2017 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 replacement" is defined as a specific age of existing equipment this 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 (ASHRAE 90.1-2013 or IECC 2015).
>
> *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 below 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 January 2, 2017 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 2015
ii. ASHRAE 90.1-2013

The Baseline Document is intended to highlight the key criteria within these codes that set the baseline for code-specific equipment; 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 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 **(cannot use IECC for some sections and ASHRAE for others; aside from interior lighting power which must follow IECC C406.3 regardless of compliance path)**. 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. That said, the regulators overseeing MA energy efficiency programs have set a specific path for IECC C406 requirements. Contact your PA representative to be sure you understand this special ruling. 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 2015 includes a section (C406) that requires new buildings to comply with at least one of six 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 compliance.

For Mass Save, the baseline for new building projects (including additions and gut-rehab of existing buildings) shall always include C406.3 (Reduced Lighting Power Density) regardless of which particular option is used by the design team for code compliance.

If State amendments require more than one C406 option for compliance, the Mass Save baseline for incentives shall still be only C406.3, and savings can be claimed for any other C406 options that are implemented into the design (even if required by energy code).

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) 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 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 be assigned an ECM 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 be the State's "base code" with amendments, or industry standard practice. Energy savings can be claimed and incentives may be offered for equipment/systems meeting stretch code that exceed the "base code" requirements.

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.

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

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 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 2015 electronic copy link at: http://codes.iccsafe.org/app/book/toc/2015/I-Codes/2015%20IECC%20HTML/index.html

ii. Massachusetts Amendments to the International Building Code link at: http://www.mass.gov/eopss/docs/dps/buildingcode/8th-edition-amendments/2016-08-12-chapters-13-51-and-115-aa-8th-ed-amendments.pdf

Line #	Div.	2017 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 base case for all projects in Massachusetts shall be C406.3 - Reduce lighting power density by 10% over Table C405.4.2(1) or Table C405.4.2(2). **IECC C406.3 shall be the base case regardless of code compliance path.**				-	High efficiency design using LEDs with LPD less than the maximum allowable by C406.3
	B	***IECC vs. ASHRAE***	Either IECC 2015 or ASHRAE 90.1 2013 can be used to define the baseline. Whichever standard is used must be followed in its entirety (cannot use IECC for some sections and ASHRAE for others).					
	C	***Acceptable Baseline Modeling Methods***	For Mass Save, the only acceptable baseline modeling method is the Prescriptive path (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 90.1-2013 Appendix G, ASHRAE 90-1 2013 Chapter 11 (Energy Cost Budget Method), and IECC 2015 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.				-	Opaque wall insulation with higher thermal resistance. Check amendments for clarification. 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.
3				Category	R-value Method*	U-value Method		
4			**Roofs**	Insulation entirely above deck	R-30ci	U-0.032		
5				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				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				Metal building	R-13 + R-13 ci ***ASHRAE R-0 + R-19ci**	U-0.052 ***ASHRAE U-0.050**		
9				Metal framed	R-13 + R-7.5 ci ***ASHRAE R-13 + R-10ci**	U-0.064 ***ASHRAE U-0.055**		
10				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 grade**	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				Joist/framing	R-30	U-0.033 ***ASHRAE U-0.038 (steel joist) and U-0.033 (wood framed/other)**		
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				Heated slabs	R-15 for 36" below ***ASHRAE R-20 for 48"**	F-0.65 ***ASHRAE F-0.688**		
16			***Opaque Doors***	Nonswinging	R-4.75 ***ASHRAE no requirement**	U-0.37 ***ASHRAE U-0.5 (swinging & nonswinging)**		
17			*ci = continuous insulation; when using R-value method, a thermal spacer shall be provided.					

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18	**Architectural**	***Window and Skylight Assemblies***	***IECC ≠ ASHRAE** Performance per IECC Table C402.4 / ASHRAE Table 5.5-5 (Climate Zone 5)				-	Window and skylight **assembly** 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).
19			***Vertical Fenestration, U-factor***			**Add'l Req.**		
20			Fixed fenestration	U-0.38 ***ASHRAE U-0.42 (metal framing)**		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**		
21			Operable fenestration	U-0.45 ***ASHRAE U-0.50 (metal framing)**				
22			Entrance doors	U-0.77				
23			Nonmetal framing	IECC same requirements as above ***ASHRAE U-0.32 (all)**				
24			***Vertical Fenestration, Solar Heat Gain Coefficient (SHGC)***					
25			Orientation	S, E, W	North	***ASHRAE SHGC = 0.40; VT/SHGC = 1.1 (all frame types)**		
26			PF < 0.2	0.4	0.53			
27			***Skylights***					
28			U-factor	U-0.5† ***ASHRAE U-0.5**		Skylight area shall be ≤ 3% of gross roof area†		
29			SHGC	0.4† ***ASHRAE SHGC-0.4**				
30			*If PF (projection factor) value greater than 0.2, see IECC 2015 Table C402.4 for SHGC requirements.					
31			†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					
32		***Window-to-Wall Ratio***	***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 wall-to-window or reduced skylight areas. IECC: per Section C402.4.1 ASHRAE: per Table 5.5-5				-	

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<tr><th rowspan="3">Line
#</th><th rowspan="3">Div.</th><th colspan="6">2017 Program Year</th></tr>
<tr><th>*System*</th><th colspan="5"></th></tr>
<tr><th>Sub-Category</th><th colspan="3">Baseline Minimum Standards & Practice</th><th>Mandatory for Code Compliance regardless of path</th><th>Potential High-Performance Practices</th></tr>
<tr><td>33</td><td rowspan="13">Mechanical</td><td>***Code Required Airside Attributes***</td><td colspan="3"></td><td></td><td></td></tr>
<tr><td>34</td><td>Demand Controlled Ventilation</td><td colspan="3">***IECC ≠ ASHRAE (difference in exceptions)**
Required for spaces > 500ft² with design occupancy ≥ 25 people per 1,000 ft².

IECC: per Section C403.2.6.1
ASHRAE: per Section 6.4.3.8

Baseline DCV strategy: CO2 sensors control AHU OA damper position, but no zone damper control.</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), or for systems with energy recovery
3. Advanced occupancy sensor based DCV where occupancy sensors are used to close zone ventilation air dampers
4. Individual zone VAV box minimum flow reset based on zone CO2 sensors (control to reduce box min. flow if CO2 levels are below threshold)</td></tr>
<tr><td>35</td><td rowspan="11">Energy Recovery</td><td colspan="3">≥ 50% effective energy recovery required for systems with the following design parameters (both %OA and CFM)</td><td rowspan="11">**Yes, IECC**</td><td rowspan="11">1. Energy recovery where not code required
2. Energy recovery effectiveness exceeding 50%
3. Reduce pressure drop associated with energy recovery</td></tr>
<tr><td>36</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>37</td><td>≥ 80% OA</td><td>all capacities</td><td>all capacities</td></tr>
<tr><td>38</td><td>≥ 70% and < 80%</td><td>≥ 1,000 CFM</td><td>all capacities</td></tr>
<tr><td>39</td><td>≥ 60% and < 70%</td><td>≥ 2,000 CFM</td><td>all capacities</td></tr>
<tr><td>40</td><td>≥ 50% and < 60%</td><td>≥ 3,500 CFM</td><td>all capacities</td></tr>
<tr><td>41</td><td>≥ 40% and < 50%</td><td>≥ 4,500 CFM</td><td>all capacities</td></tr>
<tr><td>42</td><td>≥ 30% and < 40%</td><td>≥ 5,500 CFM</td><td>all capacities</td></tr>
<tr><td>43</td><td>≥ 20% and < 30%</td><td>≥ 16,000 CFM</td><td>all capacities</td></tr>
<tr><td>44</td><td>≥ 10% and < 20%</td><td>≥ 26,000 CFM</td><td>all capacities</td></tr>
<tr><td>45</td><td colspan="3">IECC: per Section C403.2.7/Table C403.2.7(1) & (2) - some exceptions apply
ASHRAE: per Section 6.5.6/Table 6.5.6.1 - some exceptions apply</td></tr>
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46	**Mechanical**	Economizer	***IECC ≠ ASHRAE (some exceptions apply, difference in exceptions)** Air or water economizer interlocked with mechanical cooling required for each cooling system that has a fan and a cooling capacity ≥ 54,000 Btu/h IECC: per Section C403.3 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 C403.4.5 / 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 (see Market Characterization sections) 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. Water-side economizer piped in series with chiller(s) (e.g. partial economizer capability)
47					
48		Fan Airflow/Speed Control	Each DX cooled AHU ≥ 65,000 Btu/h, each chilled water AHU with a fan motor ≥ 5 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 **This baseline requirement varies from code.**	-	Modulating fan controls using VFDs or EC motors for: DX cooled AHUs < 65,000 Btu/hr, or CHW cooled AHUs with a fan motor < 5 hp, or evaporatively cooled AHUs with a fan motor < 1/4 hp using VFDs or EC motors
49		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 C403.4.1.3 ASHRAE: per Section 6.5.3.2.3	-	
50		Supply Air Temperature Reset	Multiple-zone HVAC systems 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 C403.4.4.5 ASHRAE: per Section 6.5.3.4	-	Supply air temperature reset greater than 25% of dT

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<tr><th>Sub-Category</th><th colspan="2">Baseline Minimum Standards & Practice</th><th>Mandatory for Code Compliance regardless of path</th><th>Potential High-Performance Practices</th></tr>
<tr><td>51</td><td rowspan="22">Mechanical</td><td>Fractional HP Fan Motors
(EC Motors)</td><td colspan="2">Motors for fans ≥ 1/12 hp and < 1 hp shall be electronically commutated motors or have a minimum motor efficiency of 70%.
IECC: per Section C403.4.4.4
ASHRAE: per Section 6.5.3.5</td><td>-</td><td>Higher efficiency fractional hp motors (> 70%).
Non-excitable commutated motors
Permanent magnet motors</td></tr>
<tr><td>52</td><td rowspan="21">Fan Power</td><td colspan="2">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 fan-powered terminal units combined)
CV: 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%
IECC: per Section C403.2.12/Table C403.2.12.1(1 & 2)
ASHRAE: per Section 6.5.3.1/Table 6.5.3.1-1&2</td><td rowspan="21">Yes, IECC</td><td rowspan="21">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
If pursuing lower pressure drop, a static pressure test must be conducted once system is fully balanced. This is not intended to account for a change of use with pre-existing ductwork.
Note: fanwalls are not considered any more efficient than a single larger fan with VFD control</td></tr>
<tr><td>53</td><td>Device</td><td>Adjustment</td></tr>
<tr><td>54</td><td colspan="2">Credits</td></tr>
<tr><td>55</td><td>Fully ducted return and/or exhaust air systems</td><td>0.5 in w.c.</td></tr>
<tr><td>56</td><td>Return and/or exhaust airflow control devices</td><td>0.5 in w.c.</td></tr>
<tr><td>57</td><td>Exhaust filters, scrubbers or other treatment</td><td>design pressure drop</td></tr>
<tr><td>58</td><td>Filters: MERV 9 thru 12</td><td>0.5 in w.c.</td></tr>
<tr><td>59</td><td>Filters: MERV 13 thru 15</td><td>0.9 in w.c.</td></tr>
<tr><td>60</td><td>Filters: MERV 16+</td><td>design pressure drop calculated at 2x clean filter pressure drop</td></tr>
<tr><td>61</td><td>Carbon and other gas-phase air cleaners</td><td>clean filter pressure drop at design</td></tr>
<tr><td>62</td><td>Biosafety cabinet</td><td>pressure drop of device at design</td></tr>
<tr><td>63</td><td>Energy recovery device, other than coil runaround loop</td><td>(2.2 x energy recovery effectiveness) - 0.5 in w.c. for each airstream</td></tr>
<tr><td>64</td><td>Coil runaround loop</td><td>0.6 in w.c. for each airstream</td></tr>
<tr><td>65</td><td>Evaporative humidifier/cooler in series with another cooling coil</td><td>pressure drop at design</td></tr>
<tr><td>66</td><td>Sound attenuation section</td><td>0.15 in w.c.</td></tr>
<tr><td>67</td><td>Exhaust system serving fume hoods</td><td>0.35 in w.c.</td></tr>
<tr><td>68</td><td>Laboratory and vivarium exhaust systems in high-rise buildings</td><td>0.25 in w.c. / 100 feet of vertical duct exceeding 75 feet</td></tr>
<tr><td>69</td><td colspan="2">Deductions</td></tr>
<tr><td>70</td><td>Systems without central cooling device</td><td>-0.6 in w.c.</td></tr>
<tr><td>71</td><td>Systems without central heating device</td><td>-0.3 in w.c.</td></tr>
<tr><td>72</td><td>Systems with central electric resistance heat</td><td>-0.2 in w.c.</td></tr>
</table>

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		System Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
73	**Mechanical**	***EMS Basic Functionality***	EMS points meet following requirements: - Individual zone heating and cooling controls - Temperature dead bands of at least 5˚F - Automatic shutdown/setback controls (down to 55˚F, up to 85˚F) - Optimal start capabilities - Shutoff damper controls for outdoor air intake and exhaust dampers to automatically close dampers when spaces unoccupied or in setback IECC: per Sections C403.2.4.1-3 ASHRAE: per Section 6.4.3	**Yes, IECC & ASHRAE**	See "Code Required Airside Attributes" section (line 33) for high-performance controls measures.
74		***Base Case HVAC System Design Based on Building Type***	This section is intended to provide general information regarding the acceptable baseline system types based on building type and area, but does not reflect code requirements. 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.		
75		*Equipment Sizing*	Equipment sizing according to guidance provided by ASHRAE and IECC	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.
76		*Use of Cooling*	The baseline shall only have cooling where it is actually designed	N/A	
77		Hotels (Guest Rooms) (≤ 6 floors)	PTAC units with hot water fossil fuel boiler and DX cooling (PTHP acceptable only if no natural gas is available at the site)	N/A	Higher efficiency HVAC system types, e.g.: 1. Water-source heat pumps 2. 4-pipe fan coil units with HW, CHW 3. VRF System
78		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	
79		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 *If natural gas is available then heating fuel must be natural gas	N/A	Higher efficiency HVAC system types, e.g.: 1. VAV w/ reheat 2. Dedicated outdoor air unit with zone heating and cooling units (FCUs, VRF, WSHP, chilled beams, etc.) 3. Underfloor air/displacement ventilation Note: if chilled beams are used, additional savings can be realized with a dedicated chiller to make higher temperature water

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80	**Mechanical**	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 *If natural gas is available then heating fuel must be natural gas	N/A	Higher efficiency HVAC system types, e.g.: 1. Dedicated outdoor air unit with zone heating and cooling units (FCUs, VRF, WSHP, chilled beams, etc.) 2. Underfloor air/displacement ventilation 3. Dedicated single-zone units for spaces having unique conditioning requirements or operating schedules that allow general air handling equipment to run fewer hours (case-by-case, discuss with PA) 4. Chilled water cooling Note: if chilled beams are used, additional savings can be realized with a dedicated chiller to make higher temperature water
81		Nonresidential and more than 5 floors or > 150,000 ft²	VAV with reheat, hot-water fossil fuel boiler and chilled water *If natural gas is available then heating fuel must be natural gas	N/A	Higher efficiency HVAC system types, e.g.: 1. Dedicated outdoor air unit with zone heating and cooling units (FCUs, VRF, WSHP, chilled beams, etc.) 2. Underfloor air/displacement ventilation 3. Dedicated single-zone units for spaces having unique conditioning requirements or operating schedules that allow general air handling equipment to run fewer hours (case-by-case, discuss with PA) Note: if chilled beams are used, additional savings can be realized with a dedicated chiller to make higher temperature water
82		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 design *If natural gas is available then heating must be natural gas furnace	N/A	Higher efficiency HVAC system types, e.g.: 1. VAV w/ reheat 2. Dedicated outdoor air unit with zone heating and cooling units (FCUs, VRF, WSHP, chilled beams, etc.) 3. Underfloor air/displacement ventilation Note: if chilled beams are used, additional savings can be realized with a dedicated chiller to make higher temperature water

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83	**Mechanical**	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	Higher efficiency HVAC system types, e.g.: 1. Dedicated outdoor air unit with zone heating and cooling units (FCUs, VRF, WSHP, chilled beams, etc.) 2. Central chilled water system for cooling 3. Single zone VAV control for specialty spaces
84		Geothermal Systems	Geothermal systems are recognized as a high performance practice, but cost effectiveness is a barrier for incentives. Discuss design and costs for these systems with the PA before pursuing as an ECM.		
85		***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) **This baseline requirement varies from code.**	**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) Savings cannot be claimed for variable speed fan controls with minimum speed below 50% **These high performance practices vary from code; no credit allowed for ventilation controls in systems designed to exceed to ratio of garage area to ventilation horsepower (ft²/hp) limit.**
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. Disaggregated kitchen hoods (versus one exhaust fan serving multiple hoods) 5. 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 • 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 C403.2.8 ASHRAE: per Section 6.5.7.1		

Line #	Div.	System	2017 Program Year			
		Sub-Category	Baseline Minimum Standards & Practice		Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
89	Mechanical	Kitchen Hood Exhaust Flow	Each hood has a maximum exhaust rate complying with below table:		Yes, IECC	Low flow kitchen hood exhaust system
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 C403.2.8 ASHRAE: per Table 6.5.7.1.3			
97		Fume Hood Exhaust Systems	***IECC ≠ ASHRAE** If used to bypass the energy recovery requirements of IECC 2015 Section C403.2.7, 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** **<u>This baseline requirement varies from code:</u>** • All laboratory spaces shall have time of day, scheduled airflow controls to reduce unoccupied airflow rates Note: Industry standard fume hoods specified at 100 fpm IECC: per Section C403.2.7, exception 2 ASHRAE: per Section 6.5.7.2		-	1. Systems ≤ 5,000 cfm: variable flow controls 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 10. Desiccant gas-fired dehumidification unit
98						
99						
100						

Line #	Div.	2017 Program Year			
		System Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
101	**Mechanical**	Fume Hood Exhaust Fan Control	Constant speed fans with bypass dampers to maintain plume height	-	1. Variable speed exhaust fans capable of maintaining air velocity / plume height at reduced flow 2. Multiple manifolded fans that are staged based on static pressure
102		Operable Windows		-	Window interlock controls with HVAC system Note: For natural ventilation design; check with Program Administrator to see if high-performance plan qualifies.
103		***Hydronic Systems Equipment & Controls***		-	
104		Piping Design	Same diameter piping throughout system		"Reverse Return" piping design to reduce system pressure differential
105		Hot Water Outdoor Air Temperature Setback	***IECC ≠ ASHRAE** Required for all one- or two-pipe systems IECC: per Section C403.2.5 ***ASHRAE - no requirement**	**Yes, IECC**	See HW Temperature Reset below
106		HW / CHW Temperature Reset	***IECC ≠ ASHRAE** Required for systems ≥ 500 MBH, must reset by at least 25% of system dT IECC: per Section C403.4.2.4.1 ***ASHRAE - same for systems ≥ 300 MBH (per Section 6.5.4.4); however not required if variable flow pumping controls implemented**	-	1. HW/CHW reset for systems < 500 MBH (IECC) or < 300 MBH (ASHRAE) 2. HW/CHW reset greater than 25% of system dT 3. Both HW/CHW reset and variable flow controls (ASHRAE) Note: condensing boilers should be combined with aggressive HW reset down to at least 120°F to achieve higher operating efficiency

<table>
<tr><th rowspan="3">Line
#</th><th rowspan="3">Div.</th><th colspan="6">2017 Program Year</th></tr>
<tr><th>*System*</th><th colspan="5"></th></tr>
<tr><th>Sub-Category</th><th colspan="3">Baseline Minimum Standards & Practice</th><th>Mandatory for Code Compliance regardless of path</th><th>Potential High-Performance Practices</th></tr>
<tr><td>107</td><td rowspan="10">Mechanical</td><td>HW / CHW Variable Flow Control</td><td colspan="3">***IECC ≠ ASHRAE**
Required for systems ≥ 500 MBH with ≥ 10 hp total pump capacity; must automatically reduce flow by at least 50%

IECC: per Section C403.4.2.4.2
***ASHRAE - required for systems > 10 hp total pump capacity and individual chilled-water pumps serving variable-flow systems having motors > 5 hp; must automatically reduce flow by at least 50% via installation of variable frequency drives (VFDs) (per Section 6.5.4.2)**</td><td>-</td><td>1. HW/CHW pump VFDs (IECC)
2. HW/CHW variable flow controls for systems < 500 MBH (IECC), N/A for ASHRAE
3. HW/CHW variable flow controls for systems with < 10 hp total pump power
4. HW/CHW flow reduction of greater than 50% of design flow
5. Fractional horsepower pumps with EC motors</td></tr>
<tr><td>108</td><td>Heat Rejection Loop Variable Flow Controls</td><td colspan="3">***IECC ≠ ASHRAE**
Required for systems ≥ 500 MBH with ≥ 10 hp total pump power serving water-cooled unitary air conditioners; must automatically reduce flow by at least 50%

IECC: per Section C403.4.2.4.3
***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)**</td><td>-</td><td>1. Heat Rejection Loop pump VFDs (IECC)
2. Heat Rejection Loop variable flow controls for systems < 500 MBH (IECC), N/A for ASHRAE
3. Heat Rejection Loop variable flow controls for system with < 10 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</td></tr>
<tr><td>109</td><td></td><td colspan="3">Hydronic pipe insulation meeting minimum thickness
IECC: per Table C403.2.10
***ASHRAE: per Table 6.8.3-1 and 6.8.3-2**</td><td>**Yes, IECC & ASHRAE**</td><td></td></tr>
<tr><td>110</td><td rowspan="7">*Furnaces*</td><td colspan="3">Warm-air furnaces with performance meeting IECC Table 403.2.3(4) / ASHRAE 90.1 2013 Table 6.8.1-5
This baseline requirement exceeds code for furnaces ≤ 225 MBH.</td><td rowspan="7">**Yes, IECC & ASHRAE**</td><td rowspan="7">Furnace with performance exceeding baseline requirement (e.g. condensing furnaces)</td></tr>
<tr><td>111</td><td>*Type*</td><td>*<225 MBH*</td><td>*≥225 MBH*</td></tr>
<tr><td>112</td><td>Warm Air, Gas fired</td><td>85% AFUE</td><td>80% Et</td></tr>
<tr><td>113</td><td>Warm Air, Oil Fired</td><td>83% AFUE</td><td>81% Et</td></tr>
<tr><td>114</td><td>Warm Air Duct, Gas Fired</td><td>85% AFUE</td><td rowspan="3">80% Ec</td></tr>
<tr><td>115</td><td>Warm Air Unit Heater, Gas Fired</td><td rowspan="2">80% Ec</td></tr>
<tr><td>116</td><td>Warm Air Unit Heater, Oil Fired</td></tr>
</table>

Line #	Div.	2017 Program Year					
		System Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
117	**Mechanical**	***Boilers***					
118		Selection	***IECC ≠ ASHRAE** Hot water - non-condensing boilers with performance meeting IECC 2015 Table C403.2.3(5) / ASHRAE 90.1 2013 Table 6.8.1-6: **This baseline requirement exceeds code for gas-fired hot-water boilers ≤2,500 MBH.**			**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
119			*Capacity (Input, MBH)*	*gas-fired*	*oil-fired*		
120			< 300	**85%**	80% AFUE ***ASHRAE = 84% AFUE**		
121			≥ 300 and ≤ 2,500	**85%**	82% Et		
122			> 2,500	82% Ec	84% Ec		
123			Steam plants - boilers with performance meeting IECC 2015 Table C403.2.3(5) / ASHRAE 90.1 2013 Table 6.8.1-6:			**Yes, IECC & ASHRAE**	
124			*Capacity (Input, MBH)*	*gas-fired*	*oil-fired*		
125			< 300	75% AFUE ***ASHRAE = 80% AFUE**	80% AFUE ***ASHRAE = 82% AFUE**		
126			≥ 300 and ≤ 2,500 all, except natural draft	79% Et	81% Et		
127			≥ 300 and ≤ 2,500 natural draft	77% Et			
128			> 2,500 all, except natural draft	79% Et	81% Et		
129			> 2,500 natural draft	77% Et			
130		Burner controls	Boilers ≥ 1,000 MBH shall meet the minimum turndown ratios of IECC 2015 Table C403.4.2.5 / ASHRAE 90.1 2013 Table 6.5.4.1			-	Boiler turndown beyond minimum code requirement
131			*Capacity (Input, MBH)*	*Minimum Turndown*			
132			≥ 1,000 and ≤ 5,000	3 to 1			
133			> 5,000 and ≤ 10,000	4 to 1			
134			> 10,000	5 to 1			
135			Heating systems comprised of a single boiler > 500 MBH shall have a multistage or modulating burner			-	Modulating burners on boilers < 500,000 Btu/hr capacity
136			< 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
137			Mechanical linkage control			-	Parallel positioning controls with oxygen trim
138		Boiler pumps	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE = Number of pumps equal to the number of boilers and stage on/off with boilers (per Section 6.5.4.3.2)**			-	
139		Boiler controls				-	Predictive cycling control to limit boiler cycling Heat recovery in steam plants

Line	Div.	2017 Program Year						
		System						
#		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
140	Mechanical	***Cooling Systems***						
141		Heat Pumps: Air Source	***IECC ≠ ASHRAE** Air-source heat pumps with performance meeting IECC 2015 Table C403.2.3(2) / ASHRAE 90.1-2013 Table 6.8.1-2				**Yes, IECC & ASHRAE**	Heat pumps with performance exceeding baseline requirements
142				*Equipment Type*	*Size (MBH)*	*Minimum Efficiency*		
143				Air cooled	< 65	Split: 14 SEER, 8.2 HSPF Pkgd: 14 SEER, 8.0 HSPF		
144				Through-the-wall	≤30	Split: 12 SEER, 7.4 HSPF Pkgd: 12 SEER, 7.4 HSPF		
145				Single-duct high-velocity	<65	Split: 11 SEER, 6.8 HSPF		
146				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)		
147					≥ 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)		
148					≥ 240	9.5 EER & 10.6 IEER (electric heat or no heat) 9.3 EER & 9.4 IEER (other heat) 3.2 COP (47°F db/43°F wb) 2.05 COP (17°F db/ 15°F wb)		
149		Ground-source Heat Pumps	Ground-source heat pumps with performance meeting IECC 2015 Table C403.2.3(2) / ASHRAE 90.1-2013 Table 6.8.1-2				**Yes, IECC & ASHRAE**	Heat pumps with performance exceeding baseline requirements
150				*Equipment Type*	*Size (MBH)*	*Minimum Efficiency*		
151				Water to Air: Water Loop	<17	12.2 EER (86°F EWT) 4.3 COP (68°F EWT)		
152					≥ 17 and < 65	13.0 EER (86°F EWT) 4.3 COP (68°F EWT)		
153					≥ 65 and < 135	13.0 EER (86°F EWT) 4.3 COP (68°F EWT)		
154				Water to Air: Ground Water	<135	18.0 EER (59°F EWT) 3.7 COP (50°F EWT)		
155				Brine to Air: Ground Loop	<135	14.1 EER (77°F EWT) 3.2 COP (32°F EWT)		
156				Water to Water: Water Loop	<135	10.6 EER (86°F EWT) 3.7 COP (68°F EWT)		
157				Water to Water: Ground Water	<135	16.3 EER (59°F EWT) 3.1 COP (50°F EWT)		
158				Brine to Water: Ground Loop	<135	12.1 EER (77°F EWT) 2.5 COP (32°F EWT)		

Line #	Div.	2017 Program Year						
		System						
		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
159	**Mechanical**	Heat Pumps: Standard Water Loop	Minimum heat pump water supply temperature dead band of 20°F IECC: per Section C403.4.2.3.1 ASHRAE: per Section 6.5.2.2.3				-	Controls that optimize loop temperature based upon real-time conditions and loads
160		Unitary Air Conditioners (RTUs, etc.) and Split Systems	Standard efficiency packaged/split unit with DX cooling with performance meeting IECC 2015 Table C403.2.3(1) / ASHRAE 2013 Table 6.8.1-1				**Yes, IECC & ASHRAE**	Cooling systems with performance exceeding baseline requirements, fan selection with performance exceeding baseline requirements
161				*Equipment Type*	*Size (MBH)*	*Minimum Efficiency*		
162				Air cooled	< 65	Split: 13 SEER; Pkgd: 14 SEER		
163				Through-wall	≤30	Split: 12 SEER; Pkgd: 12 SEER		
164				Single-duct high-velocity	<65	Split: 11 SEER		
165				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)**		
166					≥ 135 and < 240	11.0 EER & 12.4 IEER (electric heat or no heat) 10.8 EER & 12.2 IEER (other heat)		
167					≥ 240 and <760	10.0 EER & 11.6 IEER (electric heat or no heat) 9.8 EER & 11.4 IEER (other heat)		
168					≥ 760	9.7 EER & 11.2 IEER (electric heat or no heat) 9.5 EER & 11.0 IEER (other heat)		
169				Water cooled	<65	12.1 EER & 12.3 IEER (all)		
170					≥ 65 and < 135	12.1 EER & 13.9 IEER (electric heat or no heat) 11.9 EER & 13.7 IEER (other heat)		
171					≥ 135 and < 240	12.5 EER & 13.9 IEER (electric heat or no heat) 12.3 EER & 13.7 IEER (other heat)		
172					≥ 240 and <760	12.4 EER & 13.6 IEER (electric heat or no heat) 12.2 EER & 13.4 IEER (other heat)		
173					≥ 760	12.2 EER & 13.5 IEER (electric heat or no heat) 12.0 EER & 13.3 IEER (other heat)		
174				Evaporatively cooled	<65	12.1 EER & 12.3 IEER (all)		
175					≥ 65 and < 135	12.1 EER & 12.3 IEER (electric heat or no heat) 11.9 EER & 12.1 IEER (other heat)		
176					≥ 135 and < 240	12.0 EER & 12.2 IEER (electric heat or no heat) 11.8 EER & 12.0 IEER (other heat)		
177					≥ 240 and <760	11.9 EER & 12.1 IEER (electric heat or no heat) 11.7 EER & 11.9 IEER (other heat)		
178					≥ 760	11.7 EER & 11.9 IEER (electric heat or no heat) 11.5 EER & 11.7 IEER (other heat)		
179				Condensing Units, air cool	≥ 135	10.5 EER & 11.8 IEER		
180				Condensing Units, water cool	≥ 135	13.5 EER & 14.0 IEER		
181				Condensing units, evap. cool	≥ 135	13.5 EER & 14.0 IEER		

Line #	Div.	*System* Sub-Category	2017 Program Year Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
182	**Mechanical**	Packaged Terminal Heat Pumps and Air Conditioners	Standard efficiency units with performance meeting IECC Table C403.2.3(3)/ ASHRAE Table 6.8.1-4.	**Yes, IECC & ASHRAE**	PTHP and PTAC with performance exceeding baseline requirements
183		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.
184		<u>Equipment Selection</u>	Chiller performance meeting IECC 2015 Table C403.2.3(7) / ASHRAE 90.1-2013 Table 6.8.1-3.		

Line #	*<u>Equipment Type</u>*	*<u>Size (tons)</u>*	*<u>Minimum Efficiency (choose either Path A or Path B)</u>*	
186			*<u>Path A</u>*	*<u>Path B</u>*
187	Air cooled	<150	≥ 10.1 EER (FL) ≥ 13.7 EER (IPLV)	≥ 9.7 EER (FL) ≥ 15.8 EER (IPLV)
188		≥ 150	≥ 10.1 EER (FL) ≥ 14.0 EER (IPLV)	≥ 9.7 EER (FL) ≥ 16.1 EER (IPLV)
189	Air cooled w/o condenser, electrically operated	ALL	Units shall be rated with matching condensers and comply with air-cooled chiller requirements	
190	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)
191		≥ 75 and < 150	≤ 0.72 kW/ton (FL) ≤ 0.56 kW/ton (IPLV)	≤ 0.75 kW/ton (FL) ≤ 0.49 kW/ton (IPLV)
192		≥ 150 and < 300	≤ 0.66 kW/ton (FL) ≤ 0.54 kW/ton (IPLV)	≤ 0.68 kW/ton (FL) ≤ 0.44 kW/ton (IPLV)
193		≥ 300 and < 600	≤ 0.61 kW/ton (FL) ≤ 0.52 kW/ton (IPLV)	≤ 0.625 kW/ton (FL) ≤ 0.41 kW/ton (IPLV)
194		≥ 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)
195	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)
196		≥ 150 and < 300	≤ 0.610 kW/ton (FL) ≤ 0.550 kW/ton (IPLV)	≤ 0.635 kW/ton (FL) ≤ 0.4 kW/ton (IPLV)
197		≥ 300 and < 400	≤ 0.56 kW/ton (FL) ≤ 0.52 kW/ton (IPLV)	≤ 0.595 kW/ton (FL) ≤ 0.39kW/ton (IPLV)
198		≥ 400 and < 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)
199		≥ 600	≤ 0.56 kW/ton (FL) ≤ 0.5 kW/ton (IPLV)	≤ 0.585 kW/ton (FL) ≤ 0.38 kW/ton (IPLV)
200	Absorption, single effect	ALL (air cooled)	≥ 0.6 COP (FL)	N/A
201	Absorption, single effect	ALL (water cooled)	≥ 0.7 COP (FL)	N/A
202	Absorption, double effect	ALL (indirect fired)	≥ 1.0 COP (FL) ≥ 1.05 COP (IPLV)	N/A
203	Absorption, double effect	ALL (direct fired)	≥ 1.0 COP (FL) ≥ 1.05 COP (IPLV) ***ASHRAE - ≥ 1.0 COP (FL & IPLV)**	N/A

Line #	Div.	2017 Program Year *System* Sub-Category	Baseline Minimum Standards & Practice			Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
204	**Mechanical**	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
205		Pumping	Chilled water pumping approach (primary/secondary vs. variable primary) shall be the same as what is designed			-	
206		Piping	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE - Chilled water piping sized according to ASHRAE 90.1-2013 Table 6.5.4.6**			-	
207		Cooling Towers	Cooling tower performance meeting IECC 2015 Table C403.2.3(8) / ASHRAE 90.1-2013 Table 6.8.1-7			**Yes, IECC & ASHRAE**	Oversized cooling tower / downsized cooling tower fan motor
208			*Equipment Type*	*Rating Condition*	*Fan Performance*		
209			Propeller or axial fan, open-circuit	95°F EWT; 85°F LWT, 75°F OAT (db)	≥ 40.2 gpm/hp		
210			Centrifugal fan, open-circuit	95°F EWT; 85°F LWT, 75°F OAT (db)	≥ 20.0 gpm/hp		
211			Propeller or axial fan, closed-circuit	102°F EWT; 90°F LWT, 75°F OAT (db)	≥ 14.0 gpm/hp		
212			Centrifugal fan, closed-circuit	102°F EWT; 90°F LWT, 75°F OAT (db)	≥ 7.0 gpm/hp		
213		Condensers	Condenser performance meeting IECC 2015 Table C403.2.3(8) / ASHRAE 90.1-2013 Table 6.8.1-7			**Yes, IECC & ASHRAE**	Oversized condenser / downsized condenser fan motor
214			*Equipment Type*	*Rating Condition*	*Performance*		
215			Propeller or axial fan, evaporative	Ammonia: 140°F entering gas temp, 96.3°F condensing temp; 75°F OAT (wb)	≥ 134 MBH/hp		
216			Centrifugal fan, evaporative	Ammonia: 140°F entering gas temp, 96.3°F condensing temp; 75°F OAT (wb)	≥ 110 MBH/hp		
217			Propeller or axial fan, evaporative	R507: 165°F entering gas temp, 105°F condensing temp; 75°F OAT (wb)	≥ 157 MBH/hp		
218			Centrifugal fan, evaporative	R507: 165°F entering gas temp, 105°F condensing temp; 75°F OAT (wb)	≥ 135 MBH/hp		
219			Air-cooled	125°F condensing temp; 190°F entering gas temp; 15°F subcooling; 95°F OAT (db)	≥ 176 MBH/hp		

<table>
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#</th><th rowspan="3">Div.</th><th colspan="7">2017 Program Year</th></tr>
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<tr><th>Sub-Category</th><th colspan="4">Baseline Minimum Standards & Practice</th><th>Mandatory for Code Compliance regardless of path</th><th>Potential High-Performance Practices</th></tr>
<tr><td>220</td><td rowspan="12">Mechanical</td><td>Heat Rejection Fan Controls</td><td colspan="4">Each fan with a motor ≥7.5 hp shall have capability to operate at 2/3 speed or less with controls to automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure.

IECC: per Section C403.4.3
ASHRAE: per Section 6.5.5.2</td><td>-</td><td>Variable speed fan controls w/ VFD</td></tr>
<tr><td>221</td><td>Differential Pressure</td><td colspan="4">Differential pressure setpoint should be no more than 110% of that required to achieve design flow through heat exchanger.

ASHRAE: per Section 6.5.4.2</td><td>-</td><td></td></tr>
<tr><td>222</td><td>Condenser Water Temperature</td><td colspan="4">Constant condenser water (CW) temperature setpoint per the design.</td><td>-</td><td>Reset CW temperature setpoint based upon outside air wet bulb temperature down to minimum acceptable by chiller manufacturer and site operators; maintain an offset to ambient wet bulb (e.g. 7°F)</td></tr>
<tr><td>223</td><td>Water-side Economizer</td><td colspan="4">No water-side economizer (if not required by IECC 2015 Section C403.3)</td><td>-</td><td>Plate and frame heat exchanger for free winter cooling/water-side economizer</td></tr>
<tr><td>224</td><td></td><td colspan="4">Water-side economizer piped in parallel with chiller(s)</td><td>-</td><td>Water-side economizer piped in series with chiller(s) (e.g. partial economizer capability)</td></tr>
<tr><td>225</td><td>Thermal Storage</td><td colspan="4">No thermal storage</td><td>-</td><td>Thermal storage to reduce plant peak kW demand (consider energy penalty on overall plant energy use)</td></tr>
<tr><td>226</td><td rowspan="6">Variable Refrigerant Flow (VRF) Air Conditioners</td><td colspan="4">*IECC ≠ ASHRAE
No IECC Requirement
***ASHRAE - VRF air conditioner performance meeting ASHRAE 90.1-2013 Table 6.8.1-9**</td><td rowspan="6">**Yes, ASHRAE**</td><td rowspan="6">VRF air conditioners with performance exceeding baseline requirements.

VRF systems may be part of a broader high-performance system selection measure. See "Base Case HVAC System Design Based on Building Type" for more details.</td></tr>
<tr><td>227</td><td rowspan="5"></td><td>***Equipment Type***</td><td>***Size (MBH)***</td><td>***Minimum Efficiency***</td></tr>
<tr><td>228</td><td rowspan="4">**VRF air conditioners, air cooled**</td><td>**< 65**</td><td>**13 SEER
(VRF multisplit, all heat types)**</td></tr>
<tr><td>229</td><td>**≥ 65 and < 135**</td><td>**11.2 EER & 13.1 IEER
(VRF multisplit, electric heat or no heat)**</td></tr>
<tr><td>230</td><td>**≥ 135 and < 240**</td><td>**11.0 EER & 12.9 IEER
(VRF multisplit, electric heat or no heat)**</td></tr>
<tr><td>231</td><td>**≥ 240**</td><td>**10.0 EER & 11.6 IEER
(VRF multisplit, electric heat or no heat)**</td></tr>
</table>

Line #	Div.	2017 Program Year						
		System						
		Sub-Category	Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
232	Mechanical	Variable Refrigerant Flow (VRF) Heat Pumps	*IECC ≠ ASHRAE No IECC Requirement ***ASHRAE - VRF heat pump performance meeting ASHRAE 90.1-2013 Table 6.8.1-10**				**Yes, ASHRAE**	VRF heat pumps with performance exceeding baseline requirements. VRF systems may be part of a broader system high-performance system selection measure. See "Base Case HVAC System Design Based on Building Type" for more details.
233				***Equipment Type***	***Size (MBH)***	***Minimum Efficiency (VRF multisplit)***		
234				**VRF air cooled (cool mode)**	**< 65**	**13 SEER (all heat types)**		
235					**≥ 65 and < 135**	**11.0 EER & 12.3 IEER (electric heat/no heat) 10.8 EER & 12.1 IEER (heat recovery, electric heat/no heat)**		
236					**≥ 135 and < 240**	**10.6 EER & 11.8 IEER (electric heat/no heat) 10.4 EER & 11.6 IEER (heat recovery, electric heat/no heat)**		
237					**≥ 240**	**9.5 EER & 10.6 IEER (electric heat/no heat) 9.3 EER & 10.4 IEER (heat recovery, electric heat/no heat)**		
238				**VRF water source (cool mode)**	**< 65**	**12.0 EER; 86°F EWT 11.8 EER; 86°F EWT (heat recovery)**		
239					**≥ 65 and < 135**	**12.0 EER; 86°F EWT 11.8 EER; 86°F EWT (heat recovery)**		
240					**≥ 135 and < 240**	**10.0 EER; 86°F EWT 9.8 EER; 86°F EWT (heat recovery)**		
241				**VRF groundwater source (cool mode)**	**<135**	**16.2 EER; 59°F EWT 16.0 EER; 59°F EWT (heat recovery)**		
242					**≥ 135**	**13.8 EER; 59°F EWT 13.6 EER; 59°F EWT (heat recovery)**		
243				**VRF ground source (cool mode)**	**<135**	**13.4 EER; 77°F EWT 13.2 EER; 77°F EWT (heat recovery)**		
244					**≥ 135**	**11.0 EER; 77°F EWT 10.8 EER; 77°F EWT (heat recovery)**		
245				**VRF air cooled (heat mode)**	**< 65**	**7.7 HSPF**		
246					**≥ 65 and < 135**	**3.3 COP (47°F db/ 43°F wb); 2.25 COP (17°F db / 15°F wb)**		
247					**≥ 135**	**3.2 COP (47°F db/ 43°F wb); 2.05 COP (17°F db / 15°F wb)**		
248				**VRF water source (heat mode)**	**<135**	**4.2 COP; 68°F EWT**		
249					**≥ 135**	**3.9 COP; 68°F EWT**		
250				**VRF groundwater source (heat mode)**	**<135**	**3.6 COP; 50°F EWT**		
251					**≥ 135**	**3.3 COP; 50°F EWT**		
252				**VRF ground source (heat mode)**	**<135**	**3.1 COP; 32°F EWT**		
253					**≥ 135**	**2.8 COP; 32°F EWT**		

Line #	Div.	***System*** Sub-Category	2017 Program Year Baseline Minimum Standards & Practice				Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
254	**Mechanical**	Computer Room Air Conditioners and Condensing Units	Air conditioner and condenser performance meeting IECC 2015 Table C403.2.3(9) / ASHRAE 90.1-2013 Table 6.8.1-11 Computer rooms shall have dedicated HVAC systems				**Yes, IECC & ASHRAE**	Computer room air conditioners with performance exceeding baseline requirements.
255				*Equipment Type*	*Net Sensible Cooling Capacity (MBH)**	*Min SCOP-127** Efficiency (downflow/upflow)*		
256				Air cooled	<65	2.20/2.09		
257					≥ 65 and < 240	2.10/1.99		
258					≥ 240	1.90/1.79		
259				Water cooled	<65	2.60/2.49		
260					≥ 65 and < 240	2.50/2.39		
261					≥ 240	2.40/2.29		
262				Water cooled with fluid economizer	<65	2.55/2.44		
263					≥ 65 and < 240	2.45/2.34		
264					≥ 240	2.35/2.24		
265				Glycol cooled (40% PG)	<65	2.50/2.39		
266					≥ 65 and < 240	2.15/2.04		
267					≥ 240	2.10/1.99		
268				Glycol cooled (40% PG) with fluid economizer	<65	2.45/2.34		
269					≥ 65 and < 240	2.10/1.99		
270					≥ 240	2.05/1.94		
271			*Net sensible cooling capacity = Total Gross - Latent - Fan Power					
272			**SCOP-127 = sensible coefficient of performance, calculated by dividing the new sensible cooling capacity (watts) by total power input (watts)					
273		Walk-in coolers/ freezers, Refrigerated warehouse coolers/ freezers	Automatic door controls EC motors on all evaporator and condenser fans < 1 hp Wall, ceiling, and door minimum insulation R-25 (coolers) or R-32 (freezers) Floor minimum insulation R-28 (freezers) Timer to turn lights off within 15 minutes of occupants leaving Minimum lighting efficacy of 40 lumens per watt **<u>This baseline requirement varies from code:</u>** Temperature based defrost termination control Antisweat heaters IECC: per Sections C403.2.15 and C403.2.16 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. LED lighting 6. Remote exterior condensers (versus interior condensers with worse performance at constant space temperatures) 7. Heat recovery off of condensers 8. Permanent magnet fan motors Note: See "Market Characterizations" section for additional information and high-performance practices

Line #	Div.	2017 Program Year			
		System			
		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
274	Mechanical	Refrigerated Display Cases	Automatic lighting controls (time switch or motion sensor) Temperature based defrost Antisweat heaters for low temperature doors IECC: per Section C403.2.17 ASHRAE: per Section 6.4.6	**Yes, IECC & ASHRAE**	Hot gas defrost LED lighting (see Market Characterization section for base case) Antisweat heaters for medium temperature doors Low/no heat low temperature doors
275		Commercial Refrigeration / Refrigerator and Freezers Performance	Performance meeting IECC Tables C403.2.14(1)&(2)/ ASHRAE Tables 6.8.1-12&13.	**Yes, IECC & ASHRAE**	Commercial refrigeration, refrigerators, and freezers with performance exceeding baseline requirements.
276		Condensers / Compressors Serving Refrigeration Systems	PSC motors for condenser fans < 1 hp Variable speed fan control via condensing temperature reset Minimum condensing temperature ≤ 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 C403.5 ASHRAE: per Section 6.5.11	-	Minimum condensing temperature < 70°F Subcooling where not code required EC motors for condenser fans Floating heat pressure controls (with or without VFDs) Floating suction pressure controls
277	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
278		***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 C403.4.5 ASHRAE: per Section 6.5.6.2	-	Heat recovery where not code required

Line	Div.	2017 Program Year			
#		***System*** Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
279	**Electrical**	***Motors***			
280		Selection	Minimum motor efficiencies per: - 60 Hz NEMA Subtype I, 600 V or less - Table C405.8(1) - Subtype II and Design B Motors greater than 200 HP - Table C405.8(2) - Polyphase small electric motors - Table C405.8(3) - Capacitor-start capacitor-run and capacitor-start induction-run small electric motors - Table C405.8(4) ***ASHRAE Section 10.4.1**	**Yes, IECC & ASHRAE**	Motors exceeding baseline efficiency
281		***Plug-Loads***			
282		Automatic Receptacle Control	***IECC ≠ ASHRAE** No IECC Requirement ***ASHRAE Section 8.4.2 = Automatic receptacle controls in at least 50% of the receptacles in offices, conference rooms, printing/copying rooms, break rooms, classrooms, and individual workstations.**	**Yes, ASHRAE**	Automatic receptacle controls controlling >50% of all receptacles in required spaces, or implemented in non-required space types. Note: at this time, no incentives are available for plug load controls.
283		***Lighting***			
284		Lighting Power	The lighting baseline for all projects (regardless of code compliance path) shall be C406.3 - Reduce lighting power density by 10% over Table C405.4.2(1), if using the Building Area Method, or over Table 405.4.2(2), if using the Space-by-Space Method.	**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)

Line	Div.	2017 Program Year			
		System			
#		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
285	Electrical	Lighting Controls	***IECC ≠ ASHRAE** Automatic occupant sensor controls installed in building space types per IECC Section C405.2.1 or ASHRAE 90.1-2013 Table 9.6.2 (explained in Section 9.4.1.1) ***ASHRAE 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.**	**Yes, IECC & ASHRAE**	1. Occupancy sensors in public corridors, stairways, restrooms, primary building entrance areas, lobbies, sleeping units, spaces where patient care is directly provided, or shop and laboratory classrooms. 2. Sensor programming that automatically turns on the lighting to less than 50% power. 3. Warehouse occupancy sensors that automatically reduce lighting in aisle ways and open areas by more than 50 percent when areas unoccupied.
286			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 9.6.2 (explained in Section 9.4.1.1)	**Yes, IECC & ASHRAE**	1. For spaces that have light-reduction controls that allow for the lighting load to be reduced uniformly by at least 50%, time-switch controls in sleeping units, spaces where patient care is directly provided, areas where lighting is intended for continuous operation, or shop and laboratory classrooms. 2. Time-switch controls in areas where there is manual control and there is either a lighting power density less than 0.6 watts per square foot or the space type is one of the following: corridors, equipment rooms, public lobbies, electrical or mechanical rooms. 3. Light-reduction controls that allow for more than 50% reduction in lighting load by implementing one or more of the following: controlling all lamps/luminaires, dual switching, switching the middle lamp luminaires independently of the outer lamps, switching each luminaire or each lamp.
287					
288			Daylight-responsive (on/off) controls in "sidelight" and "toplight" daylight zones where there are greater than 150 watts of general lighting; Continuous dimming down to 15% of full light output for all daylight zone fixtures in offices, classrooms, laboratories and library reading rooms IECC: per Section C405.2.3, see Section C405.2.3.2/3 for definitions of sidelight and toplight zones. ASHRAE: per Table 9.6.2 (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, or hotel and motel sleeping units 2. Controls for continuous dimming below full lighting levels in all spaces except offices, classrooms, laboratories, and library reading rooms.

Line	Div.	2017 Program Year			
		System			
#		Sub-Category	Baseline Minimum Standards & Practice	Mandatory for Code Compliance regardless of path	Potential High-Performance Practices
289	**Electrical**	Lighting Controls (cont.)	Hotel and motel sleeping units and guest suites shall have a master control device capable of automatically switching off all installed lighting fixtures within 20 minutes of occupants leaving the room. IECC: per Section C405.2.4 ASHRAE: per Section 9.4.1.3b	**Yes, IECC & ASHRAE**	Daylight responsive controls for hotel and motel sleeping units
290				-	Network lighting controls may be eligible for incentives. Check with Program Administrator before pursuing as an ECM.
291		Parking Garage Lighting Control	***IECC ≠ ASHRAE** No IECC Requirement ***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 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; daylight controls where not required
292		Exterior Lighting	Lighting power densities compliant with IECC 2015 Table C405.5.2(2)/ ASHRAE Table 9.4.2-2, depending on lighting zone breakdown in IECC 2015 Table C405.5.2(1) / ASHRAE Table 9.4.2-1.	**Yes, IECC & ASHRAE**	High efficiency design including LEDs Note: this is a prescriptive measure and should not be included in a custom model or analysis.
293		Exterior Lighting Controls	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 as a function of dawn/dusk and a set opening and closing time. All other fixture types shall have controls to reduce connected lighting power by ≥ 30% 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 IECC: per Section C405.2.5 ASHRAE: per Section 9.4.1.4	**Yes, IECC & ASHRAE**	Automatic high/low controls (for loading docks or areas with variable occupancy; no manual override ON option)

Appendix:

Market Characterization Sections

(This section is copied from the 2015 Baseline Document and will be updated for 2017.)

Commercial New Construction Baseline Descriptions

Line #	**Div.**	***System*** Sub-Category	**2014 Program Year**	
			Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
91	**Market Characterizations**	***Supermarkets***		
92		Compressors	Reciprocating compressors	Scroll compressors
93			Capacity control through staging and unloading	VFDs for capacity control
94			Fixed head pressure controls with a minimum refrigerant SCT setpoint of 95°F	Lower refrigerant SCT setpoint acceptable by compressor manufacturer and site operators
95		Evaporator Fan Motors	Motors <1 hp & <460 V: EC or 3-phase motors for evaporator fans Motors ≥1 hp: Comply motor requirements section	Motors ≥1 hp: EC or 3-phase motors for evaporator fans
96		Condensers	Air-cooled condensers	Evaporative condensers
97			Mechanical thermal expansion valves	Electronic thermal expansion valves
98		Lighting	T8/T5 case lighting with electronic ballasts	LED lighting
99		Cases	Case doors with anti-sweat heat controls	Low-heat/no-heat doors
100			Strip curtains for isolation of refrigerated rooms	Gasketed manually operated isolation doors
101			No night curtains	Night curtains on reach-in coolers and freezers
102			Timed electric resistance defrost	More efficient defrost technology and/or controls
103		Dehumidification	Spaces served by HVAC units providing humidity control with reheat; unit performance meets requirements described above for unitary air conditioners	Heat pipe on HVAC unit with coil bypass for reheat
104				Refrigeration waste heat recovery for water heating (domestic or hydronic)
105			DX-type dehumidification with hot gas reheat	Desiccant dehumidification with heat recovery from refrigeration system for regeneration requiring no supplemental regeneration heat source

Line #	Div.	***System***	**2014 Program Year**	
		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
106	**Market Characterizations**	***Ice Rinks***		
107		Brine System	Water-cooled or evaporatively cooled brine chiller system, minimum 85°F SCT	Reset condenser water/condensing temperature setpoint based upon outside air wetbulb temperature down to minimum acceptable by chiller manufacturer and site operators
108			Condenser capacity equal to proposed installation	Oversized condenser(s)
109			Chiller performance for actual unit selection (same capacity as proposed unit, 10°F evaporator approach, 85°F min SCT)	
110			Standard brine system DX evaporators	Balanced Port DX valves or flooded evaporators to allow increased suction temp and reduced discharge pressure
111		Heat Rejection	Heat rejection through the condenser	Use condenser heat for snow melt system, sub-slab heating, or dehumidification unit
112		Refrigerant	Ammonia-based refrigeration system	CO2-based refrigeration system
113		Temperature Controls	Slab-mounted ice temperature sensor that allows brine pump to cycle on and off	Infrared ice temperature sensor (more accurate ice surface temperature readings over slab-mounted sensors)
114			Constant ice temperature setpoint	Ice temperature reset sequence based on scheduled occupancy and use
115			Non-electric resistance sub-slab frost control	
116		Pumps	Brine pump cycles on and off with compressors	VFD on brine pump operating to maintain a fixed temperature rise across evaporator heat exchanger
117		Enclosure	Low-emissivity ceiling	
118		Dehumidification	Dehumidification technology capable of maintaining equivalent space dewpoint to proposed case technology (30°F dewpoint, -10°F dewpoint with gas-fired desiccant system)	Use waste heat for re-heat or desiccant regeneration
119		Lighting	HID lighting with zone/scene control capability	Zone/scene control with high bay fluorescent, high performance metal halide, LED
120		Space Heating	Gas-fired radiant heaters above bleachers for occupant comfort; space temperatures lower than 50°F	
121		Domestic Hot Water		Reuse compressor/condenser heat for DHW and/or Zamboni ice resurfacing

Line	**Div.**	***System***	**2014 Program Year**	
#		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
122	**Market Characterizations**	***Fresh Water Supply***	VFDs on all pumps ≥ 5 hp requiring variable flow for process control or flow matching	VFDs on pumps ≤ 3 hp
123			Refrigerated dehumidifiers	Desiccant-based dehumidification
124			Throttled well pump for constant pressure or flow control	VFDs on well pumps
125		***Waste Water Treatment***	Aeration and other treatment systems in keeping with current best-practices as defined in the New England Interstate Water Pollution Control Commission's TR 16 guideline	
126			Constant speed odor control and sludge aeration systems	Variable airflow controls including VFDs on fans and blowers
127			VFDs on all pumps ≥5 hp requiring variable flow for process control or flow matching	VFDs on pumps ≤3-hp
128			Small systems (< 5 MGD): positive displacement blowers	Small systems (< 5 MGD): Centrifugal blowers, low-pressure screw compressors, motor operated valve (MOV) pressure control
129			Large systems (> 5 MGD): Turbo blowers	Large systems (> 5 MGD): Single-vane blowers, low-pressure screw compressors, MOV pressure control
130			Dissolved oxygen (DO) sensors in each aeration basin	Dual loop control where DO is used for air distribution to the tanks and maintenance of pressure setpoint in the air header determines blower output
131			Use aeration air to maintain suspension of solids in mix-limited designs	Mechanical agitators to maintain solids suspension when BOD loading would allow blowers to be set back
132			Gravity belt waste sludge thickeners	
133			Centrifuge sludge dewatering (limited to cases where centrifuge technology is appropriate)	Screw press sludge dewatering

Line #	Div.	***System***	**2014 Program Year**	
		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
134	**Market Characterizations**	***Laboratories & Vivariums***		
135		Reheat System	55˚F constant supply air temperature	Supply air temperature reset controls
136		Equipment Load	When the design equipment load density is known, the baseline load is set equal to the design load density. If new equipment load is unknown, assume 5 W/sqft during occupied hours and 3 W/sqft during unoccupied hours	
137		Heat Source	Shared with heating hot water system for air handler heating coils. Non-condensing, natural gas-fired boilers provide heating energy	
138		Supply Air System	100% outside air flow and do not transfer air from offices or other non-lab spaces	
139		General Exhaust Airflow	Minimum zone exhaust airflow defined by the customer's company standards. If undefined the baseline is 10 ACH	
140			Maintain constant exhaust stack flow rate with variable room exhaust via bypass air at the stack	Variable exhaust stack flow rate
141			Maintain constant airflow during occupied and unoccupied hours	Reduce airflow during unoccupied hours
142			Constant zone supply and exhaust flow rates	Active ventilation control: vary zone supply & exhaust flow rates based on fume sensing, time clock, or active occupancy sensors
143		Cooling System		
144		≤360 tons cooling cap	100% outside air DX packaged units with air-cooled condensers	
145		>360 tons cooling cap	Hydronic system with CHW coils in a 100% outside air handler served by water-cooled chillers	
146		Heating System		
147		≤360 tons cooling cap	100% outside air DX packaged units with gas-fired furnace	
148		>360 tons cooling cap	Hydronic system with HHW coils in a 100% outside air handler served by non-condensing natural gas-fired boilers	
149		Heat Recovery		
150		Variable Volume System	Not req. if supply & exhaust systems reduce airflow by ≥50%	Heat recovery between the exhaust and supply airflow streams in addition to minimum 50% turndown
151		Constant Volume System	Heat recovery (IECC C403.2.6)	
152		Fume Hood Control	Constant 100 fpm face velocity (Hood dimensions should match proposed design. If no data is available, assume hood height of 18")	
153			VAV hoods with manually-controlled single sash	Timeclock reduction of face velocity or automatic sashes
154		Other Exhausted Equipment	Exhaust is set to middle of manufacturer recommendation for all lab equipment, excluding hoods	

Line #	Div.	System Sub-Category	2014 Program Year Baseline Efficiency Minimum Standards & Practice	 Potential High-Performance Practices
155	Market Characterizations	***Data Centers***		
156		Space Load Estimates	IT rack consumption is primary load, shell and lighting loads are deemed negligible	
157			Waste fan power is calculated based on operating BHP, motor efficiency, and typical power factor assumptions	
158			IT load assumed to be constant and independent of OA conditions, growing only as equipment is added over time	
159			After 1-2 years the space will be operating at 50% of the non-redundant limiting capacity Typically the UPS is the limiting capacity but sometimes the installed cooling is the limiting capacity	
160		Uninterruptible Power Supply (UPS)	Double-conversion, battery-based, non-switching UPS units with capacity above 10kVA. Baseline efficiency depends on UPS unit size according to table	Efficiency exceeding baseline values (Off-line UPS, Line-interactive UPS)
161		Aisle Configuration	Hot aisle/cold aisle configuration with open aisles up to 100 W/sqft, ducted return 100-200 W/sqft and fully enclosed hot aisle/cold aisle beyond 220 W/sqft	
162		Operating Airflow Management & Air Conditions	Baseline operating conditions vary according to load density table	
163		Supply Air Setpoint	64 - 67˚F, depending on installed IT capacity	
164		Airside Temp Difference	10 - 18˚F depending on installed IT capacity	
165		Supply Fan System Efficiency	1,482 - 1,536 cfm/kW, depending on installed IT capacity	
166		Humidification	When humidification is required, electric resistance humidifier with 100% efficiency (e.g. infrared lamps)	Ultrasonic/evaporative humidification
167		Reheat	No reheat	Reheat equipment in the CRAH/C unit
168		CRAH/C Unit Fan Operation		
169		Low-Density (<10 kW/rack)	Minimum fan airflow and efficiency (CFM/kW) defined by table	Fan airflow efficiency exceeds minimum in table
170		High-Density (10-30 kW/rack)	In-row cooling	
171		Cooling System Type		
172		IT Load < 1 MW	DX refrigerant loop with remote, air-cooled condensers	DX refrigerant loop with remote, water-cooled condensers
173		IT Load ≥ 1 MW	Water-cooled chillers, variable flow, primary-only chilled water loop	
174		CRAH/C Unit Compressor Efficiency	Baseline efficiency values are defined based on size (see table)	Efficiency values exceeding baseline values
175		Free-cooling / Economizer	No free-cooling or economizer	Waterside or airside economizer or free-cooling (will become baseline with adoption of ASHRAE 90.1-2013)
176				Cross-connect to central chilled water plant

Line	Div.	*System*	2014 Program Year	
#		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
177	**Market Characterizations**	***Pools***		
178		Dehumidification	Maintain minimum ventilation rate of 0.48 CFM/SF of deck and pool area per ASHRAE 62.1 Mechanical (heat pump) dehumidification with built-in economizer	Energy recovery to the supply airstream or the pool water Variable speed drives for compressor capacity control
179		Cover	Vapor-retardant cover	
180		Pumps	Constant-speed pool water circulation pumps	VFD pool water circulation pumps
181		Controls	Readily accessible on/off heater switch, automatic time switches	
182		***Compressed Air***		
183		Uses	Used for blow off, air knives, diaphragm pumps, pumps, conveyance systems, venturi vacuum systems, etc	Electrically driven alternatives and low-pressure blowers
184		Air compressors - Oil Flooded	General manufacturing systems < 130 psi or < 200 HP oil flooded single stage compressors with modulating control via inlet valve and unloading point below 50% of rated CFM	Load/No load compressors with storage > 4 gal/CFM of compressor capacity, variable displacement compressors, VFD compressors, two stage oil flooded compressors with load/no load control and storage
185			General manufacturing systems >130 psi or > 200 HP two stage oil flooded compressors	Load/No load compressors with storage > 4 gal/CFM of compressor capacity, variable displacement compressors, VFD compressors, two stage oil flooded compressors with load/no load control and storage
186		Air compressors - Oil Free	Medical, pharmaceutical, food processing and other specialty manufacturing facilities where oil free air is required. Oil free air with single stage compression and load/no load control	Multi stage compression w/ VSD control, and storage >4 gal/CFM of compressor capacity, centrifugal compressors for larger base load combined w/ rotary screw oil free unit
187		Compressor Staging	No sequencers or automation controls	Optimize compressor utilization by incorporating sequencers &/or automation controllers

Line	**Div.**	***System***	**2014 Program Year**	
#		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
188	**Market Characterizations**	Air Dryers	For facilities requiring pressure dew point of ≥ 35˚F - refrigerated non-cycling dryers	Cycling thermal mass or variable speed dryers
189			For facilities requiring pressure dew point of < 35˚F - desiccant dryers	Incorporate desiccant dryers with dew point sensing controls to reduce regeneration frequency
190			Desiccant dryers for ≤ 35˚F dew point requirements	Incorporate piping changes to separate low dew point air demand from ≥35˚F to achieve higher overall system efficiency with use of appropriately sized combination of desiccant & refrigerant cycling or VFD dryer
191			Oil free application - Refrigerant or Desiccant Dryer	Heat of compression dryer when packaged w/ new compressor
192		Air Filtration	Standard design air filtration exceeding 3 psi pressure drop	Low pressure drop filters with pressure drop at rated flow ≤1 psi and ≤3 psi at filter element change, particulate filtration is 100% at ≥ 3.0 microns, 99.98% at 0.1 - 3.0 microns, ≤5 ppm liquid carryover, filter is deep bed, "mist eliminator style"
193		Condensate Drains	Timed or continuous air bleed type	Zero loss condensate drains
194		Air Distribution Piping	Pipe sizing resulting in air velocity ≥45 fps	Increase pipe sizing to accommodate 20-30 fps at full flow per Compressed Air Challenge (CAC) recommendations
195		Demand side measures	No pressure / flow controls, no leak management	Incorporate pressure/flow control with pressure reduction for end uses, reduce artificial demand and implement demand side improvements to reduce leakage
196			Blowing through open pipe with compressed air	Low pressure blower and engineered air nozzle
197			Sparging and agitation of process tanks with compressed air	Low pressure blower and appropriately placed air piping with nozzles
198			Cabinet cooling with venturi compressed air nozzles	Properly sized electric cabinet air conditioner
199			Venturi vacuum systems	Electric Vacuum Systems
200			Short cycling high pressure air pulsing of dust collectors	Provide secondary local storage for high pressure pulsing application with refill valving to isolate intermittent high pressure demand from rest of plant
201			Compressed air actuators in facility	Replace with electro-mechanical actuators
202			Compressed air motors	Replace with electric motors

Line #	Div.	***System*** Sub-Category	**2014 Program Year**	
			Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
203	**Market Characterizations**	***Cold Storage***		
204		< 50,000 ft^2	Split-circuit system (air units connected with close-coupled air-cooled compressor unit)	Central refrigeration system
205			For roof-mounted split system installations serving walk-in storage units, standard controls and equipment performance; timeclock initiated electric defrost and timed shutoff	Temperature-controlled evaporator fan operation Timeclock defrost with temperature sensor shutoff Hot gas defrost
206			Performance for actual unit selection (same capacity as proposed unit, 10°F evaporator approach, 95°F min SCT); assume 1% change in performance for each 1°F change in SST	Exceed baseline performance requirements of cooling equipment
207		≥ 50,000 ft^2 & < 200,000 ft^2	Halocarbon split-circuit system (air units connected with close-coupled air-cooled compressor unit)	Central refrigeration system *"Medium" cold storage is on the line between central and halocarbon systems
208		≥ 200,000 ft^2	Central refrigeration system	Heat recovery from compression
209		Evaporators	Evaporators selected for a 10°F approach to design space temperatures	
210			Standard size evaporator coils and constant operation of evaporator fans	Over-size evaporator coils with lower fan HP Temperature-controlled evaporator fan operation VFD evaporator fan operation
211		Compressors	Compressor capacity equal to proposed installation	
212			Single-stage compressor system for SST ≥-10°F (two-stage for suction temperatures below -10°F)	Two-stage compressor system for SST ≥ -10°F
213			Performance for an actual baseline unit selection (same capacity as proposed unit, 10°F evaporator approach, 85°F SCT/CW)	Compressor performance exceeding baseline performance at full load, listed SST, and 85°F SCT/CW

Line #	**Div.**	***System***	**2014 Program Year**	
		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
214	**Market Characterizations**	Controls	Cooling loads handled throughout typical day	Thermal load shifting capability by automatic space temperature reset (note this may not save energy but can impact coincident peak demand)
215			Evaporatively cooled (85°F min SCT) or water-cooled (75°F min CW) systems	Reset condenser water/condensing temperature setpoint based upon outside air wetbulb temperature down to minimum acceptable by chiller manufacturer and site operators
216			Electric defrost engaged based on timeclock with the following typical heating element run times: -10°F, 2 times per day, 15 minutes	Hot gas defrost with evaporator run time initiated defrost and timed activation period or run time limited by infrared/temperature sensors on evaporator coil
217			Non-electric resistance sub-slab frost control	
218		Seals	Manually operated motorized isolation doors OR strip doors with non-motorized doors	High-speed automatic isolation doors
219				
220			Full seals around loading dock doors to mate with vehicles	High performance dock sealing system
221		Lighting	Metal halide lights in refrigerated box trucks	LED lighting
222			HID lighting	LED with integral occupancy sensors

Line	Div.	***System***	**2014 Program Year**	
#		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
223	**Process**	***Process Cooling***		
224		Equipment Selection	Cooling capacity < 250 tons = air-cooled chiller Cooling capacity ≥ 250 tons = water-cooled chiller	High-performance water-cooled chiller with water-side economizer
225			Free-cooling if cooling required during winter months	
226		Applications	Year-round mechanical cooling for process cooling water colder than 84°F	Fluid coolers with automatic switchover/isolation valves to limit central plant chilled water use
227			Cooling towers used for heat rejection for process cooling temperatures 85°F or warmer	Water-side plate and frame heat exchanger if cooling tower is available: process water bypasses chiller, all cooling is done with the cooling tower, compressor is shut down
228		Controls	Manually adjusted isolation valves and dampers on process water, air, and exhaust systems	Interlocked controls to automatically isolate equipment when it is turned off
229		***Process Ventilation***	Design must be in compliance with local and federal health and safety code requirements, such as: NFPA, OSHA, EPA, IMC	Demand-based ventilation to reduce ventilation rates during periods of reduced occupancy or load *Must meet health and safety requirements
230			VFDs on fans, blowers, or pumps serving variable loads having motors ≥25 hp	VFDs with automatic controls on variable-load equipment having motors ≤20 hp, 2-way valves on end uses
231			VFDs on motors requiring variable speed (e.g. no mechanical speed controls unless standard industry practice)	
232			Manually adjusted isolation valves and dampers on process water, air, and exhaust systems	Interlocked controls to automatically isolate equipment when it is turned off
233		***Induction / Specialty Power Supply***	Solid-state frequency converter making constant off-frequency (i.e. not 60 Hz) power for non-drive applications (e.g. induction furnaces), manually turned off during non-production shifts	Interlocked controls to automatically turn off power source when production equipment is turned off

Line #	Div.	*System*	2014 Program Year	
		Sub-Category	Baseline Efficiency Minimum Standards & Practice	Potential High-Performance Practices
234	**Process**	***Plastic Injection Molding***		
235		Tonnage < 500 tons	Hybrid Injection Molding Machine	All-electric Injection Molding Machine
236		Tonnage ≥ 500 tons	Hydraulic Injection Molding Machine	All-electric Injection Molding Machine
237		Controls		VFD or variable flow pumps
238				Stack molds
239				Nitrogen accumulators
240		***Thermal Oxidizers***		
241		Low Flow: < 10,000 CFM	70% Efficient Recuperative	Regenerative and/or heat recovery, i.e. for space heating (>70% efficient)
242		Medium Flow: 10,000 to 30,000 CFM	70% Efficient Recuperative	Regenerative and/or heat recovery, i.e. for space heating (>70% efficient)
243		Large Flow: > 30,000 CFM	70% Efficient Recuperative or Regenerative (whichever is lower cost)	Regenerative and/or heat recovery, i.e. for space heating
244		***Process VFDs***	No variable frequency drive control of process pumps or fans	Variable frequency drives on process pumps or fans *VFD must not be used for balancing
245		***Process Regeneration***	No process regeneration	Process regeneration

Data Centers

Uninterruptible Power Supply (UPS)

UPS Size (kVA)	% Load			
	25%	50%	75%	100%
< 20	86.3%	89.1%	90.1%	90.2%
≥ 20 and ≤ 100	88.5%	90.5%	91.3%	91.9%
> 100	89.8%	93.0%	93.5%	93.8%

Source: Integral Group

*Values in table represent averages of published data from UPS manufacturers and from data used in EPA's Energy Star performance criteria.

Operating Airflow Management and Air Conditions

IT Load Density (W/sqft)	Airflow Management Practice	Return Air Temp Setpoint (F)	Supply Air Temp Setpoint (F)	Operating Airside Temp Difference (F)	Relative Humidity Range
0-100	Open	74	64	10	40-60%
101-220	Ducted Return	78	65	13	40-60%
221-400	Fully Enclosed	85	67	18	40-60%

*All levels assume that the server racks are oriented in hot aisle/cold aisle configuration.

CRAH/C Fan Operation

IT Load Density (W/sqft)	Fan Airflow Efficiency (CFM/kW)	CRAH/C Airflow Capacity (CFM)
0-100	1,536	16,800
101-220	1,508	15,800
221-400	1,482	13,875

*For high-density datacenters, defined as 10-30 kW/rack, the baseline system type is an in-row cooling solution

Cooling System Type

Design IT Load Size:	< 1 MW	≥ 1 MW
Cooling Plant	Direct-expansion refrigerant loop with remote, air-cooled condensers	Water-cooled chillers, variable flow, primary-only chilled water loop
Distribution System	Computer room air conditioners (CRACs with constant speed fans)	Chilled water computer room air handlers (CRAHs) with constant fan speed

*Source: typical practice from market surveys and field observations.

CRAC Compressor Efficiency

Nominal Cooling Capacity		Nominal Efficiency*	
kBtu/h	Tons	EER	kW/ton
< 65	< 5.42	11	1.09
65 to < 135	5.42 to < 11.25	11.2	1.07
135 to < 240	11.25 to < 20	11	1.09
240 to < 760	20 to < 63.3	10	1.2
760+	63.3+	9.7	1.24

*At ARI test conditions, efficiency values include supply and condenser fan power.

Source: Integral Group