



# Retrofitting Maryland - 2018 SF



**Standard Work Specifications**

**Field Guide for**

**Single-Family Homes**

**created by**

**Maryland Department of Housing and  
Community Development**



## 2 Health and Safety

### 2.01 Safe Work Practices

#### 2.0100 Safe Work Practices

##### 2.0100.1 Global Worker Safety

2.0100.1a	Prevention through design .....	14
2.0100.1b	Hand protection .....	14
2.0100.1c	Respiratory protection .....	15
2.0100.1d	Electrical safety .....	17
2.0100.1e	Carbon monoxide (CO) .....	18
2.0100.1f	Personal Protective Equipment .....	19
2.0100.1g	Confined space safety .....	20
2.0100.1h	Power tool safety .....	21
2.0100.1i	Chemical safety .....	22
2.0100.1j	Ergonomic safety .....	23
2.0100.1k	Hand tool safety .....	24
2.0100.1l	Slips, trips, and falls .....	24
2.0100.1m	Thermal stress .....	25
2.0100.1n	Fire safety .....	26
2.0100.1o	Asbestos-containing materials (ACM) .....	26
2.0100.1p	Lead paint assessment .....	28
2.0100.1q	Site security .....	30
2.0100.1r	Crawl space safety .....	30

##### 2.0102 Insulation

###### 2.0102.1 Insulation Worker Safety

2.0102.1a	Worker safety .....	32
2.0102.1b	Asbestos containing materials (ACM) .....	32
2.0102.1c	Materials .....	34
2.0102.1d	Lead paint assessment .....	34

##### 2.0103 Heating and Cooling Equipment

###### 2.0103.1 Combustion Worker Safety

2.0103.1a	Worker safety .....	37
2.0103.1b	Carbon monoxide (CO) .....	37
2.0103.1c	Raw fuel .....	38

###### 2.0103.2 Heating and Cooling Worker Safety

2.0103.2a	Worker safety .....	40
2.0103.2b	Mercury .....	40
2.0103.2c	Asbestos .....	41
2.0103.2d	Personal protective equipment (PPE) .....	42
2.0103.2e	Combustible gas detection .....	43
2.0103.2f	Carbon monoxide (CO) .....	44
2.0103.2g	Sealant .....	45
2.0103.2h	Safety devices .....	46

**2.0107 Basements and Crawl Spaces**

**2.0107.2 Basements and Crawl Spaces—Pre-Work Qualifications**

2.0107.2a Fuel leaks ..... 48

2.0107.2b Electrical hazards ..... 49

2.0107.2c Mold ..... 49

2.0107.2d Plumbing and water leaks ..... 50

2.0107.2e Pest and termite work ..... 50

2.0107.2f Structural repairs, modifications ..... 50

2.0107.2g Appliance and heating, ventilation, and air conditioning (HVAC) system repairs and change outs ..... 51

2.0107.2h Correctable standing water ..... 51

2.0107.2i Non-correctable standing water ..... 51

**2.0107.3 Basements and Crawl Spaces—Debris Removal**

2.0107.3a Debris removal ..... 52

2.0107.3b Debris disposal ..... 52

**2.02 Combustion Safety**

**2.0201 Combustion Safety General**

**2.0201.1 Combustion Appliance Zone (CAZ) Testing**

2.0201.1a Assessment ..... 54

2.0201.1b Fuel leak detection ..... 55

2.0201.1c Venting ..... 56

2.0201.1d Base pressure test ..... 57

2.0201.1e Depressurization test ..... 58

**2.0201.2 Combustion Safety - Make-up Air**

2.0201.2a Outside combustion make-up air ..... 61

2.0201.2b New appliances ..... 62

2.0201.2c CO detection and warning equipment ..... 63

2.0201.2d Gas ovens ..... 64

2.0201.2e Gas range burners ..... 64

2.0201.2f Solid fuel burning appliances ..... 65

**2.0201.3 Vented Combustion Appliance Safety Testing**

2.0201.3a Spillage Test ..... 67

2.0201.3b Carbon monoxide (CO) test in appliance vent ..... 67

2.0201.3c Final test out ..... 69

**2.0203 Vented Gas Appliances**

**2.0203.2 Combustion Flue Gas—Orphaned Water Heaters**

2.0203.2a Spillage testing ..... 72

2.0203.2b Flue gas removal (chimney liner or approved methods) ..... 72

2.0203.2c Retesting spillage ..... 74

2.0203.2d Required combustion air ..... 75

2.0203.2e Additional combustion air (if action is required) ..... 76

**2.0203.4 Occupant Education**

2.0203.4a Occupant health and safety ..... 78

2.0203.4b Occupant education ..... 79

**2.03 Safety Devices**

**2.0301 Combustion Safety Devices**

**2.0301.1 Smoke Alarm**

2.0301.1a Smoke alarm (hardwired) ..... 81

2.0301.1b Smoke alarm (battery operated)..... 82

**2.0301.2 Carbon Monoxide Alarm or Monitor**

2.0301.2a CO detection and warning equipment (hardwired)..... 83

2.0301.2b CO detection and warning equipment (battery operated) ..... 84

**2.04 Moisture**

**2.0403 Vapor Barriers**

**2.0403.1 Vented Crawl Spaces—Ground Moisture Barrier**

2.0403.1a Material Integrity ..... 86

2.0403.1b Coverage ..... 86

2.0403.1c Material specification ..... 87

2.0403.1d Overlap seams ..... 88

2.0403.1e Fastening..... 89

**2.0403.2 Closed Crawl Spaces—Ground Moisture Barriers**

2.0403.2a Material Integrity ..... 91

2.0403.2b Coverage ..... 91

2.0403.2c Material specification ..... 92

2.0403.2d Overlap seams ..... 93

2.0403.2e Fastening..... 94

2.0403.2f Sealing seams ..... 95

2.0403.2g Air barrier, ground moisture barrier penetrations, including fastener penetrations ..... 96

2.0403.2h Drainage ..... 97

2.0403.2i Drainage points ..... 97

**2.06 Electrical**

**2.0601 Knob and Tube Wiring**

**2.0601.1 Knob and Tube Wiring**

2.0601.1a Knob and tube identification ..... 98

2.0601.1b Live wire testing..... 98

2.0601.1c Isolation and protection ..... 99

2.0601.1d Replacement ..... 101

**2.07 Occupant Education and Access**

**2.0701 Basements and Crawl Spaces**

**2.0701.2 Crawl Space Information Sign**

2.0701.2a Sign specifications..... 104

2.0701.2b Sign content ..... 104

2.0701.2c Hazard warning ..... 106

## 3 Air Sealing

### 3.10 Attics

#### 3.1001 Penetrations and Chases

##### 3.1001.1 Penetrations and Chases

3.1001.1a	Pre-inspection .....	108
3.1001.1b	Backing and infill .....	108
3.1001.1c	Sealant selection .....	108
3.1001.1d	High temperature application .....	109

##### 3.1001.2 Chase Capping

3.1001.2a	Pre-inspection .....	112
3.1001.2b	Standard chase (interior walls covered with drywall or plaster) .....	113
3.1001.2c	Non-standard chase (interior walls covered with wood or paneling) .....	115
3.1001.2d	Support .....	116
3.1001.2e	Joint seal .....	117
3.1001.2f	Adjacent framing .....	118

##### 3.1001.3 Walls Open to Attic—Balloon Framing and Double Walls

3.1001.3a	Pre-inspection .....	120
3.1001.3b	Sealing methods .....	120
3.1001.3c	Support .....	122
3.1001.3d	Joint seal .....	123
3.1001.3e	Adjacent framing .....	124

#### 3.1003 Dropped Ceilings and Soffits

##### 3.1003.1 New Ceiling Below Original—Old Ceiling Intact or Repairable

3.1003.1a	Pre-inspection .....	126
3.1003.1b	Sealing methods .....	126
3.1003.1c	Support .....	128
3.1003.1d	Joint seal .....	130
3.1003.1e	Adjacent framing .....	131

##### 3.1003.2 Ceiling Leaks Not Repairable—No Air Barrier Above

3.1003.2a	Pre-inspection .....	133
3.1003.2b	Sealing methods .....	133
3.1003.2c	Support .....	134
3.1003.2d	Joint seal .....	135
3.1003.2e	Adjacent framing .....	136

##### 3.1003.3 Above Closets and Tubs

3.1003.3a	Pre-inspection .....	138
3.1003.3b	Above closets and tubs .....	138
3.1003.3c	Support .....	140
3.1003.3d	Joint seal .....	142
3.1003.3e	Adjacent framing .....	143

##### 3.1003.4 Dropped Ceilings

3.1003.4a	Pre-inspection .....	145
3.1003.4b	Sealing methods .....	145
3.1003.4c	Support .....	146

## Table of Contents

3.1003.4d	Joint seal .....	147
3.1003.4e	Adjacent framing .....	148
<b>3.1003.6</b>	<b>Dropped Soffits</b>	
3.1003.6a	Pre-inspection .....	150
3.1003.6b	Soffit general .....	150
3.1003.6c	Option 1: bring soffit inside (seal at top).....	151
3.1003.6d	Option 2: leave soffit outside (seal at bottom or side) .....	153
3.1003.6e	Soffits containing non-IC rated recessed lights .....	155
<b>3.12</b>	<b>Windows and Doors</b>	
<b>3.1201</b>	<b>Maintenance, Repair, and Sealing</b>	
<b>3.1201.1</b>	<b>Double-Hung Wood Windows</b>	
3.1201.1a	Lead paint assessment .....	156
3.1201.1b	Weather stripping .....	157
3.1201.1c	Sash locks .....	158
3.1201.1d	Replacement sills .....	158
3.1201.1e	Sash replacement .....	160
3.1201.1f	Adjust stops .....	160
3.1201.1g	Replace stops.....	161
<b>3.1201.2</b>	<b>Single-Unit Window and Fixed Frame with Wood Sash</b>	
3.1201.2a	Lead paint assessment .....	162
3.1201.2b	Operable windows .....	164
3.1201.2c	Air infiltration.....	164
3.1201.2d	Water infiltration.....	164
3.1201.2e	Occupant education and maintenance .....	165
<b>3.1201.3</b>	<b>Exterior Doors</b>	
3.1201.3a	Lead paint assessment .....	166
3.1201.3b	Door operation and fit.....	167
3.1201.3c	Air infiltration.....	169
3.1201.3d	Water infiltration.....	170
3.1201.3e	Occupant education and maintenance .....	171
<b>3.1202</b>	<b>Repairing/Replacing Cracked and Broken Glass</b>	
<b>3.1202.1</b>	<b>Fixed Frame with Wood Sash—Older House</b>	
3.1202.1a	Lead paint assessment .....	173
3.1202.1b	Broken glass removal.....	174
3.1202.1c	Sash preparation .....	176
3.1202.1d	New glass installation .....	177
<b>3.1202.2</b>	<b>Single-Unit Window, Mounted on Rough Opening—Newer House</b>	
3.1202.2a	Lead paint assessment .....	180
3.1202.2b	Broken glass removal.....	181
3.1202.2c	Opening preparation.....	183
3.1202.2d	New glass installation .....	184
<b>3.1203</b>	<b>Replacement</b>	
<b>3.1203.1</b>	<b>Replacement Window in Existing Window Frame</b>	
3.1203.1a	Lead paint assessment .....	187

3.1203.1b	Opening preparation.....	188
3.1203.1c	Replacement window installation .....	190
<b>3.1203.2</b>	<b>Single-Unit Window, Mounted on Rough Opening—Newer House</b>	
3.1203.2a	Lead paint assessment .....	193
3.1203.2b	Opening preparation.....	195
3.1203.2c	Replacement unit preparation .....	196
3.1203.2d	Replacement window installation .....	197
<b>3.14</b>	<b>Basements and Crawl Spaces</b>	
<b>3.1402</b>	<b>Crawl Spaces</b>	
<b>3.1402.1</b>	<b>Crawl Spaces—Sealing Floor Penetrations</b>	
3.1402.1a	Backing and infill .....	200
3.1402.1b	Sealant selection .....	201
3.1402.1c	High temperature application .....	202
<b>3.1402.3</b>	<b>Closed Crawl Spaces—Air Sealing Exterior Wall</b>	
3.1402.3a	Seal penetrations .....	205
3.1402.3b	Pest exclusion .....	206
<b>3.15</b>	<b>Attached Garages</b>	
<b>3.1501</b>	<b>Garage Openings</b>	
<b>3.1501.1</b>	<b>Penetrations, Cracks, and Doors Between Garage and House</b>	
3.1501.1a	Penetrations .....	208
3.1501.1b	Ductwork.....	208
3.1501.1c	Cracks .....	209
3.1501.1d	Garage to house door .....	211
3.1501.1e	Glass .....	213
3.1501.1f	Carbon monoxide (CO) alarm .....	214
3.1501.1g	Occupant education .....	215
<b>3.16</b>	<b>Ducts</b>	
<b>3.1601</b>	<b>Duct Preparation</b>	
<b>3.1601.3</b>	<b>Support</b>	
3.1601.3a	Support (applies to all duct types) .....	217
<b>3.1602</b>	<b>Duct Sealing</b>	
<b>3.1602.1</b>	<b>Air Sealing Duct System</b>	
3.1602.1a	New component to new component sealant selection .....	219
3.1602.1b	New component to existing component .....	219
3.1602.1c	Existing component to existing component .....	220
<b>3.1602.4</b>	<b>Air Sealing System Components</b>	
3.1602.4a	Duct boot to interior surface .....	222
3.1602.4b	Wooden plenums and building cavities .....	223
3.1602.4c	Air handler cabinet .....	225
3.1602.4d	Filter slot.....	226
<b>3.1602.5</b>	<b>Return—Framed Platform</b>	
3.1602.5a	Preparation.....	228
3.1602.5b	Infill and backing.....	228

3.1602.5c Sealant selection .....	230
<b>4 Insulation</b>	
<b>4.10 Attics</b>	
<b>4.1001 General Preparation</b>	
<b>4.1001.1 Non-Insulation Contact (IC) Recessed Light</b>	
4.1001.1a Air barrier system .....	232
4.1001.1b Enclosure top .....	233
4.1001.1c Clearance .....	234
4.1001.1d Sealants and weather stripping .....	235
<b>4.1001.2 Knob and Tube Wiring</b>	
4.1001.2a Identifying knob and tube wiring .....	236
4.1001.2b Testing to determine if live .....	237
4.1001.2c Isolate or replace .....	237
<b>4.1001.3 Fireplace Chimney and Combustion Flue Vents</b>	
4.1001.3a Verify attic prep .....	240
4.1001.3b Required clearance .....	241
4.1001.3c Safety .....	242
4.1001.3d Occupant education .....	242
<b>4.1001.4 Vented Eave or Soffit Baffles</b>	
4.1001.4a Installation .....	244
<b>4.1003 Attic Ceilings</b>	
<b>4.1003.3 Unvented Flat Roof with Existing Insulation</b>	
4.1003.3a Ventilation .....	246
4.1003.3b Installation .....	247
4.1003.3c Occupant education .....	248
<b>4.1004 Knee Walls</b>	
<b>4.1004.1 Preparation for Dense Packing</b>	
4.1004.1a Backing .....	250
4.1004.1b Installation .....	252
<b>4.1004.2 Preparation for Batt Insulation</b>	
4.1004.2a Knee wall prep for batts .....	254
4.1004.2b Installation .....	255
4.1004.2c Backing knee wall .....	256
<b>4.1005 Attic Floors</b>	
<b>4.1005.1 Accessible Floors—Batt Installation</b>	
4.1005.1a Preparation .....	258
4.1005.1b Installation .....	259
4.1005.1c Occupant education .....	260
<b>4.1005.2 Accessible Floors—Loose Fill Installation</b>	
4.1005.2a Preparation .....	262
4.1005.2b Air barrier .....	264
4.1005.2c Installation .....	265
4.1005.2d Onsite documentation .....	266

<b>4.1005.3 Accessible Floors—Batt Insulation Over Existing Insulation</b>	
4.1005.3a Preparation .....	268
4.1005.3b Installation .....	268
4.1005.3c Insulation .....	268
4.1005.3d Safety .....	269
4.1005.3e Onsite documentation .....	269
<b>4.1005.4 Accessible Floors—Loose Fill Over Existing Insulation</b>	
4.1005.4a Preparation .....	271
4.1005.4b Installation .....	271
4.1005.4c Safety .....	272
4.1005.4d Onsite documentation .....	272
<b>4.1005.5 Enclosed Bonus Room Floor Over Unconditioned Space—Dense Pack Installation</b>	
4.1005.5a Air barrier .....	274
4.1005.5b Fill floors .....	275
4.1005.5c Safety .....	277
4.1005.5d Onsite documentation .....	278
<b>4.1006 Attic Openings</b>	
<b>4.1006.1 Pull-Down Stairs</b>	
4.1006.1a Installation .....	280
4.1006.1b Sealing .....	281
<b>4.1006.2 Access Doors and Hatches</b>	
4.1006.2a Installation .....	283
4.1006.2b Sealing .....	284
4.1006.2c Attachment .....	285
<b>4.1088 Special Considerations</b>	
<b>4.1088.3 Skylights</b>	
4.1088.3a Sealing .....	288
4.1088.3b Installation .....	288
4.1088.3c Occupant education .....	290
<b>4.11 Walls</b>	
<b>4.1102 Accessible Walls</b>	
<b>4.1102.1 Open-Cavity Wall Insulation—General</b>	
4.1102.1a Sealing .....	292
4.1102.1b Installation .....	293
4.1102.1c Pre-drywall verification .....	294
4.1102.1d Onsite documentation .....	295
<b>4.1103 Enclosed Walls</b>	
<b>4.1103.1 Dense Pack Exterior Walls</b>	
4.1103.1a Exterior dense pack .....	297
4.1103.1b Onsite documentation .....	299
<b>4.1103.2 Additional Exterior Wall Cavities</b>	
4.1103.2a Location of cavities .....	301
4.1103.2b Sealing .....	301
4.1103.2c Dense packing .....	302

4.1103.2d Quality assurance..... 304

4.1103.2e Close holes..... 305

**4.13 Floors**

**4.1301 Accessible Floors**

**4.1301.1 Standard Floor System—Batt Installation**

4.1301.1a Sealing ..... 308

4.1301.1b Installation ..... 309

4.1301.1c Securing batts ..... 310

4.1301.1d Occupant education ..... 311

**4.1301.2 Standard Floor System—Loose Fill with Netting**

4.1301.2a Sealing ..... 314

4.1301.2b Netting, fabric ..... 315

4.1301.2c Installation ..... 316

4.1301.2d Occupant education ..... 318

**4.1301.3 Standard Floor System—Loose Fill with Rigid Barrier**

4.1301.3a Sealing ..... 320

4.1301.3b Rigid air barrier ..... 321

4.1301.3c Installation ..... 322

4.1301.3d Occupant education ..... 324

**4.1301.4 Dense Pack Floor System with Rigid Barrier**

4.1301.4a Sealing ..... 326

4.1301.4b Rigid air barrier ..... 327

4.1301.4c Installation ..... 328

4.1301.4d Occupant education ..... 330

**4.1301.5 Cantilevered Floor—Batt Installation**

4.1301.5a Air barrier..... 332

4.1301.5b Installation ..... 333

4.1301.5c Attachment ..... 335

4.1301.5d Exterior soffit..... 336

4.1301.5e Occupant education ..... 338

**4.1301.6 Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier**

4.1301.6a Subfloor preparation ..... 340

4.1301.6b Installation ..... 341

4.1301.6c Secure batts ..... 343

4.1301.6d Rigid air barrier ..... 344

4.1301.6e Occupant education ..... 345

**4.1301.7 Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier**

4.1301.7a Subfloor preparation ..... 347

4.1301.7b Rigid air barrier ..... 348

4.1301.7c Installation ..... 349

4.1301.7d Occupant education ..... 351

**4.1301.8 Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier**

4.1301.8a Subfloor preparation ..... 353

4.1301.8b Rigid air barrier ..... 354

4.1301.8c Installation ..... 355

4.1301.8d Occupant education ..... 357

**4.14 Basements and Crawl Spaces**

**4.1402 Basements and Crawl Space Walls**

**4.1402.2 Basement Wall Insulation—No Groundwater Leakage**

4.1402.2a R-value ..... 359

4.1402.2b Air barrier ..... 359

4.1402.2c Vapor permeability ..... 361

**4.16 Ducts**

**4.1601 Insulating Ducts**

**4.1601.2 Insulating Metal Ducts**

4.1601.2a Selection of duct insulation material ..... 362

4.1601.2b Duct sealing ..... 363

4.1601.2c Attachment of duct insulation ..... 364

4.1601.2d Taping of the duct insulation ..... 365

**5 Heating and Cooling**

**5.30 Forced Air**

**5.3003 System Assessment and Maintenance**

**5.3003.1 Data Plate Verification**

5.3003.1a Data plate verification ..... 366

**5.3003.2 Combustion Analysis of Oil-Fired Appliances**

5.3003.2a Oil system: filter ..... 367

5.3003.2b Nozzle ..... 368

5.3003.2c Fuel pressure ..... 369

5.3003.2d Place appliance in operation ..... 370

5.3003.2e Smoke Test ..... 371

5.3003.2f Steady state efficiency (SSE ) ..... 372

5.3003.2g Net stack temperature ..... 373

5.3003.2h Carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>) ..... 374

5.3003.2i Excess combustion air ..... 375

5.3003.2j CO in flue gas ..... 376

5.3003.2k Testing/inspection holes ..... 377

**5.3003.8 Evaporative Cooler Maintenance and Repairs**

5.3003.8a Assessment and diagnosis ..... 379

5.3003.8a Assessment and diagnosis ..... 381

5.3003.8b Repair and maintenance ..... 381

5.3003.8b Repair and maintenance ..... 383

5.3003.8c Occupant education ..... 384

5.3003.8c Occupant education ..... 384

**5.3003.10 Condensate Drainage of Heating and Air Conditioning Equipment**

5.3003.10a Connection ..... 386

5.3003.10b Insulation ..... 386

5.3003.10c Overflow protection: upflow ..... 387

## Table of Contents

5.3003.10d Pumps .....	388
5.3003.10e Vents and traps .....	389
5.3003.10f Drain pan .....	389
5.3003.10g Float switch.....	390
5.3003.10h Termination.....	391
<b>5.3003.14 Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)</b>	
5.3003.14a Gas Pressure.....	392
5.3003.14b Place appliance in operation .....	392
5.3003.14c Carbon dioxide (CO <sub>2</sub> )and oxygen (O <sub>2</sub> ).....	393
5.3003.14d Carbon monoxide (CO) in flue gas.....	394
5.3003.14e Testing/inspection holes.....	395

## 6 Ventilation

### 6.60 Exhaust

#### 6.6002 Components

##### 6.6002.1 Ducts

6.6002.1a Duct design and configuration .....	397
6.6002.1b Duct insulation .....	397
6.6002.1c Duct support .....	398
6.6002.1d Duct connections .....	400
6.6002.1e Duct materials.....	402

##### 6.6002.2 Terminations

6.6002.2a Hole in building shell .....	404
6.6002.2b Termination fitting .....	405
6.6002.2c Duct to termination connection .....	406
6.6002.2d Weatherproof installation.....	408
6.6002.2e Pest exclusion .....	410
6.6002.2f Termination location .....	410
6.6002.2g Kitchen exhaust.....	411

#### 6.6003 Fans

##### 6.6003.3 Through the Wall

6.6003.3a Hole in building shell .....	413
6.6003.3b Wiring .....	414
6.6003.3c Fan mounting .....	416
6.6003.3d Weatherproof installation.....	417
6.6003.3e Backdraft damper .....	419
6.6003.3f Fan housing seal .....	419
6.6003.3g Fan to interior surface seal .....	420
6.6003.3h Insulation .....	421
6.6003.3i Air flow.....	421
6.6003.3j Preventing air leakage caused by exhaust fans .....	423
6.6003.3k Combustion safety.....	424

**6.6005 Appliance Exhaust Vents**

**6.6005.1 Clothes Dryer**

6.6005.1a Clothes dryer ducting ..... 426  
 6.6005.1b Termination fitting ..... 428  
 6.6005.1c Make-up air..... 429  
 6.6005.1d Combustion safety..... 430  
 6.6005.1e Occupant education ..... 431

**6.6005.2 Kitchen Range**

6.6005.2a Wiring ..... 433  
 6.6005.2b Fan venting..... 433  
 6.6005.2c Fan ducting..... 434  
 6.6005.2d Termination fitting ..... 436  
 6.6005.2e Make-up air..... 437  
 6.6005.2f Combustion safety..... 438  
 6.6005.2g Occupant education ..... 439

**6.62 Whole Building Ventilation**

**6.6201 Air Flow Requirements**

**6.6201.2 Primary Ventilation Air Flow between Rooms**

6.6201.2a Balancing pressure..... 441

**7 Baseload**

**7.81 Water Heating**

**7.8102 Installation and Replacement**

**7.8102.2 Storage-Type Appliance**

7.8102.2a Hazardous material removal ..... 443  
 7.8102.2b Equipment removal ..... 443  
 7.8102.2c New equipment installation ..... 444  
 7.8102.2d Emergency drain pan ..... 444  
 7.8102.2e Expansion tank..... 445  
 7.8102.2f Temperature and pressure relief valve..... 445  
 7.8102.2g Dielectric unions ..... 447  
 7.8102.2h Backflow prevention ..... 447  
 7.8102.2i Thermal efficiency ..... 447  
 7.8102.2j Fuel supply ..... 448  
 7.8102.2k Discharge temperature..... 448  
 7.8102.2l Commissioning of system..... 450  
 7.8102.2m Occupant safety ..... 450  
 7.8102.2n Occupant education ..... 451

**7.8103 Maintenance/Inspection**

**7.8103.1 Storage-Type Appliance**

7.8103.1a Health and safety ..... 452  
 7.8103.1c Thermal efficiency ..... 453  
 7.8103.1e Temperature and pressure relief valve..... 454

## 2.0100.1 - Global Worker Safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Note:**

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

### 2.0100.1a - Prevention through design

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Design will be incorporated to eliminate or minimize hazards (e.g., material selection, access to equipment for installation and maintenance, placement of equipment, ductwork and condensate lines)

**Objective(s):**

Prevent worker injuries

Reduce risk exposure to toxic substances and physical hazards

### 2.0100.1b - Hand protection

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Durable and wrist-protecting gloves will be worn that can withstand work activity

**Objective(s):**

Minimize skin contact with contaminants

Protect hands from hazards



**Unsafe**

Recognize potential risks



**Safe**

Wear appropriate hand protection



GOOD: Wear nitrile gloves when handling mastic



Inspect gloves for holes and damage to minimize risk

## 2.0100.1c - Respiratory protection

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

If the risk of airborne contaminants cannot be prevented, proper respiratory protection will be provided and worn (e.g., N-95 or equivalent face mask)

When applying low pressure 2-component spray polyurethane foam, air purifying masks with an organic vapor cartridge and P-100 particulate filter will be used

When applying high-pressure SPF insulation, supplied air respirators (SARs) will be used

Consult MSDS for respiratory protection requirements

OSHA 1910.134 shall be followed for the implementation of a respiratory protection program

**Objective(s):**

Minimize exposure to airborne contaminants (e.g., insulation materials, mold spores, feces, bacteria, chemicals)



**Unsafe**

Workers need to properly protect their airways when retrofitting



**Best Practice**

Retrofits can have multiple different respiratory protection requirements

When web-enabled, click link to read [OSHA 1910.134](#)



Whenever airborne contaminants are a possibility, wear an N-95 mask



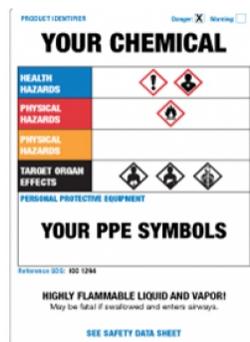
For two-component spray insulation, P-100 respirators should be used



All P-100s should be fitted to the individual worker



When working with high-pressure



When unsure what level of protection

spray foam, use a Supplied Air  
Respirator

is necessary, check the Safety Data  
Sheets (SDS) for the materials to be  
used

## 2.0100.1d - Electrical safety

### **Desired Outcome:**

Work completed safely without injury or hazardous exposure

### **Specification(s):**

An electrical safety assessment will be performed

All electric tools will be protected by ground-fault circuit interrupters (GFCI)

Three-wire type extension cords will be used with portable electric tools

Worn or frayed electrical cords will not be used

Water sources (e.g., condensate pans) and electrical sources will be kept separate

Metal ladders will be avoided

Special precautions will be taken if knob and tube wiring is present

Aluminum foil products will be kept away from live wires

For arc flash hazards, NFPA 70E will be consulted

### **Objective(s):**

Avoid electrical shock and arc flash hazards



**Unsafe**

Inspect house for unsafe electrical situations



Attics and crawl spaces should be inspected closely for electrical safety before work begins



Use GFIs and three-wire extension cords for all power tools



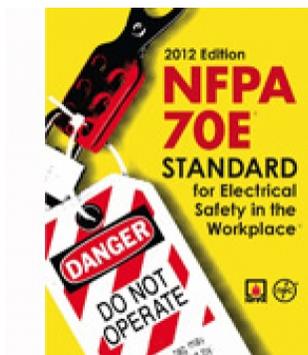
Electrical wiring should not be located near a water source



Use fiberglass ladders in place of metal



Recognize if knob and tube wiring is present and take special precautions



Follow NFPA 70E guidelines for arc flash hazards

## 2.0100.1e - Carbon monoxide (CO)

### Desired Outcome:

Work completed safely without injury or hazardous exposure

**Specification(s):**

All homes will have a carbon monoxide alarm

Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)

**Objective(s):**

Protect worker and occupant health



STOP WORK if CO levels are higher than 35ppm!!



Install carbon monoxide alarms

**Tools:**

1. CO meter

## 2.0100.1f - Personal Protective Equipment

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

MSDS and OSHA regulations will be consulted for equipment and protective clothing would be worn if contaminants are present(e.g., insulation materials)

Eye protection will always be worn (e.g., safety glasses, goggles if not using full-face respirator)

**Objective(s):**

Protect worker from skin contact with contaminants

Minimize spread of contaminants

Provide eye protection



Workers should be aware of work required and dress appropriately



Ensure workers have proper protective equipment for work environment

## 2.0100.1g - Confined space safety

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Spaces with limited ingress and egress and restricted work area will be considered confined space

Access and egress points will be located before beginning work

Inspection will be conducted for hazards, such as damaged or exposed electrical conductors, mold, sewage effluent, friable asbestos or fiberglass, pests, and other potential hazards

Adequate ventilation will be provided

Use of toxic material will be reduced

### Objective(s):

Prevent build-up of toxic or flammable contaminants

Reduce risk to the workers in the confined space

Provide adequate access and egress points

Prevent electrical shock



👍 After

Locate all access and egress points of confined spaces before entering



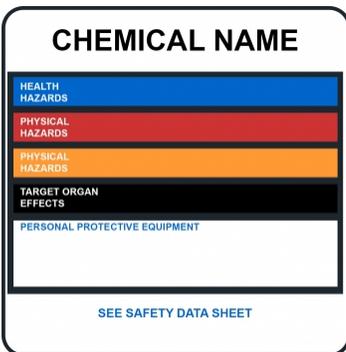
Perform visual inspection of confined spaces before beginning work



Check for frayed or worn electrical wires



In confined spaces, use a ventilator



Check GHS labels and Safety Data Sheets for all materials to minimize hazards

## 2.0100.1h - Power tool safety

### Desired Outcome:

Work completed safely without injury or hazardous exposure

**Specification(s):**

Power tools will be inspected and used in accordance with manufacturer specifications and OSHA regulations to eliminate hazards such as those associated with missing ground prongs, ungrounded circuits, misuse of power tools, noise, and improper or defective cords or extension cords. All tools must be maintained in proper operating condition with all guards securely in place

All devices used will be verified as GFCI protected or double insulated

Exhaust gases from compressors and generators will be prevented from entering interior space

**Objective(s):**

Prevent power tool injuries

Prevent buildup of toxic or flammable contaminants

## 2.0100.1i - Chemical safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Hazardous materials will be handled in accordance with manufacturer specifications, MSDS and OSHA standards to eliminate hazards associated with volatile organic compounds (VOCs), sealants, insulation, contaminated drywall, dust, foams, asbestos, lead, mercury, and fibers

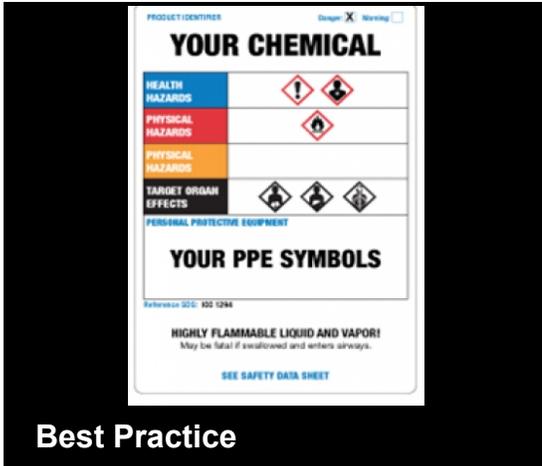
Appropriate personal protective equipment (PPE) will be provided

Workers will be trained on how to use PPE

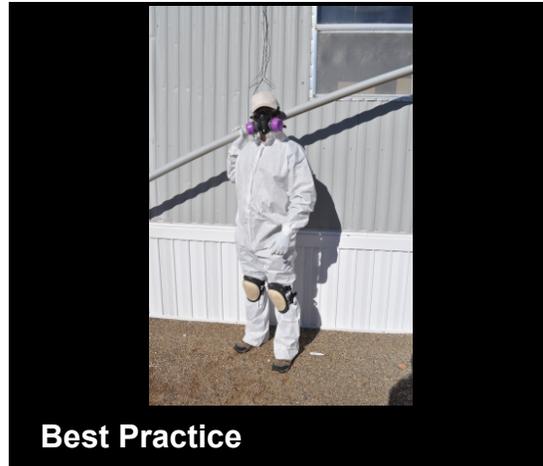
Workers will be expected to always use appropriate PPE during work

**Objective(s):**

Prevent worker exposure to toxic substances

**Best Practice**

New GHS/SDS labeling is clear and concise--workers should be familiar with how to read new Safety Data Sheets

**Best Practice**

Workers should be trained on how to wear PPE, be provided with proper PPE, and know when to use it

## 2.0100.1j - Ergonomic safety

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Appropriate PPE will be used (e.g., knee pads, bump caps, additional padding)

Proper equipment will be used for work

Proper lifting techniques will be used

### Objective(s):

Prevent injuries from awkward postures, repetitive motions, and improper lifting



Workers will take precautions to protect themselves on the job site



Hard hats, knee pads, bump caps, and team lifts help to prevent injury

**Tools:**

1. Hard hats
2. Knee pads
3. Bump caps

## 2.0100.1k - Hand tool safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Hand tools will be maintained in safe working order and used for intended purpose

**Objective(s):**

Prevent injuries

## 2.0100.1l - Slips, trips, and falls

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Caution will be used around power cords, hoses, tarps, and plastic sheeting

Precautions will be taken when ladders are used, when working at heights, or when balancing on joists

Walk boards will be used when practical

When scaffolding is used, manufacturer set-up procedures will be followed

Appropriate footwear and clothing will be worn

**Objective(s):**

Prevent injuries due to slips, trips, and falls

## 2.0100.1m - Thermal stress

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Ensure staff is aware of risks during extreme weather including the symptoms of heat stroke, heat exhaustion, and hypothermia

Appropriate ventilation, hydration, rest breaks, and cooling equipment will be provided

911 will be dialed when necessary

**Objective(s):**

Prevent heat stroke, heat stress, and cold stress related injuries



Attics and crawl spaces can be dangerous work places in the heat and the cold



DO NOT HESITATE to call 911 in potential cases of heat stroke or hypothermia

**Tools:**

1. Cool vests
2. Ventilator



Keep workers comfortable with hydration and cool vests



Provide fresh and moving air when working in hot confined spaces

## 2.0100.1n - Fire safety

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Ignition sources will be identified and eliminated (e.g., turn off pilot lights and fuel supply)

Use of flammable material will be reduced and fire-rated materials will be used

### Objective(s):

Prevent a fire hazard



**Unsafe**

Fire hazards should be removed from the work area with the permission and/or assistance of the homeowner



**Best Practice**

Set combustion appliances to off or pilot to minimize risk of fire

## 2.0100.1o - Asbestos-containing materials (ACM)

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material and to sample and test as needed

If suspected ACM is in good condition, do not disturb

If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s)

For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair in accordance with federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM

When working around ACM, do not:

- Dust, sweep, or vacuum ACM debris
- Saw, sand, scrape, or drill holes in the material
- Use abrasive pads or brushes to strip materials

Asbestos abatement or repair work should be completed prior to blower door testing; exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos

### Objective(s):

Protect workers and occupants from potential asbestos hazards



If materials that may contain asbestos are found in the home, do not disturb the material or run blower door



If asbestos is suspected, call an EPA-accredited professional.

**Materials:**

1. Containment shroud
2. Caution tape



Do not disturb ACM by vacuuming, dusting, or sweeping



Do not disturb ACM by drilling, sanding, scraping, sawing, etc.

## 2.0100.1p - Lead paint assessment

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise

The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or

any more stringent state or federal standards

**Objective(s):**

Protect workers and occupants from potential lead hazards



**Best Practice**

In homes built before 1978, test paint before beginning renovation or assume presence of lead

**Tools:**

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

**Materials:**

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsule and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative.



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

## 2.0100.1q - Site security

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Work site will be secured to prevent unauthorized entry

Temporarily disconnected equipment will be locked up and tagged out

All loose or unbagged trash and unused materials will be removed from work site daily

### Objective(s):

Protect the occupant from exposure to potential hazards

## 2.0100.1r - Crawl space safety

### Desired Outcome:

Work completed safely without injury or hazardous exposure

**Specification(s):**

The source of all contaminants (e.g., sewage, dead animals, needles) will be corrected, repaired, or removed before performing inspections that require complete access to the crawl space

If appropriate, the contaminant will be neutralized and/or a protective barrier will be installed in the area

**Objective(s):**

Ensure work safety

Prevent worker exposure to hazards

## 2.0102.1 - Insulation Worker Safety

### Desired Outcome:

Work is completed safely without injury or hazardous exposure

### 2.0102.1a - Worker safety

#### Desired Outcome:

Work is completed safely without injury or hazardous exposure

#### Specification(s):

Worker safety specifications will be followed in accordance with SWS 2.0100 Global Worker Safety

#### Objective(s):

Prevent injury

Minimize exposure to health and safety hazards

### 2.0102.1b - Asbestos containing materials (ACM)

#### Desired Outcome:

Work is completed safely without injury or hazardous exposure

#### Specification(s):

OSHA asbestos abatement protocol 29 CFR 1926.1101 will be followed if vermiculite insulation is present

Assess potential asbestos hazard; if unsure whether material contains asbestos, contact a qualified asbestos professional to assess the material, and to sample and test as needed

If suspected ACM is in good condition, do not disturb

If suspected ACM is damaged (e.g., unraveling, frayed, breaking apart), immediately isolate the area(s)

For suspected ACM that is damaged or that must be disturbed as part of the retrofit activity, contact an asbestos professional for abatement or repair, in accordance with federal, state, and local requirements; only a licensed or trained professional may abate, repair, or remove ACM

When working around ACM, do not:

- Dust, sweep, or vacuum ACM debris
- Saw, sand, scrape, or drill holes in the material
- Use abrasive pads or brushes to strip materials

Asbestos abatement or repair work should be completed prior to blower door testing; exercise appropriate caution when conducting blower door testing where friable asbestos or vermiculite attic insulation is present to avoid drawing asbestos fibers into the living space (i.e., use positively pressurized blower door testing) unless the material has been tested and found not to contain asbestos

### Objective(s):

Protect workers and occupants from potential asbestos hazards



 **Before**

If materials that may contain asbestos are found in the home, do not disturb the material or run the blower door



**Best Practice**

If asbestos is suspected, call an EPA-accredited professional.

### Materials:

1. Containment shroud
2. Caution tape



Do not disturb ACM by drilling, sanding, scraping, sawing, etc.



Do not disturb ACM by vacuuming, dusting, or sweeping

## 2.0102.1c - Materials

### Desired Outcome:

Work is completed safely without injury or hazardous exposure

### Specification(s):

All materials will be handled in accordance with manufacturer specifications or material safety data sheets (MSDS) standards

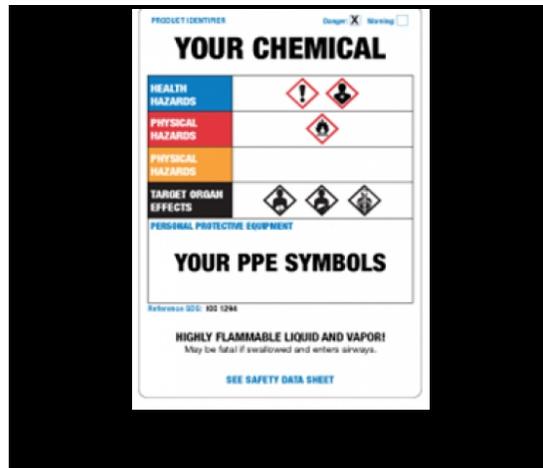
### Objective(s):

Eliminate hazards associated with incorrect, defective, or improperly used or installed materials



### Best Practice

Workers should be familiar with Safety Data Sheets for materials used and know where to locate SDS in case of emergency



New Safety Data Sheet and GHS label formatting is easier to quickly interpret

## 2.0102.1d - Lead paint assessment

### Desired Outcome:

Work is completed safely without injury or hazardous exposure

### Specification(s):

Presence of lead based paint in pre-1978 homes will be assumed unless testing confirms otherwise

The Environmental Protection Agency (EPA) Renovation, Repair, and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rule making or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



In homes built before 1978, test paint before beginning renovation or assume presence of lead

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



**1**  
Clean tools and sample site to prevent contamination



**2**  
Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



**3**  
Break capsule and shake to mix reagents. Swab sample site for 30 seconds



**4**  
Check swab for reaction



**5**  
Red indicates lead positive. White is lead negative.



**6**  
If negative, verify validity of test with provided calibration card



**7**  
Lead in calibration card should test positive and turn spot red



**8**  
Record test results to maintain documentation

## 2.0103.1 - Combustion Worker Safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

### 2.0103.1a - Worker safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

All worker safety specifications in Global Worker Safety section will be followed

**Objective(s):**

Prevent injury

Minimize exposure to health and safety hazards

### 2.0103.1b - Carbon monoxide (CO)

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Ambient CO will be monitored during combustion testing and testing will be discontinued if ambient CO level inside the home or work space exceeds 35 parts per million (ppm)

**Objective(s):**

Protect worker and occupant health



STOP WORK if CO levels measure above 35ppm!!



Install carbon monoxide alarm if none are found.

**Tools:**

1. CO meter

## 2.0103.1c - Raw fuel

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Raw fuel leaks will be monitored for before entering building spaces

If leaks are found, testing will be discontinued and condition reported to occupant immediately

**Objective(s):**

Protect worker and occupant health



Fuel leaks need to be repaired by appropriate professional



Notify occupant of any leaks

**Tools:**

- 1. Gas sniffer
- 2. Bubble solution



Check all raw fuel lines for leaks



Use multiple methods to test for leakage--bubble solution



If bubbles develop, leak is present. Notify occupant



Any leaks found should be reported to occupant and work stopped



Any leaks found should be reported to occupant and work stopped

## 2.0103.2 - Heating and Cooling Worker Safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

### 2.0103.2a - Worker safety

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Follow all worker safety specifications in SWS 2.0100 Global Worker Safety section

**Objective(s):**

Prevent injury

Minimize exposure to health and safety hazards

### 2.0103.2b - Mercury

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

When replacing existing thermostats, identify and dispose of any mercury containing thermostats in accordance with Environmental Protection Agency (EPA) guidance

**Objective(s):**

Protect worker and occupant from mercury exposure



**Unsafe**

Mercury thermostats should be replaced and disposed of properly



**Bad Practice**

Do NOT dispose of mercury thermostats in the trash--find local recycling

Paraphrased from 40 CFR 273.14: A universal waste mercury-containing thermostat or container containing only universal waste mercury-containing thermostats should be labeled or marked clearly with any of the following phrases: "Universal Waste-Mercury Thermostat(s)," "Waste Mercury Thermostat(s)," or "Used Mercury Thermostat(s)." \*\*Contact [thermostat-recycle.org](http://thermostat-recycle.org) or [earth911.org](http://earth911.org) for recycling options.

## 2.0103.2c - Asbestos

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Suspected asbestos hazards will be identified in furnaces (e.g., gaskets), wood stoves, zonal heating devices, electrical wiring insulation, boilers, and pipe insulation and corrected in accordance with EPA guidance

Workers will take precautionary measures to avoid exposure

### Objective(s):

Protect worker and occupant from asbestos exposure



**Unsafe**

Suspicious pipe insulation may contain asbestos



**Best Practice**

When asbestos is suspected, call in EPA-accredited professionals.



If exposure to ACM cannot be avoided, workers must wear P-100 masks and proper PPE to avoid ingestion or contamination

## 2.0103.2d - Personal protective equipment (PPE)

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Workers will wear personal protective equipment (PPE) as needed to protect themselves against exposure to hazards (e.g., pests, sewage, flooded duct work, mold, chemicals, scat, viruses)

Long sleeves and long pants should be worn as additional protection from liquid nitrogen and other hazardous materials

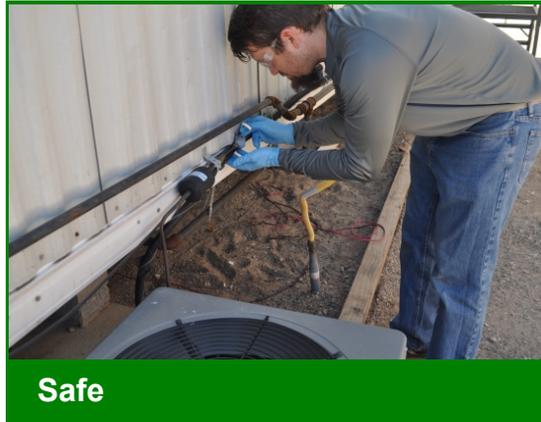
### Objective(s):

Protect worker from exposure to hazards

Protect worker from skin contact with liquid nitrogen



When working with refrigerants, short sleeves are inappropriate



Workers should dress appropriately for working with refrigerant and be aware of any addition risks in their surroundings

## 2.0103.2e - Combustible gas detection

### Desired Outcome:

Work completed safely without injury or hazardous exposure

### Specification(s):

Worker will check for presence of combustible gas leaks before work begins

Leaks will be repaired before work is performed

### Objective(s):

Protect worker and occupant from exposure to hazards



Fuel leaks need to be repaired



Repairs need to be tested and verified that they no longer leak

**Tools:**

1. Combustible gas detector
2. Testing solution

Paraphrased from 2012 IRC G2417: Leakage will be located using an approved combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the piping system will be repaired or replaced and retested.

**Measures**

**Measure 12** Repair - Gas Leak in Crawlspace (flagged)

**Comment**

#	Material / Labor	Description /Comment	Units
1	Unspecified	Misc Material	Each

Fuel leaks discovered during initial audit should be flagged for repair



Use approved combustion gas sniffer to see if repaired line still leaks



Repeatedly test repair site for leakage over a 10 minute period



Then allow testing solution to sit on newly repaired pipe joint for 10 minutes



Confirm repair and remove flag

**2.0103.2f - Carbon monoxide (CO)**

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Workers will check for presence of ambient CO before and during work

CO issues will be addressed before work is performed or continued

**Objective(s):**

Protect worker and occupant from exposure to hazards



**Best Practice**

Workers will monitor CO levels throughout work day, wearing a personal CO detector at all times



**Best Practice**

All CO issues found during initial audit should be mitigated before work begins



Personal CO detectors should be calibrated outside in fresh, open air before entering a home



If at any point CO levels exceed 35ppm, work must stop immediately and the home must be evacuated

**2.0103.2g - Sealant**

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

Pipes will be sealed by a certified professional with an approved fastening process and sealant in accordance with manufacturer specifications (International Fuel Gas Code)

Gas lines will be leak free when tested with an electronic combustible gas leak detector and verified

with bubble solution

OR

Gas lines will be leak free when tested by a standing pressure test that meets the approval of the local code

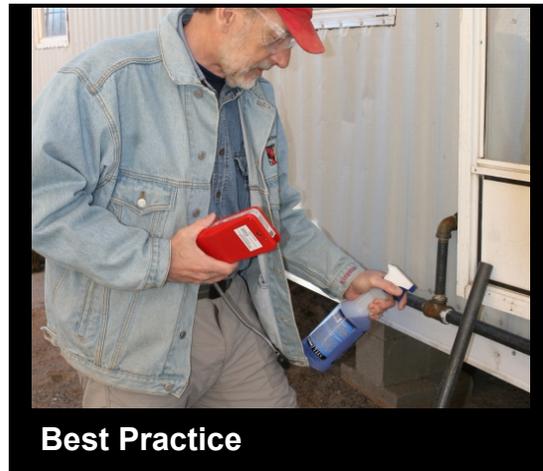
**Objective(s):**

Install gas lines with no leaks



**Best Practice**

Call a licensed professional for gas line installations and repairs.



**Best Practice**

Test any new gas line connections with combustible gas detector, and verify lack of leaks with testing solution.

**Tools:**

1. Combustible gas detector
2. Testing solution

## 2.0103.2h - Safety devices

**Desired Outcome:**

Work completed safely without injury or hazardous exposure

**Specification(s):**

A secondary LP safety detector system (valve, exhaust fan, alarm light) will be installed by a certified professional for propane piping installed below grade

When installing new equipment, a shut off valves will be installed by a certified professional at each gas appliance (ANSI Z21.15)

**Objective(s):**

Detect accumulation of dangerous levels of propane in below-grade areas

Isolate appliances from the rest of the system for emergencies, removal, or repairs



Call a certified professional

## 2.0107.2 - Basements and Crawl Spaces—Pre-Work Qualifications

### Desired Outcome:

Site properly prepared for upgrade

### 2.0107.2a - Fuel leaks

### Desired Outcome:

Site properly prepared for upgrade

### Specification(s):

Fuel leaks will be repaired and inspected in accordance with the IRC

### Objective(s):

Ensure site is safe and ready for upgrade



**Unsafe**

Fuel leaks need to be repaired



**Safe**

Repairs need to be tested and verified to no longer leak

### Tools:

1. Combustion gas detector
2. Testing solution

Paraphrased from 2012 IRC G2417: Leakage will be located using an *approved* combustible gas detector, a noncorrosive leak detection fluid or an equivalent nonflammable solution. Matches, candles, open flames or other methods that could provide a source of ignition cannot be used. Where leakage or other defects are located, the affected portion of the *pipng system* will be repaired or replaced and retested.

**Measures**

**Measure 12** Repair - Gas Leak in Crawlspace (flagged)

**Comment**

#	Material / Labor	Description /Comment	Units
1	Unspecified	Misc Material	Each

Fuel leaks discovered during initial audit should be flagged



Use approved combustion gas sniffer to see if repaired line still leaks



Repeatedly test repair site for leakage over a 10min period



Allow testing solution to sit on newly repaired pipe joint for 10min



Confirm repair and remove flag

## 2.0107.2b - Electrical hazards

**Desired Outcome:**

Site properly prepared for upgrade

**Specification(s):**

Electrical hazards will be eliminated and inspected in accordance with NFPA 70 National Electric Code

**Objective(s):**

Ensure site is safe and ready for upgrade

## 2.0107.2c - Mold

**Desired Outcome:**

Site properly prepared for upgrade

**Specification(s):**

Appropriate remediation will be completed before upgrade

**Objective(s):**

Ensure site is safe and ready for upgrade

## 2.0107.2d - Plumbing and water leaks

**Desired Outcome:**

Site properly prepared for upgrade

**Specification(s):**

Plumbing leaks will be repaired before crawl space upgrade in accordance with the IRC

**Objective(s):**

Prepare site for upgrade

## 2.0107.2e - Pest and termite work

**Desired Outcome:**

Site properly prepared for upgrade

**Specification(s):**

Pest and termite treatment will be completed before crawl space upgrade and inspected in accordance with the IRC

**Objective(s):**

Prepare site for upgrade

## 2.0107.2f - Structural repairs, modifications

**Desired Outcome:**

Site properly prepared for upgrade

**Specification(s):**

Structural repairs and modifications will be inspected and completed before crawl space upgrade in accordance with the IRC

**Objective(s):**

Prepare site for upgrade

## **2.0107.2g - Appliance and heating, ventilation, and air conditioning (HVAC) system repairs and change outs**

### **Desired Outcome:**

Site properly prepared for upgrade

### **Specification(s):**

Crawl space upgrades (e.g., sealing and insulation) are to be undertaken after appliance and HVAC system work has been completed and inspected

### **Objective(s):**

Prepare site for upgrade

## **2.0107.2h - Correctable standing water**

### **Desired Outcome:**

Site properly prepared for upgrade

### **Specification(s):**

Passive drains or sump pumps will be used to remove standing water

### **Objective(s):**

Prepare site for upgrade

## **2.0107.2i - Non-correctable standing water**

### **Desired Outcome:**

Site properly prepared for upgrade

### **Specification(s):**

Spaces with non-correctable standing water will not be considered for a closed crawl space

### **Objective(s):**

Prevent possible damage to house

## 2.0107.3 - Basements and Crawl Spaces—Debris Removal

### Desired Outcome:

Clean, safe, and easily accessible crawl space created

### 2.0107.3a - Debris removal

### Desired Outcome:

Clean, safe, and easily accessible crawl space created

### Specification(s):

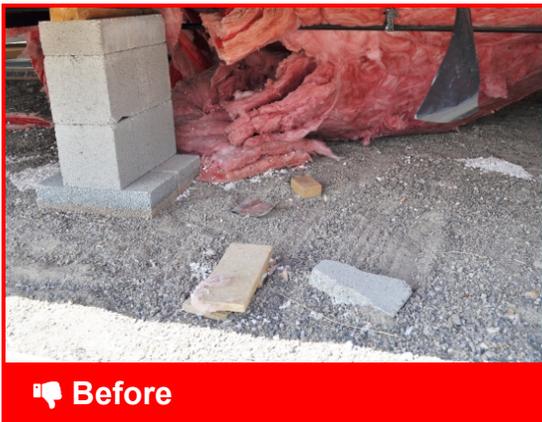
Under-floor grade will be removed of all vegetation and organic material

Debris that can cause injury or puncture ground covers (e.g., nails, glass, sheet metal screws, etc.) will be removed from the crawl space

### Objective(s):

Minimize punctures in ground liner

Minimize habitat for pests (Integrated Pest Management—IPM) and contaminant sources



**Before**

Crawl spaces with trash and overgrowth need to be made clean and safe.



**After**

Rake up and clear away trash and overgrowth.

### Tools:

1. Rake
2. Shop vacuum
3. PPE

## **2.0107.3b - Debris disposal**

**Desired Outcome:**

Clean, safe, and easily accessible crawl space created

**Specification(s):**

Debris will be properly disposed of according to type and jurisdiction

**Objective(s):**

Protect environment from damage

## 2.0201.1 - Combustion Appliance Zone (CAZ) Testing

### Desired Outcome:

Accurate information about appliance safe operation is gathered

## 2.0201.1a - Assessment

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

Emergency problems (e.g., ambient gas levels greater than 10% Lower Explosion Limit (LEL), ambient CO levels that exceed 70 ppm) will be communicated clearly and immediately to the customer, the home shall be evacuated, and appropriate personnel (e.g.: HVAC technician, utility, emergency services) shall be contacted. ;

Significant problems (e.g., gas leak less than 10% LEL, ambient CO levels that exceed 35 ppm but less than 70 ppm) will be communicated clearly and immediately to the customer and appropriate solutions will be suggested

Examine appliance for signs of damage, misuse, improper repairs, and lack of maintenance

### Objective(s):

Ensure system does not have potentially fatal problems



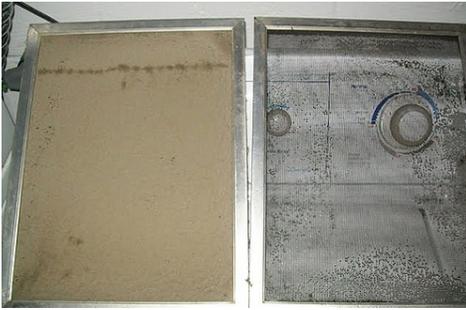
 Before

Unsafe combustion appliances indicate need for repair or replacement



 After

In cases of replacement, ensure new appliance is safe and sized properly



When a simple filter cleaning or replacement will help, make it happen



Ensure there is adequate make-up air -- combustion air inlet in closet



Stop the misuse of combustion appliances -- camp heater in bedroom



Keep occupant apprised of any health or safety concerns

## 2.0201.1b - Fuel leak detection

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

Inspect and test for gas or oil leakage at connections of natural gas, propane piping, or oil systems

If leaks are found, immediate action will be taken to notify occupant to help ensure leaks are repaired

The report will specify repair for leaks and replacement for hazardous or damaged gas or oil connectors and pipes

### Objective(s):

Detect fuel gas leaks

Determine and report need for repair



**Before**

Fuel lines should be inspected for leakage



**After**

If leaks are found, notify occupant immediately to facilitate repair

**Tools:**

1. Gas sniffer
2. Spray bottle

**Materials:**

1. Bubble solution



Inspect exterior gas and oil lines for leaks and damage



Inspect flex lines for damage, and check date on ring for pre-1973 hardware

## 2.0201.1c - Venting

**Desired Outcome:**

Accurate information about appliance safe operation is gathered

**Specification(s):**

For oil systems that require a draft regulator, the presence and operability of it (that draft regulator) will be verified and tested

Combustion venting systems will be inspected for damage, leaks, disconnections, inadequate slope, and other safety hazards

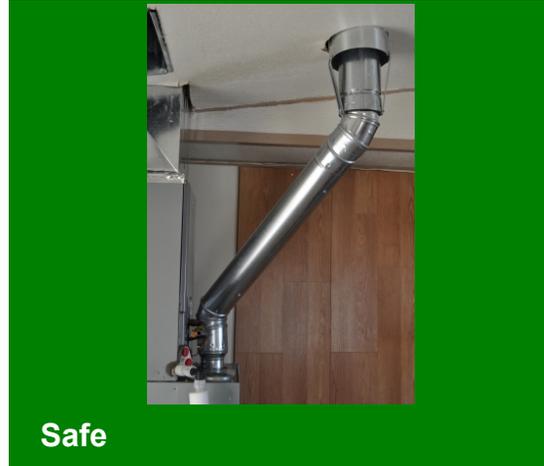
**Objective(s):**

Determine if a regulator is present and working

Determine whether vent system is in good condition and installed properly



If venting system puts occupants at risk, it needs immediate attention



Properly vented appliances make a house healthier and more efficient



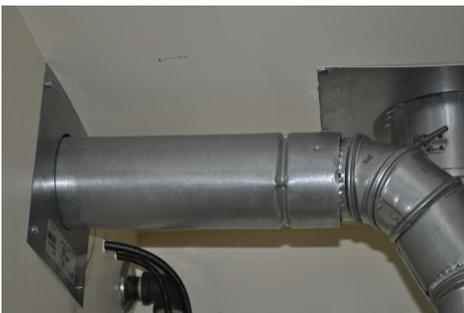
Determine if a draft regulator is installed and working



Inspect venting systems for damage



Inspect venting systems for disconnected pipes



Inspect venting systems for inadequate slope



Inspect for missing draft diverter

## 2.0201.1d - Base pressure test

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

Baseline pressure for naturally drafting vented appliances will be measured in Combustion Appliance Zone with reference to outdoors

### Objective(s):

Measure pressure difference between combustion zone and the outside under natural conditions



Natural conditions--Winter set-up, Exhaust fans off, Interior doors open

### Tools:

1. Manometer

## 2.0201.1e - Depressurization test

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

CAZ depressurization testing will be administered for all atmospherically vented appliances located inside the pressure boundary.

Depressurization test will include exhaust fans, interior door closure, or duct leakage, or a combination thereof; the test will be done to determine the largest negative pressure per BPI Standard 1200.

**Objective(s):**

Determine worst-case depressurization in combustion zone due mechanical system fans



**Best Practice**

Exhaust fans on, Check interior doors, Air handler on?

**Tools:**

1. Manometer



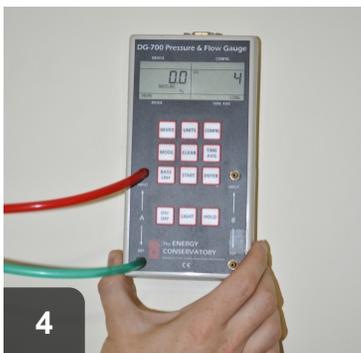
Place manometer reference hose to exterior of house



Attach test hose to be used in the interior of the house



Place test hose by combustion appliance



Take baseline reading



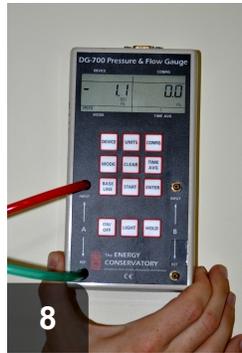
Turn on interior exhaust fans, including any clothes dryers



Is the air handler on?



Check interior doors for pressure differential either using smoke pencil or hand



Check reading against the Depressurization Limits table. If reading is less negative than allowable limit, all is well

## 2.0201.2 - Combustion Safety - Make-up Air

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 2.0201.2a - Outside combustion make-up air

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

Where applicable, combustion air will be provided from the outside and installed in accordance with the IRC for the type of appliance installed

### Objective(s):

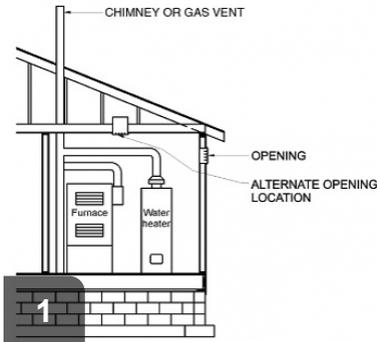
Prevent combustion byproducts from entering the house

Image 1: For homes with one permanent opening, see 2012 IRC: G2407.6.2 (304.6.2): a minimum free area of 1 in<sup>2</sup> per 3,000 Btu/h (734 mm<sup>2</sup>/kW) of total input rating of all appliances

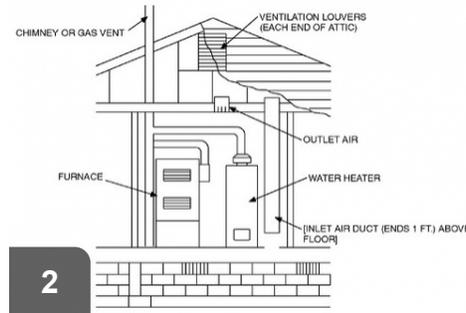
Image 2: For homes with two permanent vertical duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in<sup>2</sup> per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating of all appliances

Image 3: For homes with two permanent horizontal duct openings, see 2012 IRC G2407.6.1 (304.6.1): a minimum free area of 1 in<sup>2</sup> per 2,000 Btu/h (1,100 mm<sup>2</sup>/kW) of total input rating of all appliances

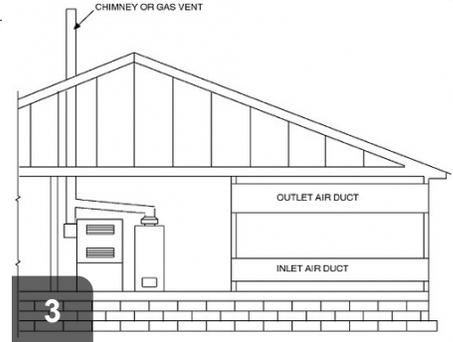
Engineered installations are also acceptable.



min free area of 1 sqin per 3,000 Btu/h (734 mm<sup>2</sup>/kW) of total input rating



min free area of 1 sqin per 4,000 Btu/h (550 mm<sup>2</sup>/kW) of total input rating



min free area of 1 sqin per 2,000 Btu/h (1100 mm<sup>2</sup>/kW) of total input rating

## 2.0201.2b - New appliances

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

If replacing appliances, a sealed-combustion, direct-vent appliance will be installed if possible. New appliances will be installed in accordance with manufacturer specifications, the IRC and additional applicable codes

### Objective(s):

Prevent combustion byproducts from entering the house



Before

Damaged combustion appliances beyond repair should be replaced



After

Sealed-combustion, direct-vent appliances should replace unsafe appliances



Two-pipe 90% efficiency furnaces are viable replacement appliances



Direct vent combustion appliances are also viable replacements

## 2.0201.2c - CO detection and warning equipment

### Desired Outcome:

Buildup of dangerous combustion byproducts in the living space prevented

### Specification(s):

CO detection or warning equipment will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in accordance with ASHRAE 62.2 and authority having local jurisdiction

Installation will be accomplished by a licensed electrician when required by local code

### Objective(s):

Alert occupant to CO exposure



### Best Practice

Carbon Monoxide alarms should be installed according to local codes



### Best Practice

Alarms should be mounted near sleeping areas--such as the one marked in red

**Tools:**

1. Drill

**Materials:**

1. CO alarm
2. Fasteners

## 2.0201.2d - Gas ovens

**Desired Outcome:**

Buildup of dangerous combustion byproducts in the living space prevented

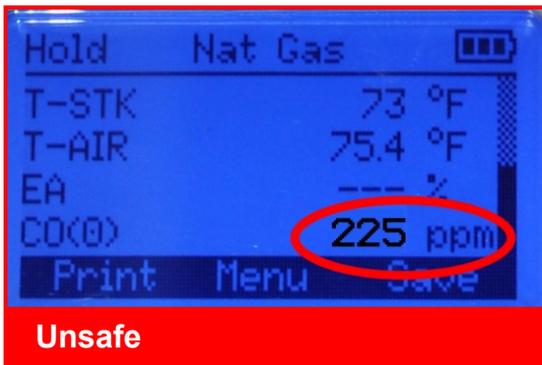
**Specification(s):**

Gas ovens will be tested for CO

A clean and tune will be conducted if measured CO in the undiluted flue gases of the oven vent at steady state exceeds 225 ppm as measured

**Objective(s):**

Ensure clean burn of gas ovens



If air-free CO reading exceeds 225ppm, order a clean and tune



Test gas oven for carbon monoxide using a combustion gas analyzer

**Tools:**

1. Combustion analyzer with probe

## 2.0201.2e - Gas range burners

**Desired Outcome:**

Buildup of dangerous combustion byproducts in the living space prevented

**Specification(s):**

Specify clean and tune if the flame has any discoloration, flame impingement, an irregular pattern, or if burners are visibly dirty, corroded, or bent

**Objective(s):**

Ensure clean burn and operation of gas range burners



👎 Before

Discoloration is a clear sign that a gas range needs a clean and tune



👍 After

A properly operating gas range burner should have an even blue flame



Gas ranges should be cleaned and tuned if improper operation is evident

## 2.0201.2f - Solid fuel burning appliances

**Desired Outcome:**

Buildup of dangerous combustion byproducts in the living space prevented

**Specification(s):**

If the solid fuel burning appliance is the primary heat source and has signs of structural failure replace solid fuel burning appliance with UL-listed and EPA - certified appliances if the existing appliance is not UL-listed

**Objective(s):**

Ensure safe operations of solid fuel burning appliances



Unsafe solid fuel burning appliances should be replaced



New appliances should be UL-listed and EPA-certified

Since 1988, the EPA has regulated particulate emissions from wood heaters. The limit is 7.5 grams per hour for non-catalytic appliances, and 4.1 grams per hour for catalytic appliances.



Locate data plate to find out appliance ratings



Check appliance rating plates for EPA and UL markings (or CSA, ETL, or WH markings)

## 2.0201.3 - Vented Combustion Appliance Safety Testing

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### 2.0201.3a - Spillage Test

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

In conditions with largest negative pressure as determined from Detail 2.0201.1e:

If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate

If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate

### Objective(s):

Detect excessive spillage of combustion gases



Test natural draft furnace or water heater for spillage in excess of 2min

### Tools:

1. Smoke pencil
2. Timer



Test all sides of natural draft flues since draft may not be uniform

## 2.0201.3b - Carbon monoxide (CO) test in appliance vent

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

CO will be tested for in undiluted flue gases of combustion appliances

In conditions with largest negative pressure as determined from Detail 2.0201.1e:

If CO levels exceed 400 ppm air-free measurement in furnaces, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

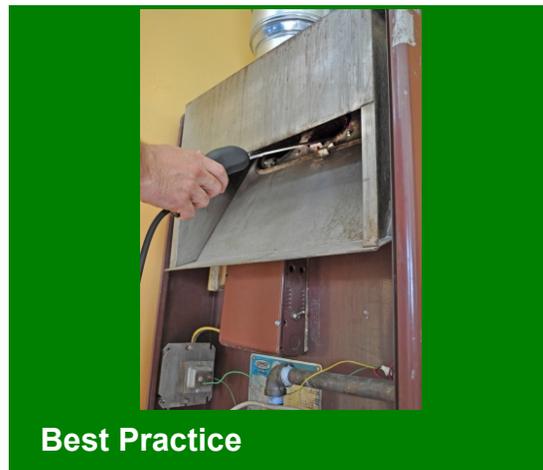
If CO levels exceed 200 ppm air-free measurement in water heaters or room heaters, service will be provided to reduce CO to below these levels (unless CO measurement is within manufacturer specifications)

### Objective(s):

Measure CO and report excessive levels



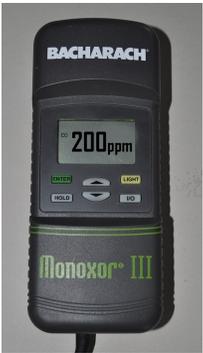
CO levels cannot exceed 200ppm as measured, unless to manufacturer specs



Test CO levels in undiluted flue gases and exhaust outlets, when accessible

### Tools:

1. Combustion analyzer with probe



CO levels cannot exceed 200ppm, or 400ppm air-free CO



Test undiluted flue gases in induced-draft furnaces--check local codes before drilling



Test undiluted flue gases in natural draft water heaters--check local codes before drilling



Test accessible exhaust outlets for direct-vent appliances



Test accessible exhaust outlets for power-vented appliances

## 2.0201.3c - Final test out

### Desired Outcome:

Accurate information about appliance safe operation is gathered

### Specification(s):

Final combustion testing will be conducted at project completion to ensure compliance with the above specifications

### Objective(s):

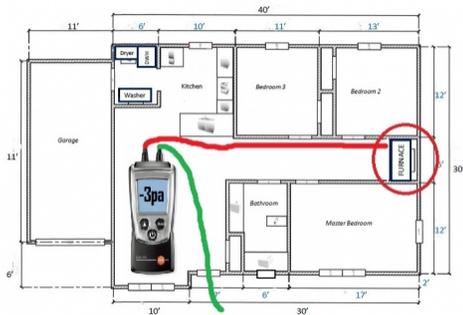
Ensure safe operation of combustion appliance within the whole house system after any repair project



Conduct spillage and depressurization testing at the end of the work day

**Tools:**

1. Manometer
2. Smoke pencil
3. Timer
4. Combustion analyzer with probe



Run depressurization test at the end of the work day



Complete spillage test using chemical smoke pencil



Test for spillage on all sides of draft diverter



Complete spillage testing on all



Complete carbon monoxide testing

combustion appliances

using a CO detector or combustion analyzer

## 2.0203.2 - Combustion Flue Gas—Orphaned Water Heaters

### Desired Outcome:

Flue gasses successfully removed from the house

### 2.0203.2a - Spillage testing

### Desired Outcome:

Flue gasses successfully removed from the house

### Specification(s):

If spillage in a combustion appliance with a warm vent exceeds two minutes during pressure testing, specify measures to mitigate

If spillage in a combustion appliance with a cold vent exceeds five minutes during pressure testing, specify measures to mitigate

### Objective(s):

Detect excessive spillage of combustion gases



Orphaned water heaters have oversized flues after a furnace is removed



### Tools:

1. Smoke pencil
2. Timer

## 2.0203.2b - Flue gas removal (chimney liner or approved

## methods)

### Desired Outcome:

Flue gasses successfully removed from the house

### Specification(s):

A chimney liner will be installed in accordance with the IRC or applicable NFPA standard

### Objective(s):

Allow water heater to vent properly

Prevent damage to the chimney



Unlined masonry chimney



Flue liner with rain cap

### Tools:

1. Hammer drill
2. Disposable brushes
3. Tin snips
4. 5/16" nut driver
5. Pulling cone
6. Rope
7. Caulking gun
8. Tape measure
9. 4 1/2" angle grinder with metal cutoff wheel

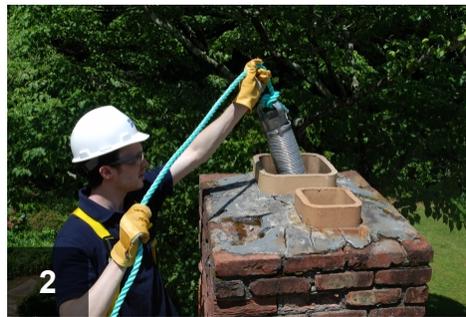
### Materials:

1. Flexible chimney liner
2. Rain cap
3. Top plate
4. B-vent adjustable elbows
5. Tees (if required to connect multiple appliances)
6. Refractory cement
7. Bricks
8. Mortar

Connect chimney liner to appliance in accordance with applicable codes.



1 Measure from the bottom termination to the chimney crown. Add one foot to the measurement and cut the liner to length



2 Pull chimney liner into position (from top or bottom, whichever is easier) with a rope and pulling cone



3 Measure and mark the flexible chimney liner at 4 inches above the chimney



4 Cut the flexible chimney liner to length



5 Install top plate over opening and attach it to the liner



6 Fasten the rain cap to the chimney liner



7 Seal around penetrations in chimney with refractory (furnace) cement



8 Connect appliance vent to the chimney liner



9 Use refractory (furnace) cement to seal metal water heater or furnace vents to the masonry chimney

## 2.0203.2c - Retesting spillage

### Desired Outcome:

Flue gasses successfully removed from the house

**Specification(s):**

If a combustion appliance spillage exceeds two minutes during pressure testing, specify measures to mitigate

**Objective(s):**

Ensure appliance is not spilling longer than two minutes with a warm vent



**Before**

If spillage continues to exceed 2 min, additional repairs are required



**After**

Repipe the flue to eliminate the oversized chimney. After repairs, spillage should no longer occur beyond 2 minutes

**Tools:**

1. Smoke pencil
2. Timer

## 2.0203.2d - Required combustion air

**Desired Outcome:**

Flue gasses successfully removed from the house

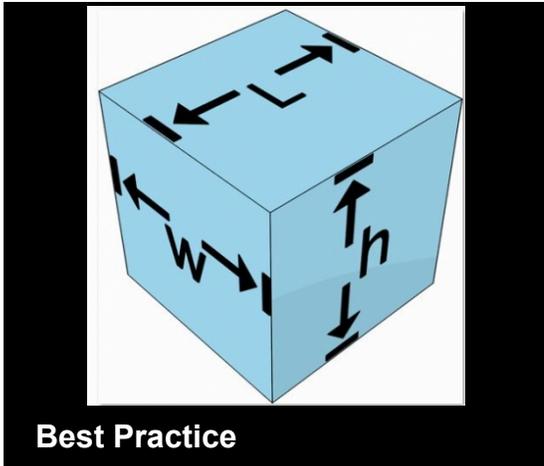
**Specification(s):**

The minimum required volume will be 50 cubic feet per 1,000 Btu /h in accordance with IRC and authority having jurisdiction.

Exception: Existing appliances that have passed combustion safety testing per BPI 1200 are deemed to have sufficient combustion air.

**Objective(s):**

Determine if existing conditions meet the combustion air calculation



**Best Practice**

If measured volume is less than 50cuft per 1000Btuh, additional combustion air is needed.



If appliances have passed combustion safety testing per BPI 1200, no additional combustion air is needed.

**Tools:**

1. Measuring tape
2. Calculator



Measure the CAZ width.



Measure the CAZ length.



Measure the CAZ height.

## 2.0203.2e - Additional combustion air (if action is required)

**Desired Outcome:**

Flue gasses successfully removed from the house

**Specification(s):**

Additional combustion air will be provided in accordance with IRC or other authority having jurisdiction

**Objective(s):**

Ensure adequate combustion air for operation of the appliance



 Before

Combustion appliance in a confined space



 After

Additional combustion air supplied by high and low vents

**Tools:**

1. Drywall saw
2. Drill
3. Tin snips
4. Tape measure

**Materials:**

1. Metal ducts

## 2.0203.4 - Occupant Education

### Desired Outcome:

Ensure persistence of resident safety

## 2.0203.4a - Occupant health and safety

### Desired Outcome:

Ensure persistence of resident safety

### Specification(s):

All homes will have a functioning CO alarm

If CO levels in interior living spaces exceed outdoor levels, potential sources will be investigated and appropriate action taken to reduce them (e.g., have a qualified professional tune, repair, or replace improperly operating combustion appliances; apply weather stripping or conduct air sealing between the garage or crawl space and the home)

### Objective(s):

Ensure occupant health and safety

Ensure indoor CO levels do not exceed outdoor CO levels



**Best Practice**

ALL houses must have carbon monoxide detectors installed near sleeping areas



**Best Practice**

Compare indoor and outdoor CO levels. If case of elevated indoor CO levels, locate the source and fix the problem

### Tools:

1. Combustion analyzer with probe
2. Personal CO monitor



Test all combustion appliances for CO exhaust and check against appropriate action levels for appliance type



Do not forget to test gas ovens as a potential source of CO -- check results against action levels



If combustion appliances are source of elevated CO levels, repair or replace as necessary



Could CO infiltration be coming from outdoor sources? Air seal and weatherstrip to minimize outdoor pollutants

## 2.0203.4b - Occupant education

### Desired Outcome:

Ensure persistence of resident safety

### Specification(s):

Occupants will be educated on the operation and maintenance of the CO alarm

Completed work on combustion appliances and recommended maintenance will be reviewed with occupant

Occupant will be provided information regarding the health effects and risk of high CO concentrations; EPA provides possible expanded actions and offers client education information in an appendix to the protocols

**Objective(s):**

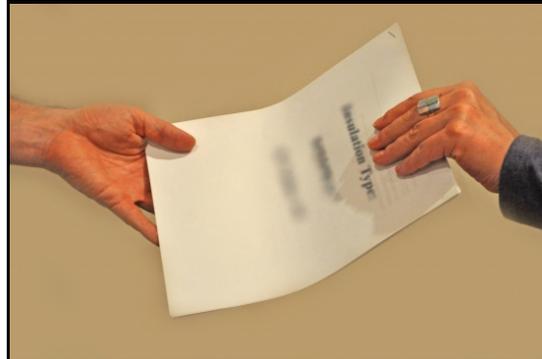
Ensure occupant can operate and maintain installations

Inform occupant regarding possible CO hazards



**Best Practice**

Review CO alarm maintenance with occupant



**Best Practice**

Provide occupant with information about CO sources, risks, and symptoms

## 2.0301.1 - Smoke Alarm

### Desired Outcome:

Properly installed smoke alarms

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

### 2.0301.1a - Smoke alarm (hardwired)

### Desired Outcome:

Properly installed smoke alarms

### Specification(s):

When installing hardwired smoke alarms, it will be listed and labeled in accordance with UL 217 and installed in accordance with the IRC or as required by the authority having jurisdiction

### Objective(s):

Ensure proper installation



Hard-wired smoke alarm mount with alarm missing



Installation of hard-wired smoke alarm

When web-enabled, click link for [IRC R314](#) on Smoke Alarm locations.



All homes should have smoke alarms installed near every sleeping area, as well as on each story of the home.

## **2.0301.1b - Smoke alarm (battery operated)**

### **Desired Outcome:**

Properly installed smoke alarms

### **Specification(s):**

When installing battery operated smoke alarms, it will be installed in accordance with manufacturer specifications

### **Objective(s):**

Ensure proper installation

## 2.0301.2 - Carbon Monoxide Alarm or Monitor

### Desired Outcome:

Properly installed CO alarms or monitors

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 2.0301.2a - CO detection and warning equipment (hardwired)

### Desired Outcome:

Properly installed CO alarms or monitors

### Specification(s):

Hardwired CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 or as required by the authority having jurisdiction

Installation will be accomplished by a licensed electrician when required by the authority having jurisdiction

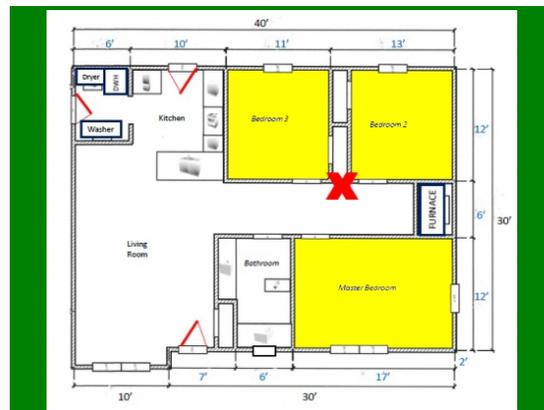
### Objective(s):

Ensure proper installation



**Best Practice**

All homes should have a carbon monoxide detector installed, whether hardwired or battery operated



**Best Practice**

Alarms should be mounted in sleeping areas--such as the one marked in red

### Tools:

1. Screwdriver

### Materials:

1. Screws

Per WPN 17-7, full compliance with ASHRAE 62.2-2016 is required.



1 Mount alarm to wall close to bedrooms



2 Plug alarm into outlet. In addition, cord can be stapled into place.

## 2.0301.2b - CO detection and warning equipment (battery operated)

### Desired Outcome:

Properly installed CO alarms or monitors

### Specification(s):

Battery-operated CO detection or warning equipment will be installed in accordance with the ASHRAE 62.2 and manufacturer specifications as required by the authority having jurisdiction

### Objective(s):

Ensure proper installation



Best Practice

Battery operated CO alarms should be UL-2075 or UL-2034 compliant



Best Practice

Houses should have carbon monoxide monitors installed near sleeping areas

**Tools:**

1. Screwdriver

**Materials:**

1. Screws

Paraphrased from 2012 IRC R315: An approved CO alarm will be installed outside of each separate sleeping area in the immediate vicinity of the bedrooms in all dwelling units. CO detectors will comply with UL 2075. Single-station CO alarms will comply with UL 2034 and will be installed in accordance with this code and the manufacturer's installation instructions. Per WPN 17-7, full compliance with ASHRAE 62.2.2016 and NFPA 720 is required.

## **2.0403.1 - Vented Crawl Spaces—Ground Moisture Barrier**

### **Desired Outcome:**

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

### **2.0403.1a - Material Integrity**

#### **Desired Outcome:**

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

#### **Specification(s):**

Care will be taken to prevent punctures during installation

#### **Objective(s):**

Protect ground moisture barrier from damage during other crawl space work

### **2.0403.1b - Coverage**

#### **Desired Outcome:**

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

#### **Specification(s):**

A ground moisture barrier that covers the exposed crawl space floor will be installed

#### **Objective(s):**

Reduce ground moisture entering the crawl space

**Before**

Uncovered crawl space floors can cause moisture damage

**After**

Ground moisture barrier to cover 100% of floor is installed last

**Materials:**

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

## 2.0403.1c - Material specification

**Desired Outcome:**

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

**Specification(s):**

A ground moisture barrier with a rating of no more than 0.1 perm will be used

A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home (5 years), and it will need replacing to remain effective

**Objective(s):**

Ensure crawl space is accessible for service and maintenance without damaging the integrity of the ground moisture barrier



Barrier must be at least 6 mil and able to withstand puncture

### Materials:

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of  $\leq 0.1$  (which translates to 6 mil or thicker). From 2007 IRC definition of vapor retarders: Class I:  $\leq 0.1$  perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

## 2.0403.1d - Overlap seams

### Desired Outcome:

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

### Specification(s):

When seams exist, they will be overlapped a minimum of 12" using reverse or upslope lapping technique

### Objective(s):

Keep water under the liner

Reduce the likelihood of damage at seams



**Before**

Ground moisture barriers help keep moisture from permeating floor.



**After**

Ground moisture barrier overlaps at least 12 in and is securely fastened

**Tools:**

1. Stapler
2. Utility knife
3. Drill

**Materials:**

1. Ballast
2. Plastic sheeting (at least 6 mil)
3. Furring strips
4. Seam tape - moisture resistant



Securely fasten moisture barrier to wall at least 6 inches from ground



Overlap seams at least 12 inches, using a shingle method to keep water out

## 2.0403.1e - Fastening

**Desired Outcome:**

Durable, effective ground moisture barrier provides long-lasting access and minimizes ground vapor

**Specification(s):**

When ground moisture barrier is installed on sloping ground, may be exposed to wind, or accessed for routine maintenance or storage it will be fastened to ground with durable fasteners or ballast(s)

**Objective(s):**

Prevent movement of the ground moisture barrier



Fastening of moisture barrier is required



Ground moisture barrier should extend up the wall and be held in place

**Tools:**

1. Stapler
2. Drill

**Materials:**

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners



Seams can be taped to prevent water leakage



Ballast or fasteners can hold barrier in place securely

## 2.0403.2 - Closed Crawl Spaces—Ground Moisture Barriers

### Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

### 2.0403.2a - Material Integrity

#### Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

#### Specification(s):

Care will be taken to prevent punctures during installation

#### Objective(s):

Protect ground moisture barrier from damage during other crawl space work

### 2.0403.2b - Coverage

#### Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

#### Specification(s):

An air barrier and ground moisture barrier, covering the exposed crawl space floor, will be installed and sealed to the wall's air and moisture barrier in accordance with ASTM E1643 and manufacturer's recommendations

Ground moisture barrier will be fastened to ground in accordance with manufacturer's recommendations and extend a minimum of 6 inches up the foundation wall

#### Objective(s):

Reduce ground moisture entering the crawl space

Create a continuous and durable connection between the wall and ground air and moisture barriers

**Before**

Uncovered crawl space floors can lead to moisture issues

**After**

Ground moisture barrier should cover 100% of floor and at least 6" of walls

**Materials:**

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

**2.0403.2c - Material specification****Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

**Specification(s):**

A ground moisture barrier with a rating of no more than 0.1 perm will be used

A ground moisture barrier will be used that meets tear and puncture resistance standard ASTM E1745

Homeowner will be advised that all plastic is biodegradable and will have a life span much shorter than the home, and it will need replacing to remain effective

**Objective(s):**

Reduce ground vapor entering the crawl space

Ensure crawl space is accessible for service and maintenance without destroying the integrity of the moisture barrier



### Best Practice

Barrier must be at least 6 mil and able to withstand puncture

#### Materials:

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

The higher a material's perm rating, the more vapor can pass through said material. Drywall typically has a perm rating of approximately 50. For vapor retarders in basements and crawl spaces, SWS calls for materials with a perm rating of  $\leq 0.1$  (which translates to 6 mil or thicker). From 2007 IRC definition of vapor retarders: Class I:  $\leq 0.1$  perm (called impermeable), Class II: 0.1 to 1.0 perm (called semi-impermeable), Class III: 1.0 perm to 10 perms (called semi-permeable).

## 2.0403.2d - Overlap seams

#### Desired Outcome:

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

#### Specification(s):

When seams exist, they will be overlapped a minimum of 12" with reverse or upslope lapping technique

For wall to floor connection, the wall moisture barrier will be installed under the ground moisture barrier

#### Objective(s):

Keep water under the liner



**Before**  
Ground moisture barriers help keep moisture from permeating floor



**After**  
Ground moisture barrier overlaps at least 12 in and is securely fastened

**Tools:**

1. Stapler
2. Utility knife
3. Drill

**Materials:**

1. Ballast
2. Plastic sheeting (at least 6 mil)
3. Furring strips
4. Moisture-resistant adhesive tape



1  
Securely fasten moisture barrier to wall at least 6 inches from ground



2  
Overlap seams at least 12 inches, using a shingle method to keep water out

## 2.0403.2e - Fastening

**Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

**Specification(s):**

When ground moisture barrier is installed on sloping ground, or accessed for routine maintenance or storage it will be fastened to ground with durable fasteners or ballast(s)

**Objective(s):**

Prevent movement and uplift of the air barrier and ground moisture barrier



Moisture barrier needs to be held in place with more permanent fasteners



Ballast or fasteners should be used to hold barrier in place securely

**Tools:**

1. Drill
2. Stapler

**Materials:**

1. Plastic sheeting (at least 6 mil)
2. Furring strips
3. Fasteners

## 2.0403.2f - Sealing seams

**Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

**Specification(s):**

A durable sealant compatible with the air barrier and ground moisture barrier will be used

**Objective(s):**

Maintain continuous air barrier and ground moisture barrier



👎 Before

Crawl spaces lacking moisture barrier risk moisture penetration of floor



👍 After

Ground moisture barriers in unvented spaces should be sealed

**Tools:**

1. Utility knife



Tape wall seams and press to ensure airtight bonding of adhesive

**Materials:**

1. Moisture-resistant adhesive tape



Tape (overlapped) floor seams to prevent movement and water leakage

## 2.0403.2g - Air barrier, ground moisture barrier penetrations, including fastener penetrations

**Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

**Specification(s):**

A durable sealant, compatible with the air barrier and ground moisture barrier, will be used

Physical attachments will be provided where practical (e.g., masonry columns, footings)

**Objective(s):**

Maintain continuous air barrier and ground moisture barrier

## 2.0403.2h - Drainage

### **Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

### **Specification(s):**

The air barrier and ground moisture barrier will not interfere with the established drainage pattern

### **Objective(s):**

Ensure proper drainage

## 2.0403.2i - Drainage points

### **Desired Outcome:**

Durable, effective air barrier and ground moisture barrier provide ongoing access and minimize ground vapor

### **Specification(s):**

Interior drainage collection points will be accessible from above and below the air barrier and ground moisture barrier

### **Objective(s):**

Remove water above and below the air barrier and ground moisture barrier

## 2.0601.1 - Knob and Tube Wiring

### Desired Outcome:

Live unsafe wiring identified and brought to local codes

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 2.0601.1a - Knob and tube identification

### Desired Outcome:

Live unsafe wiring identified and brought to local codes

### Specification(s):

Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

### Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house



Knob and tube wiring should be identified before work begins



Distinctive "knobs" are highlighted. This wiring can be a safety hazard

## 2.0601.1b - Live wire testing

### Desired Outcome:

Live unsafe wiring identified and brought to local codes

**Specification(s):**

Non-contact testing method will be used to determine if wiring is live

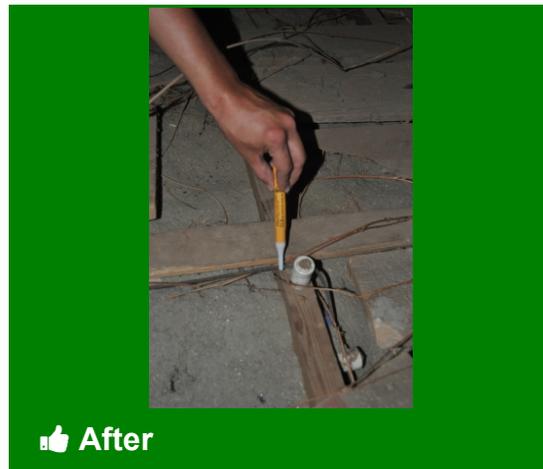
**Objective(s):**

Protect occupant safety

Preserve the integrity and safety of the house



Knob & tube wiring needs to be tested to determine if still live. Red=live



Live wiring should be dammed or professionally disabled before insulating

**Tools:**

1. Non-contact wire tester

## 2.0601.1c - Isolation and protection

**Desired Outcome:**

Live unsafe wiring identified and brought to local codes

**Specification(s):**

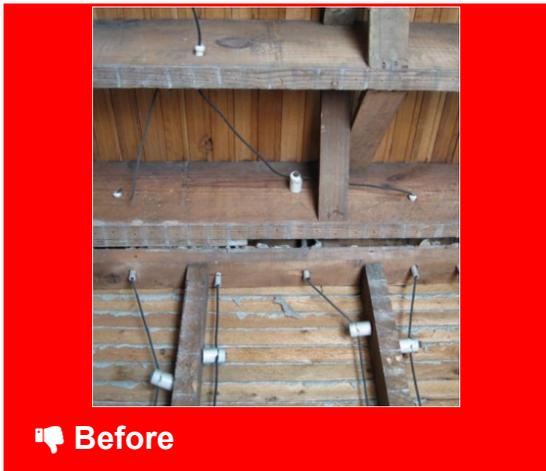
Proper clearance will be maintained around live knob and tube as required by the National Electrical Code ( NEC ) or authority having jurisdiction

When required, a dam that does not cover the top will be created to separate insulation from the wire path

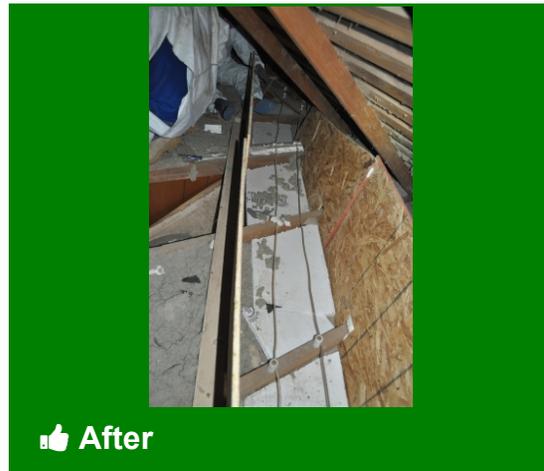
**Objective(s):**

Ensure occupant safety

Preserve the integrity and safety of the house



Live knob & tube wiring may get hot and should not be insulated over



Dams should be installed to hold back loose fill insulation

**Tools:**

1. Drill
2. Tape measure
3. Non-contact wire tester

**Materials:**

1. Plywood
2. Drywall
3. Fasteners

NEC guidelines and local jurisdictions are very particular on the treatment of knob & tube wiring. Check your local codes.



Have a certified electrician verify that wiring is safe to work around



A sign should be posted at all entrances to warn of knob & tube wiring



Warning sign should remind to contact certified electrician for repairs

**CUIDADO!**  
**Cableado eléctrico con aisladores ceramicos vivo!**  
En Inglés: knob & tube wiring  
Si es necesario realizar alguna reparación, ponerse en electricista certificado.

4

Many jurisdictions require a sign in Spanish as well



5  
Damping should extend above installed height of insulation



6  
With dams in place, insulation can begin

## 2.0601.1d - Replacement

### Desired Outcome:

Live unsafe wiring identified and brought to local codes

### Specification(s):

Wiring will be replaced with new appropriate wiring in accordance with the NEC National Electrical Code and local codes

Old wiring will be rendered inoperable by licensed electrician in accordance with the NEC National Electrical Code and local codes

### Objective(s):

Ensure occupant safety

Preserve the integrity and safety of the house



🗨️ Before

Knob and tube wiring may get hot and cannot be insulated over



👍 After

If possible, k&t wiring should be disabled and replaced with modern wiring

**Tools:**

1. Non-contact wire tester

**Materials:**

1. Romex as needed

NEC guidelines and local jurisdictions have many codes dealing with the treatment of knob & tube wiring. Check your local codes.



The entire knob and tube system should be disabled



Many electricians will remove old exposed wiring to prevent reactivation



Exposed knob and tube should be replaced with modern wiring



With modern wiring in place and old k&t disabled, insulation can begin

## 2.0701.2 - Crawl Space Information Sign

### Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

### Note:

## 2.0701.2a - Sign specifications

### Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

### Specification(s):

A durable, easily seen sign will be installed at all accesses inside of the crawl space (minimum 8 ½" x 11")

A minimum expected service life of 10 years will be ensured

### Objective(s):

Prevent damage to the crawl space after upgrade



Crawl space access points should have signage to alert occupant and workers



### Best Practice

Sign should be highly-visible, securely-fastened, and durable

## 2.0701.2b - Sign content

### Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to

occupant and users of the crawl space

**Specification(s):**

Those entering the crawl space will be cautioned not to damage the air barrier, ground moisture barrier, insulation, and mechanical components specific to the crawl space type

Anyone entering the crawl space will be alerted that immediate repairs are needed in case of damage

Installer contact information will be included on the sign in case there are questions or needs for repairs

**Objective(s):**

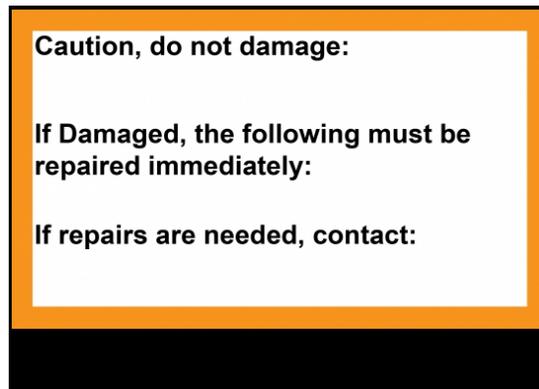
Prevent damage to the crawl space after upgrade

Educate anyone entering the crawl space

Provide occupants with a way to contact the installer

**Best Practice**

Mount sign where clearly visible to anyone entering crawl space



Be sure sign includes relevant information to aid occupant in repairs

**Tools:**

1. Printer
2. Staple gun

**Materials:**

1. Paper
2. Laminant
3. Staples

**Cuidado, no dañar:**

**Si está dañado, estos deben ser reparados inmediatamente:**

**Si es necesario realizar alguna reparación, ponerse en contacto con:**

Hacer la señal en español también

## 2.0701.2c - Hazard warning

### Desired Outcome:

Posted signs inside of the crawl space provide essential safety and maintenance information to occupant and users of the crawl space

### Specification(s):

Language prohibiting storage of hazardous and flammable materials will be provided on site

### Objective(s):

Prevent storage of hazardous or flammable materials in the crawl space

Maintain indoor air quality

Prevent a fire hazard



**Best Practice**

Mount sign where anyone entering the crawl space can see it

**PROHIBITED: DO NOT store  
Hazardous or Flammable  
Materials in this space**

Alert those entering the crawl space never to store hazardous materials

**Tools:**

1. Staple gun
2. Printer

**Materials:**

1. Paper
2. Laminant
3. Staples

**PROHIBIDO: NO almacenar  
Materiales Inflamables o  
Peligrosos en este espacio**

Hacer la señal en español también

## 3.1001.1 - Penetrations and Chases

### Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

### 3.1001.1a - Pre-inspection

#### Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work

#### Objective(s):

Repair moisture-related issues

### 3.1001.1b - Backing and infill

#### Desired Outcome:

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the hole

The infill or backing will not bend, sag, or move once installed

#### Objective(s):

Minimize hole size to ensure successful use of sealant

Ensure closure is permanent and supports any load (e.g., wind, insulation)

Ensure sealant does not fall out

## 3.1001.1c - Sealant selection

### **Desired Outcome:**

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

### **Specification(s):**

Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction

### **Objective(s):**

Select permanent sealant

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials

## 3.1001.1d - High temperature application

### **Desired Outcome:**

Penetrations and chases sealed to prevent air leakage and moisture movement between the attic and conditioned space

### **Specification(s):**

Only non-combustible sealant will be used in contact with chimneys, vents, and flues

Local codes will be referenced

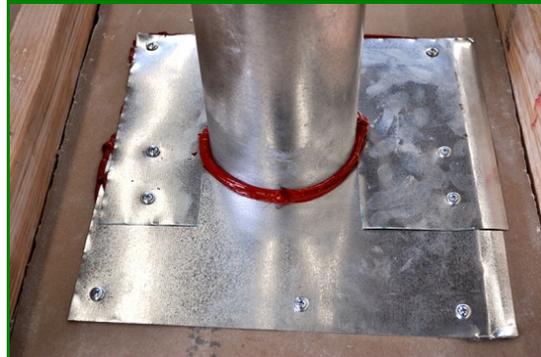
### **Objective(s):**

Prevent a fire hazard



**Before**

Gaps around combustion exhaust flues need to be sealed



**After**

Sealed penetrations and chases should utilize high-temperature materials

**Tools:**

1. Drill/screwdriver
2. Caulk gun
3. Metal snips

**Materials:**

1. High-temperature caulking
2. 26-gauge steel sheeting

See 3.1402.1c for Clearance Requirements



1

Prepare work area by removing any insulation and debris



2

Use high-temperature caulking (600F min)



3

Apply first ring of caulking to match shape of opening



4



5



6

Apply second ring of caulking to size and shape of rigid material

Fasten rigid material (26-gauge steel) and apply additional caulking

Fasten rigid material to cover penetration and seal against flue with caulk

## 3.1001.2 - Chase Capping

### Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

## 3.1001.2a - Pre-inspection

### Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

### Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a chase

Repairs will be completed before work begins

### Objective(s):

Repair moisture-related issues



Investigate under insulation in chases to verify they are undamaged



Water damage in chase due to hole to the outside

**Tools:**

1. flashlight
2. headlamp
3. hammer
4. prybar
5. circular saw
6. reciprocating saw
7. borescope
8. mirror

Removing the batt over this chimney chase provided access to see a large hole and water damage in the chimney wall.



1 Locate and expose chases to prepare for inspection and capping/sealing



2 Clear away insulation and debris to allow inspection



3 Carefully investigate areas with high potential for water leaks

## 3.1001.2b - Standard chase (interior walls covered with drywall or plaster)

**Desired Outcome:**

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Entire opening will be spanned with rigid material

Material will be cut to fit and fastened as required

**Objective(s):**

Reduce opening to what can be sealed with sealant



Unsealed standard chases covered with drywall can be leakage points



The air barrier is maintained by capping chases with rigid material

**Tools:**

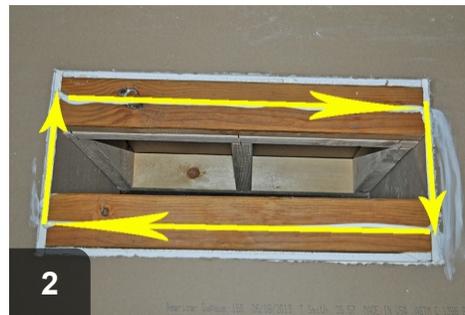
1. Drill/screwdriver
2. Caulk gun

**Materials:**

1. XPS
2. Drywall
3. Caulk
4. Sheet metal
5. OSB or plywood



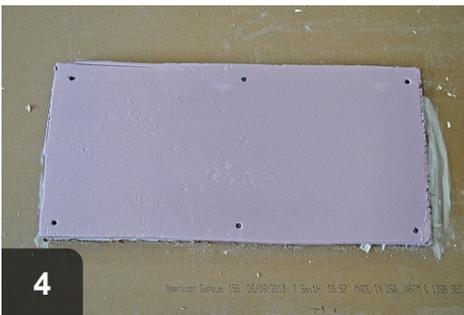
1 Clear area of debris and insulation in preparation for work



2 Apply sealant all the way around opening



3 Trim rigid material, such as drywall or XPS, to size and place over sealant



4 Fasten rigid material appropriately,

such as with screws

## 3.1001.2c - Non-standard chase (interior walls covered with wood or paneling)

### Desired Outcome:

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Material will be used that can be exposed to the interior of the house and meet the flame and smoke spread indexes as required in IRC

### Objective(s):

Prevent a fire hazard



**Before**

Paneled drop soffits typically are more combustible than plain drywall



**After**

When sealing on attic side, drywall and XPS are viable materials

### Tools:

1. Drywall saw
2. Tape measure
3. Caulk gun
4. Drill

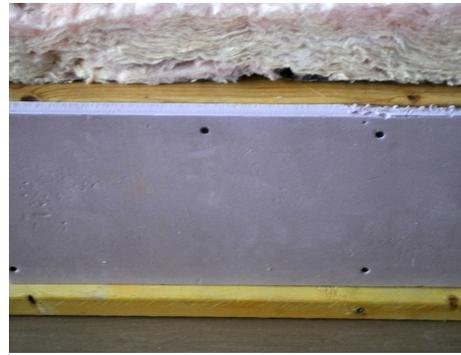
### Materials:

1. Drywall
2. XPS
3. Fire-block sealant
4. Fasteners

EPS or bead-board are not acceptable materials.



Sealing with drywall reduces overall combustibility of paneled chases



Sealing with XPS also reduces overall combustibility of paneled chases

### 3.1001.2d - Support

**Desired Outcome:**

Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

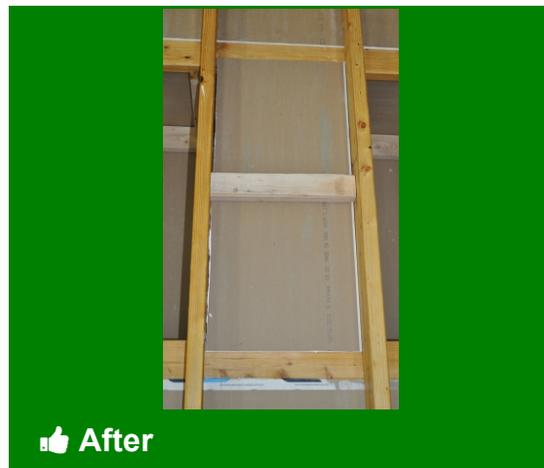
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



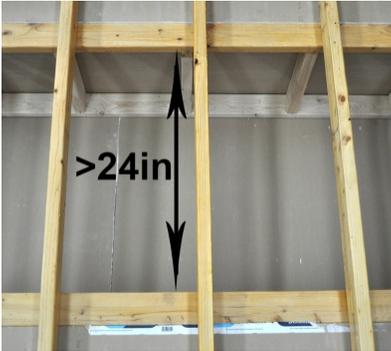
Support should prevent cap from sagging or moving

**Tools:**

1. Drill
2. Saw
3. Tape measure

**Materials:**

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

**3.1001.2e - Joint seal****Desired Outcome:**

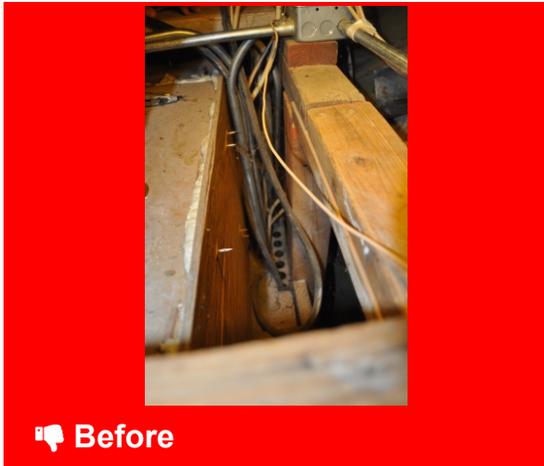
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

**Objective(s):**

Provide airtight, durable seal that does not move, bend, or sag



👎 Before

Chases need to be capped and sealed to prevent leakage



👍 After

Chase is sealed along all cracks, gaps, and penetrations

#### Tools:

1. Spray foam gun
2. Caulk gun

#### Materials:

1. Spray foam
2. Caulk

Always wear protective gloves when working with sealants.



Chase has been capped but needs to be sealed



Sealant is used to fill in all cracks and gaps along edges of chase cap



Cap is sealed

## 3.1001.2f - Adjacent framing

#### Desired Outcome:

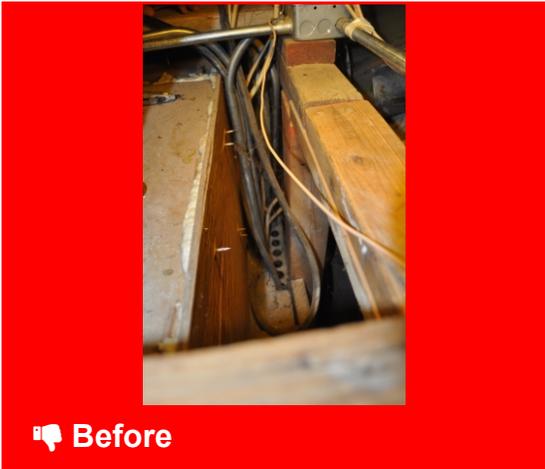
Chase capped to prevent air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

All remaining gaps at the top of the chase will be sealed

#### Objective(s):

Ensure airtight seal from one finished side of the chase to the other



Chases need to be capped and sealed to prevent leakage



Chase is sealed along all cracks, gaps, and penetrations

**Tools:**

- 1. Spray foam gun
- 2. Caulk gun

**Materials:**

- 1. Spray foam
- 2. Caulk

Always wear gloves when working with sealant.



Sealant is used to fill in all cracks and gaps along edges of chase cap



Extend seal along adjacent framing

## **3.1001.3 - Walls Open to Attic—Balloon Framing and Double Walls**

### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### **3.1001.3a - Pre-inspection**

#### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### **Specification(s):**

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

#### **Objective(s):**

Repair moisture-related issues

### **3.1001.3b - Sealing methods**

#### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### **Specification(s):**

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with spray polyurethane foam (SPF)

Sealants will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

### Objective(s):

Prevent air leakage from wall cavity to attic



**Before**

Wall cavities are open to attic



**After**

Whatever option chosen, test for visible air movement with smoke pencil

### Tools:

1. Utility knife
2. Saw
3. Insulation machine
4. Caulk gun
5. Spray foam gun

### Materials:

1. Drywall
2. XPS
3. Spray foam
4. Caulk
5. Fasteners
6. Dense packable insulation
7. Lumber



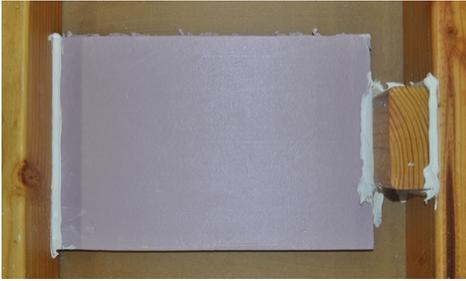
Option 1: Dense pack cavities through wood cap fastened in place



Option 2: Bridge cavities with spray foam



Option 3, Step 1: Apply sealant around opening and on surrounding framing



Option 3, Step 2, Option A: Cap with XPS and seal exposed joints



Option 3, Step 2, Option B: Cap with drywall and seal exposed joints

### 3.1001.3c - Support

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

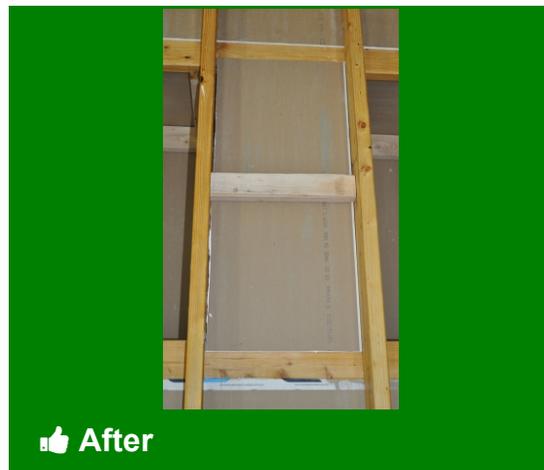
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



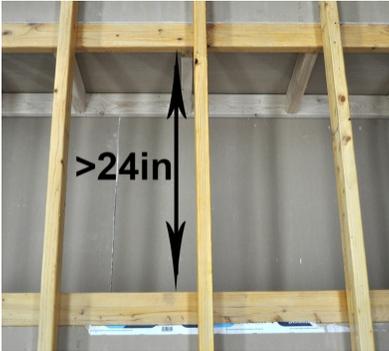
Support should prevent cap from sagging or moving

**Tools:**

1. Saw
2. Drill
3. Tape measure

**Materials:**

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

**3.1001.3d - Joint seal****Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

**Objective(s):**

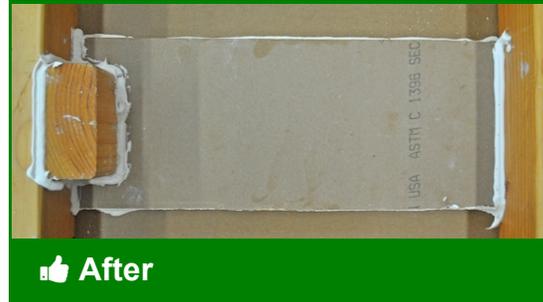
Provide airtight, durable seal that does not move, bend, or sag



Balloon framing needs to be capped and sealed to prevent leakage

**Tools:**

1. Spray foam gun
2. Caulk gun



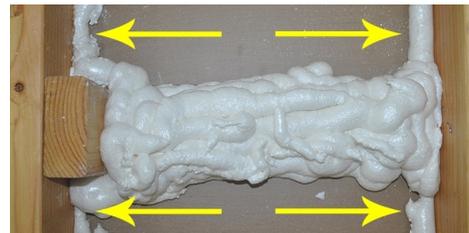
All edges of the cap should be sealed to surrounding surfaces

**Materials:**

1. Spray foam
2. Caulk



For rigid material applications, extend sealant along all seams



Extend sealant or SPF along joist to seal all gaps

## 3.1001.3e - Adjacent framing

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

All remaining gaps at the top of the opening will be sealed

OR

All remaining gaps at the top of the chase will be sealed

**Objective(s):**

Ensure airtight seal from one finished side of the wall assembly to the other



Balloon framing needs to be capped and sealed to prevent leakage



All edges of the cap should be sealed to surrounding surfaces, including adjacent framing

**Tools:**

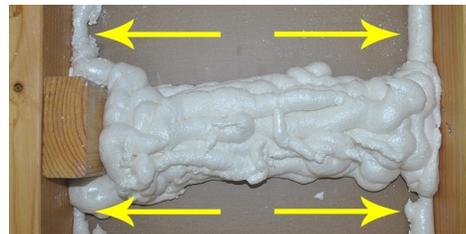
- 1. Spray foam gun
- 2. Caulk gun

**Materials:**

- 1. Spray foam (SPF)
- 2. Caulk



For rigid material applications, sealant should be applied to framing



When using SPF to bridge cavity, extend SPF along joist and adjacent framing

## **3.1003.1 - New Ceiling Below Original—Old Ceiling Intact or Repairable**

### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### **Note:**

### **3.1003.1a - Pre-inspection**

### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### **Specification(s):**

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

### **Objective(s):**

Repair moisture-related issues

### **3.1003.1b - Sealing methods**

### **Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### **Specification(s):**

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

### Objective(s):

Prevent air leakage from dropped ceiling to attic



Damage to an older ceiling reveals the new ceiling below



Rigid material sealed in place creates an air barrier

### Tools:

1. Utility knife
2. Saw
3. Drill
4. Insulation machine
5. Caulk gun
6. Spray foam gun
7. Tape measure

### Materials:

1. Caulk sealant
2. Rigid material -- XPS or Drywall
3. Spray foam
4. Fasteners
5. Dense packable insulation
6. Wrapped fiberglass batts



Prepare work area by removing existing insulation and debris



Option 1, Step 1: Run a bead of sealant around damage in old ceiling



Option 1, Step 2: Cover openings with rigid material, either XPS or drywall



Option 2: Seal with rigid material along face of stud cavities



Option 3: Dense pack cavities through fastened wood plate



Option 4: Bridge cavities at new ceiling level with wrapped batts and SPF



Whatever option chosen, test with chemical smoke to verify no leakage

### 3.1003.1c - Support

#### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

**Tools:**

1. Saw
2. Drill
3. Tape measure

**Materials:**

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

## 3.1003.1d - Joint seal

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

### Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



**Before**

Damage to an old ceiling reveals a newer ceiling below



**After**

No gaps should remain after sealant is applied

### Tools:

1. Spray foam gun
2. Caulk gun

### Materials:

1. Caulk
2. Spray foam



Apply sealant to surrounding surfaces before setting cap in place



Sealant should extend along joists and into seams at top plates



Once cap is set, apply sealant to remaining gaps and along all seams

### 3.1003.1e - Adjacent framing

#### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

#### Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Damage to an older ceiling reveals the new ceiling below



No gaps should remain after spray foam is applied

**Tools:**

1. Caulk gun
2. Spray foam gun



Caulk along all joists before setting cap

**Materials:**

1. Spray foam
2. Caulk sealant



Use sealant to fill all remaining gaps

## 3.1003.2 - Ceiling Leaks Not Repairable—No Air Barrier Above

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Note:

## 3.1003.2a - Pre-inspection

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

### Objective(s):

Repair moisture-related issues

## 3.1003.2b - Sealing methods

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Ceiling or roof and wall air and thermal barriers will be connected with a rigid airtight connection around the perimeter

OR

If ceiling will support an air barrier and insulation, a rigid airtight barrier (e.g., gypsum) will be attached to current ceiling either above or below

OR

Intermediate framing will be used to support air and thermal barrier

OR

Rigid airtight thermal barrier will be installed at the roof sheathing

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

**Objective(s):**

Prevent air leakage from dropped ceiling to attic

### 3.1003.2c - Support

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

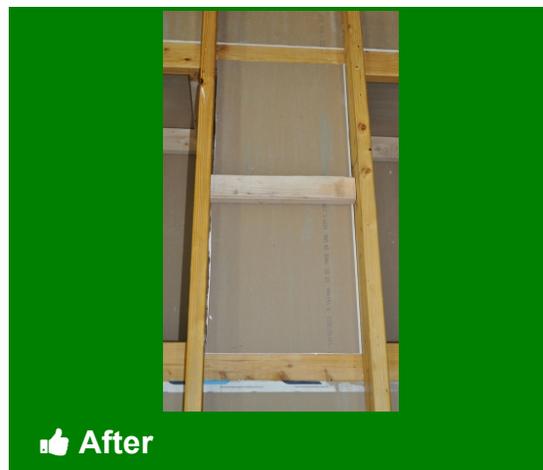
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



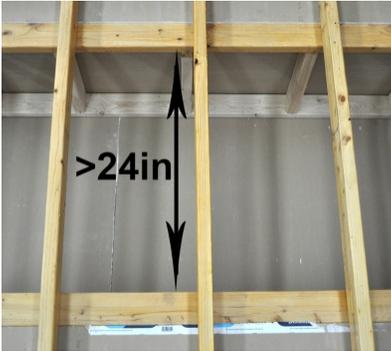
Support should prevent cap from sagging or moving

**Tools:**

1. Drill
2. Saw
3. Tape measure

**Materials:**

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

## 3.1003.2d - Joint seal

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

**Objective(s):**

Provide airtight, durable seal that does not move, bend, or sag



**Before**

Dropped soffits need to be capped and sealed to prevent leakage



**After**

No gaps should remain after sealant is applied

#### Tools:

1. Caulk gun
2. Spray foam gun

#### Materials:

1. Spray foam
2. Caulk



1

Apply sealant to surrounding surfaces before setting cap in place



2

Sealant should extend along surround joist and into seams at top plates



3

Once cap is set, apply sealant to remaining gaps and along all seams

## 3.1003.2e - Adjacent framing

#### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

**Objective(s):**

Provide airtight framing from one finished side of the dropped ceiling to the other



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

**Tools:**

1. Caulk gun
2. Spray foam gun

**Materials:**

1. Spray foam
2. Caulk sealant



Sealant should have been along all joists and adjacent framing before cap was set



Additional sealant should fill in all remaining gaps after cap has been set

### **3.1003.3 - Above Closets and Tubs**

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Note:**

#### **3.1003.3a - Pre-inspection**

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

**Objective(s):**

Repair moisture-related issues

#### **3.1003.3b - Above closets and tubs**

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

**Objective(s):**

Prevent air leakage from dropped ceiling to attic



Unsealed drop soffits over tubs and closets can be a point of leakage



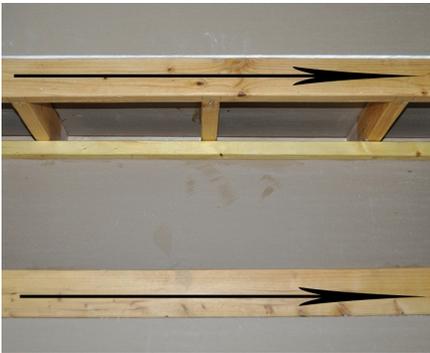
Capped soffits minimize leakage to and from unconditioned spaces

**Tools:**

1. Utility knife
2. Saw
3. Tape measure
4. Insulation machine
5. Drill
6. Caulk gun
7. Spray foam gun
8. Smoke pencil

**Materials:**

1. XPS
2. Drywall
3. Plywood
4. Caulk
5. Spray foam
6. Dense packable insulation
7. Fasteners
8. Wrapped fiberglass batts



Option 1, Step 1: Apply sealant to top-plates or other relevant surfaces



Option 1, Step 2: Cover soffit with rigid material, such as drywall



Option 1, Step 3: Secure the rigid material with screws



Option 2: Cover face of stud bay with rigid material, like XPS or plywood



Option 3: Dense pack cavity through fastened wood cap



Option 4: Bridge stud bay with wrapped fiberglass and spray foam



All Options: Test with smoke pencil to verify no air movement

## 3.1003.3c - Support

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



Support should prevent cap from sagging or moving

**Tools:**

- 1. Drill
- 2. Saw
- 3. Tape measure

**Materials:**

- 1. Lumber
- 2. Drywall
- 3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

## 3.1003.3d - Joint seal

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

### Objective(s):

Provide airtight, durable seal that does not move, bend, or sag



Uninsulated soffits can cause leakage to and from unconditioned spaces



No gaps should remain after spray foam is applied

### Tools:

1. Caulk gun
2. Spray foam gun

### Materials:

1. Caulk
2. Spray foam



Caulk surrounding surfaces before setting cap in place



Sealant should extend along surround joist and into seams at top plates



Once cap is set, apply sealant to remaining gaps and along all seams

## 3.1003.3e - Adjacent framing

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

All remaining gaps at the top of the dropped ceiling will be sealed

### Objective(s):

Provide airtight framing from one finished side of the dropped ceiling to the other



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

### Tools:

1. Caulk gun
2. Spray foam gun

### Materials:

1. Caulk sealant
2. Spray foam



1  
Apply sealant to surrounding surfaces before setting cap in place



2  
Sealant should extend along adjacent framing and into seams at top plates



3  
Additional sealant should fill in all remaining gaps after cap has been set

## 3.1003.4 - Dropped Ceilings

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### 3.1003.4a - Pre-inspection

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

**Objective(s):**

Repair moisture-related issues

### 3.1003.4b - Sealing methods

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

Entire opening will be spanned with rigid material installed in line with the ceiling level

Material will be cut to fit and fastened as required

OR

Side of stud bays will be sealed with rigid material from bottom of dropped ceiling to top-plate

OR

Wall below openings will be dense packed

OR

Wall below openings will be bridged and sealed with SPF

Seals will be used that prevent visible air movement using chemical smoke at 50 pascals of pressure difference

**Objective(s):**

Prevent air leakage from dropped ceiling to attic

## 3.1003.4c - Support

**Desired Outcome:**

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

**Specification(s):**

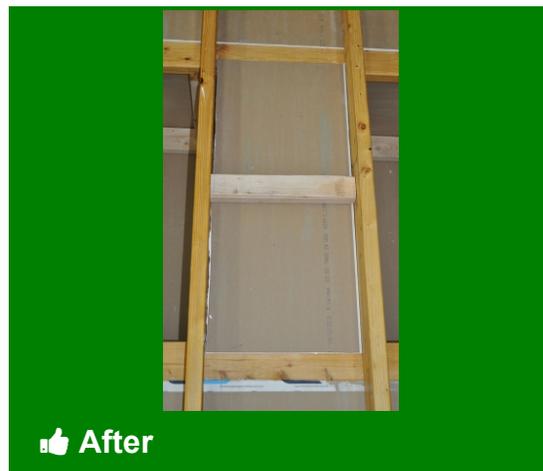
Support material will be installed for spans wider than 24", except when air barrier material is rated to span greater distance under load (e.g., wind, insulation)

**Objective(s):**

Ensure seal stays in place and does not sag



Spans greater than 24 inches require additional bracing before capping



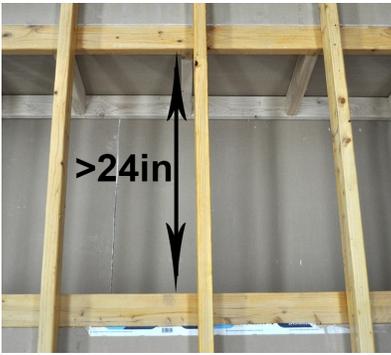
Support should prevent cap from sagging or moving

**Tools:**

1. Saw
2. Drill
3. Tape measure

**Materials:**

1. Lumber
2. Drywall
3. Fasteners



Create bracing to support spans larger than 24", either from above or below



When supporting from above, apply adhesive between drywall and bracing



Bracing can be screwed to drywall before capping chase



Ensure new bracing is secure by using screws to fasten to joist



Once chase is capped, it is now ready to be sealed along framing

## 3.1003.4d - Joint seal

### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Continuous seal will be installed around seams, cracks, joints, edges, penetrations, and connections

Pre-fabricated units may be used when meeting the desired outcome

### Objective(s):

Provide airtight, durable seal that does not move, bend or sag



👎 Before

Dropped soffits need to be capped and sealed to prevent leakage



👍 After

No gaps should remain after spray foam is applied

#### Tools:

1. Spray foam gun
2. Caulk gun

#### Materials:

1. Spray foam
2. Caulk sealant



1

Caulk surrounding surfaces before setting cap in place



2

Sealant should extend along surround joist and into seams at top plates



3

Once cap is set, apply sealant to remaining gaps and along all seams

## 3.1003.4e - Adjacent framing

#### Desired Outcome:

Continuous air barrier prevents air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

All remaining gaps will be sealed at the top of the dropped ceiling

OR

All remaining gaps at the top of the chase will be sealed

**Objective(s):**

Provide airtight framing from one finished side of the dropped ceiling to the other



Dropped soffits need to be capped and sealed to prevent leakage



No gaps should remain after sealant is applied along adjacent framing

**Tools:**

1. Spray foam gun
2. Caulk gun

**Materials:**

1. Spray foam
2. Caulk



Sealant should have been along all joists and framing before cap was set



Additional sealant should fill in all remaining gaps after cap has been set

## 3.1003.6 - Dropped Soffits

### Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

### Note:

## 3.1003.6a - Pre-inspection

### Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

### Specification(s):

An inspection will be conducted for mold, water leaks, and water damage before sealing a dropped ceiling or soffit

Repairs will be completed before work begins

### Objective(s):

Repair moisture-related issues

## 3.1003.6b - Soffit general

### Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

### Specification(s):

Air flow will be blocked at soffit in locations where access allows

### Objective(s):

Provide continuous air barrier across soffit openings



🗨️ Before

Accessible drop soffits should be sealed to prevent heat gain/loss



👍 After

Completely sealed drop soffits and chases minimize heat transfer

#### Tools:

1. Measuring tape
2. Utility knife
3. Caulk gun
4. Spray foam gun
5. Saw
6. Drill

#### Materials:

1. Caulk
2. Spray foam
3. Lumber
4. XPS
5. Fasteners

There is a variety of ways to seal soffits. Please examine 3.1003.6c and 3.1003.6d for more information.

## 3.1003.6c - Option 1: bring soffit inside (seal at top)

#### Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

Entire opening will be spanned with rigid material in line with the ceiling level

Material will be cut to fit and fastened as required

#### Objective(s):

Prevent air leakage from wall to attic

Reduce opening to what can be sealed with sealant

Ensure closure is permanent and supports any load (e.g., wind, insulation)

### Bring soffit into thermal boundary



**Before**

Standard soffits are often open to the attic and uninsulated



**After**

Rigid material encloses the soffit into the conditioned living space

#### Tools:

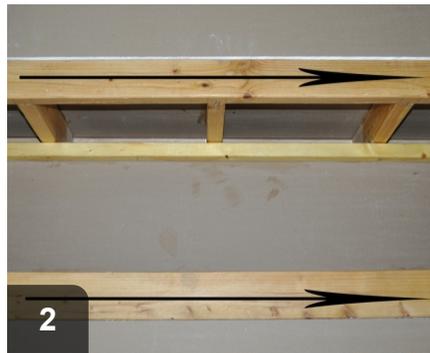
1. Drill/screwdriver
2. Caulk gun

#### Materials:

1. Drywall
2. Sealant



Soffits open to the attic need to be sealed to maintain air barrier



Apply sealant along top plates



Cap soffit with rigid material, such as drywall, cut to size



Fasten cap with screws to set sealant



Insulate over now-capped soffit

and create air barrier

## **3.1003.6d - Option 2: leave soffit outside (seal at bottom or side)**

### **Desired Outcome:**

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

### **Specification(s):**

Each stud bay will be spanned with rigid material will be cut to fit and fastened as required

OR

Backing at each stud bay will be provided and will be sealed

OR

Side of stud bays will be sealed with rigid material from bottom of soffit to top-plate

OR

A sealed rigid barrier will be installed at all transitions

### **Objective(s):**

Prevent air leakage from wall to soffit

Reduce opening to what can be sealed with sealant

Ensure soffit is outside of the thermal boundary



**Before**

Wall cavities are open to attic and heat transfer due to dropped soffit



**After**

Wall cavities capped and air-sealed in one of a variety of options

**Tools:**

1. Tape measure
2. Utility knife
3. Saw
4. Insulation machine
5. Drill
6. Caulk gun
7. Spray foam gun

**Materials:**

1. XPS
2. Drywall
3. Plywood
4. Lumber
5. Fasteners
6. Caulk
7. Spray foam
8. Dense packable insulation
9. Poly-wrapped insulation



Clear work area of insulation and debris



Option 1: Span each stud bay with rigid material at level of soffit



Option 2: Backing used to fill bays and sealed with spray foam



Option 3: Stud bay will be faced with rigid material, fastened and sealed

### 3.1003.6e - Soffits containing non-IC rated recessed lights

#### Desired Outcome:

Dropped soffits sealed to prevent air leakage and moisture movement between the attic and conditioned space

#### Specification(s):

Insulation will be kept at least 3" away from the top and side of any fixtures

If dropped soffit is to be filled with insulation, then a sealed rigid barrier enclosure will be installed to maintain a 3" clearance around the entire fixture

Top of rigid barrier enclosure will be sealed with non-insulating rigid material (e.g., gypsum or equivalent perm rating and R-value)

#### Objective(s):

Prevent light fixture from overheating

Bring light fixture inside of the air barrier

## 3.1201.1 - Double-Hung Wood Windows

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### 3.1201.1a - Lead paint assessment

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's Renovation, Repair and Painting (RRP) Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White indicates lead negative.



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

## 3.1201.1b - Weather stripping

Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

**Specification(s):**

Existing weather stripping and sash sealant will be removed

Surface where the sill meets the sash will be cleaned

Seal between the fixed components of the window (e.g., jambs, sill) will be continuous and complete while maintaining the operability of the window

Continuous and complete weather stripping will be installed on the bottom of the lower sash where it makes contact with the sill and at the top of the upper sash where it makes contact with the upper part of the window frame

**Objective(s):**

Form a complete seal from the outer edge of the sash to the jamb

Maintain operability of the window

## 3.1201.1c - Sash locks

**Desired Outcome:**

Windows operable and weather tight; improved energy efficiency performance of fenestration

**Specification(s):**

Locks will be installed so that the rails of the upper and lower sashes are flush and in full contact

No gaps will be visible between the two sashes

Locks will be installed to achieve compression of the two sashes

**Objective(s):**

Form a secure connection between the two sashes

## 3.1201.1d - Replacement sills

**Desired Outcome:**

Windows operable and weather tight; improved energy efficiency performance of fenestration

**Specification(s):**

Beveled sill will be flush with interior wall and sloped to the exterior

Seams will be continuously and completely sealed with sealant to the jambs and to the frame

Sill will be water-sealed and primed

**Objective(s):**

Form a complete seal from the bottom of the lower sash to the sill

Maintain operability of the window

Allow for drainage to the exterior



**Before**

Rot in and under a window sill is often a sign of a bigger problem



**After**

Once repaired, this window is less leaky and better supported

**Tools:**

1. Saw
2. Drill
3. Pry bar
4. Sander
5. Caulk gun

**Materials:**

1. Lumber or metal sill
2. Caulk
3. Fasteners
4. Flashing



Remove sill to determine full extent of rot and necessary repairs



Once rotted materials are cut away, determine sizing of new materials



Cut new materials flush to surrounding surfaces and pitch toward exterior



For exterior repairs, replace flashing



Set new sill, then replace and prime trim

## 3.1201.1e - Sash replacement

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Lower sash will have the same bevel on the bottom rail as the sill

Sash will be water-sealed and primed

### Objective(s):

Ensure sash remains in a fixed position when open or partially open

Maintain operability of the window

Form a complete seal from the bottom of the lower sash to the sill

## 3.1201.1f - Adjust stops

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window

### Objective(s):

Form a complete seal between the jamb, sash, and stop

Maintain operability of the window

## **3.1201.1g - Replace stops**

### **Desired Outcome:**

Windows operable and weather tight; improved energy efficiency performance of fenestration

### **Specification(s):**

Stops will be installed to keep the window securely in place

Stops will be adjusted to eliminate visible gaps between the stops and the jamb while maintaining operability of the window

### **Objective(s):**

Form a complete seal between the jamb, sash, and stop

Maintain operability of the window

## 3.1201.2 - Single-Unit Window and Fixed Frame with Wood Sash

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Note:

## 3.1201.2a - Lead paint assessment

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

**Tools:**

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

**Materials:**

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsule and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7



8

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation

## 3.1201.2b - Operable windows

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

All egress windows will be operable as required by local codes

### Objective(s):

Maintain operability of egress windows

## 3.1201.2c - Air infiltration

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Details that reduce air infiltration will be repaired, replaced, sealed, or installed (e.g., new latch for meeting rail connection, pulley seals, rope caulking for other cracks, interior storm windows)

State Energy Conservation Code or local code requirements for air leakage should be met (whichever is more stringent)

### Objective(s):

Reduce air infiltration

## 3.1201.2d - Water infiltration

### Desired Outcome:

Windows operable and weather tight; improved energy efficiency performance of fenestration

### Specification(s):

Details that reduce water infiltration will be repaired, replaced, or installed (e.g., replace missing glazing compound on sash, exterior caulking, exterior storm windows)

### Objective(s):

Reduce water infiltration

## **3.1201.2e - Occupant education and maintenance**

**Desired Outcome:**

Windows operable and weather tight; improved energy efficiency performance of fenestration

**Specification(s):**

Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain window

**Objective(s):**

Ensure long-term weather tightness

## 3.1201.3 - Exterior Doors

### Desired Outcome:

Doors operable and weather tight

### Note:

## 3.1201.3a - Lead paint assessment

### Desired Outcome:

Doors operable and weather tight

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



In homes built before 1978, test paint before beginning renovation

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

### 3.1201.3b - Door operation and fit

Desired Outcome:

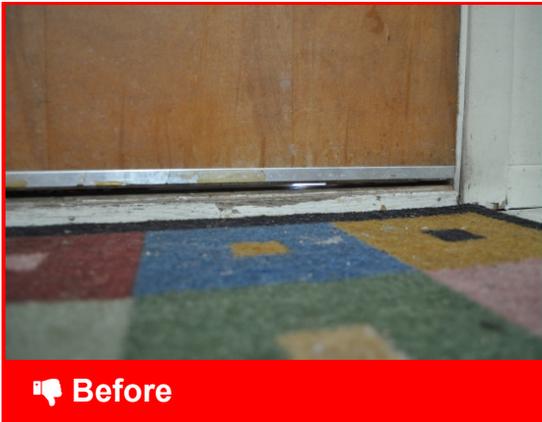
Doors operable and weather tight

**Specification(s):**

Door will be adjusted to properly fit the jamb and allow for ease of operation (e.g., hinge replacement, re-plane door, door strike adjustment)

**Objective(s):**

Ensure proper operation of the door



Daylight visible around door can indicate it does not hang true and leaks



With proper adjustment, doors should hang true and minimize leakage

**Tools:**

- 1. Screwdriver
- 2. Planer

**Materials:**

- 1. Shims



After examining how door hangs, remove door from hinges



Adjust hinge plates to bring door back into true



Adjust strike plate to allow for secure and smooth operation



Rehang door to verify adjustments worked and door operates smoothly

### 3.1201.3c - Air infiltration

**Desired Outcome:**

Doors operable and weather tight

**Specification(s):**

Details that reduce air infiltration will be repaired, replaced, sealed, or installed in accordance with State Energy Conservation Code or local code—whichever is more stringent (e.g., weather stripping, door bottoms, trim replacement with foam)

**Objective(s):**

Reduce air infiltration



Daylight visible around an exterior door indicates air infiltration



Weatherstripping and a door bottom minimize air infiltration around doors

**Tools:**

1. Screwdriver
2. Saw
3. Utility knife
4. Caulk gun
5. Drill
6. Tape measure

**Materials:**

1. Weatherstripping (Q-lan)
2. Door bottom
3. Fasteners
4. Caulk



Remove leaky door in order to affix door bottom



Measure and trim door, if necessary, to allow for door bottom



Trimming to allow for door bottom



Cut door bottom to width of door



Ensure door bottom fits snugly around door and fasten into place



Measure doorway for weatherstripping



Notch upper ends of side weatherstripping to allow for top piece



Weatherstripping should fit snugly into rabbit and against other pieces



Rehang door and verify fit, operation, and lack of air infiltration

## 3.1201.3d - Water infiltration

### Desired Outcome:

Doors operable and weather tight

### Specification(s):

Details that reduce water infiltration will be repaired, replaced, sealed, or installed (e.g., adjust threshold, caulk jamb to threshold, caulk trim, flashing)

### Objective(s):

Reduce water infiltration



Daylight visible under exterior doors indicate water can leak in



By adjusting the threshold and sealing along it, water should be kept out

### Tools:

1. Caulk gun
2. Screwdriver
3. Pry bar

### Materials:

1. Caulk sealant



Adjust threshold to minimize gap and keep water out



Caulk along threshold from inside and outside to prevent water infiltration

## **3.1201.3e - Occupant education and maintenance**

**Desired Outcome:**

Doors operable and weather tight

**Specification(s):**

Occupants will be notified of changes or repairs made and will be educated on how to operate and maintain weather stripping and caulk around door and trim

**Objective(s):**

Ensure long-term weather tightness

## 3.1202.1 - Fixed Frame with Wood Sash—Older House

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

## 3.1202.1a - Lead paint assessment

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



**1**  
Clean tools and sample site to prevent contamination



**2**  
Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



**3**  
Break capsules and shake to mix reagents. Swab sample site for 30 seconds



**4**  
Check swab for reaction



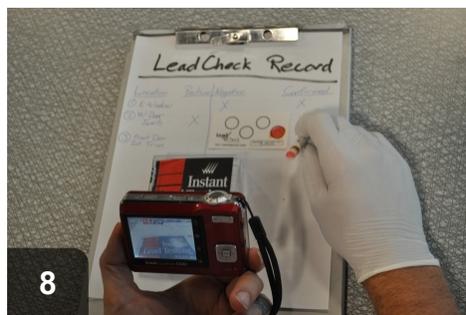
**5**  
Red indicates lead positive. White is lead negative



**6**  
If negative, verify validity of test with provided calibration card



**7**  
Lead in calibration card should test positive and turn spot red



**8**  
Record test results to maintain documentation

## 3.1202.1b - Broken glass removal

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

**Specification(s):**

Putty and push points will be removed

Broken or cracked glass will be removed

**Objective(s):**

Safely remove old glass



Broken glass with failed repairs needs to be replaced



Large pieces of glass have been removed but sash still needs preparation

**Tools:**

- 1. Putty knife
- 2. Chisel
- 3. Utility knife
- 4. Shop vacuum
- 5. Tape measure

**Materials:**

- 1. Tape

Always wear heavy work gloves when handling broken or cut glass. See also 2.0100.1b for Hand Protection.



Cut through caulk bead and glazing to



Remove old putty and glazing to



Wear heavy work gloves with working

ease removal

expose metal points holding glass in place with broken or cut glass



With sash cleared of debris, measure opening for replacement pane



Cut replacement glass 1/8" smaller than measured opening

### 3.1202.1c - Sash preparation

**Desired Outcome:**

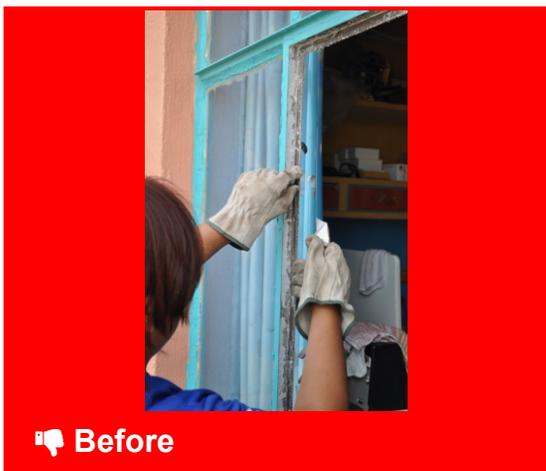
Glass complete and intact; improved energy efficiency performance of fenestration

**Specification(s):**

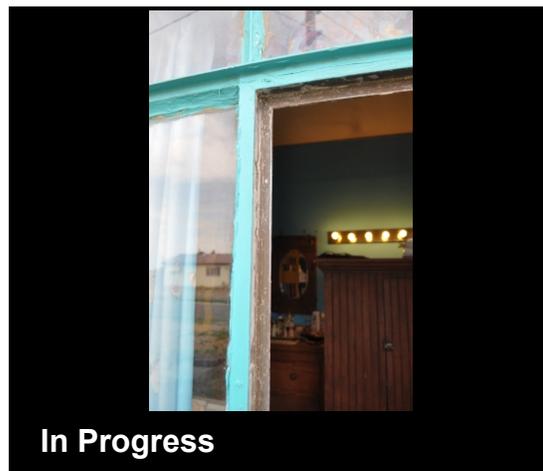
Opening will be cleaned

**Objective(s):**

Prepare opening for new glass



Remove all debris from sash either by sand paper, knife, or chisel



Mount new glass onto a clean surface

**Tools:**

1. Chisel
2. Utility knife

**Materials:**

1. Sand paper
2. Cleaning solution
3. Rags



1 Debris in the sash can cause new glass to seal improperly



2 Check closely to remove all pieces of broken glass and debris



3 With sash cleaned, glass will fit properly and glazing will seal

## 3.1202.1d - New glass installation

**Desired Outcome:**

Glass complete and intact; improved energy efficiency performance of fenestration

**Specification(s):**

Glass will be sized 1/8" to 3/16" smaller than opening to allow for movement of frame

Safety glass will be installed in accordance with local codes

Push points will be provided on each side to secure glass in frame

Glazing compound will be added in accordance with manufacturer specifications

**Objective(s):**

Ensure glazing compound will adhere to sash

Install, seal, and secure new glass in place

Allow glazing compound to harden to ensure secure installation



With sash prepared, installation of new pane can begin



Replacement glass should be securely fixed with points and glazing

**Tools:**

1. Caulk gun
2. Tape measure
3. Paint brush
4. Gloves

**Materials:**

1. Primer
2. Window glazing
3. Push points
4. Shims
5. Replacement glass
6. Tape

Always wear heavy work gloves when handling broken or cut glass. See also 2.0100.1b for Hand Protection.



With broken glass removed, measure opening for replacement glass



Cut replacement glass 1/8" smaller than measured opening



Wear heavy work gloves with working with broken or cut glass



4 Use shims to center glass while installing push points



5 With push points in place, glaze to air seal new glass pane in sash



6 Secure pane in place with tape to hold until glazing sets

## 3.1202.2 - Single-Unit Window, Mounted on Rough Opening—Newer House

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

## 3.1202.2a - Lead paint assessment

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



**1**  
Clean tools and sample site to prevent contamination



**2**  
Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



**3**  
Break capsules and shake to mix reagents. Swab sample site for 30 seconds



**4**  
Check swab for reaction



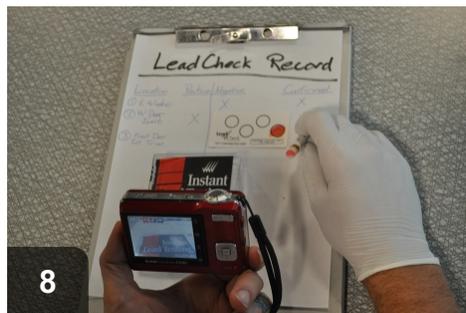
**5**  
Red indicates lead positive. White is lead negative



**6**  
If negative, verify validity of test with provided calibration card



**7**  
Lead in calibration card should test positive and turn spot red



**8**  
Record test results to maintain documentation

## 3.1202.2b - Broken glass removal

**Desired Outcome:**

Glass complete and intact; improved energy efficiency performance of fenestration

**Specification(s):**

Window stops and damaged glass will be removed

**Objective(s):**

Safely remove old glass



Broken glass with failed repairs needs to be replaced



After larger pieces are removed, the sash still needs preparation

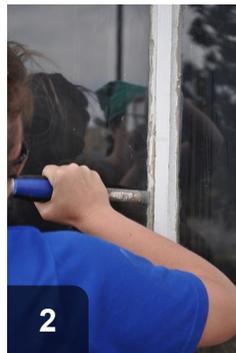
**Tools:**

- 1. Putty knife
- 2. Chisel
- 3. Utility knife
- 4. Shop vacuum
- 5. Tape measure
- 6. Gloves

**Materials:**

- 1. Tape

Always wear heavy work gloves when handling broken or cut glass. See also 2.0100.1b for Hand Protection.



Cut through caulk or glazing to simplify removal

Remove old putty and glazing from glass to expose pin nails holding glass

Always wear heavy work gloves when handling broken or cut glass



With sash cleared of debris, measure opening for replacement pane



Cut replacement glass 1/8" smaller than measured opening

## 3.1202.2c - Opening preparation

### Desired Outcome:

Glass complete and intact; improved energy efficiency performance of fenestration

### Specification(s):

Opening will be cleaned

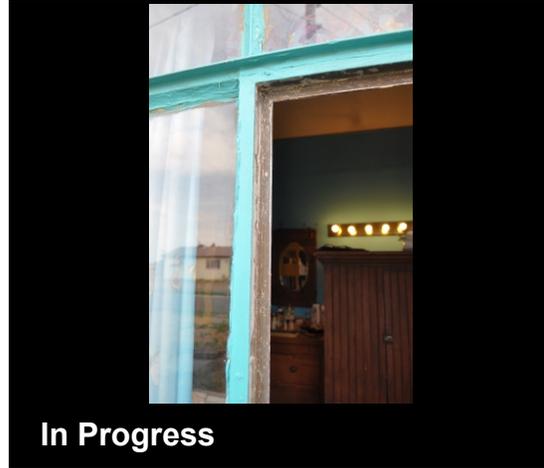
Glazing tape will be removed or replaced

### Objective(s):

Prepare opening for new glass



Remove all debris, glazing tape, and glass from sash



Sash surface must be clean before mounting new glass

**Tools:**

1. Chisel
2. Utility knife

**Materials:**

1. Cleaning solution
2. Rags



Debris in the sash can cause new glass to seal improperly



Check closely to remove and collect all broken glass and debris



With sash cleaned, glass will fit properly and glazing will seal

## 3.1202.2d - New glass installation

**Desired Outcome:**

Glass complete and intact; improved energy efficiency performance of fenestration

**Specification(s):**

Replacement glass will be sized to original width, height, and depth

Stops will be replaced or installed

Wood stops will be sealed to glass with appropriate sealant

Glass will be selected with comparable tint and coating (color and look)

Tempered glass will be installed as required by local codes

Glazing compound will be added in accordance with manufacturer specifications

**Objective(s):**

Install, seal, and secure new glass in place

Allow glazing compound to harden to ensure secure installation



With sash prepared, new pane installation can begin



Replaced glass should be held in place while glazing sets

**Tools:**

1. Caulk gun
2. Tape measure
3. Light-duty hammer

**Materials:**

1. Trim

Always wear heavy work gloves when handling broken or cut glass. See also 2.0100.1b for Hand Protection.



With broken glass removed, measure rough opening for replacement glass size

Cut replacement glass 1/8" smaller than measured opening

Wear heavy work gloves with working with broken or cut glass



4 With sash prepared, shim glass to center in opening and reinstall stops



5 Apply window glazing to air seal new pane

## 3.1203.1 - Replacement Window in Existing Window Frame

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

## 3.1203.1a - Lead paint assessment

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/ May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

### Tools:

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

### Materials:

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



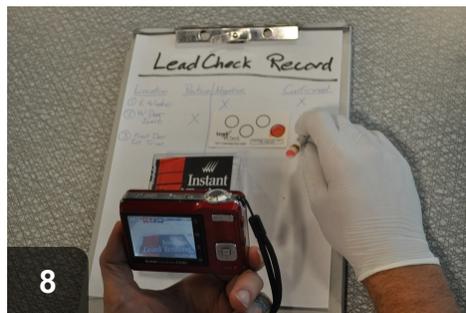
5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7 Lead in calibration card should test positive and turn spot red



8 Record test results to maintain documentation

## 3.1203.1b - Opening preparation

Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Specification(s):

Interior stops, sashes, parting strips, and pulleys will be removed

Opening will be cleaned

### Objective(s):

Provide a clean opening for replacement window unit



**Before**

Wooden window still in opening



**In Progress**

Wood window with sashes removed before replacement

### Tools:

1. Stiff bladed scraper or putty knife
2. Single-edge razor blade scraper



1

Wood double-hung window



2

Remove stop moulding (non-lead based paint). For lead based paint work requirements, visit <http://www2.epa.gov/lead>



3

Remove sashes and balances (tracks). Remove sash cords and pry pulleys out of the jamb in older units



Scrape loose paint and thoroughly clean opening

## 3.1203.1c - Replacement window installation

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Specification(s):

Replacement window will be installed in accordance with manufacturer specifications, ensuring that the exterior stops are caulked

### Objective(s):

Ensure replacement window operates properly

Ensure replacement window has a weather tight fit



Window opening ready to receive replacement window



Replacement window installed, with stop molding replaced and caulked

**Tools:**

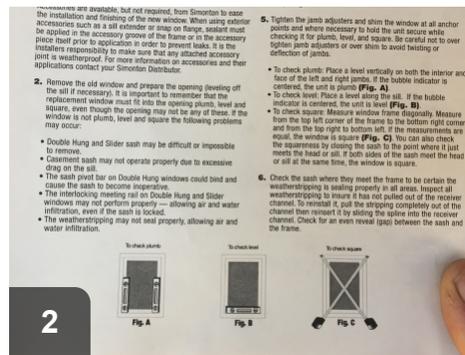
1. Utility knife
2. Hammer
3. Sharp-bladed prybar
4. Nail set punch
5. Cordless driver/drill
6. Caulking gun
7. HEPA vacuum (for lead-based paint work)

**Materials:**

1. Window, door, and trim caulk
2. 6-mil polyethylene plastic



1 Prepare and clean opening before installing new window



2 Check opening for plumb, level, and square



3 Measure diagonally both ways across opening. If measurements are equal, the opening is square



4 Apply caulk to stop molding and install the new window in accordance with manufacturer's instructions.



5 Tighten jamb adjusters and shim as necessary to achieve plumb, level, and square. Fasten window into opening



6 Make sure the sashes open, close, and lock properly. Check that the sashes are parallel with the frame as shown



Caulk new window to existing stop molding



Reinstall and caulk interior stop molding



Completed installation

## 3.1203.2 - Single-Unit Window, Mounted on Rough Opening—Newer House

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Note:

## 3.1203.2a - Lead paint assessment

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Specification(s):

Presence of lead-based paint in pre-1978 homes will be assumed unless testing confirms otherwise

EPA's RRP Program Rule (40 CFR Part 745) in pre-1978 homes and proposed changes to this rule (Federal Register/Vol. 75, No. 87/May 6, 2010) will be complied with, to be superseded by any subsequent final rulemaking or any more stringent state or federal standards

### Objective(s):

Protect worker and occupant from potential lead hazards



### Best Practice

In homes built before 1978, test paint before beginning renovation

**Tools:**

1. Note: Mask and gloves must be worn during testing
2. LeadCheck test kit
3. Utility knife
4. Camera

**Materials:**

1. Cleaning solution or cleaning wipes
2. Bag or folded paper to catch debris
3. Nitrile gloves
4. Dust mask

EPA RRP certification required to conduct Lead Paint assessment.



1 Clean tools and sample site to prevent contamination



2 Place catchment bag under sample site to catch any debris. Cut sample site at an angle to expose all older paint layers



3 Break capsules and shake to mix reagents. Swab sample site for 30 seconds



4 Check swab for reaction



5 Red indicates lead positive. White is lead negative



6 If negative, verify validity of test with provided calibration card



7



8

Lead in calibration card should test positive and turn spot red

Record test results to maintain documentation

## 3.1203.2b - Opening preparation

### Desired Outcome:

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

### Specification(s):

Replacement window will be laid out with trim

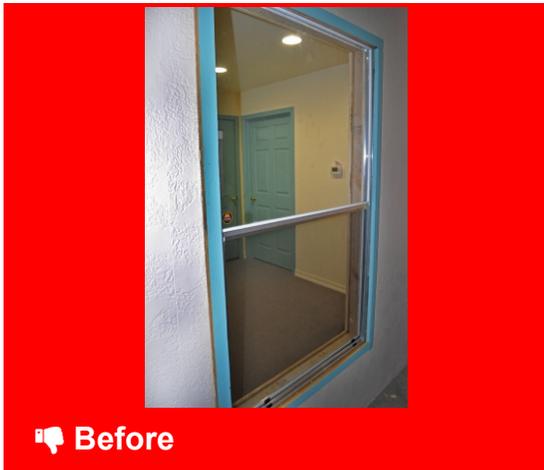
Exterior trim will be removed or exterior siding will be cut back to fit new window with trim

Existing window will be removed

Window opening will be flashed in accordance with accepted industry standards

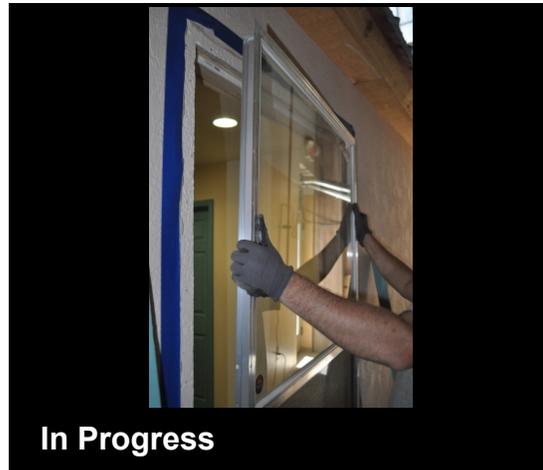
### Objective(s):

Provide a clean and properly flashed opening for replacement window unit



**Before**

Single pane window in newer home



**In Progress**

Window is removed to allow for replacement with double pane unit

### Tools:

1. Pry bar
2. Utility knife
3. Drill

### Materials:

1. Window and door flashing



Single pane window needs to be replaced with double pane



Cut through caulk at stops to break seal



Remove stops while attempting to keep damage to rough opening to minimum



Remove interior trim



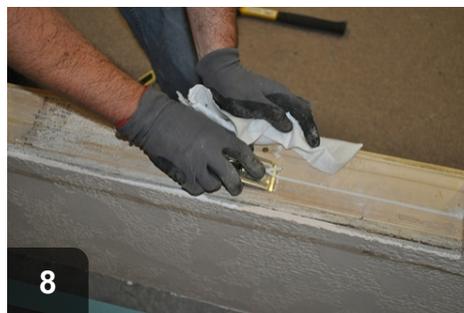
Remove exterior trim



Remove exterior fasteners to free window



Remove window from rough opening



Clean rough opening to remove old caulk and debris



Install flashing along sides and bottom of rough opening

## 3.1203.2c - Replacement unit preparation

### Desired Outcome:

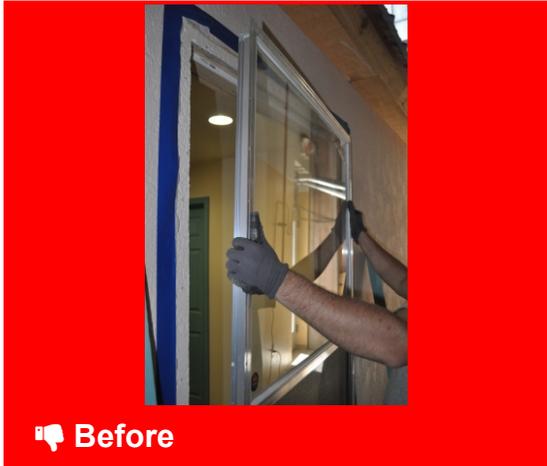
Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

**Specification(s):**

Mounting detail will be determined based on depth of window and location of window liner

**Objective(s):**

Allow for good fit and finish of replacement window



**Before**

Single pane window is being removed



**In Progress**

Double-pane unit replaces previous single-pane one

**Tools:**

1. Tape measure
2. Utility knife



1

Measure rough opening depth to determine best method of installation



2

Clean old sealant off exterior surface to allow for flange installation



3

Install unit following appropriate detail for rough opening and unit depth

## 3.1203.2d - Replacement window installation

**Desired Outcome:**

Replacement window provides weather tight fit; improved energy efficiency performance of fenestration

**Specification(s):**

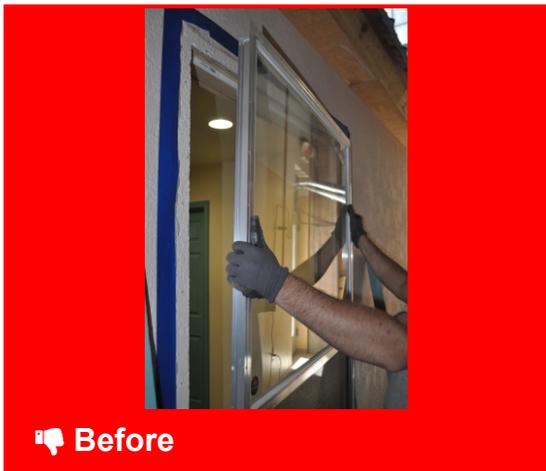
Replacement windows will be installed in accordance with manufacturer specifications and will be integrated with flashing

Gaps between the new window and existing frame will be sealed with low-expanding foam

**Objective(s):**

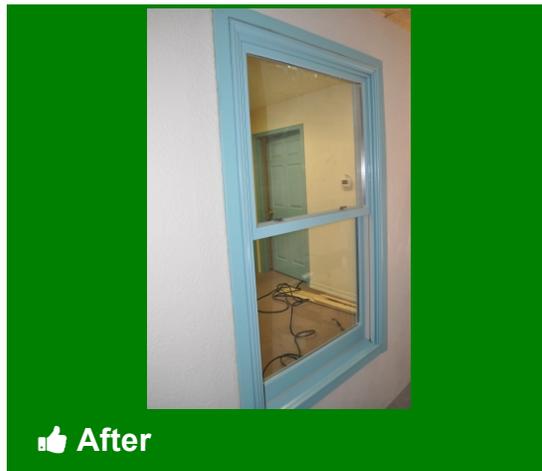
Ensure replacement window operates properly

Ensure replacement window is weather tight



Before

Single pane window is being removed to install double pane unit



After

Double pane unit installed with trim in place

**Tools:**

1. Utility knife
2. Spray foam gun
3. Drill
4. Hammer
5. Saw

**Materials:**

1. Fasteners
2. Flashing
3. Low-expansion spray foam
4. Backer rod
5. Primed trim



Install flashing to manufacturer specs



Flanges have been folded out to allow



Fasten window flange securely around

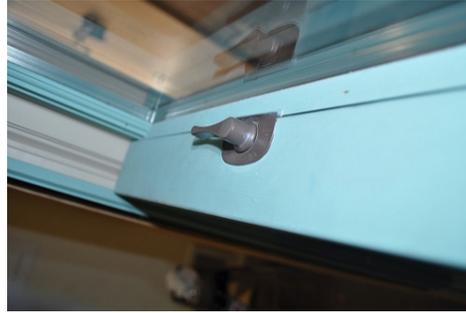
and industry standards

for easy installation

exterior of entire window



With window secured in place, check for proper function



Check that sash locks align properly, indicating window is plumb



Fill interior gap with compressible foam or appropriate sealant



Prime and replace interior trim and, if needed, sill



Replace exterior trim and patch exterior siding or finish as needed

## 3.1402.1 - Crawl Spaces—Sealing Floor Penetrations

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Note:

### 3.1402.1a - Backing and infill

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Specification(s):

Backing or infill will be provided as needed to meet the specific characteristics of the selected sealant and the characteristics of the penetration

The backing or infill will not bend, sag, or move once installed

### Objective(s):

Ensure resulting closure is permanent and supports any load (e.g., insulation)

Ensure sealant does not fall out



Gaps around floor penetrations, such as plumbing, HVAC, and electrical



Gaps should be sealed to maintain air barrier

### Tools:

1. Headlamp

### Materials:

1. Backer rod
2. Sealant



Prepare work space by removing any insulation



Infill with backer rod



Apply appropriate caulking to ensure backing/infill does not move



Visually inspect to verify no gaps remain

## 3.1402.1b - Sealant selection

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Specification(s):

Sealants will be used to fill holes no larger than recommended by manufacturer specifications

Sealants will be compatible with their intended surfaces

Sealants will allow for differential expansion and contraction between dissimilar materials

Sealants will be continuous and meet fire barrier specifications, according to authority having jurisdiction

### Objective(s):

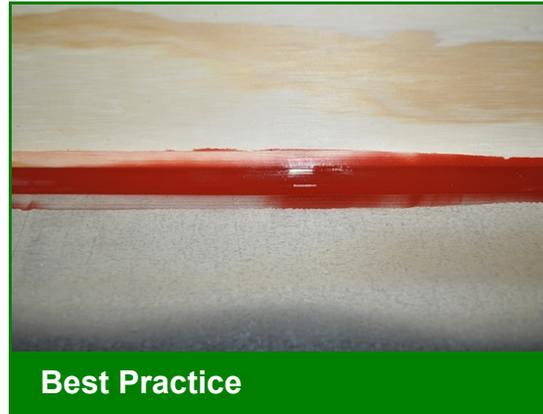
Create a permanent seal

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials



**Bad Practice**

Avoid sealants that do not allow for expansion between dissimilar materials



**Best Practice**

Flexible sealants compensate for differential expansion and maintain a seal

**Tools:**

1. Caulk gun
2. Spray foam gun

**Materials:**

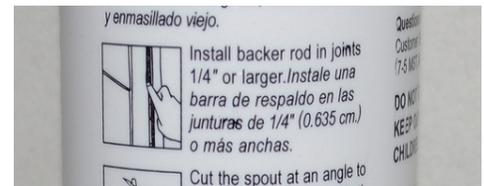
1. Caulk
2. Spray foam



Caulking can be used to span gaps up to 1/4 inch



Spray foam can be used to span gaps up to 3 inches



Check manufacturer specifications to verify spanning capabilities



Also check manufacturer specs for incompatibility with intended surfaces

## 3.1402.1c - High temperature application

### Desired Outcome:

Air leakage prevented and indoor air quality protected

### Specification(s):

Only non-combustible materials will be used in contact with chimneys, vents, and flues in accordance with authority having jurisdiction

### Objective(s):

Prevent a fire hazard



**Before**

Gaps around floor penetrations allow air and moisture movement



**After**

Use non-combustible materials, like 26-gauge steel and high-temp caulk

### Tools:

1. Caulk gun
2. Metal snips
3. Drill/screwdriver

### Materials:

1. High-temperature caulk
2. 26-gauge steel sheeting



**1**

Prepare work area by removing any insulation and debris



**2**

Use high-temperature caulking (600F min)



**3**

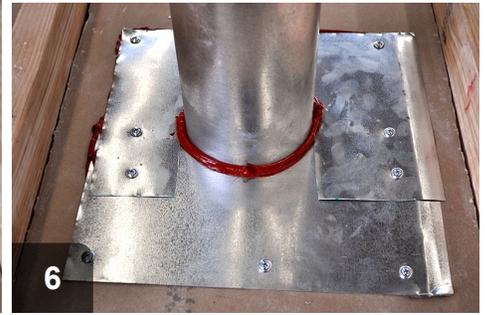
Apply first ring of caulking to match shape of opening



4 Apply second ring of caulking to size and shape of rigid material



5 Fasten rigid material (26-gauge steel) and apply additional caulking



6 Fasten rigid material to cover penetration and seal against flue with caulk

## 3.1402.3 - Closed Crawl Spaces—Air Sealing Exterior Wall

### Desired Outcome:

Well-sealed exterior wall prevents leakage and pests

### 3.1402.3a - Seal penetrations

### Desired Outcome:

Well-sealed exterior wall prevents leakage and pests

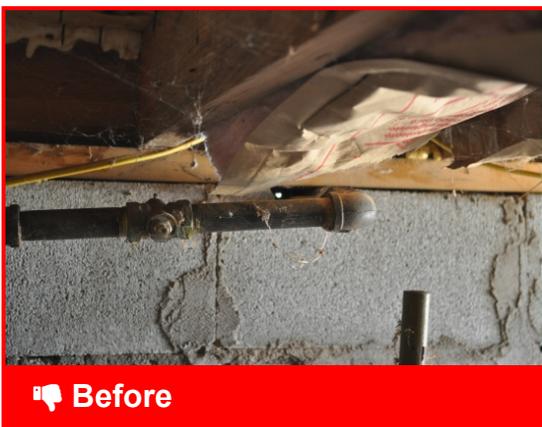
### Specification(s):

Penetrations will be sealed with a durable material

A minimum expected service life of 10 years will be ensured

### Objective(s):

Prevent air and moisture penetration into crawl space



Light showing through penetration in exterior block wall



Sealed with durable material to prevent air and water leakage, and pests

### Tools:

1. Caulk gun
2. Sprayfoam gun
3. Metal snips
4. Drill

### Materials:

1. Caulk
2. Sprayfoam
3. Metal mesh
4. Fasteners



Measure holes to determine the best backing and fill strategy



In holes larger than 1/4 inch, wire mesh should be used for backing



Sprayfoam or caulk seal the hole

### 3.1402.3b - Pest exclusion

**Desired Outcome:**

Well-sealed exterior wall prevents leakage and pests

**Specification(s):**

If penetration is greater than 1/4 inches, caulking, steel wool, or other pest-proof material will be used to fill the penetration before sealing

**Objective(s):**

Prevent pest entry



For bigger holes, extra steps should be taken to keep out pests



Choose the backing and infill strategy that works best for the hole size

**Tools:**

- 1. Caulk gun
- 2. Sprayfoam gun
- 3. Metal snips
- 4. Drill

**Materials:**

- 1. Caulk
- 2. Sprayfoam
- 3. Metal mesh
- 4. Rigid backing



For holes larger than 1/4", rigid backing should be used to keep pests out



Metal mesh or other rigid materials should be cut to fill the space



Sprayfoam can be used to seal the hole and hold mesh in place

## 3.1501.1 - Penetrations, Cracks, and Doors Between Garage and House

### Desired Outcome:

Openings from garage sealed to prevent leakage

### 3.1501.1a - Penetrations

### Desired Outcome:

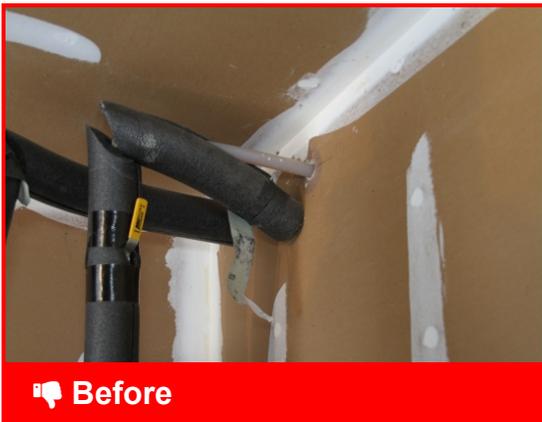
Openings from garage sealed to prevent leakage

### Specification(s):

All lighting fixtures, wiring, plumbing, venting, ducting, and gas piping penetrations will be sealed

### Objective(s):

Prevent air leakage and pollutant entry



### Materials:

1. Backer Rod
2. Caulk
3. Spray foam

## 3.1501.1b - Ductwork

### Desired Outcome:

Openings from garage sealed to prevent leakage

**Specification(s):**

All joints and connections in ductwork will be fastened and sealed with UL 181B or 181B-M welds, gaskets, adhesive mastics, or mastic-plus- embedded-fabric systems

**Objective(s):**

Prevent air leakage and pollutant entry



Unsealed joints and connections need to be sealed to prevent health risks.



Sealed ductwork connections help prevent leakage.

**Materials:**

- 1. Mesh tape
- 2. Mastic



Prepare work area by assessing any safety concerns.



Wrap joint with fiberglass mesh tape.



Apply UL 181 mastic to seal joint.

## 3.1501.1c - Cracks

**Desired Outcome:**

Openings from garage sealed to prevent leakage

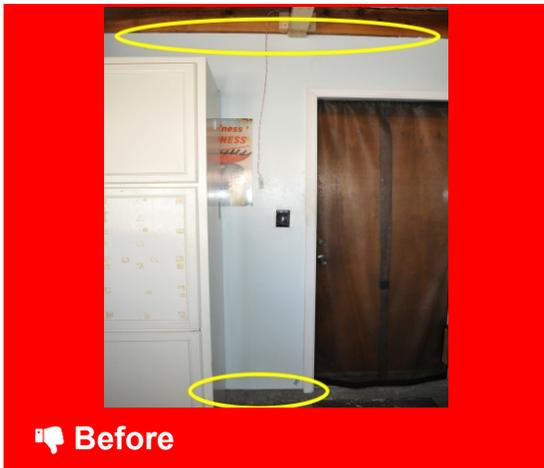
**Specification(s):**

All cracks in house and garage separation wall will be sealed, including cracks between mud sill, rim joists, subfloors, and bottom of gypsum board, ensuring the air sealing enhances the integrity of the fire resistance construction of that wall

All cracks in ceiling surfaces will be sealed

**Objective(s):**

Prevent air leakage and pollutant entry



Air sealing reduces pollutant entry, but does not diminish fire resistance

Cracks in shared walls of attached garages are a potential leakage site

**Materials:**

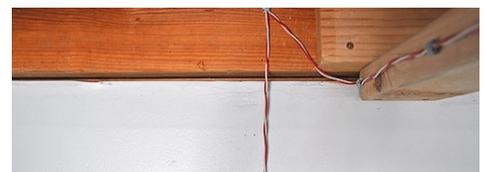
1. Sprayfoam
2. Fire-block caulk



Determine which walls are shared between garage and living space



Inspect wall and ceiling for cracks and penetrations



Clear work area of obstacles and debris



Apply appropriate sealant dependent upon size of crack and location



Ensure sealant does not decrease wall's fire resistance

## 3.1501.1d - Garage to house door

### Desired Outcome:

Openings from garage sealed to prevent leakage

### Specification(s):

Weather stripping, door sweep, and threshold will be installed to stop air leakage

### Objective(s):

Prevent air leakage and pollutant entry



**Before**

Daylight visible under door to garage indicates leakage



**After**

Door sweep, with weatherstripping, will minimize air exchange with garage

**Tools:**

1. Caulk gun
2. Screwdriver
3. Utility knife
4. Hacksaw
5. Saw
6. Tape measure
7. Drill
8. Planer

**Materials:**

1. Weatherstripping (Q-lan)
2. Door sweep
3. Caulk
4. Fasteners



Remove door for access to work space and to install sweep



Measure for weatherstripping around door



Install weatherstripping into rabbit around door



Corners of weatherstripping should be snug and secure



Adjust threshold to minimize contaminant and water infiltration



Caulk along threshold to minimize water and contaminant infiltration



Cut door sweep to width of the door

Ensure door sweep fits tightly against bottom of door and fasten in place

Rehang door to verify snug fit and smooth operation

## 3.1501.1e - Glass

### Desired Outcome:

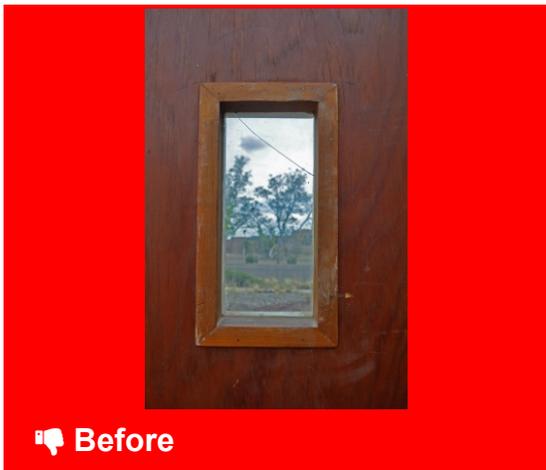
Openings from garage sealed to prevent leakage

### Specification(s):

Broken glass panes in doors will be replaced, pointed, and glazed where needed

### Objective(s):

Prevent air leakage and pollutant entry



Broken glass in exterior and garage doors allows for leakage. Replace it



With new glass in place, take care to tightly seal and replace stops

### Tools:

1. Hammer
2. Pry bar
3. Caulk gun
4. Tape measure

### Materials:

1. Brads
2. Caulk
3. Glazing
4. New glass cut to size of rough opening



Remove stops, taking care not to damage them



Remove broken glass and clean old sealant and glazing from rough opening



Measure rough opening and cut new glass to size



Apply sealant to rough opening and place new glass



Seal glass into place from inside as well to ensure no air infiltration



Replace stops and rehang door

## 3.1501.1f - Carbon monoxide (CO) alarm

### Desired Outcome:

Openings from garage sealed to prevent leakage

### Specification(s):

CO alarms will be installed in accordance with ASHRAE 62.2, applicable codes and manufacturer specifications

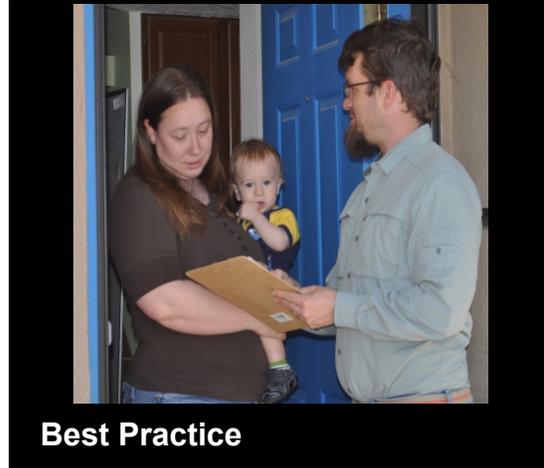
### Objective(s):

Warn occupants of CO exposure from attached garage



**Best Practice**

Carbon monoxide alarms should be installed throughout the house



**Best Practice**

Occupants should be alerted to CO alarm locations and maintenance

CO alarms should be installed one per floor and near sleeping areas.

## 3.1501.1g - Occupant education

### Desired Outcome:

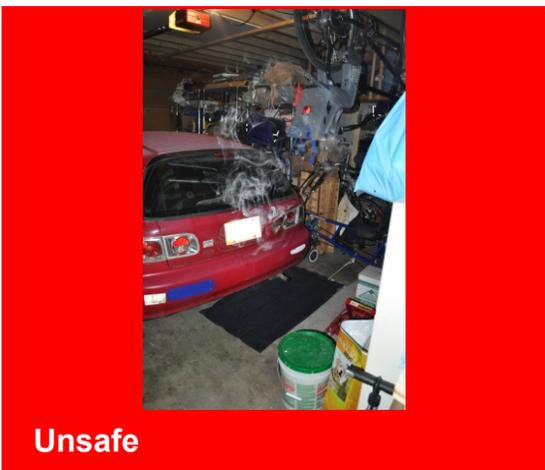
Openings from garage sealed to prevent leakage

### Specification(s):

Occupant will be educated on need to keep door from garage to house closed and not to warm up vehicles or use any gas engine appliances or grills in the garage, even if the main door is left open

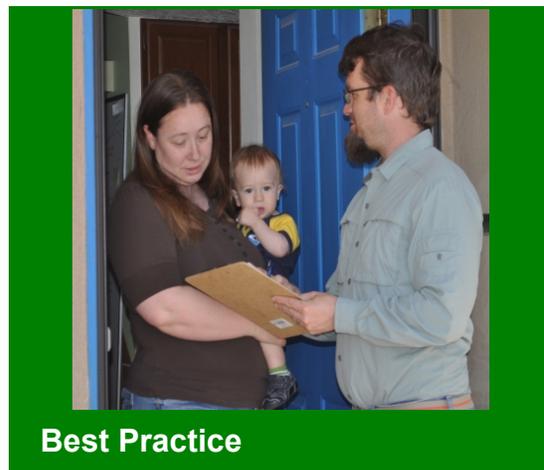
### Objective(s):

Reduce risk of CO poisoning inside of garage and adjacent rooms



**Unsafe**

Communicate importance of never running vehicles in a closed garage



**Best Practice**

Speak with occupant about hazards of using gas appliances in the garage



Occupants should never run vehicles in a closed garage



Occupants should not light combustibles inside garages



Speak with occupant about hazards of using gas appliances in the garage

### 3.1601.3 - Support

**Desired Outcome:**

Ducts and plenums properly supported

### 3.1601.3a - Support (applies to all duct types)

**Desired Outcome:**

Ducts and plenums properly supported

**Specification(s):**

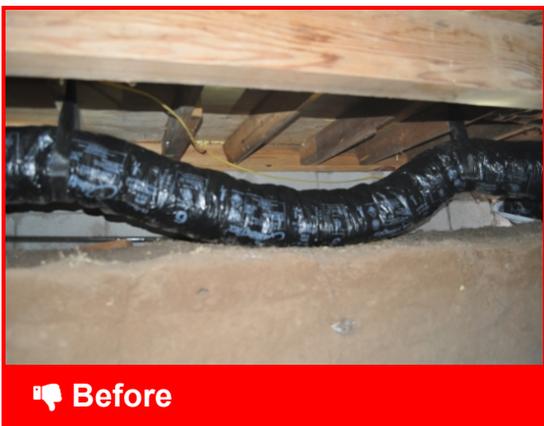
Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material

Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction

Metal ducts will be supported by 1/2 inch wide eighteen gauge metal straps or 12-gauge galvanized wire at intervals not exceeding 10 feet or other approved means

**Objective(s):**

Eliminate falling and sagging



Ducts should not be allowed to droop and drag, adding distance to run



Properly supported ducts minimize heat loss and and maximize duct run

**Tools:**

1. Metal snips
2. Utility knife
3. Drill
4. Stapler

**Materials:**

1. 18 gauge metal strap (at least 1/2" wide)
2. 12 gauge galvanized wire
3. Fabric support straps (at least 1 1/2" wide)
4. Staples
5. Fasteners



BAD: Make sure supports DO NOT compress insulation or duct



Flex ducts should have supports no less than every 4 feet



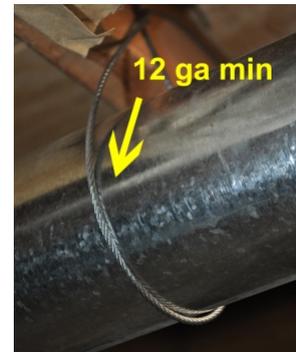
Durable strap should be at least 1 1/2 inches wide



Metal ducts should be supported every 10 feet or less with straps or wire



Metal straps should be at least 18 gauge and 1/2 inch wide



Metal wire should be at least 12 gauge and galvanized

## 3.1602.1 - Air Sealing Duct System

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

## 3.1602.1a - New component to new component sealant selection

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

Any closure system used will be in accordance with IRC Chapter 16

### Objective(s):

Ensure effectiveness of air sealing system

## 3.1602.1b - New component to existing component

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using fiberglass mesh and mastic

Mastic alone will be acceptable for holes less than ¼" that are more than 10' from air handler

Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:

- They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing
- They will be sealed using fiberglass mesh and mastic

### Objective(s):

Eliminate air leakage into or out of ducts and plenums

Ensure adhesion of primary seal (mastic and fiberglass mesh) to the duct

Reinforce seal

Support mastic and fiberglass mesh during curing

## 3.1602.1c - Existing component to existing component

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

Seams, cracks, joints, holes, and penetrations less than ¼" will be sealed using UL 181 fiber-embedded mastic

Seams, cracks, joints, holes, and penetrations between ¼" and ¾" will be sealed in two stages:

\* They will be backed using temporary tape (e.g., foil tape) as a support prior to sealing\* They will be sealed using fiberglass mesh and mastic

Seams, cracks, joints, holes, and penetrations larger than ¾" will be repaired using rigid duct material

Mastic will overlap repair joint or existing temporary tape by at least 1" on all sides

### Objective(s):

Eliminate air leakage into or out of ducts and plenums

Ensure adhesion of primary seal (fiberglass mesh and mastic) to the duct

Reinforce seal

Support fiberglass mesh and mastic during curing



 Before

Unsealed joints and connections need to be sealed to prevent health risks



 After

Sealed ductwork connections help prevent leakage

**Materials:**

1. Mastic
2. Fiberglass mesh tape



Prepare work area by assessing any safety concerns



Wrap joint with fiberglass mesh tape



Apply UL 181 mastic to seal joint

## 3.1602.4 - Air Sealing System Components

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### 3.1602.4a - Duct boot to interior surface

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

All gaps between boot and interior surface that defines conditioned space will be air sealed

Gypsum edge will be wetted before applying water-based sealant

Sealants will be continuous and be in accordance with IRC

### Objective(s):

Prevent air leakage

Prevent a fire hazard



Gaps around duct boots allow for leakage to and from the attic



Use a mesh in mastic system to seal duct boot to interior surface

### Tools:

1. Utility knife
2. Spray bottle
3. Putty knife

### Materials:

1. Mastic
2. Mesh tape



1 Remove grill to expose duct boot and gaps



2 Wet the edges of the drywall to ensure a good bond



3 Cut mesh tape to fit around duct boot and cover gaps



4 Apply mastic over mesh tape to create heat resistant, durable bond



5 Once mastic is set, grill can be replaced and mastic should not show

## 3.1602.4b - Wooden plenums and building cavities

### Desired Outcome:

Ducts and plenums sealed to prevent leakage

### Specification(s):

Accessible connections and joints will be made airtight using approved material

### Objective(s):

Ensure ducts and plenums will not leak



👎 Before

Locate unsealed ducts constructed from building cavities



👍 After

Return plenum lined with fiberglass duct board and sealed with mastic

### Tools:

1. disposable brushes
2. tape measure
3. utility knife
4. rubber gloves
5. framing square or T-square
6. tin snips

### Materials:

1. mastic
2. fiberglass duct board
3. UL 181 listed mastic tape
4. sheet metal
5. screws

Use approved materials to seal ductwork; cover organic materials with airtight, non-organic material such as mastic, metal, or duct board. Foam products are not allowable inside duct returns. In addition, IRC R316.4 requires that all foam products be separated from the inside of the home by a thermal barrier.

From NFPA 90B 4.2.1.3: "The interior of combustible ducts shall be lined with noncombustible material at points where there might be danger from incandescent particles dropped through the register or heater, such as directly under floor registers, the bottom of vertical ducts, or heaters having a bottom return."

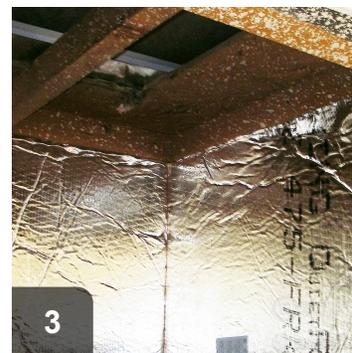
From NFPA 90B 4.3.1.1: "Duct coverings, duct linings, and tapes used in duct systems shall have a maximum flame spread index of 25 without evidence of continued progressive combustion and a maximum smoke developed index of 50 when tested in accordance with ASTM E 84 or ANSI/UL 723..."



Identify building cavities used as ducts



Seal penetrations around AC lineset and wiring



Cut and Install appropriate board material to create an airtight duct



Seal all seams and joints with duct mastic

## 3.1602.4c - Air handler cabinet

### Desired Outcome:

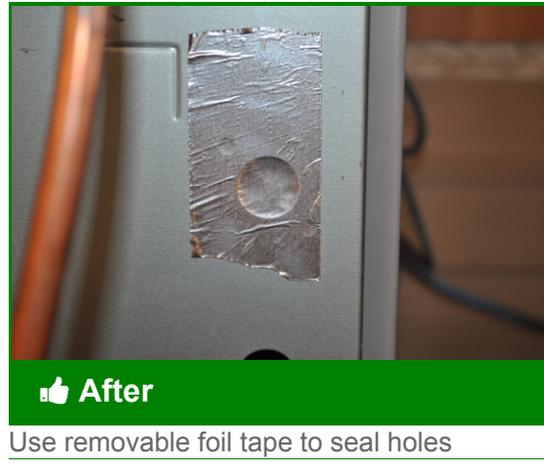
Ducts and plenums sealed to prevent leakage

### Specification(s):

Joints will be closed and cracks and holes not needed for proper function of unit will be sealed using removable sealant (e.g., foil tape) or in accordance with the original equipment manufacturer directions (if available)

### Objective(s):

Reduce air leakage while maintaining accessibility



Unnecessary holes in the air handler cabinet need to be sealed

**Materials:**

- 1. Foil tape



Unnecessary holes in the air handler cabinet should be sealed



Removable foil tape should be used to seal



Fully cover holes with tape to seal completely

## 3.1602.4d - Filter slot

**Desired Outcome:**

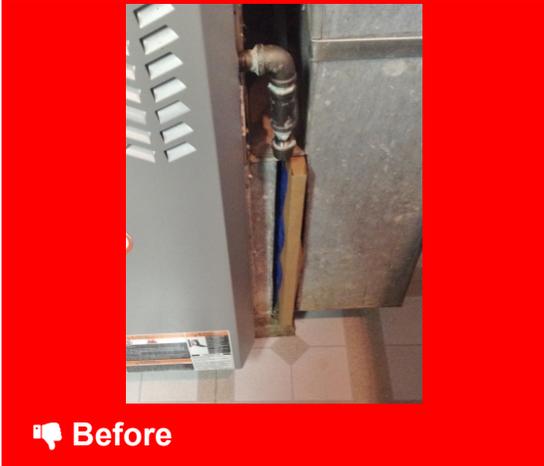
Ducts and plenums sealed to prevent leakage

**Specification(s):**

A pre-manufactured or site manufactured durable filter slot cover will be installed

**Objective(s):**

Reduce air leakage while maintaining accessibility



 Before

Uncovered filter slots are a point of leakage



 After

Filter slots should be covered

## 3.1602.5 - Return—Framed Platform

### Desired Outcome:

The return duct installed to prevent air leakage

## 3.1602.5a - Preparation

### Desired Outcome:

The return duct installed to prevent air leakage

### Specification(s):

Debris and dirt will be cleaned out of the return platform

### Objective(s):

Allow for the application of rigid materials and sealants



Dirty, unsealed return platform needs to be cleaned out before sealing



Vacuum out debris and dirt from the return to prepare work area

### Tools:

1. Shop vacuum

## 3.1602.5b - Infill and backing

### Desired Outcome:

The return duct installed to prevent air leakage

### Specification(s):

Backing or infill will be provided as needed to meet the specific characteristics of the selected material and the characteristics of the open space

Backing or infill will not bend, sag, or move once installed

Material will be rated for use in return duct systems

### Objective(s):

Minimize hole size to ensure successful use of sealant

Ensure closure is permanent and supports any load (e.g., return air pressure)

Ensure sealant does not fall out



Leakage from air return into wall cavities should be eliminated



Only materials rated for use in higher temperature areas should be used, such as drywall

### Tools:

1. Tape measure
2. Utility knife
3. Drill
4. Caulk gun

### Materials:

1. Drywall
2. Fire-resistant caulk
3. Fasteners



Do NOT use EPS or XPS in air returns due to proximity to combustion appliances

### 3.1602.5c - Sealant selection

**Desired Outcome:**

The return duct installed to prevent air leakage

**Specification(s):**

Sealants will be continuous and be in accordance with IRC

**Objective(s):**

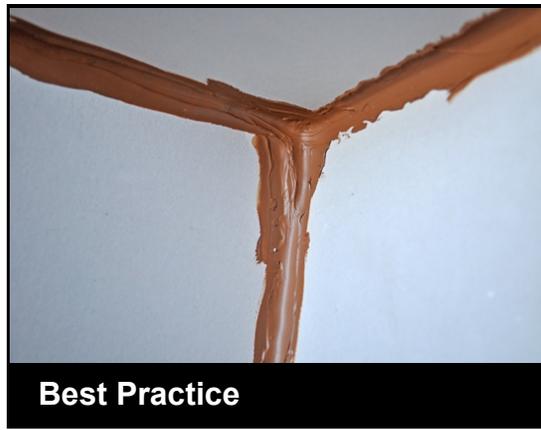
Select permanent sealant

Ensure sealant meets or exceeds the performance characteristics of the surrounding materials



**Best Practice**

Sealants, like mesh and UL 181 mastic, meet IRC, ASTM, and UL specs



**Best Practice**

Caulk sealants will be continuous

**Tools:**

- 1. Caulk gun
- 2. Utility knife
- 3. Taping knife

**Materials:**

- 1. Fiberglass mesh
- 2. Siliconized caulk
- 3. UL 181 mastic

Paraphrased from 2012 IRC R302.9: Wall and ceiling finishes will have a flame spread index of 200 or less and a smoke-developed index of 450 or less

## 4.1001.1 - Non-Insulation Contact (IC) Recessed Light

### Desired Outcome:

Ensure safety from fire and prevent air leakage

## 4.1001.1a - Air barrier system

### Desired Outcome:

Ensure safety from fire and prevent air leakage

### Specification(s):

A fire-rated air barrier system (i.e., equivalent to 5/8 fire code gypsum wallboard) will be used to separate non- IC rated recessed lights from insulation, using one of the methods below:

A fire-rated airtight closure taller than surrounding attic insulation will be placed over non- IC rated recessed lights

OR

The non- IC rated light fixture will be replaced with an airtight IC - rated fixture or insert

OR

The fixture(s) may be replaced with surface mounted fixture and opening sealed

OR Air sealing measures as approved by the authority having jurisdiction

### Objective(s):

Prevent a fire hazard

Prevent air leakage through fixture



**Before**

Non-IC rated recessed light fixtures should be dammed from insulation



**After**

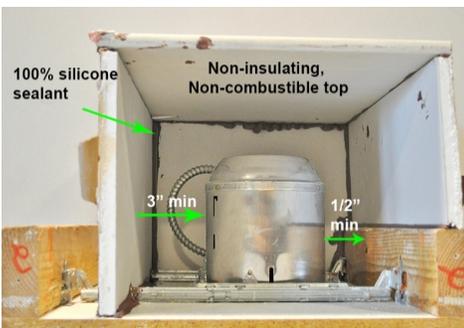
Sealed box around non-IC light should be taller than surrounding insulation

**Tools:**

1. Utility knife
2. Tape measure

**Materials:**

1. 5/8" fire-rated drywall
2. Fire-rated caulk sealant



Box should be constructed with clearances in mind



Sealed box should be constructed of fire-rated drywall



OR non-IC can light can be replaced with IC-rated recessed light

## 4.1001.1b - Enclosure top

**Desired Outcome:**

Ensure safety from fire and prevent air leakage

**Specification(s):**

The top-fire rated enclosure material will have an R-value of 0.56 or less

The top of the enclosure will be left free of insulation

**Objective(s):**

Prevent heat build up



**Before**

Non-IC rated recessed lights create excess heat and are a fire risk



**After**  
Once dammed from insulation, it should still not have insulation on top

**Tools:**

1. Utility knife
2. Caulk gun

**Materials:**

1. Drywall

## 4.1001.1c - Clearance

**Desired Outcome:**

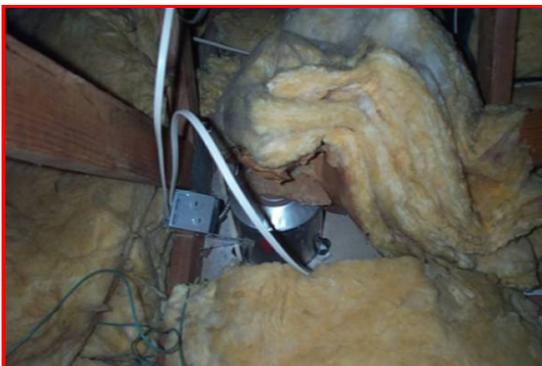
Ensure safety from fire and prevent air leakage

**Specification(s):**

The entire closure will maintain a 3" clearance between the closure and the fixture including wiring, box, and ballast

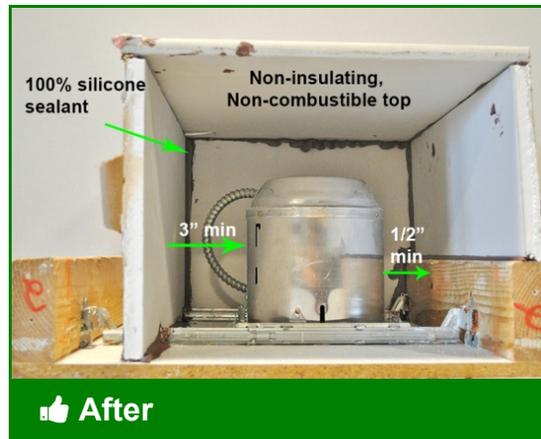
**Objective(s):**

Keep an air space around the fixture



**Before**

Non-IC rated recessed lights produce excess heat and can be a fire risk



**After**  
A 3 inch clearance should be kept from boxing materials

**Tools:**

1. Utility knife
2. Tape measure
3. Caulk gun

**Materials:**

1. Fire-rated sealant
2. Drywall

## 4.1001.1d - Sealants and weather stripping

**Desired Outcome:**

Ensure safety from fire and prevent air leakage

**Specification(s):**

Caulk, mastic, or foam will be used on all edges, gaps, cracks, holes, and penetrations of closure material only

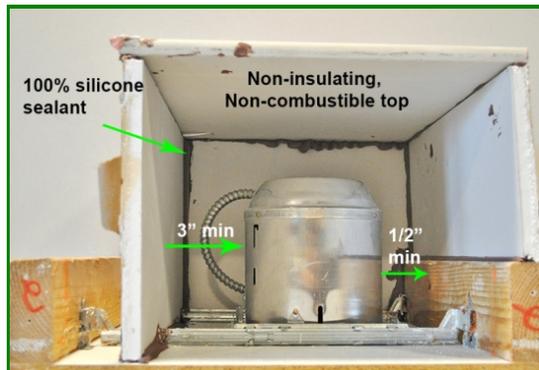
**Objective(s):**

To prevent air leakage, completely adhere the sealant to all surfaces to be sealed



**Before**

Non-IC recessed light fixtures produce excess heat and can be a fire risk



**After**

Entire box should be sealed, but none should come in contact with light

**Tools:**

1. Caulk gun
2. Spray foam gun
3. Putty knife

**Materials:**

1. Fire-rated silicone caulk
2. UL-181 mastic
3. Spray foam

## 4.1001.2 - Knob and Tube Wiring

### Desired Outcome:

Insulation kept away from contact with live wiring

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 4.1001.2a - Identifying knob and tube wiring

### Desired Outcome:

Insulation kept away from contact with live wiring

### Specification(s):

Contractor, assessor, auditor, or similar will inspect and assess the house to identify knob and tube wiring

### Objective(s):

Determine if knob and tube wiring exists



**Unsafe**

Identify knob and tube wiring in homes to insulate properly and safely



More knob & tube wiring



Knob & tube wiring again

## 4.1001.2b - Testing to determine if live

### Desired Outcome:

Insulation kept away from contact with live wiring

### Specification(s):

Non-contact testing method will be used to identify live wiring

### Objective(s):

Ensure safety of occupants, workers, and house

Plan where remediation is needed



**Unsafe**

Knob & tube wiring needs to be tested to determine if still live. Red=live



**Safe**

Live wiring should be dammed or professionally disabled before insulating

### Tools:

1. Non-contact wire tester

## 4.1001.2c - Isolate or replace

### Desired Outcome:

Insulation kept away from contact with live wiring

### Specification(s):

Proper clearance will be maintained around live knob and tube as required by the National Electrical Code ( NEC ) or authority having jurisdiction

When required, a dam that does not cover the top will be created to separate insulation from the wire path

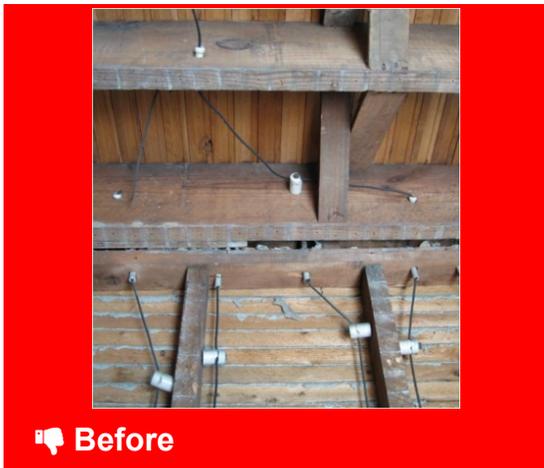
### Objective(s):

Ensure work can be completed safely

Protect occupant and house

Ensure future work can be done safely

Prevent the overheating of the wiring



Knob & tube wiring radiates heat and cannot be insulated over



Before insulation, wiring should be dammed or disabled and replaced

### Tools:

1. Non-contact wire tester
2. Drywall
3. Plywood
4. Saw
5. Drill
6. Tape measure

### Materials:

1. Fasteners
2. Romex as needed

NEC guidelines and local jurisdictions often closely prescribe the treatment of knob & tube wiring. Check your local codes.



If electrician determines wiring is safe and keeps it active, isolate wires



To isolate, dams higher than intended insulation depth should be installed



Warning of knob & tube should be posted at all entrances to related spaces



Warning signs should encourage the use of certified electrician for repairs



Some jurisdictions require warning signs in Spanish as well



If knob & tube can be replaced, all existent k&t should be disabled



Many electricians will remove exposed wires to prevent reactivation



Modern wiring should replace all knob & tube

## 4.1001.3 - Fireplace Chimney and Combustion Flue Vents

### Desired Outcome:

Combustible materials kept away from combustion sources

### 4.1001.3a - Verify attic prep

### Desired Outcome:

Combustible materials kept away from combustion sources

### Specification(s):

Holes, penetrations, and bypasses will be sealed

Dams will be fixed in places that maintain required clearance

### Objective(s):

Prevent air leakage

Ensure insulation dams maintain clearance



 Before

Gaps and penetrations in attic need to be sealed to maintain air barrier



 After

Chimneys, flues, and light fixtures should be dammed to prevent fire

### Tools:

1. Metal snips
2. Caulk gun
3. Fasteners

### Materials:

1. 26-gauge steel sheeting
2. High temperature caulk
3. Caulk
4. Backer rod
5. Spray foam



Gaps around flues and penetrations need to be sealed before insulating



High temperature caulk should be used for flues and chimneys



26-gauge steel should be used to construct seals and dams on flues



Only construct dam after sealing has been completed properly



Dammed chimneys, flues and light fixtures prevent fires

## 4.1001.3b - Required clearance

### Desired Outcome:

Combustible materials kept away from combustion sources

### Specification(s):

A rigid dam having a height to ensure a 3" clearance area free of insulation or combustibles between combustion flue vent and dam, unless the flue vent is listed for a lesser clearance

### Objective(s):

Ensure dam material does not bend, move, or sag

Prevent a fire hazard



**Before**

To prevent fire hazards, flues, chimneys, and light fixtures require dams



**After**

Observe a 3 inch minimum clearance for dams around flues and chimneys

**Tools:**

1. Metal snips

**Materials:**

1. 26-gauge steel sheeting
2. Fasteners

## 4.1001.3c - Safety

**Desired Outcome:**

Combustible materials kept away from combustion sources

**Specification(s):**

Insulation will not be allowed between a heat-generating appliance and a dam unless material is rated for contact with heat generating sources

**Objective(s):**

Prevent a fire hazard



**Before**

Dams around flues, chimneys, and light fixtures should hold back insulation



**After**

Clear dams of any loose insulation in order to minimize risk of fire

# 4.1001.3d - Occupant education

## Desired Outcome:

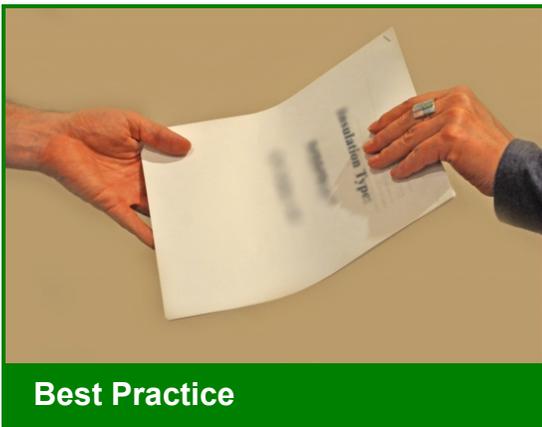
Combustible materials kept away from combustion sources

## Specification(s):

Documentation of material and R-value will be provided to occupant

## Objective(s):

Provide occupant with documentation of installation

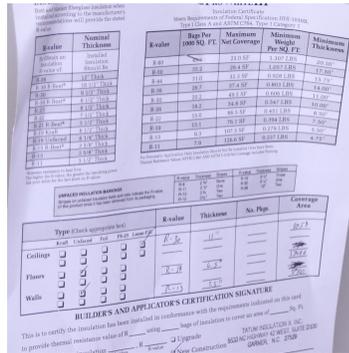


**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1001.4 - Vented Eave or Soffit Baffles

### Desired Outcome:

Attic ventilation meets code requirements and insulation is protected from wind washing

### Note:

### 4.1001.4a - Installation

### Desired Outcome:

Attic ventilation meets code requirements and insulation is protected from wind washing

### Specification(s):

If soffit venting or eave venting is present, baffles will be mechanically fastened to block wind entry into insulation or to prevent insulation from blowing back into the attic

If soffit venting or eave venting is present, baffles will be installed to maintain clearance between the roof deck and baffle in accordance with manufacturer specifications

Installation will allow for the highest possible R-value above the top plate of the exterior wall

### Objective(s):

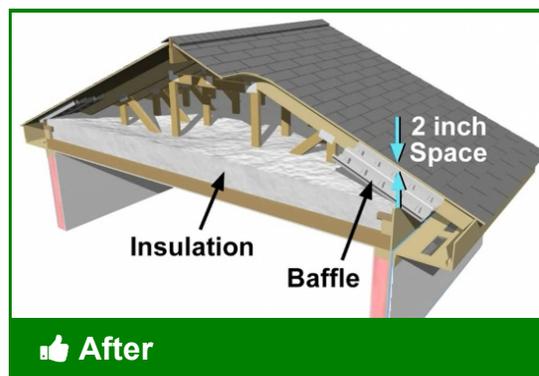
Ensure insulation R-value is not reduced

Maintain attic ventilation



 Before

Insulation should not block vented eaves



 After

Baffles installed in vented attics to allow air flow past insulation

### Tools:

1. Stapler

### Materials:

1. Baffles
2. Staples



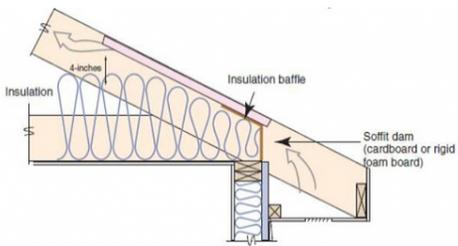
Allow a standard two inch gap for air flow through eave



Baffles should be securely fastened to prevent movement over time



Once baffles are properly installed, insulation can be placed against them



Baffles also hold insulation from falling into eave

## 4.1003.3 - Unvented Flat Roof with Existing Insulation

### Desired Outcome:

Insulation reduces heat flow through unvented roof

## 4.1003.3a - Ventilation

### Desired Outcome:

Insulation reduces heat flow through unvented roof

### Specification(s):

Code compliant ventilation will be installed before insulation

### Objective(s):

Reduce possibility of moisture issues



Unvented flat roofs should have venting installed



Vents in the space below the roof help maintain proper air flow

### Tools:

1. Saw
2. Grinder
3. Metal snips
4. Drill

### Materials:

1. Metal lath
2. Stucco



Unvented flat roofs should have venting installed



Vents in the space below the roof help maintain proper air flow



Mushroom capped vents in the roof are equally important to air flow

## 4.1003.3b - Installation

### Desired Outcome:

Insulation reduces heat flow through unvented roof

### Specification(s):

Roof cavities will be blown with loose fill insulation (or roof cavities will be dense packed with insulation) without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



**Before**

Vent reveals attic is insulated with old rug -- not adequate.



**In Progress**

Attic will be dense packed to r-value specified on Work Order.

**Tools:**

1. Insulation machine

**Materials:**

1. Loose fillable or dense packable insulation

## 4.1003.3c - Occupant education

**Desired Outcome:**

Insulation reduces heat flow through unvented roof

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

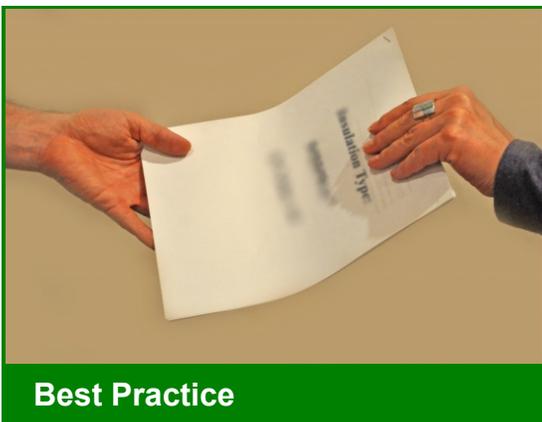
**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



Provide occupant with documentation of and about insulation installed



## 4.1004.1 - Preparation for Dense Packing

### **Desired Outcome:**

Airtight cavity and insulated knee wall

## 4.1004.1a - Backing

### **Desired Outcome:**

Airtight cavity and insulated knee wall

### **Specification(s):**

All knee walls will have top and bottom plate or blockers installed using rigid materials

When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed

If fabric is used before dense packing, it will be secured, according to manufacturers specifications or with furring strips every wall stud

If rigid material is used, material will be installed to cover 100% of the surface of the accessible knee wall area

If foam sheathing is used, sheathing will be listed for uncovered use in an attic or covered with a fire barrier

### **Objective(s):**

Eliminate bending, sagging, or movement that may result in air leakage

Prevent air leakage through the top or bottom of the knee wall

Ensure material will not tear under stress from wind loads or insulation



🗨 Before

Knee walls often need sealing and insulation



👍 After

Knee wall is prepped for dense pack insulation

**Tools:**

1. Tape measure
2. Utility knife
3. Caulk gun
4. Spray foam gun
5. Drill
6. Stapler

**Materials:**

1. Drywall
2. XPS
3. Caulk
4. Spray foam
5. Fasteners
6. Staples



Knee walls missing top plates need one created from rigid material



Top plate holds dense pack insulation in cavity



New top plate should be sealed to surrounding joists and studs



Bottom plates also need to be installed. Measure for size

Cut to size and attempt to install in line with air barrier above

Seal to surrounding joist



If using house-wrap or fabric, tack in place with furring strips or staples



Drywall is also a good barrier for dense packing knee walls

## 4.1004.1b - Installation

### Desired Outcome:

Airtight cavity and insulated knee wall

### Specification(s):

All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

Insulation that is blown behind fabric or air barrier material will be blown dense to a minimum specification of 3.5 pounds per cubic foot for cellulose

Follow manufacturer's requirements for fiberglass dense pack applications

### Objective(s):

Eliminate misalignment of existing insulation

Prevent insulation from settling or moving



**Before**

Existing batt insulation should be adjusted to fit properly



**After**

If properly dense-packed, insulation should hold in place when finished



Attach furring strips to create pockets for dense-pack insulation



Insulation should meet manufacturer specifications for density.

## 4.1004.2 - Preparation for Batt Insulation

### Desired Outcome:

Airtight cavity and properly insulated knee wall

## 4.1004.2a - Knee wall prep for batts

### Desired Outcome:

Airtight cavity and properly insulated knee wall

### Specification(s):

All knee walls will have a top and bottom plate or blockers installed using a Rigid material

All joints, cracks, and penetrations will be sealed in finished material, including interior surface to framing connections

When knee wall floor and walls are being insulated, the floor joist running under the knee wall will be air sealed.

### Objective(s):

Eliminate bending, sagging, or movement that may result in air leakage

Prevent air leakage through the top or bottom of the knee wall

Create an air barrier



Top plate is missing from knee wall



New top plate is sealed to adjacent framing

**Tools:**

1. Spray foam gun
2. Caulk gun
3. Tape measure
4. Utility knife
5. Drill
6. Saw

**Materials:**

1. XPS
2. Lumber
3. Caulk
4. Spray foam
5. Fasteners



Top plate has been cut and fit to size



Top plate has been sealed to adjacent framing



Bottom plate is also missing. Space is measured so XPS can be cut



Bottom plate is cut to size



Bottom plate is placed in line with interior air barrier



Bottom plate is also sealed to surrounding joist and framing

## 4.1004.2b - Installation

**Desired Outcome:**

Airtight cavity and properly insulated knee wall

**Specification(s):**

Insulation will be installed using one of the following methods:

- New batts will be installed in accordance with manufacture specifications

- All existing batted insulation will be adjusted to ensure it is in full contact with the interior cladding and the top and bottom plates

**Objective(s):**

Eliminate misalignment of existing insulation



**Before**

Knee wall with batts improperly installed and missing from stud bays



**After**

Properly fit insulation filling full volume of stud bay

**Tools:**

1. Utility knife
2. Tape measure

**Materials:**

1. Fiberglass batts



Where existing insulation is improperly installed, fix it



Kraft-face should go to "warm in winter" side and batt should fill bay



Batts should fill entire volume of knee wall stud bays

**4.1004.2c - Backing knee wall**

**Desired Outcome:**

Airtight cavity and properly insulated knee wall

**Specification(s):**

If rigid material is used, material will be installed to cover 100% of the surface of the knee wall

If foam sheathing is used, sheathing will be listed for uncovered use in attic, or covered with a fire barrier

**Objective(s):**

Prevent insulation from settling or moving



**Before**

Knee walls with batt insulation require covering



**After**

Foam sheathing? Needs to be covered with a fire barrier

**Tools:**

1. Utility knife
2. Tape measure
3. Drill

**Materials:**

1. Drywall
2. House wrap



Fiberglass batts in attic knee walls can be held in place by house wrap



If foam sheathing is used, it needs to be covered with a fire barrier

## 4.1005.1 - Accessible Floors—Batt Installation

### Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

### 4.1005.1a - Preparation

### Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces

All electrical junctions will be flagged to be seen above the level of the insulation

Open electrical junction boxes will have covers installed

### Objective(s):

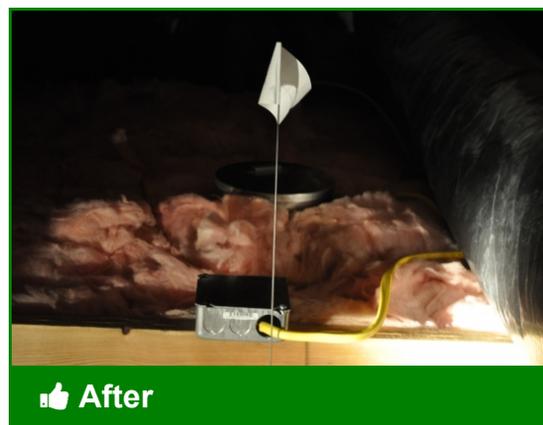
Access the workspace

Provide location of electrical junctions for future servicing

Prevent an electrical hazard



Remove flooring in attic spaces to access floor cavities and insulate



Flag electrical junctions to make future maintenance and repairs easier

**Tools:**

1. Hammer
2. Pry bar

**Materials:**

1. Flags



Pry up flooring to access floor cavities



Check cavity for electrical junctions and penetrations



If electrical junctions are found, they should be enclosed and flagged



Air seal any penetrations

## 4.1005.1b - Installation

**Desired Outcome:**

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**

Batt insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to the prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



Accessible attic floors should be air sealed and insulated



Insulate floor cavities to prescribe R-value from the work order

**Tools:**

1. Hammer
2. Utility knife
3. Tape measure

**Materials:**

1. Fiberglass batts



Insert fiberglass batts into floor cavities, kraft-face down



Fill entire volume of floor cavity



Once insulated, flooring should be reinstalled

## 4.1005.1c - Occupant education

**Desired Outcome:**

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness

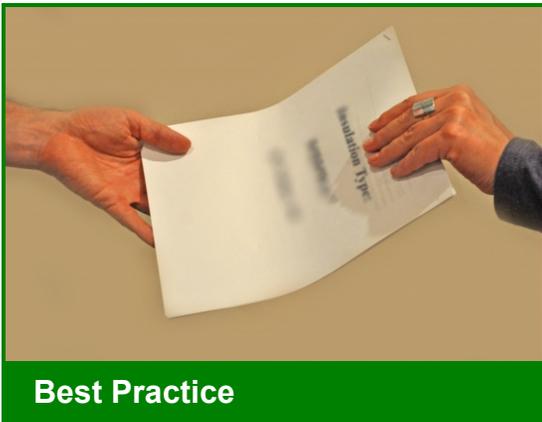
- R-value

**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Type	R-value	Thickness	No. Pkg.	Coverage Area
Blanket				
Cellulose				
Fiberglass				
Mineral Wool				
Perlite				
Polystyrene				
Urethane				
XPS				

Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1005.2 - Accessible Floors—Loose Fill Installation

### Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

## 4.1005.2a - Preparation

### Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Subfloor or drywall will be removed to access cavities as necessary, including inaccessible knee-wall attic floor spaces

Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier

All electrical boxes will be flagged to be seen above the level of the insulation

Open electrical junctions will have covers installed

Insulation dams and enclosures will be installed as required

### Objective(s):

Access the workspace

Verify uniformity of insulation material

Provide location of electrical boxes for future servicing

Prevent an electrical hazard



Accessible attic floors should be air sealed and insulated



Depth markers and insulation dams aid in proper insulation of attic spaces

**Tools:**

1. Pry bar
2. Hammer
3. Caulk gun
4. Utility knife
5. Staple gun
6. Spray foam gun
7. Tape measure

**Materials:**

1. Flags
2. Depth markers
3. Staples
4. XPS
5. Caulk
6. Spray foam



Check cavity for electrical junctions and penetrations



Flag and install covers on electrical junctions



Seal any penetrations



Non-IC (insulation contact) can lights should be covered with a dam and have no insulation on top



Install depth markers and insulation dams above height of insulation

## 4.1005.2b - Air barrier

### Desired Outcome:

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

### Objective(s):

Hold dense pack in place



**Before**

When missing, bottom plates must be installed under knee walls



**After**

New bottom plates complete air barrier and hold insulation in place

**Tools:**

1. Tape measure
2. Utility knife
3. Saw
4. Drill
5. Spray foam gun
6. Caulk gun

**Materials:**

1. Spray foam
2. XPS
3. Drywall
4. Plywood
5. Fasteners
6. Caulk sealant



Measure floor cavity for new bottom plate



Cut rigid material, such as XPS, to size to snugly fit into cavity



Align block with air barrier of conditioned space



Air seal around new bottom plate with spray foam

## 4.1005.2c - Installation

**Desired Outcome:**

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**

All insulation will be installed to the minimum unsettled depth and the maximum coverage per bag to reach a consistent depth for desired R-value indicated on the manufacturer's coverage chart.

**Objective(s):**

Reduce heating and air conditioning costs

Improve comfort

Minimize noise



**Before**

Accessible attic floor should be air sealed and insulated



**After**

Check chart on package to ensure proper insulation depth to achieve R-value

**Tools:**

1. Insulation machine

**Materials:**

1. Loose fill insulation



Use depth markers to ensure insulation has reached prescribed R-value



Where flooring cannot be removed, verify insulation is meeting R-value goal

**4.1005.2d - Onsite documentation**

**Desired Outcome:**

Consistent, thermal boundary between conditioned and unconditioned space controls the heat flow

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness
- Number of bags installed in accordance with manufacturer specification

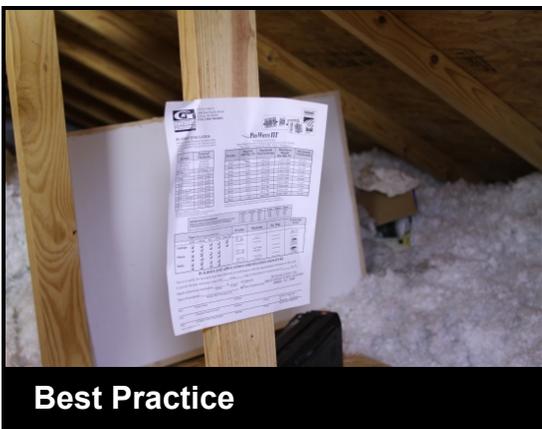
**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

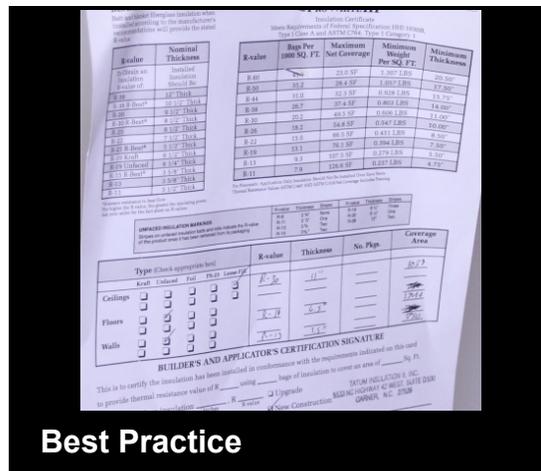
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Information on insulation installed should be posted nearby



**Best Practice**

Posted info includes insulation type, r-value, depth, coverage area, etc.

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. To figure out the R-value of the insulation, use the data that the manufacturer gives you. The receipt must be dated and signed by the installer.

## **4.1005.3 - Accessible Floors—Batt Insulation Over Existing Insulation**

### **Desired Outcome:**

Insulation controls heat transfer through ceiling

### **4.1005.3a - Preparation**

#### **Desired Outcome:**

Insulation controls heat transfer through ceiling

#### **Specification(s):**

Existing insulation will be in contact with the air barrier prior to installing additional insulation on top

#### **Objective(s):**

Ensure proper performance of insulation

### **4.1005.3b - Installation**

#### **Desired Outcome:**

Insulation controls heat transfer through ceiling

#### **Specification(s):**

If the top of the existing insulation is below the top of the framing, new batts will be installed parallel with framing members

If the top of the existing insulation is above the top of the framing, new batts will be installed perpendicular to framing members

#### **Objective(s):**

Ensure uniform depth of insulation in continuous contact with existing insulation

Eliminate voids and gaps

### **4.1005.3c - Insulation**

#### **Desired Outcome:**

Insulation controls heat transfer through ceiling

**Specification(s):**

Batts will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value

## 4.1005.3d - Safety

**Desired Outcome:**

Insulation controls heat transfer through ceiling

**Specification(s):**

Insulation will not be allowed on top of non-IC rated can light boxes or between a heat generating appliance and a dam, unless material is rated for contact with heat generating sources

**Objective(s):**

Prevent a fire hazard

## 4.1005.3e - Onsite documentation

**Desired Outcome:**

Insulation controls heat transfer through ceiling

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

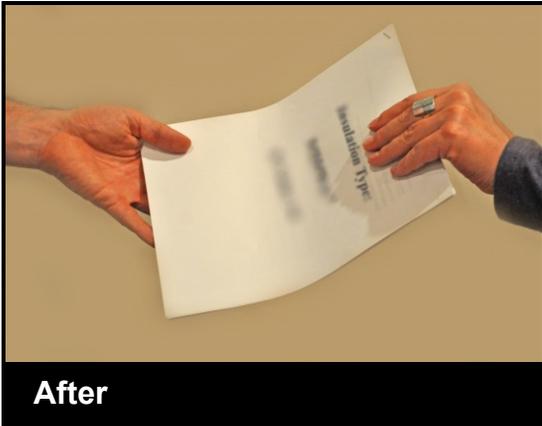
**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

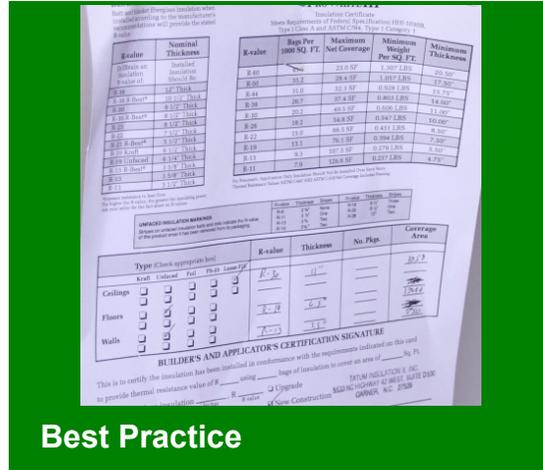
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



After

Provide occupant with documentation of and about insulation installed



Best Practice

Documentation should include insulation material and r-value

## 4.1005.4 - Accessible Floors—Loose Fill Over Existing Insulation

### Desired Outcome:

Insulation controls heat transfer through ceiling

### 4.1005.4a - Preparation

#### Desired Outcome:

Insulation controls heat transfer through ceiling

#### Specification(s):

Existing insulation will be in contact with the air barrier prior to installing additional insulation on top

Insulation will be adequately marked for depth a minimum of every 300 square feet of attic area, with measurement beginning at the air barrier

All electrical junction boxes will be flagged to be seen above the level of the insulation

Open electrical junction boxes will have covers installed

Insulation dams and enclosures will be installed as required

#### Objective(s):

Ensure proper performance of insulation Verify uniformity of insulation material Provide location of electrical junctions for future servicing

Prevent an electrical hazard

### 4.1005.4b - Installation

#### Desired Outcome:

Insulation controls heat transfer through ceiling

#### Specification(s):

The correct depth and number of bags will be blown in accordance with manufacturer specifications

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value

## 4.1005.4c - Safety

**Desired Outcome:**

Insulation controls heat transfer through ceiling

**Specification(s):**

Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources

**Objective(s):**

Prevent a fire hazard

## 4.1005.4d - Onsite documentation

**Desired Outcome:**

Insulation controls heat transfer through ceiling

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

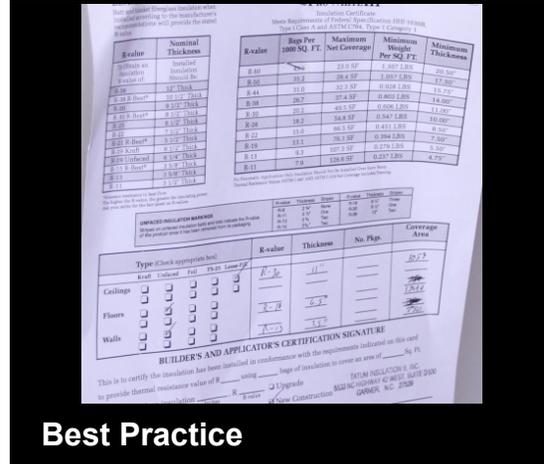
Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Written documentation of insulation type and efficiency will be provided



**Best Practice**

Information should include depth of loose fill installed and once settled

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For loose-fill, the receipt must show the coverage area, initial installed thickness, minimum settled thickness, R-value, and the number of bags used. To figure out the R-value of the insulation, use the data that the manufacturer gives you. The receipt must be dated and signed by the installer.

## 4.1005.5 - Enclosed Bonus Room Floor Over Unconditioned Space—Dense Pack Installation

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### 4.1005.5a - Air barrier

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

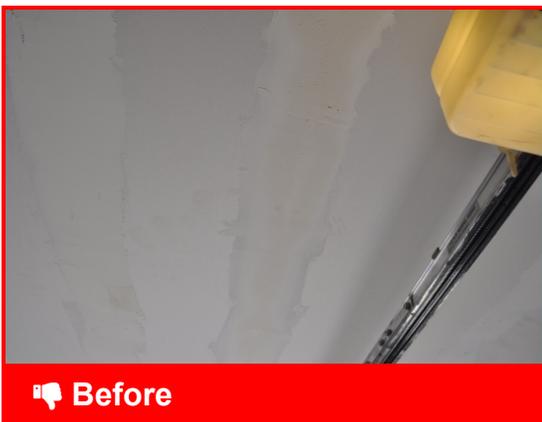
### Specification(s):

Existence of air barrier material in line with the knee walls will be installed or verified when dense packing

Air barrier material will not bend, sag, or move once dense packed

### Objective(s):

Hold dense pack in place



This finished garage below a bonus room is an unconditioned space



Rigid material forms an air barrier located under the bonus room stem wall

### Tools:

1. Drywall saw
2. Utility knife
3. Tape measure
4. Straight edge

### Materials:

1. XPS or other rigid material
2. Fasteners



Snap chalk lines to keep access cuts clean and easy to repair



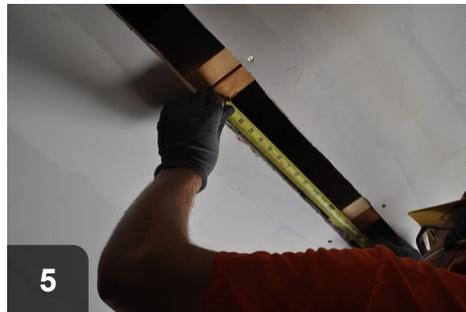
Cut through garage ceiling to access joist cavities below bonus room



The rigid block should be placed in line with the stem wall above



Measure joist cavity depth



Measure joist cavity width



Cut XPS, or other rigid material, to measured size of joist cavity



Rigid block should fit snugly into joist cavity and be fastened mechanically to prevent insulation leaks



Fastened rigid block will hold the insulation in place under the bonus room above

## 4.1005.5b - Fill floors

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Each cavity will be 100% filled to consistent density:

- Cellulose material will be installed to a minimum density of 3.5 pounds per cubic foot or to a maximum density structurally allowable
- Loose fiberglass material will be installed and will be specifically approved for air flow resistance to a minimum density per the manufacturer's recommendations

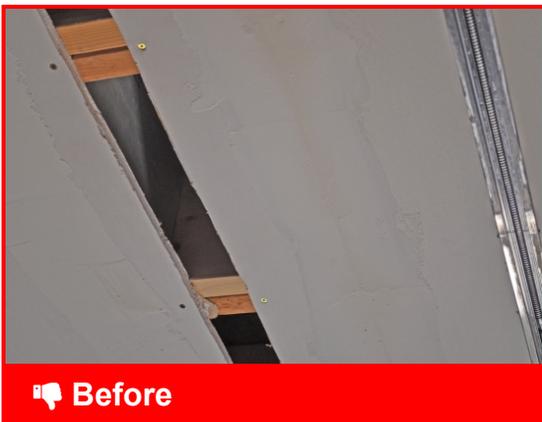
The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction

### Objective(s):

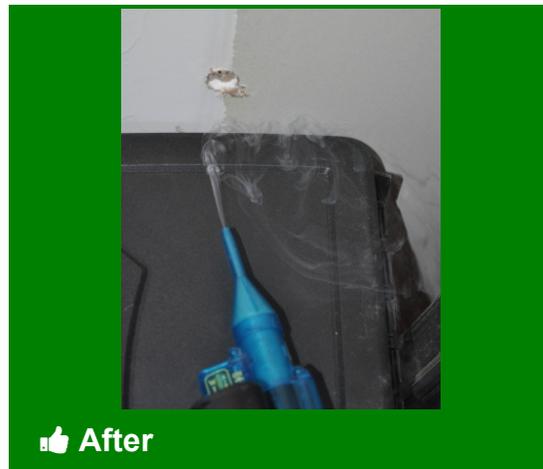
Eliminate voids and settling

Minimize framing cavity air flows



**Before**

With rigid block in place under bonus room stem wall, insulation can begin



**After**

Chemical smoke at 50pa indicates insulation is at appropriate density

### Tools:

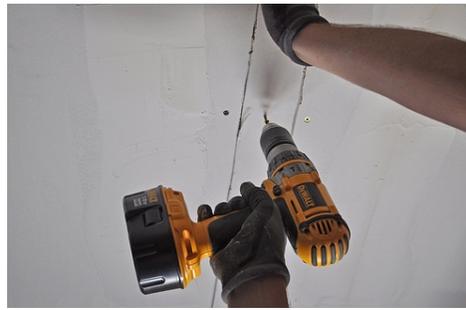
1. Insulation machine
2. Drill
3. Smoke pencil
4. Blower door
5. Small hole saw bit

### Materials:

1. Cellulose insulation
2. Dense packable insulation
3. Spackle
4. Seam tape



Blow insulation into cavities to density appropriate for chosen material



Close cavities with access panel cut out at the beginning



Cut small test holes in cavities to verify specified density has been met



Set up blower door and depressurize bonus room to -50pa wrt outside



With blower door running, chemical smoke should not draw into test holes



Tape and spackle access panel and test holes to repair garage ceiling

## 4.1005.5c - Safety

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

Insulation will not be allowed on top of non-IC rated can light boxes or between a heat-generating appliance and a dam, unless material is rated for contact with heat generating sources

### Objective(s):

Prevent a fire hazard



👎 Before

Dams around flues, chimneys, and light fixtures should hold back insulation



👍 After

Clear dams of any insulation or debris in order to minimize risk of fire



No insulation on top of non-insulation contact (non-IC) rated fixtures

## 4.1005.5d - Onsite documentation

### Desired Outcome:

A consistent thermal boundary between conditioned and unconditioned space controls the heat flow

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



Documentation of insulation installed should be provided in writing

Paraphrased from 16 CFR 460.17: If you are an installer, you must give your customers a contract or receipt for the insulation you install. For all insulation except loose-fill and aluminum foil, the receipt must show the coverage area, thickness, and R-value of the insulation you installed. The receipt must be dated and signed by the installer. To figure out the R-value of the insulation, use the data that the manufacturer gives you.



Rather than posting in the insulated space, a "receipt" may be provided

Insulation Type	Nominal Thickness	R-value	Weight Per Sq. Ft.	Minimum Thickness
Polystyrene	1 1/2" Thick	5.0	2.50	1 1/2"
Polystyrene	2" Thick	6.7	3.33	2"
Polystyrene	2 1/2" Thick	8.3	4.17	2 1/2"
Polystyrene	3" Thick	10.0	5.00	3"
Polystyrene	3 1/2" Thick	11.7	5.85	3 1/2"
Polystyrene	4" Thick	13.3	6.67	4"
Polystyrene	4 1/2" Thick	15.0	7.50	4 1/2"
Polystyrene	5" Thick	16.7	8.33	5"
Polystyrene	5 1/2" Thick	18.3	9.17	5 1/2"
Polystyrene	6" Thick	20.0	10.00	6"
Polystyrene	6 1/2" Thick	21.7	10.85	6 1/2"
Polystyrene	7" Thick	23.3	11.67	7"
Polystyrene	7 1/2" Thick	25.0	12.50	7 1/2"
Polystyrene	8" Thick	26.7	13.33	8"
Polystyrene	8 1/2" Thick	28.3	14.17	8 1/2"
Polystyrene	9" Thick	30.0	15.00	9"
Polystyrene	9 1/2" Thick	31.7	15.85	9 1/2"
Polystyrene	10" Thick	33.3	16.67	10"
Polystyrene	10 1/2" Thick	35.0	17.50	10 1/2"
Polystyrene	11" Thick	36.7	18.33	11"
Polystyrene	11 1/2" Thick	38.3	19.17	11 1/2"
Polystyrene	12" Thick	40.0	20.00	12"
Polystyrene	12 1/2" Thick	41.7	20.85	12 1/2"
Polystyrene	13" Thick	43.3	21.67	13"
Polystyrene	13 1/2" Thick	45.0	22.50	13 1/2"
Polystyrene	14" Thick	46.7	23.33	14"
Polystyrene	14 1/2" Thick	48.3	24.17	14 1/2"
Polystyrene	15" Thick	50.0	25.00	15"
Polystyrene	15 1/2" Thick	51.7	25.85	15 1/2"
Polystyrene	16" Thick	53.3	26.67	16"
Polystyrene	16 1/2" Thick	55.0	27.50	16 1/2"
Polystyrene	17" Thick	56.7	28.33	17"
Polystyrene	17 1/2" Thick	58.3	29.17	17 1/2"
Polystyrene	18" Thick	60.0	30.00	18"
Polystyrene	18 1/2" Thick	61.7	30.85	18 1/2"
Polystyrene	19" Thick	63.3	31.67	19"
Polystyrene	19 1/2" Thick	65.0	32.50	19 1/2"
Polystyrene	20" Thick	66.7	33.33	20"
Polystyrene	20 1/2" Thick	68.3	34.17	20 1/2"
Polystyrene	21" Thick	70.0	35.00	21"
Polystyrene	21 1/2" Thick	71.7	35.85	21 1/2"
Polystyrene	22" Thick	73.3	36.67	22"
Polystyrene	22 1/2" Thick	75.0	37.50	22 1/2"
Polystyrene	23" Thick	76.7	38.33	23"
Polystyrene	23 1/2" Thick	78.3	39.17	23 1/2"
Polystyrene	24" Thick	80.0	40.00	24"
Polystyrene	24 1/2" Thick	81.7	40.85	24 1/2"
Polystyrene	25" Thick	83.3	41.67	25"
Polystyrene	25 1/2" Thick	85.0	42.50	25 1/2"
Polystyrene	26" Thick	86.7	43.33	26"
Polystyrene	26 1/2" Thick	88.3	44.17	26 1/2"
Polystyrene	27" Thick	90.0	45.00	27"
Polystyrene	27 1/2" Thick	91.7	45.85	27 1/2"
Polystyrene	28" Thick	93.3	46.67	28"
Polystyrene	28 1/2" Thick	95.0	47.50	28 1/2"
Polystyrene	29" Thick	96.7	48.33	29"
Polystyrene	29 1/2" Thick	98.3	49.17	29 1/2"
Polystyrene	30" Thick	100.0	50.00	30"

Information should include insulation type, r-value, coverage area, etc.

## 4.1006.1 - Pull-Down Stairs

### Desired Outcome:

Pull-down attic stair properly sealed and insulated

## 4.1006.1a - Installation

### Desired Outcome:

Pull-down attic stair properly sealed and insulated

### Specification(s):

Top-side of the attic enclosure will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly

Pull-down stair rough opening will be surrounded with a durable, rigid dam that is higher than the level of the attic floor insulation

Counter-weights should be considered to ease accessibility for excessively heavy hatches

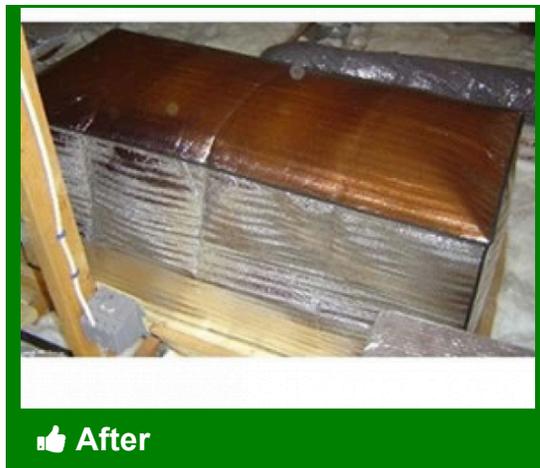
### Objective(s):

Achieve uniform R-value

Prevent loose insulation from entering the living area



Insulation needs to be dammed to keep from falling through during operation



Insulated pull-down stairs cover installed to prevent air leakage

**Tools:**

1. Tape measure
2. Drill
3. Saw
4. Caulk gun

**Materials:**

1. Caulk sealant
2. Lumber
3. XPS
4. Pre-fabricated stairwell cover



Stairs and hatch should both be insulated to match r-value of attic

## 4.1006.1b - Sealing

**Desired Outcome:**

Pull-down attic stair properly sealed and insulated

**Specification(s):**

Entire pull-down stair assembly will be covered with an airtight and removable/openable enclosure inside the attic space

Pull-down stair frame will be caulked, gasketed, weatherstripped, or otherwise sealed with an air barrier material, suitable film, frictionally engaging components or solid material that allows attic door operation

**Objective(s):**

Prevent air leakage



**Before**

Unsealed pull-down stairs leads to air leakage to and from the attic



**After**

To preserve thermal envelope, an airtight seal needs to be created

**Tools:**

1. Caulk gun

**Materials:**

1. Weatherstripping
2. Spray foam
3. Caulk



Seal around frame of pull-down stairs with appropriate sealant



Weatherstrip around stair panel to encourage a tight seal



Remember to seal finish details and trim



Insulation and sealing should be airtight but openable

## 4.1006.2 - Access Doors and Hatches

### Desired Outcome:

Attic access door properly sealed and insulated

## 4.1006.2a - Installation

### Desired Outcome:

Attic access door properly sealed and insulated

### Specification(s):

Hatches will be insulated to the maximum R-value structurally allowable up to the R-value of the adjoining insulated assembly

Attic hatches rough opening will be surrounded with a durable,rigid protective baffle that is higher than the level of the surrounding attic floor insulation

### Objective(s):

Achieve uniform R-value on the attic door or hatch

Achieve uniform R-value on the attic floor

Prevent loose attic floor insulation from entering the living area



 Before

Uninsulated attic hatches and access panels weaken the thermal envelope



 After

Hatch cover or panel access door should match r-value of attic insulation

**Materials:**

1. XPS
2. Lumber
3. Weatherstripping
4. Fasteners



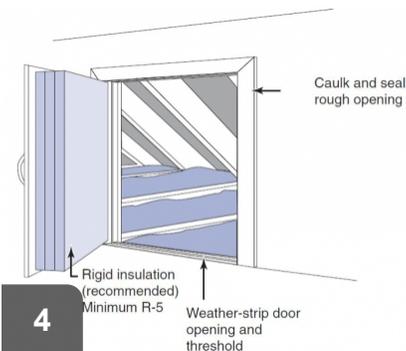
1 Create hatch cover that matches r-value of surrounding insulation



2 Build dam to hold back attic insulation and hold cover in place tightly



3 Weatherstrip underside of hatch cover to create tight seal



4 Alternate installation for vertical access panel to attic

## 4.1006.2b - Sealing

**Desired Outcome:**

Attic access door properly sealed and insulated

**Specification(s):**

Access hatch frames will be sealed using caulk, gasket, weather-strip, or otherwise sealed with an air barrier material, suitable film, or solid material

Options will include installing a latch or lock or frictionally engaged components that do not require a latch

The measure must include a protective baffle or insulation barrier

**Objective(s):**

Prevent air leakage



Unsealed attic hatches and panel doors allow air leakage to and from attic



Once sealed, air leakage at attic hatch or door should be minimized

**Materials:**

1. Weatherstripping
2. 3/4" Lumber
3. Caulk



Remember to seal around finish details and framing on interior



Build insulation dam from 3/4 inch lumber and seal around base



Weatherstrip around bottom edge of hatch cover to create air tight seal

**4.1006.2c - Attachment**

**Desired Outcome:**

Attic access door properly sealed and insulated

**Specification(s):**

Insulation will be permanently attached and in complete contact with the air barrier

**Objective(s):**

Insulate to prescribed R-value



**Before**

Unsealed and uninsulated attic hatches and access doors allow leakage



**After**

Rigid insulation on back of new hatch cover attached firmly and squarely to allow for air-tight fit

**Tools:**

1. Caulk gun
2. Utility knife

**Materials:**

1. XPS
2. Adhesive



1

Apply foam tape to "warm side" face of attic hatch



2

Ensure an air tight seal by making sure foam tape has no gaps



3

Apply strong adhesive to "cold-side" of hatch



4



5



6

Adhesive should ring perimeter as well as criss-crossing hatch to ensure complete attachment of insulation

Affix XPS insulation to "cold-side" of hatch with adhesive, ensuring XPS is tight and square to hatch

Repeat adhesive and XPS layers to reach maximum R-value without making hatch excessively heavy or awkward



All XPS layers should be attached firmly to one another and square to hatch

## 4.1088.3 - Skylights

**Desired Outcome:**

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

### 4.1088.3a - Sealing

**Desired Outcome:**

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

**Specification(s):**

Holes and penetrations will be sealed

Bypasses will be blocked and sealed

**Objective(s):**

Prevent air leakage

### 4.1088.3b - Installation

**Desired Outcome:**

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

**Specification(s):**

Insulation will be installed in accordance with manufacturer specifications and will be in full contact with all sides of existing cavity without gaps, voids, compressions, misalignments, or wind intrusions

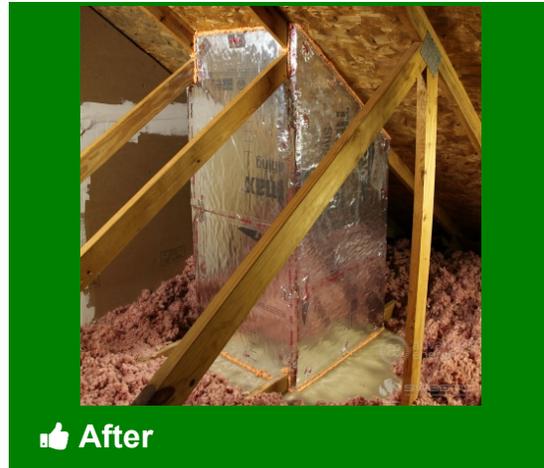
Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



Uninsulated, unsealed skylight well



Insulated, air sealed skylight well

**Tools:**

1. stapler
2. tape measure
3. utility knife
4. caulking gun
5. foam gun

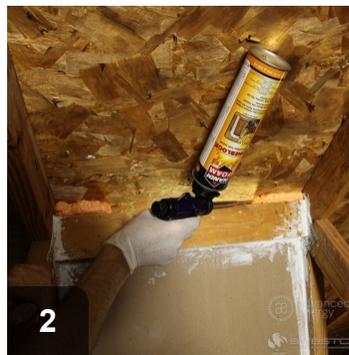
**Materials:**

1. caulk
2. one-part foam sealant
3. insulation (fiberglass, cellulose, spray polyurethane foam, polyisocyanurate board, extruded polystyrene board, or other as needed to achieve specified R-value)
4. air barrier material (drywall, foam board, paneling, hardboard, etc.)

Air-permeable insulation such as fiberglass or cellulose should be covered with a sealed attic-side air barrier.



Skylight well



Carefully seal all seams and joints



Install insulation in complete contact with all sides of the cavity.



Install an attic-side air barrier.



The air barrier may be constructed from rigid insulation board. Seal the attic side air barrier

## 4.1088.3c - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

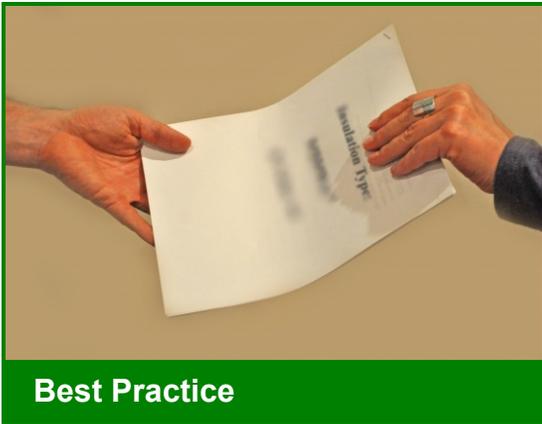
- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Type	Rated Thickness	R-value	Max. Depth	Min. Depth	Min. Area
Blanket	1.5"	3.13	1.5"	1.5"	100%
Blanket	2.0"	4.18	2.0"	2.0"	100%
Blanket	2.5"	5.23	2.5"	2.5"	100%
Blanket	3.0"	6.28	3.0"	3.0"	100%
Blanket	3.5"	7.33	3.5"	3.5"	100%
Blanket	4.0"	8.38	4.0"	4.0"	100%
Blanket	4.5"	9.43	4.5"	4.5"	100%
Blanket	5.0"	10.48	5.0"	5.0"	100%
Blanket	5.5"	11.53	5.5"	5.5"	100%
Blanket	6.0"	12.58	6.0"	6.0"	100%
Blanket	6.5"	13.63	6.5"	6.5"	100%
Blanket	7.0"	14.68	7.0"	7.0"	100%
Blanket	7.5"	15.73	7.5"	7.5"	100%
Blanket	8.0"	16.78	8.0"	8.0"	100%
Blanket	8.5"	17.83	8.5"	8.5"	100%
Blanket	9.0"	18.88	9.0"	9.0"	100%
Blanket	9.5"	19.93	9.5"	9.5"	100%
Blanket	10.0"	20.98	10.0"	10.0"	100%
Blanket	10.5"	22.03	10.5"	10.5"	100%
Blanket	11.0"	23.08	11.0"	11.0"	100%
Blanket	11.5"	24.13	11.5"	11.5"	100%
Blanket	12.0"	25.18	12.0"	12.0"	100%
Blanket	12.5"	26.23	12.5"	12.5"	100%
Blanket	13.0"	27.28	13.0"	13.0"	100%
Blanket	13.5"	28.33	13.5"	13.5"	100%
Blanket	14.0"	29.38	14.0"	14.0"	100%
Blanket	14.5"	30.43	14.5"	14.5"	100%
Blanket	15.0"	31.48	15.0"	15.0"	100%
Blanket	15.5"	32.53	15.5"	15.5"	100%
Blanket	16.0"	33.58	16.0"	16.0"	100%
Blanket	16.5"	34.63	16.5"	16.5"	100%
Blanket	17.0"	35.68	17.0"	17.0"	100%
Blanket	17.5"	36.73	17.5"	17.5"	100%
Blanket	18.0"	37.78	18.0"	18.0"	100%
Blanket	18.5"	38.83	18.5"	18.5"	100%
Blanket	19.0"	39.88	19.0"	19.0"	100%
Blanket	19.5"	40.93	19.5"	19.5"	100%
Blanket	20.0"	41.98	20.0"	20.0"	100%
Blanket	20.5"	43.03	20.5"	20.5"	100%
Blanket	21.0"	44.08	21.0"	21.0"	100%
Blanket	21.5"	45.13	21.5"	21.5"	100%
Blanket	22.0"	46.18	22.0"	22.0"	100%
Blanket	22.5"	47.23	22.5"	22.5"	100%
Blanket	23.0"	48.28	23.0"	23.0"	100%
Blanket	23.5"	49.33	23.5"	23.5"	100%
Blanket	24.0"	50.38	24.0"	24.0"	100%
Blanket	24.5"	51.43	24.5"	24.5"	100%
Blanket	25.0"	52.48	25.0"	25.0"	100%
Blanket	25.5"	53.53	25.5"	25.5"	100%
Blanket	26.0"	54.58	26.0"	26.0"	100%
Blanket	26.5"	55.63	26.5"	26.5"	100%
Blanket	27.0"	56.68	27.0"	27.0"	100%
Blanket	27.5"	57.73	27.5"	27.5"	100%
Blanket	28.0"	58.78	28.0"	28.0"	100%
Blanket	28.5"	59.83	28.5"	28.5"	100%
Blanket	29.0"	60.88	29.0"	29.0"	100%
Blanket	29.5"	61.93	29.5"	29.5"	100%
Blanket	30.0"	62.98	30.0"	30.0"	100%
Blanket	30.5"	64.03	30.5"	30.5"	100%
Blanket	31.0"	65.08	31.0"	31.0"	100%
Blanket	31.5"	66.13	31.5"	31.5"	100%
Blanket	32.0"	67.18	32.0"	32.0"	100%
Blanket	32.5"	68.23	32.5"	32.5"	100%
Blanket	33.0"	69.28	33.0"	33.0"	100%
Blanket	33.5"	70.33	33.5"	33.5"	100%
Blanket	34.0"	71.38	34.0"	34.0"	100%
Blanket	34.5"	72.43	34.5"	34.5"	100%
Blanket	35.0"	73.48	35.0"	35.0"	100%
Blanket	35.5"	74.53	35.5"	35.5"	100%
Blanket	36.0"	75.58	36.0"	36.0"	100%
Blanket	36.5"	76.63	36.5"	36.5"	100%
Blanket	37.0"	77.68	37.0"	37.0"	100%
Blanket	37.5"	78.73	37.5"	37.5"	100%
Blanket	38.0"	79.78	38.0"	38.0"	100%
Blanket	38.5"	80.83	38.5"	38.5"	100%
Blanket	39.0"	81.88	39.0"	39.0"	100%
Blanket	39.5"	82.93	39.5"	39.5"	100%
Blanket	40.0"	83.98	40.0"	40.0"	100%
Blanket	40.5"	85.03	40.5"	40.5"	100%
Blanket	41.0"	86.08	41.0"	41.0"	100%
Blanket	41.5"	87.13	41.5"	41.5"	100%
Blanket	42.0"	88.18	42.0"	42.0"	100%
Blanket	42.5"	89.23	42.5"	42.5"	100%
Blanket	43.0"	90.28	43.0"	43.0"	100%
Blanket	43.5"	91.33	43.5"	43.5"	100%
Blanket	44.0"	92.38	44.0"	44.0"	100%
Blanket	44.5"	93.43	44.5"	44.5"	100%
Blanket	45.0"	94.48	45.0"	45.0"	100%
Blanket	45.5"	95.53	45.5"	45.5"	100%
Blanket	46.0"	96.58	46.0"	46.0"	100%
Blanket	46.5"	97.63	46.5"	46.5"	100%
Blanket	47.0"	98.68	47.0"	47.0"	100%
Blanket	47.5"	99.73	47.5"	47.5"	100%
Blanket	48.0"	100.78	48.0"	48.0"	100%
Blanket	48.5"	101.83	48.5"	48.5"	100%
Blanket	49.0"	102.88	49.0"	49.0"	100%
Blanket	49.5"	103.93	49.5"	49.5"	100%
Blanket	50.0"	104.98	50.0"	50.0"	100%
Blanket	50.5"	106.03	50.5"	50.5"	100%
Blanket	51.0"	107.08	51.0"	51.0"	100%
Blanket	51.5"	108.13	51.5"	51.5"	100%
Blanket	52.0"	109.18	52.0"	52.0"	100%
Blanket	52.5"	110.23	52.5"	52.5"	100%
Blanket	53.0"	111.28	53.0"	53.0"	100%
Blanket	53.5"	112.33	53.5"	53.5"	100%
Blanket	54.0"	113.38	54.0"	54.0"	100%
Blanket	54.5"	114.43	54.5"	54.5"	100%
Blanket	55.0"	115.48	55.0"	55.0"	100%
Blanket	55.5"	116.53	55.5"	55.5"	100%
Blanket	56.0"	117.58	56.0"	56.0"	100%
Blanket	56.5"	118.63	56.5"	56.5"	100%
Blanket	57.0"	119.68	57.0"	57.0"	100%
Blanket	57.5"	120.73	57.5"	57.5"	100%
Blanket	58.0"	121.78	58.0"	58.0"	100%
Blanket	58.5"	122.83	58.5"	58.5"	100%
Blanket	59.0"	123.88	59.0"	59.0"	100%
Blanket	59.5"	124.93	59.5"	59.5"	100%
Blanket	60.0"	125.98	60.0"	60.0"	100%
Blanket	60.5"	127.03	60.5"	60.5"	100%
Blanket	61.0"	128.08	61.0"	61.0"	100%
Blanket	61.5"	129.13	61.5"	61.5"	100%
Blanket	62.0"	130.18	62.0"	62.0"	100%
Blanket	62.5"	131.23	62.5"	62.5"	100%
Blanket	63.0"	132.28	63.0"	63.0"	100%
Blanket	63.5"	133.33	63.5"	63.5"	100%
Blanket	64.0"	134.38	64.0"	64.0"	100%
Blanket	64.5"	135.43	64.5"	64.5"	100%
Blanket	65.0"	136.48	65.0"	65.0"	100%
Blanket	65.5"	137.53	65.5"	65.5"	100%
Blanket	66.0"	138.58	66.0"	66.0"	100%
Blanket	66.5"	139.63	66.5"	66.5"	100%
Blanket	67.0"	140.68	67.0"	67.0"	100%
Blanket	67.5"	141.73	67.5"	67.5"	100%
Blanket	68.0"	142.78	68.0"	68.0"	100%
Blanket	68.5"	143.83	68.5"	68.5"	100%
Blanket	69.0"	144.88	69.0"	69.0"	100%
Blanket	69.5"	145.93	69.5"	69.5"	100%
Blanket	70.0"	146.98	70.0"	70.0"	100%
Blanket	70.5"	148.03	70.5"	70.5"	100%
Blanket	71.0"	149.08	71.0"	71.0"	100%
Blanket	71.5"	150.13	71.5"	71.5"	100%
Blanket	72.0"	151.18	72.0"	72.0"	100%
Blanket	72.5"	152.23	72.5"	72.5"	100%
Blanket	73.0"	153.28	73.0"	73.0"	100%
Blanket	73.5"	154.33	73.5"	73.5"	100%
Blanket	74.0"	155.38	74.0"	74.0"	100%
Blanket	74.5"	156.43	74.5"	74.5"	100%
Blanket	75.0"	157.48	75.0"	75.0"	100%
Blanket	75.5"	158.53	75.5"	75.5"	100%
Blanket	76.0"	159.58	76.0"	76.0"	100%
Blanket	76.5"	160.63	76.5"	76.5"	100%
Blanket	77.0"	161.68	77.0"	77.0"	100%
Blanket	77.5"	162.73	77.5"	77.5"	100%
Blanket	78.0"	163.78	78.0"	78.0"	100%
Blanket	78.5"	164.83	78.5"	78.5"	100%
Blanket	79.0"	165.88	79.0"	79.0"	100%
Blanket	79.5"	166.93	79.5"	79.5"	100%
Blanket	80.0"	167.98	80.0"	80.0"	100%
Blanket	80.5"	169.03	80.5"	80.5"	100%
Blanket	81.0"	170.08	81.0"	81.0"	100%
Blanket	81.5"	171.13	81.5"	81.5"	100%
Blanket	82.0"	172.18	82.0"	82.0"	100%
Blanket	82.5"	173.23	82.5"	82.5"	100%
Blanket	83.0"	174.28	83.0"	83.0"	100%
Blanket	83.5"	175.33	83.5"	83.5"	100%
Blanket	84.0"	176.38	84.0"	84.0"	100%
Blanket	84.5"	177.43	84.5"	84.5"	100%
Blanket	85.0"	178.48	85.0"	85.0"	100%
Blanket	85.5"	179.53	85.5"	85.5"	100%
Blanket	86.0"	180.58	86.0"	86.0"	100%
Blanket	86.5"	181.63	86.5"	86.5"	100%
Blanket	87.0"	182.68	87.0"	87.0"	100%
Blanket	87.5"	183.73	87.5"	87.5"	100%
Blanket	88.0"	184.78	88.0"	88.0"	100%
Blanket	88.5"	185.83	88.5"	88.5"	100%
Blanket	89.0"	186.88	89.0"	89.0"	100%
Blanket	89.5"	187.93	89.5"	89.5"	100%
Blanket	90.0"	188.98	90.0"	90.0"	100%
Blanket	90.5"	190.03	90.5"	90.5"	100%
Blanket	91.0"	191.08	91.0"	91.0"	100%
Blanket	91.5"	192.13	91.5"	91.5"	100%
Blanket	92.0"	193.18	92.0"	92.0"	100%
Blanket	92.5"	194.23	92.5"	92.5"	100%
Blanket					

## 4.1102.1 - Open-Cavity Wall Insulation—General

### Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

### 4.1102.1a - Sealing

### Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

### Specification(s):

Holes and penetrations will be sealed

Bypasses will be blocked and sealed

### Objective(s):

Prevent air leakage



Penetrations and bypasses create places where blown in insulation can leak



Sealed penetrations offer leakage protection and keep insulation in place

### Tools:

1. Caulk gun

### Materials:

1. Backer rod
2. Spray foam
3. Caulk



Open walls to be insulated and drywalled need air sealing



Penetrations and bypasses should be sealed to keep insulation in cavities



Use backer rod or other infill for larger penetrations



Seal penetration with caulk or fire-block, as appropriate

## 4.1102.1b - Installation

### Desired Outcome:

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

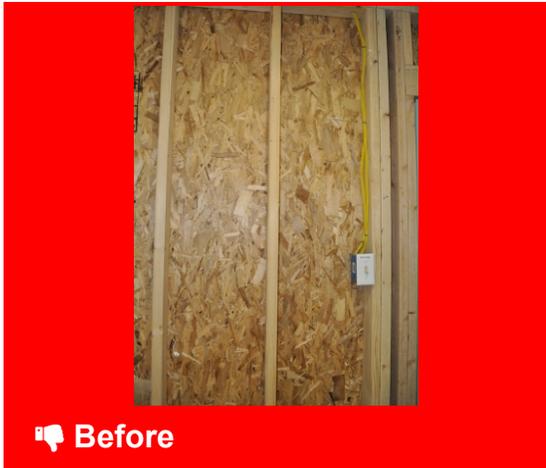
### Specification(s):

Insulation will be installed in accordance with manufacturer specifications without gaps, voids, compressions, misalignments, or wind intrusions

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



**Before**

Open walls should be insulated



**After**

Well-insulated rooms are significantly more comfortable in all seasons

**Tools:**

1. Insulation machine
2. Staple gun

**Materials:**

1. Loose fillable insulation
2. Netting
3. Staples
4. Fiberglass batts



Wall should be netted and insulation blow in to prescribed R-value



OR: Wall can be insulated using batts installed without gaps and face-stapled

## 4.1102.1c - Pre-drywall verification

**Desired Outcome:**

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

**Specification(s):**

Verification of complete installation without gaps, voids, compressions, misalignments, or wind intrusions will be provided

**Objective(s):**

Install insulation correctly



**Before**

Verify insulation is properly installed before drywalling



**After**

Once proper installation is verified, begin drywalling to finish wall

**Tools:**

1. Hands
2. Eyes



Take a visual and physical inspection of insulation installation

## 4.1102.1d - Onsite documentation

**Desired Outcome:**

Consistent, uniform thermal boundary between the conditioned space and unconditioned space to prescribed R-value

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

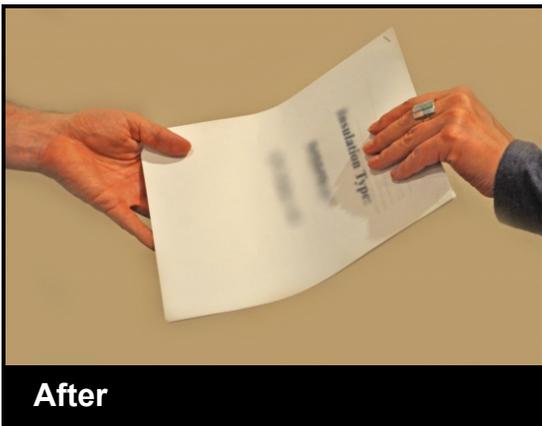
- Insulation type
- Coverage area
- R-value
- Installed thickness and settled thickness (settled thickness required for loose-fill only)
- Number of bags installed in accordance with manufacturer specifications (for loose-fill only)

**Objective(s):**

Document job completion to contract specifications

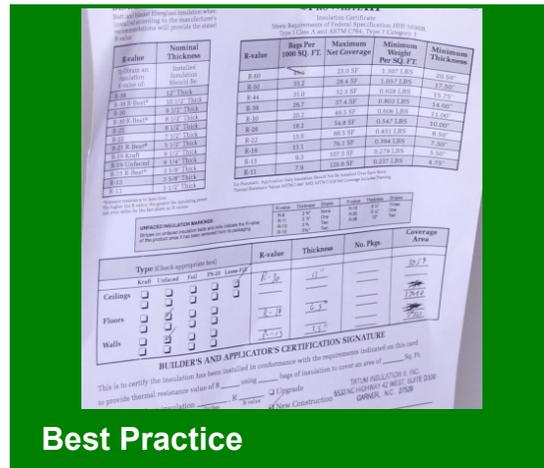
Confirm amount of insulation installed

Comply with 16 CFR 460.17



**After**

Provide occupant with documentation of and about insulation installed



**Best Practice**

Documentation should include insulation material and r-value

## 4.1103.1 - Dense Pack Exterior Walls

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1103.1a - Exterior dense pack

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Using fill tube or an alternative method as approved by the authority having jurisdiction, 100% of each cavity will be filled to a consistent density:

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot or greater density
- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit air flow that corresponds to an air permeance value of 3.5 cfm /sq. ft. at 50 pascals, as measured using ASTM C 522, E 283, or E 2178; the number of bags installed will be confirmed and will match the number required on the coverage chart
- All holes and penetrations will be plugged and/or sealed

Insulation will be verified to prevent visible air movement using chemical smoke at 50 pascals of pressure difference

### Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed



Install insulation to correct density (at least 3.5 pounds per cubic foot for cellulose, or 1.5 pounds for fiberglass)

**Tools:**

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape

**Materials:**

1. cellulose or fiberglass insulation (any fiberglass material used must be specifically approved for air flow resistance by the manufacturer)
2. wooden, plastic, or foam plugs to fill installation holes
3. piece of fiberglass batt or towel to stop insulation from blowing out around the hose



Calculate the number of bags needed and verify the number you actually install.



Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.



Adjust the pressure with the blower controls.



4 Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.



5 With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.



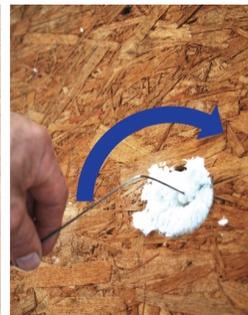
6 Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density



7 Check that cavities are filled and are the proper density.



8 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



9 Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke

## 4.1103.1b - Onsite documentation

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed Comply with 16 CFR 460.17

ORDERED		SHIPPED	DESCRIPTION	PRICE	AMOUNT
			1,040 ft <sup>2</sup>	\$0.60/ft <sup>2</sup>	624.00
			3.5 inches thick		
			R-15		
			Fiberglass dense pack insulation		
			(18 bags) (30 lb. ea.)		

*Note: In the original image, the date '6/10/15' and the description '1,040 ft<sup>2</sup>, 3.5 inches thick, R-15' are circled in red.*



Installer shall provide a dated insulation receipt showing coverage area, R-value, and thickness

Obtain a dated insulation receipt showing coverage area, R-value, and thickness from the installer.

## 4.1103.2 - Additional Exterior Wall Cavities

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

## 4.1103.2a - Location of cavities

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

### Specification(s):

Details remaining in or between completed wall sections will be located and accessed

### Objective(s):

Ensure the last gaps and framing edges in the thermal boundary, roof-wall joints, floor-wall joints, etc., are found and finished



Cavities missing insulation allow greater heat transfer than insulated ones



Either from inside or outside, using IR camera to locate cavities for fill

### Tools:

1. Infrared camera
2. Drill
3. Hole saw
4. Tape measure
5. Probe

## 4.1103.2b - Sealing

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

### Specification(s):

Backing will be provided and all newly uncovered openings will be sealed with air barriers, foam, or mastic, maintaining all required clearances

### Objective(s):

Ensure the air barrier is connected across all accessible house elements



 Before

Unsealed penetrations should be sealed to ensure insulation stays in place



 After

Once air barrier has been preserved by sealing, insulation can begin

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Fire-block, when necessary

## 4.1103.2c - Dense packing

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

### Specification(s):

Using fill tube, 100% of each cavity will be filled to a consistent density:

- Cellulose insulation used in an enclosed cavity will be installed at 3.5 pounds per cubic foot

or greater density

- Blown fiberglass, mineral fiber, or rock and slag wool used in an enclosed cavity will be installed at or above the manufacturer recommended density to limit airflow that corresponds to an air permeance value of 3.5 cfm/sq. ft. at 50 pascals, as measured using ASTM , SITE C 522, E 283, or E 2178
- The number of bags installed will be confirmed and will match the number required on the coverage chart

Insulation will be verified to prevent visible air movement at 50 pascals of pressure difference using chemical smoke or other approved verification method by the authority having jurisdiction

### Objective(s):

Eliminate voids and settling

Minimize framing cavity air flows



Make accurate count of insulation bags to be installed



Install insulation to correct density (at least 3.5 pounds per cubic foot for cellulose, or 1.5 pounds for fiberglass)

### Tools:

1. insulation blowing machine
2. pressure gauge
3. blower door
4. chemical smoke dispenser
5. drill
6. tape measure
7. ladder
8. utility flag bent into a "Z" shape



1 Calculate the number of bags needed and verify the number you actually install.



2 Check that the static pressure at the blowing machine and at the hose end is at least 2.9 PSI.



3 Adjust the pressure with the blower control knobs.



4 Adjust the feed gate to fill an 8-foot wall cavity in 2 to 4 minutes.



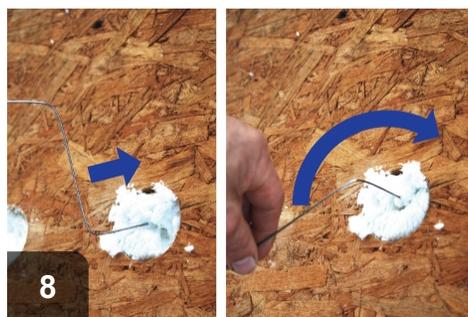
5 With a rag or fiberglass batt to prevent insulation blowing out, fill all cavities in exterior walls with insulation.



6 Check to make sure all cavities are properly filled. One of these is empty, and another is not filled to proper density.



7 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



8 Insert a bent utility flag into insulation. If it is possible to turn, the cavity needs more insulation.



9 Check for air leakage reduction after dense-pack insulation using a blower door at -50 Pascals and smoke.

## 4.1103.2d - Quality assurance

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to

other treatments

**Specification(s):**

Completed wall sections will be viewed using infrared camera with blower door operating

Any voids or low density areas will be drilled and re-packed

**Objective(s):**

Establish air barrier and thermal boundary

Confirm no voids or hidden air flows remain



Uninsulated exterior wall cavities to be insulated



Reduced temperature difference indicating insulated wall cavities

**Tools:**

- 1. Infrared camera



Depressurize house (if safe) to -50pa wrt outside



Inspect for voids and low density areas



Reduced temperature difference indicating insulated wall cavities

## 4.1103.2e - Close holes

### Desired Outcome:

Properly installed insulation reduces heat flow through walls and framing cavities inaccessible to other treatments

### Specification(s):

Installation holes will be plugged as follows:

- Exterior holes will be weather barrier patched
- Interior holes will be coated and patched to match original interior surface

All construction debris and dust will be collected and removed

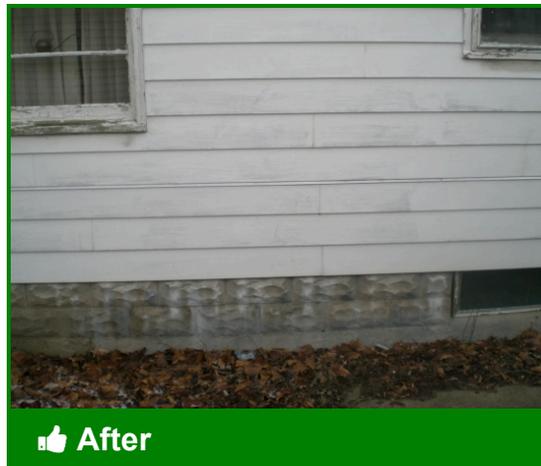
### Objective(s):

Ensure house is returned to watertight and clean condition



**In Progress**

With insulation complete, wall needs to be patched to better-than-found



**After**

When repair is finished, it shouldn't be obvious any work was done

### Tools:

1. Taping knife
2. Caulk gun
3. Drill
4. Paint brush

### Materials:

1. Spackle
2. House wrap
3. Lath
4. Stucco
5. Fasteners
6. Adhesive
7. Primer
8. Drywall
9. XPS



For interior access, locate access holes at studs for easier patching



Once drywall patches are spackled, prime and paint.



For exterior access, use a drop cloth or gutter to help with clean up



Plug holes with rigid material that will not move or sag over time



For stucco and plaster patches, lath will need to be used to hold weight



If possible, maintain house wrap, or replace it after holes are plugged



Put siding back in place, or return exterior finish to match remaining wall

## 4.1301.1 - Standard Floor System—Batt Installation

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.1a - Sealing

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing the floor system will be completed before insulating

### Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.1b - Installation

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

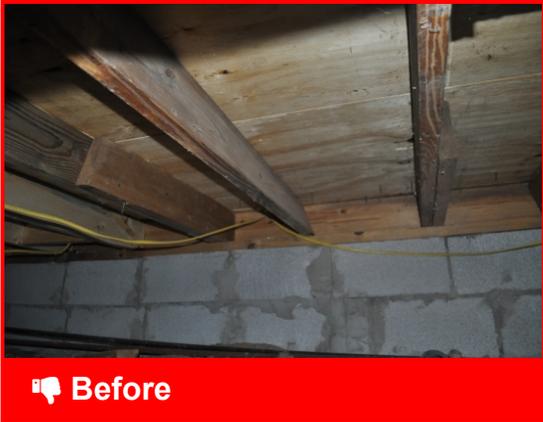
Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to subfloor

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



**Before**

Uninsulated floors above unconditioned spaces are an energy drain



**After**

Batts should fill most of joist bay and be in full contact with subfloor

**Tools:**

1. Utility knife
2. Tape measure

**Materials:**

1. Kraft-faced fiberglass batts to work order specifications

**Measures**

Measure 8 Floor Ins. R-11		Components F1					
Comment		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Q
1	Insulation	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.22	\$259.60	<input type="checkbox"/>
2	Labor	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Kraft-faced Batts - R-11	Each	1	\$100.00	\$100.00	<input type="checkbox"/>



Order and install insulation as called for in Work Order

If precise r-value cannot be purchased, choose option with greater r-value

Install kraft-faced batts with paper against subfloor



Ensure batts are in full contact with subfloor and remain uncompressed

## 4.1301.1c - Securing batts

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Batts will be secured with physical fasteners

### Objective(s):

Ensure insulation remains in contact with subfloor



Fiberglass batts should not be hanging away from subfloor



"Lightning rods" or twine can be used to hold batts in contact

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Lightning rods
2. Twine
3. Fasteners



Batt should be in contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

## 4.1301.1d - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



### Best Practice

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Certification Form

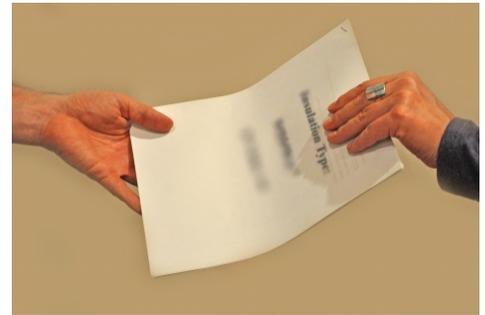
Insulation Certification Form (ICC-700) - 2012 Edition

ICC-700-1.1 (2012)

Insulation Material	R-value	Thickness	No. Pgs	Coverage Area
1.1	1.1	1.1"		10.0
1.2	1.2	1.2"		10.0
1.3	1.3	1.3"		10.0
1.4	1.4	1.4"		10.0
1.5	1.5	1.5"		10.0
1.6	1.6	1.6"		10.0
1.7	1.7	1.7"		10.0
1.8	1.8	1.8"		10.0
1.9	1.9	1.9"		10.0
1.10	1.10	1.10"		10.0
1.11	1.11	1.11"		10.0
1.12	1.12	1.12"		10.0
1.13	1.13	1.13"		10.0
1.14	1.14	1.14"		10.0
1.15	1.15	1.15"		10.0
1.16	1.16	1.16"		10.0
1.17	1.17	1.17"		10.0
1.18	1.18	1.18"		10.0
1.19	1.19	1.19"		10.0
1.20	1.20	1.20"		10.0

ICC-700-1.1 (2012)

Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1301.2 - Standard Floor System—Loose Fill with Netting

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

## 4.1301.2a - Sealing

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing the floor system will be completed before insulating

### Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.2b - Netting, fabric

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

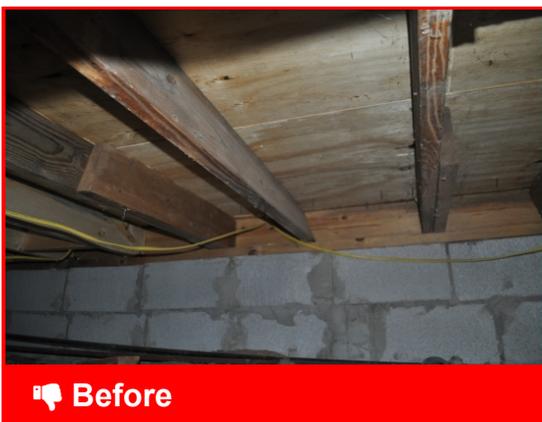
### Specification(s):

When using netting or fabric, staples will be placed according to manufacturer specifications

Netting or fabric will meet local fire codes

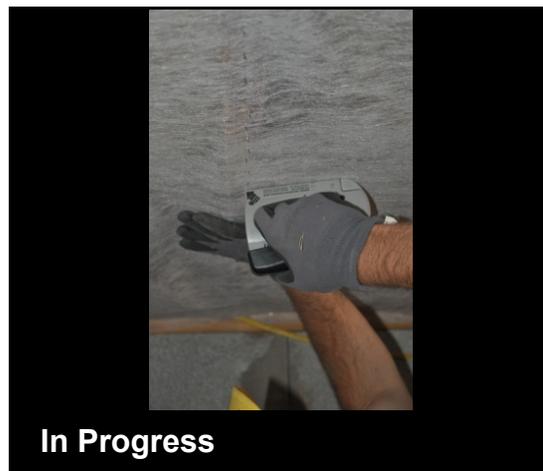
### Objective(s):

Secure insulation



**Before**

Uninsulated floors above unconditioned spaces are an energy drain



**In Progress**

Netting is secured to joists and sills to create cavities for insulation

**Tools:**

1. Utility knife
2. Scissors
3. Stapler

**Materials:**

1. Fabric netting
2. Staples



1 Secure netting across each joist to create separate cavities



2 Secure netting across sills to prevent leakage of insulation



3 Keep netting taut while stapling to prevent wrinkles and leakage



4 Staples should be kept tightly together, placed no more than 1 1/2" apart

## 4.1301.2c - Installation

**Desired Outcome:**

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Insulation in netted or fabric cavities will be dense packed with loose fill insulation in accordance with manufacturer specifications

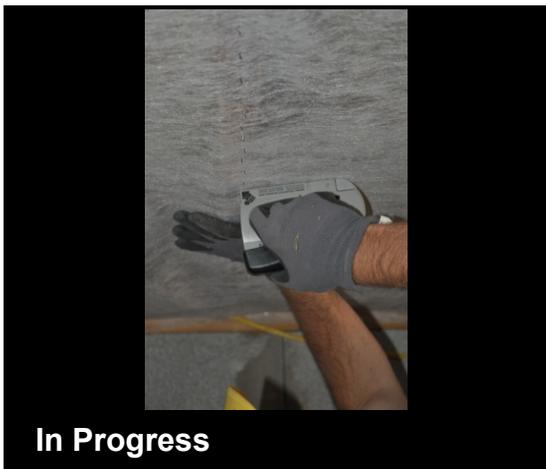
Insulation will be installed to prescribed R-value

Insulation will be in continuous contact with air barrier

**Objective(s):**

Insulate to prescribed R-value

Ensure a continuous thermal boundary between conditioned and unconditioned space



**In Progress**

With netting in place, insulation can begin



**After**

Cavities filled to manufacturer specs to achieve prescribed r-value

**Tools:**

1. Utility knife
2. Insulation machine

**Materials:**

1. Loose fill fiberglass or cellulose

**Measures**

Measure 7		Floor Ins. R-30		Components F1			
		Comment					
		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Q
1	Insulation	Floor Insulation - Net & Fill - R-30	SqFt	1180	\$0.59	\$696.20	<input type="checkbox"/>
2	Labor	Floor Insulation - Net & Fill - R-30	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Net & Fill - R-30	Each	1	\$100.00	\$100.00	<input type="checkbox"/>

Order and install insulation based on specifications in work order



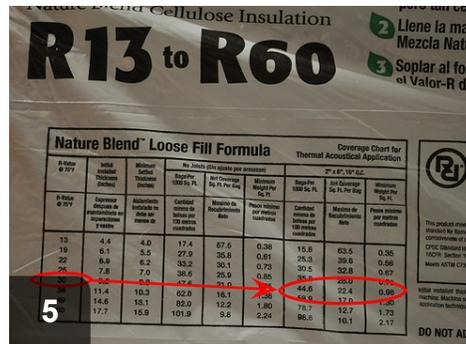
Always wear proper PPE when blowing in insulation



Cut holes in each individual cavity to insert insulation machine nozzle



Ensure that hole is large enough for nozzle without allowing for outflow



Consult manufacturer specs on insulation packaging for proper installation



Blow in insulation to prescribed r-value

## 4.1301.2d - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

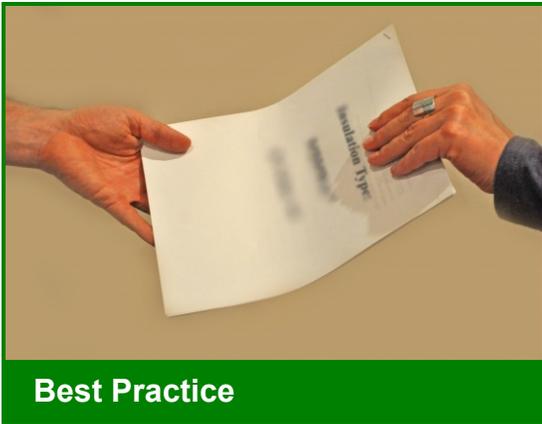
### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Type	Rated Thickness	R-value	Max. Per 100 SQ. FT.	Minimum Not Covered	Minimum Weight Per Sq. Ft.	Minimum Thickness
EPS	1.5"	3.81	100	100	1.50	1.5"
EPS	2.0"	5.08	100	100	2.00	2.0"
EPS	2.5"	6.35	100	100	2.50	2.5"
EPS	3.0"	7.62	100	100	3.00	3.0"
EPS	3.5"	8.89	100	100	3.50	3.5"
EPS	4.0"	10.16	100	100	4.00	4.0"
EPS	4.5"	11.43	100	100	4.50	4.5"
EPS	5.0"	12.70	100	100	5.00	5.0"
EPS	5.5"	13.97	100	100	5.50	5.5"
EPS	6.0"	15.24	100	100	6.00	6.0"
EPS	6.5"	16.51	100	100	6.50	6.5"
EPS	7.0"	17.78	100	100	7.00	7.0"
EPS	7.5"	19.05	100	100	7.50	7.5"
EPS	8.0"	20.32	100	100	8.00	8.0"
EPS	8.5"	21.59	100	100	8.50	8.5"
EPS	9.0"	22.86	100	100	9.00	9.0"
EPS	9.5"	24.13	100	100	9.50	9.5"
EPS	10.0"	25.40	100	100	10.00	10.0"
EPS	10.5"	26.67	100	100	10.50	10.5"
EPS	11.0"	27.94	100	100	11.00	11.0"
EPS	11.5"	29.21	100	100	11.50	11.5"
EPS	12.0"	30.48	100	100	12.00	12.0"
EPS	12.5"	31.75	100	100	12.50	12.5"
EPS	13.0"	33.02	100	100	13.00	13.0"
EPS	13.5"	34.29	100	100	13.50	13.5"
EPS	14.0"	35.56	100	100	14.00	14.0"
EPS	14.5"	36.83	100	100	14.50	14.5"
EPS	15.0"	38.10	100	100	15.00	15.0"
EPS	15.5"	39.37	100	100	15.50	15.5"
EPS	16.0"	40.64	100	100	16.00	16.0"
EPS	16.5"	41.91	100	100	16.50	16.5"
EPS	17.0"	43.18	100	100	17.00	17.0"
EPS	17.5"	44.45	100	100	17.50	17.5"
EPS	18.0"	45.72	100	100	18.00	18.0"
EPS	18.5"	46.99	100	100	18.50	18.5"
EPS	19.0"	48.26	100	100	19.00	19.0"
EPS	19.5"	49.53	100	100	19.50	19.5"
EPS	20.0"	50.80	100	100	20.00	20.0"
EPS	20.5"	52.07	100	100	20.50	20.5"
EPS	21.0"	53.34	100	100	21.00	21.0"
EPS	21.5"	54.61	100	100	21.50	21.5"
EPS	22.0"	55.88	100	100	22.00	22.0"
EPS	22.5"	57.15	100	100	22.50	22.5"
EPS	23.0"	58.42	100	100	23.00	23.0"
EPS	23.5"	59.69	100	100	23.50	23.5"
EPS	24.0"	60.96	100	100	24.00	24.0"
EPS	24.5"	62.23	100	100	24.50	24.5"
EPS	25.0"	63.50	100	100	25.00	25.0"
EPS	25.5"	64.77	100	100	25.50	25.5"
EPS	26.0"	66.04	100	100	26.00	26.0"
EPS	26.5"	67.31	100	100	26.50	26.5"
EPS	27.0"	68.58	100	100	27.00	27.0"
EPS	27.5"	69.85	100	100	27.50	27.5"
EPS	28.0"	71.12	100	100	28.00	28.0"
EPS	28.5"	72.39	100	100	28.50	28.5"
EPS	29.0"	73.66	100	100	29.00	29.0"
EPS	29.5"	74.93	100	100	29.50	29.5"
EPS	30.0"	76.20	100	100	30.00	30.0"
EPS	30.5"	77.47	100	100	30.50	30.5"
EPS	31.0"	78.74	100	100	31.00	31.0"
EPS	31.5"	80.01	100	100	31.50	31.5"
EPS	32.0"	81.28	100	100	32.00	32.0"
EPS	32.5"	82.55	100	100	32.50	32.5"
EPS	33.0"	83.82	100	100	33.00	33.0"
EPS	33.5"	85.09	100	100	33.50	33.5"
EPS	34.0"	86.36	100	100	34.00	34.0"
EPS	34.5"	87.63	100	100	34.50	34.5"
EPS	35.0"	88.90	100	100	35.00	35.0"
EPS	35.5"	90.17	100	100	35.50	35.5"
EPS	36.0"	91.44	100	100	36.00	36.0"
EPS	36.5"	92.71	100	100	36.50	36.5"
EPS	37.0"	93.98	100	100	37.00	37.0"
EPS	37.5"	95.25	100	100	37.50	37.5"
EPS	38.0"	96.52	100	100	38.00	38.0"
EPS	38.5"	97.79	100	100	38.50	38.5"
EPS	39.0"	99.06	100	100	39.00	39.0"
EPS	39.5"	100.33	100	100	39.50	39.5"
EPS	40.0"	101.60	100	100	40.00	40.0"
EPS	40.5"	102.87	100	100	40.50	40.5"
EPS	41.0"	104.14	100	100	41.00	41.0"
EPS	41.5"	105.41	100	100	41.50	41.5"
EPS	42.0"	106.68	100	100	42.00	42.0"
EPS	42.5"	107.95	100	100	42.50	42.5"
EPS	43.0"	109.22	100	100	43.00	43.0"
EPS	43.5"	110.49	100	100	43.50	43.5"
EPS	44.0"	111.76	100	100	44.00	44.0"
EPS	44.5"	113.03	100	100	44.50	44.5"
EPS	45.0"	114.30	100	100	45.00	45.0"
EPS	45.5"	115.57	100	100	45.50	45.5"
EPS	46.0"	116.84	100	100	46.00	46.0"
EPS	46.5"	118.11	100	100	46.50	46.5"
EPS	47.0"	119.38	100	100	47.00	47.0"
EPS	47.5"	120.65	100	100	47.50	47.5"
EPS	48.0"	121.92	100	100	48.00	48.0"
EPS	48.5"	123.19	100	100	48.50	48.5"
EPS	49.0"	124.46	100	100	49.00	49.0"
EPS	49.5"	125.73	100	100	49.50	49.5"
EPS	50.0"	127.00	100	100	50.00	50.0"
EPS	50.5"	128.27	100	100	50.50	50.5"
EPS	51.0"	129.54	100	100	51.00	51.0"
EPS	51.5"	130.81	100	100	51.50	51.5"
EPS	52.0"	132.08	100	100	52.00	52.0"
EPS	52.5"	133.35	100	100	52.50	52.5"
EPS	53.0"	134.62	100	100	53.00	53.0"
EPS	53.5"	135.89	100	100	53.50	53.5"
EPS	54.0"	137.16	100	100	54.00	54.0"
EPS	54.5"	138.43	100	100	54.50	54.5"
EPS	55.0"	139.70	100	100	55.00	55.0"
EPS	55.5"	140.97	100	100	55.50	55.5"
EPS	56.0"	142.24	100	100	56.00	56.0"
EPS	56.5"	143.51	100	100	56.50	56.5"
EPS	57.0"	144.78	100	100	57.00	57.0"
EPS	57.5"	146.05	100	100	57.50	57.5"
EPS	58.0"	147.32	100	100	58.00	58.0"
EPS	58.5"	148.59	100	100	58.50	58.5"
EPS	59.0"	149.86	100	100	59.00	59.0"
EPS	59.5"	151.13	100	100	59.50	59.5"
EPS	60.0"	152.40	100	100	60.00	60.0"
EPS	60.5"	153.67	100	100	60.50	60.5"
EPS	61.0"	154.94	100	100	61.00	61.0"
EPS	61.5"	156.21	100	100	61.50	61.5"
EPS	62.0"	157.48	100	100	62.00	62.0"
EPS	62.5"	158.75	100	100	62.50	62.5"
EPS	63.0"	160.02	100	100	63.00	63.0"
EPS	63.5"	161.29	100	100	63.50	63.5"
EPS	64.0"	162.56	100	100	64.00	64.0"
EPS	64.5"	163.83	100	100	64.50	64.5"
EPS	65.0"	165.10	100	100	65.00	65.0"
EPS	65.5"	166.37	100	100	65.50	65.5"
EPS	66.0"	167.64	100	100	66.00	66.0"
EPS	66.5"	168.91	100	100	66.50	66.5"
EPS	67.0"	170.18	100	100	67.00	67.0"
EPS	67.5"	171.45	100	100	67.50	67.5"
EPS	68.0"	172.72	100	100	68.00	68.0"
EPS	68.5"	173.99	100	100	68.50	68.5"
EPS	69.0"	175.26	100	100	69.00	69.0"
EPS	69.5"	176.53	100	100	69.50	69.5"
EPS	70.0"	177.80	100	100	70.00	70.0"
EPS	70.5"	179.07	100	100	70.50	70.5"
EPS	71.0"	180.34	100	100	71.00	71.0"
EPS	71.5"	181.61	100	100	71.50	71.5"
EPS	72.0"	182.88	100	100	72.00	72.0"
EPS	72.5"	184.15	100	100	72.50	72.5"
EPS	73.0"	185.42	100	100	73.00	73.0"
EPS	73.5"	186.69	100	100	73.50	73.5"
EPS	74.0"	187.96	100	100	74.00	74.0"
EPS	74.5"	189.23	100	100	74.50	74.5"
EPS	75.0"	190.50	100	100	75.00	75.0"
EPS	75.5"	191.77	100	100	75.50	75.5"
EPS	76.0"	193.04	100	100	76.00	76.0"
EPS	76.5"	194.31	100	100	76.50	76.5"
EPS	77.0"	195.58	100	100	77.00	77.0"
EPS	77.5"	196.85	100	100	77.50	77.5"
EPS	78.0"	198.12	100	100	78.00	78.0"
EPS	78.5"	199.39	100	100	78.50	78.5"
EPS	79.0"	200.66	100	100	79.00	79.0"
EPS	79.5"	201.93	100	100	79.50	79.5"
EPS	80.0"	203.20	100	100	80.00	80.0"
EPS	80.5"	204.47	100	100	80.50	80.5"
EPS	81.0"	205.74	100	100	81.00	81.0"
EPS	81.5"	207.01	100	100	8	

## 4.1301.3 - Standard Floor System—Loose Fill with Rigid Barrier

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.3a - Sealing

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing the floor system will be completed before insulating

### Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Backer rod
2. Caulk
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.3b - Rigid air barrier

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

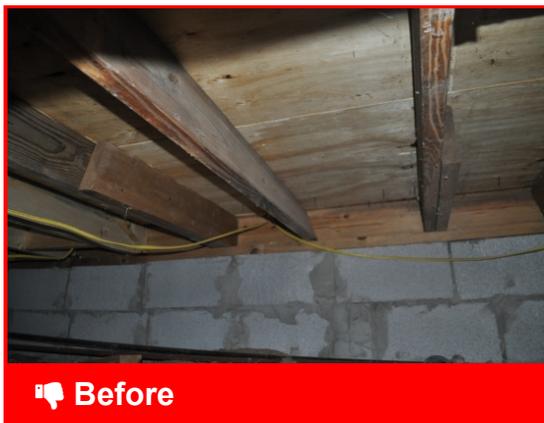
### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

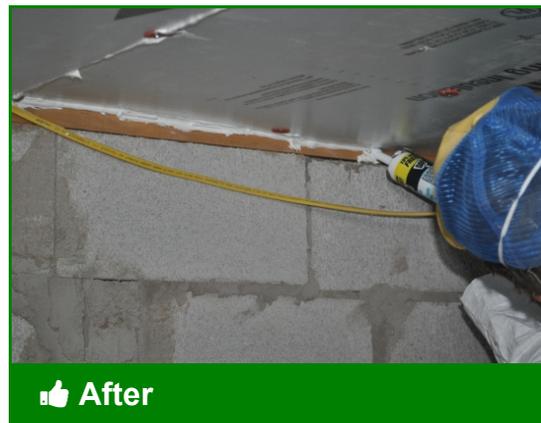
### Objective(s):

Relocate air barrier



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers provide air sealing and create cavities for insulation

**Tools:**

1. Utility knife
2. Saw
3. Drill
4. Caulk gun

**Materials:**

1. Rigid material - drywall, XPS, plywood
2. Fasteners
3. Caulk



Attach barrier to joists using appropriate fasteners for chosen material



When possible, align seams with joist. Seal all seams with caulk



Pay particular attention to sealing at complex joints to prevent leakage



Remember to seal along sills as well

## 4.1301.3c - Installation

**Desired Outcome:**

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



**Before**



**After**

Once rigid barrier is sealed, insulation can be blown in

**Tools:**

1. Insulation machine
2. Caulk gun

**Materials:**

1. Loose fill insulation
2. Caulk

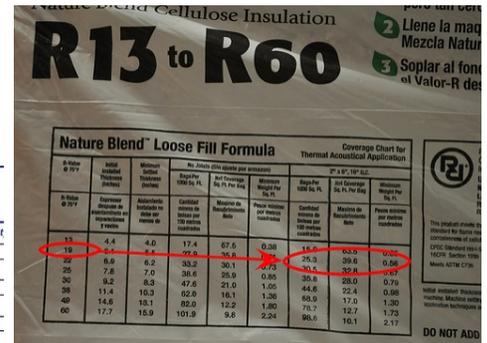


Make sure to wear proper PPE when working with insulation

**Measures**

Measure 7 Floor Ins. R-19		Components F1					
Comment		Estimated					
#	Material / Labor	Description /Comment	Units	Qty	Unit Cost	Total	Qt
1	Insulation	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	<input type="checkbox"/>
2	Labor	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Loose-fill + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	<input type="checkbox"/>

Purchase and install loose fill to r-value specified on Work Order



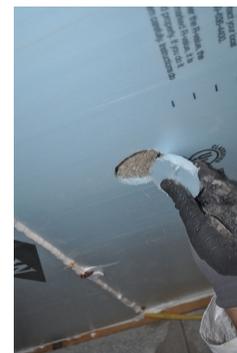
Check manufacturer specifications for proper density to reach r-value



Drill hole slightly larger than hose in



Loose fill cavities created by rigid



Once filled to prescribed density,

rigid barrier

barrier

prepare plug to preserve rigid barrier



Plug should be sealed in place to prevent leakage

## 4.1301.3d - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

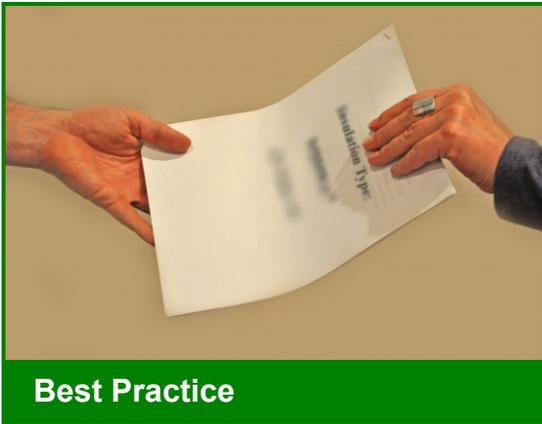
### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Certification Form

Insulation Type	Rated Thickness	R-value	Max Per 100 SQ. FT. Not Covered	Minimum Weight Per Sq. FT.	Minimum Thickness
EPS	1.5"	3.75	100%	1.10	1.5"
EPS	2.0"	5.0	100%	1.10	2.0"
EPS	2.5"	6.25	100%	1.10	2.5"
EPS	3.0"	7.5	100%	1.10	3.0"
EPS	3.5"	8.75	100%	1.10	3.5"
EPS	4.0"	10.0	100%	1.10	4.0"
EPS	4.5"	11.25	100%	1.10	4.5"
EPS	5.0"	12.5	100%	1.10	5.0"
EPS	5.5"	13.75	100%	1.10	5.5"
EPS	6.0"	15.0	100%	1.10	6.0"
EPS	6.5"	16.25	100%	1.10	6.5"
EPS	7.0"	17.5	100%	1.10	7.0"
EPS	7.5"	18.75	100%	1.10	7.5"
EPS	8.0"	20.0	100%	1.10	8.0"
EPS	8.5"	21.25	100%	1.10	8.5"
EPS	9.0"	22.5	100%	1.10	9.0"
EPS	9.5"	23.75	100%	1.10	9.5"
EPS	10.0"	25.0	100%	1.10	10.0"
EPS	10.5"	26.25	100%	1.10	10.5"
EPS	11.0"	27.5	100%	1.10	11.0"
EPS	11.5"	28.75	100%	1.10	11.5"
EPS	12.0"	30.0	100%	1.10	12.0"
EPS	12.5"	31.25	100%	1.10	12.5"
EPS	13.0"	32.5	100%	1.10	13.0"
EPS	13.5"	33.75	100%	1.10	13.5"
EPS	14.0"	35.0	100%	1.10	14.0"
EPS	14.5"	36.25	100%	1.10	14.5"
EPS	15.0"	37.5	100%	1.10	15.0"
EPS	15.5"	38.75	100%	1.10	15.5"
EPS	16.0"	40.0	100%	1.10	16.0"
EPS	16.5"	41.25	100%	1.10	16.5"
EPS	17.0"	42.5	100%	1.10	17.0"
EPS	17.5"	43.75	100%	1.10	17.5"
EPS	18.0"	45.0	100%	1.10	18.0"
EPS	18.5"	46.25	100%	1.10	18.5"
EPS	19.0"	47.5	100%	1.10	19.0"
EPS	19.5"	48.75	100%	1.10	19.5"
EPS	20.0"	50.0	100%	1.10	20.0"
EPS	20.5"	51.25	100%	1.10	20.5"
EPS	21.0"	52.5	100%	1.10	21.0"
EPS	21.5"	53.75	100%	1.10	21.5"
EPS	22.0"	55.0	100%	1.10	22.0"
EPS	22.5"	56.25	100%	1.10	22.5"
EPS	23.0"	57.5	100%	1.10	23.0"
EPS	23.5"	58.75	100%	1.10	23.5"
EPS	24.0"	60.0	100%	1.10	24.0"
EPS	24.5"	61.25	100%	1.10	24.5"
EPS	25.0"	62.5	100%	1.10	25.0"
EPS	25.5"	63.75	100%	1.10	25.5"
EPS	26.0"	65.0	100%	1.10	26.0"
EPS	26.5"	66.25	100%	1.10	26.5"
EPS	27.0"	67.5	100%	1.10	27.0"
EPS	27.5"	68.75	100%	1.10	27.5"
EPS	28.0"	70.0	100%	1.10	28.0"
EPS	28.5"	71.25	100%	1.10	28.5"
EPS	29.0"	72.5	100%	1.10	29.0"
EPS	29.5"	73.75	100%	1.10	29.5"
EPS	30.0"	75.0	100%	1.10	30.0"
EPS	30.5"	76.25	100%	1.10	30.5"
EPS	31.0"	77.5	100%	1.10	31.0"
EPS	31.5"	78.75	100%	1.10	31.5"
EPS	32.0"	80.0	100%	1.10	32.0"
EPS	32.5"	81.25	100%	1.10	32.5"
EPS	33.0"	82.5	100%	1.10	33.0"
EPS	33.5"	83.75	100%	1.10	33.5"
EPS	34.0"	85.0	100%	1.10	34.0"
EPS	34.5"	86.25	100%	1.10	34.5"
EPS	35.0"	87.5	100%	1.10	35.0"
EPS	35.5"	88.75	100%	1.10	35.5"
EPS	36.0"	90.0	100%	1.10	36.0"
EPS	36.5"	91.25	100%	1.10	36.5"
EPS	37.0"	92.5	100%	1.10	37.0"
EPS	37.5"	93.75	100%	1.10	37.5"
EPS	38.0"	95.0	100%	1.10	38.0"
EPS	38.5"	96.25	100%	1.10	38.5"
EPS	39.0"	97.5	100%	1.10	39.0"
EPS	39.5"	98.75	100%	1.10	39.5"
EPS	40.0"	100.0	100%	1.10	40.0"
EPS	40.5"	101.25	100%	1.10	40.5"
EPS	41.0"	102.5	100%	1.10	41.0"
EPS	41.5"	103.75	100%	1.10	41.5"
EPS	42.0"	105.0	100%	1.10	42.0"
EPS	42.5"	106.25	100%	1.10	42.5"
EPS	43.0"	107.5	100%	1.10	43.0"
EPS	43.5"	108.75	100%	1.10	43.5"
EPS	44.0"	110.0	100%	1.10	44.0"
EPS	44.5"	111.25	100%	1.10	44.5"
EPS	45.0"	112.5	100%	1.10	45.0"
EPS	45.5"	113.75	100%	1.10	45.5"
EPS	46.0"	115.0	100%	1.10	46.0"
EPS	46.5"	116.25	100%	1.10	46.5"
EPS	47.0"	117.5	100%	1.10	47.0"
EPS	47.5"	118.75	100%	1.10	47.5"
EPS	48.0"	120.0	100%	1.10	48.0"
EPS	48.5"	121.25	100%	1.10	48.5"
EPS	49.0"	122.5	100%	1.10	49.0"
EPS	49.5"	123.75	100%	1.10	49.5"
EPS	50.0"	125.0	100%	1.10	50.0"
EPS	50.5"	126.25	100%	1.10	50.5"
EPS	51.0"	127.5	100%	1.10	51.0"
EPS	51.5"	128.75	100%	1.10	51.5"
EPS	52.0"	130.0	100%	1.10	52.0"
EPS	52.5"	131.25	100%	1.10	52.5"
EPS	53.0"	132.5	100%	1.10	53.0"
EPS	53.5"	133.75	100%	1.10	53.5"
EPS	54.0"	135.0	100%	1.10	54.0"
EPS	54.5"	136.25	100%	1.10	54.5"
EPS	55.0"	137.5	100%	1.10	55.0"
EPS	55.5"	138.75	100%	1.10	55.5"
EPS	56.0"	140.0	100%	1.10	56.0"
EPS	56.5"	141.25	100%	1.10	56.5"
EPS	57.0"	142.5	100%	1.10	57.0"
EPS	57.5"	143.75	100%	1.10	57.5"
EPS	58.0"	145.0	100%	1.10	58.0"
EPS	58.5"	146.25	100%	1.10	58.5"
EPS	59.0"	147.5	100%	1.10	59.0"
EPS	59.5"	148.75	100%	1.10	59.5"
EPS	60.0"	150.0	100%	1.10	60.0"
EPS	60.5"	151.25	100%	1.10	60.5"
EPS	61.0"	152.5	100%	1.10	61.0"
EPS	61.5"	153.75	100%	1.10	61.5"
EPS	62.0"	155.0	100%	1.10	62.0"
EPS	62.5"	156.25	100%	1.10	62.5"
EPS	63.0"	157.5	100%	1.10	63.0"
EPS	63.5"	158.75	100%	1.10	63.5"
EPS	64.0"	160.0	100%	1.10	64.0"
EPS	64.5"	161.25	100%	1.10	64.5"
EPS	65.0"	162.5	100%	1.10	65.0"
EPS	65.5"	163.75	100%	1.10	65.5"
EPS	66.0"	165.0	100%	1.10	66.0"
EPS	66.5"	166.25	100%	1.10	66.5"
EPS	67.0"	167.5	100%	1.10	67.0"
EPS	67.5"	168.75	100%	1.10	67.5"
EPS	68.0"	170.0	100%	1.10	68.0"
EPS	68.5"	171.25	100%	1.10	68.5"
EPS	69.0"	172.5	100%	1.10	69.0"
EPS	69.5"	173.75	100%	1.10	69.5"
EPS	70.0"	175.0	100%	1.10	70.0"
EPS	70.5"	176.25	100%	1.10	70.5"
EPS	71.0"	177.5	100%	1.10	71.0"
EPS	71.5"	178.75	100%	1.10	71.5"
EPS	72.0"	180.0	100%	1.10	72.0"
EPS	72.5"	181.25	100%	1.10	72.5"
EPS	73.0"	182.5	100%	1.10	73.0"
EPS	73.5"	183.75	100%	1.10	73.5"
EPS	74.0"	185.0	100%	1.10	74.0"
EPS	74.5"	186.25	100%	1.10	74.5"
EPS	75.0"	187.5	100%	1.10	75.0"
EPS	75.5"	188.75	100%	1.10	75.5"
EPS	76.0"	190.0	100%	1.10	76.0"
EPS	76.5"	191.25	100%	1.10	76.5"
EPS	77.0"	192.5	100%	1.10	77.0"
EPS	77.5"	193.75	100%	1.10	77.5"
EPS	78.0"	195.0	100%	1.10	78.0"
EPS	78.5"	196.25	100%	1.10	78.5"
EPS	79.0"	197.5	100%	1.10	79.0"
EPS	79.5"	198.75	100%	1.10	79.5"
EPS	80.0"	200.0	100%	1.10	80.0"
EPS	80.5"	201.25	100%	1.10	80.5"
EPS	81.0"	202.5	100%	1.10	81.0"
EPS	81.5"	203.75	100%	1.10	81.5"
EPS	82.0"	205.0	100%	1.10	82.0"
EPS	82.5"	206.25	100%	1.10	82.5"
EPS	83.0"	207.5	100%	1.10	83.0"
EPS	83.5"	208.75	100%	1.10	83.5"
EPS	84.0"	210.0	100%	1.10	84.0"
EPS	84.5"	211.25	100%	1.10	84.5"
EPS	85.0"	212.5	100%	1.10	85.0"
EPS	85.5"	213.75	100%	1.10	85.5"
EPS	86.0"	215.0	100%	1.10	86.0"
EPS	86.5"	216.25	100%	1.10	86.5"
EPS	87.0"	217.5	100%	1.10	87.0"
EPS	87.5"	218.75	100%	1.10	87.5"
EPS	88.0"	220.0	100%	1.10	88.0"
EPS	88.5"	221.25	100%	1.10	88.5"
EPS	89.0"	222.5	100%	1.10	89.0"
EPS	89.5"	223.75	100%	1.10	89.5"
EPS	90.0"	225.0	100%	1.10	90.0"
EPS	90.5"	226.25	100%	1.10	90.5"
EPS	91.0"	227.5	100%	1.10	91.0"
EPS	91.5"	228.75	100%	1.10	91.5"
EPS	92.0"	230.0	100%	1.10	92.0"
EPS	92.5"	231.25	100%	1.10	92.5"
EPS	93.0"	232.5	100%	1.10	93.0"
EPS	93.5"	233.75	100%	1.10	93.5"
EPS	94.0"	235.0	100%	1.10	94.0"
EPS	94.5"	236.25	100%</		

## 4.1301.4 - Dense Pack Floor System with Rigid Barrier

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.4a - Sealing

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing the floor system will be completed before insulating

### Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk small gaps and to hold backer rod in place

## 4.1301.4b - Rigid air barrier

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

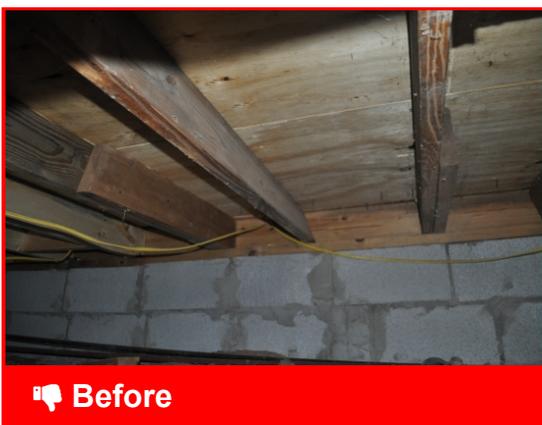
### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

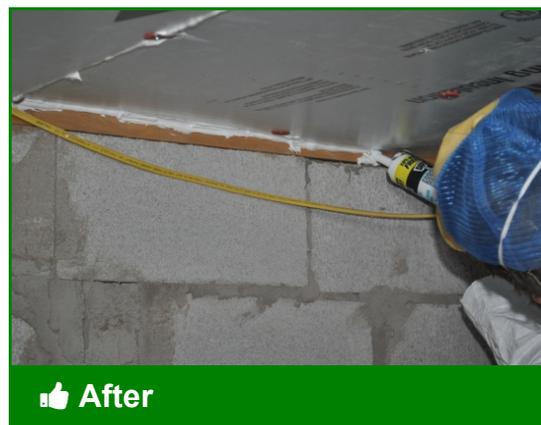
Seams and penetrations will be sealed

### Objective(s):

Relocate air barrier



Uninsulated floors over unconditioned spaces are an energy drain



Rigid barriers allow for air sealing and create cavities for insulation

**Tools:**

1. Utility knife
2. Saw
3. Drill
4. Tape measure
5. Caulk gun

**Materials:**

1. Rigid material -- drywall, XPS, plywood
2. Fasteners
3. Caulk



Securely fasten rigid barrier, aligning seams with joist when possible



Seal all seams with caulk to prevent leakage



Pay particular attention at complex joints



Remember to caulk along sills

## 4.1301.4c - Installation

**Desired Outcome:**

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



**Before**

Once rigid barrier is sealed, insulation can be blown in



**After**

Rigid barrier should be resealed to maintain air barrier after filling

**Tools:**

1. Insulation machine
2. Caulk gun

**Materials:**

1. Dense packable insulation
2. Caulk



Ensure that proper PPE is worn while working with insulation

**Measures**

Measure 7 Floor Ins. R-19		Components F1				
Comment		Estimated				
#	Material / Labor Description / Comment	Units	Qty	Unit Cost	Total	Qty
1	Insulation Floor insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	
2	Labor Floor insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	
3	Miscellaneous Su Floor insulation - Dense-pack + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	

Fill cavities to specified r-value from Work Order

**NOMINAL 30-LB. BAG COVERAGE CHART FOR CLOSED CAVITY APPLICATION**

Thermal Resistance	Cavity Depth/Insulation Thickness	Installed Density	Minimum Weight per Area	Number of Bags per 1,000 Sq. Ft.	Maximum Coverage per Bag
R-value	inches	lb/ft <sup>3</sup>	lb/ft <sup>2</sup>	bags	ft <sup>2</sup> /bag
14.0	1.8	0.55	17.5	57.1	57.1
15.0	2.0	0.583	19.4	51.4	51.4
15.1	2.2	0.602	21.4	46.8	46.8
15.2	2.4	0.700	23.3	42.9	42.9
15.5	2.6	0.750	25.5	39.2	39.2
15.9	2.8	0.750	27.5	36.4	36.4
16.0	3.0	0.817	30.5	32.8	32.8
21.0	2.2	1.000	33.8	29.6	29.6
21.9	2.4	1.100	38.7	25.8	25.8
24.1	2.8	1.150	40.7	24.6	24.6

The coverage per bag shown in the above chart is for the preferred area position only and does not account for the space taken up by wall studs, joists, headers, corners, window framing, etc. Depending on the construction details in a given structure, gross coverage for the overall wood framed wall area may vary.

Check manufacturer specifications for r-value before filling



Drill hole slightly larger than nozzle



Dense pack insulation into floor



When filled to specified density and r-

into rigid barrier with hole saw

cavities

value, fill access hole



Plug access hole and seal to maintain air barrier

## 4.1301.4d - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

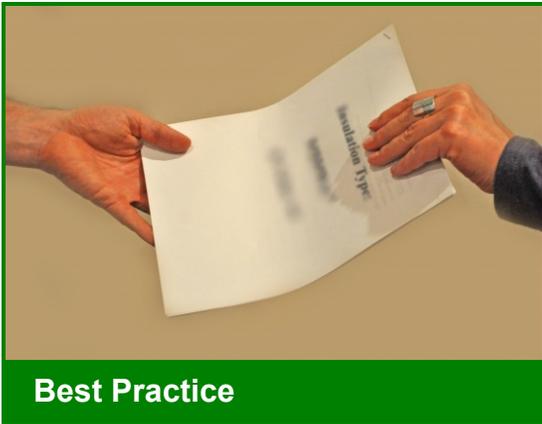
- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Certification Form

Insulation Type	Rated Thickness	R-value	Max. Per Sq. Ft.	Minimum Thickness	Minimum Weight	Minimum Thickness
EPS	1.5"	5.0	10.0	1.5"	1.500	1.5"
EPS	2.0"	6.7	13.4	2.0"	2.000	2.0"
EPS	2.5"	8.3	16.6	2.5"	2.500	2.5"
EPS	3.0"	10.0	20.0	3.0"	3.000	3.0"
EPS	3.5"	11.7	23.3	3.5"	3.500	3.5"
EPS	4.0"	13.3	26.7	4.0"	4.000	4.0"
EPS	4.5"	15.0	30.0	4.5"	4.500	4.5"
EPS	5.0"	16.7	33.3	5.0"	5.000	5.0"
EPS	5.5"	18.3	36.7	5.5"	5.500	5.5"
EPS	6.0"	20.0	40.0	6.0"	6.000	6.0"
EPS	6.5"	21.7	43.3	6.5"	6.500	6.5"
EPS	7.0"	23.3	46.7	7.0"	7.000	7.0"
EPS	7.5"	25.0	50.0	7.5"	7.500	7.5"
EPS	8.0"	26.7	53.3	8.0"	8.000	8.0"
EPS	8.5"	28.3	56.7	8.5"	8.500	8.5"
EPS	9.0"	30.0	60.0	9.0"	9.000	9.0"
EPS	9.5"	31.7	63.3	9.5"	9.500	9.5"
EPS	10.0"	33.3	66.7	10.0"	10.000	10.0"
EPS	10.5"	35.0	70.0	10.5"	10.500	10.5"
EPS	11.0"	36.7	73.3	11.0"	11.000	11.0"
EPS	11.5"	38.3	76.7	11.5"	11.500	11.5"
EPS	12.0"	40.0	80.0	12.0"	12.000	12.0"
EPS	12.5"	41.7	83.3	12.5"	12.500	12.5"
EPS	13.0"	43.3	86.7	13.0"	13.000	13.0"
EPS	13.5"	45.0	90.0	13.5"	13.500	13.5"
EPS	14.0"	46.7	93.3	14.0"	14.000	14.0"
EPS	14.5"	48.3	96.7	14.5"	14.500	14.5"
EPS	15.0"	50.0	100.0	15.0"	15.000	15.0"
EPS	15.5"	51.7	103.3	15.5"	15.500	15.5"
EPS	16.0"	53.3	106.7	16.0"	16.000	16.0"
EPS	16.5"	55.0	110.0	16.5"	16.500	16.5"
EPS	17.0"	56.7	113.3	17.0"	17.000	17.0"
EPS	17.5"	58.3	116.7	17.5"	17.500	17.5"
EPS	18.0"	60.0	120.0	18.0"	18.000	18.0"
EPS	18.5"	61.7	123.3	18.5"	18.500	18.5"
EPS	19.0"	63.3	126.7	19.0"	19.000	19.0"
EPS	19.5"	65.0	130.0	19.5"	19.500	19.5"
EPS	20.0"	66.7	133.3	20.0"	20.000	20.0"
EPS	20.5"	68.3	136.7	20.5"	20.500	20.5"
EPS	21.0"	70.0	140.0	21.0"	21.000	21.0"
EPS	21.5"	71.7	143.3	21.5"	21.500	21.5"
EPS	22.0"	73.3	146.7	22.0"	22.000	22.0"
EPS	22.5"	75.0	150.0	22.5"	22.500	22.5"
EPS	23.0"	76.7	153.3	23.0"	23.000	23.0"
EPS	23.5"	78.3	156.7	23.5"	23.500	23.5"
EPS	24.0"	80.0	160.0	24.0"	24.000	24.0"
EPS	24.5"	81.7	163.3	24.5"	24.500	24.5"
EPS	25.0"	83.3	166.7	25.0"	25.000	25.0"
EPS	25.5"	85.0	170.0	25.5"	25.500	25.5"
EPS	26.0"	86.7	173.3	26.0"	26.000	26.0"
EPS	26.5"	88.3	176.7	26.5"	26.500	26.5"
EPS	27.0"	90.0	180.0	27.0"	27.000	27.0"
EPS	27.5"	91.7	183.3	27.5"	27.500	27.5"
EPS	28.0"	93.3	186.7	28.0"	28.000	28.0"
EPS	28.5"	95.0	190.0	28.5"	28.500	28.5"
EPS	29.0"	96.7	193.3	29.0"	29.000	29.0"
EPS	29.5"	98.3	196.7	29.5"	29.500	29.5"
EPS	30.0"	100.0	200.0	30.0"	30.000	30.0"
EPS	30.5"	101.7	203.3	30.5"	30.500	30.5"
EPS	31.0"	103.3	206.7	31.0"	31.000	31.0"
EPS	31.5"	105.0	210.0	31.5"	31.500	31.5"
EPS	32.0"	106.7	213.3	32.0"	32.000	32.0"
EPS	32.5"	108.3	216.7	32.5"	32.500	32.5"
EPS	33.0"	110.0	220.0	33.0"	33.000	33.0"
EPS	33.5"	111.7	223.3	33.5"	33.500	33.5"
EPS	34.0"	113.3	226.7	34.0"	34.000	34.0"
EPS	34.5"	115.0	230.0	34.5"	34.500	34.5"
EPS	35.0"	116.7	233.3	35.0"	35.000	35.0"
EPS	35.5"	118.3	236.7	35.5"	35.500	35.5"
EPS	36.0"	120.0	240.0	36.0"	36.000	36.0"
EPS	36.5"	121.7	243.3	36.5"	36.500	36.5"
EPS	37.0"	123.3	246.7	37.0"	37.000	37.0"
EPS	37.5"	125.0	250.0	37.5"	37.500	37.5"
EPS	38.0"	126.7	253.3	38.0"	38.000	38.0"
EPS	38.5"	128.3	256.7	38.5"	38.500	38.5"
EPS	39.0"	130.0	260.0	39.0"	39.000	39.0"
EPS	39.5"	131.7	263.3	39.5"	39.500	39.5"
EPS	40.0"	133.3	266.7	40.0"	40.000	40.0"
EPS	40.5"	135.0	270.0	40.5"	40.500	40.5"
EPS	41.0"	136.7	273.3	41.0"	41.000	41.0"
EPS	41.5"	138.3	276.7	41.5"	41.500	41.5"
EPS	42.0"	140.0	280.0	42.0"	42.000	42.0"
EPS	42.5"	141.7	283.3	42.5"	42.500	42.5"
EPS	43.0"	143.3	286.7	43.0"	43.000	43.0"
EPS	43.5"	145.0	290.0	43.5"	43.500	43.5"
EPS	44.0"	146.7	293.3	44.0"	44.000	44.0"
EPS	44.5"	148.3	296.7	44.5"	44.500	44.5"
EPS	45.0"	150.0	300.0	45.0"	45.000	45.0"
EPS	45.5"	151.7	303.3	45.5"	45.500	45.5"
EPS	46.0"	153.3	306.7	46.0"	46.000	46.0"
EPS	46.5"	155.0	310.0	46.5"	46.500	46.5"
EPS	47.0"	156.7	313.3	47.0"	47.000	47.0"
EPS	47.5"	158.3	316.7	47.5"	47.500	47.5"
EPS	48.0"	160.0	320.0	48.0"	48.000	48.0"
EPS	48.5"	161.7	323.3	48.5"	48.500	48.5"
EPS	49.0"	163.3	326.7	49.0"	49.000	49.0"
EPS	49.5"	165.0	330.0	49.5"	49.500	49.5"
EPS	50.0"	166.7	333.3	50.0"	50.000	50.0"
EPS	50.5"	168.3	336.7	50.5"	50.500	50.5"
EPS	51.0"	170.0	340.0	51.0"	51.000	51.0"
EPS	51.5"	171.7	343.3	51.5"	51.500	51.5"
EPS	52.0"	173.3	346.7	52.0"	52.000	52.0"
EPS	52.5"	175.0	350.0	52.5"	52.500	52.5"
EPS	53.0"	176.7	353.3	53.0"	53.000	53.0"
EPS	53.5"	178.3	356.7	53.5"	53.500	53.5"
EPS	54.0"	180.0	360.0	54.0"	54.000	54.0"
EPS	54.5"	181.7	363.3	54.5"	54.500	54.5"
EPS	55.0"	183.3	366.7	55.0"	55.000	55.0"
EPS	55.5"	185.0	370.0	55.5"	55.500	55.5"
EPS	56.0"	186.7	373.3	56.0"	56.000	56.0"
EPS	56.5"	188.3	376.7	56.5"	56.500	56.5"
EPS	57.0"	190.0	380.0	57.0"	57.000	57.0"
EPS	57.5"	191.7	383.3	57.5"	57.500	57.5"
EPS	58.0"	193.3	386.7	58.0"	58.000	58.0"
EPS	58.5"	195.0	390.0	58.5"	58.500	58.5"
EPS	59.0"	196.7	393.3	59.0"	59.000	59.0"
EPS	59.5"	198.3	396.7	59.5"	59.500	59.5"
EPS	60.0"	200.0	400.0	60.0"	60.000	60.0"
EPS	60.5"	201.7	403.3	60.5"	60.500	60.5"
EPS	61.0"	203.3	406.7	61.0"	61.000	61.0"
EPS	61.5"	205.0	410.0	61.5"	61.500	61.5"
EPS	62.0"	206.7	413.3	62.0"	62.000	62.0"
EPS	62.5"	208.3	416.7	62.5"	62.500	62.5"
EPS	63.0"	210.0	420.0	63.0"	63.000	63.0"
EPS	63.5"	211.7	423.3	63.5"	63.500	63.5"
EPS	64.0"	213.3	426.7	64.0"	64.000	64.0"
EPS	64.5"	215.0	430.0	64.5"	64.500	64.5"
EPS	65.0"	216.7	433.3	65.0"	65.000	65.0"
EPS	65.5"	218.3	436.7	65.5"	65.500	65.5"
EPS	66.0"	220.0	440.0	66.0"	66.000	66.0"
EPS	66.5"	221.7	443.3	66.5"	66.500	66.5"
EPS	67.0"	223.3	446.7	67.0"	67.000	67.0"
EPS	67.5"	225.0	450.0	67.5"	67.500	67.5"
EPS	68.0"	226.7	453.3	68.0"	68.000	68.0"
EPS	68.5"	228.3	456.7	68.5"	68.500	68.5"
EPS	69.0"	230.0	460.0	69.0"	69.000	69.0"
EPS	69.5"	231.7	463.3	69.5"	69.500	69.5"
EPS	70.0"	233.3	466.7	70.0"	70.000	70.0"
EPS	70.5"	235.0	470.0	70.5"	70.500	70.5"
EPS	71.0"	236.7	473.3	71.0"	71.000	71.0"
EPS	71.5"	238.3	476.7	71.5"	71.500	71.5"
EPS	72.0"	240.0	480.0	72.0"	72.000	72.0"
EPS	72.5"	241.7	483.3	72.5"	72.500	72.5"
EPS	73.0"	243.3	486.7	73.0"	73.000	73.0"
EPS	73.5"	245.0	490.0	73.5"	73.500	73.5"
EPS	74.0"	246.7	493.3	74.0"	74.000	74.0"
EPS	74.5"	248.3	496.7	74.5"	74.500	74.5"
EPS	75.0"	250.0	500.0	75.0"	75.000	75.0"
EPS	75.5"	251.7	503.3	75.5"	75.500	75.5"
EPS	76.0"	253.3	506.7	76.0"	76.000	76.0"
EPS	76.5"	255.0	510.0	76.5"	76.500	76.5"
EPS	77.0"	256.7	513.3	77.0"	77.000	77.0"
EPS	77.5"	258.3	516.7	77.5"	77.500	77.5"
EPS	78.0"	260.0	520.0	78.0"	78.000	78.0"
EPS	78.5"	261.7	523.3	78.5"	78.500	

## 4.1301.5 - Cantilevered Floor—Batt Installation

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.5a - Air barrier

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Air barrier will be installed between joists and sealed

Air barrier will be placed to the most interior edge of the top plate of the wall below

### Objective(s):

Separate cantilevered floor from conditioned floor space

Allow for insulation



Cavities are open allowing unconditioned air to communicate within the space between floors.



Cavity has been blocked, sealed, and insulated. Rigid air barrier is hidden behind insulation in this photo

**Tools:**

1. tape measure
2. utility knife
3. flashlight
4. caulking gun
5. foam gun

**Materials:**

1. rigid air barrier (plywood, OSB, drywall, rigid foam board)
2. caulk or foam sealant
3. dense-pack cellulose or fiberglass insulation
4. batt insulation
5. two-part spray polyurethane foam (optional)

1. Stuff the cavities with fiberglass insulation as a backer, and then apply two-part spray polyurethane foam to seal the openings. 2. Cut and install drywall, plywood, OSB, or rigid foam board in each cavity, then seal around the edges with foam or caulk. 3. Install dense-pack insulation in cantilevered area, being careful to extend it inward past the supporting wall (this also accomplishes insulating the cantilevered floor area).

Install insulation at the required R-value in permanent contact with the subfloor under the cantilevered section.



**1**  
Measure cavity to determine size necessary for blocking.



**2**  
Measure and cut blocking to fit snugly between floor joists.



**3**  
Ensure the blocking is placed to the most interior edge of the top plate of the wall below.



**4**  
Air seal blocking around its perimeter edges with foam or caulk.



**5**  
Cut batt insulation to match the size of the blocking.

## 4.1301.5b - Installation

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Air barrier will be insulated between joist from top plate of the wall below to subfloor above

Cantilevered subfloor will be insulated in complete contact with the floor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to the air barrier

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



Cavities are open and subfloor of conditioned space above is uninsulated.



Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

### Tools:

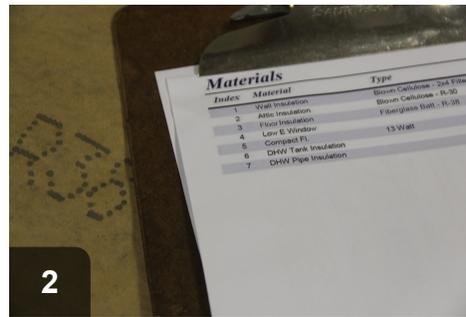
1. drill
2. mechanical fasteners
3. claw hammer or pry bar

### Materials:

1. batt insulation - kraft-faced or unfaced
2. insulation supports



1 Cavities are open and subfloor of conditioned space above is uninsulated.



2 Insulation R-value to be installed matches the work order.



3 Here the worker is removing the kraft facing, which may be needed in some areas.



4 Ensure the batt is positioned correctly.



5 Batt insulation is installed to either fill the cavity or be properly supported to maintain contact with the subfloor.

## 4.1301.5c - Attachment

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Batts will be secured with physical fasteners

### Objective(s):

Ensure insulation remains in contact with subfloor and air barrier



**Before**

Insulation should be secured to prevent drooping or movement



**After**

"Lightning rods" or twine should keep full contact with the subfloor

**Tools:**

1. Utility knife
2. Drill
3. Staple gun

**Materials:**

1. Lightning rods
2. Twine
3. Fasteners



Batts should have full contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

## 4.1301.5d - Exterior soffit

**Desired Outcome:**

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Exterior soffit material will be installed and sealed

**Objective(s):**

Cover and protect insulation



**Before**

Cavities have been insulated but are still exposed.



**After**

After all accessible cavities have been air sealed and insulated, replace sheathing and siding to cover insulation.

**Tools:**

1. claw hammer
2. drill
3. mechanical fasteners

**Materials:**

1. OSB/Plywood(where existing)
2. Vinyl Soffit(where existing)



Cantilevered floors should be insulated to preserve thermal boundary



Seal off floor cavities using previously removed materials, in this case OSB and vinyl soffit.



Re-install any materials that were removed, such as OSB, J-channels, and vinyl soffit.



Completed installation

## 4.1301.5e - Occupant education

### Desired Outcome:

Consistent, uniform thermal boundary between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



## 4.1301.6 - Pier Construction Subfloor Insulation—Batt Installation with Rigid Barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.6a - Subfloor preparation

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space will be completed before insulating

### Objective(s):

Ensure airtight envelope

Prevent leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.6b - Installation

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Insulation will be installed in contact with subfloor without gaps, voids, compressions, misalignments, or wind intrusions

If kraft-faced batts are used, they will be installed with kraft facing to subfloor

Insulation will be installed to prescribed R-value

### Objective(s):

Insulate to prescribed R-value



**Before**

Uninsulated floors above unconditioned spaces are an energy drain



**After**

Batts should fill most of joist bay and be in full contact with subfloor

**Tools:**

1. Utility knife
2. Drill

**Materials:**

1. Kraft-faced fiberglass batts to work order specifications
2. Rigid barrier -- drywall, plywood, XPS
3. Fasteners

**Measures**

Measure 8 Floor Ins. R-11		Components F1					
Comment		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Q
1	Insulation	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.22	\$259.60	<input type="checkbox"/>
2	Labor	Floor Insulation - Kraft-faced Batts - R-11	SqFt	1180	\$0.35	\$413.00	<input type="checkbox"/>
3	Miscellaneous Su	Floor Insulation - Kraft-faced Batts - R-11	Each	1	\$100.00	\$100.00	<input type="checkbox"/>

Order and install insulation as called for in Work Order



If precise r-value cannot be purchased, choose option with greater r-value



Install kraft-faced batts with paper against subfloor



Ensure batts are in full contact with subfloor and remain uncompressed

## 4.1301.6c - Secure batts

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Batts will be secured with physical fasteners

### Objective(s):

Ensure insulation remains in contact with subfloor



 Before

Batts should not hang away from subfloor



 After

"Lightning rods" or twine should be used to maintain contact

### Tools:

1. Utility knife
2. Drill
3. Staple gun

### Materials:

1. Lightning rods
2. Twine
3. Fasteners



Batts should be in full contact with subfloor without being compressed



Twine fastened across bays in a zig-zag pattern can also be used

## 4.1301.6d - Rigid air barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly

Seams and penetrations will be sealed

### Objective(s):

Protect insulation



Unfaced fiberglass batts can be attractive housing for pests



Rigid barrier allows for air sealing and protects batt insulation

**Tools:**

1. Utility knife
2. Saw
3. Drill
4. Tape measure
5. Caulk gun

**Materials:**

1. Rigid material - drywall, XPS, plywood
2. Caulk
3. Fasteners



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to complex joints



Remember to seal along sills

## 4.1301.6e - Occupant education

**Desired Outcome:**

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

A dated receipt signed by the installer will be provided that includes:

- Coverage area

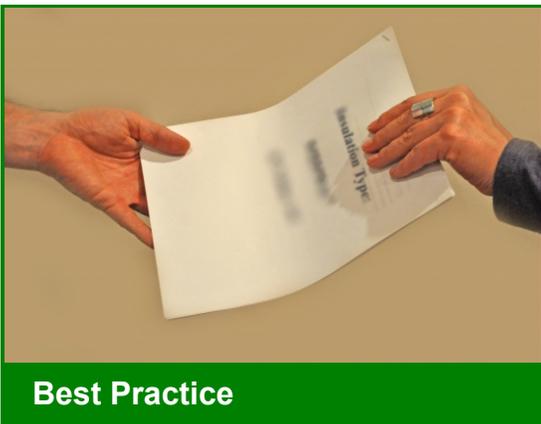
- Thickness
- R-value

**Objective(s):**

Document job completion to contract specifications

Confirm amount of insulation installed

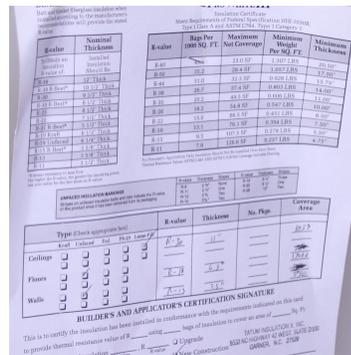
Comply with 16 CFR 460.17



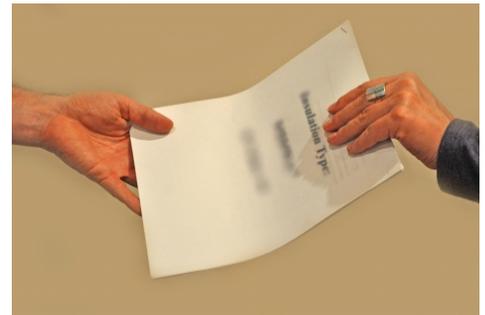
Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support



Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1301.7 - Pier Construction Subfloor Insulation—Loose Fill with Rigid Barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.7a - Subfloor preparation

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space will be completed before insulating

### Objective(s):

Prevent air leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.7b - Rigid air barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

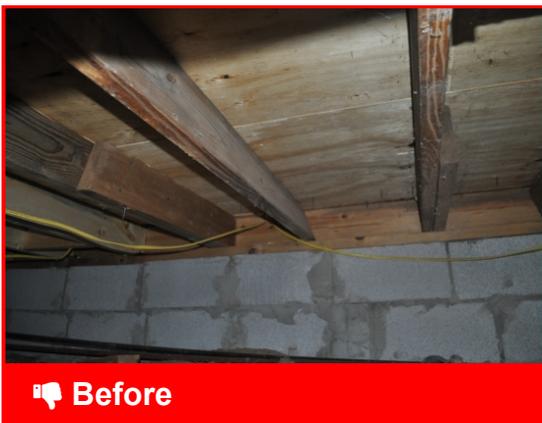
### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

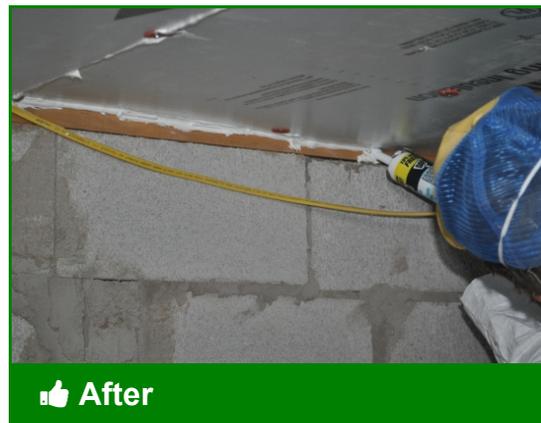
### Objective(s):

Relocate air barrier



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers allow for air sealing while creating cavities for insulation

**Tools:**

1. Utility knife
2. Saw
3. Drill
4. Tape measure
5. Caulk gun

**Materials:**

1. Rigid material - drywall, XPS, plywood
2. Fasteners
3. Caulk



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams to prevent leakage



Pay particular attention to complex joints



Remember to caulk along sills

## 4.1301.7c - Installation

**Desired Outcome:**

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Loose fill insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



**Before**

Once rigid barrier has been sealed, insulation can be blown in



**After**

After insulating, restore rigid barrier to prevent leakage

**Tools:**

1. Insulation machine
2. Caulk gun

**Materials:**

1. Loose fill insulation
2. Caulk

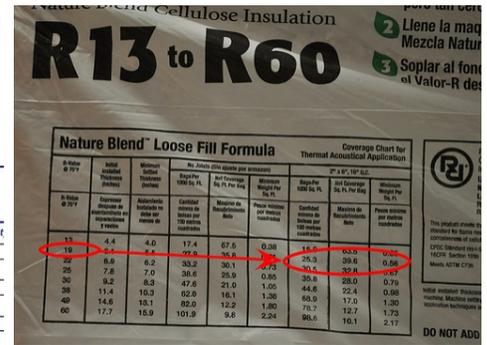


Always wear proper PPE when working with insulation

**Measures**

Measure 7 Floor Ins. R-19		Components F1					
Comment		Estimated					
#	Material / Labor	Description /Comment	Units	Qty	Unit Cost	Total	Qt
1	Insulation	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	
2	Labor	Floor Insulation - Loose-fill + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	
3	Miscellaneous Su	Floor Insulation - Loose-fill + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	

Purchase and install insulation to r-value specified on Work Order



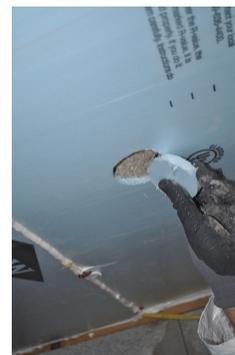
Check manufacturer specs to ensure proper installation and density



Drill hole in rigid barrier slightly larger



Fill cavities formed by rigid barrier



Once cavities have been filled to

than insulation hose

with loose fill insulation

specified r-value, prepare plug



Seal rigid barrier to prevent leakage

## 4.1301.7d - Occupant education

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

- Insulation type
- Coverage area
- R-value
- Installed thickness and minimum settled thickness
- Number of bags installed in accordance with manufacturer specifications

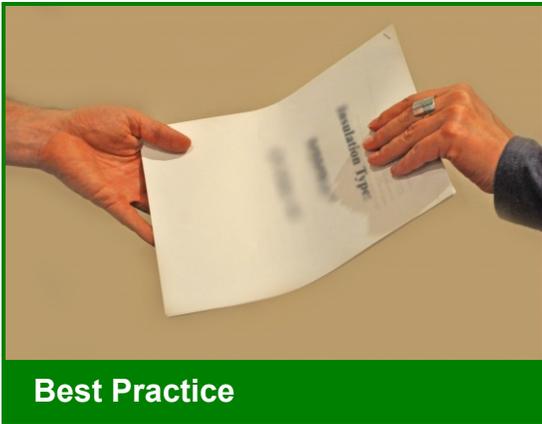
### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Ensure ability to match bags required for total area completed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Type	Rated Thickness	R-value	Thickens	No. Pkg	Coverage Area
Collaps	<input type="checkbox"/>				
Floors	<input type="checkbox"/>				
Walls	<input type="checkbox"/>				

Insulation Type	Rated Thickness	R-value	Thickens	No. Pkg	Coverage Area
Collaps	<input type="checkbox"/>				
Floors	<input type="checkbox"/>				
Walls	<input type="checkbox"/>				

Documentation should include insulation material and r-value



Provide occupant with copies of all documentation

## 4.1301.8 - Pier Construction Subfloor Installation—Dense Pack with Rigid Barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### 4.1301.8a - Subfloor preparation

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

Sealing between house and crawl space will be completed before insulating

### Objective(s):

Prevent air leakage



Gaps around penetrations can cause air leakage and negate insulation



Sealed penetrations maintain the air barrier

### Tools:

1. Caulk gun

### Materials:

1. Caulk
2. Backer rod
3. Spray foam

Be alert to high-temperature flues and chimneys and use appropriate sealants and materials. See 3.1402.1c.



Locate gaps around penetrations for plumbing, electrical, etc.



Fill gaps greater than 1/4 inch with backer rod or spray foam



Caulk smaller gaps and to hold backer rod in place

## 4.1301.8b - Rigid air barrier

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

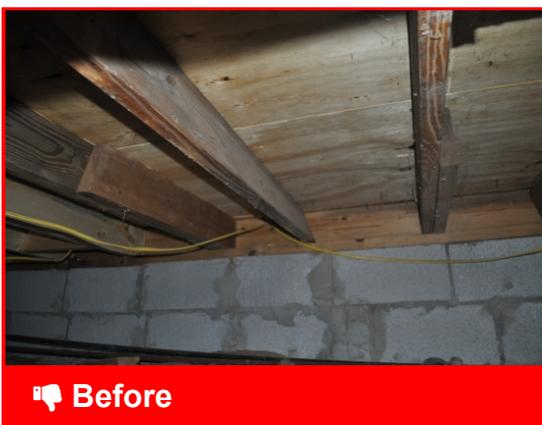
### Specification(s):

A rigid air barrier will be mechanically fastened to underside of floor assembly, providing 100% coverage of the floor assembly

Seams and penetrations will be sealed

### Objective(s):

Relocate air barrier



 Before

Uninsulated floors over unconditioned spaces are an energy drain



 After

Rigid barriers allow for air sealing while creating cavities for insulation

**Tools:**

1. Utility knife
2. Saw
3. Drill
4. Tape measure
5. Caulk gun

**Materials:**

1. Rigid material - drywall, XPS, plywood
2. Fasteners
3. Caulk



Fasten rigid barrier, aligning seams with joists when possible



Seal all seams with caulk to prevent leakage



Pay particular attention to complex seams



Remember to seal along sills

## 4.1301.8c - Installation

**Desired Outcome:**

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

**Specification(s):**

Dense pack insulation will be installed between air barrier and subfloor according to manufacturer specifications

Insulation will be installed to prescribed R-value

**Objective(s):**

Insulate to prescribed R-value



**Before**

Once rigid barrier has been sealed, insulation can be blown in



**After**

Rigid barrier should be sealed after insulating to maintain air barrier

**Tools:**

1. Insulation machine
2. Caulk gun

**Materials:**

1. Dense packable insulation
2. Caulk



Make sure to wear proper PPE when working with insulation

**Measures**

Measure 7 Floor Ins. R-19		Components F1					
Comment		Estimated					
#	Material / Labor	Description / Comment	Units	Qty	Unit Cost	Total	Qty
1	Insulation	Floor insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.37	\$436.60	
2	Labor	Floor insulation - Dense-pack + Rigid Barrier - R-19	SqFt	1180	\$0.35	\$413.00	
3	Miscellaneous Su	Floor insulation - Dense-pack + Rigid Barrier - R-19	Each	1	\$100.00	\$100.00	

Purchase and install insulation as per Work Order

**NOMINAL 30-LB. BAG COVERAGE CHART FOR CLOSED CAVITY APPLICATION**

Thermal Resistance	Cavity Depth/Insulation Thickness	Installed Density	Minimum Weight per Area	Number of Bags per 1,000 Sq. Ft.	Maximum Coverage per Bag
R-value	inches	lb/cu ft	lb/sq ft	bags	ft <sup>2</sup> /bag
14.0	1.8	0.55	17.5	57.1	57.1
15.0	2.0	0.583	19.4	51.4	51.4
15.1	2.2	0.602	21.4	46.8	46.8
15.2	2.4	0.700	22.3	44.8	44.8
15.5	2.6	0.750	23.5	42.6	42.6
15.9	2.8	0.750	25.5	39.2	39.2
16.0	3.0	0.817	26.8	37.3	37.3
16.8	3.2	1.006	28.8	34.7	34.7
17.9	3.4	1.100	28.7	34.8	34.8
18.1	3.6	1.150	28.7	34.8	34.8

The coverage per bag shown in the above chart is for the preferred installation method and does not account for the space taken up by wall studs, joists, headers, corners, window framing, etc. Depending on the construction details in a given structure, gross coverage for the overall wood framed wall area may vary.

Check manufacturer specifications to install properly



Drill hole in rigid barrier slightly larger



Blown in insulation to density and r-



Once cavity is filled, prepare plug to

than insulation hose

value specified by work order

reseal rigid barrier



Securely seal plug into rigid barrier to prevent leakage

## 4.1301.8d - Occupant education

### Desired Outcome:

Consistent, uniform thermal barrier between conditioned and unconditioned space to prescribed R-value of an adjoining insulated assembly

### Specification(s):

A dated receipt signed by the installer will be provided that includes:

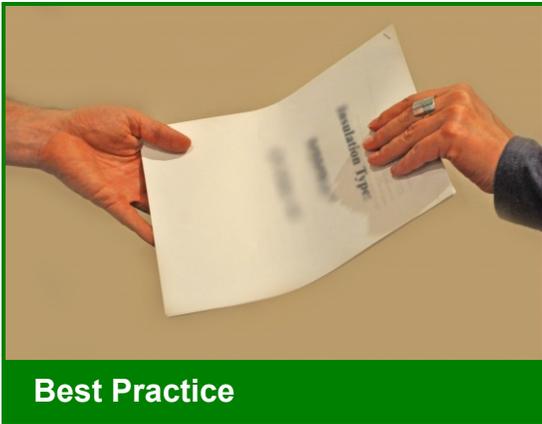
- Coverage area
- Thickness
- R-value

### Objective(s):

Document job completion to contract specifications

Confirm amount of insulation installed

Comply with 16 CFR 460.17



**Best Practice**

Provide occupant with documentation of and about insulation installed



Communicate professionally with occupant to provide information and support

Insulation Type	Rated Thickness	R-value	Max. Per 100 SQ. FT.	Minimum Not Covered	Minimum Weight Per Sq. Ft.	Minimum Thickness
EPS	1.5"	3.8	100	100	1.50	1.5"
EPS	2.0"	5.1	100	100	2.00	2.0"
EPS	2.5"	6.4	100	100	2.50	2.5"
EPS	3.0"	7.7	100	100	3.00	3.0"
EPS	3.5"	9.0	100	100	3.50	3.5"
EPS	4.0"	10.3	100	100	4.00	4.0"
EPS	4.5"	11.6	100	100	4.50	4.5"
EPS	5.0"	12.9	100	100	5.00	5.0"
EPS	5.5"	14.2	100	100	5.50	5.5"
EPS	6.0"	15.5	100	100	6.00	6.0"
EPS	6.5"	16.8	100	100	6.50	6.5"
EPS	7.0"	18.1	100	100	7.00	7.0"
EPS	7.5"	19.4	100	100	7.50	7.5"
EPS	8.0"	20.7	100	100	8.00	8.0"
EPS	8.5"	22.0	100	100	8.50	8.5"
EPS	9.0"	23.3	100	100	9.00	9.0"
EPS	9.5"	24.6	100	100	9.50	9.5"
EPS	10.0"	25.9	100	100	10.00	10.0"
EPS	10.5"	27.2	100	100	10.50	10.5"
EPS	11.0"	28.5	100	100	11.00	11.0"
EPS	11.5"	29.8	100	100	11.50	11.5"
EPS	12.0"	31.1	100	100	12.00	12.0"
EPS	12.5"	32.4	100	100	12.50	12.5"
EPS	13.0"	33.7	100	100	13.00	13.0"
EPS	13.5"	35.0	100	100	13.50	13.5"
EPS	14.0"	36.3	100	100	14.00	14.0"
EPS	14.5"	37.6	100	100	14.50	14.5"
EPS	15.0"	38.9	100	100	15.00	15.0"
EPS	15.5"	40.2	100	100	15.50	15.5"
EPS	16.0"	41.5	100	100	16.00	16.0"
EPS	16.5"	42.8	100	100	16.50	16.5"
EPS	17.0"	44.1	100	100	17.00	17.0"
EPS	17.5"	45.4	100	100	17.50	17.5"
EPS	18.0"	46.7	100	100	18.00	18.0"
EPS	18.5"	48.0	100	100	18.50	18.5"
EPS	19.0"	49.3	100	100	19.00	19.0"
EPS	19.5"	50.6	100	100	19.50	19.5"
EPS	20.0"	51.9	100	100	20.00	20.0"
EPS	20.5"	53.2	100	100	20.50	20.5"
EPS	21.0"	54.5	100	100	21.00	21.0"
EPS	21.5"	55.8	100	100	21.50	21.5"
EPS	22.0"	57.1	100	100	22.00	22.0"
EPS	22.5"	58.4	100	100	22.50	22.5"
EPS	23.0"	59.7	100	100	23.00	23.0"
EPS	23.5"	61.0	100	100	23.50	23.5"
EPS	24.0"	62.3	100	100	24.00	24.0"
EPS	24.5"	63.6	100	100	24.50	24.5"
EPS	25.0"	64.9	100	100	25.00	25.0"
EPS	25.5"	66.2	100	100	25.50	25.5"
EPS	26.0"	67.5	100	100	26.00	26.0"
EPS	26.5"	68.8	100	100	26.50	26.5"
EPS	27.0"	70.1	100	100	27.00	27.0"
EPS	27.5"	71.4	100	100	27.50	27.5"
EPS	28.0"	72.7	100	100	28.00	28.0"
EPS	28.5"	74.0	100	100	28.50	28.5"
EPS	29.0"	75.3	100	100	29.00	29.0"
EPS	29.5"	76.6	100	100	29.50	29.5"
EPS	30.0"	77.9	100	100	30.00	30.0"
EPS	30.5"	79.2	100	100	30.50	30.5"
EPS	31.0"	80.5	100	100	31.00	31.0"
EPS	31.5"	81.8	100	100	31.50	31.5"
EPS	32.0"	83.1	100	100	32.00	32.0"
EPS	32.5"	84.4	100	100	32.50	32.5"
EPS	33.0"	85.7	100	100	33.00	33.0"
EPS	33.5"	87.0	100	100	33.50	33.5"
EPS	34.0"	88.3	100	100	34.00	34.0"
EPS	34.5"	89.6	100	100	34.50	34.5"
EPS	35.0"	90.9	100	100	35.00	35.0"
EPS	35.5"	92.2	100	100	35.50	35.5"
EPS	36.0"	93.5	100	100	36.00	36.0"
EPS	36.5"	94.8	100	100	36.50	36.5"
EPS	37.0"	96.1	100	100	37.00	37.0"
EPS	37.5"	97.4	100	100	37.50	37.5"
EPS	38.0"	98.7	100	100	38.00	38.0"
EPS	38.5"	100.0	100	100	38.50	38.5"
EPS	39.0"	101.3	100	100	39.00	39.0"
EPS	39.5"	102.6	100	100	39.50	39.5"
EPS	40.0"	103.9	100	100	40.00	40.0"
EPS	40.5"	105.2	100	100	40.50	40.5"
EPS	41.0"	106.5	100	100	41.00	41.0"
EPS	41.5"	107.8	100	100	41.50	41.5"
EPS	42.0"	109.1	100	100	42.00	42.0"
EPS	42.5"	110.4	100	100	42.50	42.5"
EPS	43.0"	111.7	100	100	43.00	43.0"
EPS	43.5"	113.0	100	100	43.50	43.5"
EPS	44.0"	114.3	100	100	44.00	44.0"
EPS	44.5"	115.6	100	100	44.50	44.5"
EPS	45.0"	116.9	100	100	45.00	45.0"
EPS	45.5"	118.2	100	100	45.50	45.5"
EPS	46.0"	119.5	100	100	46.00	46.0"
EPS	46.5"	120.8	100	100	46.50	46.5"
EPS	47.0"	122.1	100	100	47.00	47.0"
EPS	47.5"	123.4	100	100	47.50	47.5"
EPS	48.0"	124.7	100	100	48.00	48.0"
EPS	48.5"	126.0	100	100	48.50	48.5"
EPS	49.0"	127.3	100	100	49.00	49.0"
EPS	49.5"	128.6	100	100	49.50	49.5"
EPS	50.0"	129.9	100	100	50.00	50.0"
EPS	50.5"	131.2	100	100	50.50	50.5"
EPS	51.0"	132.5	100	100	51.00	51.0"
EPS	51.5"	133.8	100	100	51.50	51.5"
EPS	52.0"	135.1	100	100	52.00	52.0"
EPS	52.5"	136.4	100	100	52.50	52.5"
EPS	53.0"	137.7	100	100	53.00	53.0"
EPS	53.5"	139.0	100	100	53.50	53.5"
EPS	54.0"	140.3	100	100	54.00	54.0"
EPS	54.5"	141.6	100	100	54.50	54.5"
EPS	55.0"	142.9	100	100	55.00	55.0"
EPS	55.5"	144.2	100	100	55.50	55.5"
EPS	56.0"	145.5	100	100	56.00	56.0"
EPS	56.5"	146.8	100	100	56.50	56.5"
EPS	57.0"	148.1	100	100	57.00	57.0"
EPS	57.5"	149.4	100	100	57.50	57.5"
EPS	58.0"	150.7	100	100	58.00	58.0"
EPS	58.5"	152.0	100	100	58.50	58.5"
EPS	59.0"	153.3	100	100	59.00	59.0"
EPS	59.5"	154.6	100	100	59.50	59.5"
EPS	60.0"	155.9	100	100	60.00	60.0"
EPS	60.5"	157.2	100	100	60.50	60.5"
EPS	61.0"	158.5	100	100	61.00	61.0"
EPS	61.5"	159.8	100	100	61.50	61.5"
EPS	62.0"	161.1	100	100	62.00	62.0"
EPS	62.5"	162.4	100	100	62.50	62.5"
EPS	63.0"	163.7	100	100	63.00	63.0"
EPS	63.5"	165.0	100	100	63.50	63.5"
EPS	64.0"	166.3	100	100	64.00	64.0"
EPS	64.5"	167.6	100	100	64.50	64.5"
EPS	65.0"	168.9	100	100	65.00	65.0"
EPS	65.5"	170.2	100	100	65.50	65.5"
EPS	66.0"	171.5	100	100	66.00	66.0"
EPS	66.5"	172.8	100	100	66.50	66.5"
EPS	67.0"	174.1	100	100	67.00	67.0"
EPS	67.5"	175.4	100	100	67.50	67.5"
EPS	68.0"	176.7	100	100	68.00	68.0"
EPS	68.5"	178.0	100	100	68.50	68.5"
EPS	69.0"	179.3	100	100	69.00	69.0"
EPS	69.5"	180.6	100	100	69.50	69.5"
EPS	70.0"	181.9	100	100	70.00	70.0"
EPS	70.5"	183.2	100	100	70.50	70.5"
EPS	71.0"	184.5	100	100	71.00	71.0"
EPS	71.5"	185.8	100	100	71.50	71.5"
EPS	72.0"	187.1	100	100	72.00	72.0"
EPS	72.5"	188.4	100	100	72.50	72.5"
EPS	73.0"	189.7	100	100	73.00	73.0"
EPS	73.5"	191.0	100	100	73.50	73.5"
EPS	74.0"	192.3	100	100	74.00	74.0"
EPS	74.5"	193.6	100	100	74.50	74.5"
EPS	75.0"	194.9	100	100	75.00	75.0"
EPS	75.5"	196.2	100	100	75.50	75.5"
EPS	76.0"	197.5	100	100	76.00	76.0"
EPS	76.5"	198.8	100	100	76.50	76.5"
EPS	77.0"	200.1	100	100	77.00	77.0"
EPS	77.5"	201.4	100	100	77.50	77.5"
EPS	78.0"	202.7	100	100	78.00	78.0"
EPS	78.5"	204.0	100	100	78.50	78.5"
EPS	79.0"	205.3	100	100	79.00	79.0"
EPS	79.5"	206.6	100	100	79.50	79.5"
EPS	80.0"	207.9	100	100	80.00	80.0"
EPS	80.5"	209.2	100	100	80.50	80.5"
EPS	81.0"	210.5	100	100	81.00	81.0"
EPS	81.5"	211.8	100	100	81.50	81.5"
EPS	82.0"	213.1	100	100	82.00	82.0"
EPS	82.5"	214.4	100	100	82.50	82

## 4.1402.2 - Basement Wall Insulation—No Groundwater Leakage

### Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

### 4.1402.2a - R-value

### Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

### Specification(s):

Regional IECC will be followed for required R-values

### Objective(s):

Improve thermal performance of the basement and living space

	Continuous Rigid Insulation, Interior or Exterior	Interior Cavity Insulation
Zone 1	0	0
Zone 2	0	0
Zone 3	5	13
Zone 4, except marine	10	13
Zone 5 and marine 4	15	19
Zone 6-8	16	19

### Best Practice

Find your regional zone and insulation application to determine r-value

## 4.1402.2b - Air barrier

### Desired Outcome:

Basement insulation improves thermal performance and ensures sufficient drying potential

### Specification(s):

A continuous air barrier will be installed on the warm side of the insulation

### Objective(s):

Prevent condensation on the basement wall



**Before**

Basement shows no sign of ground water penetration, but needs insulation



**After**

Insulation and drywall create an air barrier

**Tools:**

1. Utility knife
2. Tape measure
3. Drill
4. Taping knife

**Materials:**

1. XPS insulation board
2. Kraft-faced fiberglass batts
3. Drywall
4. Spackle
5. Seam tape
6. Fasteners



XPS insulation board is a non-absorbent insulation option



The drywall still provides an air barrier to keep moisture build up on wall



OR Kraft-faced fiberglass batts can be used with paper toward living space



Both kraft-face and drywall create air barrier, but batts are absorbent

## **4.1402.2c - Vapor permeability**

### **Desired Outcome:**

Basement insulation improves thermal performance and ensures sufficient drying potential

### **Specification(s):**

When absorbent insulation materials are installed, assembly will remain vapor semi-impermeable to the interior in all climate zones except Zone 7

### **Objective(s):**

Provide drying potential to the basement

## 4.1601.2 - Insulating Metal Ducts

### Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

## 4.1601.2a - Selection of duct insulation material

### Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

### Specification(s):

Duct insulation on all ducts located in unconditioned spaces will be a minimum of R-8, in accordance with local code, or buried under attic insulation, whichever is greater, and have an attached vapor retarder

Hot humid and warm coastal regions will not bury ducts

### Objective(s):

Decrease heat loss and condensation problems



 Before

Uninsulated ducts in unconditioned spaces are an energy drain



 After

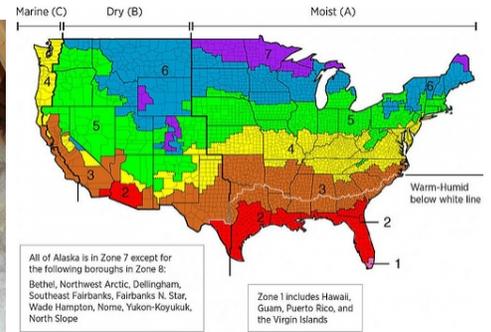
Properly insulated ducts operate at much higher rates of efficiency



Ducts in unconditioned areas should have r-8 insulation with vapor barrier



OR ducts can be buried in loose fill in attic spaces in drier climates



Burying ducts is discouraged in warm coastal and hot humid regions

## 4.1601.2b - Duct sealing

### Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

### Specification(s):

All joints, seams, and connections in ductwork shall be securely fastened and sealed with UL 181 B-M mastics (adhesives) or mastic- plus-embedded-fabric systems installed in accordance with the manufacturer's instructions before insulation is applied

### Objective(s):

Minimize duct leakage



**Before**

Unsealed joints and connections need to be sealed to prevent health risks



**After**

Sealed ductwork connections help prevent leakage

### Tools:

1. Putty knife

### Materials:

1. Mesh tape
2. Mastic



1 Prepare work area by assessing any safety concerns



2 Wrap joint with fiberglass mesh tape



3 Apply UL 181 mastic to seal joint

## 4.1601.2c - Attachment of duct insulation

### Desired Outcome:

Lowered thermal conductance of duct system and minimized condensation on the duct system

### Specification(s):

Duct insulation will be secured to the duct system using metal wire or rot-proof nylon twine

Pattern of the wire or twine will be sufficient to securely hold the duct insulation tight to the duct

### Objective(s):

Ensure a secure connection between the duct system and the duct insulation



Materials holding insulation in place should not compress or kink duct



Durable materials can be attached without compressing insulation

**Tools:**

1. Scissors
2. Metal snips

**Materials:**

1. Nylon twine
2. Wire
3. Tie bands

## 4.1601.2d - Taping of the duct insulation

**Desired Outcome:**

Lowered thermal conductance of duct system and minimized condensation on the duct system

**Specification(s):**

Using a tape approved by the manufacturer, all seams and connection of the duct insulation will be taped

No gaps will exist between pieces of duct insulation

**Objective(s):**

Prevent gaps in the vapor barrier of the insulation



Unsecured and sealed insulation around ducts is useless



All seams should be sealed with UL-181 duct tape to preserve vapor barrier

**Tools:**

1. Utility knife

**Materials:**

1. UL-181 tape
2. R-8 duct insulation with vapor barrier

## 5.3003.1 - Data Plate Verification

### Desired Outcome:

Data for commissioning and future service work is recorded

### 5.3003.1a - Data plate verification

### Desired Outcome:

Data for commissioning and future service work is recorded

### Specification(s):

Equipment will be visually inspected

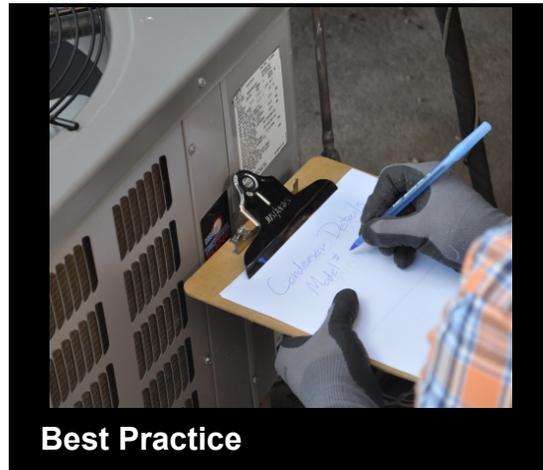
Information will be recorded from the equipment data plates indoors and outdoors where available

### Objective(s):

Ensure technician has equipment data necessary for commissioning and future service work



Thoroughly inspect all heating and cooling equipment for safe operation and locate data plate to record information



Record model information about heating and cooling equipment to ensure proper maintenance

## 5.3003.2 - Combustion Analysis of Oil-Fired Appliances

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail. If new installation or replacement is necessary, ANSI / ACCA 5 QI HVAC Quality Installation Specification will be followed.

## 5.3003.2a - Oil system: filter

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

### Specification(s):

Filter will be present, clean, and leak free

### Objective(s):

Ensure oil filter is present and functional



**Best Practice**

Locate oil filter(s) on oil-fired water heaters and furnaces, and check for need of cleaning or replacement



If necessary, replace with appropriate filter and gasket

**Tools:**

1. Wrench

**Materials:**

1. Replacement oil filter
2. Gasket



Some systems have more than one filter. One filter is typically located close to fuel tank and may be outdoors.



Take note of filter model number for easy replacement

## 5.3003.2b - Nozzle

**Desired Outcome:**

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

Nozzle size, angle, and spray pattern will be correct for design input and within equipment firing rate of the heating system manufacturer. Position of nozzle and electrodes will be in accordance with manufacturer specifications

**Objective(s):**

Ensure equipment is outfitted with the correct nozzle per manufacturer guidelines



Locate nozzles on oil-fired water heaters and furnaces

**Effects of Pressure On Nozzle Flow Rate**

Nozzle Rating at 100 PSI	Nozzle Flow Rates In Gallons Per Hour (Approx.)						
	120 PSI	140 PSI	160 PSI	175 PSI	200 PSI	300 PSI	
0.40	0.44	0.47	0.51	0.53	0.57	0.69	
0.50	0.55	0.59	0.63	0.66	0.71	0.87	
0.60	0.66	0.71	0.76	0.79	0.85	1.04	
0.65	0.71	0.77	0.82	0.86	0.92	1.13	
0.75	0.82	0.89	0.95	0.99	1.06	1.30	
0.85	0.93	1.01	1.08	1.12	1.20	1.47	
0.90	0.99	1.10	1.14	1.19	1.27	1.56	
1.00	1.10	1.20	1.26	1.32	1.41	1.73	
1.10	1.20	1.31	1.39	1.46	1.56	1.91	
1.20	1.31	1.48	1.52	1.59	1.70	2.08	
1.30	1.48	1.60	1.66	1.73	1.85	2.27	
1.40	1.64	1.77	1.85	1.90	2.03	2.34	
1.65	1.81	1.95	2.09	2.18	2.33	2.60	
1.75	1.92	2.07	2.21	2.32	2.47	2.86	
2.00	2.19	2.37	2.53	2.65	2.83	3.03	
2.25	2.46	2.66	2.85	2.98	3.18	3.46	
2.50	2.74	2.96	3.16	3.31	3.54	3.90	
2.75	3.01	3.25	3.46	3.64	3.89	4.33	
3.00	3.29	3.55	3.79	3.97	4.24	4.76	

**Best Practice**

Verify that nozzle size is appropriate for model by consulting flow chart

**Tools:**

1. Calipers
2. Nozzle Sizing Capacity Chart

## 5.3003.2c - Fuel pressure

**Desired Outcome:**

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

Measurement will be verified in accordance with manufacturer specifications

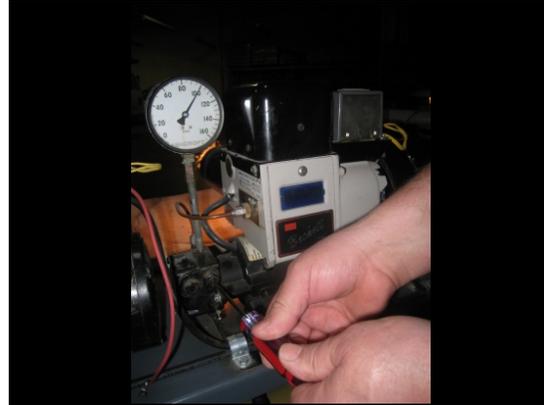
**Objective(s):**

Ensure correct oil pump pressure for nozzle installed and at OEM's specified values per ACCA



**Best Practice**

Check oil-fired furnaces and water heaters for proper fuel pressure



**In Progress**

Verify that fuel pressure matches manufacturer's specifications

## 5.3003.2d - Place appliance in operation

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

### Specification(s):

Heating equipment will be placed in operation in accordance with applicable standards and manufacturer specifications when available

### Objective(s):

Prepare equipment for combustion analysis tests



Verify oil-fired furnaces and water heaters are operating safely

## 5.3003.2e - Smoke Test

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

### Specification(s):

Smoke test will be conducted before any combustion testing is completed

Smoke spot reading will be in accordance with burner manufacturer specifications

If smoke test is more than actionable levels, specify a clean and tune

### Objective(s):

Determine whether equipment is operating within acceptable range according to smoke test and call for action if needed



Verify oil-fired furnaces and water heaters are operating safely



### Best Practice

Smoke tests determine if oil-fired appliances burn cleanly by testing soot

### Tools:

1. Smoke testing pump

### Materials:

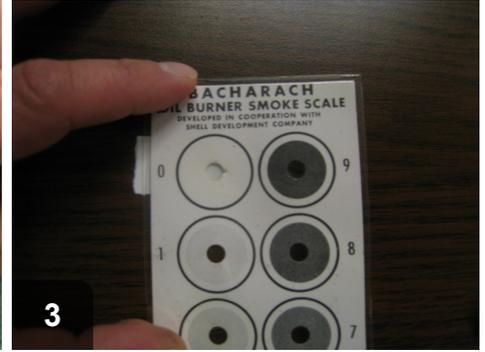
1. Filter paper



Place filter paper in testing pump and draw air through paper



Remove paper and verify draw was successful by checking for soot



Compare level of soot deposit against smoke chart. A rating of 0 is ideal



Appliances with ratings of 3 or higher should be cleaned and tuned

## 5.3003.2f - Steady state efficiency (SSE )

### Desired Outcome:

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

### Specification(s):

Measurement will be verified in accordance with manufacturer specifications

### Objective(s):

Determine whether steady state efficiency is within manufacturer range

**In Progress**

Test flue gases to determine steady state efficiency

**After**

Test 10-15min after firing, when appliance is at steady state. Reading should be within manufacturer's tolerances

**Tools:**

1. Combustion analyzer with probe
2. Drill

## 5.3003.2g - Net stack temperature

**Desired Outcome:**

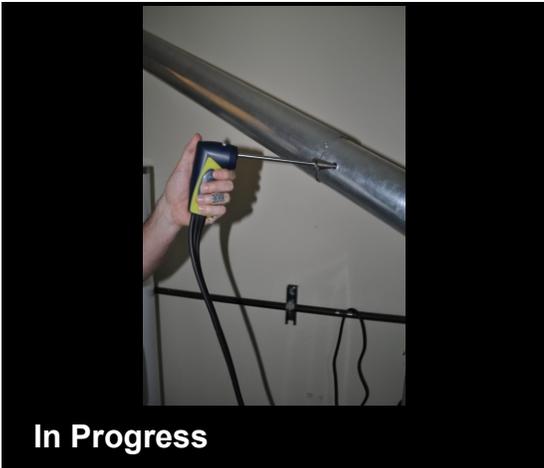
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

Net stack temperature will be measured and verified in accordance with manufacturer specifications

**Objective(s):**

Determine whether net stack temperature is within manufacturer's recommended range



Verify oil-fired appliances are not burning hotter than manufacturer specs



T-stack minus T-air equals net stack temperature. Check against specs

**Tools:**

1. Combustion analyzer with probe
2. Drill

T=temperature. T-stack minus T-air = Delta T or Net Stack Temperature.

## 5.3003.2h - Carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>)

**Desired Outcome:**

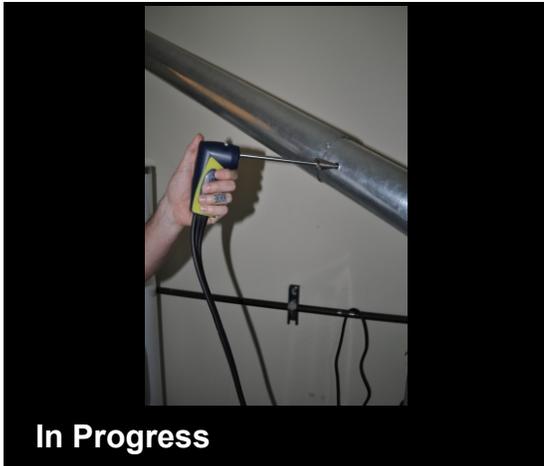
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

Measurement will be verified in accordance with manufacturer specifications

**Objective(s):**

Verify combustion performance of equipment is within manufacturer recommended range based on CO<sub>2</sub> and O<sub>2</sub> readings

**In Progress**

Verify oil-fired appliances are burning safely by testing CO<sub>2</sub> and O<sub>2</sub> levels

**After**

Levels should be within industry standards and match manufacturer specs

**Tools:**

1. Combustion analyzer with probe
2. Drill

15.4% should be the highest allowable level of CO<sub>2</sub> produced by an oil-fired appliance.

O<sub>2</sub> levels in the atmosphere are at a constant 20.9%. O<sub>2</sub> readings in appliances vary due to O<sub>2</sub> density and the efficiency of the combustion process.

**5.3003.2i - Excess combustion air****Desired Outcome:**

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

Excess combustion air will be calculated and shown to be in accordance with manufacturer specifications

**Objective(s):**

Verify combustion performance of equipment is within manufacturer recommended range based on excess combustion air readings

**In Progress**

Oil-fired appliances require an appropriate level of air mixed with the oil

**After**

The percentage of Excess Air (EA) should be within manufacturer specs

**Tools:**

1. Combustion analyzer with probe
2. Drill

## 5.3003.2j - CO in flue gas

**Desired Outcome:**

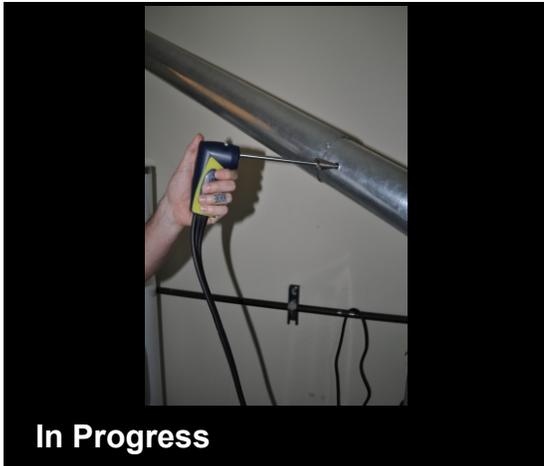
Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

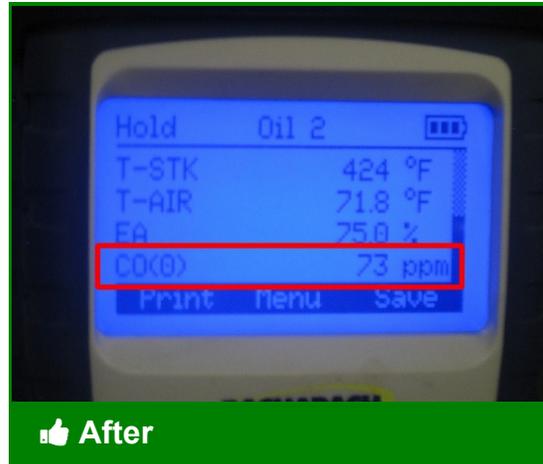
Measure CO and recommend actions to ensure that [CO](#) in the undiluted flue gas will be less than 400 ppm air-free

**Objective(s):**

Ensure CO in undiluted flue gas is less than 400 ppm air-free

**In Progress**

Test oil-fired appliances for air-free CO in the flue gases to verify safe levels

**After**

Air-free CO, or CO(0), should be less than 400ppm

**Tools:**

1. Combustion analyzer with probe
2. Drill

## 5.3003.2k - Testing/inspection holes

**Desired Outcome:**

Analysis on critical components and operations completed in accordance with industry and manufacturer specifications to ensure equipment operates as designed, safely, efficiently and is durable.

**Specification(s):**

All testing and inspection holes will be sealed with approved materials

**Objective(s):**

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



**Best Practice**

Foil tape should be used to seal testing holes unless high temperature sealant is required by jurisdictional code

---

**Materials:**

1. Foil tape
2. High temperature sealant

Check jurisdictional code for approved method

## 5.3003.8 - Evaporative Cooler Maintenance and Repairs

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### 5.3003.8a - Assessment and diagnosis

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

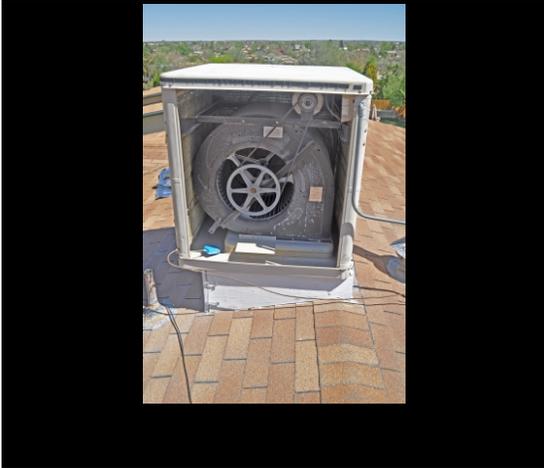
The following system elements will be assessed:

- Pump
- Pan
- Spider
- Float
- Damper
- Roof jack support
- Water line
- Water valve
- Electrical
- Pads
- Motor
- Fan

Elements will be repaired or replaced as needed in accordance with manufacturer instructions

### Objective(s):

Ensure all components function properly



Assess wear and tear on various parts of evaporative cooler



Pads have deposits and are shrunken from age. Replace



Pump needs to be cleaned of calcium deposits



Pan has calcium deposits as well but still holds water



Check spider, which distributes water to pads, for cracks and leaks



The float, attached to the water valve, shows no signs of cracking



The damper needs to be opened at the beginning of summer



The roof jack shows some signs of cracking and should be resealed



Water line is in tact and not leaking



Water valve has signs of deposits, but isn't leaking



Motor and electrical are in good working order

## 5.3003.8a - Assessment and diagnosis

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

The following system elements will be assessed:

- Pump
- Pan
- Spider
- Float
- Damper
- Roof jack support
- Water line
- Water valve
- Electrical
- Pads
- Motor
- Fan

Elements will be repaired or replaced as needed in accordance with manufacturer instructions

### Objective(s):

Ensure all components function properly

## 5.3003.8b - Repair and maintenance

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

**Specification(s):**

Calcium deposits will be removed

Pads will be replaced

Any additional repairs or replacements will be made as necessary in accordance with manufacturer's instructions

**Objective(s):**

Protect the potable water supply from cross-contamination

Ensure evaporative cooler functions properly



Old swamp cooler pad on left needs replacement due to calcium depositing



Pads have been replaced; calcium deposits have been removed. Ready to run

**Tools:**

1. Large vessel

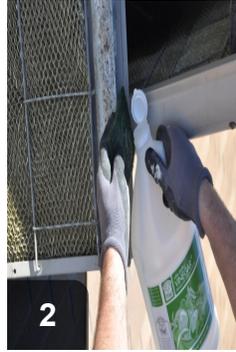
**Materials:**

1. Scrub pads
2. Distilled white vinegar

See also SWS 2.0100.1f and 2.0100.1l for Health & Safety measures.



When working on a roof, always be sure to wear a fall-protection harness and proper PPE



Use vinegar both as a soak and on scrub pads to remove calcium deposits



Scrub calcium deposits off all surfaces, including trickle trough



Exterior deposits should also be cleaned. Can you tell which part is clean?



Measure and cut, if necessary, new pads designed for use in swamp coolers



Reinstall new pads, held in place with metal bracketing

## 5.3003.8b - Repair and maintenance

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

Calcium deposits will be removed

Pads will be replaced

Any additional repairs or replacements will be made as necessary in accordance with manufacturer's instructions

### Objective(s):

Protect the potable water supply from cross-contamination

Ensure evaporative cooler functions properly

## 5.3003.8c - Occupant education

### Desired Outcome:

Evaporative cooler evaluated and maintained as needed

### Specification(s):

A regular service schedule will be recommended to occupant

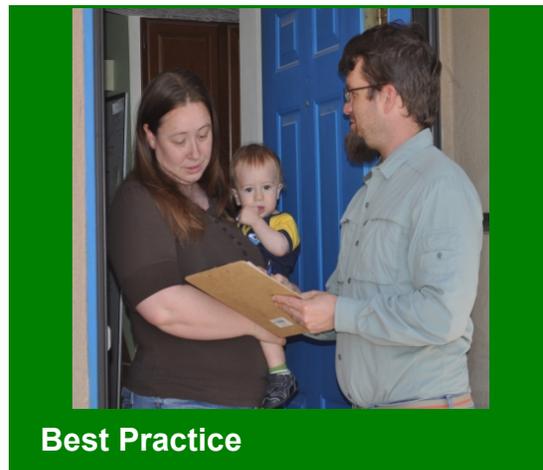
Issues regarding multiple systems running will be discussed with occupant

### Objective(s):

Ensure the occupant understands basic operation and the importance of regular maintenance



Occupants with evaporative coolers should be alerted to proper maintenance



### Best Practice

Communicate professionally with occupant to provide information and support

Standard Evaporative Cooler Maintenance
Spring (Start-Up)
Clean Pump
Clean Spider Nozzles and Drip Trough
Oil Blower and Motor Bearings - DO NOT Over Oil
Change Pads
Check Belt Condition and Tension (3/4" deflection @ 3lb. Force)
Check water bleed-off and clear any clogs
Remove damper/baffle (if present)
Plug in motor and pump
Turn-on/Reconnect Electricity
Mid-season Checks
Clean/Replace Pads - depends on water quality
Winter Shut Down
Turn-off/Disconnect Electricity
Drain Water (pan and all lines)
Unplug motor and pump
Insert damper/baffle (if equipped)
Cover unit

Review properly and timely evaporative cooler maintenance



Explain evaporative and refrigerative cooling should not be run together

## **5.3003.8c - Occupant education**

**Desired Outcome:**

Evaporative cooler evaluated and maintained as needed

**Specification(s):**

A regular service schedule will be recommended to occupant

Issues regarding multiple systems running will be discussed with occupant

**Objective(s):**

Ensure the occupant understands basic operation and the importance of regular maintenance

## 5.3003.10 - Condensate Drainage of Heating and Air Conditioning Equipment

### Desired Outcome:

Equipment and condensate drain operate as designed

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

### 5.3003.10a - Connection

### Desired Outcome:

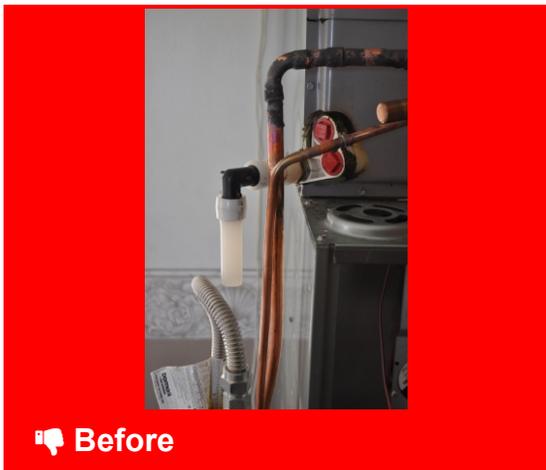
Equipment and condensate drain operate as designed

### Specification(s):

Connections in condensate drain system will be watertight

### Objective(s):

Ensure condensate drain connections do not leak



HVAC equipment needs condensate drainage to prevent water damage



Drainage pipes should be sealed to be watertight

### Tools:

1. Hacksaw
2. Crimper

### Materials:

1. Pex piping and angles
2. PVC piping and angles
3. Purple primer
4. PVC cement

## 5.3003.10b - Insulation

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Condensate drainlines will be insulated with a minimum 1" of insulation with a vapor retarder when there is potential for condensation or freezing on the drainline

### Objective(s):

Ensure condensate drain connections do not leak



 Before

Once drainage pipes cross into unconditioned space, they can freeze



 After

Pipes in unconditioned spaces should be insulated with 1" pipe insulation

### Tools:

1. Tape measure
2. Utility knife

### Materials:

1. 1" thick pipe insulation
2. Zip ties

## 5.3003.10c - Overflow protection: upflow

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Secondary drain pan and float switch will be installed when overflow could damage finished surfaces

OR

Float switch in the primary condensate drain for upflow systems will be installed when overflow

could damage finished surfaces

**Objective(s):**

Ensure condensate drain connections do not leak



A float switch should be installed to prevent overflow and damage

## 5.3003.10d - Pumps

**Desired Outcome:**

Equipment and condensate drain operate as designed

**Specification(s):**

Condensate drain pumps will be installed when condensate cannot be drained by gravity

Power source for pump will be installed

Operation and drainage of pump will be verified

**Objective(s):**

Ensure condensate drain connections do not leak



👎 Before

HVAC equipment that drains upward through a roof cannot drain naturally



👍 After

For non-gravity draining systems, a pump is necessary



HVAC unit is mounted to "historic" adobe wall which cannot be penetrated



Instead, unit is drained by utilizing a pipe and pump in the next room



The pump is connected directly into the sewage system

## 5.3003.10e - Vents and traps

### Desired Outcome:

Equipment and condensate drain operate as designed

### Specification(s):

Vents and traps will be installed on condensate drainlines

Trap supplied with the equipment will be used and manufacturer specifications will be followed

### Objective(s):

Ensure condensate drain operates as designed

Ensure condensate drain does not leak air

## 5.3003.10f - Drain pan

**Desired Outcome:**

Equipment and condensate drain operate as designed

**Specification(s):**

Condensate from all cooling coils or evaporators shall be conveyed from the drain pan outlet to an approved place of disposal

Such piping shall maintain a minimum horizontal slope in the direction of discharge of not less than 1/8 unit vertical in 12 units horizontal (1% slope)

Condensate shall not discharge into a street, alley, or other areas where it would cause a nuisance

**Objective(s):**

Prevent water damage from drain system malfunction

## 5.3003.10g - Float switch

**Desired Outcome:**

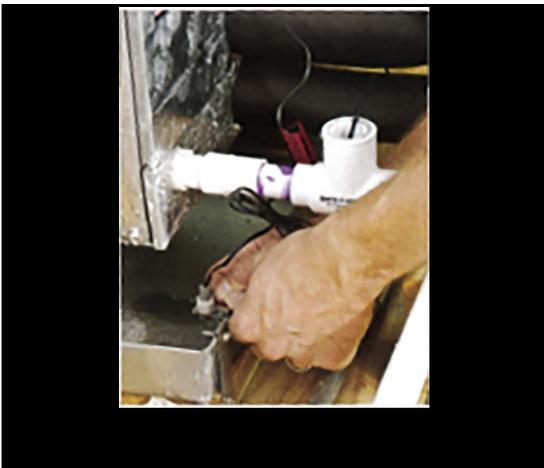
Equipment and condensate drain operate as designed

**Specification(s):**

All secondary drain pans will have a float switch and be drained away through a drainline

**Objective(s):**

Prevent water overflowing the pan and draining onto the ceiling below



Float switches should be installed in drainage pans to prevent overflow

## **5.3003.10h - Termination**

**Desired Outcome:**

Equipment and condensate drain operate as designed

**Specification(s):**

Condensate drain will be terminated in accordance with local codes

**Objective(s):**

Ensure condensate does not leak to the house

Ensure condensate drain does not freeze

## 5.3003.14 - Combustion Analysis of Gas-Fired Appliances (LP and Natural Gas)

### Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

### 5.3003.14a - Gas Pressure

### Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

Measurement will be verified by a certified professional in accordance with fuel type and manufacturer specifications

### Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable

### 5.3003.14b - Place appliance in operation

### Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

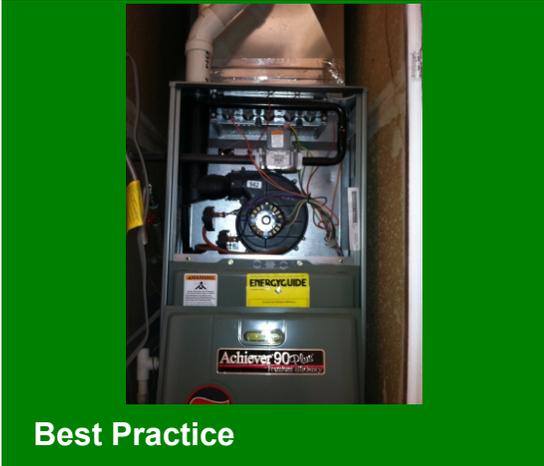
### Specification(s):

Heating equipment will be placed in operation in accordance with applicable [NFPA](#) standards and manufacturer specifications when available

### Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



Only place appliances in operation that are installed to manufacturer specification and have passed combustion testing

## 5.3003.14c - Carbon dioxide (CO<sub>2</sub>) and oxygen (O<sub>2</sub>)

### Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

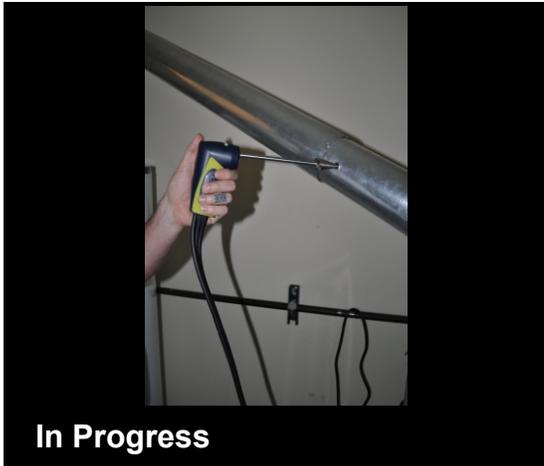
### Specification(s):

Measurement will be verified in accordance with industry manuals (e.g., Testo, Bacharach)

### Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



Verify gas-fired appliances are burning safely by testing CO<sub>2</sub> and O<sub>2</sub> levels



Levels should be within industry standards and match manufacturer specs

**Tools:**

1. Combustion analyzer with probe
2. Drill

O<sub>2</sub> levels in the atmosphere are at a constant 20.9%. O<sub>2</sub> readings in appliances vary due to O<sub>2</sub> density and the efficiency of the combustion process.

## 5.3003.14d - Carbon monoxide (CO) in flue gas

**Desired Outcome:**

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

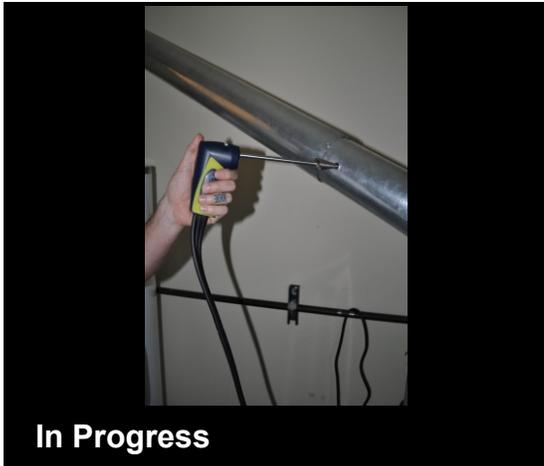
**Specification(s):**

CO in the undiluted flue gas will be less than 400 ppm air-free

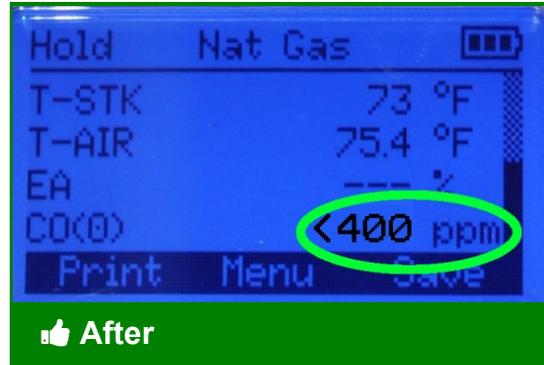
**Objective(s):**

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



Test undiluted flue gasses for carbon monoxide levels



Air-free CO, or CO(0), should be less than 400ppm

### Tools:

1. Combustion analyzer with probe
2. Drill

## 5.3003.14e - Testing/inspection holes

### Desired Outcome:

Analysis of critical components and operations completed in accordance with industry and manufacturer specifications

### Specification(s):

All testing and inspection holes will be sealed with manufacturer approved materials

### Objective(s):

Ensure equipment:

- Operates as designed
- Operates safely
- Operates efficiently
- Is durable



**Best Practice**

Foil tape should be used to seal testing holes unless high temperature sealant is required by jurisdictional code

---

**Materials:**

1. Foil tape
2. High temperature sealant

Check jurisdictional code for approved method of sealing

## 6.6002.1 - Ducts

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

## 6.6002.1a - Duct design and configuration

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

### Specification(s):

Ventilation ducts will be as short, straight, and smooth as possible

Ventilation ducts will not be smaller than the connections to which they are attached

### Objective(s):

Effectively move the required volume of air



Duct work for exhaust fans should be short, smooth, and not pinch down



Duct is the same size as the outlet and makes shortest run possible

### Tools:

1. Metal snips
2. Drill

### Materials:

1. Metal duct piping
2. Fasteners

See also ASHRAE 62.2-2016.

## 6.6002.1b - Duct insulation

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

### Specification(s):

Ducts installed outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local codes

### Objective(s):

Prevent condensation from forming or collecting inside of the ductwork



Uninsulated ducts in unconditioned spaces are an energy drain



R-8 insulation with a vapor barrier should be securely wrapped around ducts

### Tools:

1. Utility knife
2. Metal snips

### Materials:

1. R-8 insulation with vapor barrier
2. Nylon twine
3. Wire
4. UL-181 duct tape

See also ASHRAE 62.2-2016. Check local codes to see if R-8 is accepted level of insulation.

## 6.6002.1c - Duct support

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

### Specification(s):

Flexible and duct board ducts and plenums will be supported every 4' using a minimum of 1 ½" wide material

Support materials will be applied in a way that does not crimp ductwork or cause the interior dimensions of the ductwork to be less than specified (e.g., ceiling, framing, strapping); duct support must be installed in accordance with authority having jurisdiction

Metal ducts will be supported by 1/2" or wider 18-gauge strapping or 12 gauge or thicker galvanized wire no less than 10' apart

### Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system

Eliminate falling and sagging



Ducts should not be allowed to droop or sag to maximize efficiency



Supports should be evenly spaced to allow for minimal distance of run

### Tools:

1. Drill
2. Metal snips
3. Utility knife

### Materials:

1. Durable straps at least 1 1/2" wide
2. 18 gauge metal strap at least 1/2" wide
3. 12 gauge galvanized wire
4. Staples
5. Fasteners

See also ASHRAE 62.2-2016.



**BAD:** Make sure supports **DO NOT** compress insulation or duct



Flex ducts should have support straps at least every 4 feet



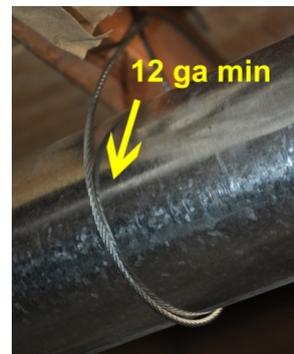
Support straps should be at least 1 1/2 inches wide



Metal ducts should be supported at 10 feet or less with wire or metal strap



Metal strap should be at least 18 gauge and 1/2 inch wide



Metal wire should be at least 12 gauge and galvanized

## 6.6002.1d - Duct connections

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

### Specification(s):

Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally spaced screws

Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic- plus-embedded-fabric systems, or tapes

Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool

PVC-to-PVC materials will be fastened with approved PVC cement

Other specialized duct fittings will be fastened in accordance with manufacturer specifications

In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

**Objective(s):**

Effectively move the required volume of air

Preserve the integrity of the duct system



**Before**

Fan duct is disconnected and venting into the attic space.



**After**

Fan has been vented with sealed, insulated duct material.

**Tools:**

1. Drill
2. Tie band tensioner
3. Brush

**Materials:**

1. Tie bands
2. Insulated flex duct
3. Mastic
4. PVC primer
5. PVC cement



Apply mastic to the connection fitting



Snug duct liner onto connection fitting



Use tie band and tensioner to secure liner to connection fitting



Apply mastic to fan connection



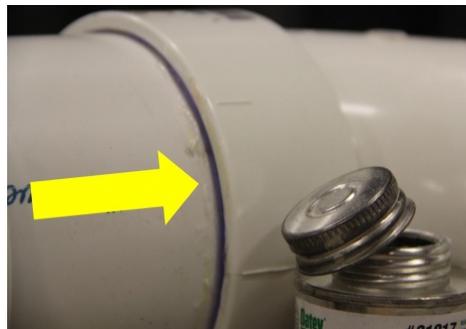
Using mechanical fasteners, secure connection fitting to fan connection



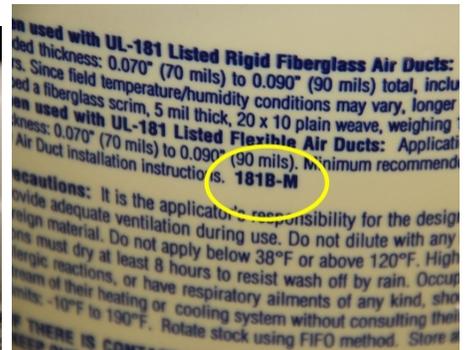
Snug insulation to fan housing and strap into place



Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum



PVC-to-PVC connections should use PVC primer and cement



Sealants should be UL181-M or UL181B-M listed

## 6.6002.1e - Duct materials

### Desired Outcome:

Installed ducts effectively move the required volume of air and prevent condensation

### Specification(s):

Flexible materials will be UL 181 listed or Air Diffusion Council approved

The metal gauge of rigid kitchen fan ducting shall meet code requirements or the approval of the authority having jurisdiction.

### Objective(s):

Effectively move the required volume of air

Preserve the integrity of the duct system



**Bad Practice**

Existing duct is installed incorrectly and is not UL listed

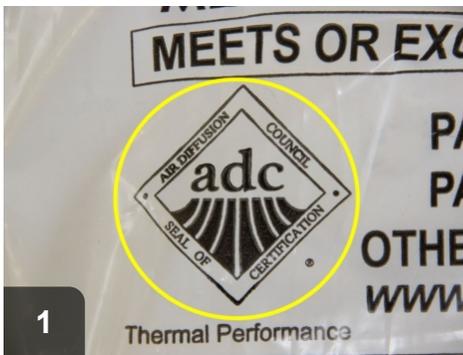


**Best Practice**

This flexible duct conforms to UL 181

**Materials:**

1. All materials should be UL 181 Listed
2. 30-gauge minimum Rigid Duct



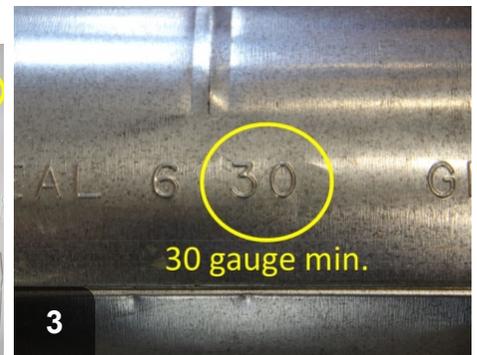
1

Look for the Air Diffusion Council seal.



2

Flex installed should meet or exceed UL181.



3

When rigid duct is being used, its wall thickness should be 30 gauge minimum.

## 6.6002.2 - Terminations

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

## 6.6002.2a - Hole in building shell

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

A hole no greater than a 1/4" greater than the fitting will be cut to accommodate termination fitting

### Objective(s):

Allow for ease of weatherproofing



 Before

Exhaust fans need exterior ventilation, often through roofs and walls



 After

Hole should be no more than 1/4" larger than termination fitting diameter

### Tools:

1. Hole saw
2. Drill
3. Tape measure



1 Locate the center of your vent hole by drilling from inside through roof



2 Measure the termination fitting to determine proper hole saw diameter



3 Based on termination fitting size (in this case, 4"), mark to cut hole



4 Hole should be no more than 1/4" larger than termination fitting diameter



5 Verify hole size is correct before installation

## 6.6002.2b - Termination fitting

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

A termination fitting with an integrated collar will be used

Collar will be at least the same diameter as the exhaust fan outlet; if collar is larger than exhaust fan outlet, a rigid metal transition will be used

Fitting will be appropriate for regional weather conditions and installation location on house so as not to be rendered inoperable

### Objective(s):

Effectively move the required volume of air to the outside

Preserve integrity of the building envelope

Ensure durable installation



Termination fittings with no collar are to be avoided



Properly sized ducts with snug connections to collared fittings last longer

**Tools:**

1. Drill

**Materials:**

1. Fasteners



BAD: Termination fittings without collars should be avoided



Termination fittings with collars should be used for exhaust ventilation



Collared fittings extend through the roof to fasten securely with duct

## 6.6002.2c - Duct to termination connection

**Desired Outcome:**

Securely installed termination fittings with unrestricted air flow

**Specification(s):**

Duct will be connected and sealed to termination fitting as follows:

- Round metal-to-metal or metal-to-PVC will be fastened with a minimum of three equally

spaced screws

- Other metal-to-metal or metal-to-PVC connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- Flexible duct-to-metal or flexible duct-to-PVC will be fastened with tie bands using a tie band tensioning tool
- PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

Fasteners will not inhibit damper operation

### Objective(s):

Effectively move the required volume of air to the outside

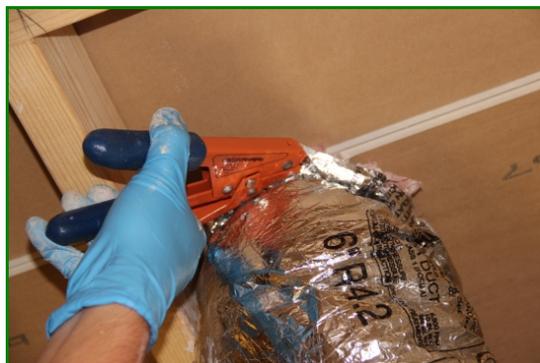
Preserve integrity of the building envelope

Ensure durable installation



 Before

Termination is not mechanically fastened, or sealed appropriately.



 After

Termination fitting is secure, and duct is sealed to termination.

### Tools:

1. wire cutter
2. chip brush
3. zip tie tension tool
4. utility knife

### Materials:

1. insulated flex duct with liner
2. UL 181 sealant
3. zip tie straps
4. PVC primer
5. PVC cement



1 With other end of the duct connected to the fan, cut duct to desired length.



2 Apply mastic to termination fitting.



3 Fit duct liner on to termination fitting.



4 With duct liner in place, use the zip tie tension tool to secure the liner to the fitting.



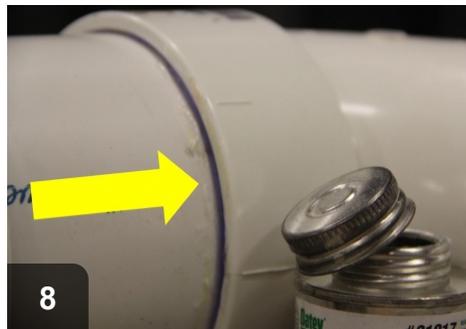
5 With liner secured and zip tie trimmed, you are ready to pull the insulation to cover the fitting.



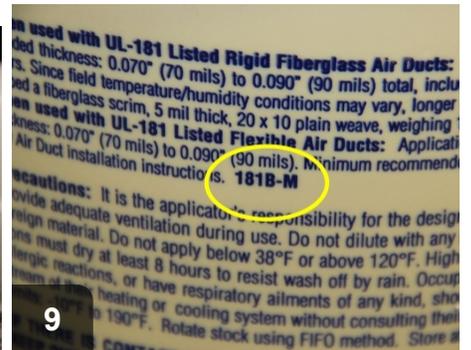
6 Ensure termination damper functions as intended.



7 Round metal-to-metal connections require fiberglass mesh tape and 3 mechanical fasteners minimum.



8 PVC-to-PVC connections should use PVC primer and cement.



9 Sealants should be UL181-M or UL181B-M listed.

## 6.6002.2d - Weatherproof installation

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

**Specification(s):**

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Installation will not inhibit damper operation

Manufacturer specifications will be followed

**Objective(s):**

Preserve integrity of the building envelope

Ensure a weather tight and durable termination installation

Ensure unrestricted air flow



**Before**

Holes for termination fitting need to be sealed to weatherproof



**After**

Termination installation should follow shingling to deter water penetration

**Tools:**

1. Hole saw
2. Caulk gun
3. Drill

**Materials:**

1. Fasteners
2. Caulk



Termination fitting is installed to repel water and sealed

## 6.6002.2e - Pest exclusion

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

Screen material with no less than ¼" and no greater than ½" hole size in any direction will be used

Installation will not inhibit damper operation or restrict air flow

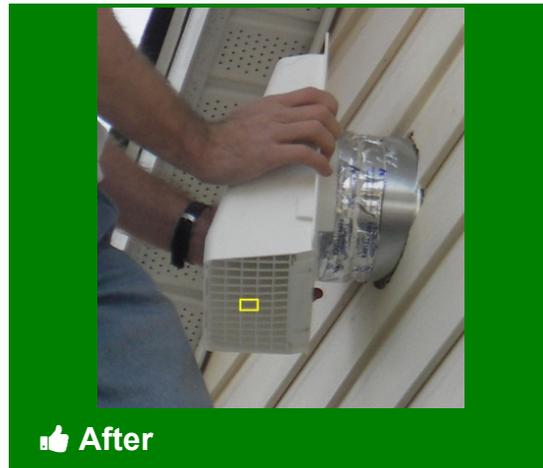
### Objective(s):

Prevent pest entry

Ensure proper air flow



Exhaust terminations without screens are an invitation to pest intrusion



Screen mesh should be between 1/4" and 1/2" in either direction

## 6.6002.2f - Termination location

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

Terminations will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors.

Terminations will be installed:

- A minimum of 3' away from any property line
- A minimum of 3' away from operable opening to houses
- A minimum of 10' away from mechanical intake
- As required by authority having jurisdiction

### Objective(s):

Prevent exhaust from reentering house



Exhaust vent has been improperly mounted too close to mechanical vent



Exhaust vent was properly mounted over 3ft from door, window, and deed line

### Tools:

1. Measuring tape
2. Hole saw
3. Drill

## 6.6002.2g - Kitchen exhaust

### Desired Outcome:

Securely installed termination fittings with unrestricted air flow

### Specification(s):

Galvanized steel, stainless steel, or copper will be used for termination fitting for kitchen exhaust

### Objective(s):

Prevent a fire hazard



Kitchen exhaust vents should not be made from highly combustible materials



This roof-mounted kitchen exhaust fan is galvanized steel--heat resistant

## 6.6003.3 - Through the Wall

### Desired Outcome:

Through the wall fans installed to specification

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 6.6003.3a - Hole in building shell

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

A hole no greater than a 1/4 inch greater than the assembly will be cut to accommodate fan assembly

### Objective(s):

Allow for ease of weatherproofing



 Before

Determine size to cut hole by measuring fan assembly and ducting



 After

A snug fit should be ensured to minimize weatherproofing required

### Tools:

1. Tape measure
2. Saw



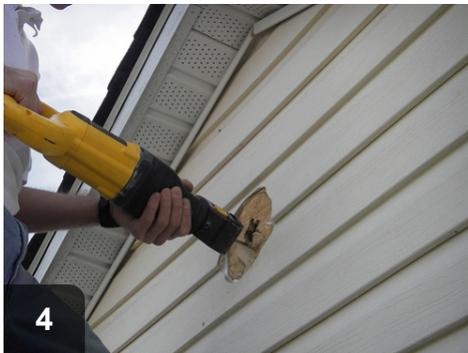
Measure the termination fitting to determine proper hole diameter (in this case, 4")



Hole should be no more than 1/4" larger than assembly diameter



Clear wall surface and mark hole size 1/4" larger than termination fitting



Since opening is larger than most hole saws, precision cutting is important

## 6.6003.3b - Wiring

### Desired Outcome:

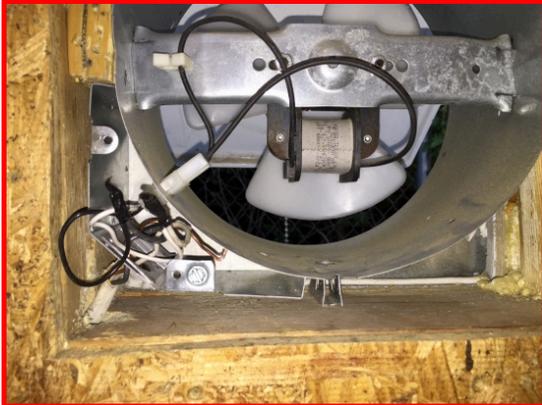
Through the wall fans installed to specification

### Specification(s):

Wiring will be installed in accordance with original equipment manufacturer specifications, and local and national electrical and mechanical codes

### Objective(s):

Prevent an electrical hazard



**Before**

Incorrect: disconnected ground, no wire nuts on splices, no clamp on wires passing through junction box



**After**

Fan junction box with cover installed

**Tools:**

1. Wire strippers
2. Utility knife or cable ripper
3. Screwdriver
4. Non-contact voltage tester
5. Lineman's pliers

**Materials:**

1. Ground wire crimp sleeves
2. Non-metallic sheathed wire (Type NM-B) e.g., Romex®
3. Plastic junction box and cover plate
4. Wire nuts
5. Cable staples
6. Clamp-type cable connectors

Follow manufacturer's specifications and applicable codes when wiring newly installed equipment.



1

Inspect for: proper ground, wire nuts on splices, clamps on wiring where it enters junction box, cover installed on box



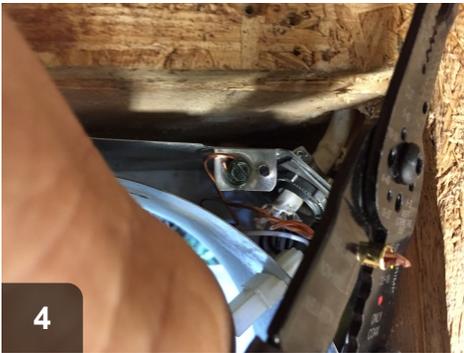
2

Install clamp on wiring into junction box



3

Install wire nuts on splices



Use crimp sleeves to connect ground wires



Tuck wiring into place



Reinstall cover on junction box

## 6.6003.3c - Fan mounting

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Fan outlet will be oriented toward the final termination location

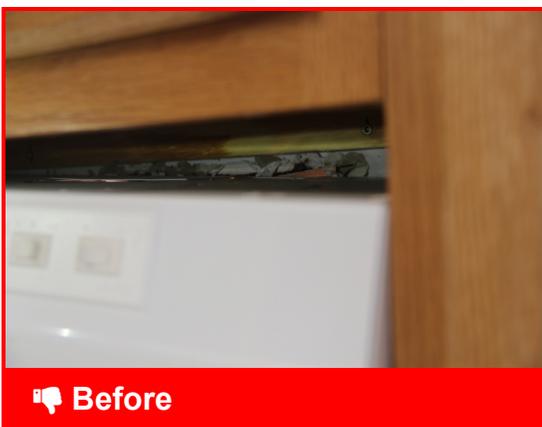
Fan will be oriented so the equivalent length of the duct run is as short as possible

Fan will be mounted securely according to manufacturer specifications

### Objective(s):

Install mounting fan securely

Ensure fan housing does not shake, rattle, or hum when operating



Improperly aligned fan



Fan is mounted securely with the termination outlet lined up.

**Tools:**

1. drill
2. drill bits

**Materials:**

1. fasteners



Fan is not properly supported, resulting in a improper alignment with the termination location.



Line the fan up so the outlet lines up with the termination.



Install the fan using factory mounting holes, ensuring a tight fit and quiet operation.

## 6.6003.3d - Weatherproof installation

**Desired Outcome:**

Through the wall fans installed to specification

**Specification(s):**

Exterior termination fitting will be flashed or weather sealed

Water will be directed away from penetration

Termination fitting installation will not inhibit damper operation

Manufacturer specifications will be followed

**Objective(s):**

Preserve integrity of the building envelope

Ensure a weather tight and durable installation

Ensure unrestricted air flow



**Best Practice**

Apply sealant behind termination cap, taking care to apply sealant to all edges.



**Best Practice**

Termination is sealed and securely attached to the wall.

**Tools:**

1. caulk gun
2. drill
3. drill bits
4. reciprocating saw
5. drywall saw or utility knife

**Materials:**

1. weatherproof termination kit with pest screen
2. caulk or equivalent sealant
3. mechanical fasteners



1

Clean existing sealant to ensure proper adhesion to the surface.



2

Once area around the termination opening is cleaned, apply sealant to all four sides of the opening.



3

Install screws through the sealant, which will tighten the fitting and squeeze out excess sealant.



4



5

Wipe away excess sealant for a clean look.

Ensure damper swings open freely, and closes with a tight fit.

## 6.6003.3e - Backdraft damper

### Desired Outcome:

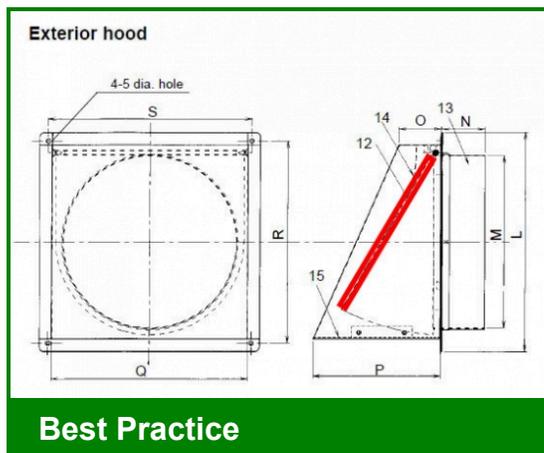
Through the wall fans installed to specification

### Specification(s):

A backdraft damper will be installed between the outlet side of the fan and the exterior

### Objective(s):

Prevent reverse air flow when the fan is off



Damper should be installed to maintain exterior air barrier

## 6.6003.3f - Fan housing seal

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

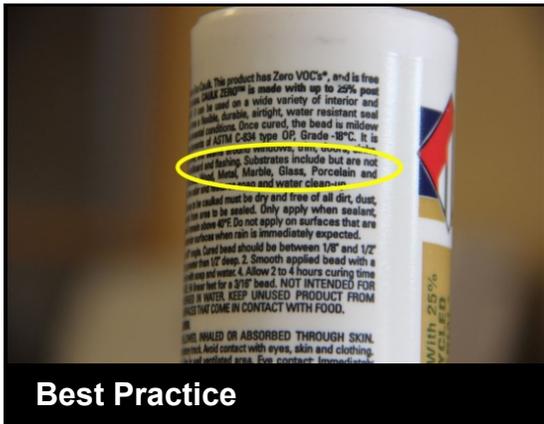
Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

### Objective(s):

Prevent air leakage through fan housing

Ensure a permanent seal to the building air barrier



**Best Practice**

Sealant should be waterproof and adhere to the desired surfaces.



**Best Practice**

Seal unused holes in the fan housing.

**Tools:**

1. caulk gun

**Materials:**

1. weatherproof, code approved caulk

## 6.6003.3g - Fan to interior surface seal

**Desired Outcome:**

Through the wall fans installed to specification

**Specification(s):**

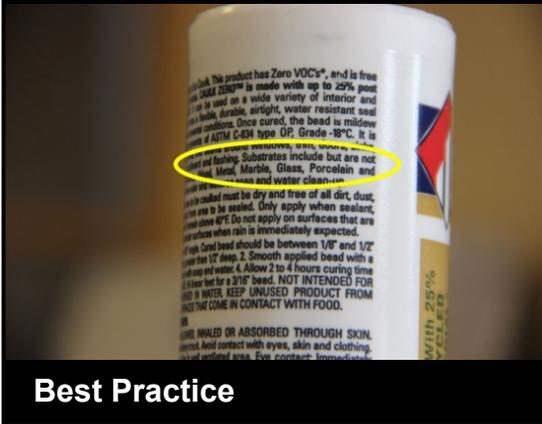
Sealants will be compatible with their intended surfaces

Sealants will be continuous and meet fire barrier specifications

**Objective(s):**

Prevent air leakage around intake housing

Prevent a fire hazard



Sealant should be waterproof and adhere to desired surfaces.



Sealant should be applied to the fan housing where it comes in contact with the exterior wall.

**Tools:**

1. caulk gun

**Materials:**

1. code approved caulk

## 6.6003.3h - Insulation

**Desired Outcome:**

Through the wall fans installed to specification

**Specification(s):**

All components outside of the thermal envelope will be insulated to a minimum of R-8 or equivalent to local code

Exception: If system operates continuously, fan housing need not be insulated

**Objective(s):**

Preserve integrity of the duct system

## 6.6003.3i - Air flow

**Desired Outcome:**

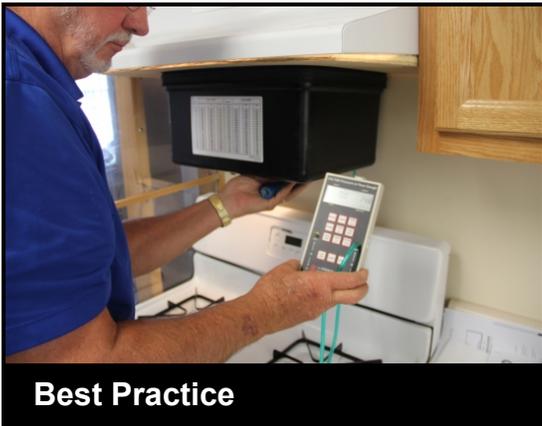
Through the wall fans installed to specification

**Specification(s):**

Air flows in CFM will be measured and adjusted to meet the design requirements

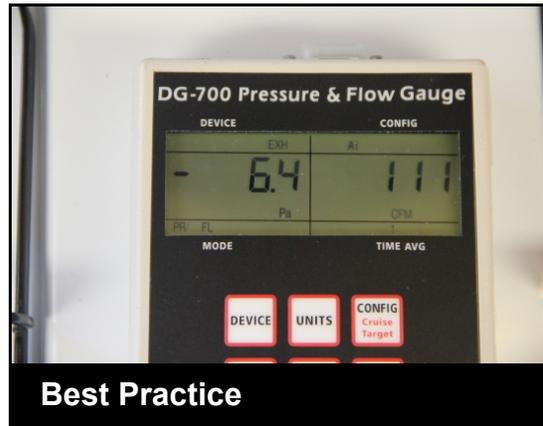
**Objective(s):**

Exhaust sufficient air from desired locations to outside



**Best Practice**

Using a digital manometer, exhaust flow meter and fabricated cover, measure the fan flow.



**Best Practice**

Air flow should be within acceptable limits for the location of the fan.

**Tools:**

1. exhaust fan flow meter
2. manometer

**Materials:**

1. a fabricated cover for fans larger than the flow meter



1

The exhaust fan flow meter won't fit most range hoods. A fabricated cover is needed.



2

A fabricated cover can be used so long as the opening is smaller than the meter itself and larger than the E1 opening.



3

Attach a pressure hose to the exhaust fan flow meter.



4



5



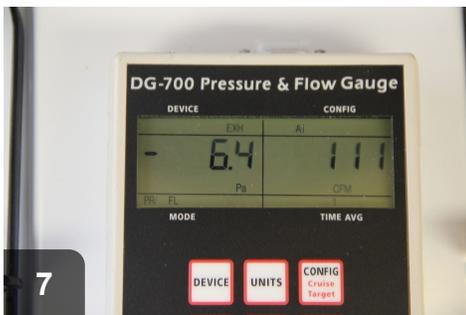
50 CFM min

160 CFM min

Attach a the hose to a T connection on channels A & B with the manometer set to measure exhaust fan flow.

With manometer properly set up, prepare to test air flow

Fans must pull the required CFM according to ASHRAE.



With the manometer Mode set to PR/FL, Device set to EXH, and Config set to E1, this fan pulls 111 CFM.

## 6.6003.3j - Preventing air leakage caused by exhaust fans

### Desired Outcome:

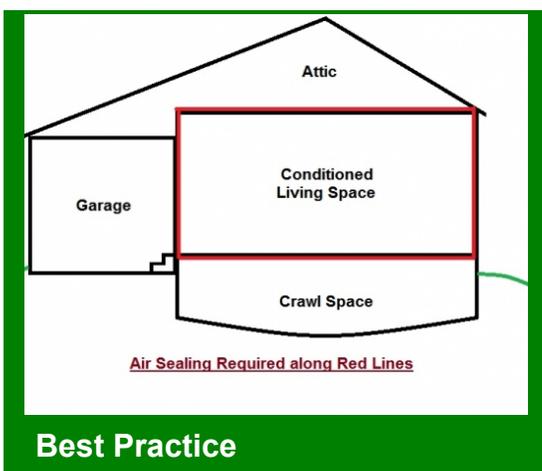
Through the wall fans installed to specification

### Specification(s):

Leakage to the house from other spaces will be prevented (e.g., garages, unconditioned crawl spaces, unconditioned attics)

### Objective(s):

Ensure occupant health and safety



The barrier between conditioned and unconditioned spaces should be sealed

See also SWS 3.1501.1 Air Sealing Garage Penetrations.

## 6.6003.3k - Combustion safety

### Desired Outcome:

Through the wall fans installed to specification

### Specification(s):

Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

Make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

### Objective(s):

Ensure safe operation of combustion appliances



**Before**

Installing new ventilation can cause imbalances within the house

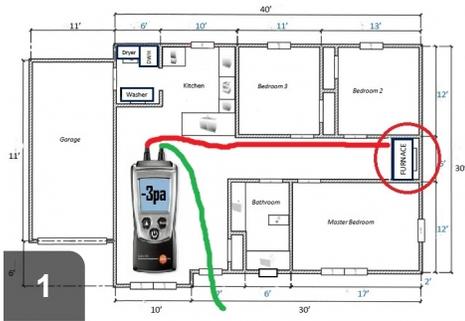


**After**

Test that depressurization limit is not being exceeded by new ventilation

### Tools:

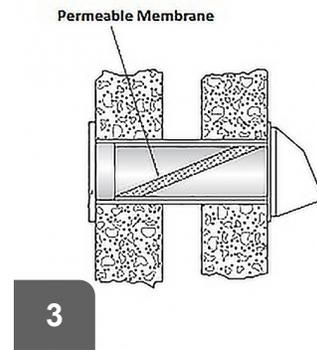
1. Manometer



1 Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



2 If depressurization limit is exceeded, mitigate to eliminate safety risk



3 Mitigate safety risk with make-up air or other pressure relief



4 After mitigation, verify that depressurization limits are not being exceeded

## 6.6005.1 - Clothes Dryer

### Desired Outcome:

Dryer air exhausted efficiently and safely

## 6.6005.1a - Clothes dryer ducting

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

Clothes dryers will be ducted to the outdoors, which does not include unconditioned spaces such as attics and crawl spaces that are ventilated with the outdoors

As short a run as practical of rigid sheet metal or semi-rigid sheet metal venting material will be used in accordance with manufacturer specifications

Dryer ducts exceeding 35' in duct equivalent length will have a dryer booster fan installed

Plastic venting material will not be used

Uninsulated clothes dryer duct will not pass through unconditioned spaces such as attics and crawl spaces, except where allowed by the authority having jurisdiction

Ducts will be connected and sealed as follows:

- UL listed foil type or semi-rigid sheet metal to rigid metal will be fastened with clamp
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

In addition:

- Sheet metal screws or other fasteners that will obstruct the exhaust flow will not be used
- Condensing dryers will be plumbed to a drain

### Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



**Before**

Dryer is vented outside, but with the incorrect material.



**After**

Dryer is vented outdoors, with correct material. Run is as short and straight as possible ensuring maximum flow.

**Tools:**

1. metal trimmers
2. drill

**Materials:**

1. metal flex duct
2. dryer vent kit
3. hose clamps



**1**

Disconnect existing vent pipe from termination. If hose clamp is installed, save for reuse.



**2**

Disconnect existing vent pipe from dryer.



**3**

Attach approved vent material to termination vent. Termination vent may need to be trimmed.



4 Trim metal vent to ensure the run is as short and straight as possible.



5 Connect vent pipe to dryer.



6 Dryer vents to outdoors, and exhaust damper is functional.



7 For vent runs >35 feet, a booster fan is required.



8 Duct runs outside of conditioned space must be insulated and properly supported.

## 6.6005.1b - Termination fitting

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

Termination fitting manufactured for use with dryers will be installed

A backdraft damper will be included, as described in termination fitting detail

### Objective(s):

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



### Best Practice

Termination fittings for dryers should have backdraft dampers



Most modern dryer vents have a built-in backdraft damper



To minimize pest intrusion, mesh >1/4" square can be used (see 6.6002.2e)

## 6.6005.1c - Make-up air

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

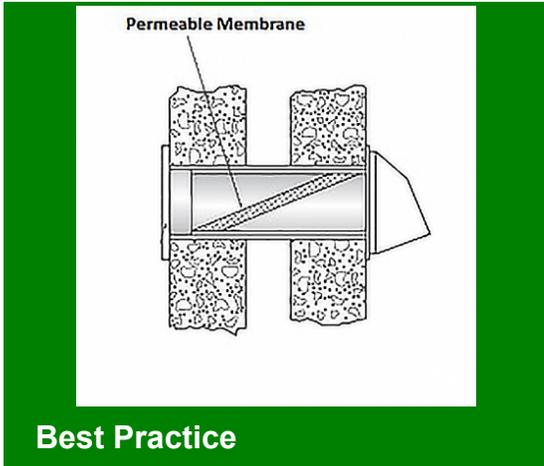
If natural draft combustion appliances are present and if worst-case CAZ and/or other performance based testing is conducted and indicates a need for make-up air, make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

If natural draft combustion appliances are present and if no performance based testing is conducted, make-up air will be provided prescriptively in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

**Objective(s):**

Preserve integrity of building envelope

Effectively move air from clothes dryer to outside



**Best Practice**

A passive inlet vent can provide make-up air for dryer exhaust

**Tools:**

1. Drill
2. Hole saw
3. Caulk gun

**Materials:**

1. Caulk sealant
2. Fasteners

**6.6005.1d - Combustion safety**

**Desired Outcome:**

Dryer air exhausted efficiently and safely

**Specification(s):**

Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

**Objective(s):**

Ensure safe operation of combustion appliances

Ensure occupant health and safety



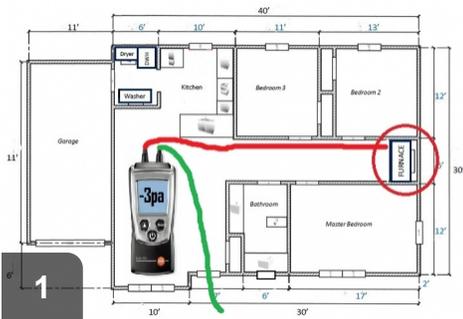
Appliance exhaust, such as that for a dryer, can cause depressurization



Test to verify combustion appliances are within depressurization limits

**Tools:**

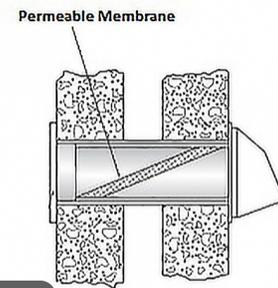
1. Manometer



Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



If depressurization limit is exceeded, mitigate to eliminate safety risk



Install make-up air, such as a passive inlet vent, or other pressure relief



After mitigation, verify that depressurization limit is not being exceeded

## 6.6005.1e - Occupant education

### Desired Outcome:

Dryer air exhausted efficiently and safely

### Specification(s):

Occupant will be instructed to keep lint filter and termination fitting clean

Occupant will be instructed to keep dryer booster fan clean, if present

Occupant will be instructed on clothes dryer operation safety including information on items that must not be placed in the clothes dryer (items with any oil or other flammable liquid on it, foam, rubber, plastic or other heat-sensitive fabric, glass fiber materials)

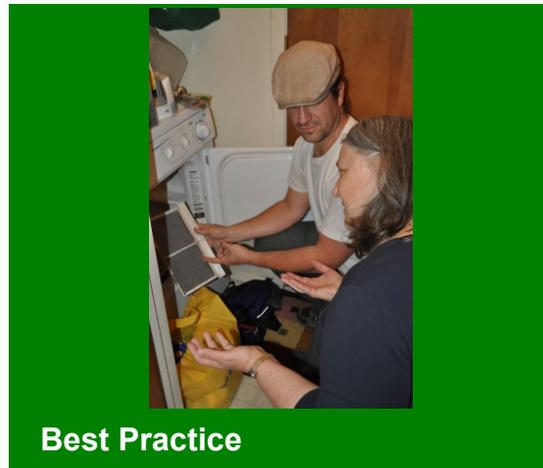
### Objective(s):

Effectively move air from clothes dryer to outside



**Unsafe**

Neglect of clothes dryer maintenance can cause fire hazards

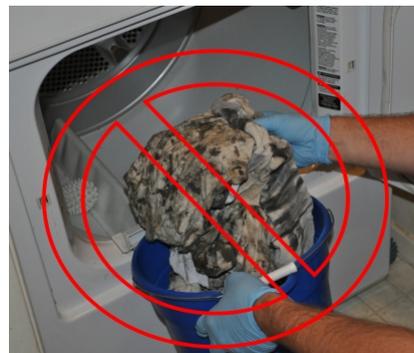


**Best Practice**

Occupants should be taught to clean lint filters and termination fittings



In homes with booster fans, occupant should know location and how to clean



Occupants should be taught never to put flammable articles in dryer (in this case, oily rags)

## 6.6005.2 - Kitchen Range

**Desired Outcome:**

Kitchen range fan installed to specification

**Note:**

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

### 6.6005.2a - Wiring

**Desired Outcome:**

Kitchen range fan installed to specification

**Specification(s):**

Wiring will be installed in accordance with local regulations or the IRC in the absence of such regulations or where those regulations are not as stringent as the IRC

Wiring will be installed in accordance with original equipment manufacturer specifications and local and national electrical and mechanical codes

**Objective(s):**

Prevent an electrical hazard

### 6.6005.2b - Fan venting

**Desired Outcome:**

Kitchen range fan installed to specification

**Specification(s):**

Kitchen range fans will be vented to the outdoors

Recirculating fans will not be used as a ventilating device

**Objective(s):**

Remove cooking contaminants from the house

Preserve integrity of building envelope



👎 Before

Recirculating fans over ranges do not actually remove contaminants



👍 After

Daylight visible through dampered kitchen exhaust proves venting access

## 6.6005.2c - Fan ducting

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

Kitchen range fans will be ducted to the outdoors

As short a run as practical of smooth wall metal duct will be used, following manufacturer specifications

Ducting will be connected and sealed as follows:

- Metal-to-metal will be fastened with a minimum of three equally spaced screws
- Other metal-to-metal connections will be securely fastened and sealed with welds, gaskets, mastics (adhesives), mastic-plus-embedded-fabric systems, or tapes
- For down-draft exhaust systems, PVC-to-PVC materials will be fastened with approved PVC cement
- Other specialized duct fittings will be fastened in accordance with manufacturer specifications
- In addition to mechanical fasteners, duct connections will be sealed with UL 181B or 181B-M listed material

### Objective(s):

Preserve integrity of building envelope

Effectively move air from range to outside



👎 Before

Exhaust duct should be smooth-walled and in as short a run as possible



👍 After

Daylight visible through dampered kitchen exhaust proves outside access

**Tools:**

1. Drill
2. Putty knife
3. Tape measure
4. Metal snips
5. Saw

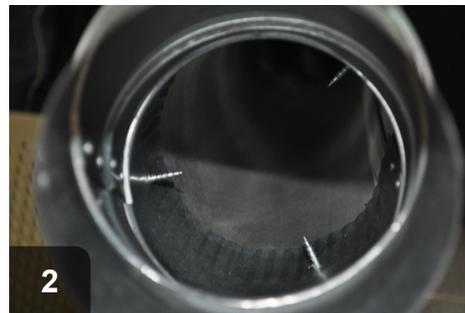
**Materials:**

1. Round metal ducting
2. Mastic
3. Fiberglass mesh tape
4. Fasteners

See also 6.6002.1d. Note: Only smooth-wall metal duct will be used, except for down-draft exhaust systems where PVC is acceptable as well. Flex duct is NOT acceptable for kitchen fan exhaust application.



Duct run should be as smooth and short as possible



Duct should be fastened securely with three evenly-spaced screws



Then joints should be secured with fiberglass tape



Finally, joint should be secured with UL-181 mastic

## 6.6005.2d - Termination fitting

### Desired Outcome:

Kitchen range fan installed to specification

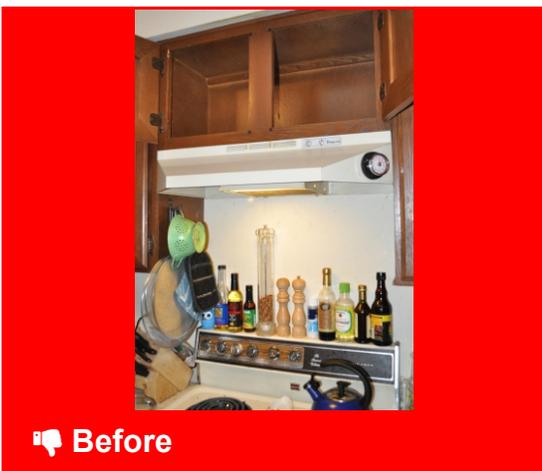
### Specification(s):

Termination fitting will be installed including a backdraft damper, as described in termination fitting detail

### Objective(s):

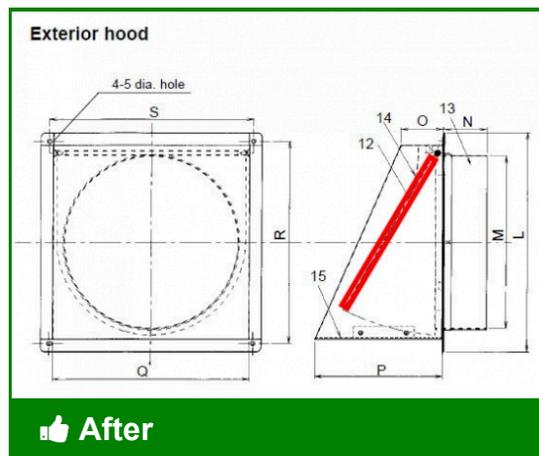
Ensure safe operation of combustion appliances

Ensure occupant health and safety



**Before**

Kitchen fans should exhaust to the exterior, not just recirculate air



**After**

Exhaust fans should have backdraft dampers



Backdraft damper on roof mounted exhaust fan



An interior backdraft damper can also be installed for good measure

## 6.6005.2e - Make-up air

### Desired Outcome:

Kitchen range fan installed to specification

### Specification(s):

If natural draft combustion appliances are present and if worst-case CAZ and/or other performance based testing is conducted and indicates a need for make-up air, make-up air will be provided in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

If natural draft combustion appliances are present and if no performance based testing is conducted, make-up air will be provided prescriptively in accordance with the current version of ASHRAE 62.2 and in compliance with the authority having jurisdiction.

### Objective(s):

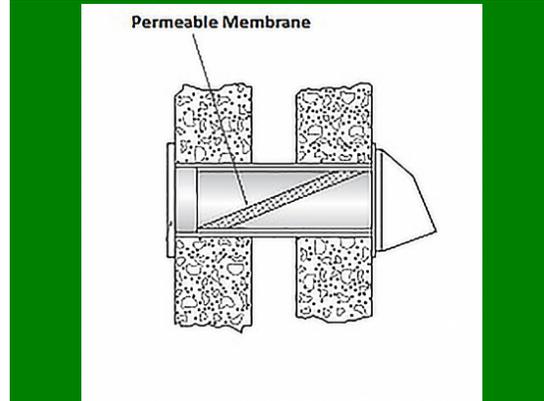
Ensure safe operation of combustion appliances

Ensure occupant health and safety



**Before**

If kitchen exhaust is venting at more than 200 cfm, provide make-up air



**After**

A passive inlet vent can provide make-up air for kitchen exhaust

**Tools:**

1. Drill
2. Hole saw
3. Caulk gun

**Materials:**

1. Caulk sealant
2. Fasteners

## 6.6005.2f - Combustion safety

**Desired Outcome:**

Kitchen range fan installed to specification

**Specification(s):**

Pressure effects caused by fans will be assessed and corrected when found outside of combustion safety standards

**Objective(s):**

Ensure safe operation of combustion appliances

Ensure occupant health and safety



**Before**

Kitchen exhaust fans can cause combustion appliances to depressurize

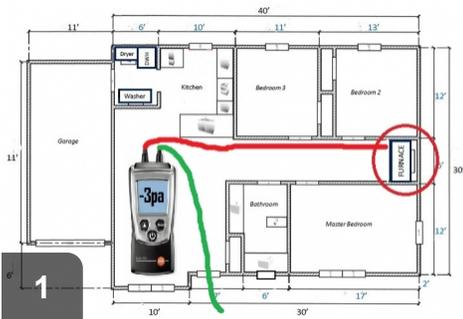


**After**

Test that combustion appliances are operating within depressurization limit

**Tools:**

1. Manometer



**1**

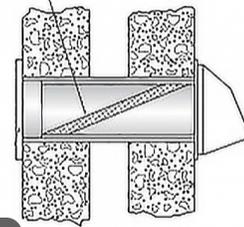
Run depressurization testing on house to ensure new ventilation isn't causing unsafe conditions



**2**

If appliances exceed depressurization limit, mitigate to reduce risk

Permeable Membrane



**3**

Install a source of make-up air, such as a passive inlet vent



**4**

After mitigation, verify that depressurization limits are not being exceeded

## 6.6005.2g - Occupant education

**Desired Outcome:**

Kitchen range fan installed to specification

**Specification(s):**

Occupant will be instructed to keep grease filters and termination fitting clean

**Objective(s):**

Effectively move air from kitchen range to outdoors

## 6.6201.2 - Primary Ventilation Air Flow between Rooms

### Desired Outcome:

Air circulates freely between rooms

## 6.6201.2a - Balancing pressure

### Desired Outcome:

Air circulates freely between rooms

### Specification(s):

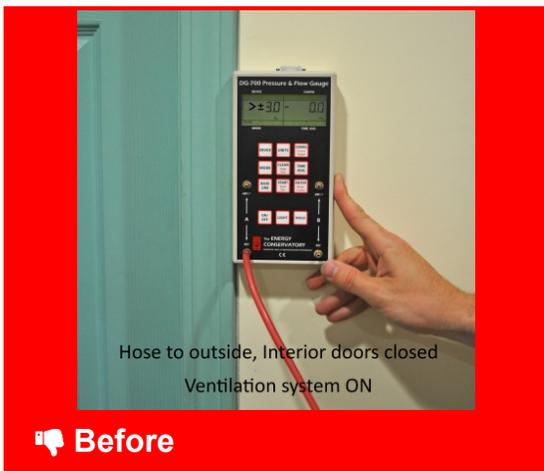
An appropriate means of pressure balancing will be installed (e.g., transfer grilles, jumper ducts, individual room returns)

No room will exceed +/- 3 pascals with reference to the common area with all interior doors closed and ventilation systems running

### Objective(s):

Ensure free flow of air between rooms

Preserve integrity of the building envelope



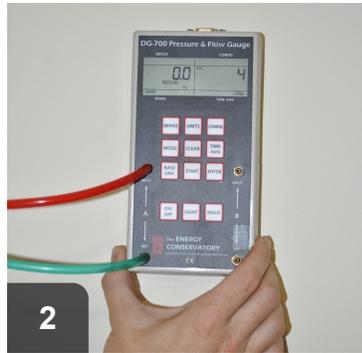
If reading is >+/-3pa, interior ventilation needs to be installed



Passive door vents and individual room returns are two possibilities



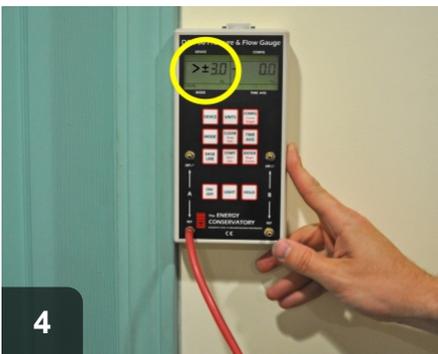
With interior doors open, put reference hose to exterior



Take baseline reading



Turn on exhaust fans and close interior doors



With hose under door, check pressure again. Readings  $> \pm 3\text{pa}$  indicate a need for interior ventilation

## 7.8102.2 - Storage-Type Appliance

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Note:**

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 7.8102.2a - Hazardous material removal

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

Health concerns in the removal and replacement of equipment (e.g., asbestos, other hazardous materials) will be identified

Written notification will be provided to occupants of the discovery of hazardous material, including contact information for regional EPA asbestos coordinator

Occupant will be asked to contract with an EPA-certified asbestos contractor to conduct abatement before equipment removal and replacement (occupant is responsible for abatement or remediation)

**Objective(s):**

Remediate health hazards using EPA-certified contractors

## 7.8102.2b - Equipment removal

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

Accepted industry procedures and practices will be followed to:

- Remove old water heater and associated components in accordance with IRC or authority having jurisdiction

- Seal any unused chimney openings and penetrations in accordance with IRC or authority having jurisdiction
- Remove unused oil tank, lines, valves, and associated equipment in accordance with IRC or authority having jurisdiction

All work shall be completed by a licensed plumbing professional where required by the authority having jurisdiction and installed to industry-accepted standards

**Objective(s):**

Ensure the safety of the workers and occupants

Preserve integrity of the building

Remove old equipment in a timely and efficient manner

## 7.8102.2c - New equipment installation

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

New water heater and associated components will be installed to accepted industry standards, in accordance with the IRC and manufacturer specifications

The system will be installed to be freeze resistant

Any existing water leaks will be repaired before installation begins

Any penetrations to the exterior of the home created by the installation of the equipment will be sealed

**Objective(s):**

Ensure the safety of the workers and occupants

Preserve integrity of the building

Remove old equipment in a timely and efficient manner

## 7.8102.2d - Emergency drain pan

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

An emergency drain pan and drain line shall be installed in accordance with the IRC

### Objective(s):

Collect and safely dispose of water escaping from the storage tank

## 7.8102.2e - Expansion tank

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

Expansion tanks will be installed where required and in accordance with the AHJ

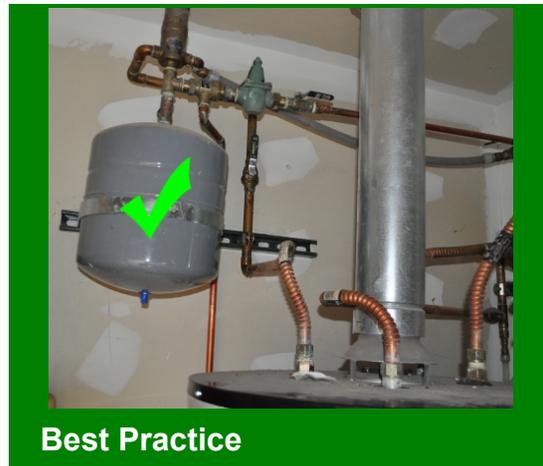
### Objective(s):

Protect the storage tank from expansion



**Bad Practice**

Need to eliminate the valves between the storage tank and expansion tank



**Best Practice**

GOOD: Expansion tank is installed on both cold sides

Appropriate licensing for installer required.

## 7.8102.2f - Temperature and pressure relief valve

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications

Temperature and pressure relief valve discharge tube will be installed in accordance with IRC

### Objective(s):

Discharge excessive energy (pressure or temperature) from storage tank to safe location



**Before**

Water heaters should be not capped off at t&p valve



**After**

T&P discharge should be piped to a safe and observable location

### Tools:

1. Pipe wrench
2. Hacksaw

### Materials:

1. PVC
2. Plumber's epoxy

Check local jurisdictional codes. Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.



GOOD: T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system

## 7.8102.2g - Dielectric unions

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

Dielectric unions will be installed in accordance with the IRC, authority having jurisdiction, and according to manufacturer specifications

### Objective(s):

Break the stray voltage electrical circuit through the storage tank

## 7.8102.2h - Backflow prevention

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

Backflow prevention will be installed in accordance with manufacturer specifications and all applicable codes

### Objective(s):

Protect water supply from contamination

## 7.8102.2i - Thermal efficiency

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

If additional tank insulation is installed, it will be rated a minimum of R-11 and will be installed to manufacturer specifications

If additional insulation is installed, it will be installed based on fuel type, making sure not to obstruct draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates

The first 6' of inlet and outlet piping will be insulated in accordance with manufacturer specifications

Combustible pipe insulation must maintain a minimum clearance of 6" from gas water heater draft hood and/or single wall metal pipe. Clearance from vent such as "B" vent should be maintained per vent manufacturer's specifications

Heat traps will be installed on the inlet and outlet piping where not provided by manufacturer

**Objective(s):**

Reduce standby loss from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting

## 7.8102.2j - Fuel supply

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

Electric or fossil fuel supply components will be installed to accepted industry standards as per NFPA 31 and 54, or NFPA 70 National Electric Code (NEC) for electric components, or authority having jurisdiction

**Objective(s):**

Provide sufficient fuel to the water heater, burner, or element

## 7.8102.2k - Discharge temperature

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

Discharge temperature will be set not to exceed 120° or as prescribed by local code

### Objective(s):

Ensure safe hot water supply temperature to fixtures



**Unsafe**

Water heaters producing water over 120 degrees raise heating costs



**Safe**

Water heaters should produce water under 120 degrees to prevent scalding

### Tools:

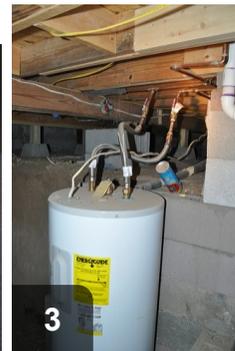
1. Thermometer



Test temperature of hot water at faucets in house



Hot water temperatures should not exceed 120 degrees Fahrenheit



Adjust water heater settings and insulate as needed



After adjustment and insulation, retest to verify temp is under 120 degrees

## 7.8102.2I - Commissioning of system

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

### Specification(s):

The following will be checked once the system has been filled and purged:

- Safety controls
- Combustion safety and efficiency
- Operational controls
- Fuel and water leaks
- Local code requirements

Commissioning will be in compliance with manufacturer specifications and relevant industry standards

### Objective(s):

Ensure safe system function

Keep cost of ownership as low as possible

## 7.8102.2m - Occupant safety

### Desired Outcome:

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of

ownership

**Specification(s):**

Carbon monoxide (CO) alarms will be installed in each dwelling in accordance with ASHRAE 62.2 and authority having local jurisdiction

Occupant will be provided information regarding the health effects and risk of high CO concentrations as well as a list of monitors that can provide more detail regarding CO levels

**Objective(s):**

Ensure occupant life safety; CO alarms are designed to detect levels at which occupants might become unable to evacuate

## 7.8102.2n - Occupant education

**Desired Outcome:**

Safe and reliable hot water source provided that meets occupant needs at lowest possible cost of ownership

**Specification(s):**

Completed work will be reviewed

Occupants will be educated on the safe and efficient operation and maintenance of the system, including:

- Adjustment of water temperature and target temperature in accordance with local code
- Periodic drain and flush
- Expansion tank and backflow preventer (no occupant maintenance required)
- Periodic inspection, maintenance, or replacement

**Objective(s):**

Ensure occupant is informed of the safe, efficient operation and maintenance of the system

## 7.8103.1 - Storage-Type Appliance

### Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

### Note:

The authority having jurisdiction may require that a licensed professional perform certain tasks outlined in this detail.

## 7.8103.1a - Health and safety

### Desired Outcome:

Safe, reliable, and efficient operation of the appliance maintained

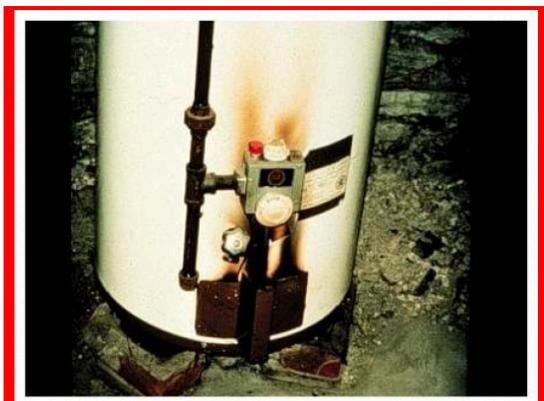
### Specification(s):

Combustion safety testing will be performed in accordance with the Health and Safety Chapter of the Standard Work Specifications for Single Family Housing or other equivalent practice

Electrical components will be verified to comply with NEC (e.g., no electrical box connector, no disconnect, improperly sized breaker and wire)

### Objective(s):

Identify potential health and safety issues



 Before

Complete combustion safety testing to ensure healthy, safe work environment



 After

When completed work, retest to verify home is still healthy and safe

**Tools:**

1. Personal CO monitor
2. Combustion analyzer with probe
3. Manometer
4. Smoke pencil

**Materials:**

1. CO alarm
2. Fasteners

See also SWS 2.0201.1a-2.0203.4d for all Combustion Safety details and SWS 2.0100.1d for General Electrical Safety.

## 7.8103.1c - Thermal efficiency

**Desired Outcome:**

Safe, reliable, and efficient operation of the appliance maintained

**Specification(s):**

Water heater storage tanks shall have a minimum R-value of R-24, unless the SIR to add insulation is less than 1.0

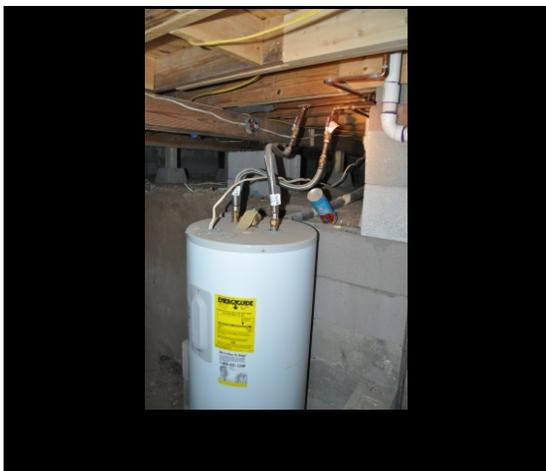
Added insulation will not obstruct the unit's draft diverter, pressure relief valve, thermostats, hi-limit switch, plumbing pipes or elements, and thermostat access plates

The first 6' of inlet and outlet piping will be insulated in accordance with IRC or local requirements, whichever is greater

**Objective(s):**

Reduce standby losses from near tank piping and storage tank

Ensure insulation does not make contact with flue gas venting



Standard water heaters have built-in insulation ranging from R-7 to R-20.



Storage-type water heaters should be wrapped to bring total value to R-24

**Tools:**

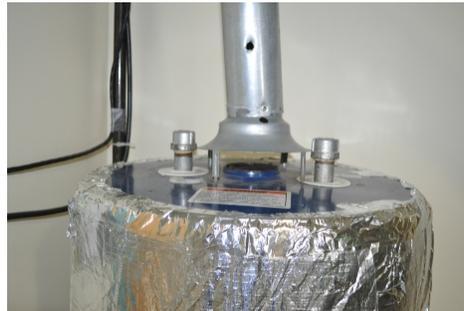
1. Utility knife

**Materials:**

1. Pipe wrap
2. Water heater blanket
3. Foil tape
4. Long zip ties



Check occupant's water heater model to see what r-value is built-in



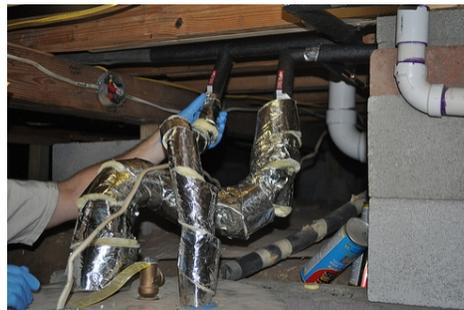
Blanket does not obstruct draft diverter or plumbing pipes and elements



Wrap does not obstruct ventilation, thermostat access plate, hi-limit switch, or fuel line



Data plate should still be accessible after wrapping



Both hot and cold water pipes should be insulated to R-3 for first 6ft

## 7.8103.1e - Temperature and pressure relief valve

**Desired Outcome:**

Safe, reliable, and efficient operation of the appliance maintained

**Specification(s):**

Correct temperature and pressure relief valve will be installed in compliance with IRC and according to manufacturer specifications

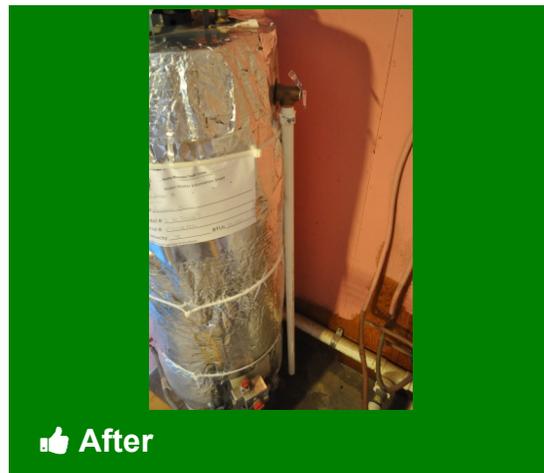
Temperature and pressure relief valve discharge tube will be installed in accordance with IRC

**Objective(s):**

Discharge excessive energy (pressure or temperature) from storage tank to safe location



Water heaters should be not capped off at t&p valve



T&P discharge should be piped to a safe and observable location

**Tools:**

1. Pipe wrench
2. Hacksaw

**Materials:**

1. PVC
2. Plumber's epoxy

Check local jurisdictional codes. Paraphrased from 2012 IRC P2803.6.1: Temperature and pressure relief valve discharge pipes should not be connected to drainage system. T&P discharge pipes should be a clean line without valve or tee, flowing with gravity to an observable and safe location that cannot cause personal injury or structural damage -- the floor, an existing drain pan, a waste receptor, or to the outdoors. Pipe should not terminate more than 6" from floor, pan or waste receptor.



GOOD: T&P discharge should be piped within 6" of the floor or to outdoors



BAD: T&P discharge should flow with gravity and be observable



BAD: T&P discharge should not be piped into drainage system