Baseline Document: Massachusetts & Rhode Island ©
2014

This document is intended to serve as an aid to National Grid personnel and technical assistance providers in the development of reasonable base case assumptions as part of National Grid's large C&I incentive program for commercial new construction. The baseline descriptions reflect current minimum standards set by state building codes and other governing bodies as well as common practices in industry as determined by National Grid. All baseline descriptions must meet state building codes, and it should be noted that this document does not list all code requirements.

Eligible high-performance alternatives to baseline practices are presented as suggestions and may not be applicable to all installations. These recommendations are presented as aids in identifying potential design improvements and are developed based on National Grid's past experience. Other sources of suggested high efficiency design alternatives include the Massachusetts stretch code, IECC 2012, ASHRAE 90.1-2010, and the ASHRAE advanced energy design guide series for achieving 50% energy reduction in offices, schools, box retail buildings, and hospitals.

Refer to the IECC 2012 *Scope and Administration* section (C101) for what building types the energy code applies to.

Disclaimer: If the site has quantitative and documentated data that suggests a different baseline than what is described in this document, the customer-specific data should be used.

Code Changeover Dates
Massachusetts - July 1, 2014
Rhode Island - October 1, 2013

Climate Zones
Massachusetts - 5A
Rhode Island - 5A

Note: The IECC 2012 requires all buildings to comply with one of three additional efficiency package options*: more efficient HVAC equipment, more efficient lighting systems, or renewable energy systems. The new section is intended to achieve additional energy efficiency in commercial buildings designed to meet the IECC 2012 while providing flexibility in how that energy efficiency is achieved. Details of these requirements are included in this document.*

Please contact ngrid.baseline@nationalgrid.com with any questions regarding this document.

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Additional References

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1. California Title 24: Building Energy Efficiency Program

2. Energy Efficiency Baselines for Data Centers: Statewide Customized New Construction and Customized Retrofit Incentive Programs
(Integral Group, March 1, 2013)

3. Combined Heat and Power ("CHP") Program: Guidebook for Submitting CHP Applications for an Energy Efficiency Incentive in Massachusetts

4. Advanced Buildings Core Performance

5. National Grid Technical Assistance Guidance Document for Laboratories

6. National Grid Technical Assistance Guidance Document for Data Centers

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Line #	Div.	System / Sub-Category	2014 Program Year: Baseline Efficiency Minimum Standards & Practice	2014 Program Year: Potential High-Performance Practices
1	Additional Requirements	***Building Requirements***	As required by IECC 2012 C406, buildings shall comply with at least one of the following: 1. Efficient HVAC Performance in accordance with Section C406.2 2. Efficient Lighting System in accordance with Section C406.3 3. On-Site Supply of Renewable Energy in accordance with Section C406.4	Exceed requirements of IECC 2012 C406: 1. Comply with more than one option (or) 2. Exceed min HVAC or lighting requirements in C406 (or) 3. Exceed on-site renewable energy requirements in C406.4 *Note: National Grid cannot incentivize energy savings from renewable energy sources
2	Architectural	***Opaque Assemblies***	Performance per IECC 2012 Table 402.1.2, Zone 5; modeled as lightweight construction	Opaque wall assemblies with higher thermal resistance.
3	Architectural	***Window and Skylight Assemblies***	Performance per IECC 2012 Table 402.3	Window and skylight assembly U-values exceed code requirements (note that values for assemblies account for frame effects and are not the same as center-of-glass values provided by glass manufacturers)
4	Mechanical	***Code Required Airside Attributes***	Design ventilation rates meet requirements of IMC 2009 (Section 4)	Demand-controlled ventilation (DCV) controls when not required by code
5	Mechanical	Energy Recovery	Energy recovery as required by IECC 2012 403.2.6	More effective energy recovery systems (where not code required, higher heat recovery effectiveness than code)
6	Mechanical	Economizer	Economizer required on all cooling systems ≥ 33 MBH Economizer per IECC 2012 403.3.1 (simple) and 403.4.1 (complex), assume comparative drybulb control with 70°F upper limit; based on ASHRAE 90.1 Table G3.1.2.6B	Economizer controls exceeding requirements of ASHRAE 90.1 2010 Table G3.1.2.6B (where not required by code, on cooling systems < 33 MBH, etc.)
7	Mechanical	VAV Systems	VFD on fans as required by IECC 2012 403.4.2: Individual VAV fans with motors ≥ 7.5 hp shall be driven by a mechanical or electric VFD	VFDs where not required by code
8	Mechanical		For complex multizone VAV systems, minimum turndown at terminal units as required by IECC 2012 403.4.5. Reduce supply air to each zone to: (1) 30% of max supply air OR (2) ≤ 300 CFM where max flow rate is < 10% of total fan system supply airflow rate OR (3) min ventilation rates in Chapter 4 of IMC (See exceptions)	Lower turndown limits to minimize reheat requirements and fan energy *Must maintain proper air distribution for space comfort requirements

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9	Mechanical	Fan Power	Fan power at design conditions per IECC 2012 403.2.10.1 and 403.2.10.2 (see Tables C403.2.10.1(1) and C403.2.10.1(2))	Lower fan motor horsepower requirements at design through reduced pressure and/or airflow and/or increased fan efficiency
10	Mechanical	Air Filtration	Air filtration equipment meeting requirements in ASHRAE 62.1: Particulate matter filters or air cleaners having a MERV of ≥6 must be provided upstream of all cooling coils or other devices with wetted surfaces through which air is supplied to an occupied space Meet fan power limitation in ASHRAE 90.1 2010 Table 6.5.3.1.1A	Filters with lower pressure drop
11	Mechanical	***Energy Management Systems***	EMS points meet IECC 2012 code requirements: - Automatic setback controls (down to 55˚F, up to 85˚F, typ.) - Temperature deadbands of at least 5˚F - Shutoff damper controls - Individual zone heating and cooling controls - Automatic DAT reset - Demand controlled ventilation (maintain < 550 ppm, typ.) - Dual enthalpy economizer controls	Intelligent thermostats (Optimal start-stop) Monitor points beyond code requirements Demand controlled ventilation (where not required) Dual enthalpy controls (where not required)
12	Mechanical	***Airside Baseline Set by NGrid***		
13	Mechanical	Single-zone HVAC Systems	Zone size limited to one tenant space: • Office: 25,000 ft² (max) • Other: 5,000 ft² (max) Packaged equipment to be equipped with full digital controls capable of IECC 2012 required sequences	Facility-wide DDC system controlling all packaged units, equipment with energy conservation strategies beyond basic code requirements (See CA Title 24) RTU optimization controls, such as fan speed indexing, compressor varying, fan speed varying Dedicated outdoor air unit with zone-conditioning
14	Mechanical	Direct-Fired MUA Heater	Direct-fired unit	High-temperature direct-fired heater at ASHRAE min recommended air change rate
15	Mechanical	Complex HVAC Systems - Controls	Automatic controls to turn on/off main HVAC equipment based on building occupancy and allow IECC 2012 required sequences	Facility-wide DDC system controlling all terminal units, energy conservation strategies beyond basic code requirements

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16	Mechanical	Office Space < 25,000 ft²	Constant-volume supply, return, exhaust fans	Higher efficiency air-side systems allowing for less fan energy use (i.e. VAV system)
17		Office Space ≥ 25,000 ft²	VAV systems with VFDs on fans, 5,000 sqft max zone size	High-efficiency air-side system design allowing for lower fan energy and less reheat Dedicated single-zone units for spaces having unique conditioning requirements that allow general air handling equipment to be shut down during unoccupied hours
18		Manufacturing and Warehouse Areas	Reject process heat	Reclaim process heat with make-up air unit
19			Large single-zone constant-volume packaged units	VAV distribution and control systems
20		Hotels	Non-guest room areas served by constant volume systems	Higher efficiency air system such as VAV system
21			Guest rooms served by PTAC units with hydronic heat (fossil source) or PTHP units (electric and other) according to ASHRAE 90.1 2010 Table G3.1.1A	Higher efficiency air system
22			Manual setback (programmable thermostats adjusted by staff) for unrented rooms	Occupancy-based setback controls during unrented periods
23		Schools	Classrooms with central chilled water: fan coil units with hydronic heat (fossil)	EC motors in FCUs Valence units Chilled beams Underflow air
24			Classrooms with cooling but no chilled water system: PTAC units with hydronic heat (fossil) or PTHP units (electric)	Higher efficiency air system, i.e. energy recovery unit with fan coil units
25			Classrooms with no cooling: unit ventilators with hydronic heat (fossil)	Higher efficiency air system
26		VRF Systems	Air-source heat pumps with electric heat and/or gas backup heat (or) Water-source heat pumps (or) DX cooling with gas heating *Baseline cannot use PTAC or PTHP units	VRF system must provide both heating and cooling VRF system with high-performance outdoor compressor/condenser unit(s), must exceed minimum efficiency requirements in ASHRAE 90.1 2010 Table 6.8.1 Dedicated outdoor air system with energy recovery and VRF zone conditioning Indoor fan coil units with EC motors

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27	Mechanical	Other Space Types	Other space types (except manu/storage areas): single zones smaller than 5,000 sqft served by constant volume units, or VAV or multizone with zone size ≤ 5,000 sqft	Higher efficiency air system
28	Mechanical	Parking Garages	Enclosed parking garage ventilation systems shall automatically detect contamination levels and stage fans or modulate fan airflow rates to 50% or less of design capacity provided acceptable contaminant levels are maintained (see exceptions: ASHRAE 90.1 2010 6.4.3.4.5)	
29	Mechanical	Kitchen Hood Exhaust Systems	Systems ≤ 5,000 cfm: constant volume with automatic on/off control and no dedicated makeup unless required by IMC 2009 501.3 or NFPA-96 2008 Section 8.3	Systems ≤ 5,000 cfm: VFD on exhaust fan with sensor-based velocity controls, dedicated makeup air (no mech cooling, heat only to 60°F)
30	Mechanical		Systems > 5,000 cfm: Each hood has an exhaust rate complying with Table 6.5.7.1.3. Have one of the following: (1) ≥ 50% of all replacement air is transfer air, (2) DCV on ≥ 75% of exhaust air, or (3) energy recovery with ≥ 40% effectiveness on ≥ 50% of total exhaust airflow (according to ASHRAE 90.1 2010 6.5.7.1)	Systems > 5,000 cfm: hood exhaust system complying with more than 1 option in ASHRAE 90.1 Table 6.5.7.1.3
31	Mechanical	Fume Hood Exhaust Systems	Systems ≤ 5,000 cfm: constant volume exhaust with constant volume supply/makeup air systems	Automatically controlled exhaust volume based on sash position or occupancy; VFD on exhaust fans
32	Mechanical			Sensible heat recovery
33	Mechanical		Systems > 5,000 cfm must include at least one of the following: (1) VAV system capable of reducing exhaust and makeup flow rates and/or incorporate energy recovery should meet equation in 6.5.7.2 (2) Zones capable of reducing flow rates by 50% of design rates, or min to maintain pressure requirements (3) Makeup air supply ≥ 75% of exhaust flow rate, heated ≤ 2F below room setpoint, cooled ≤ 3F above setpoint, no humidification added, and no simultaneous H/C (ASHRAE 90.1 2010 6.5.7.2)	Exceed requirements of ASHRAE 90.1 2010 6.5.7.2

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34	Mechanical	Airside energy recovery (not code required)	No energy recovery if not code-required	Energy recovery with at least 50% sensible effectiveness
35		Operable Windows		Window interlock controls with HVAC system
36		***Hydronic Systems Equipment & Controls***	VFDs on hydronic pumps per IECC 2012 403.4.3.4 (systems ≥ 300 MBH in design output capacity supplying heated or chilled water to comfort conditioning systems)	VFDs on pumps where not required (e.g. systems with temperature reset)
37			Hydronic pipe insulation meeting minimum thickness in IECC 2012 Table 403.2.8	
38		***Furnaces***	Warm air furnace with performance meeting IECC Table C403.2.3(4)	Furnace with performance exceeding IECC Table C403.2.3(4)
39		***Boilers***		
40		Selection	Hot water - non-condensing boilers with performance meeting IECC 2012 Table C403.2.3(5)	Non-condensing boilers with performance exceeding IECC 2012 Table C403.2.3(5) Modulating condensing boilers with return water temperature reset controls (temp. must be within condensing range)
41			Steam plants - boilers with performance meeting IECC 2012 Table C403.2.3(5)	Boiler economizers
42		Burner controls	Boilers with burner sizes not governed by code have non-modulating controls	Modulating burners on boilers < 500,000 Btu/hr capacity
43			Constant-speed forced-draft burner fans having inlet guide vane or outlet damper volume control	VFD on forced-draft burner fans
44			Mechanical linkage control	Parallel positioning controls with oxygen trim
45		Boiler pumps	> 10 hp: VFD boiler feed water pumps having automatic modulating valve makeup water control	VFDs on all boiler feed water pumps with automatic pressure controls
46		Boiler controls		Predictive cycling control to limit boiler cycling Heat recovery in steam plants

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47	Mechanical	***Cooling Systems***		
48		Heat Pumps: Air Source	Air-source heat pumps for cooling, hydronic heat source for supplemental heating where needed (performance meeting IECC 2012 Table C403.2.3(2)	Water-loop (including groundwater loop) heat pumps with performance exceeding IECC 2012 Table C403.2.3(2)
49		Ground-source Heat Pumps	Ground-source heat pumps with performance meeting IECC 2012 Table C403.2.3(2)	Higher efficiency heat pumps
50		Heat Pumps: Standard Water Loop	Standard loop temperature controls per IECC 2012 403.4.3.3	Controls that optimize loop temperature based upon real-time conditions and loads
51		Unitary Air Conditioners (RTUs, etc)	Air cooled, standard efficiency packaged unit with DX cooling with performance meeting IECC 2012 Table C403.2.3(1)	High-efficiency cooling systems, high-efficiency fan selection
52			Minimum refrigerant saturated condensing temperature of 95°F for air-cooled systems and 70°F for water-cooled and evaporatively cooled systems	Minimum SCWT lower than baseline requirement
53			Use heating system for reheat at unit	Run-around heat pipes or hot gas reheat to minimize reheat requirements from other sources
54		Split Systems	Air cooled systems with performance meeting IECC 2012 Table C403.2.3(1)	High-efficiency systems
55			Minimum refrigerant saturated condensing temperature of 95°F for air-cooled systems and 70°F for water-cooled and evaporatively cooled systems	Minimum SCT lower than baseline requirement
56		Chilled Water Plants	*(design CHWT >35°F)*	
57		Equipment Selection	< 250 tons = air-cooled chiller ≥ 250 tons = water-cooled chiller *Chiller performance must meet minimum requirements in IECC 2012 403.2.3	Air-cooled chiller with integrated dry cooler or water-cooled chiller with water-side economizer *Performance exceeding requirements in IECC 2012 403.2.3
58			Systems ≥ 250 tons, if winter cooling required (hospitals/labs, etc), chiller must have water-side economizer or automatic switchover to separate system	

Line #	Div.	***System*** Sub-Category	2014 Program Year Baseline Efficiency Minimum Standards & Practice	2014 Program Year Potential High-Performance Practices
59	Mechanical	Chiller Sequencing	If multiple chillers are present, assume they would be manually staged based on load	Optimal automatic chiller sequencing based on total plant efficiency
60		Pumping	Constant-flow chillers with primary/secondary pumping system; VFDs on secondary pumps per code requirements	Variable-flow chiller system with VFD on primary pumps
61			CHW pumps serving variable-flow systems > 5 hp must have VFDs	CHW pumps ≤ 5 hp with VFDs
62		Chilled Water Temperature	Systems ≥ 25 tons must: (1) automatically reset supply water temperature by ≥ 25% of design supply-to-return water temperature difference OR (2) reduce pump flow by at least 50% of design flow rate based on load (IECC 2012 403.4.3.4)	Exceed requirements of IECC 2012 403.4.3.4
63			Standard 10°F chilled water system differential	Higher temperature differential, increased savings with oversized pipes (consider chiller performance and fan energy penalties)
64		Piping	Chilled water piping sizing according to ASHRAE 90.1 2010 Table 6.5.4.5	
65		Cooling Towers	Induced draft cooling towers having a nominal motor size ≥38.2 gpm/hp at 95°F/85°F/75°F wb (ASHRAE 90.1-2010 Table 6.8.1G)	Oversize cooling tower box, downsize fan motor
66			Induced-draft cooling tower with centrifugal fan having a nominal motor size ≥ 20 gpm/hp at 95°F/85°F/75°F wb (ASHRAE 90.1-2010 Table 6.8.1G). Fans ≥7.5 hp must have 2-speed motor with automatic controls	VFD for cooling tower
67			CT fan speed control per code requirements, minimize number of operating fans (ASHRAE section 6.5.5.2). Fans ≥7.5 hp shall have capability to operate at 2/3 speed or less with automatic controls	VFDs on all cooling towers, maximize number of operating tower fans

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68	Mechanical	Differential Pressure	Differential pressure setpoint should be no more than 110% of that required to achieve design flow through heat exchanger. (ASHRAE 90.1 2010 6.5.4)	
69	Mechanical	Condenser Water Temperature	Constant condenser water (CW) temperature setpoint of 70°F (per ASHRAE 90.1-2010 G3.1.3.11)	Reset CW temperature setpoint based upon outside air wetbulb temperature down to minimum acceptable by chiller manufacturer and site operators; maintain an offset to ambient wetbulb (e.g. 7°F)
70	Mechanical	Water-side Economizer	No water-side economizer (if not required by IECC 2012 403.4.1)	Plate and frame heat exchanger for free winter cooling/water-side economizer
71	Mechanical		Manually activated switchover to free cooling operation; automated isolation valves on cooling towers, chillers, and heat exchangers	Automatic switchover into and out of free cooling based on ambient wetbulb, chilled water load, and cooling tower capacity
72	Mechanical	Thermal Storage	No thermal storage	Thermal storage to reduce plant peak kW demand (consider energy penalty on overall plant energy use)
73	Mechanical	***Service Water***		
74	Mechanical	Equipment Selection	Must meet minimum efficiency requirements in IECC 2012 Table 404.2	Exceed requirements of IECC 2012 Table 404.2
75	Mechanical	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 2012 Section C403.4.6)	Heat recovery where not code-required

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76	Electrical	***Motors***		
77		Selection	AC 3-phase, 60-Hz motors 1 hp and larger: NEMA premium efficiency motors	Advanced technology motors: permanent magnet, all copper rotor motors
78			Motors < 1 hp: PSC motors	Motors < 1 hp: Electronically commutated (EC) motors
79		Power transmission	Belt drive transmission system	Synchronous power transmission
80		***Lighting***		
81		IECC 2012 Compliance	*Note: If New Construction project decides to comply with IECC 2012 406.3 Lighting Performance, must meet minimum LPD in Table C406.3*	
82		High Bay Lighting *(ceiling >20')*	High bay lighting systems with no controls, must meet IECC 2009 LPD (RI. IECC 2012 after Jan. 2014, MA. IECC 2012 after Jan. 2015)	Higher performance LED fixtures with integral lighting controls, lighting redesign and lighting commissioning
83		Standard Interior Lighting *(ceiling <20')*	Lighting system design must meet IECC 2009 LPD (RI IECC 2012 after Jan. 2014, MA IECC 2012 after Jan. 2015)	Higher performance LED fixtures with network lighting controls, lighting redesign and lighting commissioning
84		Lighting Controls	Comply with IECC 2012 405.2.1 automatic lighting shutoff	Occupancy sensors and other automatic controls where not required
85			Comply with ASHRAE 90.1-2010 9.4.1 space control, including occ sensors in classrooms (see exceptions), conference/meeting rooms, and lunch/break rooms	
86			Bi-level switching as required by IECC 2012 405.2.2.1	Bi-level switching where not required
87			Daylighting dimming controls in accordance with IECC 2012 C405.2.2.3	Daylight dimming controls where not required
88		Exterior Lighting	Lighting power densities per IECC 2012 Tables 405.6.2(1) and (2)	High efficiency design incorporating LED fixtures
89			HID technology	Higher efficiency fixtures or system designs providing equivalent light levels and improved controllability
90			Timeclock and/or photocell controls	Automatic high/low controls (for loading docks or areas with variable occupancy; no manual override ON option)

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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

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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

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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

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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	

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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 (see attachment)	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 (see attachment)	
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 (see attachment)	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

Commercial New Construction Baseline Descriptions
Massachusetts and Rhode Island

Line #	Div.	System / Sub-Category	2014 Program Year: Baseline Efficiency Minimum Standards & Practice	2014 Program Year: 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

Commercial New Construction Baseline Descriptions
Massachusetts and Rhode Island

Line #	Div.	*System* Sub-Category	2014 Program Year 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

Commercial New Construction Baseline Descriptions
Massachusetts and Rhode Island

Line #	Div.	System / Sub-Category	2014 Program Year: Baseline Efficiency Minimum Standards & Practice	2014 Program Year: Potential High-Performance Practices
203	Market Characterizations	***Cold Storage***		
204		< 50,000 ft²	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 ft² & < 200,000 ft²	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 ft²	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

Commercial New Construction Baseline Descriptions
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Line #	Div.	*System* Sub-Category	2014 Program Year 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	
218 219		Seals	Manually operated motorized isolation doors OR strip doors with non-motorized doors	High-speed automatic isolation doors
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

Commercial New Construction Baseline Descriptions
Massachusetts and Rhode Island

Line #	Div.	System / Sub-Category	2014 Program Year: Baseline Efficiency Minimum Standards & Practice	2014 Program Year: 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

Commercial New Construction Baseline Descriptions
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Line #	Div.	System / Sub-Category	2014 Program Year: Baseline Efficiency Minimum Standards & Practice	2014 Program Year: Potential High-Performance Practices
234	Process	***Plastic Injection Molding Machines***		
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%	86.3%	90.1%	90.2%
≥ 20 and ≤ 100	88.5%	88.5%	91.3%	91.9%
> 100	89.8%	89.8%	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