Time-Based Scheduling of Residential Ventilation

by

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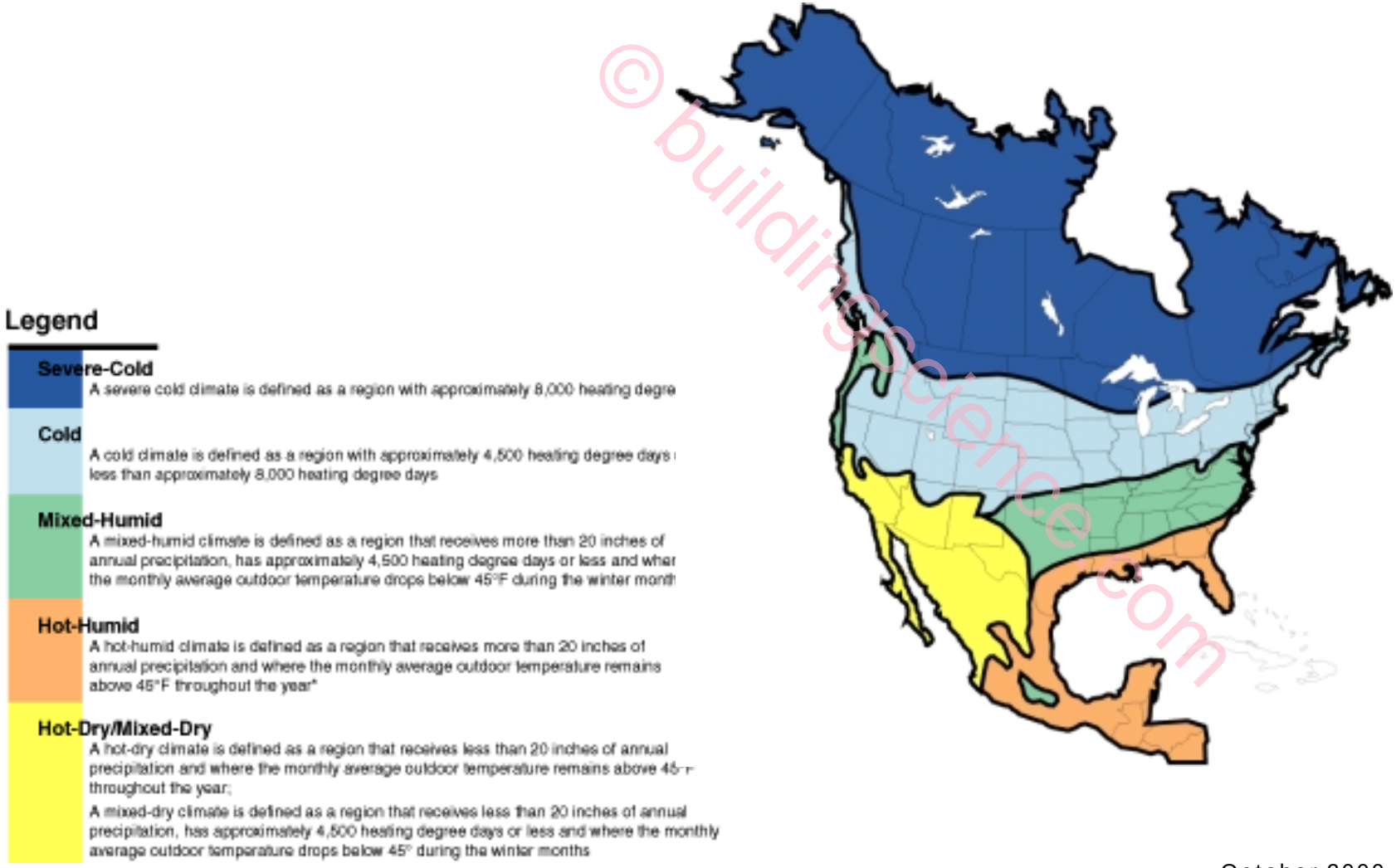
Climate Specific Design Solutions



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Purposes of ventilation

1. Point-source ventilation - Remove Pollutants
   - exhaust fans: kitchen, bath, laundry

2. Whole-building ventilation - Dilute Pollutants
   - supply, exhaust, or balanced fans distributing to all rooms

Time Basis of ventilation operation

1. Continuous, or constant operation
   - usually smaller fans: supply, exhaust, HRV/ERV

2. Intermittent operation
   - usually larger fan/blower: central air handler

Constant Operation

- Sizing
  - cfm per person (use bedroom count plus 1 as estimate)
  - cfm per person + “offgasing” ventilation
  - cfm per person + offgasing + excess capacity
- Timing
  - no timing or scheduling controls needed, except:
    - an ON/OFF switch for vacations or unusual circumstances
    - a “bump-up” control to get excess capacity for a time

Intermittent Operation

- Sizing
  - constant flow divided by duty cycle fraction
  - constant flow reduced by low background infiltration amount when blower is not on, all divided by duty cycle fraction

$$\dot{Q}_{cfan} = \frac{(\dot{Q}_{cont}) - (\frac{I}{60} V (1 - f))}{f}$$

Intermittent Operation

where,

$$f = \frac{t_{on}}{t_{on} + t_{off}} = \frac{t_{on}}{t_{total}}$$

and,

$$t_{on} = \frac{f\,(t_{off})}{1 - f}$$

and,

$$t_{off} = \frac{(1 - f)t_{on}}{f}$$

Intermittent Operation

- Sizing, cont.
  - have fixed outside air flow to work with and back-calculate the duty cycle needed

$$f = \frac{\dot{Q}_{co} - \frac{IV}{60}}{\dot{Q}_{in} - \frac{IV}{60}}$$

Intermittent Operation

- Timing
  - basic equation: $t_{total} = t_{on} + t_{off}$
    - choose which terms you want to fix (selected by design) and which ones you want to be variable (user selected)

t_{off}	t_{on}	t_{total}
calculated	variable	fixed
fixed	fixed	calculated
variable	variable	calculated

Builder Town & Country Homes
Subdivision Centennial Crossing
Location Vernon Hills, Illinois
Climate cold

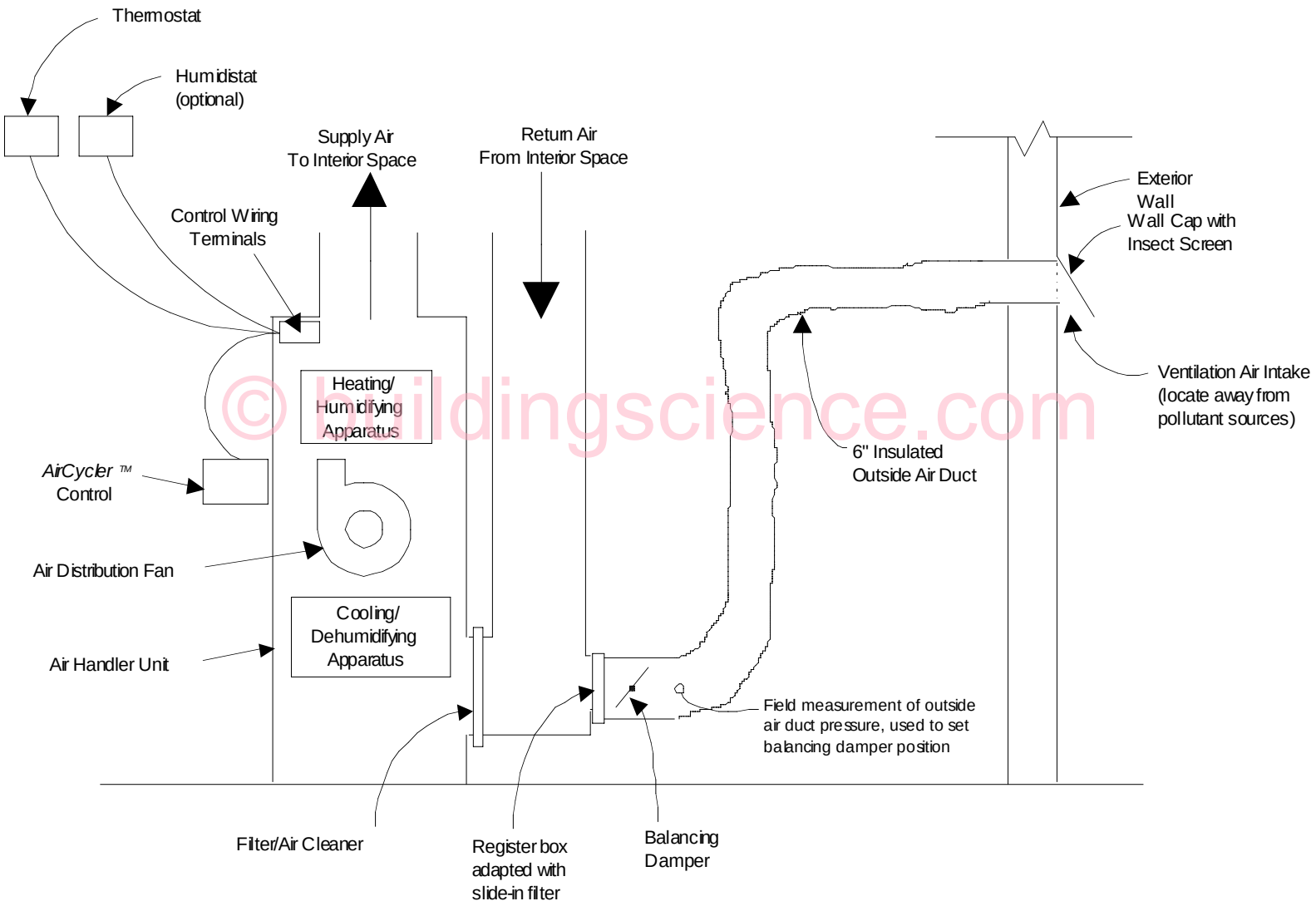
Homes Started or Completed 189 of 191

Ventilation system

- Central-fan-integrated supply with fan recycling
  - 6” insulated OA duct to AHU return, with balancing damper
  - 7% outside air fraction, minimum 33% duty cycle
  - filtration by AHU filter
  - no complaints after three years

Central-fan-integrated supply ventilation

Interior closet or basement configuration



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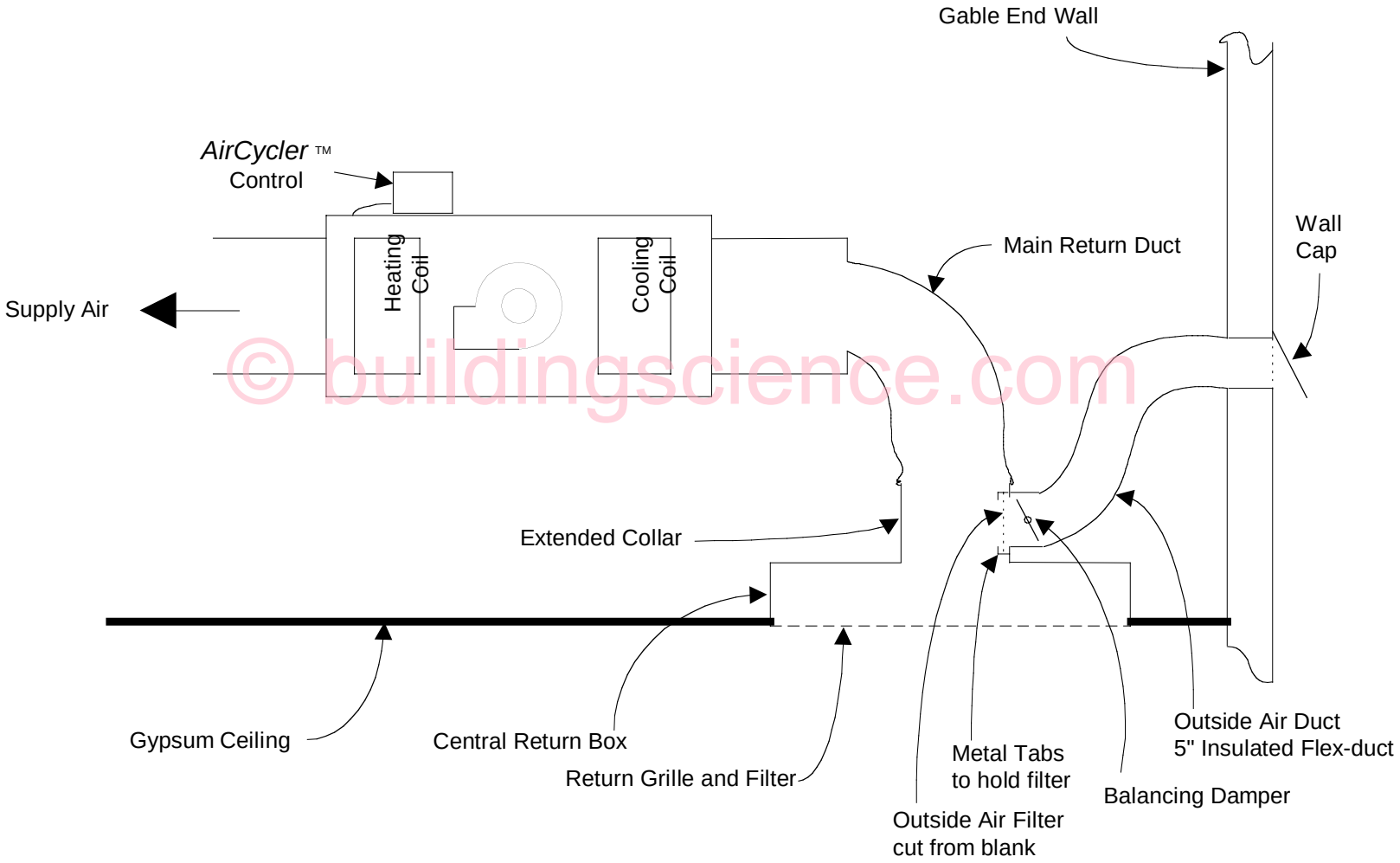
Central-fan-integrated supply ventilation

Unvented-cathedralized attic configuration



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Monitored Runtime Data

Centennial Crossing, Lot 22

	Cool ON (%)	Heat ON (%)	Fan Recycling Vent ON (%)	Fan Recycling Cost ($)
Apr (27-30)	0	12	12	0.24
May	1	2	15	3.06
Jun	7	1	10	2.05
Jul	10	0	12	2.58
Aug	10	0	13	2.72
Sep	5	0	15	2.96
Oct	0	4	15	3.07
Nov	0	13	10	1.99
Dec	0	20	6	1.31
Jan	0	31	3	0.60
Feb	0	23	5	0.95
Mar (1-9)	0	25	4	0.23

Notes: Fan recycling control set for 25 min OFF, 6 min ON (19% duty cycle)

Monitored Runtime Data

Centennial Crossing, Lot 176

	Cool ON (%)	Heat ON (%)	Fan Recycling Vent ON (%)	Fan Recycling Cost ($)
Aug	21	0	17	3.52
Sep	10	0	21	4.24
Oct	0	5	20	4.12
Nov	0	15	12	2.33
Dec	0	27	6	1.35
Jan	0	35	3	0.54
Feb	0	24	5	1.00

Notes: Fan recycling control set for 20 min OFF, 8 min ON (29% duty cycle)

Monitored Runtime Data

Centennial Crossing, Lot 179

	Cool ON (%)	Heat ON (%)	Fan Recycling Vent ON (%)	Fan Recycling Cost ($)
Oct	0	5	24	4.97
Nov	0	15	14	2.81
Dec	0	25	9	1.81
Jan	0	34	3	0.68
Feb	0	26	6	1.18
Mar (1-8)	0	31	3	0.17

Notes: Fan recycling control set for 20 OFF 10 ON (33% duty cycle)

Lot 6
Arbor View

Indoor temperature variation from the house average