



# Envelope Compliance Certificate

## 2009 IECC

### Section 1: Project Information

Project Type: **New Construction**

Project Title : East Bridgewater Junior/Senior High School

Construction Site:

11 Plymouth Street  
East Bridgewater, MA 02333  
Permit No. TBD  
Permit Date: TBD

Owner/Agent:

Susan Cole  
11 Plymouth Street  
East Bridgewater, MA 02333  
508-378-5956  
scote@ebps.net

Designer/Contractor:

James Jordan  
Ai3 Architects  
286 Boston Post Road  
Wayland, MA 01778  
508-358-0790  
jordan@ai3architects.com

### Section 2: General Information

Building Location (for weather data): **East Bridgewater, Massachusetts**  
Climate Zone: **5a**  
Building Type for Envelope Requirements: **Non-Residential**  
Vertical Glazing / Wall Area Pct.: **19%**  
Skylight Glazing / Roof Area Pct.: **0%**

**Activity Type(s)**

School/University

**Floor Area**

213257

### Section 3: Requirements Checklist

**Envelope PASSES: Design 6% better than code.**

#### Climate-Specific Requirements:

Component Name/Description	Gross Area or Perimeter	Cavity R-Value	Cont. R-Value	Proposed U-Factor	Budget U-Factor(a)
Roof - PVC Membrane: Insulation Entirely Above Deck	102735	---	40.0	0.025	0.048
Skylight: Metal Frame with Thermal Break:Double Pane with Low-E, Tinted, SHGC 0.69	492	---	---	0.290	0.600
Roof - Vented/Naillable: Attic Roof with Steel Joists	6188	0.0	25.0	0.039	0.027
Floor - Slab on Grade: Slab-On-Grade:Unheated, Horizontal with vertical 4 ft.	2397	---	10.0	---	---
Exterior Wall South - Metal Stud: Steel-Framed, 16" o.c.	16399	9.0	10.0	0.058	0.064
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	2599	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	446	---	---	0.430	0.450
Hollow Metal Door: Insulated Metal, Swinging	138	---	---	0.310	0.700
Exterior Wall South - 8" CMU: Concrete Block:8", Partially Grouted, Cells Empty,Normal Density , Furring: None	3553	---	10.0	0.082	0.090
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	522	---	---	0.450	0.550
Storefront: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	359	---	---	0.430	0.450
Overhead Coiling Door: Insulated Metal, Non-Swinging	88	---	---	0.310	0.500
Exterior Wall East - Metal Stud: Steel-Framed, 16" o.c.	13187	9.0	10.0	0.058	0.064

Aluminum Window: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	1790	---	---	0.450	0.450
Storefront/Curtainwall: Wood Frame:Double Pane with Low-E, Clear, SHGC 0.37	1156	---	---	0.430	0.350
Exterior Wall East - 8" CMU: Concrete Block:8", Partially Grouted, Cells Empty,Normal Density , Furring: None	1441	---	10.0	0.082	0.090
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	161	---	---	0.450	0.550
Exterior Wall North - Metal Stud: Steel-Framed, 16" o.c.	11674	9.0	10.0	0.058	0.064
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	1127	---	---	0.450	0.550
Storefront/ Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	810	---	---	0.430	0.450
Exterior Wall North - 8" CMU: Concrete Block:8", Partially Grouted, Cells Empty,Normal Density , Furring: None	9148	---	10.0	0.082	0.090
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	670	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	558	---	---	0.430	0.450
Hollow Metal Door: Insulated Metal, Swinging	109	---	---	0.310	0.700
Exterior Wall West - Metal Stud: Steel-Framed, 16" o.c.	9480	9.0	10.0	0.058	0.064
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	167	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	643	---	---	0.430	0.450
Exterior Wall West - 8" CMU: Concrete Block:8", Partially Grouted, Cells Empty,Normal Density , Furring: None	3911	---	10.0	0.082	0.090
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	500	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	46	---	---	0.430	0.450
Hollow Metal Door: Insulated Metal, Swinging	149	---	---	0.310	0.700
Ext. Wall Courtyard - Metal Stud: Steel-Framed, 16" o.c.	20558	9.0	10.0	0.058	0.064
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	4773	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	360	---	---	0.430	0.450
Ext. Wall Courtyard - 8" CMU: Concrete Block:8", Partially Grouted, Cells Empty,Normal Density , Furring: None	1246	---	10.0	0.082	0.090
Aluminum Window: Metal Frame with Thermal Break:Double Pane with Low-E, Clear, SHGC 0.37	292	---	---	0.450	0.550
Storefront/Curtainwall: Metal Frame Curtain Wall/Storefront:Double Pane with Low-E, Clear, SHGC 0.37	63	---	---	0.430	0.450

(a) Budget U-factors are used for software baseline calculations ONLY, and are not code requirements.

#### Air Leakage, Component Certification, and Vapor Retarder Requirements:

- 1. All joints and penetrations are caulked, gasketed or covered with a moisture vapor-permeable wrapping material installed in accordance with the manufacturer's installation instructions.
- 2. Windows, doors, and skylights certified as meeting leakage requirements.
- 3. Component R-values & U-factors labeled as certified.
- 4. No roof insulation is installed on a suspended ceiling with removable ceiling panels.
- 5. 'Other' components have supporting documentation for proposed U-Factors.
- 6. Insulation installed according to manufacturer's instructions, in substantial contact with the surface being insulated, and in a manner that achieves the rated R-value without compressing the insulation.
- 7. Stair, elevator shaft vents, and other outdoor air intake and exhaust openings in the building envelope are equipped with motorized dampers.
- 8. Cargo doors and loading dock doors are weather sealed.
- 9. Recessed lighting fixtures installed in the building envelope are Type IC rated as meeting ASTM E283, are sealed with gasket or caulk.
- 10. Building entrance doors have a vestibule equipped with closing devices.
  - Exceptions:*
  - Building entrances with revolving doors.
  - Doors that open directly from a space less than 3000 sq. ft. in area.

## Section 4: Compliance Statement

Compliance Statement: The proposed envelope design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed envelope system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

JAMES S. JORDAN      [Signature]      6-14-11  
Name - Title      Signature      Date



COMcheck Software Version 3.8.1

# Interior Lighting Compliance Certificate

## 2009 IECC

### Section 1: Project Information

Project Type: **New Construction**

Project Title : East Bridgewater High School

Construction Site:

11 Plymouth Street  
East Bridgewater, MA 02333  
Permit No. TBD  
Permit Date: TBD

Owner/Agent:

Susan Cote  
11 Plymouth Street  
East Bridgewater, MA 02333  
508-378-5956  
scote@ebps.net

Designer/Contractor:

James Jordan  
Ai3 Architects  
286 Boston Post Road  
Wayland, MA 01778  
508-358-0790  
jordan@ai3architects.com

### Section 2: Interior Lighting and Power Calculation

A Area Category	B Floor Area (ft <sup>2</sup> )	C Allowed Watts / ft <sup>2</sup>	D Allowed Watts (B x C)
School/University	213257	1.2	255908
Total Allowed Watts =			255908

### Section 3: Interior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
School/University (213257 sq.ft.)				
T8 / T12 Fluorescent 1: A: 8' PENDANT / 46" T5 28W / Electronic	4	217	120	26040
T8 / T12 Fluorescent 1 copy 1: AD: 8' PENDANT / 46" T5 28W / Electronic	4	173	120	20760
T8 / T12 Fluorescent 1: AE: 8' PENDANT / 46" T5 28W / Electronic	4	1	120	120
T8 / T12 Fluorescent 5: A1: 4' PENDANT / 46" T5 28W / Electronic	2	154	60	9240
T8 / T12 Fluorescent 5 copy 1: A1D: 4' PENDANT / 46" T5 28W / Electronic	2	1	60	60
T8 / T12 Fluorescent 6: A2: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	24	60	1440
T8 / T12 Fluorescent 6 copy 1: A2D: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	4	60	240
T8 / T12 Fluorescent 7: A2E: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	3	60	180
T8 / T12 Fluorescent 8: A3: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	50	60	3000
T8 / T12 Fluorescent 7 copy 1: A3D: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	9	90	810
T8 / T12 Fluorescent 9: A3E: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	11	90	990
T8 / T12 Fluorescent 10: A4: 2' x 4' RECESSED / 46" T5 28W / Electronic	4	5	120	600
T8 / T12 Fluorescent 10 copy 1: A4E: 2' x 4' RECESSED / 46" T5 28W / Electronic	4	5	120	600
T8 / T12 Fluorescent 10 copy 1: A5: 2' x 4' RECESSED / 46" T5 28W / Electronic	6	4	180	720
T8 / T12 Fluorescent 10 copy 2: A5D: 2' x 4' RECESSED / 46" T5 28W / Electronic	6	4	180	720
T8 / T12 Fluorescent 10 copy 3: A6: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	4	90	360
T8 / T12 Fluorescent 10 copy 4: A7: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	42	60	2520
T8 / T12 Fluorescent 12: B: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	277	60	16620
T8 / T12 Fluorescent 14: B2: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	35	60	2100
T8 / T12 Fluorescent 14 copy 1: B2E: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	1	60	60
T8 / T12 Fluorescent 14 copy 1: B3: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	3	40	90	3600
T8 / T12 Fluorescent 14 copy 2: B4: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	3	7	90	630
T8 / T12 Fluorescent 18: C2: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	93	60	5580
T8 / T12 Fluorescent 18 copy 2: C2D: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	21	60	1260

T8 / T12 Fluorescent 18 copy 1: C2E: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	2	6	60	360
T8 / T12 Fluorescent 18 copy 1: C3: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	3	35	90	3150
T8 / T12 Fluorescent 18 copy 2: C3D: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	3	3	90	270
T8 / T12 Fluorescent 18 copy 2: C4: 2' x 2' RECESSED / 22" T5 HO 24W / Electronic	4	19	120	2280
T8 / T12 Fluorescent 25 copy 1: D2: 1' x 4' Recessed / 46" T5 28W / Electronic	2	63	60	3780
Compact Fluorescent 1 copy 2: DC1: LED / Other / Electronic	1	5	30	150
Compact Fluorescent 1 copy 3: DC2: LED / Other / Electronic	1	2	60	120
Compact Fluorescent 1 copy 4: DC3: LED / Other / Electronic	1	1	75	75
T8 / T12 Fluorescent 25: E2: 1' x 4' SURFACE / 46" T5 28W / Electronic	2	41	60	2460
T8 / T12 Fluorescent 26: E3: 1' x 4' SURFACE / 46" T5 28W / Electronic	3	32	90	2880
T8 / T12 Fluorescent 25 copy 1: E4: 1' x 4' SURFACE / 46" T5 28W / Electronic	4	9	120	1080
T8 / T12 Fluorescent 27: F: 4' STRIP SURFACE / 46" T5 28W / Electronic	2	79	60	4740
T8 / T12 Fluorescent 27 copy 2: F2: 4' STRIP SURFACE / 46" T5 28W / Electronic	2	4	60	240
T8 / T12 Fluorescent 27 copy 3: G: LED / Other / Premium efficiency	1	48	100	4800
T8 / T12 Fluorescent 27 copy 4: J: LED / Other / Premium efficiency	1	9	27	243
T8 / T12 Fluorescent 1: K: LENSED 2 x 4 / 46" T5 28W / Electronic	4	16	120	1920
T8 / T12 Fluorescent 1: K1: LENSED 2 x 2 / 22" T5 HO 24W / Electronic	3	2	90	180
Compact Fluorescent 1: L: COMPACT FLOUR. / QUAD 4-PIN 26W / Electronic	2	228	56	12768
Compact Fluorescent 4 copy 1: L1: COMPACT FLUOR. / Twin Tube 40W / Electronic	2	3	98	294
Compact Fluorescent 3: L2: COMPACT FLUOR. / Twin Tube 55W / Electronic	2	32	125	4000
Compact Fluorescent 4: L3: COMPACT FLUOR. / Twin Tube 40W / Electronic	2	63	98	6174
Compact Fluorescent 4 copy 1: L4: COMPACT FLUOR. / TRIPLE TUBE / Electronic	2	7	74	518
Compact Fluorescent 1 copy 1: L5: LED / Other / Electronic	1	6	14	84
Incandescent 11: M: Incandescent 75W	1	6	75	450
T8 / T12 Fluorescent 3: N2: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	61	60	3660
T8 / T12 Fluorescent 4: N2E: 2' x 4' RECESSED / 46" T5 28W / Electronic	2	6	60	360
T8 / T12 Fluorescent 5: N3: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	15	90	1350
T8 / T12 Fluorescent 5 copy 1: N3E: 2' x 4' RECESSED / 46" T5 28W / Electronic	3	5	90	450
Linear Fluorescent 31: P: 46" T5 HO 54W / Electronic	6	36	350	12600
Compact Fluorescent 4 copy 2: P3: COMPACT FLUOR. / Triple 4-pin 42W / Electronic	6	26	300	7800
T8 / T12 Fluorescent 1 copy 1: RL: 8' PENDANT / 46" T5 28W / Electronic	4	4	120	480
Compact Fluorescent 8: Q: Triple 4-pin 26W / Electronic	1	22	28	616
Compact Fluorescent 7: U: WALL LIGHT / Quad 2-pin 26W / Electronic	2	66	56	3696
T8 / T12 Fluorescent 25 copy 2: UC: UNDERCOUNTER / 46" T5 28W / Electronic	1	17	31	527
Linear Fluorescent 29: V: 46" T5 28W / Electronic	2	10	60	600
Incandescent 4: Y: LIGHT (ELEV. PIT) / Incandescent 150W	1	1	150	150
Incandescent 7: Z: Incandescent 150W	1	7	150	1050
Compact Fluorescent 10: BB: Twin Tube 18W / Electronic	1	38	20	760
Compact Fluorescent 10 copy 1: CC1: LED / Other / Electronic	1	26	53	1378
Incandescent 10: DD: Incandescent 150W	1	4	150	600
Compact Fluorescent 12: FF: Twin Tube 50W / Electronic	8	1	340	340
Compact Fluorescent 12 copy 1: FF1: Triple 4-pin 26W / Electronic	2	2	56	112
Compact Fluorescent 12 copy 2: FF2: Triple 4-pin 26W / Electronic	8	12	224	2688
Compact Fluorescent 12 copy 3: FF3: BIAx 39W / Electronic	6	6	270	1620
Compact Fluorescent 12 copy 4: FF4: Triple 4-pin 42W / Electronic	4	16	200	3200
Compact Fluorescent 1 copy 2: HH: LED / Other / Electronic	1	60	53	3180
Compact Fluorescent 1 copy 3: HH1: LED / Other / Electronic	1	4	30	120
Compact Fluorescent 11: JJ: Twin Tube 24/26/27W / Electronic	1	14	30	420
Compact Fluorescent 1 copy 3: LL: LED / Other / Electronic	1	13	20	260

Total Proposed Watts = 199283

## Section 4: Requirements Checklist

### Lighting Wattage:

1. Total proposed watts must be less than or equal to total allowed watts.

Allowed Watts	Proposed Watts	Complies
255908	199283	YES

### Controls, Switching, and Wiring:

2. Daylight zones under skylights more than 15 feet from the perimeter have lighting controls separate from daylight zones adjacent to vertical fenestration.

3. Daylight zones have individual lighting controls independent from that of the general area lighting.

*Exceptions:*

- Contiguous daylight zones spanning no more than two orientations are allowed to be controlled by a single controlling device.
- Daylight spaces enclosed by walls or ceiling height partitions and containing two or fewer light fixtures are not required to have a separate switch for general area lighting.

4. Independent controls for each space (switch/occupancy sensor).

*Exceptions:*

- Areas designated as security or emergency areas that must be continuously illuminated.
- Lighting in stairways or corridors that are elements of the means of egress.

5. Master switch at entry to hotel/motel guest room.
6. Individual dwelling units separately metered.
7. Medical task lighting or art/history display lighting claimed to be exempt from compliance has a control device independent of the control of the nonexempt lighting.
8. Each space required to have a manual control also allows for reducing the connected lighting load by at least 50 percent by either controlling all luminaires, dual switching of alternate rows of luminaires, alternate luminaires, or alternate lamps, switching the middle lamp luminaires independently of other lamps, or switching each luminaire or each lamp.

*Exceptions:*

- Only one luminaire in space.
- An occupant-sensing device controls the area.
- The area is a corridor, storeroom, restroom, public lobby or sleeping unit.
- Areas that use less than 0.6 Watts/sq.ft.

9. Automatic lighting shutoff control in buildings larger than 5,000 sq.ft.

*Exceptions:*

- Sleeping units, patient care areas; and spaces where automatic shutoff would endanger safety or security.

10. Photocell/astronomical time switch on exterior lights.

*Exceptions:*

- Lighting intended for 24 hour use.

11. Tandem wired one-lamp and three-lamp ballasted luminaires (No single-lamp ballasts).

*Exceptions:*

- Electronic high-frequency ballasts; Luminaires on emergency circuits or with no available pair.

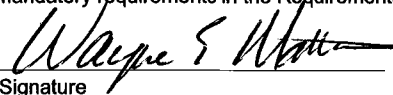
**Interior Lighting PASSES: Design 22% better than code.**

## Section 5: Compliance Statement

*Compliance Statement:* The proposed lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Wayne E. Mattson, P.E. - Principal

Name - Title

 6/27/11

Signature

Date



COMcheck Software Version 3.8.1

# Exterior Lighting Compliance Certificate

## 2009 IECC

### Section 1: Project Information

Project Type: **New Construction**

Project Title : East Bridgewater High School

Exterior Lighting Zone: **2 (Residential mixed use area)**

Construction Site:

11 Plymouth Street  
 East Bridgewater, MA 02333  
 Permit No. TBD  
 Permit Date: TBD

Owner/Agent:

Susan Cote  
 11 Plymouth Street  
 East Bridgewater, MA 02333  
 508-378-5956  
 scote@ebps.net

Designer/Contractor:

James Jordan  
 Ai3 Architects  
 286 Boston Post Road  
 Wayland, MA 01778  
 508-358-0790  
 jordan@ai3architects.com

### Section 2: Exterior Lighting Area/Surface Power Calculation

A Exterior Area/Surface	B Quantity	C Allowed Watts / Unit	D Tradable Wattage	E Allowed Watts (B x C)	F Proposed Watts
P1 (Parking area)	116150 ft2	0.06	Yes	6969	5700
P2 (Parking area)	36100 ft2	0.06	Yes	2166	1400
Courtyard (Walkway >= 10 feet wide)	6651 ft2	0.14	Yes	931	240
D1 (Driveway)	26300 ft2	0.06	Yes	1578	1300
D2 (Driveway)	11000 ft2	0.06	Yes	660	600
D3 (Driveway)	33110 ft2	0.06	Yes	1987	1600
W1 (Walkway >= 10 feet wide)	15625 ft2	0.14	Yes	2188	700
Entry canopy	256 ft2	0.25	Yes	64	170
Entry canopy	256 ft2	0.25	Yes	64	170
Entry canopy	90 ft2	0.25	Yes	23	125
Entry canopy	160 ft2	0.25	Yes	40	125
Entry canopy	160 ft2	0.25	Yes	40	125
Entry canopy	340 ft2	0.25	Yes	85	250
Entry canopy	1920 ft2	0.25	Yes	480	1125
Entry canopy	198 ft2	0.25	Yes	50	125
Entry canopy	720 ft2	0.25	Yes	180	720
Entry canopy	128 ft2	0.25	Yes	32	170
Entry canopy	180 ft2	0.25	Yes	45	170
Entry canopy	16 ft2	0.25	Yes	4	170
Entry canopy	16 ft2	0.25	Yes	4	170
Other door (not main entry)	3 ft of door width	20	Yes	60	125
Other door (not main entry)	6 ft of door width	20	Yes	120	125
Other door (not main entry)	3 ft of door width	20	Yes	60	125
Other door (not main entry)	6 ft of door width	20	Yes	120	125
Other door (not main entry)	6 ft of door width	20	Yes	120	125
Other door (not main entry)	6 ft of door width	20	Yes	120	125
Other door (not main entry)	3 ft of door width	20	Yes	60	125
Other door (not main entry)	3 ft of door width	20	Yes	60	125
Illuminated length of facade wall or surface	31 ft	2.5	No	78	200
Illuminated length of facade wall or surface	86 ft	2.5	No	215	500
Illuminated length of facade wall or surface	96 ft	2.5	No	240	140
Illuminated length of facade wall or surface	85 ft	2.5	No	213	250

Total Tradable Watts\* = 18308 16155

Total Allowed Watts = 19053

Total Allowed Supplemental Watts\*\* = 600

\* Wattage tradeoffs are only allowed between tradable areas/surfaces.

\*\* A supplemental allowance equal to 600 watts may be applied toward compliance of both non-tradable and tradable areas/surfaces.

### Section 3: Exterior Lighting Fixture Schedule

A Fixture ID : Description / Lamp / Wattage Per Lamp / Ballast	B Lamps/ Fixture	C # of Fixtures	D Fixture Watt.	E (C X D)
<b>P1 ( Parking area 116150 ft2): Tradable Wattage</b>				
Compact Fluorescent 1: SL1: LED POLE MOUNTED / Other / Electronic	1	7	100	700
Compact Fluorescent 1 copy 1: SL2: LED POLE MOUNTED / Other / Electronic	2	25	200	5000
<b>P2 ( Parking area 36100 ft2): Tradable Wattage</b>				
Compact Fluorescent 1 copy 1: SL1: LED POLE MOUNTED / Other / Electronic	1	6	100	600
Compact Fluorescent 1 copy 2: SL2: LED POLE MOUNTED / Other / Electronic	2	4	200	800
<b>Courtyard ( Walkway &gt;= 10 feet wide 6651 ft2): Tradable Wattage</b>				
Compact Fluorescent 5: SL4: LED BOLLARD / Other / Electronic	1	12	20	240
<b>D1 ( Driveway 26300 ft2): Tradable Wattage</b>				
Compact Fluorescent 1 copy 1: SL1: LED POLE MOUNTED / Other / Electronic	1	13	100	1300
<b>D2 ( Driveway 11000 ft2): Tradable Wattage</b>				
Compact Fluorescent 1 copy 2: SL1: LED POLE MOUNTED / Other / Electronic	1	6	100	600
<b>D3 ( Driveway 33110 ft2): Tradable Wattage</b>				
Compact Fluorescent 1 copy 3: SL1: LED POLE MOUNTED / Other / Electronic	1	16	100	1600
<b>W1 ( Walkway &gt;= 10 feet wide 15625 ft2): Tradable Wattage</b>				
Compact Fluorescent 1 copy 4: SL3: LED POLE MOUNTED / Other / Electronic	1	7	100	700
<b>Entry canopy (256 ft2): Tradable Wattage</b>				
HID 1 copy 1: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Entry canopy (256 ft2): Tradable Wattage</b>				
HID 1 copy 2: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Entry canopy (90 ft2): Tradable Wattage</b>				
HID 1 copy 3: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	1	125	125
<b>Entry canopy (160 ft2): Tradable Wattage</b>				
HID 1 copy 4: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	1	125	125
<b>Entry canopy (160 ft2): Tradable Wattage</b>				
HID 1 copy 5: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	1	125	125
<b>Entry canopy (340 ft2): Tradable Wattage</b>				
HID 1 copy 6: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	2	125	250
<b>Entry canopy (1920 ft2): Tradable Wattage</b>				
HID 1 copy 7: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	9	125	1125
<b>Entry canopy (198 ft2): Tradable Wattage</b>				
HID 1 copy 7: T2: CANOPY LIGHT / Metal Halide 100W / Standard	1	1	125	125
<b>Entry canopy (720 ft2): Tradable Wattage</b>				
HID 1: T: CANOPY LIGHT / Metal Halide 150W / Standard	1	4	180	720
<b>Entry canopy (128 ft2): Tradable Wattage</b>				
HID 1 copy 2: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Entry canopy (180 ft2): Tradable Wattage</b>				
HID 1 copy 3: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Entry canopy (16 ft2): Tradable Wattage</b>				
HID 1 copy 4: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Entry canopy (16 ft2): Tradable Wattage</b>				
HID 1 copy 5: T1: CANOPY LIGHT / Metal Halide 70W / Standard	1	2	85	170
<b>Other door (not main entry) (3 ft of door width): Tradable Wattage</b>				
HID 14: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
<b>Other door (not main entry) (6 ft of door width): Tradable Wattage</b>				
HID 14 copy 1: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
<b>Other door (not main entry) (3 ft of door width): Tradable Wattage</b>				
HID 14 copy 2: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125



Other door (not main entry) (6 ft of door width): Tradable Wattage HID 14 copy 3: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
Other door (not main entry) (6 ft of door width): Tradable Wattage HID 14 copy 4: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
Other door (not main entry) (6 ft of door width): Tradable Wattage HID 14 copy 5: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
Other door (not main entry) (3 ft of door width): Tradable Wattage HID 14 copy 6: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
Other door (not main entry) (3 ft of door width): Tradable Wattage HID 14 copy 7: SL8: DOOR / Metal Halide 100W / Standard	1	1	125	125
Illuminated length of facade wall or surface (31 ft): Non-tradable Wattage Compact Fluorescent 1 copy 1: SL5: LED / Other / Electronic	1	2	100	200
Illuminated length of facade wall or surface (86 ft): Non-tradable Wattage HID 14 copy 8: SL8: WALL / Metal Halide 100W / Standard	1	4	125	500
Illuminated length of facade wall or surface (96 ft): Non-tradable Wattage Compact Fluorescent 1 copy 2: SL13: LED / Other / Electronic	1	7	20	140
Illuminated length of facade wall or surface (85 ft): Non-tradable Wattage HID 14 copy 9: SL8: WALL / Metal Halide 100W / Standard	1	2	125	250

Total Tradable Proposed Watts = 16155

## Section 4: Requirements Checklist

### Lighting Wattage:

1. Within each non-tradable area/surface, total proposed watts must be less than or equal to total allowed watts. Across all tradable areas/surfaces, total proposed watts must be less than or equal to total allowed watts.

**Compliance:** Passes using supplemental allowance watts.

### Controls, Switching, and Wiring:

2. All exemption claims are associated with fixtures that have a control device independent of the control of the nonexempt lighting.
3. Lighting not designated for dusk-to-dawn operation is controlled by either a photosensor (with time switch), or an astronomical time switch.
4. Lighting designated for dusk-to-dawn operation is controlled by an astronomical time switch or photosensor.
5. All time switches are capable of retaining programming and the time setting during loss of power for a period of at least 10 hours.

### Exterior Lighting Efficacy:

6. All exterior building grounds luminaires that operate at greater than 100W have minimum efficacy of 60 lumen/watt.

#### Exceptions:

- Lighting that has been claimed as exempt and is identified as such in Section 3 table above.
- Lighting that is specifically designated as required by a health or life safety statute, ordinance, or regulation.
- Emergency lighting that is automatically off during normal building operation.
- Lighting that is controlled by motion sensor.

**Exterior Lighting PASSES:** Design 13% better than code.

## Section 5: Compliance Statement

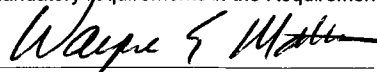
**Compliance Statement:** The proposed exterior lighting design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed lighting system has been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Wayne E. Mattson, P.E. - Principal

Name - Title

Signature

Date

 6/27/11



# Mechanical Compliance Certificate

## 2009 IECC

### Section 1: Project Information

Project Type: **New Construction**

Project Title : East Bridgewater High School

Construction Site:

11 Plymouth Street  
East Bridgewater, MA 02333  
Permit No. TBD  
Permit Date: TBD

Owner/Agent:

Susan Cote  
11 Plymouth Street  
East Bridgewater, MA 02333  
508-378-5956  
scote@ebps.net

Designer/Contractor:

James Jordan  
Ai3 Architects  
286 Boston Post Road  
Wayland, MA 01778  
508-358-0790  
jordan@ai3architects.com

### Section 2: General Information

Building Location (for weather data):

**East Bridgewater, Massachusetts**

Climate Zone:

**5a**

### Section 3: Mechanical Systems List

#### Quantity   System Type & Description

- |   |                                                                                                                                                                                          |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | HVAC System 1 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 424 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 1154 kBtu/h, Air Economizer |
| 1 | HVAC System 2 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 83 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 420 kBtu/h, Air Economizer   |
| 1 | HVAC System 3 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 359 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 923 kBtu/h, Air Economizer  |
| 1 | HVAC System 4 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 598 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 1472 kBtu/h, Air Economizer |
| 1 | HVAC System 5 (Single Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 862 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 643 kBtu/h, Air Economizer    |
| 1 | HVAC System 6 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 41 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 192 kBtu/h, Air Economizer   |
| 1 | HVAC System 7 (Single Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 681 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 527 kBtu/h, Air Economizer    |
| 1 | HVAC System 8 (Multiple-Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 37 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 61 kBtu/h, Air Economizer    |
| 1 | HVAC System 9 (Single Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 1708 kBtu/h                                                                             |
| 1 | HVAC System 10 (Single Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 60 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 243 kBtu/h, Air Economizer    |
| 1 | HVAC System 11 (Multiple-Zone) :<br>Heating: 1 each - Other, Hot Water, Capacity = 282 kBtu/h                                                                                            |
| 1 | HVAC System 12 (Single Zone) :<br>Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 111 kBtu/h<br>Cooling: 1 each - Hydronic Coil, Capacity = 55 kBtu/h, Air Economizer    |

- 1 HVAC System 13 (Single Zone) :  
Heating: 1 each - Hydronic or Steam Coil, Hot Water, Capacity = 263 kBtu/h  
Cooling: 1 each - Hydronic Coil, Capacity = 113 kBtu/h, Air Economizer
- 5 Plant 1: Heating: Hot Water Boiler, Capacity 1620 kBtu/h, Gas, Efficiency: 96.00 % Et
- 1 Plant 2: Cooling: Water Chiller, Capacity 395 tons, Condenser Air-Cooled, Efficiency: 18.50 EER, Rotary Screw or Scroll Chiller
- 1 Water Heater 1: Gas Storage Water Heater, Capacity: 432 gallons, Input Rating: 500 Btu/h w/ Circulation Pump, Efficiency: 95.00 % Et
- 1 Water Heater 2: Gas Storage Water Heater, Capacity: 257 gallons, Input Rating: 500 Btu/h w/ Circulation Pump, Efficiency: 95.00 % Et

## Section 4: Requirements Checklist

### Requirements Specific To: HVAC System 1 :

- 1. Minimum one temperature control device per zone
- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Discharge dampers prohibited with fan motors > 10 hp
- 4. Balancing and pressure test connections on all hydronic terminal devices
- 5. Integrated air economizer required
- 6. Systems serving more than one zone must be VAV systems
- 7. Single-duct VAV terminals reduce primary air before reheating
- 8. Fan equipped with electrical variable-speed drive
- 9. Separate hot and cold water supply and returns
- 10. Multiple boilers must have automatic controls that sequence operation with load
- 11. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 12. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 13. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 14. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
- 15. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
- 16. Hot gas bypass limited to 25% of total cooling capacity

### Requirements Specific To: HVAC System 2 :

- 1. Minimum one temperature control device per zone
- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Balancing and pressure test connections on all hydronic terminal devices
- 4. Integrated air economizer required
- 5. Systems serving more than one zone must be VAV systems
- 6. Single-duct VAV terminals reduce primary air before reheating
- 7. Separate hot and cold water supply and returns
- 8. Multiple boilers must have automatic controls that sequence operation with load
- 9. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 10. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 11. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 12. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm

- 13. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
- 14. Hot gas bypass limited to 25% of total cooling capacity

### Requirements Specific To: HVAC System 3 :

- 1. Minimum one temperature control device per zone
- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Discharge dampers prohibited with fan motors > 10 hp
- 4. Balancing and pressure test connections on all hydronic terminal devices
- 5. Integrated air economizer required
- 6. Systems serving more than one zone must be VAV systems
- 7. Single-duct VAV terminals reduce primary air before reheating
- 8. Fan equipped with electrical variable-speed drive
- 9. Separate hot and cold water supply and returns
- 10. Multiple boilers must have automatic controls that sequence operation with load
- 11. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 12. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 13. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 14. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
- 15. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
- 16. Hot gas bypass limited to 25% of total cooling capacity

### Requirements Specific To: HVAC System 4 :

- 1. Minimum one temperature control device per zone
- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Discharge dampers prohibited with fan motors > 10 hp
- 4. Balancing and pressure test connections on all hydronic terminal devices
- 5. Integrated air economizer required
- 6. Systems serving more than one zone must be VAV systems
- 7. Single-duct VAV terminals reduce primary air before reheating
- 8. Fan equipped with electrical variable-speed drive
- 9. Separate hot and cold water supply and returns
- 10. Multiple boilers must have automatic controls that sequence operation with load
- 11. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 12. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 13. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 14. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
- 15. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.

Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.

Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.

16. Hot gas bypass limited to 25% of total cooling capacity

#### Requirements Specific To: HVAC System 5 :

- 1. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Integrated air economizer required
- 4. Separate hot and cold water supply and returns
- 5. Multiple boilers must have automatic controls that sequence operation with load
- 6. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 7. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 8. Hot gas bypass limited to 25% of total cooling capacity

#### Requirements Specific To: HVAC System 6 :

- 1. Minimum one temperature control device per zone
- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Balancing and pressure test connections on all hydronic terminal devices
- 4. Integrated air economizer required
- 5. Systems serving more than one zone must be VAV systems
- 6. Single-duct VAV terminals reduce primary air before reheating
- 7. Separate hot and cold water supply and returns
- 8. Multiple boilers must have automatic controls that sequence operation with load
- 9. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 10. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 11. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 12. Total VAV fan nameplate motor horsepower  $\leq 1.5 \text{ hp}/1000 \text{ cfm}$
- 13. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
- 14. Hot gas bypass limited to 50% of total cooling capacity

#### Requirements Specific To: HVAC System 7 :

- 1. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Integrated air economizer required
- 4. Separate hot and cold water supply and returns
- 5. Multiple boilers must have automatic controls that sequence operation with load
- 6. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 7. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 8. Hot gas bypass limited to 25% of total cooling capacity

#### Requirements Specific To: HVAC System 8 :

- 1. Minimum one temperature control device per zone

- 2. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 3. Balancing and pressure test connections on all hydronic terminal devices
- 4. Integrated air economizer required
- 5. Systems serving more than one zone must be VAV systems
- 6. Single-duct VAV terminals reduce primary air before reheating
- 7. Separate hot and cold water supply and returns
- 8. Multiple boilers must have automatic controls that sequence operation with load
- 9. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 10. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 11. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 12. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
- 13. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
- 14. Hot gas bypass limited to 50% of total cooling capacity

**Requirements Specific To: HVAC System 9 :**

- 1. Balancing and pressure test connections on all hydronic terminal devices

**Requirements Specific To: HVAC System 10 :**

- 1. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Integrated air economizer required
- 4. Separate hot and cold water supply and returns
- 5. Multiple boilers must have automatic controls that sequence operation with load
- 6. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 7. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 8. Hot gas bypass limited to 25% of total cooling capacity

**Requirements Specific To: HVAC System 11 :**

- 1. Minimum one temperature control device per zone
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Systems serving more than one zone must be VAV systems
  - Exception: Where pressure relationships must be maintained
  - Exception: Zones or supply air systems with at least 75% of reheating/recooling energy site recovered or site solar
  - Exception: Zones with humidity requirements for special processes
  - Exception: Zones with cfm <300 and flow rate <10% of total design flow rate
  - Exception: Outside air needed to meet IMC Chapter 4
- 4. Controls capable of resetting supply air temp (SAT) by 25% of SAT-room temp difference
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
- 5. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
- 6. For each fan, the selected fan motor is be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.

- Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.

### Requirements Specific To: HVAC System 12 :

- 1. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Integrated air economizer required
- 4. Separate hot and cold water supply and returns
- 5. Multiple boilers must have automatic controls that sequence operation with load
- 6. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 7. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 8. Hot gas bypass limited to 50% of total cooling capacity

### Requirements Specific To: HVAC System 13 :

- 1. Cooling system provides a means to relieve excess outdoor air during economizer operation.
- 2. Balancing and pressure test connections on all hydronic terminal devices
- 3. Integrated air economizer required
- 4. Separate hot and cold water supply and returns
- 5. Multiple boilers must have automatic controls that sequence operation with load
- 6. Single boiler >500 kBtu/h input capacity must have a multistaged or modulating burner
- 7. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 8. Hot gas bypass limited to 50% of total cooling capacity

### Requirements Specific To: Plant 1 :

- 1. Equipment minimum efficiency: Boiler Thermal Efficiency 75% Et 80% Ec
- 2. Two-pipe changeover heating/cooling controls must have:
  - a) 15 degrees F deadband where boiler and chiller can not operate,
  - b) allow operation in either heating or cooling for at least 4 hrs. and
  - c) prevent difference between heating and cooling set points greater than 30 degrees F
- 3. Newly purchased heating equipment meets the efficiency requirements  
- used equipment must meet 80% Et @ maximum capacity
- 4. Systems with multiple boilers have automatic controls capable of sequencing boiler operation
- 5. Hydronic heating systems comprised of a single boiler and >500 kBtu/h input design capacity include either a multistaged or modulating burner

### Requirements Specific To: Plant 2 :

- 1. Equipment minimum efficiency: Chiller: 9.562 EER (12.75 IPLV)
- 2. Hot gas bypass prohibited unless system has multiple steps of unloading or continuous capacity modulation

### Requirements Specific To: Water Heater 1 :

- 1. Gas Storage Water Heater efficiency: 80.0 % Et (630 SL, kBtu/h)
- 2. All piping in circulating system insulated
- 3. Hot water storage temperature adjustable down to 120°F or lower
- 4. Automatic time control of heat tapes and recirculating systems present
- 5. Controls will shut off operation of circulating pump between water heater/boiler and storage tanks within 5 minutes after end of heating cycle

### Requirements Specific To: Water Heater 2 :

- 1. Gas Storage Water Heater efficiency: 80.0 % Et (631 SL, kBtu/h)
- 2. All piping in circulating system insulated
- 3. Hot water storage temperature adjustable down to 120°F or lower
- 4. Automatic time control of heat tapes and recirculating systems present
- 5. Controls will shut off operation of circulating pump between water heater/boiler and storage tanks within 5 minutes after end of heating cycle

### Generic Requirements: Must be met by all systems to which the requirement is applicable:

- 1. Plant equipment and system capacity no greater than needed to meet loads
  - Exception: Standby equipment automatically off when primary system is operating

- Exception: Multiple units controlled to sequence operation as a function of load
- 2. Minimum one temperature control device per system
- 3. Minimum one humidity control device per installed humidification/dehumidification system
- 4. Load calculations per ASHRAE/ACCA Standard 183
- 5. Automatic Controls: Setback to 55°F (heat) and 85°F (cool); 7-day clock, 2-hour occupant override, 10-hour backup
  - Exception: Continuously operating zones
  - Exception: 2 kW demand or less, submit calculations
- 6. Outside-air source for ventilation; system capable of reducing OSA to required minimum
- 7. R-5 supply and return air duct insulation in unconditioned spaces
  - R-8 supply and return air duct insulation outside the building
  - R-8 insulation between ducts and the building exterior when ducts are part of a building assembly
  - Exception: Ducts located within equipment
  - Exception: Ducts with interior and exterior temperature difference not exceeding 15°F.
- 8. Mechanical fasteners and sealants used to connect ducts and air distribution equipment
- 9. Ducts sealed - longitudinal seams on rigid ducts; transverse seams on all ducts; UL 181A or 181B tapes and mastics
- 10. Hot water pipe insulation: 1.5 in. for pipes <=1.5 in. and 2 in. for pipes >1.5 in.  
 Chilled water/refrigerant/brine pipe insulation: 1.5 in. for pipes <=1.5 in. and 1.5 in. for pipes >1.5 in.  
 Steam pipe insulation: 1.5 in. for pipes <=1.5 in. and 3 in. for pipes >1.5 in.
  - Exception: Piping within HVAC equipment.
  - Exception: Fluid temperatures between 55 and 105°F.
  - Exception: Fluid not heated or cooled with renewable energy.
  - Exception: Piping within room fan-coil (with AHRI440 rating) and unit ventilators (with AHRI840 rating).
  - Exception: Runouts <4 ft in length.
- 11. Operation and maintenance manual provided to building owner
- 12. Piping, insulated to 1/2 in. if nominal diameter of pipe is <1.5 in.;  
 Larger pipe insulated to 1 in. thickness
- 13. Lavatory faucet outlet temperatures in public restrooms limited to 110°F (43°C)
- 14. Thermostatic controls have 5°F deadband
  - Exception: Thermostats requiring manual changeover between heating and cooling
  - Exception: Special occupancy or special applications where wide temperature ranges are not acceptable and are approved by the authority having jurisdiction.
- 15. Hot water distribution systems >=300 kBtu/h must have one of the following:
  - a) controls that reset supply water temperature by 25% of supply/return delta T
  - b) mechanical or electrical adjustable-speed pump drive(s)
  - c) two-way valves at all heating coils
  - d) multiple-stage pumps
  - e) other system controls that reduce pump flow by at least 50% based on load
    - calculations required
  - Exception: Where the supply temperature reset controls cannot be implemented without causing improper operation of heating, cooling, humidification, or dehumidification systems.
  - Exception: Hydronic systems that use variable flow to reduce pumping energy.
- 16. Balancing devices provided in accordance with IMC (2006) 603.17
- 17. Demand control ventilation (DCV) present for high design occupancy areas (>40 person/1000 ft<sup>2</sup> in spaces >500 ft<sup>2</sup>) and served by systems with any one of 1) an air-side economizer, 2) automatic modulating control of the outdoor air damper, or 3) a design outdoor airflow greater than 3000 cfm.
  - Exception: Systems with heat recovery.
  - Exception: Multiple-zone systems without DDC of individual zones communicating with a central control panel.
  - Exception: Systems with a design outdoor airflow less than 1200 cfm.
  - Exception: Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1200 cfm.
- 18. Motorized, automatic shutoff dampers required on exhaust and outdoor air supply openings
  - Exception: Gravity dampers acceptable in buildings <3 stories
  - Exception: Gravity dampers acceptable in systems with outside or exhaust air flow rates less than 300 cfm where dampers are interlocked with fan
- 19. Automatic controls for freeze protection systems present
- 20. Three-pipe systems not used
- 21. Exhaust air heat recovery included for systems 5,000 cfm or greater with more than 70% outside air fraction or specifically exempted
  - Exception: Hazardous exhaust systems, commercial kitchen and clothes dryer exhaust systems that the International Mechanical Code prohibits the use of energy recovery systems.



- Exception: Systems serving spaces that are heated and not cooled to less than 60°F.
- Exception: Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
- Exception: Heating systems in climates with less than 3600 HDD.
- Exception: Cooling systems in climates with a 1 percent cooling design wet-bulb temperature less than 64°F.
- Exception: Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
- Exception: Laboratory fume hood exhaust systems that have either a variable air volume system capable of reducing exhaust and makeup air volume to 50 percent or less of design values or, a separate make up air supply meeting the following makeup air requirements: a) at least 75 percent of exhaust flow rate, b) heated to no more than 2°F below room setpoint temperature, c) cooled to no lower than 3°F above room setpoint temperature, d) no humidification added, e) no simultaneous heating and cooling.

## Section 5: Compliance Statement

*Compliance Statement:* The proposed mechanical design represented in this document is consistent with the building plans, specifications and other calculations submitted with this permit application. The proposed mechanical systems have been designed to meet the 2009 IECC requirements in COMcheck Version 3.8.1 and to comply with the mandatory requirements in the Requirements Checklist.

Wayne E. Mattson, P.E. - Principal



6/27/11

Name - Title

Signature

Date



# Mechanical Requirements Description

## 2009 IECC

The following list provides more detailed descriptions of the requirements in Section 4 of the Mechanical Compliance Certificate.

### Requirements Specific To: HVAC System 1 :

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Fans with motors > 10 hp may not be equipped with discharge dampers.
4. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
5. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
6. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
7. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.
8. Fans over 10 hp on a variable-flow system must have electrical variable-speed drives.
9. Fan system terminal units must have separate hot and cold water supply and return piping.
10. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
11. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
12. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
13. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
14. Total VAV fan nameplate motor horsepower  $\leq$  1.5 hp/1000 cfm
15. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
16. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

### Requirements Specific To: HVAC System 2 :

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
4. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
5. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
6. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.
7. Fan system terminal units must have separate hot and cold water supply and return piping.
8. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
9. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
10. Two-pipe changeover heating/cooling controls must:

- a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
11. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
    - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
    - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
    - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
  12. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
  13. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
    - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
    - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
  14. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

#### **Requirements Specific To: HVAC System 3 :**

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Fans with motors > 10 hp may not be equipped with discharge dampers.
4. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
5. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
6. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
7. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.
8. Fans over 10 hp on a variable-flow system must have electrical variable-speed drives.
9. Fan system terminal units must have separate hot and cold water supply and return piping.
10. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
11. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
12. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
13. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
14. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
15. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
16. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

#### **Requirements Specific To: HVAC System 4 :**

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Fans with motors > 10 hp may not be equipped with discharge dampers.
4. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
5. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
6. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
7. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.

8. Fans over 10 hp on a variable-flow system must have electrical variable-speed drives.
9. Fan system terminal units must have separate hot and cold water supply and return piping.
10. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
11. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
12. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
13. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
14. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
15. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
16. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

#### **Requirements Specific To: HVAC System 5 :**

1. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
4. Fan system terminal units must have separate hot and cold water supply and return piping.
5. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
6. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
7. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
8. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

#### **Requirements Specific To: HVAC System 6 :**

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
4. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
5. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
6. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.
7. Fan system terminal units must have separate hot and cold water supply and return piping.
8. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
9. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
10. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
11. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
12. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
13. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.

- Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
14. For cooling systems  $\leq$  240 kBtu/h, maximum hot gas bypass capacity must be no more than 50% total cooling capacity.

**Requirements Specific To: HVAC System 7 :**

1. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
4. Fan system terminal units must have separate hot and cold water supply and return piping.
5. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
6. A single boiler with  $>$ 500 kBtu/h input capacity must have a multistaged or modulating burner.
7. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
8. For cooling systems  $>$  240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

**Requirements Specific To: HVAC System 8 :**

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
3. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
4. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
5. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams.
6. The specified multiple-zone system is equipped with single-duct VAV terminals. These terminals must be equipped with dampers, air valves, or other means to reduce the supply of primary supply air to a minimum prior to reheating.
7. Fan system terminal units must have separate hot and cold water supply and return piping.
8. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
9. A single boiler with  $>$ 500 kBtu/h input capacity must have a multistaged or modulating burner.
10. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
11. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
12. Total VAV fan nameplate motor horsepower  $\leq$  1.5 hp/1000 cfm
13. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.
14. For cooling systems  $\leq$  240 kBtu/h, maximum hot gas bypass capacity must be no more than 50% total cooling capacity.

**Requirements Specific To: HVAC System 9 :**

1. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.

**Requirements Specific To: HVAC System 10 :**

1. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
4. Fan system terminal units must have separate hot and cold water supply and return piping.
5. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
6. A single boiler with  $>$ 500 kBtu/h input capacity must have a multistaged or modulating burner.

7. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
8. For cooling systems > 240 kBtu/h, maximum hot gas bypass capacity must be no more than 25% of total cooling capacity.

**Requirements Specific To: HVAC System 11 :**

1. Each zone of a multiple-zone system must have its own temperature control device.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. Systems serving multiple thermostatic control zones must be variable-flow systems. Zone terminal controls must reduce the flow of primary supply air before reheating, recooling, or mixing air streams to one of the following:
  - a) 30% of the maximum supply air to each zone,
  - b) 300 cfm or less where the maximum flow rate is less than 10% of the total fan system supply airflow rate, or
  - c) minimum ventilation requirements of Chapter 4 of the International Mechanical Code.
    - Exception: VAV controls are not required for zones with special pressurization or cross-contamination requirements. These zones must be called out in the construction documents for easy identification during field inspection.
    - Exception: VAV controls are not required for zones or supply air systems where at least 75% of the reheating and recooling energy is made available through the use of site-recovered or site solar energy. These zones must be called out in the construction documents for easy identification during field inspection.
    - Exception: VAV controls are not required for zones with special humidity control requirements for specialized processes. These zones must be called out in the construction documents for easy identification during field inspection.
    - Exception: VAV controls are not required for zones that require less than 300 cfm of supply air provided the total airflow to these zones does not exceed 10% of the total design flow rate for the system.
    - Exception: VAV controls are not required where constant volume supply air is necessary to meet the minimum outside air requirements of Chapter 4 of the International Mechanical Code. These zones must be called out in the construction documents for easy identification during field inspection.
4. Automatic controls capable of resetting supply-air temperature (within a range of 25 percent of the difference between supply-air and design air temperature) in response to building loads or outdoor air temperature exist on systems serving multiple zones.
  - Exception: Systems that prevent reheating, recooling or mixing of heated and cooled supply air
  - Exception: Seventy five percent of the energy for reheating is from site-recovered or site solar energy sources.
  - Exception: Zones with peak supply air quantities of 300 cfm (142 L/s) or less.
5. Total VAV fan nameplate motor horsepower <= 1.5 hp/1000 cfm
6. For each fan, the selected fan motor must be no larger than the first available motor size greater than the brake hp. The fan brake hp must be indicated on the design documents to allow for compliance verification by the code official.
  - Exception: For fans less than 6 brake hp, where the first available motor larger than the brake hp has a nameplate rating within 50% of the brake hp, the next larger nameplate motor size may be selected.
  - Exception: For fans 6 brake hp and larger, where the first available motor larger than the brake hp has a nameplate rating with 30% of the brake hp, the next larger nameplate motor size may be selected.

**Requirements Specific To: HVAC System 12 :**

1. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
4. Fan system terminal units must have separate hot and cold water supply and return piping.
5. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
6. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
7. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
8. For cooling systems <= 240 kBtu/h, maximum hot gas bypass capacity must be no more than 50% total cooling capacity.

**Requirements Specific To: HVAC System 13 :**

1. Cooling system provides a means to relieve excess outdoor air during economizer operation to prevent overpressurizing the building.
2. Hydronic heating and cooling coils must be equipped with a way to pressure test connections and measure and balance water flow and pressure.
3. An integrated air economizer is required for individual cooling systems over 54 kBtu/h in the selected project location and allows simultaneous operation of outdoor-air and mechanical cooling.
4. Fan system terminal units must have separate hot and cold water supply and return piping.
5. Multiple packaged boilers must have automatic controls capable of sequencing the operation of the boilers.
6. A single boiler with >500 kBtu/h input capacity must have a multistaged or modulating burner.
7. Two-pipe changeover heating/cooling controls must:

- a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
8. For cooling systems  $\leq$  240 kBtu/h, maximum hot gas bypass capacity must be no more than 50% total cooling capacity.

**Requirements Specific To: Plant 1 :**

1. The specified heating and/or cooling equipment is covered by the ASHRAE 90.1 Code and must meet the following minimum efficiency:  
Boiler Thermal Efficiency 75% Et 80% Ec
2. Two-pipe changeover heating/cooling controls must:
  - a) allow a deadband between changeover from one mode (heating/cooling) to the other of at least 15 degrees F outside temperatures
  - b) allow operation in one mode (heating/cooling) for at least 4 hours before changing over to the other mode
  - c) allow heating and cooling supply temperatures at the changeover point to be no more than 30 degrees F apart.
3. The specified heating equipment is covered by Federal minimum efficiency requirements. New equipment of this type can be assumed to meet or exceed ASHRAE 90.1 Code requirements for equipment efficiency. Used equipment must meet 80% Et @ maximum capacity.
4. Systems with multiple boilers have automatic controls capable of sequencing the operation of the boilers.
5. Hydronic heating systems comprised of a single boiler and >500 kBtu/h input design capacity include either a multistaged or modulating burner.

**Requirements Specific To: Plant 2 :**

1. The specified heating and/or cooling equipment is covered by the ASHRAE 90.1 Code and must meet the following minimum efficiency:  
Chiller: 9.562 EER (12.75 IPLV)
2. Hot gas bypass or other evaporator pressure controls must be used on cooling equipment with multiple step or continuous capacity unloading. The maximum amount of hot gas bypass must be 50% of total capacity if  $\leq$ 240 kBtu/h and 25% of total capacity if <240 kBtu/h. Unitary packaged systems  $\leq$ 90 kBtu/h are exempted from this requirement.

**Requirements Specific To: Water Heater 1 :**

1. Service water heating equipment used solely for heating potable water, pool heaters, and hot water storage tanks must meet the following minimum efficiency: Gas Storage Water Heater efficiency: 80.0 % Et (630 SL, kBtu/h)
2. Insulation must be provided for recirculating system piping, including the supply and return piping of a circulating tank type water heater.
3. Temperature controls must be provided that allow for storage temperature adjustment from 120°F or lower to a maximum temperature compatible with the intended use except when the manufacturer's installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion. Documentation of the installation instructions must be provided to be exempted from this requirement.
4. Systems designed to maintain usage temperatures in hot water pipes, such as recirculating hot water systems or heat trace, must be equipped with automatic time switches or other controls that can be set to switch off the temperature maintenance system during extended periods when hot water is not required.
5. When used to maintain storage tank water temperature, recirculating pumps must be equipped with controls limiting operation to the start of the heating cycle to a maximum of 5 minutes after the end of the heating cycle.

**Requirements Specific To: Water Heater 2 :**

1. Service water heating equipment used solely for heating potable water, pool heaters, and hot water storage tanks must meet the following minimum efficiency: Gas Storage Water Heater efficiency: 80.0 % Et (631 SL, kBtu/h)
2. Insulation must be provided for recirculating system piping, including the supply and return piping of a circulating tank type water heater.
3. Temperature controls must be provided that allow for storage temperature adjustment from 120°F or lower to a maximum temperature compatible with the intended use except when the manufacturer's installation instructions specify a higher minimum thermostat setting to minimize condensation and resulting corrosion. Documentation of the installation instructions must be provided to be exempted from this requirement.
4. Systems designed to maintain usage temperatures in hot water pipes, such as recirculating hot water systems or heat trace, must be equipped with automatic time switches or other controls that can be set to switch off the temperature maintenance system during extended periods when hot water is not required.
5. When used to maintain storage tank water temperature, recirculating pumps must be equipped with controls limiting operation to the start of the heating cycle to a maximum of 5 minutes after the end of the heating cycle.

**Generic Requirements: Must be met by all systems to which the requirement is applicable:**

1. All equipment and systems must be sized to be no greater than needed to meet calculated loads. A single piece of equipment providing both heating and cooling must satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.
  - Exception: The equipment and/or system capacity may be greater than calculated loads for standby purposes. Standby equipment must be automatically controlled to be off when the primary equipment and/or system is operating.
  - Exception: Multiple units of the same equipment type whose combined capacities exceed the calculated load are allowed if they are provided with controls to sequence operation of the units as the load increases or decreases.
2. Each heating or cooling system serving a single zone must have its own temperature control device.
3. Each humidification system must have its own humidity control device.
4. Design heating and cooling loads for the building must be determined using procedures in the ASHRAE Handbook of Fundamentals or an approved equivalent calculation procedure.
5. The system or zone control must be a programmable thermostat or other automatic control meeting the following criteria:
  - a) capable of setting back temperature to 55°F during heating and setting up to 85°F during cooling,
  - b) capable of automatically setting back or shutting down systems during unoccupied hours using 7 different day schedules,
  - c) have an accessible 2-hour occupant override,

- d) have a battery back-up capable of maintaining programmed settings for at least 10 hours without power.
- Exception: A setback or shutoff control is not required on thermostats that control systems serving areas that operate continuously.
- Exception: A setback or shutoff control is not required on systems with total energy demand of 2 kW (6,826 Btu/h) or less.
- 6. The system must supply outside ventilation air as required by Chapter 4 of the International Mechanical Code. If the ventilation system is designed to supply outdoor-air quantities exceeding minimum required levels, the system must be capable of reducing outdoor-air flow to the minimum required levels.
- 7. Air ducts must be insulated to the following levels:
  - a) Supply and return air ducts for conditioned air located in unconditioned spaces (spaces neither heated nor cooled) must be insulated with a minimum of R-5. Unconditioned spaces include attics, crawl spaces, unheated basements, and unheated garages.
  - b) Supply and return air ducts and plenums must be insulated to a minimum of R-8 when located outside the building.
  - c) When ducts are located within exterior components (e.g., floors or roofs), minimum R-8 insulation is required only between the duct and the building exterior.
  - Exception: Duct insulation is not required on ducts located within equipment.
  - Exception: Duct insulation is not required when the design temperature difference between the interior and exterior of the duct or plenum does not exceed 15°F.
- 8. Mechanical fasteners and seals, mastics, or gaskets must be used when connecting ducts to fans and other air distribution equipment, including multiple-zone terminal units.
- 9. All joints, longitudinal and transverse seams, and connections in ductwork must be securely sealed using weldments; mechanical fasteners with seals, gaskets, or mastics; mesh and mastic sealing systems; or tapes. Tapes and mastics must be listed and labeled in accordance with UL 181A and shall be marked '181A-P' for pressure sensitive tape, '181A-M' for mastic or '181A-H' for heat-sensitive tape. Tapes and mastics used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked '181B-FX' for pressure-sensitive tape or '181B-M' for mastic. Unlisted duct tape is not permitted as a sealant on any metal ducts.
- 10. All pipes serving space-conditioning systems must be insulated as follows:
  - Hot water piping for heating systems:
    - 1 1/2 in. for pipes  $\leq$  1 1/2-in. nominal diameter,
    - 2 in. for pipes  $>$  1 1/2-in. nominal diameter.
  - Chilled water, refrigerant, and brine piping systems:
    - 1 1/2 in. insulation for pipes  $\leq$  1 1/2-in. nominal diameter,
    - 1 1/2 in. insulation for pipes  $>$  1 1/2-in. nominal diameter.
  - Steam piping:
    - 1 1/2 in. insulation for pipes  $\leq$  1 1/2-in. nominal diameter,
    - 3 in. insulation for pipes  $>$  1 1/2-in. nominal diameter.
  - Exception: Pipe insulation is not required for factory-installed piping within HVAC equipment.
  - Exception: Pipe insulation is not required for piping that conveys fluids having a design operating temperature range between 55°F and 105°F.
  - Exception: Pipe insulation is not required for piping that conveys fluids that have not been heated or cooled through the use of fossil fuels or electric power.
  - Exception: Piping within room fan-coil (with AHRI440 rating) and unit ventilators (with AHRI840 rating).
  - Exception: Pipe insulation is not required for runout piping not exceeding 4 ft in length and 1 in. in diameter between the control valve and HVAC coil.
- 11. Operation and maintenance documentation must be provided to the owner that includes at least the following information:
  - a) equipment capacity (input and output) and required maintenance actions
  - b) equipment operation and maintenance manuals
  - c) HVAC system control maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions; desired or field-determined set points must be permanently recorded on control drawings, at control devices, or, for digital control systems, in programming comments
  - d) complete narrative of how each system is intended to operate.
- 12. Service hot water piping, where required, must be insulated to 1/2 in. if pipe less than 1.5 in. nominal diameter. Larger pipe must be insulated to 1 in.. Pipe insulation will have a conductivity of less than 0.28 Btu.in/(h-ft<sup>2</sup>-°F).
- 13. Temperature controlling means must be provided to limit the maximum temperature of water delivered from lavatory faucets in public facility restrooms to 110°F.
- 14. Thermostats controlling both heating and cooling must be capable of maintaining a 5°F deadband (a range of temperature where no heating or cooling is provided).
  - Exception: Deadband capability is not required if the thermostat does not have automatic changeover capability between heating and cooling.
  - Exception: Special occupancy or special applications where wide temperature ranges are not acceptable and are approved by the authority having jurisdiction.
- 15. Hot water space-heating systems with a capacity exceeding 300 kBtu/h supplying heated water to comfort conditioning systems must include controls that automatically reset supply water temperatures by representative building loads (including return water temperature) or by outside air temperature.



- Exception: Where the supply temperature reset controls cannot be implemented without causing improper operation of heating, cooling, humidification, or dehumidification systems.
  - Exception: Hydronic systems that use variable flow to reduce pumping energy.
16. Balancing devices provided in accordance with IMC (2006) 603.17.
17. Demand control ventilation (DCV) required for high design occupancy areas (>40 person/1000 ft<sup>2</sup> in spaces >500 ft<sup>2</sup>) and served by systems with any one of 1) an air-side economizer, 2) automatic modulating control of the outdoor air damper, or 3) a design outdoor airflow greater than 3000 cfm.
- Exception: Systems with heat recovery.
  - Exception: Multiple-zone systems without DDC of individual zones communicating with a central control panel.
  - Exception: Systems with a design outdoor airflow less than 1200 cfm.
  - Exception: Spaces where the supply airflow rate minus any makeup or outgoing transfer air requirement is less than 1200 cfm.
18. Outdoor air supply and exhaust systems must have motorized dampers that automatically shut when the systems or spaces served are not in use. Dampers must be capable of automatically shutting off during preoccupancy building warm-up, cool-down, and setback, except when ventilation reduces energy costs (e.g., night purge) or when ventilation must be supplied to meet code requirements. Both outdoor air supply and exhaust air dampers must have a maximum leakage rate of 3 cfm/ft<sup>2</sup> at 1.0 in w.g. when tested in accordance with AMCA Standard 500.
- Exception: Gravity (non-motorized) dampers are acceptable in buildings less than three stories in height.
  - Exception: Systems with a design outside air intake or exhaust capacity of 300 cfm (140 L/s) or less that are equipped with motor operated dampers that open and close when the unit is energized and de-energized, respectively.
19. All freeze protection systems, including self-regulating heat tracing, must include automatic controls capable of shutting off the systems when outside air temperatures are above 40°F or when the conditions of the protected fluid will prevent freezing. Snow- and ice-melting systems must include automatic controls capable of shutting off the systems when the pavement temperature is above 50°F and no precipitation is falling, and an automatic or manual control that will allow shutoff when the outdoor temperature is above 40°F.
20. Hydronic systems that use a common return system for both hot water and chilled water must not be used.
21. Individual fan systems with a design supply air capacity of 5000 cfm or greater and minimum outside air supply of 70 percent or greater of the supply air capacity must have an energy recovery system with at least a 50 percent effectiveness. Where cooling with outdoor air is required there is a means to bypass or control the energy recovery system to permit cooling with outdoor air.
- Exception: Hazardous exhaust systems, commercial kitchen and clothes dryer exhaust systems that the International Mechanical Code prohibits the use of energy recovery systems.
  - Exception: Systems serving spaces that are heated and not cooled to less than 60°F.
  - Exception: Where more than 60 percent of the outdoor heating energy is provided from site-recovered or site solar energy.
  - Exception: Heating systems in climates with less than 3600 HDD.
  - Exception: Cooling systems in climates with a 1 percent cooling design wet-bulb temperature less than 64°F.
  - Exception: Systems requiring dehumidification that employ energy recovery in series with the cooling coil.
  - Exception: Laboratory fume hood exhaust systems that have either a variable air volume system capable of reducing exhaust and makeup air volume to 50 percent or less of design values or, a separate make up air supply meeting the following makeup air requirements: a) at least 75 percent of exhaust flow rate, b) heated to no more than 2°F below room setpoint temperature, c) cooled to no lower than 3°F above room setpoint temperature, d) no humidification added, e) no simultaneous heating and cooling.