cladding support system to reduce thermal bridging. *Note: Thermal bridging must be accounted for when estimating effective R-values/U-values for insulated stud cavities (the base case U-values account for thermal bridging). ASHRAE 90.1 Appendix A provides effective U-values with thermal bridging. Additionally 3D thermal bridging associated with linear and/or point transmittances must be accounted for in exterior wall assemblies. The same bridging factor adjustments shall be performed in the base case and design case models. The MA Simulation Guidelines explain the process for estimating these impacts.

		Category	R-value Method*	U-value Method
3				
4	**Roofs**	Insulation entirely above deck	R-30ci	U-0.032
5	**Roofs**	Metal buildings	R-19 + R-11 LS ***ASHRAE - R19+ R-11 LS or R-25 + R-8 LS**	U-0.035 ***ASHRAE U-0.037**
6	**Roofs**	Attic and other	R-38 ***ASHRAE R-49**	U-0.027 ***ASHRAE U-0.021**
7	**Walls, above grade**	Mass	R-11.4 ci	U-0.090
8	**Walls, above grade**	Metal building	R-13 + R-13 ci ***ASHRAE R-0 + R-19ci**	U-0.052 ***ASHRAE U-0.050**
9	**Walls, above grade**	Metal framed	R-13 + R-7.5 ci ***ASHRAE R-13 + R-10ci**	U-0.064 ***ASHRAE U-0.055**
10	**Walls, above grade**	Wood framed and other	R-13 + R-3.8 ci or R-20 ***ASHRAE R-13 + R-7.5ci or R-19 + R-5ci**	U-0.064 ***ASHRAE U-0.051**
11	**Walls, below**	Below-grade wall	R-7.5 ci	C-0.119
12	**Floors**	Mass	R-10 ci ***ASHRAE R-14.6ci**	U-0.074 ***ASHRAE U-0.057**
13	**Floors**	Joist/framing	R-30	U-0.033 ***ASHRAE U-0.038 (steel joist) and U-0.033 (wood**
14	**Slab-on-grade floors**	Unheated slabs	R-10 for 24" below ***ASHRAE R-15 for 24"**	F-0.54 ***ASHRAE F-0.52**
15	**Slab-on-grade floors**	Heated slabs	R-15 for 36" below + R-5 full slab ***ASHRAE R-20 for 48"**	F-0.79 (perimeter), 0.64 (full slab) ***ASHRAE F-0.688**
16	***Opaque Doors***	Nonswinging	R-4.75 ***ASHRAE no requirement**	IECC no requirement ***ASHRAE U-0.31**
17	***Opaque Doors***	Swinging	No requirement	U-0.37
18	***Opaque Doors***	Garage door < 14% glazing	IECC no requirement	U-0.31 ***ASHRAE no requirement**
19		*ci = continuous insulation; when using R-value method, a thermal spacer shall be provided.		

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<tr><td></td><td></td><td colspan="4">System</td></tr>
<tr><td></td><td></td><td>Sub-Category</td><td colspan="2">Baseline Minimum Standards & Practice</td><td>Mandatory for Code Compliance regardless of path</td><td>Potential High-Performance Practices</td></tr>
<tr><td>20</td><td rowspan="14">Architectural</td><td rowspan="14">Window and Skylight Assemblies</td><td colspan="2">*IECC ≠ ASHRAE
Performance per IECC Table C402.4 / ASHRAE Table 5.5-5 (Climate Zone 5)</td><td rowspan="14">-</td><td rowspan="14">Window and skylight <u>assembly</u> U-values exceed code requirements (note that the baseline values for assemblies include frame effects and are not the same as center-of-glass values provided by glass manufacturers).</td></tr>
<tr><td>21</td><td colspan="2">Vertical Fenestration, U-factor</td><td>Add'l Req.</td></tr>
<tr><td>22</td><td>Fixed fenestration</td><td>U-0.38
*ASHRAE U-0.38 (metal fenestration framing)</td><td rowspan="4">Vertical fenestration area shall be ≤ 30% of gross above-grade wall area†
*ASHRAE allows vertical fenestration to be ≤ 40% of gross above-grade wall area</td></tr>
<tr><td>23</td><td>Operable fenestration</td><td>U-0.45
*ASHRAE U-0.46 (metal fenestration framing)</td></tr>
<tr><td>24</td><td>Entrance doors</td><td>U-0.77
*ASHRAE U-0.68 (metal fenestration framing)</td></tr>
<tr><td>25</td><td>Nonmetal framing</td><td>IECC same requirements as above
*ASHRAE U-0.31 (all)</td></tr>
<tr><td>26</td><td colspan="3">Vertical Fenestration, Solar Heat Gain Coefficient (SHGC)</td></tr>
<tr><td>27</td><td>Orientation</td><td>S, E, W</td><td>North</td><td rowspan="2">*ASHRAE SHGC = 0.38; VT/SHGC ≥ 1.1 (all frame types)</td></tr>
<tr><td>28</td><td>PF < 0.2*</td><td>0.38</td><td>0.51</td></tr>
<tr><td>29</td><td colspan="3">Skylights</td></tr>
<tr><td>30</td><td>U-factor</td><td colspan="2">U-0.5†</td><td rowspan="2">Skylight area shall be ≤ 3% of gross roof area†</td></tr>
<tr><td>31</td><td>SHGC</td><td colspan="2">0.4†</td></tr>
<tr><td>32</td><td colspan="4">*If PF (projection factor) value greater than 0.2, see IECC 2018 Table C402.4 for SHGC requirements.</td></tr>
<tr><td>33</td><td colspan="4">†Some exceptions apply. See IECC Sections C402.4.1.1, C402.4.1.2 and C402.4.3; ASHRAE sections 5.5.4.2.2, 5.5.4.3, and 5.5.4.4</td></tr>
<tr><td>34</td><td>Window-to-Wall Ratio</td><td colspan="2">*IECC ≠ ASHRAE
Window-to-wall ratio per design and no greater than 30% (*ASHRAE = 40%) of gross above-grade wall area. Skylight area per design and no greater than 3% of gross roof area.
No credit allowed for reduced window-to-wall or reduced skylight areas.

IECC: per Section C402.4.1
ASHRAE: per Table 5.5-5</td><td>-</td><td>If the design window-to-wall ratio exceeds the maximum value allowed by code, this difference in WWR must be modeled between the baseline and design case.</td></tr>
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<tr><td>35</td><td rowspan="14">Mechanical</td><td colspan="4">Code Required Airside Attributes</td></tr>
<tr><td>36</td><td>Zone Isolation</td><td>HVAC systems serving zones > 25,000 ft² or zones that span more than one floor and are designed to operate or be occupied non-simultaneously are required to be divided into isolation areas with control devices configured to automatically shut off the supply of conditioned air and outside air to and exhaust air from the isolation area.

IECC: per Section C403.2.1
ASHRAE: per Section 6.4.3.3.5</td><td>Yes, IECC</td><td></td></tr>
<tr><td>37</td><td>Demand Controlled Ventilation</td><td>*IECC ≠ ASHRAE (difference in exceptions)
Required for spaces > 500ft² with design occupancy ≥ 25 people per 1,000 ft².
Some exemptions: see high performance practices for details

IECC: per Section C403.7.1
ASHRAE: per Section 6.4.3.8</td><td>Yes, IECC & ASHRAE</td><td>1. DCV in space that are either < 500 ft² or have a design occupancy < 25 people per 1,000 ft².
2. DCV for systems with an outdoor airflow < 1,200 cfm (IECC) or < 750 cfm (ASHRAE)
3. DCV for systems with energy recovery</td></tr>
<tr><td>38</td><td>Energy Recovery</td><td colspan="2">≥ 50% effective energy recovery required for systems with the following design parameters (both %OA and CFM).</td><td rowspan="10">Yes, IECC</td><td rowspan="10">1. Energy recovery where not code required
2. Energy recovery effectiveness exceeding 50%
3. Use of low face velocity in recovery selection, modulating bypass dampers, or other strategies to reduce interior static pressure losses associated with energy recovery</td></tr>
<tr><td>39</td><td></td><td>% OA</td><td>Systems Operating < 8,000 hours/year, CFM</td><td>Systems Operating ≥ 8,000 hours/year, CFM</td></tr>
<tr><td>40</td><td></td><td>≥ 80% OA</td><td>> 120 CFM</td><td>≥ 40 CFM</td></tr>
<tr><td>41</td><td></td><td>≥ 70% and < 80%</td><td>≥ 1,000 CFM</td><td>≥ 50 CFM</td></tr>
<tr><td>42</td><td></td><td>≥ 60% and < 70%</td><td>≥ 2,000 CFM</td><td>≥ 60 CFM</td></tr>
<tr><td>43</td><td></td><td>≥ 50% and < 60%</td><td>≥ 3,500 CFM</td><td>≥ 70 CFM</td></tr>
<tr><td>44</td><td></td><td>≥ 40% and < 50%</td><td>≥ 4,500 CFM</td><td>≥ 80 CFM</td></tr>
<tr><td>45</td><td></td><td>≥ 30% and < 40%</td><td>≥ 5,500 CFM</td><td>≥ 100 CFM</td></tr>
<tr><td>46</td><td></td><td>≥ 20% and < 30%</td><td>≥ 16,000 CFM</td><td>≥ 130 CFM</td></tr>
<tr><td>47</td><td></td><td>≥ 10% and < 20%</td><td>≥ 26,000 CFM</td><td>≥ 200 CFM</td></tr>
<tr><td>48</td><td></td><td colspan="2">IECC: per Section C403.7.4/Tables C403.7.4(1) & (2) - some exceptions apply
ASHRAE: per Section 6.5.6/Tables 6.5.6.1(1) & (2) - some exceptions apply</td></tr>
</table>

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49	Mechanical	Energy Recovery (Cont.)	Dual Recovery Wheel/Dehumidifcation Reheat - Where a central air handler reheat section is required to temper supply air during dehumidification, the baseline reheat shall be defined as follows: For DX air handlers with central dehumidification reheat, the Baseline shall have a hot gas reheat coil. For Chilled Water air handlers with central dehumidifcation reheat, the Baseline shall have a mechanical central system reheat coil. The reheat coil heating source shall match the typical heat source for the building (e.g. hot water, fossil fuel furnace, electric heat pump). If the building uses only electric heat, the baseline reheat coil shall be a heat pump.		For Chilled Water air handlers: Dual recovery wheel (or coil) system with a second heat recovery element to provide necessary reheat. Note: No high performance alternative for DX systems, because hot gas reheat provides similar benefit as a second recovery element.
50 51		Economizer	***IECC ≠ ASHRAE (some exceptions apply, difference in exceptions)** Air or water economizer interlocked with mechanical cooling required for: - each individual fan system with a cooling capacity ≥ 54,000 Btu/h - each chilled water system with a total cooling capacity (less cooling capacity provided with air economizers) of 1,320 MBH for local water cooled chilled water systems or 1,720 MBH for air cooled or district water cooled chilled water systems. The total supply capacity of all fan cooling units not provided with economizers shall be ≤ 20% of the total supply capacity of all fan cooling units in the building or 300,000 Btu/h. Note: Each indiviual zone terminal unit (i.e. VRF, fan coil unit, heat pump) qualifies as an individual fan system. ***ASHRAE - required for each cooling system, regardless of type, that has a fan and a cooling capacity ≥ 54,000 Btu/h** IECC: per Section C403.5 ASHRAE: per Section 6.5.1	-	Economizers in systems with: 1. Total cooling capacity < 54,000 Btu/h 2. Service water heat recovery in accordance with IECC Section C403.9.5/ ASHRAE Section 6.5.6.2.2 (see "Service Water Heat Recovery" section below) 3. Cooling efficiency at least 49% better than code (ASHRAE only) 4. Process cooling systems where economizer is not considered standard practice 5. If it can be documented that one type of economizer (water or air) is both more expensive and more efficient than the other, acceptable to compare economizer types. 6. Plate and frame heat exchanger for free winter cooling/water-side economizer where not code required.
52		Water-side Economizer	Water-side economizer piped in parallel with chiller(s)	-	Water-side economizer piped in series with chiller(s) (e.g. partial economizer capability)
53		Multizone System Airflow Control	Each supply air system serving multiple zones must be variable volume with zone controls to reduce the volume of air that is reheated, recooled, or mixed to 20% of zone peak design supply for systems with DDC controls or 30% for other systems unless a higher outside airflow is required by IMC (such as DOAS) or otherwise approved by code official. IECC: per Section C403.6.1 ASHRAE: per Section 6.5.2.1	-	VAV control for systems where ≥ 75% of the energy for reheating or for providing warm air in mixing systems is provided by a site-recovered or site-solar energy source, provided this site energy requirement is documented in the MRD.

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54	**Mechanical**	Fan Airflow/Speed Control	Each DX cooled AHU ≥ 65,000 Btu/h, each chilled water AHU with a fan motor ≥ 1/4 HP, and each evaporatively cooled AHU with a fan motor ≥ 1/4 HP must have one of the following: - VFDs with modulating fan speed controls, or - EC motors with multi-speed control Not required for chilled water and evaporatively cooled units with fan motors of < 1 hp where the units are not used to provide ventilation air and indoor fan cycles with load. **<u>This baseline requirement varies from code.</u>**	-	Modulating fan speed controls using VFDs or EC motors for: DX cooled AHUs < 65,000 Btu/hr, or CHW cooled AHUs with a fan motor < 1/4 hp, or evaporatively cooled AHUs with a fan motor < 1/4 hp using VFDs or EC motors
55		Static Pressure Reset	Static pressure reset required for systems where zone VAV boxes are controlled by a central energy management system (EMS). IECC: per Section C403.6.8 ASHRAE: per Section 6.5.3.2.3	-	
56		Supply Air Temperature Reset	Multiple-zone HVAC systems (including DOAS) shall have supply air temperature reset capable of resetting air temperature by at least 25% of the difference between design supply air temp and room air temp. IECC: per Section C403.6.5 ASHRAE: per Section 6.5.3.5	-	1. Supply air temperature reset greater than 25% of dT 2. Supply air temperature reset in system where at least 75% of the energy for reheating is from site-recovered or site-solar energy sources, provided this site energy requirement is documented in the MRD.
57		Fractional HP Fan Motors (EC Motors)	Motors for fans ≥ 1/12 hp and < 1 hp shall be electronically commutated (EC) motors or have a minimum motor efficiency of 70%. IECC: per Section C403.8.4 ASHRAE: per Section 6.5.3.6	**Yes, IECC**	Higher efficiency fractional hp motors (> 70%). Non-excitable commutated motors Permanent magnet motors

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58	Mechanical	Fan Power	Each fan system with > 5 hp motor power, shall not exceed the allowable fan system nameplate hp or bhp at design conditions (includes supply, return, exhaust, and zonal fan units combined). Include the supply air from the ventilation unit and the zone recirculated air from any terminal units in calculating total CFM. Constant Volume: hp ≤ CFM · 0.0011 OR bhp ≤ CFM · 0.00094 + Allowances VAV: hp ≤ CFM · 0.0015 OR bhp ≤ CFM · 0.0013 + Allowances Allowances = Sum of (PD Adjustment × CFM/4131) All fans > 5 hp shall have a minimum fan efficiency grade of 67%	**Yes, IECC**	Lower fan motor horsepower requirements at design through reduced pressure (e.g. increased duct size) and/or increased fan efficiency, high efficiency filters with reduced pressure drop. This is not intended to account for a change of use with pre-existing ductwork. **If credit is taken for systems with fan HP/BHP below the code maximum allowable, a penalty must also be taken for any systems in the design that exceed the code maximum allowable fan HP/BHP.** Note: fanwalls are not considered any more efficient than a single larger fan with VFD control
59			**<u>Fan systems <5 hp not governed by code.</u>** All fan systems < 5hp shall be modeled with baseline fan power equal to the design fan power. IECC: per Section C403.8.1&3/Table C403.8.1(1 & 2) ASHRAE: per Section 6.5.3.1/Table 6.5.3.1-1&2		
60			Device: Adjustment		
61			***Allowance - PD Adjustments***		
62			Fully ducted return and/or exhaust air systems: 0.5 in w.c.		
63			Return and/or exhaust airflow control devices: 0.5 in w.c.		
64			Exhaust filters, scrubbers or other treatment: design pressure drop		
65			Filters: MERV 9 thru 12: 0.5 in w.c.		
66			Filters: MERV 13 thru 15: 0.9 in w.c.		
67			Filters: MERV 16+: design pressure drop calculated at 2x clean filter pressure drop		
68			Carbon and other gas-phase air cleaners: clean filter pressure drop at design		
69			Biosafety cabinet: pressure drop of device at design		
70			Energy recovery device, other than coil runaround loop: for each airstream, (2.2 x energy recovery effectiveness) - 0.5 in w.c.		
71			Coil runaround loop: 0.6 in w.c. for each airstream		
72			Evaporative humidifier/cooler in series with another cooling coil: pressure drop at design		
73			Sound attenuation section: 0.15 in w.c.		
74			Exhaust system serving fume hoods: 0.35 in w.c.		
75			Laboratory and vivarium exhaust systems in high-rise buildings: 0.25 in w.c. / 100 feet of vertical duct exceeding 75 feet		
76			***Deductions***		
77			Systems without central cooling device: -0.6 in w.c.		
78			Systems without central heating device: -0.3 in w.c.		
79			Systems with central electric resistance heat: -0.2 in w.c.		

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80	Mechanical	***EMS Basic Functionality***	EMS functionality meeting the following requirements: - Individual zone heating and cooling controls - Temperature dead bands of at least 5˚F - Automatic shutdown/setback controls - Optimal start capabilities - Shutoff damper controls for outdoor air intake and exhaust dampers to automatically close dampers when spaces unoccupied or in setback - Shut off vestibule heating when outdoor air temperature > 45°F; maintain vestibule temperature ≤ 60°F (heating) and ≥ 85°F (cooling) - IECC Only - Hot water reset control based on outside air temperature IECC: per Sections C403.4.1-2 ASHRAE: per Section 6.4.3	**Yes, IECC & ASHRAE**	See "Code Required Airside Attributes" section (line 35) for additional baseline controls and potential high-performance controls measures.
81		***Base Case HVAC System Design Based on Building Type***	In general, the baseline should reflect the same type of HVAC systems that are designed, unless the design team has seriously considered other, less efficient HVAC system types. If the design team considered multiple HVAC system types and ultimately chose a more energy efficient option, then the designed system strategy can be compared to a different baseline system type, provided that the baseline system type meets the following guidelines: 1. The baseline was actually considered for potential implementation by the design team and owner, 2. The baseline is physically, architecturally, and economically feasible for the given project, 3. The baseline type is at least as efficient as the system types outlined in Appendix A for the respective building type, 4. The PA must approve the baseline system type to be used The system types outlined in Appendix A are suggested as a minimum Industry Standard Practice for the respective building types. ASHRAE 90.1 Appendix G cannot be used to model a baseline building for Mass Save savings. Refer to the specific prescriptive code sections for all equipment performance and controls requirements.		

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82	Mechanical	***Core & Shell Buildings***	<u>Equipment/Systems Fully Designed within Core building scope (Central building HVAC equipment, envelope, and core spaces, typically):</u> Systems shall meet all baseline requirements as defined within the applicable sections of this Baseline Document.		Exceed minimum baseline requirements for equipment that is fully designed within the Core building scope.
83			<u>Equipment/Systems Not Fully Designed (e.g. shell/future tenant spaces, typically):</u> Systems shall meet all baseline requirements as defined within the applicable sections of this Baseline Document. *Consult the MA Simulation Guidelines for guidance on shell/future tenant area load assumptions		Proposed/Design Case equipment and systems must be identical to Baseline in the shell/future tenant areas.
84			<u>Core & Shell Buildings Designed for Laboratory Use:</u> For Core & Shell designs that include ventilation/exhaust systems to meet laboratory air change requirements, the baseline shall include time of day scheduled airflow controls to reduce lab ventilation rates by at least 50% of design rates during unoccupied hours. (see MA Simulation Guiidelines for guidance on occupied/unoccupied lab air change rates.) Lab exhaust air energy recovery is not required in the baseline; however, ventilation/exhaust systems designed to serve both lab and non-lab space must have baseline-compliant energy recovery for the non-lab exhaust air.		Exhaust air energy recovery from lab exhaust

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		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
85	Mechanical	***Special Ventilation System Types***			
86		Parking Garages	Enclosed parking garage ventilation controls that automatically detect contamination levels and modulate fan airflow rates to 50% or less of design capacity for systems with either: 1. ≥ 22,500 cfm exhaust (IECC) 2. a total area of ≥ 30,000 ft² (ASHRAE) Savings cannot be claimed for variable speed fan controls with minimum speed below 50% No credit allowed for ventilation controls in systems designed to exceed the ratio of garage area to ventilation horsepower (ft²/hp) limits listed in ASHRAE and IECC. **<u>This baseline requirement varies from code.</u>**	**Yes, IECC & ASHRAE**	Garage ventilation controls for systems without heating or cooling and with either: 1. < 22,500 cfm exhaust (IECC) 2. a total area < 30,000 ft² (ASHRAE)
87		Kitchen Hood Exhaust Controls	Replacement air directly to hood shall be ≤ 10% of total hood exhaust airflow.	**Yes, IECC**	1. Systems ≤ 5,000 cfm: VFD on exhaust fan with sensor-based velocity controls, dedicated makeup air 2. Systems ≤ 5,000 cfm: systems with one or more of the baseline options 3. Systems > 5,000 cfm: hood exhaust system complying with more than one baseline option 4. Dishwasher hood interlocked with dishwasher operation
88			Systems > 5,000 cfm are required to have one of the following: • ≥ 50% of all replacement air is transfer air from an adjacent zone • DCV on ≥ 75% of exhaust air capable of 50% airflow reductions, or • energy recovery with ≥ 40% sensible effectiveness on ≥ 50% of total exhaust airflow. IECC: per Section C403.7.5 ASHRAE: per Section 6.5.7.1		
89		Kitchen Hood Exhaust Flow	Each hood has a maximum exhaust rate complying with below table:	**Yes, IECC**	Low flow kitchen hood exhaust system. For savings to be claimed, the kitchen hood designer must provide a calculation indicating the allowable maximum flow rate and the design case flow rate.
90			Type of Hood: Light / Medium / Heavy / Extra-Heavy (-Duty) (CFM per Linear Foot of Hood Length)		
91			Wall-mounted canopy: 140 / 210 / 280 / 385		
92			Single Island: 280 / 350 / 420 / 490		
93			Double island (per side): 175 / 210 / 280 / 385		
94			Eyebrow: 175 / 175 / NA / NA		
95			Backshelf/Pass-over: 210 / 210 / 280 / NA		
96			IECC: per Table C403.7.5 ASHRAE: per Table 6.5.7.2.2		

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		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
97	**Mechanical**	Laboratory Exhaust Systems	**<u>This baseline requirement varies from code:</u>** • All laboratory spaces (**for ASHRAE only systems with > 5,000 CFM of exhaust)** shall have time of day, scheduled airflow controls to reduce unoccupied airflow rates by at least 50%. Note: Industry standard fume hoods specified at 100 fpm ***IECC ≠ ASHRAE** If used to bypass the energy recovery requirements of IECC 2018 Section C403.7.4, fume hoods shall have either: • VAV hood exhaust and supply systems capable of 50% airflow reductions • Direct makeup air ≥ 75% of the exhaust rate, heated no warmer than 2°F above room setpoint and cooled no cooler than 3°F below room setpoint ***ASHRAE - Systems > 5,000 cfm must:** **• Implement one of above IECC options, OR** **• Install a combination of turndown and/or heat recovery to comply with below formula:** **A+B x (E/M) ≥ 50%** **A = % airflow reduction over design (supply & exhaust)** **B = % sensible recovery effectiveness** **E = exhaust airflow rate through heat recovery** **M = system makeup airflow rate** IECC: per Section C403.7.4, exception 2 ASHRAE: per Section 6.5.7.3 For air-side systems that serve both laboratory and non-laboratory spaces, exhaust air energy recovery is required in the baseline for the non-lab space exhaust air regardless of how the lab spaces are designed/controlled.	-	1. Systems ≤ 5,000 cfm: variable flow controls (ASHRAE) 2. Systems > 5,000 cfm: exceed requirements for turndown and heat recovery 3. Systems complying with more than one baseline option 4.. VAV fume hood systems with minimum 50% airflow reduction and with energy recovery (IECC) 5. Occupancy based airflow setback 6. Hazard sensing system to modulate airflow based on contaminant levels 7. Ventless fume hoods (this may not have an incremental cost) 8. Low-flow fume hoods (< 100 fpm) 9. Cascaded air
98					
99					
100					
101					
102		Laboratory Exhaust Fan Control	Staged constant speed fans with plenum bypass damper, the number of fans shall meet the design case. The plenum bypass damper is controlled to maintain exhaust riser static pressure. Staging control minimizes the number of active fans.	-	Variable speed exhaust fans capable of maintaining air velocity / plume height at reduced flow

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		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
103	**Mechanical**	Operable Windows	Operable windows per the proposed design.	-	Window interlock controls with HVAC system Note: For natural ventilation design; check with Program Administrator to see if high-performance plan qualifies.
104		Guest Room HVAC System Temperature Controls	For R-1† buildings with > 50 guestrooms: - Automatically raise cooling setpoint and lower heating setpoint by 4°F within 30 minutes of the occupant leaving - Automatically raise the cooling setpoint to ≥ 80°F and lower the heating setpoint to < 60°F when guestroom unrented or unoccupied for > 16 hours IECC: per Section C403.7.6.1 ASHRAE: per Section 6.4.3.3.5.1 †Type R-1 buildings are residential occupancies containing sleeping units where the occupants are primarily transient in nature, including boarding houses, hotels and motels.	**Yes, IECC & ASHRAE**	Guestroom HVAC system automatic temperature controls for R-1 buildings with ≤ 50 guestrooms.
105		Guest Room HVAC System Ventilation Controls	For R-1† buildings with > 50 guestrooms: - Automatically turn off ventilation and exhaust fans within 30 minutes of the occupant leaving or provide isolation devices that automatically shut off the supply of outdoor air to and exhaust air from the guestrooms. IECC: per Section C403.7.6.2 ASHRAE: per Section 6.4.3.3.5.2 †Type R-1 buildings are residential occupancies containing sleeping units where the occupants are primarily transient in nature, including boarding houses, hotels and motels.	**Yes, IECC & ASHRAE**	Guestroom HVAC system automatic ventilation controls for R-1 buildings with ≤ 50 guestrooms.

Line #	Div.	2020 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
106	Mechanical	***Hydronic Systems Equipment & Controls***		-	
107		HW / CHW Temperature Reset	Required for systems ≥ 300 MBH, must reset by at least 25% of system dT IECC: per Section C403.4.4 ASHRAE: per Section 6.5.4.4 *for IECC, per Section C403.4.1.5, HW temperature reset should be based on OA temperature.	-	1. HW/CHW reset for systems < 300 MBH 2. HW/CHW reset greater than 25% of system dT Note: condensing boilers should be combined with aggressive HW reset down to at least 120°F to achieve higher operating efficiency
108		HW / CHW Variable Flow Control	***IECC ≠ ASHRAE** Required for systems ≥ 300 MBH with ≥ 2 hp total pump capacity; must automatically reduce flow by at least 50%. VFDs are required for pumps ≥ 7.5 hp where DDC controls installed and for pumps ≥ 2 hp that operate continuously or based on time of day schedule. (DP sensors controlling VFD speed should be located at a remote coil.) IECC: per Section C403.4.4 ***ASHRAE - required for systems with three or more control valves; individual hot water or chilled-water pumps serving variable-flow systems having motors > 7.5 hp; must automatically reduce flow by at least 75% via installation of variable frequency drives (VFDs) (per Section 6.5.4.2)**	-	1. HW/CHW pump VFDs for pumps < 7.5 hp with DDC controls (IECC) 2. HW/CHW variable flow controls for systems < 300 MBH (IECC), N/A for ASHRAE 3. HW/CHW variable flow controls for systems with < 2 hp total pump power (IECC) 4. HW/CHW flow reduction of greater than 50% of design flow (IECC) or greater than 75% of design flow (ASHRAE) 5. Fractional horsepower pumps with EC motors and variable flow control. 6. HW VFDs where > 50% of annual heat generated by electric boiler
109		Heat Rejection Loop Variable Flow Controls	***IECC ≠ ASHRAE** Required for systems ≥ 300 MBH with either ≥ 2 hp total pump power (pumps scheduled or continuously operating) or ≥ 7.5 hp total pump power (DDC controls) serving water-cooled unitary air conditioners; must automatically reduce flow by at least 50%. VFDs are required for pumps ≥ 7.5 hp where DDC controls installed and for pumps ≥ 2 hp that operate continuously or based on time of day schedule. IECC: per Section C403.4.4 ***ASHRAE - required for hydronic heat pumps and water-cooled unitary air conditioners with total pump system power > 5hp; must automatically reduce flow by at least 50% via installation of variable frequency drives (VFDs) (per Section 6.5.4.5.2)**	-	1. Heat Rejection Loop pump VFDs for pumps < 7.5 hp with DDC controls (IECC) 2. Heat Rejection Loop variable flow controls for systems < 300 MBH (IECC), N/A for ASHRAE 3. Heat Rejection Loop variable flow controls for system with < 7.5 hp total pump power (IECC) or < 5 hp (ASHRAE) 4. Heat Rejection Loop flow reduction of greater than 50% of design flow 5. Fractional horsepower pumps with EC motors

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		Sub-Category	Baseline Minimum Standards & Practice		Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
110	Mechnical	Piping Insulation	Hydronic pipe insulation meeting minimum thickness IECC: per Table C403.11.3 ***ASHRAE: per Table 6.8.3-1 and 6.8.3-2**		**Yes, IECC & ASHRAE**	
111		Heat Pumps: Standard Water Loop	Minimum heat pump water supply temperature dead band of 20°F IECC: per Section C403.4.3.3.1 ASHRAE: per Section 6.5.2.2.3		-	Controls that optimize loop temperature based upon real-time conditions and loads
112		Heat Pump: Valves	***IECC ≠ ASHRAE** Two way valves for each hydronic heat pump where the total pump system power is >10 hp IECC: per Section C403.4.3.3.3 ***ASHRAE - required for all hydronic heat pumps (no size limit), unless units utilize a fluid economizer (per Section 6.5.4.6)**		-	Two way valves and variable flow controls for systems where total pump power ≤ 10 hp (IECC)
113		***Furnaces***	**<u>This baseline requirement exceeds code for furnaces ≤ 225 MBH.</u>** Warm-air furnaces with performance meeting IECC Table 403.3.2(4) / ASHRAE 90.1 2016 Table 6.8.1-5		**Yes, IECC & ASHRAE**	Furnace with performance exceeding baseline requirement (e.g. condensing furnaces)
114			*<u>Type</u>*	*<u><225 MBH</u>*	*<u>≥225 MBH</u>*	
115			Warm Air, Gas fired	**85% AFUE**	80% Et	
116			Warm Air, Oil Fired	**83% AFUE**	81% Et	
117			Warm Air Duct, Gas Fired	**85% AFUE**	80% Ec	
118			Warm Air Unit Heater, Gas Fired	80% Ec		
119			Warm Air Unit Heater, Oil Fired			

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		Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
120	Mechanical	***Boilers***					
121		Selection	**<u>This baseline requirement exceeds code for gas-fired hot-water boilers ≤ 2,500 MBH.</u>** ***IECC ≠ ASHRAE** Hot water - non-condensing boilers with performance meeting IECC 2018 Table C403.3.2(5) / ASHRAE 90.1 2016 Table 6.8.1-6:			**Yes, IECC & ASHRAE**	Boilers with performance exceeding baseline requirement Note: condensing boilers should be combined with aggressive HW reset down to at least 120°F to achieve higher operating efficiency
122				*<u>Capacity (Input, MBH)</u>*	*<u>gas-fired</u>*	*<u>oil-fired</u>*		
123				< 300	**85%**	84% AFUE		
124				≥ 300 and ≤ 2,500	**85%**	82% Et		
125				> 2,500	82% Ec	84% Ec		
126			Steam plants - boilers with performance meeting IECC 2018 Table C403.3.2(5) / ASHRAE 90.1 2016 Table 6.8.1-6:				**Yes, IECC & ASHRAE**	
127				*<u>Capacity (Input, MBH)</u>*	*<u>gas-fired</u>*	*<u>oil-fired</u>*		
128				< 300	80% AFUE	82% AFUE		
129				≥ 300 and ≤ 2,500 all, except natural draft	79% Et	81% Et		
130				≥ 300 and ≤ 2,500 natural draft	79% Et			
131				> 2,500 all, except natural draft	79% Et	81% Et		
132				> 2,500 natural draft	79% Et			
133		Burner controls	Boilers ≥ 1,000 MBH shall meet the minimum turndown ratios of IECC 2018 Table C403.3.4 / ASHRAE 90.1 2016 Table 6.5.4.1				-	Boiler turndown beyond minimum code requirement
134				*<u>Capacity (Input, MBH)</u>*	*<u>Minimum Turndown</u>*			
135				≥ 1,000 and ≤ 5,000	3 to 1			
136				> 5,000 and ≤ 10,000	4 to 1			
137				> 10,000	5 to 1			
138			Heating systems comprised of a single boiler > 500 MBH shall have a multistage or modulating burner IECC: Section C403.4.3				-	Modulating burners on boilers < 500,000 Btu/hr capacity
139			< 25 hp: Constant-speed forced-draft burner fans having inlet guide vane or outlet damper volume control ≥ 25 hp: VFD on draft fan				-	VFD on forced-draft burner fans < 25 hp
140			Mechanical linkage control				-	Parallel positioning controls with oxygen trim
141		Boiler pumps	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE = For systems with multiple boilers, automatically shut off flow through each boiler when that specific boiler is shut off. For systems with multiple boilers and constant speed pumps, number of pumps equal to the number of boilers and stage on/off with boilers (per Section 6.5.4.3.2)**				-	
142		Boiler staging controls					-	Predictive cycling control to limit boiler cycling Heat recovery in steam plants

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		Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
143	Mechanical	***Cooling Systems***					
144		Heat Pumps: Air Source (excludes VRF, see VRF section)	***IECC ≠ ASHRAE** Air-source heat pumps with performance meeting IECC 2018 Table C403.3.2(2) / ASHRAE 90.1-2016 Table 6.8.1-2			**Yes, IECC & ASHRAE**	Heat pumps with performance exceeding baseline requirements
145			*Equipment Type*	*Size (MBH)*	*Minimum Efficiency*		
146			Air cooled	< 65	Split: 14 SEER, 8.2 HSPF Pkgd: 14 SEER, 8.0 HSPF		
147			Through-the-wall	≤30	Split: 12 SEER, 7.4 HSPF Pkgd: 12 SEER, 7.4 HSPF		
148			Single-duct high-velocity	<65	Split: 11 SEER, 6.8 HSPF		
149			Air cooled	≥ 65 and < 135	11.0 EER & 12.0 IEER (electric heat or no heat) ***ASHRAE = 12.2 IEER** (electric heat or no heat) 10.8 EER & 11.8 IEER (other heat) ***ASHRAE = 12.0 IEER (other heat)** 3.3 COP (47°F db/43°F wb) 2.25 COP (17°F db/ 15°F wb)		
150				≥ 135 and < 240	10.6 EER & 11.6 IEER (electric heat or no heat) 10.4 EER & 11.4 IEER (other heat) 3.2 COP (47°F db/43°F wb) 2.05 COP (17°F db/ 15°F wb)		
151				≥ 240	9.5 EER & 10.6 IEER (electric heat or no heat) 9.3 EER & 9.4 IEER (other heat) ***ASHRAE = 10.4 IEER (other heat)** 3.2 COP (47°F db/43°F wb) 2.05 COP (17°F db/ 15°F wb)		
152		Ground-source Heat Pumps	Ground-source heat pumps with performance meeting IECC 2015 Table C403.3.2(2) / ASHRAE 90.1-2016 Table 6.8.1-2 For equipment outside of the capacity ranges shown below, baseline performance should reflect alternate less efficient equipment that is available to purchase.			**Yes, IECC & ASHRAE**	Heat pumps with performance exceeding baseline requirements
153			*Equipment Type*	*Size (MBH)*	*Minimum Efficiency*		
154			Water to Air: Water Loop	<17	12.2 EER (86°F EWT) 4.3 COP (68°F EWT)		
155				≥ 17 and < 65	13.0 EER (86°F EWT) 4.3 COP (68°F EWT)		
156				≥ 65 and < 135	13.0 EER (86°F EWT) 4.3 COP (68°F EWT)		
157			Water to Air: Ground Water	<135	18.0 EER (59°F EWT) 3.7 COP (50°F EWT)		
158			Brine to Air: Ground Loop	<135	14.1 EER (77°F EWT) 3.2 COP (32°F EWT)		
159			Water to Water: Water Loop	<135	10.6 EER (86°F EWT) 3.7 COP (68°F EWT)		
160			Water to Water: Ground Water	<135	16.3 EER (59°F EWT) 3.1 COP (50°F EWT)		
161			Brine to Water: Ground Loop	<135	12.1 EER (77°F EWT) 2.5 COP (32°F EWT)		

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		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
162	**Mechanical**	Unitary Air Conditioners (RTUs, etc.) and Split Systems	Standard efficiency packaged/split unit with DX cooling with performance meeting IECC 2018 Table C403.3.2(1) / ASHRAE 2016 Table 6.8.1-1				**Yes, IECC & ASHRAE**	Cooling systems with performance exceeding baseline requirements
163				*Equipment*	*Size (MBH)*	*Minimum Efficiency*		
164				Air cooled	< 65	Split: 13 SEER; Pkgd: 14 SEER		
165				Through-wall	≤30	Split: 12 SEER; Pkgd: 12 SEER		
166				Small-duct high-velocity	<65	Split: 11 SEER		
167				Air cooled	≥ 65 and < 135	11.2 EER & 12.8 IEER (electric heat or no heat) ***ASHRAE - 11.2 EER & 12.9 IEER (electric heat or no heat)** 11.0 EER & 12.6 IEER (other heat) ***ASHRAE - 11.0 EER & 12.7 IEER (other heat)**		
168					≥ 135 and < 240	11.0 EER & 12.4 IEER (electric heat or no heat) 10.8 EER & 12.2 IEER (other heat)		
169					≥ 240 and <760	10.0 EER & 11.6 IEER (electric heat or no heat) 9.8 EER & 11.4 IEER (other heat)		
170					≥ 760	9.7 EER & 11.2 IEER (electric heat or no heat) 9.5 EER & 11.0 IEER (other heat)		
171				Water cooled	<65	12.1 EER & 12.3 IEER (all)		
172					≥ 65 and < 135	12.1 EER & 13.9 IEER (electric heat or no heat) 11.9 EER & 13.7 IEER (other heat)		
173					≥ 135 and < 240	12.5 EER & 13.9 IEER (electric heat or no heat) 12.3 EER & 13.7 IEER (other heat)		
174					≥ 240 and <760	12.4 EER & 13.6 IEER (electric heat or no heat) 12.2 EER & 13.4 IEER (other heat)		
175					≥ 760	12.2 EER & 13.5 IEER (electric heat or no heat) 12.0 EER & 13.3 IEER (other heat)		
176				Evaporatively cooled	<65	12.1 EER & 12.3 IEER (all)		
177					≥ 65 and < 135	12.1 EER & 12.3 IEER (electric heat or no heat) 11.9 EER & 12.1 IEER (other heat)		
178					≥ 135 and < 240	12.0 EER & 12.2 IEER (electric heat or no heat) 11.8 EER & 12.0 IEER (other heat)		
179					≥ 240 and <760	11.9 EER & 12.1 IEER (electric heat or no heat) 11.7 EER & 11.9 IEER (other heat)		
180					≥ 760	11.7 EER & 11.9 IEER (electric heat or no heat) 11.5 EER & 11.7 IEER (other heat)		
181				Condensing Units, air cool	≥ 135	10.5 EER & 11.8 IEER		
182				Condensing Units, water	≥ 135	13.5 EER & 14.0 IEER		
183				Condensing units, evap.	≥ 135	13.5 EER & 14.0 IEER		
184		Packaged Terminal Heat Pumps and Air Conditioners	Standard efficiency units with performance meeting IECC Table C403.3.2(3)/ ASHRAE Table 6.8.1-4.				**Yes, IECC & ASHRAE**	PTHP and PTAC with performance exceeding baseline requirements

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		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
185	**Mechanical**	Chilled Water Plants	*(design CHWT > 35°F)*				**Yes, IECC & ASHRAE**	Chillers with performance exceeding baseline requirements. *Note: In general, the condensing type for the base case chiller must be the same as what is designed. There must be approval from the PA for situations where an air-cooled chiller is being considered compared to water-cooled.
186		Equipment Selection	Chiller performance meeting IECC 2018 Table C403.3.2(7) / ASHRAE 90.1-2016 Table 6.8.1-3.					
187				*Equipment Type*	*Size (tons)*	*Minimum Efficiency (choose either Path A or Path B)*		
188						*Path A*	*Path B*	
189				Air cooled	<150	≥ 10.1 EER (FL) ≥ 13.7 EER (IPLV)	≥ 9.7 EER (FL) ≥ 15.8 EER (IPLV)	
190					≥ 150	≥ 10.1 EER (FL) ≥ 14.0 EER (IPLV)	≥ 9.7 EER (FL) ≥ 16.1 EER (IPLV)	
191				Air cooled w/o condenser, electrically operated	ALL	Units shall be rated with matching condensers and comply with air-cooled chiller requirements		
192				Water cooled, electrically operated, positive displacement	< 75	≤ 0.75 kW/ton (FL) ≤ 0.6 kW/ton (IPLV)	≤ 0.78 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	
193					≥ 75 and < 150	≤ 0.72 kW/ton (FL) ≤ 0.56 kW/ton (IPLV)	≤ 0.75 kW/ton (FL) ≤ 0.49 kW/ton (IPLV)	
194					≥ 150 and < 300	≤ 0.66 kW/ton (FL) ≤ 0.54 kW/ton (IPLV)	≤ 0.68 kW/ton (FL) ≤ 0.44 kW/ton (IPLV)	
195					≥ 300 and < 600	≤ 0.61 kW/ton (FL) ≤ 0.52 kW/ton (IPLV)	≤ 0.625 kW/ton (FL) ≤ 0.41 kW/ton (IPLV)	
196					≥ 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)	
197				Water cooled, electrically operated centrifugal	<150	≤ 0.610 kW/ton (FL) ≤ 0.550 kW/ton (IPLV)	≤ 0.695 kW/ton (FL) ≤ 0.440 kW/ton (IPLV)	
198					≥ 150 and < 300	≤ 0.610 kW/ton (FL) ≤ 0.550 kW/ton (IPLV)	≤ 0.635 kW/ton (FL) ≤ 0.4 kW/ton (IPLV)	
199					≥ 300 and < 400	≤ 0.56 kW/ton (FL) ≤ 0.52 kW/ton (IPLV)	≤ 0.595 kW/ton (FL) ≤ 0.39 kW/ton (IPLV)	
200					≥ 400 and < 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)	
201					≥ 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)	
202				Absorption, single effect	ALL (air cooled)	≥ 0.6 COP (FL)	N/A	
203				Absorption, single effect	ALL (water cooled)	≥ 0.7 COP (FL)	N/A	
204				Absorption, double effect	ALL (indirect fired)	≥ 1.0 COP (FL) ≥ 1.05 COP (IPLV)	N/A	
205				Absorption, double effect	ALL (direct fired)	≥ 1.0 COP (FL) ≥ 1.05 COP (IPLV) ***ASHRAE - ≥ 1.0 COP (FL & IPLV)**	N/A	
206		Chiller Sequencing	Automatic lead/lag chiller staging (run one chiller to full capacity before staging on second chiller)				-	Optimal automatic chiller sequencing based on total plant efficiency Different-sized chillers with optimized sequencing for prolonged high-load vs low-load operation

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		System					
		Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
207	Mechanical	Pumping	Chilled water pumping approach (primary/secondary vs. variable primary) shall be the same as what is designed			-	
208		Piping	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE - Chilled water piping sized according to ASHRAE 90.1-2016 Table 6.5.4.6**			-	
209		Coil Selection	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE - Chilled water coils shall be selected to provide a 15°F or higher difference between the leaving and entering water temperatures and a minimum 57°F leaving water temperature per ASHRAE 90.1-2016 Section 6.5.4.7 (some exceptions apply)**				Design coil dT greater than 15°F
210		Cooling Towers	Cooling tower performance meeting IECC 2018 Table C403.3.2(8) / ASHRAE 90.1-2016 Table 6.8.1-7			**Yes, IECC & ASHRAE**	Oversize cooling tower evaporative surface area in order to reduce the required cooling tower fan motor size
211			*Equipment Type*	*Rating Condition*	*Fan Performance*		
212			Propeller or axial fan, open-circuit	95°F EWT; 85°F LWT, 75°F OAT (db)	≥ 40.2 gpm/hp		
213			Centrifugal fan, open-circuit	95°F EWT; 85°F LWT, 75°F OAT (db)	≥ 20.0 gpm/hp		
214			Propeller or axial fan, closed-circuit	102°F EWT; 90°F LWT, 75°F OAT (db)	≥ 16.1 gpm/hp		
215			Centrifugal fan, closed-circuit	102°F EWT; 90°F LWT, 75°F OAT (db)	≥ 7.0 gpm/hp		
216		Condensers	Condenser performance meeting IECC 2018 Table C403.3.2(8) / ASHRAE 90.1-2016 Table 6.8.1-7			**Yes, IECC & ASHRAE**	Oversize condenser heat exchanger surface area in order to reduce the required condenser fan motor size
217			*Equipment Type*	*Rating Condition*	*Performance*		
218			Propeller or axial fan, evaporative	Ammonia: 140°F entering gas temp, 96.3°F condensing temp; 75°F OAT (wb)	≥ 134 MBH/hp		
219			Centrifugal fan, evaporative	Ammonia: 140°F entering gas temp, 96.3°F condensing temp; 75°F OAT (wb)	≥ 110 MBH/hp		
220			Propeller or axial fan, evaporative	R507: 165°F entering gas temp, 105°F condensing temp; 75°F OAT (wb)	≥ 157 MBH/hp		
221			Centrifugal fan, evaporative	R507: 165°F entering gas temp, 105°F condensing temp; 75°F OAT (wb)	≥ 135 MBH/hp		
222			Air-cooled	125°F condensing temp; 190°F entering gas temp; 15°F subcooling; 95°F OAT (db)	≥ 176 MBH/hp		

Line #	Div.	2020 Program Year					
		System					
		Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
223	Mechanical	Heat Rejection Fan Controls	Each fan system with connected motor power ≥ 5 hp shall have capability to operate at 50% speed or less with controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure. IECC: per Section C403.9.1 ASHRAE: per Section 6.5.5.2			-	Variable speed fan controls w/ VFD. When considering savings for these controls, provide documentation showing two-speed fans are an option from the manufacturer.
224		Condenser Water Temperature	Condenser water (CW) temperature setpoint of 70°F, floating up to the design leaving water temperature for the cooling tower.			-	Reset CW temperature setpoint below 70°F
225		Water-side Economizer	See "Economizer" section starting on line 49.			-	
226		Thermal Storage	No thermal storage			-	Thermal storage to reduce plant peak kW demand (consider energy penalty on overall plant energy use)
227		Variable Refrigerant Flow (VRF) Air Conditioners	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE - VRF air conditioner performance meeting ASHRAE 90.1-2016 Table 6.8.1-9**			**Yes, ASHRAE**	VRF air conditioners with performance exceeding baseline requirements.
228				***Equipment Type***	***Size (MBH)***	***Minimum Efficiency***	
229				**VRF air conditioners, air cooled**	**< 65**	**13 SEER (VRF multisplit, all heat types)**	
230					**≥ 65 and < 135**	**11.2 EER & 15.5 IEER (VRF multisplit, electric heat or no heat)**	
231					**≥ 135 and < 240**	**11.0 EER & 14.9 IEER (VRF multisplit, electric heat or no heat)**	
232					**≥ 240**	**10.0 EER & 13.9 IEER (VRF multisplit, electric heat or no heat)**	

Line #	Div.	2020 Program Year						
		System						
		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
233	Mechanical	Variable Refrigerant Flow (VRF) Heat Pumps	***IECC ≠ ASHRAE** No IECC Requirement - Use ASHRAE requirements for all projects. ***ASHRAE - VRF heat pump performance meeting ASHRAE 90.1-2016 Table 6.8.1-10**				**Yes, ASHRAE**	VRF heat pumps with performance exceeding baseline requirements.
234				***Equipment Type***	***Size (MBH)***	***Minimum Efficiency (VRF multisplit)***		
235				**VRF air cooled (cool mode)**	**< 65**	**13 SEER (all heat types)**		
236					**≥ 65 and < 135**	**11.0 EER &14.6 IEER (electric heat/no heat)** **10.8 EER & 14.4 IEER (heat recovery, electric heat/no heat)**		
237					**≥ 135 and < 240**	**10.6 EER & 13.9 IEER (electric heat/no heat)** **10.4 EER & 13.7 IEER (heat recovery, electric heat/no heat)**		
238					**≥ 240**	**9.5 EER & 12.7 IEER (electric heat/no heat)** **9.3 EER & 12.5 IEER (heat recovery, electric heat/no heat)**		
239				**VRF water source (cool mode)**	**< 65**	**12.0 EER & 16 IEER; 86°F EWT** **11.8 EER & 15.8 IEER; 86°F EWT (heat recovery)**		
240					**≥ 65 and < 135**	**12.0 EER & 16 IEER; 86°F EWT** **11.8 EER & 15.8 IEER; 86°F EWT (heat recovery)**		
241					**≥ 135 and < 240**	**10.0 EER & 14.0 IEER; 86°F EWT** **9.8 EER & 13.8 IEER; 86°F EWT (heat recovery)**		
242					**≥ 240**	**10.0 EER & 12.0 IEER; 86°F EWT** **9.8 EER & 11.8 IEER; 86°F EWT (heat recovery)**		
243				**VRF groundwater source (cool mode)**	**<135**	**16.2 EER; 59°F EWT** **16.0 EER; 59°F EWT (heat recovery)**		
244					**≥ 135**	**13.8 EER; 59°F EWT** **13.6 EER; 59°F EWT (heat recovery)**		
245				**VRF ground source (cool mode)**	**<135**	**13.4 EER; 77°F EWT** **13.2 EER; 77°F EWT (heat recovery)**		
246					**≥ 135**	**11.0 EER; 77°F EWT** **10.8 EER; 77°F EWT (heat recovery)**		
247				**VRF air cooled (heat mode)**	**< 65**	**7.7 HSPF**		
248					**≥ 65 and < 135**	**3.3 COP (47°F db/ 43°F wb); 2.25 COP (17°F db / 15°F wb)**		
249					**≥ 135**	**3.2 COP (47°F db/ 43°F wb); 2.05 COP (17°F db / 15°F wb)**		
250				**VRF water source (heat mode)**	**<135**	**4.3 COP; 68°F EWT**		
251					**≥ 135 and < 240**	**4.0 COP; 68°F EWT**		
252					**≥ 240**	**3.9 COP; 68°F EWT**		
253				**VRF groundwater source (heat mode)**	**<135**	**3.6 COP; 50°F EWT**		
254					**≥ 135**	**3.3 COP; 50°F EWT**		
255				**VRF ground source (heat mode)**	**<135**	**3.1 COP; 32°F EWT**		
256					**≥ 135**	**2.8 COP; 32°F EWT**		

<table>
<tr><th>Line #</th><th>Div.</th><th colspan="4">2020 Program Year</th></tr>
<tr><td></td><td></td><td colspan="4">System</td></tr>
<tr><td></td><td></td><td>Sub-Category</td><td colspan="2">Baseline Minimum Standards & Practice</td><td>Mandatory for Code Compliance regardless of path</td><td>Potential High-Performance Practices</td></tr>
<tr><td>257</td><td rowspan="285">Mechanical</td><td>DX-DOAS Units</td><td colspan="2">*IECC ≠ ASHRAE
No IECC Requirement
*ASHRAE - DX DOAS unit performance meeting ASHRAE 90.1-2016 Tables 6.8.1-15 and</td><td rowspan="11">Yes, ASHRAE</td><td rowspan="11">DX-DOAS units with performance exceeding the baseline requirements.</td></tr>
<tr><td>258</td><td></td><td>Equipment Type</td><td>Minimum Efficiency (without energy recovery)</td><td>Minimum Efficiency (with energy recovery)</td></tr>
<tr><td>259</td><td></td><td>Air cooled (dehumidification mode)</td><td>4.0 ISMRE</td><td>5.2 ISMRE</td></tr>
<tr><td>260</td><td></td><td>Air Source Heat Pumps (dehumidification mode)</td><td>4.0 ISMRE</td><td>5.2 ISMRE</td></tr>
<tr><td>261</td><td></td><td>Water cooled (dehumidification mode)</td><td>4.9 ISMRE (cooling tower condenser water)</td><td>5.3 ISMRE (cooling tower condenser water)</td></tr>
<tr><td>262</td><td></td><td>Air source heat pump (heating mode)</td><td>2.7 ISCOP</td><td>3.3 ISCOP</td></tr>
<tr><td>263</td><td></td><td>Water source heat pump (dehumidification mode)</td><td>4.8 ISMRE (ground source, closed loop)</td><td>5.2 ISMRE (ground source, closed loop)</td></tr>
<tr><td>264</td><td></td><td>Water source heat pump (heating mode)</td><td>2.0 ISCOP (ground source, closed loop)</td><td>3.8 ISCOP (ground source, closed loop)</td></tr>
<tr><td>265</td><td colspan="3">*ISMRE = integrated seasonal moisture removal efficiency</td></tr>
<tr><td>266</td><td colspan="3">*ISCOP = integrated seasonal coefficient of Performance</td></tr>
<tr><td>267</td><td>Computer Room Air Conditioners and Condensing Units (Excludes Chilled Water Air Handlers)</td><td colspan="2">*IECC ≠ ASHRAE
Air conditioner and condenser performance meeting IECC 2018 Table C403.3.2(9) / ASHRAE 90.1-2016 Table 6.8.1-11
Computer rooms shall have dedicated air-side HVAC systems.</td><td rowspan="28">Yes, IECC & ASHRAE</td><td rowspan="28">Computer room air conditioners with performance exceeding baseline requirements.

For new data centers designed with central chiller plants, consult the PA regarding savings potential.</td></tr>
<tr><td>268</td><td></td><td>Equipment Type</td><td>Net Sensible Cooling Capacity (MBH)*</td><td>Min SCOP-127** Efficiency (downflow/upflow)</td><td>*ASHRAE - Min SCOP Efficiency (downflow / upflow - ducted / upflow - nonducted / horizontal-flow)</td></tr>
<tr><td>269</td><td></td><td rowspan="3">Air cooled</td><td><65</td><td>2.20/2.09</td><td>2.30/2.10/2.09/2.45</td></tr>
<tr><td>270</td><td></td><td>≥ 65 and < 240</td><td>2.10/1.99</td><td>2.20/2.05/1.99/2.35</td></tr>
<tr><td>271</td><td></td><td>≥ 240</td><td>1.90/1.79</td><td>2.00/1.85/1.79/2.15</td></tr>
<tr><td>272</td><td></td><td rowspan="3">Water cooled</td><td><65</td><td>2.60/2.49</td><td>2.50/2.30/2.25/2.70</td></tr>
<tr><td>273</td><td></td><td>≥ 65 and < 240</td><td>2.50/2.39</td><td>2.40/2.20/2.15/2.60</td></tr>
<tr><td>274</td><td></td><td>≥ 240</td><td>2.40/2.29</td><td>2.25/2.10/2.05/2.45</td></tr>
<tr><td>275</td><td></td><td rowspan="3">Water cooled with fluid economizer</td><td><65</td><td>2.55/2.44</td><td>2.45/2.25/2.20/2.60</td></tr>
<tr><td>276</td><td></td><td>≥ 65 and < 240</td><td>2.45/2.34</td><td>2.35/2.15/2.10/2.55</td></tr>
<tr><td>277</td><td></td><td>≥ 240</td><td>2.35/2.24</td><td>2.20/2.05/2.00/2.40</td></tr>
<tr><td>278</td><td></td><td rowspan="3">Glycol cooled (40% PG)</td><td><65</td><td>2.50/2.39</td><td>2.30/2.10/2.00/2.40</td></tr>
<tr><td>279</td><td></td><td>≥ 65 and < 240</td><td>2.15/2.04</td><td>2.05/1.85/1.85/2.15</td></tr>
<tr><td>280</td><td></td><td>≥ 240</td><td>2.10/1.99</td><td>1.95/1.80/1.75/2.10</td></tr>
<tr><td>281</td><td></td><td rowspan="3">Glycol cooled (40% PG) with fluid economizer</td><td><65</td><td>2.45/2.34</td><td>2.25/2.10/2.00/2.35</td></tr>
<tr><td>282</td><td></td><td>≥ 65 and < 240</td><td>2.10/1.99</td><td>1.95/1.80/1.75/2.10</td></tr>
<tr><td>283</td><td></td><td>≥ 240</td><td>2.05/1.94</td><td>1.90/1.80/1.70/2.10</td></tr>
<tr><td>284</td><td colspan="3">*Net sensible cooling capacity = Total Gross - Latent - Fan Power</td></tr>
<tr><td>285</td><td colspan="3">**SCOP-127 = sensible coefficient of performance, calculated by dividing the new sensible cooling capacity (watts) by total power input (watts)</td></tr>
</table>

Line #	Div.	2020 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
286 287	Mechanical	Walk-in coolers/ freezers, Refrigerated warehouse coolers/ freezers	Automatic door closer controls EC motors on all evaporator and condenser fans < 1 hp Wall, ceiling, and door minimum insulation R-25 (coolers) or R-32 (freezers) Doorways shall have strip doors, curtains, spring-hinged doors, or other method of minimizing infiltration when doors are open. Floor minimum insulation R-28 (freezers) Timer to turn lights off within 15 minutes of occupants leaving LED lighting **<u>This baseline requirement varies from code:</u>** Temperature based defrost termination control On/Off type antisweat door heater controls (baseline shall assume that heater controls reduce heater run time by 46% for freezers and by 74% for coolers.) IECC: per Sections C403.10.1 and C403.10.2 ASHRAE: per Section 6.4.5	**Yes, IECC & ASHRAE**	1. Coolers with insulation > R-25 (wall, ceiling, or door) 2. Freezers with insulation > R-32 (wall, ceiling, or door) 3. Walk-in freezers with floor insulation > R-28 4. Hot gas defrost 5. Remote exterior condensers (versus interior condensers with worse performance at constant space temperatures) 6. Heat recovery off of condensers 7. Permanent magnet fan motors 8. Micro-pulse antisweat door heater controls that reduce heater run time by more than baseline threshold
288		Refrigerated Display Cases	Automatic lighting controls (time switch or motion sensor) LED lighting Temperature based defrost controls Where antisweat heaters are installed, antisweat heater controls for low temperature (freezer) doors (baseline shall assume that heater controls reduce heater run time by 46% for freezers) IECC: per Section C403.10.3	**Yes, IECC & ASHRAE**	1. Hot gas defrost 2. Antisweat heater controls for medium temperature doors 3. Micro-pulse antisweat door heater controls that reduce heater run time by more than baseline threshold 4. Low/no heat low temperature doors
289		Commercial Refrigerators and Freezers (Stand-Alone)	(Stand-Alone, Cabinet Type with Packaged Compressors) Performance meeting IECC Tables C403.10.1(1)&(2)/ ASHRAE Tables 6.8.1-12&13.	**Yes, IECC & ASHRAE**	Commercial refrigeration, refrigerators, and freezers with performance exceeding baseline requirements.
290		Remote Condensers & Remote Compressors Serving Refrigeration Systems	PSC motors for condenser fans < 1 hp Variable speed condenser fan control Condensing temperature reset (Min. condensing temp. ≤ 70°F) Compressors with suction pressure reset (some exceptions apply) Subcooling for compressors ≥ 100 MBH with maximum suction temperature of -10°F Cycling crankcase heaters IECC: per Section C403.10.4 ASHRAE: per Section 6.5.11	-	Minimum condensing temperature < 70°F (check manufacturer's specifications to determine if viable) Subcooling where not code required EC motors for condenser fans Floating suction pressure controls if not code required per exceptions

Line #	Div.	2020 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
291	**Mechanical**	Indoor Pool Dehumidifiers (Vapor Compression Based)	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE -All equipment types shall have a minimum MRE of 3.5 per ASHRAE 90.1-2016 Table 6.8.1-14** **MRE = moisture removal efficiency, a ratio of the moisture removal capacity (lbs of moisture/hr) to the input power kW of the equipment**	**Yes, ASHRAE**	1) Indoor pool dehumidifiers with performance exceeding the baseline requirements. 2) Waste heat used for pool heating
292	**Service Water Heating**	***Equipment Performance***	Water heating equipment and storage tanks must meet minimum performance requirements of IECC Table C404.2 / ASHRAE Table 7.8	**Yes, IECC & ASHRAE**	Exceed requirements of IECC Table C404.2 / ASHRAE Table 7.8 Condensing gas-fired DHW heaters Heat pump electric HW heaters
293		Gas-fired water heaters	*Equipment Type* / *Size (MBH)* / *Minimum Efficiency*		
294			Storage water heaters (gas) / ≤ 75 / 0.675-0.0015×V*, EF (≥ 20 gal & ≤ 55 gal) 0.8012 - 0.00078×V*, EF (> 55 gal & ≤100 gallons) ***ASHRAE - not specified**		
295			>75 and ≤ 155 / 80% Et		
296			>155 / 80% Et		
297			Instantaneous water heaters (gas) / > 50 and ≤ 200 / 0.82-0.0019×V*, EF ***ASHRAE - not specified**		
298			≥ 200 / 80% Et		
299			ALL / ≥ 1,000 / 90% Et (See below section for "High Input Service Water Heating Systems")		
300			*V is the rated volume in gallons. See code tables for additional water heater types.		
301		Electric Water Heaters	For building using a heat pump water heater, an electric resistance water heater is an acceptable base case.		Heat pump water heater (air temperature and sensible heating loads within zones must be accounted for if heat is sourced from air within a conditioned space)
302		High Input Service Water Heating Systems	For gas-fired water-heating equipment systems with total combined input capacity ≥ 1,000,000 Btu/h: 1. If one singular piece of equipment, the equipment shall have a minimum thermal efficiency of 90% Et. 2. If multiple pieces of equipment, the combined input-capacity-weighted-average efficiency shall be a minimum of 90% Et. (Note there are exceptions for water heaters installed in individual dwelling units and water heaters with an input capacity ≤ 100,000 Btu/hr) IECC: per Section C404.2.1 ASHRAE: per Section 7.5.3		1) Exceed baseline efficiency requirement 2) Thermal efficiency > 80% if ≥ 25% of the annual service water-heating requirement is provided by on-site renewable energy or site recovered energy

Line #	Div.	2020 Program Year			
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		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
303	**Service Water Heating**	***Heat Recovery***	Condenser heat recovery for heating or reheating of service hot water provided the facility operates 24 hr/day, total heat capacity exceeds 6,000 MBH of heat rejection, and design service water load exceeds 1,000 MBH Heat recovery system must provide the smaller of: 1. 60% of peak heat rejection load at design conditions 2. Preheating required to raise peak hot water draw to 85˚F IECC: per Section C403.9.5 ASHRAE: per Section 6.5.6.2	-	Condenser heat recovery where not code required
304	**Electrical**	***Motors***			
305		Selection	Minimum motor efficiencies per: - 60 Hz NEMA Design A, NEMA Design B, and IEC Design N Motors - Table C405.7(1) - 60 Hz NEMA Design C and IEC Design H Motors - Table C405.7(2) - Polyphase small electric motors - Table C405.7(3) - Capacitor-start capacitor-run and capacitor-start induction-run small electric motors - Table C405.7(4) *ASHRAE Section 10.4.1	**Yes, IECC & ASHRAE**	Motors exceeding baseline efficiency
306		***Plug-Loads***			
307		Automatic Receptacle Control	**<u>This baseline requirement varies from code.</u>** Automatic receptacle controls in at least 50% of the receptacles in offices, conference rooms, printing/copying rooms, break rooms, classrooms, and individual workstations. ASHRAE Section 8.4.2	**Yes, ASHRAE**	Automatic receptacle controls controlling >50% of all receptacles in required spaces, or implemented in non-required space types.

Line #	Div.	2020 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
308	Elecrical	***Lighting***			
309		Lighting Power	Maximum lighting power density per the MA Amendments Table C405.3.2(1), if using the Building Area Method, or per the MA Amendments Table 405.3.2(2), if using the Space-by-Space Method. See Appendix B for specific LPD values. A spreadsheet version of Appendix B is attached to this document. The same LPD modeling approach (either Building Area Method or Space-by-Space Method) must be utilized in modeling both the baseline and design.	**Yes, IECC**	High efficiency design including LEDs with LPD less than the maximum allowable (Field "tuning" of LED fixtures for reduced watts should be supported with clear design documentation and any tuning requirements should be outlined in MRD)
310 311 312		Lighting Occupancy Sensor Control	***IECC ≠ ASHRAE** Automatic occupant sensor controls installed in following space types: ▪ Classrooms/lecture/training rooms ▪ Conference/meeting/multipurpose rooms ▪ Copy/print rooms ▪ Lounges/breakrooms ▪ Enclosed offices ▪ Open plan office areas - for this space type, sensor controls must be configured to reduce general lighting in control zones independently from entire open plan office space. Each control zone must be ≤ 600 SF. ▪ Restrooms ▪ Locker rooms ▪ Spaces ≤ 300 SF enclosed by floor to ceiling partitions ▪ Warehouse storage areas IECC: per Section C405.2.1 *ASHRAE - differences in required sensor locations per Table 9.6.1 (explained in Section 9.4.1.1). Section 9.4.1.1(g) requires that stairwell lights be automatically controlled to reduce power by at least 50% within 20 minutes of all occupants leaving the space.		
313 314		Lighting Time Switch Control	Time-switch controls installed in building areas not provided with occupancy sensors. Light-reduction controls allowing occupants to manually reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50% . IECC: per Section C405.2.2 ASHRAE: per Table 9.6.1 (explained in Section 9.4.1.1)	**Yes, IECC & ASHRAE**	

Line #	Div.	2020 Program Year			
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		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
315 316	**Electrical**	Lighting Daylight Dimming Control	***IECC ≠ ASHRAE (some differences in exceptions)** Daylight-responsive (on/off) controls in "sidelight" and "toplight" daylight zones where there are greater than 100 watts of general lighting; Continuous dimming down to 15% of full light output for all daylight zone fixtures IECC: per Section C405.2.3, see Section C405.2.3.2/3 for definitions of sidelight and toplight zones. ASHRAE: per Table 9.6.1 (explained in Section 9.4.1.1)	**Yes, IECC & ASHRAE**	1. Daylight responsive controls in: · spaces in health care facilities where patient care is directly provided · dwelling units and sleeping units · hotel and motel sleeping units 2. Controls for new buildings where the total connected lighting power ≤ LPAnorm × (1.0 - 0.4 × UDZFA / TBFA) (IECC Only) LPAnorm = lighting power allowanced calculated per Section C405.3.2 and reduced in accordance with Section C406.3 UDZFA = uncontrolled daylight zone floor area is the sum of all sidelit and toplit zones without daylight responsive controls TBFA = total building floor area
317		Lighting Dwelling Unit Controls	***IECC ≠ ASHRAE** Dwelling units shall be provided with controls to either automatically turn off lights within 20 minutes after all occupants have left the space (via occupancy sensors) or to manually reduce the connected lighting load in a reasonably uniform illumination pattern by at least 50% IECC: per Section C405.2.4 ***ASHRAE: per Section 9.4.1.3b = for all guestrooms and dwelling units, automatically turn off power to the lighting and switched receptacles in each enclosed space within 20 minutes after all occupants have left the space; bathrooms shall be controlled separately and have controls to automatically turn off bathroom lighting within 30 minutes after all occupants have left the bathroom.**	**Yes, IECC & ASHRAE**	Daylight responsive controls for dwelling units, dorms, hotel and motel sleeping units.
318		Lighting Controls for Non-Visual Applications	***IECC ≠ ASHRAE** Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control that is independent of the controls for other lighting within the room or space. IECC: per Section C405.2.4 ***ASHRAE no requirement**	**Yes, IECC**	

Line #	Div.	2020 Program Year			
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		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
319	**Electrical**	Parking Garage Lighting Control	***IECC ≠ ASHRAE** No IECC Requirement. If claiming savings, baseline must meet ASHRAE baseline requirements. ***ASHRAE Section 9.4.1.2 =** **· Automatic lighting shutoff required when spaces scheduled to be unoccupied.** **· Lighting power of each luminaire shall be automatically reduced by a minimum of 30% when there is no activity detected within a lighting zone for 20 minutes.** **· Lighting power for covered vehicle entrances and exits from building and parking structures must be automatically controlled to reduce lighting 50% from sunset to sunrise.** **· Daylight controls to reduce lighting power by at least 50% for lighting fixtures within 20 feet of any perimeter wall structure that has a minimum 40% "opening-to-wall" ratio and no exterior obstructions within 20 feet.**	**Yes, ASHRAE**	Automatic parking garage lighting controls that allow for luminaires to reduce lighting power by > 30% when no activity detected for 20 minutes; > 50% lighting power reduction for covered vehicle entrances and exits from sunset to sunrise; >50% lighting power reduction for fixtures within 20 feet of any perimeter wall structure and a minimum 40% "opening-to-wall-ratio"; daylight controls where not required
320		Exterior Lighting	Lighting power densities compliant with IECC 2018 Table C405.4.2(2&3)/ ASHRAE Table 9.4.2-2, depending on lighting zone breakdown in IECC 2018 Table C405.4.2(1) / ASHRAE Table 9.4.2-1. The baseline exterior lighting power allowance shall have the same illumnated area as the design case.	**Yes, IECC & ASHRAE**	High efficiency design including LEDs Note: this is a prescriptive measure and savings should not be included in a custom model or analysis.
321		Exterior Lighting Controls	***IECC ≠ ASHRAE** Timeclock and/or photocell controls that automatically turn off lighting fixtures as a function of available daylight. Façade and landscape lighting controls to shut off lighting no later than 1 hour after business closing and to turn on lights no earlier than 1 hour before business opening **(*ASHRAE = shut off between midnight or business closing, whichever is later, and 6AM or business opening, whichever is earlier)**. All other fixture types shall have controls to reduce connected lighting power by ≥ 30% **(*ASHRAE ≥ 50%)** from 12AM to 6AM, from one hour after business closing to one hour before business opening, or during any period when activity not detected for 15 minutes ***ASHRAE - luminaires ≥78 W and mounted ≤ 24 feet above the ground shall be controlled to automatically reduce the power of each luminaire by a minimum of 50% when no activity has been detected for 15 minutes**	**Yes, IECC & ASHRAE**	Automatic high/low controls (for loading docks or areas with variable occupancy; no manual override ON option)

Line #	Div.	APPENDIX A - BASE CASE HVAC SYSTEM DESIGN			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
A1	Mechanical	***Base Case HVAC System Design Based on Building Type***	In general, the baseline should reflect the same type of HVAC systems that are designed, unless the design team has seriously considered other, less efficient HVAC system types. If the design team considered multiple HVAC system types and ultimately chose a more energy efficient option, then the designed system strategy can be compared to a different baseline system type, provided that the baseline system type meets the following guidelines: 1. The baseline was actually considered for potential implementation by the design team and owner, 2. The baseline is physically, architecturally, and economically feasible for the given project, 3. The baseline type is at least as efficient as the system types outlined in Appendix A for the respective building type, 4. The PA must approve the baseline system type to be used The system types outlined in Appendix A are suggested as a minimum Industry Standard Practice for the respective building types. ASHRAE 90.1 Appendix G cannot be used to model a baseline building for Mass Save savings. Refer to the specific prescriptive code sections for all equipment performance and controls requirements.		
A2		*Equipment Sizing*	Equipment sizing shall match the design. For Integrated Design studies, sizing in the baseline model (if necessary) can only be increased to reduce unmet hours such that the total unmet hours in the baseline are similar to the design model.	N/A	In comprehensive projects, if equipment downsizing is possible via implementation of high-performance measures (e.g. improved envelope performance, reduced LPD, etc.), saving can be claimed for downsized equipment.
A3		*Use of Cooling*	The baseline shall only have cooling where it is actually designed	N/A	
A4		Hotels (Guest Rooms) (≤ 6 floors)	PTAC units with hot water fossil fuel boiler and DX cooling	N/A	
A5		Hotels (Guest Rooms) (> 6 floors) and all Multifamily	Water-source heat pumps, or 4-pipe fan coil units with HW, CHW *For multi-family buildings, consult PA to determine whether building should be considered under the Commercial program.	N/A	
A6		Nonresidential ≤ 3 floors and < 25,000 ft² OR Warehouses/ Manufacturing Space	Packaged Constant Volume AHUs with DX Cooling, and central heating section Each AHU serves no more than 5,000 ft² of conditioned space with zoning identical to the design	N/A	
A7		Nonresidential AND -4 or 5 floors and < 25,000 ft², OR - 5 floors or fewer and 25,000 ft² to 150,000 ft²	Packaged rooftop VAV with reheat, hot-water boiler and DX cooling	N/A	

Line #	Div.	APPENDIX A - BASE CASE HVAC SYSTEM DESIGN			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
A8	**Mechanical**	Nonresidential and more than 5 floors or > 150,000 ft²	VAV with reheat, hot-water fossil fuel boiler and chilled water	N/A	
A9		Retail with ≤ 2 Floors	Packaged Constant Volume AHUs with DX Cooling, and central heating section Each AHU serves no more than 5,000 ft² of conditioned space with zoning identical to the	N/A	
A10		Schools (all sizes)	Packaged VAV air handling units with DX cooling and HW reheat for multi-zone service (e.g. classrooms, offices, etc.) Packaged Constant Volume AHUs with DX cooling for specialty spaces (e.g. auditorium, gym, cafeteria, etc.) Central HW boiler plant serving AHUs, VAV reheats, and perimeter radiant heating elements	N/A	

APPENDIX B: BASELINE LPD VALUES (PER MA AMENDMENTS)

Note: The MassSave Baseline LPD values are defined by the MA Amendments which differ from IECC 2018; however the IECC 2018 values are provided for reference.

A spreadsheet version of this appendix is attached to this document.

Building Area Method		
Building Type	**MA Amendments* (MassSave Baseline)**	**IECC 2018**
Automotive facility	0.75	0.71
Convention center	0.64	0.76
Courthouse	0.79	0.90
Dining: bar lounge/leisure	0.8	0.90
Dining: cafeteria/fast food	0.76	0.79
Dining: family	0.71	0.78
Dormitory	0.53	0.61
Exercise center	0.72	0.65
Fire station	0.56	0.53
Gymnasium	0.76	0.68
Health care clinic	0.81	0.82
Hospital	0.96	1.05
Hotel/Motel	0.56	0.75
Library	0.83	0.78
Manufacturing facility	0.82	0.90
Motion picture theater	0.44	0.83
Multifamily	0.45	0.68
Museum	0.55	1.06
Office	0.64	0.79
Parking garage	0.18	0.15
Penitentiary	0.69	0.75
Performance arts theater	0.84	1.18
Police Station	0.66	0.80
Post office	0.65	0.67
Religious building	0.67	0.94
Retail	0.84	1.06
School/university	0.72	0.81
Sports arena	0.76	0.87
Town hall	0.69	0.80
Transportation	0.5	0.61
Warehouse	0.45	0.48
Workshop	0.91	0.90

*MassSave follows the MA Amendments to define baseline LPD

Space-by-Space Method			
Common/Building Specific	Space Type	MA Amendments* (MassSave Baseline)	IECC 2018
Common Space types	Audience seating area - In a convention center	0.82	0.82
Common Space types	Audience seating area - In a gymnasium	0.23	0.65
Common Space types	Audience seating area - In a motion picture theater	0.27	1.14
Common Space types	Audience seating area - In a penetentiary	0.67	0.28
Common Space types	Audience seating area - In a performing arts theater	1.16	2.03
Common Space types	Audience seating area - In a religious building	0.72	1.53
Common Space types	Audience seating area - In a sports arena	0.33	0.43
Common Space types	Audience seating area - In an auditorium	0.61	0.63
Common Space types	Audience seating area - OTHERWISE	0.23	0.43
Common Space types	Banking activity area	0.61	0.86
Common Space types	Classroom/lecture hall/ training room - In a penetentiary	0.89	1.34
Common Space types	Classroom/lecture hall/ training room - OTHERWISE	0.71	0.96
Common Space types	Computer Room	0.94	1.33
Common Space types	Conference/meeting/multipurpose room	0.97	1.07
Common Space types	Copy/Print Room	0.31	0.56
Common Space types	Corridor - facillity for viusually impaired (not primarily used by staff)	0.71	0.92
Common Space types	Corridor - In a hospital	0.71	0.92
Common Space types	Corridor - In a manufacturing facility	0.29	0.29
Common Space types	Corridor - OTHERWISE	0.41	0.66
Common Space types	Courtroom	1.2	1.39
Common Space types	Dining area - facillity for viusually impaired (not primarily used by staff)	1.27	2.00
Common Space types	Dining area - In a penetentiary	0.42	0.96
Common Space types	Dining area - In bar/lounge or leisure dining	0.86	0.93
Common Space types	Dining area - In cafeteria or fast food dining	0.4	0.63
Common Space types	Dining area - In family dining	0.6	0.71
Common Space types	Dining area - OTHERWISE	0.43	0.63
Common Space types	Electrical/mechanical	0.43	0.43
Common Space types	Emergency vehicle parking	0.52	0.41
Common Space types	Food preparation	1.09	1.06
Common Space types	Guest room	0.41	0.77
Common Space types	Laboratory - In or as classrooms	1.11	1.20
Common Space types	Laboratory - OTHERWISE	1.33	1.45
Common Space types	Laundry/washing area	0.53	0.43
Common Space types	Loading dock, interior	0.88	0.58
Common Space types	Lobby - facillity for viusually impaired (not primarily used by staff)	1.69	2.03
Common Space types	Lobby - for an elevator	0.65	0.68
Common Space types	Lobby - In a hotel	0.51	1.06
Common Space types	Lobby - In a motion picture theater	0.23	0.45
Common Space types	Lobby - In a performing arts theater	1.25	1.70
Common Space types	Lobby - OTHERWISE	0.84	1.00
Common Space types	Locker room	0.52	0.48
Common Space types	Lounge/breakroom - In a **healthcare facility**	0.42	0.78
Common Space types	Lounge/breakroom - OTHERWISE	0.59	0.62
Common Space types	Office - enclosed (<=250 sqft)	0.74	0.93
Common Space types	Office - enclosed (>250 sqft)	0.66	0.93
Common Space types	Office - open plan	0.61	0.81
Common Space types	Parking area, interior	0.15	0.14
Common Space types	Pharmacy area	1.66	1.34
Common Space types	Restroom - facillity for viusually impaired (not primarily used by staff)	1.26	0.96
Common Space types	Restroom - OTHERWISE	0.63	0.85
Common Space types	Sales area	1.05	1.22
Common Space types	Seating area, general	0.23	0.42
Common Space types	Stairwell	0.49	0.58
Common Space types	Storage room	0.51	0.46
Common Space types	Vehicular Maintenance area	0.6	0.56
Common Space types	Workshop	1.26	1.14

Space-by-Space Method			
Common/Building Specific	Space Type	MA Amendments* (MassSave Baseline)	IECC 2018
Building Specific Space Types	Convention center - exhibit space	0.61	0.88
Building Specific Space Types	Dormitory - living quarters	0.5	0.54
Building Specific Space Types	Facility for visually imparired - In a Chapel (not primarily used by staff)	0.7	1.06
Building Specific Space Types	Facility for visually imparired - In a rec room (not primarily used by staff)	1.77	1.80
Building Specific Space Types	Fire Station - sleeping quarters	0.23	0.20
Building Specific Space Types	Gymnasium/fitness center - In a playing area	0.85	0.82
Building Specific Space Types	Gymnasium/fitness center - In an exercise area	0.9	0.50
Building Specific Space Types	Healthcare Facility - In a medical supply room	0.62	0.54
Building Specific Space Types	Healthcare Facility - In a nursery	0.92	1.00
Building Specific Space Types	Healthcare Facility - In a patient room	0.68	0.62
Building Specific Space Types	Healthcare Facility - In a physical therepay room	0.91	0.84
Building Specific Space Types	Healthcare Facility - In an exam/treatment room	1.4	1.68
Building Specific Space Types	Healthcare Facility - In an imaging room	0.94	1.06
Building Specific Space Types	Healthcare Facility - In an nurse's station	1.17	0.81
Building Specific Space Types	Healthcare Facility - In an operating room	2.26	2.17
Building Specific Space Types	Healthcare Facility - In a recovery room	1.25	1.03
Building Specific Space Types	Library - In a reading area	0.96	0.82
Building Specific Space Types	Library - In the stacks	1.18	1.20
Building Specific Space Types	Manufacturing - In a detailed manufacturing area	0.8	0.93
Building Specific Space Types	Manufacturing - In a high bay area (25- – 50-foot floor-ceiling height)	1.24	0.75
Building Specific Space Types	Manufacturing - In a low bay area (<25-foot floor-ceiling height)	0.86	0.96
Building Specific Space Types	Manufacturing - In an equipment room	0.76	0.65
Building Specific Space Types	Manufacturing - In an extra high bay area (>50-foot floor-ceiling height)	1.42	1.05
Building Specific Space Types	Museum - In a general exhibition area	0.31	1.05
Building Specific Space Types	Museum - In a restoration room	1.1	0.85
Building Specific Space Types	Performing arts theater - dressing room	0.41	0.36
Building Specific Space Types	Post office - sorting area	0.76	0.68
Building Specific Space Types	Religious building - In a fellowship hall	0.54	0.55
Building Specific Space Types	Religious building - In a worship/pulpit/choir area	0.85	1.53
Building Specific Space Types	Retail - In a dressing/fitting area	0.51	0.50
Building Specific Space Types	Retail - In a mall concourse	0.82	0.90
Building Specific Space Types	Sports arena - playing area - For a Class I facility	2.94	2.47
Building Specific Space Types	Sports arena - playing area - For a Class II facility	2.01	1.96
Building Specific Space Types	Sports arena - playing area - For a Class III facility	1.3	1.70
Building Specific Space Types	Sports arena - playing area - For a Class IV facility	0.86	1.13
Building Specific Space Types	Transportation facility - At a terminal ticket counter	0.51	0.62
Building Specific Space Types	Transportation facility - In a baggage/carousel area	0.39	0.45
Building Specific Space Types	Transportation facility - In an airport concourse	0.25	0.31
Building Specific Space Types	Warehouse - storage area - For medium to bulky, palletized items	0.33	0.35
Building Specific Space Types	Warehouse - storage area - For smaller, hand-carried items	0.69	0.69

*MassSave follows the MA Amendments to define baseline LPD