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Populus
Sustainable Design Consulting

Populus Contractor Operations Guide for Boulder County's EnergySmart Service

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EnergySmart, administered by Populus, LLC, is a Boulder County residential energy efficiency service funded by a federal grant designed to facilitate the implementation of efficiency solutions.

Populus Contact Information

Address: 1722 14th St. Suite 210 Boulder, CO 80302

Phone: 303-325-7650 / **Fax:** 303-747-5806

Website: www.popboulder.com

Peter Stelling, Contractor Manager

Cell: 720-288-7059

Peter.stelling@popboulder.com

EnergySmart Info and Enrollment

EnergySmart Hotline: 303-544-1000

EnergySmart website: www.energysmartyes.com

Note to all contractors about using this manual:

The EnergySmart Service has 2 separate pools of contractors: An Insulation and Air-sealing Contractor pool and all other contractors. The contractors who offer insulation and air sealing services are monitored more closely. Their work is subject to Quality Assurance Inspections and they are required to complete combustion safety testing and Blower door tests. The first section of this manual outlines requirements for all contractors. The second half of this manual outlines requirements for all insulation and air-sealing work completed for homes coming through the EnergySmart Service.

Contractor Requirements (All Contractors)

Required Paperwork on-file with Contractor Manager

(Following the Application Process with Boulder County)

- Signed Contractor Agreement
- Current copies of Insurance Certificates listing both Populus and Boulder County as Additional Insured. Please resend current copies of these certificates upon yearly renewal to peter.stelling@popboulder.com .

Waste Management Guidelines

- Contractor agrees to abide by any Waste Management Plan developed and adopted by Boulder County, as amended from time to time. This plan is available at http://www.energysmartyes.com/files/EnergySmart_WASTE_MANAGEMENT_PLAN_1_28_11.pdf

Branding Guidelines

- We want all contractors in our pool to be able to market your involvement in EnergySmart using our brand and logo. However, we do not want to mislead any Boulder County residents about our services and our relationship with our contractors.
- Contractors are allowed to use our brand and logo as long as they follow these simple guidelines:
 - Contractors must follow our brand usage guidelines, specifying colors, size, etc., found online at: http://www.energysmartyes.com/files/EnergySmart_Standards-Contractors_partners.pdf
 - In addition to following all usage guidelines for the EnergySmart logo and brand, all marketing materials containing the EnergySmart brand that will be seen by the public must be pre-approved by EnergySmart staff. Contractors are responsible for sending a copy of any collateral to Beth Beckel (bbeckel@bouldercounty.org) for approval before public release. She will respond to you within 2 business days.

Reporting Requirements: Invoices (All Contractors)

For every job completed as a part of the EnergySmart Service, it is the contractor's responsibility to submit a copy of the invoice to either the Advisor associated with the particular Homeowner account, or to contractordata@popboulder.com within 2 weeks of the completion of the job.

Reporting Requirements: Signoff Sheets (Insulation Jobs Only)

In addition to submitting an invoice, every job completed as a part of the EnergySmart Service that includes Insulation and Air Sealing as a part of the scope must also complete a signoff sheet and submit to contractordata@popboulder.com. This form includes Test-in and Test-out Blower Door numbers as well as Combustion Appliance Zone (CAZ) testing results. The Contractor's BPI certified Manager must sign-off on these results. This form is primarily intended to ensure that the Combustion Appliance Zone (CAZ) Test results are adequately discussed with the Homeowner, and that they are notified of steps that can be taken to rectify issues indicated by those results.

The Homeowner is given the option of signing to indicate that they do not want to pursue those recommendations or that they intend to hire someone else to address the CAZ issues.

The Insulation and Air Sealing Sign-off sheet is available at:

http://www.energysmartyes.com/files/EnergySmart_Insulation_Contractor_Sign-Off_Sheet_12-1-201120Fillable.pdf and must be submitted within 2 weeks of the completion of the job.

Reporting Requirements: Paperwork Submission Guidelines (All Contractors)

File Naming Convention:

- For Signoff Sheets: Jobsite Address, Homeowner Last Name, "Signoff sheet" (e.g. 123 Mainstreet Ave Smith Signoff Sheet)
- For Invoices: Jobsite Address, Homeowner Last Name, "Invoice" (e.g. 123 Mainstreet Ave Smith Invoice)
- For data Files (insulation Contractors Only): Jobsite Address, Homeowner Last Name, "Test-In or Test-out" (e.g. 123 Mainstreet Ave Smith Test-out)

Send all files to New Address

- Please send all files to: contractordata@popboulder.com

Send Everything at the same time

- For each address, please do not send 1 file, then another, and then another all at different times. This makes it very difficult to manage. Wait until you have everything for that address, and send it all at once.

Clarification of what to send:

- All Jobs that include Insulation and Air Sealing as a part of the work scope
 - Signoff Sheet
 - Invoice
 - For the Tectite files, you need to be generating those and keeping them on file, but you do not have to submit those to the program, except for when requested as a part of QA.
- All other Jobs that do not include insulation and air sealing
 - Invoice only
- The signoff sheet and invoice for each address can be in a single PDF or separate PDFs, whichever is easier, but please do not combine documentation for separate addresses

Reporting Requirements: Quarterly Time Tracking (All Contractors)

As a condition of the Federal funding for EnergySmart, we are required to collect data on the number of hours contractors spend doing work within the program. The purpose is to track leveraged jobs as a part of ARRA funded projects. You will need to keep track of ALL hours related to projects you actually get; including labor, management, driving, admin, etc. You do not have to track hours for jobs that you bid but did not win. Two weeks prior to the end of the Quarter, the Contractor Manager will forward via email a simple spreadsheet created by the County to help you report this data. Instructions will be included both in that email, and in the spreadsheet itself. That spreadsheet is due by the end of the quarter. This is a very important part of maintaining funding for the program, and failure to submit these reports can be grounds for removal from the program.

Professionalism Guidelines & Contact with Customers (All Contractors)

The EnergySmart service relies heavily upon positive word of mouth for marketing. Our goal is to ensure that clients are completely satisfied with their EnergySmart experience, including their interactions with contractors referred by the program. It is expected that contractors will handle all interactions with EnergySmart clients with the utmost respect and professionalism. Populus reserves the right to remove a contractor from the EnergySmart pool based upon repeated customer complaints related to customer service or professionalism.

Populus has established the following general guidelines for contractors:

- Respect the customer's time and be prompt for all appointments. If you expect to be more than a few minutes late, call the customer and let them know that you're running late and when you expect to be there.
- Follow through on your commitments to customers, including providing estimates in a timely manner.
- Keep in mind that you are being allowed into someone's home; act as you would want a stranger to act in your own home. Respect the customer's home and follow all rules of the house (i.e. taking off shoes, not parking in the driveway, smoking in people's homes, etc.)
- If you make a mess of any kind, clean it up immediately.

In addition, to promote the professionalism of the EnergySmart service, contractors should refrain from making disparaging remarks regarding other contractors in the EnergySmart pool.

Overview of Bid Process (All Contractors)

Contractor Bidding

EnergySmart advisors will be assisting customers to choose contractors to bid their projects. In some cases, the advisor may contact the contractor directly to schedule an estimate meeting at the customer's house and in other cases the customer may prefer to have the contractor contact them directly to schedule the estimate meeting.

Requirements for "Active Status"

To promote an efficient process and out of fairness for other contractors, contracting companies are expected to have reasonable scheduling availability for EnergySmart customers. To be eligible to receive EnergySmart referrals and be on "active status", a contracting company must have no greater than a two (2) week lead time for scheduling initial customer estimate meetings. If your company is experiencing high work volumes and is not able to schedule new estimate meetings within two weeks, you must notify Peter Stelling at Populus and he will temporarily put your company on "Inactive" status until you notify him that you are ready for additional referrals.

Contractor Referral Process & Response Time Requirements

The most common method for contractor bidding will be email referrals containing the customer's contact information and information about the home.

When an EnergySmart advisor provides an email customer referral to a contractor, the following timeline will be strictly enforced:

- Contractor must contact the customer to schedule an estimate meeting within two business days (48 hours) of receiving the customer referral email
 - Decision not to bid: If a contractor receives a customer referral email and the contractor does not wish to bid the project, the contractor must notify the EnergySmart advisor within one business day (24 hours) of receiving the customer referral email
- Following an on-site estimate meeting, contractors must provide a written estimate to the customer Within the following timeframes
 - For all insulation and air-sealing jobs within three business days (72 hours) of the visit to the customer's house
 - For all other jobs: within 5 business days of the visit to the customer's house
 - Decision not to bid: If a contractor visits a home for an estimate meeting and determines that they do not wish to bid the project, the contractor must notify the EnergySmart advisor within one business day (24 hours) of the visit to the customer's house

Failure to meet these response time requirements three times within one calendar year will result in removal from the EnergySmart pool of contractors.

Simultaneous Bidding – Bidding “Parties”

Some customers have requested that we schedule contractor visits simultaneously. Usually we have found that this option is appealing to busy customers who don't have several hours to visit with multiple contractors or to customers who own multiple properties and want to consolidate bidding for all properties. In these cases, the EnergySmart advisor will coordinate scheduling with the contractors and the customer.

For companies participating in the bidding party process, we will hold your representatives to the highest standards of professionalism to ensure that the customer's experience reflects positively on the EnergySmart service.

EnergySmart Customers Contact Contractor Directly

Some customers prefer to contact contracting companies directly without their EnergySmart advisor sending a referral. The Advisors will be asking the Homeowner to notify contractors that they contact directly that they are in the EnergySmart Program, however, to ensure that program standards and reporting requirements are met for all EnergySmart projects, it is the responsibility of the contractor to determine whether the customer is participating in EnergySmart. If you have any questions about whether a customer is currently enrolled, please contact the EnergySmart call center at 303-544-1000 and we can search our customer management system.

Insulation and Air-Sealing Contractor and Subcontractor Requirements

All installers and subcontractors of Insulation and Air-Sealing Contractors receiving referrals from Boulder County's EnergySmart Service must meet one of the following requirements:

1. Certification as a Building Performance Institute ("BPI") energy analyst or equivalent
2. Complete a two-day insulation and air sealing training course offered by Boulder County on an ongoing and as-needed basis.

Each enrolled contractor must also:

1. Attend a mandatory contractor orientation before completing any work for EnergySmart. These sessions are offered on an ongoing and as-needed basis.
2. Have at least one BPI certified professional on staff who is required to sign off on the Combustion Appliance Zone test performed at the end of the job once all work is completed.

Required Equipment

All contractors must own or have access to the following equipment:

- Blower Door, Manometer & automated blower door testing software (such as TecTite or FanTestic)
- Laptop (or netbook) to run the blower door software on-site
- Combustion analyzer (CO Detector)
- "Puffer stick" or similar device for testing spillage on naturally drafting water heaters and furnaces

Insulation and Air Sealing Standards and Quality Control

Standards

- All insulation and air sealing work must adhere to BPI's Standard Work Specifications for Insulation and Air Sealing (See Appendix A). An Insulation and Air Sealing Checklist was derived directly from these specifications, and will be used by the Contractor Manager to determine whether work adheres to these standards. That checklist can be found at the end of this guide and can also be found on the EnergySmart website as well: http://www.energysmartyes.com/files/Ins_checklist_from_BPI_standards.pdf
- A Blower Door Test is required both before and after insulation and/or air sealing work. A comparison between the test-in and test-out numbers will be used to ensure the air sealing work did in fact yield a reduction in the home's air infiltration. Please refer to the section in this manual about Automated Blower Door Testing
- A Combustion Appliance Zone (CAZ) Test is required in accordance with BPI Standards and by a BPI Certified Building Analyst both at the beginning and completion of insulation and/or air sealing work (test in / test out).
- You must be certified or licensed in your respective trade as required by law to participate in this program. In some cases, you must be licensed in Boulder County.

- Please refer to the matrix in Appendix E which outlines most residential projects and whether or not such work requires a permit (organized by municipality).
- It is the contractor's responsibility to know when a permit is required for any project for which they are contracted within the EnergySmart Program.
- It is also the contractor's responsibility to obtain permits and inspections as required by the jurisdiction in which the work is being done.
- All municipalities in Boulder County are on either 2006 or 2009 IRC. Even if the work you are performing does not require a permit, you are still required to build to Code. Please refer to Section R105.2 of both the '06 and '09 revisions of the IRC: "Work exempt from permit. Permits shall not be required for the following. Exemption from permit requirements of this code shall not be deemed to grant authorization for any work to be done in any manner in violation of the provisions of this code or any other laws or ordinances of this jurisdiction."

Quality Assurance Inspections

A Quality Control check will be performed by the Populus Contractor Manager on the first 5 jobs completed by each Contractor and 5% of all subsequent work. These QC checks can occur while the work is in process, or after the work has been completed. A Quality Control Inspection may be triggered at any time at the discretion of the Contractor Manager as a result of complaints by the Homeowner or a notice from the Advisor of potentially sub-standard work.

Automated Blower Door Testing

All contractors participating in Boulder County's EnergySmart Service will be required to do both a test-in and test-out on all houses that include insulation and/or air sealing as a part of the scope of work. To standardize the collection of this data, you will be required to use the automated software that is associated with whichever blower door make and model you use. For the Minneapolis Blower Door, the software is called TecTite, and for Retrotec, the software is called FanTestic!. Both software packages can be run on either a laptop or a netbook. Both software packages are free. The contractor is responsible for collecting and keeping on file these data files, however they will only be asked to submit these files when requested for QC purposes.

For the Minneapolis Blower Door, you can go to the energy conservatory website and download a 30-day trial version <http://www.energyconservatory.com/products/products8.htm>. This is the full version of the software with a 30-day timer. When the timer runs out, call the Energy Conservatory at 612-827-1117. They will turn off the timer with you over the phone.

If you are using RetroTec gear, you can download a 30day trial version of the pro version that just loses its pro features after 30 days. The basic version will still do the basic multi-point test that we need and is free.

Minneapolis Blower Door Setup

There are 2 extra cables that are required to use the TecTite software. One is a fan control cable that connects the DG-700 to the fan controller. This is a simple mono 1/8" mini plug. The other is a 9-pin RS-232 serial cable. Depending on your computer, you may also need a serial to USB adapter. The Energy Conservatory carries all the necessary cables.

A standard configuration file has been distributed to all of you and will further simplify data collection by already having the test parameters set.

Once you have TecTite open, from the "File" menu select "New Test with Custom Configuration". It will ask for the location of the configuration file. Once TecTite has opened this new test (as yet unnamed), enter the Test Date and Technician as well as the Customer Name and Building Address. No information is required in the "Building Info" screen. In the "Climate Info" screen, input the indoor and outdoor temperatures. Then proceed to the "Test Graph" window. There is a "Data Box Info" button at the bottom left that has some troubleshooting tips in case you are having trouble connecting the DG-700 to your computer. Once a link is established, the Status Bar below the graph will turn green and say "Ready". Simply hit "Start Test" and the software will guide you through the process step-by-step.

Once the software completes the test, you must save the test file with the address in the title. Then proceed to the "Test Results" Screen, and record the CFM50 number on the required Contractor Signoff Sheet. Again, the Contractor is responsible for maintaining a record of these test data files, but will only be required to submit them to the Contractor Manager for particular houses that are selected for QC checks.

Appendix A – BPI Standard Work Specifications for Attic Air Sealing and Other Details

Standard Work Specifications for Attic Air Sealing and Other Details

Version 1.2



Building Performance Institute, Inc.

Building Performance Institute, Inc.

Acknowledgements

The Building Performance Institute, Inc. would like to thank those who support the BPI national expansion and all of the dedicated professionals who have participated in the development of this document.

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Building Performance Institute, Inc. Letter of Address



To all building energy retrofit professionals:

We all know the adage, "Do it right the first time." To get it right the first time, we need to know the right way and the wrong way. This assumes there is some set of instructions available entitled "The Right Way to Do Things." Unfortunately, these instructions usually aren't available to us- until now.

Enter Advanced Energy's commitment to providing the home energy retrofit industry with a set of Standard Work Specifications (SWS). The SWS define the minimum conditions necessary for the delivery of high quality work and specify desired outcomes. This first volume focuses on air leakage control in attics and sidewalls. Advanced Energy developed the initial set of SWS documents with financial support from Masco Home Services *WellHome* and the participation of subject matter experts, including:

- Jim Fitzgerald, Conservation Services Group
- Larry Harmon, Air Barrier Solutions, LLC
- Anthony Cox, New River Center for Energy Research and Training
- Chris Clay, Building Performance Center
- John Tooley, Advanced Energy
- Courtney Moriarta, WellHome
- Keith Aldridge, Advanced Energy (Facilitator)

The National Renewable Energy Laboratory (NREL) has hired Advanced Energy to complete the SWS effort using the knowledge and experience of subject matter experts from across the industry. Expected completion corresponds to Vice President Biden's request for a *Recovery Through Retrofit* plan by the end of September 2010.

Here's to getting it right the first time!

A handwritten signature in blue ink that reads "Larry Zarker".

Larry Zarker
Chief Executive Officer

Building Performance Institute Inc. Standard Work Specifications



Creators of the National Standards for the Building Performance Institute

The signatures on this page represent some of the nation's premiere technical experts who, in March 2010, met to collaborate on the preliminary phase of Building Performance Institute's evolving work effort to create Standard Work Specifications for the entire nation. Incorporating their practical field expertise in the development of the standards ensures successful implementation in homes nationwide.

Chris Clay

Anthony S.

Anthony S.

Adam Schaller

Anthony S.

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What are Standard Work Specifications (SWSs)?

In order to maintain quality during a time of rapid growth it is critical to base all training, work and quality control on Standard Work Specifications (SWSs).

The SWS approach has several essential steps:

Step 1: Agree upon a set of SWSs. These specifications must not only define minimum conditions for high quality work but must also clearly define desired outcomes. Where longevity, effectiveness and safety are in question SWSs will specify materials. (Mastic versus tape as a duct sealant, ASTM and UL listed materials, etc.) SWSs eliminate opinions and set clear expectations.

Step 2: SWSs should not define best practice. Best practice must align with SWSs and must be dictated and trained by the company. Materials must also align with SWSs. Material selection and efficiency of retrofit methods must be the responsibility of the company.

Step 3: SWSs lead to standardized training. This training adheres to and is driven by SWSs, efficiency, cost and safety. SWSs are the solid foundation of sustainable high quality work. The company must be the responsible party for proper skills training.

Step 4: Training leads to increased skills that lead to the need for a career ladder for willing workers. Internal certification must become the first step to external certification. Each has value to the company.

Internal value = a career ladder

External value = ability to market superior performance

SWSs very seldom change; however best practice, efficiency and materials must continually improve. A certifying body best serves the industry by establishing a solid plumb line (SWSs) that a company can measure its performance against. SWSs level the playing field. Every company, at a minimum, must adhere to the SWS. Companies establish a competitive edge in the marketplace by improving performance, efficiency and material cost control.

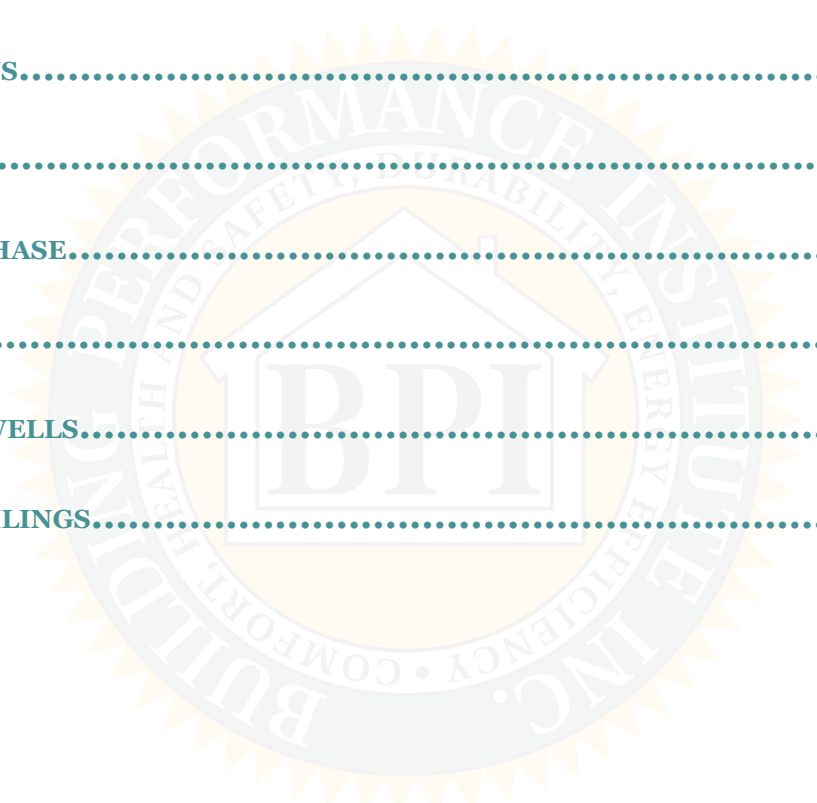
SWSs serve as the basis for writing Job Instruction Breakdown Sheets (JIBs).

The image shows a document titled "Building Performance Institute Inc. Standard Work Specifications" with a BPI logo. The document is for "1 - ATTIC AIR SEALING DETAIL: PENETRATIONS (E.G. WIRING, PLUMBING, DUCTING AND PIPING)". It lists a "DESIRED OUTCOME(S): 1) No air passage." and a table with three rows: "BACKING AND INFILL", "SEALANT SELECTION", and "HIGH TEMPERATURE APPLICATION". Each row has columns for "SPECIFICATIONS" and "DESIRED OUTCOME(S)". At the bottom, it says "Revision Date 5-21-2010" and has the "Advanced ENERGY" logo.

| SPECIFICATIONS | DESIRED OUTCOME(S) | |
|-------------------------------------|---|--|
| BACKING AND INFILL | 1) Provide backing or infill as needed to meet the specific characteristics of the selected material and the characteristics of the hole. 2) The infill must not bend, sag or move once installed. | 1) Hole size is small enough to use a sealant. 2) Resulting closure is permanent and supports any load such as insulation. 3) Sealant does not fall out. |
| SEALANT SELECTION | Materials shall: adhere, cohere, be continuous, meet similar characteristics as surfaces attached to and meet ignition barrier Specifications. | 1) Permanent. 2) Closure meets or exceeds the performance characteristics of the surrounding materials. (see sealant selection doc) |
| HIGH TEMPERATURE APPLICATION | Only non-combustible materials shall be used in contact with chimneys, vents and flues. | Do not create fire hazard. |

Attic Air Sealing

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Building Performance Institute, Inc. Standard Work Specifications



1 - ATTIC AIR SEALING DETAIL: PENETRATIONS (E.G. WIRING, PLUMBING, DUCTING AND PIPING)

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|--|
| <u>BACKING AND INFILL</u> | <ol style="list-style-type: none"> 1) Provide backing or infill as needed to meet the specific characteristics of the selected material and the characteristics of the hole. 2) The infill must not bend, sag or move once installed. | <ol style="list-style-type: none"> 1) Hole size is small enough to use a sealant. 2) Resulting closure is permanent and supports any load such as insulation. 3) Sealant does not fall out. |
| <u>SEALANT SELECTION</u> | Materials shall: adhere, cohere, be continuous, meet similar characteristics as surfaces attached to and meet ignition barrier Specifications. | <ol style="list-style-type: none"> 1) Permanent. 2) Closure meets or exceeds the performance characteristics of the surrounding materials. <i>(see sealant selection doc)</i> |
| <u>HIGH TEMPERATURE APPLICATION</u> | Only non-combustible materials shall be used in contact with chimneys, vents and flues. | Do not create fire hazard. |

Building Performance Institute, Inc. Standard Work Specifications



2 - ATTIC AIR SEALING DETAIL: CHASE PREP.

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|--|
| <u>BACKING AND INFILL</u> | <ol style="list-style-type: none"> 1) Provide backing or infill as needed to meet the specific characteristics of the selected material and the characteristics of the hole. 2) The infill must not bend, sag or move once installed. | <ol style="list-style-type: none"> 1) Hole size is small enough to use a sealant. 2) Resulting closure is permanent and supports any load such as insulation. 3) Sealant does not fall out. 4) Does not violate fire code. |
| <u>SEALANT SELECTION</u> | Materials shall: adhere, cohere, be continuous, meet similar characteristics as surfaces attached to, and meet ignition barrier Specifications. | <ol style="list-style-type: none"> 1) Permanent. 2) Closure meets or exceeds the performance characteristics of the surrounding materials. <i>(see sealant selection doc)</i> |
| <u>HIGH TEMPERATURE APPLICATION</u> | Only non-combustible materials shall be used in contact with chimneys, vents and flues. | Do not create fire hazard. |

Building Performance Institute, Inc. Standard Work Specifications



3 - ATTIC AIR SEALING DETAIL: CAPPING A CHASE

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|---|
| <p><u>STANDARD CHASE</u> (15-minute fire-rated material, e.g. gypsum lined)</p> | <p>Entire hole spanned with rigid material. Cut to fit and fasten as required.</p> | <ol style="list-style-type: none"> 1) Reduce opening to what can be sealed with sealant. 2) Must support load as required. (e.g. insulation) 3) Bring the chase into the thermal envelope. |
| <p><u>NON STANDARD CHASE</u> (not 15-minute fire-rated, e.g. bookcases, chest of drawers or lined with paneling or other non fire-rated material)</p> | <p>Use material that is allowed to be exposed to the interior of the house.</p> | <p>Do not create fire hazard.</p> |
| <p><u>SUPPORT</u></p> | <p>Install support material for spans wider than 24" except when material is rated to span greater distance under load.</p> | <p>Air seal stays in place and does not sag.</p> |
| <p><u>SEAL JOINT</u></p> | <p>Install continuous seal around seams, cracks, joints, edges, penetrations and connections.</p> | <p>Air tight, durable, does not move, bend or sag.</p> |
| <p><u>ADJACENT FRAMING</u></p> | <p>Seal all remaining gaps at the top of chase.</p> | <p>Air tight from one finished side of the chase to the other.</p> |

Building Performance Institute, Inc. Standard Work Specifications



4 - ATTIC AIR SEALING DETAIL: SOFFIT

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|---|
| <u>SOFFIT GENERAL</u> | Block air flow at soffit in locations that access allows. | Make air barrier continuous across soffit openings. |
| <u>OPTION 1 BRING SOFFIT INSIDE</u> (Seal at top) | Entire opening spanned with rigid material in line with the ceiling level. Cut to fit and fasten as required. | <ol style="list-style-type: none"> 1) Stop air from moving from wall to attic. 2) Reduce opening to what can be sealed with sealant. 3) Must support load as required. (e.g. insulation) 4) Bring the soffit into the thermal envelope. |
| <u>OPTION 2 LEAVE SOFFIT OUTSIDE</u> (Seal at bottom or side) | <p>Openings into the soffit created by the stud bays are blocked:</p> <ol style="list-style-type: none"> 1) Each stud bay is spanned with rigid material. Cut to fit and fasten as required. <p>or</p> <ol style="list-style-type: none"> 2) Provide backing at each stud bay and seal completely with foam. <p>or</p> <ol style="list-style-type: none"> 3) Seal side of stud bays with rigid material from bottom of soffit to top-plate. | <ol style="list-style-type: none"> 1) Stop air from moving from wall to soffit. 2) Reduce opening to what can be sealed with sealant. 3) Leave soffit outside of the thermal envelope. |

Continued...→

Building Performance Institute, Inc. Standard Work Specifications



| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|--|
| <u>MIXED SEALING STRATEGY</u> | Install sealed rigid barrier at all transitions between areas treated with Options 1 and 2. | Create a continuous air barrier. |
| <u>SOFFITS CONTAINING NON-IC RATED RECESSED LIGHTS</u> | <p>1) No insulation above or within 3” of side of fixture.</p> <p>2) If soffit is to be filled with insulation, then install sealed rigid barrier enclosure to maintain a 3” clearance on sides.</p> <p>3) Top of rigid barrier enclosure to be air sealed with non-insulating rigid material. (e.g. gypsum or equivalent perm rating and R-value)</p> | <p>1) Keep light fixture from overheating.</p> <p>2) Bring the light fixture inside the air barrier.</p> |
| <u>SOFFIT AREA CANNOT BE REACHED FROM ATTIC</u> | Provide backing at each stud bay and seal completely with foam. | Stop air from moving between wall and soffit. |

Revision Date
5.21.2010



Building Performance Institute, Inc. Standard Work Specifications



5 - ATTIC AIR SEALING DETAIL: OPEN STAIRWELL (TYPE: INTERIOR WITH SLOPED CEILING)

DESIRED OUTCOME(S):

1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|---|--|
| <p><u>STANDARD VOID OVER STAIRWELL</u> (15-minute fire-rated material, e.g. gypsum lined)</p> | <p>Entire opening spanned with rigid material. Cut to fit and fasten as required.</p> | <p>1) Stop air from moving from wall to attic. 2) Reduce opening to what can be sealed with sealant. 3) Must support load as required. (e.g. insulation)</p> |
| <p><u>NON STANDARD VOID OVER STAIRWELL</u> (Surfaces around void are not 15-minute fire-rated, e.g. bookcases, chest of drawers or lined with paneling or other non fire-rated material)</p> | <p>Use material that is allowed to be exposed to the interior of the house.</p> | <p>Do not create fire hazard.</p> |
| <p><u>SUPPORT</u></p> | <p>Install support material for spans wider than 24" except when material is rated to span greater distance under load.</p> | <p>Air seal stays in place and does not sag.</p> |
| <p><u>SEAL JOINT</u></p> | <p>Install continuous seal around seams, cracks, joints, edges, penetrations and connections.</p> | <p>Air tight, durable, does not move, bend or sag.</p> |

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|----------------------------------|
| <u>ADJACENT FRAMING</u> <u>JOIN AIR BARRIERS</u> <u>PERIMETER SEALING</u> | Extend the air barrier on all four sides from the finished ceiling up to the new barrier. (Gain access as needed e.g. pull flooring) | Create a continuous air barrier. |

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6 - ATTIC AIR SEALING DETAIL: OPEN STAIRWELL (TYPE: STAIRWELL TO ATTIC WITH DOOR AT BOTTOM WITH NO CEILING ABOVE)

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|--|
| OPTION 1 BRING STAIRWELL INSIDE | <ol style="list-style-type: none"> 1) Entire opening spanned with insulated and rigid material in line with the ceiling level that also includes an airtight and operable insulated panel for repeated access. 2) Provide airtight seal between level of new closure/cap and interior ceiling around perimeter. (Gain access as needed e.g. pull flooring) | <ol style="list-style-type: none"> 1) Stop air from moving between conditioned space and attic through stairwell. 2) Support insulation. 3) Bring the stairwell inside. 4) Ensure the new closure ties into the existing air barrier on all sides. |
| OPTION 2 KEEP STAIRWELL OUTSIDE | <ol style="list-style-type: none"> 1) Create an air barrier and install insulation material continuous across all surfaces of stairwell (walls and stairs) and include weather stripped and insulated door. <p>or</p> <ol style="list-style-type: none"> 2) Pack all cavities (e.g. walls, floors, landings, under stairs) between stairs and conditioned space with an insulation material tested to resist airflow. Weather strip and insulate door. <p>or</p> <ol style="list-style-type: none"> 3) Use a combination of the above methods. | <ol style="list-style-type: none"> 1) Reduce substantial air leakage and provide continuous thermal boundary. 2) Maximum feasible thermal performance. |

Continued...→

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|---|
| <u>SUPPORT</u> | Install support material for spans wider than 24” except when material is rated to span greater distance under load. | Air seal stays in place and does not sag. |
| <u>SEAL JOINT</u> | Install continuous seal around seams, cracks, joints, edges, penetrations and connections. | Air tight, durable, does not move, bend or sag. |
| <u>ADJACENT FRAMING</u> <u>JOIN AIR BARRIERS</u> <u>PERIMETER SEALING</u> | Extend the air barrier on all four sides from the finished ceiling up to the new barrier. (Gain access as needed e.g. pull flooring) | Create a continuous air barrier. |

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7 - ATTIC AIR SEALING DETAIL: OPEN STAIRWELL (TYPE: STAIRWELL TO ATTIC WITH DOOR AT TOP WITH FINISHED CEILING ABOVE)

DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|---|
| <p style="text-align: center;">OPTION 1 BRING STAIRWELL INSIDE</p> | <p>1) Provide airtight seal between level of new closure/cap and interior ceiling around perimeter. (Gain access as needed e.g. pull flooring)</p> <p>or</p> <p>2) Create an air barrier and install insulation material continuous across all surfaces of stairwell (walls and stairs) and include weather stripped and insulated door.</p> <p>or</p> <p>3) Pack all cavities (e.g. walls, floors, landings, under stairs) between stairs and conditioned space with an insulation material tested to resist airflow. Weather strip and insulate door.</p> <p>or</p> <p>4) Use a combination of the above methods.</p> | <p>1) Reduce substantial air leakage and provide continuous thermal boundary.</p> <p>2) Maximum feasible thermal performance.</p> |

Continued...→

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|---|
| <u>SUPPORT</u> | Install support material for spans wider than 24” except when material is rated to span greater distance under load. | Air seal stays in place and does not sag. |
| <u>SEAL JOINT</u> | Install continuous seal around seams, cracks, joints, edges, penetrations and connections. | Air tight, durable, does not move, bend or sag. |
| <u>ADJACENT FRAMING</u> <u>JOIN AIR BARRIERS</u> <u>PERIMETER SEALING</u> | Extend the air barrier on all four sides from the finished ceiling up to the new barrier. (Gain access as needed e.g. pull flooring) | Create a continuous air barrier. |

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8 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS (TYPE: RAISED TOP PLATE WITH WALLS OPEN TO ATTIC)

DESIRED OUTCOME(S):

1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| | SPECIFICATIONS | DESIRED OUTCOME(S) |
|---------------------------------------|---|---|
| <p><u>SEALING METHODS</u></p> | <p>1) Entire opening spanned with rigid material in line with the ceiling level. Cut to fit and fasten as required. or 2) Seal side of stud bays with rigid material from bottom of dropped ceiling to top-plate. or 3) Dense pack wall below openings.</p> | <p>1) Stop air from moving from dropped ceiling to attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference.</p> |
| <p><u>SUPPORT</u></p> | <p>Install support material for spans wider than 24" except when material is rated to span greater distance under load.</p> | <p>Air seal stays in place and does not sag.</p> |
| <p><u>SEAL JOINT</u></p> | <p>Install continuous seal around seams, cracks, joints, edges, penetrations and connections.</p> | <p>Air tight, durable, does not move, bend or sag.</p> |
| <p><u>ADJACENT FRAMING</u></p> | <p>Seal all remaining gaps at the top of dropped ceiling.</p> | <p>Air tight from one finished side of the dropped ceiling to the other.</p> |

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9 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS

(TYPE: NEW CEILING BELOW ORIGINAL (T-BAR OR SOLID) OLD CEILING INTACT OR REPAIRABLE)

DESIRED OUTCOME(S):

- 1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|---|
| <u>BRING DROPPED CEILING INSIDE</u> | Create continuous air barrier at original ceiling level. | 1) Block air leakage between inside and attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference. |
| <u>SUPPORT</u> | Install support material for spans wider than 24" except when material is rated to span greater distance under load. | Air seal stays in place and does not sag. |
| <u>SEAL JOINT</u> | Install continuous seal around seams, cracks, joints, edges, penetrations and connections. | Air tight, durable, does not move, bend or sag. |
| <u>ADJACENT FRAMING</u> | Seal all remaining gaps at the top of dropped ceiling. | Air tight from one finished side of the dropped ceiling to the other. |

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10 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS

(TYPE: NEW CEILING BELOW ORIGINAL (T-BAR OR SOLID) OLD CEILING NOT INTACT)

DESIRED OUTCOME(S):

1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--------------------------------|--|---|
| <u>SEALING METHODS</u> | 1) Entire opening spanned with rigid material in line with the ceiling level. Cut to fit and fasten as required. or 2) Seal side of stud bays with rigid material from bottom of dropped ceiling to top-plate. or 3) Dense pack wall below openings. | 1) Stop air from moving from dropped ceiling to attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference. |
| <u>SUPPORT</u> | Install support material for spans wider than 24" except when material is rated to span greater distance under load. | Air seal stays in place and does not sag. |
| <u>SEAL JOINT</u> | Install continuous seal around seams, cracks, joints, edges, penetrations and connections. | Air tight, durable, does not move, bend or sag. |
| <u>ADJACENT FRAMING</u> | Seal all remaining gaps at the top of dropped ceiling. | Air tight from one finished side of the dropped ceiling to the other. |

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11 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS (TYPE: OVER CLOSETS AND TUBS)

DESIRED OUTCOME(S):

1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| | SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|---|---|
| <p align="center"><u>OVER CLOSETS AND TUBS</u></p> | <p>1) Entire opening spanned with rigid material in line with the ceiling level. Cut to fit and fasten as required. or 2) Seal side of stud bays with rigid material from bottom of dropped ceiling to top-plate. or 3) Dense pack wall below openings.</p> | <p>1) Stop air leakage from dropped ceiling to attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference.</p> |
| <p align="center"><u>SUPPORT</u></p> | <p>Install support material for spans wider than 24" except when material is rated to span greater distance under load.</p> | <p>Air seal stays in place and does not sag.</p> |
| <p align="center"><u>SEAL JOINT</u></p> | <p>Install continuous seal around seams, cracks, joints, edges, penetrations and connections.</p> | <p>Air tight, durable, does not move, bend or sag.</p> |
| <p align="center"><u>ADJACENT FRAMING</u></p> | <p>Seal all remaining gaps at the top of dropped ceiling.</p> | <p>Air tight from one finished side of the dropped ceiling to the other.</p> |

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12 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS

(TYPE: LEAKY CEILING YOU CANNOT FIX WITH NO AIR BARRIER ABOVE, E.G. T-BAR, TONGUE & GROOVE OR ACOUSTICAL TILES)

DESIRED OUTCOME(S):

- 1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|-------------------------------|--|---|
| <u>SEALING METHODS</u> | 1) Connect ceiling/roof and wall air and thermal barriers with a rigid airtight connection all around the perimeter or 2) If ceiling will support an air barrier and insulation, attach rigid airtight barrier (e.g. gypsum) to current ceiling either above or below or 3) Use intermediate framing to support air and thermal barrier; or 4) Install rigid airtight thermal barrier at the roof sheathing.* | 1) Stop air leakage from dropped ceiling to attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference. |
| <u>SUPPORT</u> | Install support material for spans wider than 24" except when material is rated to span greater distance under load. | Air seal stays in place and does not sag. |

* Reference: IRC 806.4

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--------------------------------|--|---|
| <u>SEAL JOINT</u> | Install continuous seal around seams, cracks, joints, edges, penetrations and connections. | Air tight, durable, does not move, bend or sag. |
| <u>ADJACENT FRAMING</u> | Seal all remaining gaps at the top of dropped ceiling. | Air tight from one finished side of the dropped ceiling to the other. |

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13 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS (TYPE: 3-D WALLS, E.G. ARCHWAYS OR BUILT-INS)

DESIRED OUTCOME(S):

1) Ensure there is a continuous air and thermal barrier between the area below the dropped ceiling and the attic or roof deck.

| | SPECIFICATIONS | DESIRED OUTCOME(S) |
|---------------------------------------|---|---|
| <p><u>SEALING METHODS</u></p> | <p>1) Entire opening spanned with rigid material in line with the ceiling level. Cut to fit and fasten as required. or 2) Seal side of stud bays with rigid material from bottom of dropped ceiling to top-plate. or 3) Dense pack wall below openings.</p> | <p>1) Stop air from moving from dropped ceiling to attic. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference.</p> |
| <p><u>SUPPORT</u></p> | <p>Install support material for spans wider than 24" except when material is rated to span greater distance under load.</p> | <p>Air seal stays in place and does not sag.</p> |
| <p><u>SEAL JOINT</u></p> | <p>Install continuous seal around seams, cracks, joints, edges, penetrations and connections.</p> | <p>Air tight, durable, does not move, bend or sag.</p> |
| <p><u>ADJACENT FRAMING</u></p> | <p>Seal all remaining gaps at the top of dropped ceiling.</p> | <p>Air tight from one finished side of the dropped ceiling to the other.</p> |

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14 - ATTIC AIR SEALING DETAIL: DROPPED CEILINGS

(TYPE: DROPPED CEILINGS WITH LIGHT BOXES/FIXTURES, E.G. FLUORESCENT LIGHTS OR NON-IC RATED RECESSED LIGHTS)

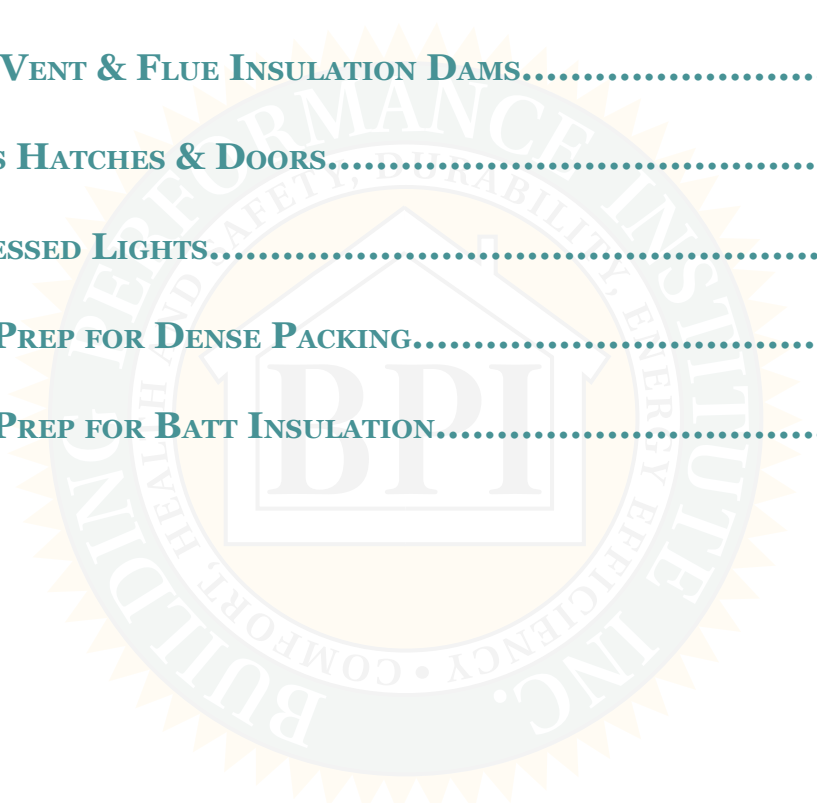
DESIRED OUTCOME(S):

- 1) Stop air leakage from light box/fixture and provide proper clearance.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|---|
| <p><u>LIGHT BOXES</u> (e.g. fluorescent lights)</p> | <p>Provide airtight seal between light box enclosure and interior ceiling around perimeter. (Gain access as needed, e.g. pull flooring)</p> | <ol style="list-style-type: none"> 1) Stop air leakage. 2) No visible air movement using chemical smoke at 50 pascals of pressure difference. |
| <p><u>NON-IC RATED RECESSED LIGHTS</u></p> | <ol style="list-style-type: none"> 1) No insulation above or within 3" of side of fixture. 2) If dropped ceiling is to be filled with insulation, then install sealed rigid barrier enclosure to maintain a 3" clearance on sides. 3) Top of rigid barrier enclosure to be air sealed with non-insulating rigid material. (e.g. gypsum or equivalent perm rating and R-value) | <ol style="list-style-type: none"> 1) Keep light fixture from overheating. 2) Bring the light fixture inside the air barrier. |

Attic Insulation Prep

| <u>DETAIL NAME</u> | <u>PAGE NUMBER</u> |
|---|--------------------|
| COMBUSTION VENT & FLUE INSULATION DAMS..... | 23 |
| ATTIC ACCESS HATCHES & DOORS..... | 24 |
| NON IC RECESSED LIGHTS..... | 25 |
| KNEE WALL PREP FOR DENSE PACKING..... | 26 |
| KNEE WALL PREP FOR BATT INSULATION..... | 27 |



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1 - ATTIC INSULATION PREP DETAIL: COMBUSTION VENTS & FLUE INSULATION DAMS

DESIRED OUTCOME(S):

- 1) No combustion materials will be closer than 3” from a combustion source.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|-------------------------|---|--|
| <u>CLEARANCE</u> | A rigid dam having a height greater than the insulation to be installed constructed to assure a 3” clearance between the dam and the combustion vent or flue. | Stop bending, sagging or movement that may result in a fire danger for rigid material or insulation. |

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2 - ATTIC INSULATION PREP DETAIL: ATTIC ACCESS HATCHES & DOORS

DESIRED OUTCOME(S):

- 1) Air does not enter or exit the house through attic access hatches and doors.
- 2) Complete insulation coverage exists throughout the ceiling plane.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| <p><u>INSULATION DAM</u></p> <p>1) A rigid dam (wood or better) having a height greater than insulation shall be constructed to assure insulation doesn't fall into the access opening. or 2) If attic space does not allow for a rigid dam, insulation batt can act as insulation dam.</p> | <p>Keep insulation in place.</p> |
| <p><u>SEALANTS & WEATHER-STRIPPING</u></p> <p>1) Sealant shall be used on all gaps and cracks adjacent to the attic access hatch or door on the house side. 2) All access hatches and doors shall be weather-stripped.</p> | <p>1) Adhesion of the sealant to all surfaces to be sealed. 2) All sealants and weather-stripping will block air flow.</p> |
| <p><u>INSULATION</u></p> <p>1) Hatch shall be insulated to the same R-value as surrounding surface (e.g. attic or knee wall). 2) Insulation must be permanently attached and in complete contact with hatch.</p> | <p>Achieve continuous thermal barrier that is durable.</p> |

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3 - ATTIC INSULATION PREP DETAIL: NON-INSULATION CONTACT (IC) RECESSED LIGHT

DESIRED OUTCOME(S):

1) An air barrier system that stops the passage of air into or out of the house through the fixture.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| <p><u>AIR BARRIER SYSTEM</u></p> | <p>1) An air tight closure taller than surrounding attic insulation shall be placed over non-insulation contact (IC) rated recessed light fixtures. or 2) Put in an air tight enclosure with a dam and see above. or 3) Replace with IC rated light fixture.</p> |
| <p><u>ENCLOSURE TOP</u></p> | <p>1) Reduce the occurrence of fire due the closeness of air barrier system and a recessed fixture. 2) Stop air movement through fixture.</p> |
| <p><u>CLEARANCE</u></p> | <p>1) The top closure material shall not exceed R-value of 0.5. 2) Do not insulate over top of enclosure.</p> |
| <p><u>SEALANTS & WEATHER-STRIPPING</u></p> | <p>The closure shall maintain a 3" clearance between the closure and the fixture including wiring box and ballast.</p> |
| | <p>Prevent heat buildup.</p> |
| | <p>Keep an air space around the fixture.</p> |
| | <p>Complete adhesion of the sealant to all surfaces to be sealed in order to preclude the passage of air.</p> |

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4 - ATTIC INSULATION PREP DETAIL: KNEE WALL PREP FOR DENSE PACKING

DESIRED OUTCOME(S):

- 1) Air tight cavity and completely properly insulated knee wall.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|--|
| <u>BACK KNEE WALL FOR DENSE PACK</u> | All knee walls shall have a top and bottom plate or blockers installed using a rigid material. | <ol style="list-style-type: none"> 1) Eliminate bending, sagging or movement that may result in air leakage. 2) Stop air leakage through the top or bottom of the knee wall. |
| | If fabric material is used before dense packing, secured it with 1" crown staples every 2" or furring strips every wall stud. | Material is secured in a manner that it cannot tear under stress of wind loads and dense packing of insulation. |
| | <ol style="list-style-type: none"> 1) If rigid material is used it must cover the entire surface of the accessible knee wall area. 2) If foam sheathing is used, it must be listed for uncovered use in an attic; or covered with an ignition/thermal barrier. | <ol style="list-style-type: none"> 1) Assure 100% coverage. 2) Reduce fire spread. |
| <u>INSULATION</u> | All existing batted insulation must be adjusted to assure it is in full contact with the interior cladding and top and bottom plates. | Eliminate misalignment of existing insulation. |
| | Insulation that is blown behind fabric or air barrier material must be blown dense (3.5 pounds per cubic foot for cellulose or 2.2 pounds per cubic foot for fiberglass). | No insulation settling or movement. |

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5 - ATTIC INSULATION PREP DETAIL: KNEE WALL PREP FOR BATT INSULATION

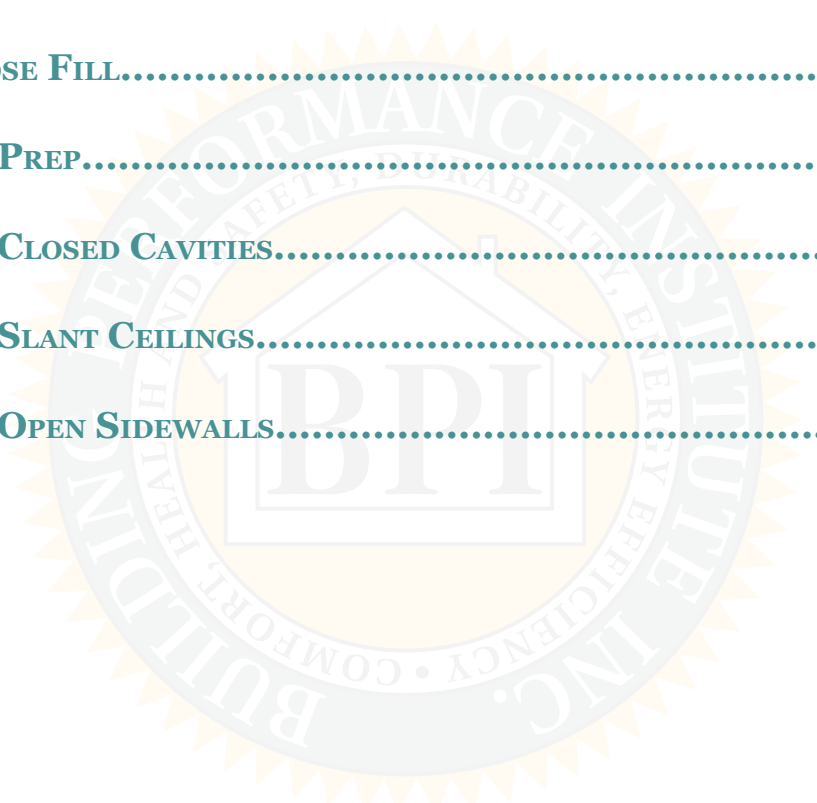
DESIRED OUTCOME(S):

1) Air tight cavity and completely properly insulated knee wall.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|--|
| <u>KNEE WALL PREP FOR BATTS</u> | All knee walls shall have a top and bottom plate or blockers installed using a rigid material. | 1) Eliminate bending, sagging or movement that may result in air leakage. 2) Stop air leakage through the top or bottom of the knee wall. |
| | Air seal all joints, cracks and penetrations in finished material including interior surface to framing connections. | Create and air barrier. |
| <u>INSULATION</u> | 1) Install new batts. or 2) All existing batted insulation must be adjusted to assure it is in full contact with the interior cladding and top and bottom plates. | Eliminate misalignment of existing insulation. |
| <u>BACKING KNEE WALL</u> | 1) If fabric material is used before dense packing, secured it with 1" crown staples every 2" or furring strips every wall stud. 2) If rigid material is used it must cover the entire surface of the accessible knee wall area. 3) If foam sheathing is used, it must be listed for uncovered use in an attic; or covered with an ignition/thermal barrier. | No insulation settling or movement. |

Attic Insulation

| <u>DETAIL NAME</u> | <u>PAGE NUMBER</u> |
|--|--------------------|
| BLOW IN LOOSE FILL..... | 29 |
| DENSE PACK PREP..... | 31 |
| DENSE PACK CLOSED CAVITIES..... | 32 |
| DENSE PACK SLANT CEILINGS..... | 33 |
| DENSE PACK OPEN SIDEWALLS..... | 34 |



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1 - ATTIC INSULATION: BLOW IN LOOSE FILL

DESIRED OUTCOME(S):

1) Attic work completed to specified R-value and performance goals are met.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--------------------------------|---|---|
| <u>PRE-INSTALLATION</u> | Confirm all attic prep before blowing insulation. | 1) Fire hazards addressed. 2) Effective ventilation - assured for roof wetting from interior moisture - has been reduced. 3) Pathways for dust and odors have been reduced. |
| <u>SETUP</u> | Install attic depth markers no less than 1 for every 300 square feet. | 1) Aid to installer. 2) Quickly shows depth after completion. 3) Quickly shows evenness and minimum. 4) Reduces need to enter attic to measure. |

Continued...→

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|------------------------|--|--|
| <u>INSULATE</u> | <ol style="list-style-type: none"> 1) Blow all insulation level and to the depth indicated on manufacturer's coverage chart for desired R-value. | <ol style="list-style-type: none"> 1) Known performance is ensured. 2) Heating and air conditioning costs are reduced. 3) Improved comfort. 4) Quieter home. |
| <u>LABEL</u> | <p>Provide a signed and dated attic card with:</p> <ol style="list-style-type: none"> 1) Insulation type. 2) Installed thickness and settled thickness. 3) Coverage area. 4) R-value. 5) Number of bags installed as per manufactures specifications. | <ol style="list-style-type: none"> 1) Document job completion to contract specifications. 2) Confirm bags installed use. 3) Match bags required for total area completed. |

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2 - ATTIC INSULATION: DENSE PACK PREP

DESIRED OUTCOME(S):

- 1) Preparation to assure proper material density is achieved safely without a mess.

| | SPECIFICATIONS | DESIRED OUTCOME(S) |
|--------------------|---|---|
| <u>PREP</u> | <ol style="list-style-type: none"> 1) Lead safe 2) Determine cavities are free of hazards, intact and can support dense-pack pressures. 3) Block all escape openings for material. 4) Gain access and probe each cavity, locating all floor joists and blockers. 5) Mask interior and control dust during drilling when accessing from interior. 6) Confirm electrical supply will support blowing machine power demand. 7) Perform blowing machine pressure test: air on full, feed off, gate closed. Confirm hose outlet pressure shall be at least 80 inches of Water Column (WC) or 2.9 psi. | <ol style="list-style-type: none"> 1) Proper preparation prevents damage and mess. 2) Thorough access gives 100% coverage. 3) Proper equipment & process gives consistent density that retards airflow through cavities. |

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3 - ATTIC INSULATION: DENSE PACK CLOSED CAVITIES (E.G. STORAGE PLATFORMS)

DESIRED OUTCOME(S):

- 1) Complete and consistent insulation coverage throughout ceiling plane and closed attic sections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.
- 3) Maintain attic storage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---------------------------|--|--|
| <u>FILL FLOORS</u> | <ol style="list-style-type: none"> 1) Completely fill each cavity to a consistent density: <ul style="list-style-type: none"> • Install cellulose material to a minimum density of 3.5 lbs/ cubic foot. • Install loose fiberglass material specifically approved for air flow resistance to a minimum density of 2.2 lbs/ cubic foot. 2) Materials are approved to meet the BPI air semi permeable standard. 3) Confirm the number of bags installed matches the number required on the coverage chart. | <ol style="list-style-type: none"> 1) 100% of cavity filled to proper density in order to eliminate voids and settling 2) Consistent with no void areas, no settling. 3) Block air flow. 4) No visible air movement using chemical smoke at 50 pascals of pressure difference. |

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4 - ATTIC INSULATION: DENSE PACK SLANT CEILINGS

DESIRED OUTCOME(S):

- 1) Complete and consistent insulation coverage throughout ceiling plane and closed attic sections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.
- 3) Maintain attic storage.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|--|--|
| <p><u>FILL</u> <u>SLANT CEILINGS</u></p> | <ol style="list-style-type: none"> 1) Using tube, completely fill each cavity to a consistent density: <ul style="list-style-type: none"> • Install cellulose material to a minimum density of 3.5 lbs/ cubic foot. • Install loose fiberglass material specifically approved for air flow resistance to a minimum density of 2.2 lbs/ cubic foot. 2) Materials are approved to meet the BPI air semi permeable standard. 3) Confirm the number of bags installed matches the number required on the coverage chart. |
| | <ol style="list-style-type: none"> 1) 100% of cavity filled to proper density in order to eliminate voids and settling 2) Consistent with no void areas, no settling. 3) Block air flow. 4) No visible air movement using chemical smoke at 50 pascals of pressure difference. |

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5 - ATTIC INSULATION: DENSE PACK OPEN SIDEWALLS ACCESSIBLE FROM ATTIC

DESIRED OUTCOME(S):

- 1) Complete and consistent insulation coverage throughout ceiling plane and closed attic sections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.
- 3) Maintain attic storage.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| <p style="text-align: center;"><u>FILL OPEN END/SIDE WALLS</u> (Accessible from attic)</p> | <ol style="list-style-type: none"> 1) If exterior walls are open into attic and included in work scope, insert tube full length and pack with cellulose or fiberglass insulation. 2) Using tube, completely fill each cavity to a consistent density: <ul style="list-style-type: none"> • Install cellulose material to a minimum density of 3.5 lbs/cubic foot. • Install loose fiberglass material specifically approved for air flow resistance to a minimum density of 2.2 lbs/cubic foot. 3) Materials are approved to meet the BPI air semi permeable standard. |

Continued...→

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|---|---|
| <p><u>FILL</u> <u>OPEN END/SIDE</u> <u>WALLS</u> (Accessible from attic)</p> | <p>4) Confirm the number of bags installed matches the number required on the coverage chart.</p> | <p>1) 100% of cavity filled to proper density in order to eliminate voids and settling</p> <p>2) Consistent with no void areas, no settling.</p> <p>3) Block air flow.</p> <p>4) No visible air movement using chemical smoke at 50 pascals of pressure difference.</p> |

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Floor Air Sealing

DETAIL NAME

PAGE NUMBER

PENETRATIONS.....37



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1 - FLOOR AIR SEALING DETAIL: PENETRATIONS (E.G. WIRING, PLUMBING, DUCTING AND PIPING)

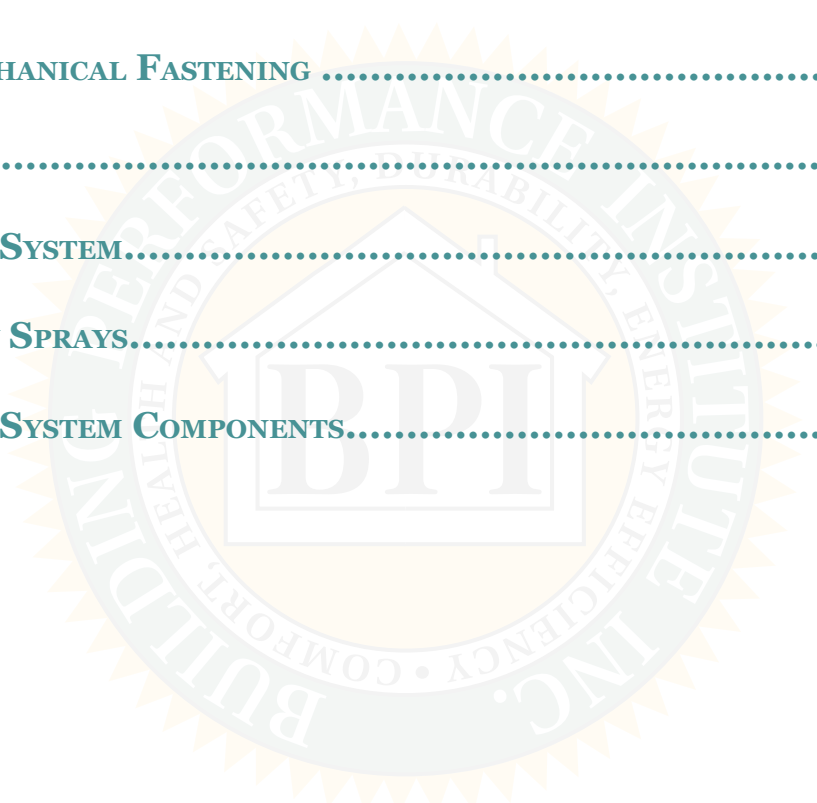
DESIRED OUTCOME(S):

- 1) No air passage.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|--|
| <u>BACKING AND INFILL</u> | <ol style="list-style-type: none"> 1) Provide backing or infill as needed to meet the specific characteristics of the selected material and the characteristics of the hole. 2) The infill must not bend, sag or move once installed. | <ol style="list-style-type: none"> 1) Hole size is small enough to use a sealant. 2) Resulting closure is permanent and supports any load such as insulation. 3) Sealant does not fall out. |
| <u>SEALANT SELECTION</u> | Materials shall: adhere, cohere, be continuous, meet similar characteristics as surfaces attached to and meet ignition barrier Specifications. | <ol style="list-style-type: none"> 1) Permanent. 2) Closure meets or exceeds the performance characteristics of the surrounding materials. <i>(see sealant selection doc)</i> |
| <u>HIGH TEMPERATURE APPLICATION</u> | Only non-combustible materials shall be used in contact with chimneys, vents and flues. | Do not create fire hazard. |

Duct Sealing

| <u>DETAIL NAME</u> | <u>PAGE NUMBER</u> |
|--|--------------------|
| PREP & MECHANICAL FASTENING | 39 |
| SUPPORT..... | 41 |
| AIR SEALING SYSTEM..... | 42 |
| PROPRIETARY SPRAYS..... | 44 |
| AIR SEALING SYSTEM COMPONENTS..... | 45 |



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1 - DUCT SEALING DETAIL: PREP & MECHANICAL FASTENING

DESIRED OUTCOME(S):

- 1) Ducts and plenums are properly fastened and supported and air will not leak out of or into return or supply plenums and ducts.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|---|---|
| PREP <i>Applies to All Duct Types</i> | <ol style="list-style-type: none"> 1) Clear away surrounding insulation to expose joints to be sealed. 2) Clean duct surface to accept sealant. 3) Return insulation or replace with equivalent R-value. | <ol style="list-style-type: none"> 1) Gain access while maintaining insulation value. 2) Achieve proper adhesion for air tight seal. |
| MECHANICAL FASTENING | All duct and plenum connections must be mechanically fastened. | |
| | METAL TO METAL | Fasten with a minimum of three screws equally spaced.* |
| | FLEX TO METAL | <ol style="list-style-type: none"> 1) Fasten with tie bands using tie band tool. 2) Install screw on exterior side of tie band through flex duct. |
| | DUCT BOARD TO DUCT BOARD | Fasten with clinch stapler. |
| | | Keep ducts and plenums from coming apart while air sealing and making the joint durable. |

* Reference: SMACNA, ADC

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| SPECIFICATIONS | | DESIRED OUTCOME(S) | |
|-----------------------------|--|--|---|
| MECHANICAL FASTENING | All duct and plenum connections must be mechanically fastened. | Keep ducts and plenums from coming apart while air sealing and making the joint durable. | |
| | DUCT BOARD TO METAL | | Use take-off collars with mechanical fastener (such as an integral flange collar, a finger joint collar). |
| | DUCT BOARD TO FLEX | | Must use metal take-off collar. |
| | METAL PLENUM TO AIR HANDLER CABINET | | Fasten with a minimum of three screws equally spaced.* |
| | DUCT BOARD PLENUM TO AIR HANDLER CABINET | | Fasten termination bar/metal strip with screws, sandwiching duct board. |
| | BOOT TO WOOD | | Fasten with screws or nails. |
| BOOT TO GYPSUM | 1) Fasten boot hanger to adjacent framing with screws or nails. 2) Connect boot to boot hanger with screws. or 3) Install integral snap boots. | | |

* Reference: SMACNA, ADC

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2 - DUCT SEALING DETAIL: SUPPORT

DESIRED OUTCOME(S):

1) Ducts and plenums are properly fastened and supported and air will not leak out of or into return or supply plenums and ducts.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|---|---------------------------------------|
| <p><u>SUPPORT</u> <i>Applies to All Duct Types</i></p> | <p>1) Flex and duct board ducts and plenums must be supported every 5' using min 1 1/2" wide material and not crimp duct work, causing the interior dimensions of the duct work to be less than specified. (e.g. ceiling, framing, strapping)</p> <p>2) Metal ducts must be supported by metal strapping, rods or other materials per standards.*</p> | <p>Eliminate falling and sagging.</p> |

* Reference: SMACNA, ADC

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3 - DUCT SEALING DETAIL: AIR SEALING SYSTEM

DESIRED OUTCOME(S):

1) Ducts and plenums are properly fastened and supported and air will not leak out of or into return or supply plenums and ducts.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|---|---|
| <u>NEW COMPONENT TO NEW COMPONENT SEALANT SELECTION</u> | Any closure system used must meet or exceed applicable standards.* | Air sealing effectiveness of adhesive may be achieved with new components |
| <u>NEW COMPONENT TO EXISTING COMPONENT</u> OR <u>EXISTING TO EXISTING</u> | <p>1) All seams, cracks, joints, holes and penetrations less than a 1/4 inch, shall be air sealed using fiberglass mesh and mastic meeting the Specifications.** Mastic alone is acceptable for holes less than 1/4 inch that are more than 10' from air handler.</p> <p>2) All seams, cracks, joints, holes and penetrations between 1/4 and 3/4 inch shall be backed using "temporary" tape (e.g. duct tape) as a support prior to air sealing using fiberglass mesh and mastic meeting the Specifications.**</p> | <p>1) Eliminate air leakage into or out of ducts and plenums.</p> <p>2) Adhesion of primary air seal (fiberglass mesh and mastic) to the duct.</p> <p>3) Reinforce air seal.</p> <p>4) Support mastic and fiberglass mesh from sagging, falling off or through a leak site prior to curing.</p> |

* Reference: SMACNA, ADC, ACCA

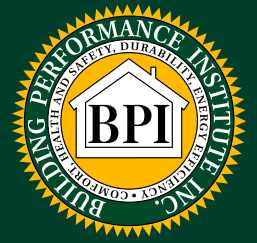
** UL 181M and NFPA 90a & 90b

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|---|
| <p><u>NEW COMPONENT</u> TO <u>EXISTING</u> <u>COMPONENT</u></p> <p>OR</p> <p><u>EXISTING</u> TO <u>EXISTING</u></p> | <p>3) The fiberglass mesh and mastic must overlap temporary tape by at least 1” on all sides and be the primary seal.</p> <p>4) All seams, cracks, joints, holes and penetrations larger than 3/4 inch shall be repaired using rigid duct material.</p> <p>5) The fiberglass mesh and mastic must overlap repair joint by at least 1” on all sides and be the primary seal meeting the Specifications.**</p> | <p>1) Eliminate air leakage into or out of ducts and plenums.</p> <p>2) Adhesion of primary air seal (fiberglass mesh and mastic) to the duct.</p> <p>3) Reinforce air seal.</p> <p>4) Support mastic and fiberglass mesh from sagging, falling off or through a leak site prior to curing.</p> |

** Reference: UL 181M and NFPA 90a & 90b

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4 - DUCT SEALING DETAIL: PROPRIETARY SPRAY APPLIED TOTAL DUCT SYSTEMS

DESIRED OUTCOME(S):

1) Ducts and plenums are properly fastened and supported and air will not leak out of or into return or supply plenums and ducts.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|---|----------------------|
| <u>INTERNAL</u> OR <u>EXTERNAL</u> <u>APPLICATION</u> | 1) Installation must meet manufacturers specifications.* and 2) Additional Specifications / standards.** | Reduce duct leakage. |

* Reference: See manufacturer specs.

** UL 181M and NFPA 90a & 90b

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5 - DUCT SEALING DETAIL: AIR SEALING SYSTEM COMPONENTS

DESIRED OUTCOME(S):

1) Ducts and plenums are properly fastened and supported and air will not leak out of or into return or supply plenums and ducts.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|--|
| <u>DUCT BOOT TO INTERIOR SURFACE</u> | <p>1) All gaps between boot and gypsum less than a 1/4 inch, shall be air sealed using mastic meeting the Specifications.*</p> <p>2) Gypsum edge shall be wetted before applying mastic.</p> | Stop air leakage. |
| <u>WOODEN PLENUMS/ BUILDING CAVITIES</u> | All accessible connections and joints must be made air tight using approved material meeting the Specifications.* | Ducts and plenums will not leak out of or into return or supply plenums and ducts. |
| <u>AIR HANDLER CABINET</u> | Close off all joints, cracks and holes not needed for proper function of unit using removable sealant. (e.g. duct tape) | Reduce air leakage while maintaining accessibility. |
| <u>FILTER SLOT</u> | Install a pre-manufactured or site manufactured durable filter slot cover. | |

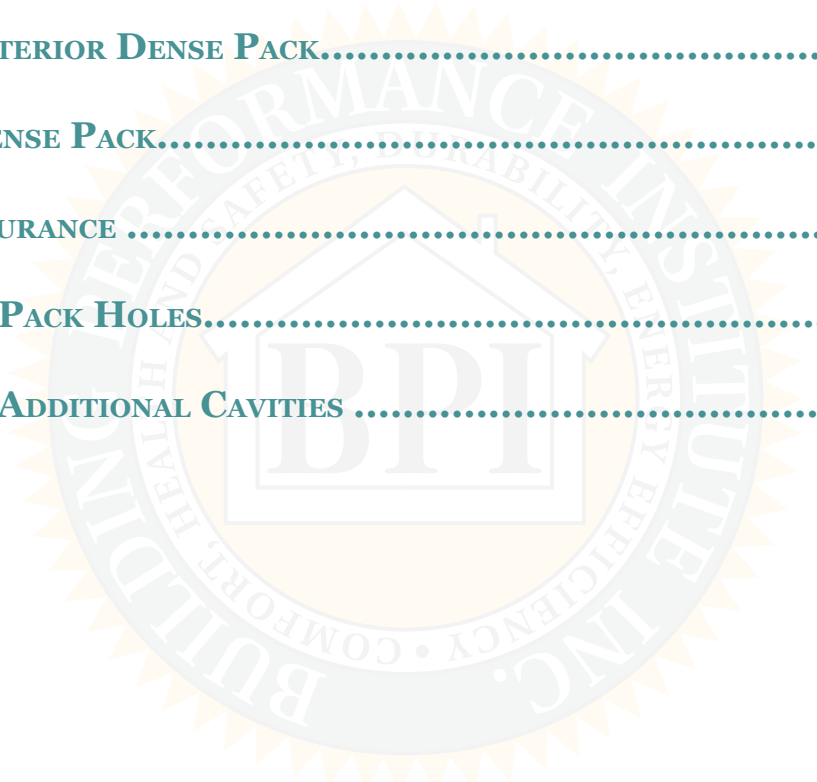
* Reference: UL 181M and NFPA 90a & 90b

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Walls

| <u>DETAIL NAME</u> | <u>PAGE NUMBER</u> |
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| EXTERIOR DENSE PACK..... | 49 |
| QUALITY ASSURANCE | 50 |
| PLUG DENSE PACK HOLES..... | 51 |
| DENSE PACK ADDITIONAL CAVITIES | 52 |



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1 - WALLS: PREP FOR EXTERIOR DENSE PACK

DESIRED OUTCOME(S):

- 1) Complete insulation coverage without settling or voids throughout exterior wall plane and embedded framing connections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|--------------------|---|
| <u>PREP</u> | <ol style="list-style-type: none"> 1) Lead safe 2) Determine cavities are free of hazards, intact and can support dense-pack pressures. 3) Locate drilling hazards. (e.g. wiring, venting, fuel piping) 4) Install blocking around*: <ul style="list-style-type: none"> • All openings to inside, crawl space and basement for fibrous material. • High temperature or fire-rated materials. • Wiring and electrical hazards • Heat sources. 4) Gain access, drill sheath as needed, probe to locate each cavity, wall studs and blockers. 5) Mask interior and control dust during drilling when accessing from interior. |

* Reference: ASTM C 1015

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| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--------------------|---|--|
| <u>PREP</u> | <p>6) Confirm electrical supply will support blowing machine power demand.</p> <p>7) Perform blowing machine pressure test: air on full, feed off, gate closed. Confirm hose outlet pressure shall be at least 80 inches of Water Column (WC) or 2.9 psi.</p> | <p>1) Proper preparation reduces damage and mess.</p> <p>2) Thorough access allows 100% coverage.</p> <p>3) Proper equipment and process results in consistent density, preventing settling and retarding air flow through cavities.</p> <p>4) Workers, house and equipment are protected from damage.</p> |

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2 - WALLS: EXTERIOR DENSE PACK

DESIRED OUTCOME(S):

- 1) Complete insulation coverage without settling or voids throughout exterior wall plane and embedded framing connections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| <p style="text-align: center;"><u>EXTERIOR DENSE PACK</u></p> <ol style="list-style-type: none"> 1) Completely fill each cavity to a consistent density: <ul style="list-style-type: none"> • Install cellulose material to a minimum density of 3.5 lbs/cubic foot. • Install loose fiberglass material specifically approved for air flow resistance to a minimum density of 2.2 lbs/cubic foot. 2) Materials are approved to meet the BPI air semi permeable standard. 3) Confirm the number of bags installed matches the number required on the coverage chart. | <ol style="list-style-type: none"> 1) 100% of cavity filled to proper density in order to eliminate voids and settling 2) Consistent with no void areas, no settling. 3) Block air flow. 4) No visible air movement using chemical smoke at 50 pascals of pressure difference. |

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3 - WALLS: QUALITY ASSURANCE FOR EXTERIOR DENSE PACK

DESIRED OUTCOME(S):

- 1) Complete insulation coverage without settling or voids throughout exterior wall plane and embedded framing connections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|--|---|
| <p style="text-align: center;"><u>QUALITY ASSURANCE</u></p> | <p>1) View completed wall sections on infrared camera with blower door.</p> <p>2) Drill and pack any void, re-pack low density areas.</p> |
| | <p>Completed work confirmed: no voids or hidden air flows.</p> |

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4 - WALLS: PLUG EXTERIOR DENSE PACK HOLES

DESIRED OUTCOME(S):

- 1) Complete insulation coverage without settling or voids throughout exterior wall plane and embedded framing connections.
- 2) Minimize framing cavity air flows inaccessible to other treatments.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---------------------------|---|--|
| <u>CLOSE HOLES</u> | <ol style="list-style-type: none"> 1) Plug installation holes: <ul style="list-style-type: none"> • Exterior holes: patch weather barrier. • Interior holes: rough coat patch. 2) Collect and remove all construction debris and dust. | <ol style="list-style-type: none"> 1) Exterior holes are watertight. 2) Work space or house is in clean condition. |

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5 - WALLS: DENSE PACK ADDITIONAL CAVITIES

DESIRED OUTCOME(S):

1) Complete insulation and air sealing in walls and other details inaccessible to usual treatments.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|------------------------------|---|--|
| <u>FIND AND OPEN</u> | 1) Find what is left after accessible walls and attics are done. 2) Locate and gain access to details remaining in or between completed wall sections. | The last gaps and framing edges in the thermal envelope, roof-wall joints, floor-wall joints, etc. are found and finished. |
| <u>SEAL AIR LEAKS</u> | Provide backing and seal all newly uncovered openings within reach with barriers, foam or mastic, maintaining all required clearances. | The air barrier is connected across all accessible building elements. |

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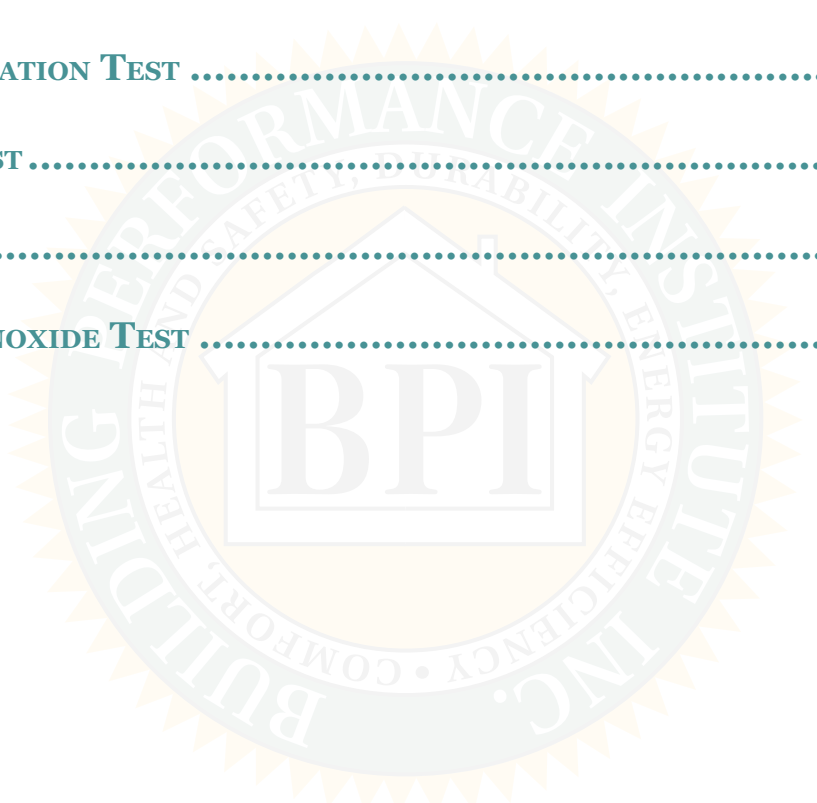
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| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| <p style="text-align: center;"><u>PACK WHAT YOU CAN'T SEAL</u></p> | <p>1) Completely fill each cavity to a consistent density:</p> <ul style="list-style-type: none"> • Install cellulose material to a minimum density of 3.5 lbs/ cubic foot. • Install loose fiberglass material specifically approved for air flow resistance to a minimum density of 2.2 lbs/ cubic foot. <p>2) Materials are approved to meet the BPI air semi permeable standard.</p> <p>3) Confirm the number of bags installed matches the number required on the coverage chart.</p> |
| <p style="text-align: center;"><u>QUALITY ASSURANCE</u></p> | <p>1) 100% of cavity filled to proper density in order to eliminate voids and settling</p> <p>2) Consistent with no void areas, no settling.</p> <p>3) Block air flow.</p> <p>4) No visible air movement using chemical smoke at 50 pascals of pressure difference.</p> |
| <p>1) View completed wall sections on infrared camera with blower door.</p> <p>2) Drill and pack any void, re-pack low density areas.</p> <p>3) Plug installation holes patch weather barrier.</p> <p>4) Collect and remove all construction debris and dust.</p> | <p>1) Thermal envelope is established.</p> <p>2) Completed work confirmed: no voids or hidden air flows.</p> <p>3) House is returned to water-tight, clean condition.</p> |

Combustion Safety Testing

| <u>DETAIL NAME</u> | <u>PAGE NUMBER</u> |
|-----------------------------|--------------------|
| DEPRESSURIZATION TEST | 55 |
| SPILLAGE TEST | 56 |
| DRAFT TEST..... | 57 |
| CARBON MONOXIDE TEST | 58 |



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1 - COMBUSTION SAFETY TESTING: DEPRESSURIZATION TEST

DESIRED OUTCOME(S):

1) Measurement of the combined effect of mechanical system fans on combustion zone pressure.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|--|--|---|
| MECHANICAL AIR DISTRIBUTION & INTERACTING RELATIONSHIPS | <u>DUCT LEAKAGE</u> | The furnace, heat pump and air conditioner air handler fan shall be on the high speed setting. |
| | <u>INTERIOR DOOR CLOSURE</u> | 1) Close bedroom door. Check direction of air flow. 2) Door closure shall be included in worst case testing. |
| | <u>EXHAUST & SUPPLY FANS SMALLER THAN 150 CFM</u> | Bath, kitchen, laundry room, dryer, attic, crawl space and ventilation (exhaust and supply) fans shall be included in worst case testing. |
| <p>1) The combined effect of the above mechanical air distribution fans creating the worst case conditions shall not exceed negative pressures listed in the Combustion Appliance Zone Depressurization Limits Table.</p> <p>2) The limits will be according to the venting conditions listed in the same table.</p> | | Reduce the occurrence of back drafting, pressure induced flame roll-out and carbon monoxide production and prolonged spillage of flue gasses. |

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2 - COMBUSTION SAFETY TESTING: SPILLAGE TEST

DESIRED OUTCOME(S):

- 1) Combustion gases do not spill from the draft diverter for more than one minute under worst case conditions.

| SPECIFICATIONS | DESIRED OUTCOME(S) |
|---|--|
| Upon firing a furnace or water heater under worst case conditions, combustion gases shall not spill out of the draft diverter for more than one minute. | Detect excessive spillage of combustion gases. |

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3 - COMBUSTION SAFETY TESTING: DRAFT TEST

DESIRED OUTCOME(S):

- 1) Combustion gases do not enter the living space under worst case conditions.

| SPECIFICATIONS | | DESIRED OUTCOME(S) | |
|--|-------------------------------------|--|--|
| VENT TYPE | <u>SEPARATE VENT</u> | <ol style="list-style-type: none"> 1) Separately vented gas and oil furnaces, boilers and water heaters shall have draft tested after 5 minutes of run time. 2) This test will be conducted while the house is set up in worst case. | Reduce the occurrence of appliances back drafting. |
| | <u>INTERIOR DOOR CLOSURE</u> | <ol style="list-style-type: none"> 1) Shared vented gas and oil furnaces, boilers and water heaters shall have draft tested after 5 minutes of run time. 2) The lowest Btu appliance will be tested first then allowed to cool 5 minutes before testing the next. 3) This test will be conducted while the house is set up in worst case. | Reduce the occurrence of appliances back drafting. |
| All draft pressures shall be equal to or greater than minimum draft pressures listed on the Minimum Acceptable Draft Pressures Table . | | Reduce the occurrence of appliances back drafting at different outdoor temperatures. | |

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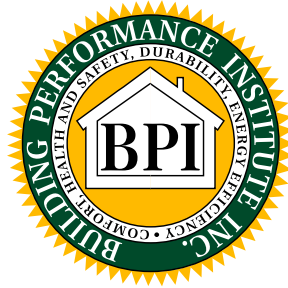


4 - COMBUSTION SAFETY TESTING: CARBON MONOXIDE TEST

DESIRED OUTCOME(S):

- 1) Proper action is taken when a gas or oil furnace, boiler, water heater and gas stove and oven produces CO.

| SPECIFICATIONS | | DESIRED OUTCOME(S) |
|---|--|--|
| <u>GAS AND OIL</u> <u>NATURAL DRAFT, 80%</u> <u>INDUCED DRAFT</u> | <u>FURNACES,</u> <u>BOILERS AND</u> <u>WATER HEAT-</u> <u>ERS</u> | Shall be tested for carbon monoxide production after 5 minutes of run time. CO measurement is taken when the appliance comes to steady state. |
| <u>GAS</u> | <u>STOVES</u> <u>AND OVENS</u> | Oven shall be tested for production of carbon monoxide. CO measurement is taken after the oven has been operating for 5 minutes. |



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Appendix B - 2006 IRC pertaining to Crawlspace

**TABLE R405.1
PROPERTIES OF SOILS CLASSIFIED ACCORDING TO THE UNIFIED SOIL CLASSIFICATION SYSTEM**

| SOIL GROUP | UNIFIED SOIL CLASSIFICATION SYSTEM SYMBOL | SOIL DESCRIPTION | DRAINAGE CHARACTERISTICS ^a | FROST HEAVE POTENTIAL | VOLUME CHANGE POTENTIAL EXPANSION ^b |
|------------|---|--|---------------------------------------|-----------------------|--|
| Group I | GW | Well-graded gravels, gravel sand mixtures, little or no fines | Good | Low | Low |
| | GP | Poorly graded gravels or gravel sand mixtures, little or no fines | Good | Low | Low |
| | SW | Well-graded sands, gravelly sands, little or no fines | Good | Low | Low |
| | SP | Poorly graded sands or gravelly sands, little or no fines | Good | Low | Low |
| | GM | Silty gravels, gravel-sand-silt mixtures | Good | Medium | Low |
| | SM | Silty sand, sand-silt mixtures | Good | Medium | Low |
| Group II | GC | Clayey gravels, gravel-sand-clay mixtures | Medium | Medium | Low |
| | SC | Clayey sands, sand-clay mixture | Medium | Medium | Low |
| | ML | Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity | Medium | High | Low |
| | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays | Medium | Medium | Medium to Low |
| Group III | CH | Inorganic clays of high plasticity, fat clays | Poor | Medium | High |
| | MH | Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts | Poor | High | High |
| Group IV | OL | Organic silts and organic silty clays of low plasticity | Poor | Medium | Medium |
| | OH | Organic clays of medium to high plasticity, organic silts | Unsatisfactory | Medium | High |
| | Pt | Peat and other highly organic soils | Unsatisfactory | Medium | High |

For SI: 1 inch = 25.4 mm.

- a. The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 inches to 4 inches per hour, and poor is less than 2 inches per hour.
- b. Soils with a low potential expansion typically have a plasticity index (PI) of 0 to 15, soils with a medium potential expansion have a PI of 10 to 35 and soils with a high potential expansion have a PI greater than 20.

materials provided that the least dimension of the covering shall not exceed 1/4 inch (6.4 mm):

1. Perforated sheet metal plates not less than 0.070 inch (1.8 mm) thick.
2. Expanded sheet metal plates not less than 0.047 inch (1.2 mm) thick.
3. Cast-iron grill or grating.
4. Extruded load-bearing brick vents.
5. Hardware cloth of 0.035 inch (0.89 mm) wire or heavier.
6. Corrosion-resistant wire mesh, with the least dimension being 1/8 inch (3.2 mm).

R408.3 Unvented crawl space. Ventilation openings in under-floor spaces specified in Sections R408.1 and R408.2 shall not be required where:

1. Exposed earth is covered with a continuous vapor retarder. Joints of the vapor retarder shall overlap by 6

inches (152 mm) and shall be sealed or taped. The edges of the vapor retarder shall extend at least 6 inches (152 mm) up the stem wall and shall be attached and sealed to the stem wall; and

2. One of the following is provided for the under-floor space:
 - 2.1. Continuously operated mechanical exhaust ventilation at a rate equal to 1 cfm (0.47 L/s) for each 50 ft² (4.7 m²) of crawlspace floor area, including an air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.8;
 - 2.2. Conditioned air supply sized to deliver at a rate equal to 1 cfm (0.47 L/s) for each 50 ft² (4.7 m²) of under-floor area, including a return air pathway to the common area (such as a duct or transfer grille), and perimeter walls insulated in accordance with Section N1102.2.8;

2.3. Plenum complying with Section M1601.4, if under-floor space is used as a plenum.

R408.4 Access. Access shall be provided to all under-floor spaces. Access openings through the floor shall be a minimum of 18 inches by 24 inches (457 mm by 610 mm). Openings through a perimeter wall shall be not less than 16 inches by 24 inches (407 mm by 610 mm). When any portion of the through-wall access is below grade, an areaway not less than 16 inches by 24 inches (407 mm by 610 mm) shall be provided. The bottom of the areaway shall be below the threshold of the access opening. Through wall access openings shall not be located under a door to the residence. See Section M1305.1.4 for access requirements where mechanical equipment is located under floors.

R408.5 Removal of debris. The under-floor grade shall be cleaned of all vegetation and organic material. All wood forms used for placing concrete shall be removed before a building is occupied or used for any purpose. All construction materials shall be removed before a building is occupied or used for any purpose.

R408.6 Finished grade. The finished grade of under-floor surface may be located at the bottom of the footings; however, where there is evidence that the groundwater table can rise to within 6 inches (152 mm) of the finished floor at the building perimeter or where there is evidence that the surface water does not readily drain from the building site, the grade in the under-floor space shall be as high as the outside finished grade, unless an approved drainage system is provided.

R408.7 Flood resistance. For buildings located in areas prone to flooding as established in Table R301.2(1):

1. Walls enclosing the under-floor space shall be provided with flood openings in accordance with Section R324.2.2.
2. The finished ground level of the under-floor space shall be equal to or higher than the outside finished ground level.

Exception: Under-floor spaces that meet the requirements of FEMA/FIA TB 11-1.

Appendix C – QC Checklist of BPI Standards

| | | Insulation and Air-Sealing Checklist |
|----------------------|--------------------------|---|
| Item Complete | Not Part of Scope | <u>Attic</u> |
| | | <u>Attic Air Sealing</u> |
| | | Thermal Boundry Continuous and supports insulation Load |
| | | Minor attic penetrations sealed (e.g. wiring, plumbing, ducting). Continuous seal around joints, seams cracks, edges, penetrations and connections. |
| | | Proper Sealants and materials used. Non-combustable materials used around ignition sources (e.g. Flues, Chimneys, Vents) |
| | | <u>Attic Insulation</u> |
| | | Proper clearance provided around combustion sources. |
| | | Rigid dam (wood or better) having height greater than surrounding insulation is constructed to ensure insulation does not fall into access opening. |
| | | Attic access hatch is insulated to same R-value as surrounding insulation and is permanently attached to hatch cover. Hatch cover is properly gasketed |
| | | Non insulation contact (IC) lights have an air tight enclosure taller than the surrounding insulation. 3" of clearance is maintained. Top of enclosure has an R value not to exceed R.5 |
| | | Knee wall insulation has 6-sided encapsulation with proper insulation/air barrier alignment and has all gaps cracks and penetrations sealed |
| | | Dense pack insulation blown to proper density and completely fills all cavities |
| | | Install attic depth markers no less than 1 for every 300sqft |
| | | Blow all insulation level and to depth indicated on manufacturer's coverage chart for desired R-value |
| | | Signed and dated attic card properly filled out and given to homeowner |
| | | Attic ventilation maintained (e.g. soffit baffles present) |
| | | <u>Floor & Wall</u> |
| | | <u>Floor and wall Air Sealing</u> |
| | | Continuous air barrier present with an air-tight seal around joints, seams cracks, edges, penetrations and connections. |
| | | Complete insulation coverage without settling or voids throughout exterior wall plane. |
| | | Drill and fill holes are patched and returned to paint-ready condition |
| | | <u>Duct Sealing</u> |
| | | Ducts and plenums are properly fastened and supported |
| | | All accessible joints and seams are properly sealed to prevent air leakage |
| | | <u>Crawl Spaces</u> |
| | | Vapor barrier properly installed per IRC |
| | | Appropriate ventilation or conditioned air supply and return path present per IRC |
| | | If access is from outside, hatch is properly insulated and gasketed |
| | | <u>Combustion Safety</u> |
| | | Contractor signoff sheet completed |

Appendix D - Insulation and Air Sealing Contractor Signoff Sheet

Contractor Sign-Off Sheet Insulation / Air-Sealing



Contractor Name (Company): _____

Homeowner Name(s) (Include and indicate name on deed if different):

Project Address _____ City _____ Zip _____

1) Brief Description of Work Performed. Please also attach a final invoice:

2) Please provide Test-in blower-door test results: _____ CFM50

3) Please provide Test-out blower-door test results: _____ CFM50

4) If below 0.35 nACH, was mechanical ventilation recommended (Circle one)? Yes No N/A

5) Please provide the following Combustion Safety Test results:

| Item | Test In | Test out |
|--|---------|----------|
| Combustion air present? (Yes/No) | | |
| CAZ #1 Worst-case CAZ Depressurization ΔP WRT Outdoors (Pa) | | |
| CAZ #1 Worst-case CAZ Depressurization Test: (Pass/Fail)** If failing this test, additional makeup air or modifications to the building shell must be included in work scope to bring the depressurization within acceptable limits | | |
| DHW Worst Case Spillage Test: (Pass/Fail) | | |
| DHW Worst case Flue Static Pressure (Pa) (list pressure and PASS/FAIL per BPI standards) | | |
| DHW: CO Levels (undiluted flue gases)(ppm) | | |
| DHW Nat. Cond. Spillage Test (only necessary if failing worst case): (Pass/Fail) | | |
| DHW Nat. Cond. Flue Static Pressure (Pa) (list pressure and PASS/FAIL per BPI standards) | | |
| CAZ #2 (if present) Worst-case CAZ Depressurization ΔP WRT Outdoors (Pa) | | |
| CAZ #2 (if present) Worst-case CAZ Depressurization Test: (Pass/Fail)** If failing this test, additional makeup air or modifications to the building shell must be included in work scope to bring the depressurization within acceptable limits | | |
| Furnace Worst Case Spillage Test: (Pass/Fail) | | |
| Furnace Worst Case Flue Static Pressure (Pa) (list pressure and PASS/FAIL per standards) | | |
| Furnace/Boiler: CO Levels (undiluted flue gases)(ppm) | | |
| Furnace Nat. Cond. Spillage Test (only necessary if failing worst case): (Pass/Fail) | | |
| Furnace Nat Cond. Flue Static Pressure (Pa) (list pressure and PASS/FAIL per standards) | | |
| Gas Stove/Oven CO level (undiluted exhaust at steady state) | | |
| Other Combustion Appliance CO Levels (undiluted flue gases)(ppm) | | |
| CAZ #1 Ambient CO Level (ppm) | | |
| CAZ #2 Ambient CO Level (ppm) | | |
| CAZ Technician Name: | | |

Appendix E – Matrix Outlining Permit Requirements by Municipality in Boulder County



Residential Permit & Inspection Information

| Category | MEASURE | BOULDER (2006 IRC) | LAFAYETTE (2006 IRC) | LONGMONT (2009 IRC) | LOUISVILLE (2009 IRC) | LYONS (2006 IRC) | NEDERLAND (2006 IRC) | SUPERIOR (2006 IRC) | ERIE (2006 IRC) | UNINCORPORATED BOULDER COUNTY & JAMESTOWN (2009 IRC) |
|-----------------------------|--|-----------------------|--------------------------------------|--------------------------------------|--------------------------------------|--------------------------------------|-------------------------|--------------------------------------|---------------------------|---|
| Air Sealing and Ventilation | Air sealing | | | | | X | X | | | |
| | Duct sealing | | | | | X | X | | | |
| | Energy or heat recovery ventilator | X | X | X | | X | X | X | x | X |
| | Whole house fan | X | X | X | | X | X | X | x | X |
| | Attic fan | X | X | X | | X | X | X | x | X |
| Insulation | Attic | | YES, ONLY IF STRUCTURAL CHANGES MADE | X | | | X | | | |
| | Wall | | YES, ONLY IF STRUCTURAL CHANGES MADE | X | YES, ONLY IF STRUCTURAL CHANGES MADE | YES, ONLY IF STRUCTURAL CHANGES MADE | X | | x | |
| | Floor (over unconditioned space) | | YES, ONLY IF STRUCTURAL CHANGES MADE | X | YES, ONLY IF STRUCTURAL CHANGES MADE | YES, ONLY IF STRUCTURAL CHANGES MADE | X | | x | |
| | Ducts (in unconditioned space) | | YES, ONLY IF STRUCTURAL CHANGES MADE | X | YES, ONLY IF STRUCTURAL CHANGES MADE | YES, ONLY IF STRUCTURAL CHANGES MADE | X | | x | |
| | Perimeter (foundation) | | YES, ONLY IF STRUCTURAL CHANGES MADE | X | YES, ONLY IF STRUCTURAL CHANGES MADE | | X | | x | |
| Space Heating and Cooling | High efficiency furnace | X | X | X | X | X | X | X | x | X |
| | Boiler | X | X | X | X | X | X | X | x | X |
| | Ground source heat pump | X | X | X | X | X | X | X | x | X |
| | Radiant heating and cooling (floor, wall, and ceiling) | X | X | X | X | X | X | X | x | X |
| | Evaporative cooler | X | X | X | X | X | X | X | x | X |
| | Central air conditioner | X | X | X | X | X | X | X | x | X |
| | Programmable Thermostats | | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | | | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | No as long as low voltage | YES, ONLY IF LINE VOLTAGE: 110 VOLTS |

| | | | | | | | | | | |
|------------------------------|---|---|--------------------------------------|---|---|---|-----------------------------|--------------------------------------|---|---|
| Water Heating | Demand/tankless | X | X | X | X | X | X | X | x | X |
| | High efficiency natural gas storage | X | X | X | X | X | X | X | x | X |
| Lighting | Fixtures, ballasts | | | X | X | | | X | x | |
| | Timers, sensors | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | X | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | | YES, ONLY IF LINE VOLTAGE: 110 VOLTS | | YES, ONLY IF LINE VOLTAGE: 110 VOLTS |
| Daylighting | Lightshelves | X | X | X | X | X | X | X | | X |
| | Tubular skylights | X | X | X | X | X | X | X | x | X |
| Windows, Doors and Skylights | Exterior windows and glass doors | YES, ONLY IF THE SIZE OF OPENING IS CHANGED | X | X | X | YES, ONLY IF THE SIZE OF OPENING IS CHANGED | X | X | YES, ONLY IF THE SIZE OF OPENING IS CHANGED | X |
| | Storm windows | | | X | | | | X | | |
| | Insulating shutters | | | X | | | | X | | |
| | Insulating exterior doors | YES, ONLY IF THE SIZE OF OPENING IS CHANGED | | X | YES, ONLY IF THE SIZE OF OPENING IS CHANGED | | X | X | | YES, ONLY IF THE SIZE OF OPENING IS CHANGED |
| | Skylights | X | X | X | X | X | X | X | x | X |
| Reflective Roof | Metal or asphalt roof | X | YES, ONLY IF LOAD INCREASES | X | X | X | YES, ONLY IF LOAD INCREASES | X | x | X |
| Pool Equipment | High efficiency pool circulating pump | X | X | X | X | X | X | X | x | X |
| | Automatic pool cover | X | X | X | X | X | X | X | x | X |
| | Air source heat pump | X | X | X | X | X | X | X | x | X |
| Landscaping | Focused on heating/cooling | | | | | | | | | |
| Solar hot water | Rooftop (Includes replacement for orphan solar hot water systems) | X | X | X | X | X | X | X | x | X |
| | Pool | X | X | X | X | X | X | X | x | X |
| | Hot tub | X | X | X | X | X | | X | x | X |
| Solar photovoltaics | | X | X | X | X | X | X | X | x | X |
| Small wind | | X | X | X | X | X | X | X | x | X |
| Wood/pellet stoves | Pellet stoves | X | X | X | X | X | X | X | x | X |
| | High efficiency fireplaces & fireplace inserts | X | X | X | X | X | X | X | x | X |
| | Advanced combustion / gasification wood or pellet stoves | X | X | X | X | X | X | X | x | X |

This information is intended only as a guide. EnergySmart does not guarantee that this information is current and accurate. Please contact the municipality in which you are doing work to confirm specific Permit and Inspection Requirements.