

Table of Figures

1. Site Planning

Figure 1-1 Solar Path Chart	4
Figure 1-2 Wind Roses Summer and Winter	5
Figure 1-3 Natural Ventilation Design Strategies	6
Figure 1-4 Stack Effect	7
Figure 1-5 Overhang Types	7
Figure 1-6 Site Planning	8
Figure 1-7 Site Planning	9

2. The House as a System

Figure 2-1 Home Losing Heat through Conduction in Winter	14
Figure 2-2 Convection in the Home	15
Figure 2-3 Radiation Entering House	15
Figure 2-4 Air Quality Problems from “Fresh” Air	16
Figure 2-5 Thermal Boundaries	17
Figure 2-6 Conditions for Condensation	17
Figure 2-7 Psychometric Chart	19
Figure 2-8 Winter Dew Point Temperature Inside Walls	19
Figure 2-9 Summer Condensation in Walls	20
Figure 2-10 Relative Humidity Ranges	21
Figure 2-11 Bulk Moisture Transport	23
Figure 2-12 Drainage Plane	24
Figure 2-13 Capillary Action	25
Figure 2-14 Typical Water Vapor Transport	26
Figure 2-15 Drying to the Interior	27

3. Energy Efficient Features

Figure 3-1 International Residential Code (2006) Climate Zone Map	33
Figure 3-2 Envelope Construction Ideas	34
Figure 3-3 Sealing Holes in Framing	34
Figure 3-4 More Sealing Techniques	35
Figure 3-5 Typical Insulated Concrete Forms (ICF)	44
Figure 3-6 Typical Structural Insulated Panel	45

4. Air Leakage Sealing - Materials and Techniques

Figure 4-1 Creating a Pressure Boundary	54
Figure 4-2 Wind Driven Infiltration	55
Figure 4-3 The Stack Effect	55
Figure 4-4 Mechanical System Driven Infiltration	56
Figure 4-5 Blower Door	57
Figure 4-6 Home Blower Door Test	58
Figure 4-7 Air Leakage through Bypass	59
Figure 4-8 Typical Home Air Leakage Sites	60
Figure 4-9 Sealing Bypasses	62
Figure 4-10 Sealing More Bypasses	63
Figure 4-11 Airtight Drywall Method Air Barrier	64
Figure 4-12 Creating an Air Barrier Between Floors	66
Figure 4-13 Housewrap – Window Connection	68
Figure 4-14 Recommended Housewrap Installation Process & Procedure	69
Figure 4-15 Sealing Sheathing as Exterior Air Barrier	70

5. Insulation Materials and Techniques

Figure 5-1 Insulating the Building Envelope Recommended Insulation Values	73
Figure 5-2 Insulating Concrete Block Cores	77
Figure 5-3 Relative Humidity (RH) and Foundation Vents	78
Figure 5-4 Interior Foam Wall Insulation	79
Figure 5-5 Interior Framed Wall	79
Figure 5-6 Insulated Concrete Form Wall Systems	80
Figure 5-7 Insulated Wood Framed Floors	81
Figure 5-8 Insulated Floor over Pier Foundation	82
Figure 5-9 Insulated, Sealed Crawlspace Walls	83
Figure 5-10 Floor Insulation Details	84
Figure 5-11 Let-in Bracing	86
Figure 5-12 Advanced Framing Insulation Details	87
Figure 5-13 Standard Framing versus Advanced Framing	88
Figure 5-14 Insulating Walls with Batts	89
Figure 5-15 Blown Sidewall Insulation Options	90
Figure 5-16 Spray Foam Insulation	91
Figure 5-17 Structural Insulated Panels (SIP)	92
Figure 5-18 Structural Insulated Panels Construction	93
Figure 5-19 Foam Sheathing Keeps Walls Warmer	95
Figure 5-20 Average Wall R-Value	97
Figure 5-21 Ridge and Soffit Vents	98
Figure 5-22 Pressure Problems Due to Powered Attic Ventilators	99
Figure 5-23 Attic Blocking Requirements	101
Figure 5-24 Full Width Batts	102
Figure 5-25 Insulating under Attic Floors	102
Figure 5-26 Insulation Options for Eaves	104
Figure 5-27 Airtight, IC-rated Recessed Lamps	105
Figure 5-28 Cathedral Ceiling Insulation Options	106
Figure 5-29 Cathedral Ceiling – Exterior Roof Insulation	107

6. *Windows and Doors*

Figure 6-1 Window Anatomy	110
Figure 6-2 Winter Heat Loss in a Typical Double-glazed Window	111
Figure 6-3 Summer Heat Gain in a Typical Double-glazed, Low-e Window	111
Figure 6-4 Relative Intensity of the Solar Spectrum	112
Figure 6-5 Metal Window with Thermal Break	115
Figure 6-6 Low-e, Gas-filled Windows	116
Figure 6-7 NFRC Label	117
Figure 6-8 Inside Window Temperatures in Cold Weather	118
Figure 6-9 Composition of Solar Heat Gain into Home	118
Figure 6-10 Guidelines for Overhangs	119

7. *Heating, Ventilation, and Air Conditioning*

Figure 7-1 Components of Forced-Air Systems	123
Figure 7-2 Automatic Zoned System with Dampened Bypass Duct	126
Figure 7-3 Air Conditioning with the Vapor Compression Cycle	127
Figure 7-4 Air Source Heat Pump	130
Figure 7-5 Sealed Mechanical Room Design for Non-direct Vent Furnace	132
Figure 7-6 Integrated Space and Water Heating System	134
Figure 7-7 Efficient Wood Heater Design	136
Figure 7-8 Direct Vent Heaters	137
Figure 7-9 Ventilation with Spot Fans	138
Figure 7-10 Whole House Ventilation System	139
Figure 7-11 Heat Recovery Ventilation (HRV) System	141

8. *Duct Design and Sealing*

Figure 8-1 Types of Ductwork	143
Figure 8-2 Efficiency Losses Due to Attic Return Leaks	145
Figure 8-3 Sealing Flex-duct Collar with Mastic	146
Figure 8-4 Disconnected Ducts are High Priorities	148
Figure 8-5 Duct Test on Return Grille	149
Figure 8-6 Duct Leaks in Inside Spaces	149
Figure 8-7 Seal All Leaks in Air Handling Unit	150
Figure 8-8 Shelf-Mounted Systems without Returns	150
Figure 8-9 Seal All Leaky Takeoffs	151
Figure 8-10 Sealing Leaky Boots	151
Figure 8-11 Comparison of Air Flow in Different 6-inch Ducts	152
Figure 8-12 Jump Duct	154
Figure 8-13 Transfer Grills – Over Doors	155
Figure 8-14 Transfer Grills – In Wall	156
Figure 8-15 Louvered Passage Doors	156

9. Water Heating, Appliances and Lighting

Figure 9-1 Typical Breakdown of Hot Water Use	160
Figure 9-2 Insulating Jackets for Electric and Gas Water Heaters	161
Figure 9-3 Heat Pump Water Heaters	162
Figure 9-4 Active Solar Water Heating Systems	163
Figure 9-5 Batch Solar Water Heating Systems	164
Figure 9-6 EnergyGuide Label	166
Figure 9-7 Efficacy of Different Lighting Types	169

10. Energy Efficient Roofing

Figure 10-1 Color Standard Cool Roof Color Materials	176
Figure 10-2 Laminated Shingles	178
Figure 10-3 Natural Slate Tiles	178
Figure 10-4 Concrete Tiles	179
Figure 10-5 Rubber Shingles	179
Figure 10-6 Landscaped “Green Roof”	185