Home Upgrade
Energy Upgrade California®

2015 HOME UPGRADE

INSTALLATION SPECIFICATIONS

FOR PACIFIC GAS AND ELECTRIC COMPANY TERRITORY

Build It GREEN™
Smart Solutions from the Ground Up

Version 3.1, April 1, 2015

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1 Introduction

Energy Upgrade California® Home Upgrade offers property owners a choice of two Home Upgrade pathways, Home Upgrade (formerly Basic Package) and Advanced Home Upgrade (formerly Advanced Package). All projects conducted through either program pathway must include Combustion Appliance Safety (CAS) testing. CAS testing must be conducted before and after the upgrade ('Test-In' and 'Test-Out') is completed and anytime work is done that impacts the pressurization of the home (including air- and/or duct- sealing measures). All homes must pass CAS testing. Repairs or other corrective actions (as specified in the *Combustion Appliance Safety Action Guidelines* and *Whole House Combustion Appliance Safety Test Procedure For Pacific Gas and Electric Company [PG&E] Home Upgrade Program*) should be added to work scopes. Please manage expectations with customers accordingly.

The following is a brief overview of the differences between the two Home Upgrade pathways:

- The Home Upgrade pathway focuses on the 'low hanging fruit' of energy efficiency and requires installation of at least three (3) energy efficiency 'upgrade' measures, as well as installation or verification of the existence of at least one CO Alarm or Detector (see Section 2.6 for specific requirement details). The Home Upgrade pathway offers customers and Program participants an easy entry point to 'whole house' energy efficiency while leaving open the opportunity for additional comprehensive upgrades in the future. Home Upgrade pathway incentives are not available for homes in two-four unit buildings (use Advanced Home Upgrade for these). Home Upgrade projects in PG&E service territory are administered in all counties served by PG&E, **except** within the nine Bay Area counties (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma), where those projects are administered by the San Francisco Bay Area Regional Energy Network (BayREN).
- The Advanced Home Upgrade pathway provides a customized solution for each property owner, starting with a 'whole house' energy assessment to evaluate current systems and identify opportunities for improvements. Advanced Home Upgrade also requires at least a 10% expected improvement in performance based on modeling a minimum of at least two (2) installed energy efficiency 'upgrade' measures, as well as installation or verification of the existence of at least one CO Alarm or Detector (see Section 2.6 for specific requirement details). Two-four unit buildings must use Advanced Home Upgrade. Advanced Home Upgrade projects in PG&E service territory are administered PG&E in all counties served by PG&E, **including** the nine Bay Area counties.

Additionally, the Home Upgrade pathway is intended to serve Customers who are unable or not yet ready to invest in a broader set of upgrade measures. It also opens the Program to contractors who will gain experience and training to later qualify to offer the Advanced Home Upgrade pathway. The Home Upgrade pathway requires selection of at least one Base measure and at least two additional Base and/or Flex measures (see *Home Upgrade Program Participant Handbook* for details on types of measures and measures combinations requirements). Improvements must meet or exceed all applicable Title 24 Standards and Program technical specifications/eligibility requirements.

Advanced Home Upgrade maximizes opportunities for long-term energy savings in addition to

providing customers a more customized path to home performance than the Home Upgrade pathway. Advanced Home Upgrade requires diagnostic (building- and duct-leakage) 'test-in' and 'test-out' assessments (along with CAS 'test-in' and 'test-out') consistent with *Building Performance Institute Technical Standards for the Building Analyst Professional* and *Whole House Combustion Appliance Safety Test Procedure For Pacific Gas and Electric Company (PG&E) Home Upgrade Program*.

For Home Upgrade and Advanced Home Upgrade pathways, the 'test-in' begins the process of defining a comprehensive or 'conditions-appropriate' work scope for each job (including discovery of whether a home has existing health or safety issues to inform that work scope). The 'test-out' is used to document that specified improvements have been properly applied and/or sized and installed and that safety tests have been successfully completed.

While not strictly required, it is recommended that Advanced Home Upgrade work scopes include any Home Upgrade measure(s) that is not already installed. Measures being claimed as part of a scope of work for Home Upgrade must meet minimum eligibility requirements specified in Table 1 (below). Measures being claimed as part of a scope of work for Advanced Home Upgrade are recommended to meet minimum eligibility requirements specified in Table 3 (see Section 3).

This document provides a set of installation specifications for energy efficiency measures and/or health and safety tasks that are required for or eligible for inclusion in either Home Upgrade or Advanced Home Upgrade projects. In addition, each upgrade must follow national, state and local laws and pull permits in compliance with state and local requirements. The specification for each measure discusses minimum requirements, best practices, and may also include verification protocols for the Quality Assurance (QA) verifier and Field Quality Control (FQC) verifier. The QA verifier will apply the verification protocols to confirm that the minimum requirements were adequately met in 'desktop review' (after an application has been submitted for review for incentive processing). The FQC verifier will apply the verification protocols to confirm that the minimum requirements were adequately met in the field. The quality assurance and quality control processes and the roles of the QA verifier and Field Quality Control (FQC) verifier are discussed in more depth in the *Participant Handbook*.

2 Home Upgrade Pathway

Table 1. Home Upgrade Measures

Measure Description	PG&E Eligibility Requirements	Program Standard
1. **Air sealing (Whole Building)**	≥ 15% leakage reduction from vintage table defaults or ≥ 30% leakage reduction from vintage table defaults; not eligible for measure if measure is already installed	0.35 ACHn target, 0.5 ACHn minimum performance, achieved in accordance with BPI Standards and ASHRAE 62.2; if ACHn standards conflict with building leakage reduction, PG&E Eligibility Requirements shall govern while also adhering to BPI and ASHRAE 62.2
2. **Attic Insulation & Air Sealing**	Insulation Upgrade ≥ R-30 (≥ R-38 in climate zones 1, 11-13, 16); Existing R-Value lower than target upgrade installed; visual verification for air-seal of attic plane (only); not eligible for measure if measure is already installed	R-38 or better, recommend adherence to BPI Shell Standards and/or CEC QII standards
3. **Duct sealing**	Seal to ≤ 10% for existing systems or Seal to ≤ 6% for replacement ducts; not eligible for measure if measure is already installed	Reduce duct leakage to 10% or less (existing ducts) or 6% or less (replacement duct system) of nominal air flow of the heating/cooling system or actual air flow as measured; meet or exceed Title 24 requirements
4. **Duct Insulation**	Insulate ≥ R-8; existing condition is less than R-8; not eligible for measure if measure is already installed	Insulate ≥ R-8; ducts located in unconditioned spaces shall be buried in insulation or insulated to minimum R-8
5. **Wall Insulation**	Insulate ≥ R-13; existing condition is less than R-13; not eligible for measure if measure is already installed	Insulate ≥ R-13, recommend adherence to BPI Shell Standards and/or CEC QII standards
6. **Floor Insulation**	Insulate ≥ R-19; existing condition is less than R-19; not eligible for measure if measure is already installed	Insulate ≥ R-19, recommend adherence to BPI Shell Standards and/or CEC QII standards
7. **Windows**	0.32 U,0.25 SHGC; existing windows are higher than0.32 U,0.25 SHGC; not eligible for measure if measure is already installed	Replace all windows with 0.32 U,0.25 SHGC

8. **Central Gas Furnace**	Central natural gas furnace ≥ 92% AFUE or ≥ 95% AFUE; existing equipment lower AFUE than target upgrade installed; not eligible for measure if measure is already installed	Central natural gas furnace ≥ 92% AFUE
9. Gas Wall Heater	Natural gas wall heater ≥ 70% AFUE; existing equipment lower AFUE than target upgrade installed; not eligible for measure if measure is already installed	Natural gas wall heater ≥ 70% AFUE
10. Central Air Conditioner	Central air conditioning 15 SEER/12.7 EER; existing equipment lower SEER/EER than target upgrade installed; not eligible for measure if measure is already installed	Central air conditioning 15 SEER/12.7 EER
11. Gas Storage Water Heater	Natural gas storage water heater EF ≥ 0.67; existing equipment lower EF than target upgrade installed; not eligible for measure if measure is already installed	Natural gas storage water heater EF ≥ 0.70
12. Gas On-Demand (Tankless) Water Heater	Natural gas on-demand water heater EF ≥ 0.82; existing equipment lower EF than target upgrade installed; not eligible for measure if measure is already installed	Natural gas on-demand water heater EF ≥ 0.82
13. Electric Storage Water Heater	Electric storage (hybrid heat-pump) water heater EF ≥ 2.00; existing equipment lower EF than target upgrade installed; not eligible for measure if measure is already installed	Electric storage (hybrid heat-pump) water heater EF ≥ 2.00

Customers who receive both gas and electric service from PG&E are eligible for the all of the Home Upgrade measures listed above. Customers who receive either gas or electric service from another utility are eligible for a rebate, depending on which energy services they receive from PG&E, as long as PG&E supplies the type of fuel used by any equipment selected as part of the combined measures contributing to the incentive amount. However, upgrades of existing equipment must be for more efficient versions of the same type of equipment (i.e., less-efficient Gas Central

Furnace to more-efficient Gas Central Furnace, etc.). Fuel-switching is not eligible for rebate in Home Upgrade.

Additionally, customers must have existing air-conditioning if they only have PG&E electric service or an existing natural gas furnace if they only have PG&E gas service, regardless of whether the equipment is selected as a measure as part of a Home Upgrade application.

2.1 Air Sealing

Per BPI, an effective and continuous thermal and pressure boundary shall be established in each home through the installation of appropriate air sealing and insulation measures. Wherever possible, air sealing and insulation strategies shall be designed to align the thermal and pressure boundaries to create a single continuous thermal envelope.

Air sealing strategies should be determined based on blower door diagnostic results, visual inspection of critical by-pass areas, and indoor air quality evaluations for each home.

2.1.1 Minimum Requirements

- Home Upgrade pathway eligibility: There has been no air sealing in the home to the current/selected leakage reduction target in the past 6 years.
- All air sealing should be performed before insulation installation.
- The air sealing target is:
    - For Home Upgrade, the Whole Building Air Sealing building leakage reduction percentage specification (≥ 15% leakage reduction from vintage table defaults or ≥ 30% leakage reduction from vintage table defaults for Specific Leakage Area [SLA], as defined by the California Energy Commission [CEC])
    - For Advanced Home Upgrade, 0.35 ACHn or better (air changes per hour naturally) or, minimally, 0.50 ACHn.
- When Whole Building Air Sealing is performed, if the measured CFM50 is less than 70% of the Building Airflow Standard, as set forth in ASHRAE 62-1989, mechanical ventilation must be installed according to the standards.[1]
- Whole house air sealing to reduce air infiltration shall be done in accordance with Building Performance Institute (BPI) Standards as follows:[2]
    - Air sealing measures shall be prioritized to reduce the stack effect and inhibit moisture migration into attics or other interstitial spaces.
    - Blower door quick tests should be performed during air sealing to track progress and verify results.

[1] American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (1989), *Ventilation for Acceptable Indoor Air Quality*, ANSI/ASHRAE Standard 62-1989, www.ashrae.org.

[2] Building Performance Institute (v1/4/12),*Building Performance Institute Technical Standards for the Building Analyst Professional, www.bpi.org/standards_approved.aspx*

- Garage to living space connections should be tested for air tightness using a smoke stick or, pressure measurements in conjunction with the blower door. Air leaks between the garage and living space should be sealed as part of the work scope.
- Attic ventilation shall not be recommended or installed without first verifying the presence of an effective air barrier and thermal barrier between the attic and the living space or specifying appropriate attic air sealing as part of the work scope.
- Air seal communication between the attic and living space first. Areas to seal include but, are not limited to: by-passes around chimneys, ducts, drop soffits, shower inserts or other large penetrations; interior and exterior wall top-plates; and plumbing and wiring penetrations.
- Leakage paths identified between attached or tuck-under garages and the living space must always be sealed.
- Seal off leakage paths through interstitial building cavities using manual air sealing, high density cellulose cavity insulation (see below), or spray-foam products.
- If the house CFM50 is still higher than the Building Airflow Standard after sealing the attic, garage, and basement, interior air-sealing may be performed as needed including: sealing around plumbing penetrations, caulking around window and door casings, caulking around molding and baseboards, or other significant leakage areas identified using the blower door.
- Air sealing installations should be installed to be permanent improvements to the structure. Products with an expected lifespan of less than 20 years should not be used.
- A blower door test (required for Advanced Home Upgrade; required for Home Upgrade 'test-out' if Whole Building Air Sealing measure was selected) and combustion appliance safety (CAS) test must be performed before and after the installation of air sealing (each day if necessary) to ensure safety and when a mechanical ventilation system is installed in a building where combustion appliances are present. All CAS tests must include testing to meet minimum safety requirements for draft, spillage, and CAZ depressurization.

Using Insulation for Air Sealing:

- Where leakage paths are identified that cannot be accessed or reasonably sealed using conventional air sealing techniques, high density cellulose or foam insulation shall be installed strategically to reduce airflow through the building shell.
- If cellulose insulation is to be used as an air barrier in an enclosed cavity, it must be installed at a minimum density of 3.5 pounds per cubic foot.
- Fiberglass insulation is not an air barrier and may never be used as an air sealing material.

2.1.2 Best Practices

- Although the Program target is 0.35 ACHn, a better practice is to air seal as much as possible to reduce energy loss and to mitigate unwanted pollutants from entering the home (target at least 15% leakage reduction). This may trigger the inclusion of a separate mechanical ventilation system for the home as is required by ASHRAE 62.2 or ASHRAE 62.1989, which would provide ventilation air for the occupants due to a tighter building envelope. Customers should be made aware of this potential outcome. Although this strategy may intuitively seem in contradiction to logic and program goals (saving energy), the research has shown that most often tighter structures with mechanical ventilation systems save more energy than leaky structures without mechanical ventilation.
- Zonal pressure diagnostic testing should be performed to identify those areas of the structure that have the most air leakage. Typically, the high areas of the home (ceiling plane of top floor) have the most cost-effectiveness due to the "stack-effect" (heat rising and leaving the structure). Penetrations in the ceiling plane, including light fixtures, exhaust fans, speakers, and attic hatches, should be sealed as accessible with the appropriate materials. Non-insulation rated light fixtures could/should be replaced with ICAT (insulation contact, air-tight) type fixtures.
- Air sealing around vent stacks and chimneys may need special care. Some of these pipes and vents can get very hot and therefore, only heat resistant materials should be utilized including heat-resistant caulking and/or foam sealants that are rated for this purpose.
- Consider low-VOC content materials whenever possible for the health of your crews and the occupants.

2.1.3 Verification

- The contractor shall report test-in (Advanced Home Upgrade only) and test-out (for appropriate measure for Home Upgrade and always for Advanced Home Upgrade) results to the Program Administrators in CFM50.
- For Advanced Home Upgrade, there must be measurable improvement between the initial blower door test-in results and the post-upgrade blower door test-out results. Home Upgrade test-out must show a 15 or 30 percent leakage reduction (or better, depending on measure target selected).
- The FQC verifier's test results should be within rounding error (0.5 percent) of the reported test-out (post-upgrade) numbers.
- FQC verifiers will be assessing the effectiveness of the work performed and determine if all reasonable efforts had been made to mitigate accessible uncontrolled infiltration.

2.2 Attic Insulation

According to BPI Shell Standards; prior to installing insulation in an existing home, a thorough inspection of the interior and exterior of the home is required to identify areas where

installation of insulation may be unsafe. Problem areas include: areas with knob-and-tube wiring, recessed light fixtures, areas where moisture is present or suspected, and structurally unsound building elements (e.g., suspended acoustical tile ceilings, wood paneling). Problems that are identified must be communicated to customers in writing and should be remedied prior to insulating.

2.2.1 General Requirements for Insulation

- Air sealing (all accessible areas) should be performed before insulation is installed.
- CAS (for Home Upgrade and Advanced Home Upgrade) and Blower door (for Advanced Home Upgrade) testing shall be performed whenever insulation, air sealing, or ventilation is installed to confirm safe conditions for the occupants.
- All insulation material must be new and meet or exceed all applicable local, state and federal standards.
- Newly installed insulation must benefit the occupant(s). Insulation should be installed between a conditioned living area and all-accessible unconditioned non-living area. Installing insulation in building assemblies with minimal or no potential for heat-transfer (i.e., garage ceiling to vented attic, interior ceiling [1st story] to interior floor [2nd story], etc.) does not qualify.
- Materials shall comply with, and be installed in conformance with, all applicable building codes for building and installed to meet all applicable fire codes.[3]
- Installing insulation shall be done per manufacturer's recommendations and should be done in accordance with Building Performance Institute (BPI) Standards[4] and California Quality Insulation Installation Standards (QII), as specified in Building Energy Efficiency Standards Residential Appendices RA3.5.[5]
- Insulation shall not be installed where live knob-and-tube wiring exists unless wiring has been surveyed by a C-10 electrical contractor and certified to be acceptable for encapsulation. Whenever possible, upgrade wiring to current standards before insulating.
- Materials shall be certified to be in compliance with California insulation quality standards, as listed in the *2014 Directory of Certified Insulation Materials*.[6]

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[3] California Building Standards Commission (2013), *California Building Standards Code: California Code of Regulations Title 24, www.bsc.ca.gov/Home/Current2013Codes.aspx*

[4] Building Performance Institute (v1/4/12),*Building Performance Institute Technical Standards for the Building Analyst Professional, www.bpi.org/standards_approved.aspx*

[5] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

[6] State of California Department of Consumer Affairs (2014), *Directory of Certified Insulation Materials,* www.bhfti.ca.gov/consumer/ti_directory.pdf

- Materials shall comply with flame spread rating and smoke density requirements of Title 24, Part 2, Chapter 7, Section 706, and Chapter 26: all installations with exposed facings must use fire retardant facings which have been tested and certified not to exceed a flame spread of 25 and a smoke development rating of 450. Insulation facings that do not touch a ceiling, wall, or floor surface, and faced batts on the undersides of roofs with an air space between the ceiling and facing are considered exposed applications.[7]
- Materials shall be installed according to manufacturer specifications and instructions.

2.2.2 Best Practices for Insulation

- When requested or available, specify environmentally preferable materials:
    - **Cellulose, Cotton, Wool:** Minimum 75 percent post-consumer recycled content as recommended by EPA's Recovered Materials Advisory Notice (RMAN) AND demonstrated low-emitting as defined by California's Section 01350.
    - **Fiberglass:** Minimum 20 percent recovered (pre or post-consumer recycled) content as recommended by EPA's Recovered Materials Advisory Notice (RMAN) *and* demonstrated low-emitting as defined by California's Section 1350.
    - **Spray Foam:** Demonstrated low-emitting as defined by California's Section 01350. Recommended minimum five percent recovered (pre-or post- consumer) recycled content or agriculture- based content as recommended by EPA's Recovered Materials Advisory Notice (RMAN).

2.2.3 Minimum Requirements for Attic Insulation

- **Home Upgrade Pathway Eligibility**: Documented, pre-existing insulation levels must be lower than the targeted upgrade R-Value (e.g., lower than R-30 Insulation in climate zones 2-5 or lower than R-38 in climate zones 1, 11-13, 16). Homes with pre-existing attic insulations levels exceeding the targeted upgrade R-Value may be improved per Advanced Home Upgrade pathway if the additional insulation level can be modeled within reasonable building assembly (roof-attic) assumptions.
- **Advanced Home Upgrade Pathway Eligibility**: Documented, pre-existing insulation levels must be lower than the targeted upgrade R-Value and upgraded R-Value must meet or exceed current state and/or local code requirement.
- Insulation must be installed in the attic of the conditioned living area.
- Attic insulation should not be recommended or installed without first verifying the presence of an effective air barrier between the attic and living space or specifying appropriate attic air sealing as part of the work scope. To evaluate the effectiveness of the attic-to-living space air barrier, certain techniques can be used such as:
    - Pressure differential diagnostics, series leakage tests, and "add a hole".

[7] California Building Standards Commission (2013), *California Building Standards Code: California Code of Regulations Title 24,* www.bsc.ca.gov/Home/Current2013Codes.aspx

- Visually inspecting the attic floor underneath the insulation layer to locate air by-passes and cavities.
- Inspecting the current insulation material for signs of infiltration (blackened).
- Using a smoke stick with a blower door running in the conditioned space to see if the smoke is drawn down into the living space.
- Reversing the blower door (pressurizing) and conduct Infrared investigation from the attic-side of the ceiling to see if heat transfer is occurring.

If there is air movement identified by one of the above methods, those areas should be addressed as part of the work scope prior to insulation being installed.

- Attic crawl space should be adequate (ideally, 24 inches or more between the bottom of the roof rafter and the top of the ceiling joists) and accounted for, depending on the type of insulation being installed.
- All attic access openings, including doors, hatches, and pull-down stairs shall have a tightly fitting cover which is insulated to a minimum R-14 (preferably, the same R-value as the upgraded attic insulation). Permanently attach rigid foam or batt insulation to the access door using adhesive or mechanical fastener. The bottom of the attic access shall be properly gasketed to prevent air movement.
- R-values of installed insulation shall be determined based on an actual measurement of the insulation depth and the R-value per inch for that product. Refer to *Building Performance Institute Technical Standards for the Building Analyst Professional* for typical insulation R-values and effective R-values for batt insulation.[8] For Advanced Home Upgrade (when modeling in approved Program software), voids in insulation must be accounted for by determining the net square footage of uninsulated area and recording it as a separate component of the building. For Home Upgrade, all accessible areas should be insulated to the claimed R-value.
- All recessed light fixtures that penetrate the ceiling shall be IC (insulation contact) and AT (air tight) rated and shall be sealed with a gasket or caulk between the housing and the finished surface or, if not IC rated, recessed light fixtures must be 'boxed-in' with approved fire-rated materials (i.e., fire-rated drywall 'boxes', "fire-boxes", etc.) and air-sealed with fire-rated caulk. Chimneys and other "hot vents" must be baffled with an effective dam prior to insulating to maintain a safe clearance to the insulation being installed. Consult local code enforcement for clearance distance.
- Single-walled flue pipes require a minimum 6-inch clearance to insulation or other combustible materials. Refer to NFPA 54 for additional requirements for specific chimney materials.

[8] Building Performance Institute (v1/4/12),*Building Performance Institute Technical Standards for the Building Analyst Professional, www.bpi.org/standards_approved.aspx*

- Hard covers or draft stops shall be placed over all drop ceiling areas and interior wall cavities to keep insulation in place and stop air movement. If hard covers or draft stops are missing or incomplete, they shall be completed before insulation is installed.
- Required eave ventilation shall not be obstructed—the 'net-free' ventilation area of the eave vent shall be maintained. Eave vent baffles shall be installed to prevent air movement under or into the insulation.

2.2.3.1 *Standards for Insulating Kneewalls*

- All kneewalls and skylight shafts should be insulated to a minimum of R-19. If loose-fill insulation is used it shall be properly supported with netting or other support material.
- The insulation should be installed without gaps and with minimal compression.
- The house side of the insulation should be in continuous contact with the back of the drywall (air barrier) or other wall finish.
- The insulation shall be supported so that it will not fall down by either fitting to the framing, stapling in place with minimal compression, or using other support such as netting.
- Walls of interior closets for heating ventilation and air conditioning (HVAC) and/or water heating equipment, which require combustion air venting, should be insulated to the same R-value as the exterior walls.
- Insulation installed in kneewalls or other exposed vertical areas within an attic must be covered on the cold side with an air barrier such as ½-inch plywood, 5/8-inch drywall, FSK, or other air-sealing, fire-rated material to protect the insulation from wind-washing and prevent convection within the insulation. This measure is not necessary if rigid foam insulation is used. Local codes might also require fireproofing of those vertical surfaces on the attic side.

2.2.3.2 *Standards for Batt Insulation*

- Batt insulation should be installed at full loft with the insulation in full contact with the warm side of the building surface. Gaps between the insulation and the building elements must be avoided. Insulation batts should not be compressed, folded, tucked, rolled, or otherwise compromised when installed for insulation purposes.
- Batts should be correctly sized to fit snugly at the sides and ends. Batts should be installed so that they will be in contact with the air barrier. Where necessary, batts should be cut to fit properly - there should be no gaps, nor should the insulation be doubled-over or compressed.
- Batts shall be cut to butt-fit around wiring and plumbing, or be split (delaminated) so that one layer can fit behind the wiring or plumbing, and one layer fit in front.
- For batts that are taller than the trusses, full-width batts should be used so that they expand to touch each other over the trusses.

2.2.3.3 *Standards for Loose-Fill Ceiling Insulation*

- Insulation should be blown to a uniform thickness throughout the attic at appropriate air pressure and material quantity (depth and/or weight) to ensure complete coverage and manufacturer's recommended density to achieve the prescribed R-value without voids, gaps, or settling in enclosed cavities. Insulation should be applied all the way to the outer edge of the wall top plate.
- Attic rulers appropriate to the material installed shall be evenly distributed throughout the attic to verify depth: one ruler for every 250 square feet and clearly readable from the attic access in all directions. The rulers shall be scaled to read inches of insulation and the R-value installed.
- Insulation should be applied underneath and on both sides of obstructions such as cross-bracing and wiring.

2.2.3.4 *Standards for Spray Foam Insulation*

Spray foam insulation (SPF) increases thermal performance and reduces air infiltration significantly. When it is used, all work should conform to California regulations as specified in Building Energy Efficiency Standards Joint Appendices JA3.5.6[9]

Ceiling and Roof Insulation:

- SPF insulation should be spray-applied to fully adhere to the substrate (roof deck or ceiling).
- SPF insulation should be spray-applied to fully adhere to the joist and other framing faces to form a complete air seal within the construction cavity.
- SPF insulation should be installed in a continuous and fully adhered manner to form an air barrier.
- SPF insulation should be spray-applied to fully adhere to and seal around wiring and plumbing.
- SPF insulation should not be applied directly to recessed lighting fixtures. Recessed light fixtures must be either insulated by methods other than SPF (such as mineral fiber) or enclosed in a box fabricated from ½-inch plywood, 18 gauge sheet metal, 1/4-inch hard board or 5/8-inch drywall. The exterior of the box may then be insulated with SPF. If the fixtures are not air tight or not rated for insulation contact (IC), the fixtures shall either be replaced or eliminated.

HVAC Platform

[9] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

- A minimum of 3 inches of SPF insulation should be placed below any plywood platform or cat-walks installed in vented attics for HVAC equipment and access to assure that the overall assembly meets the required insulation values listed in the compliance documentation.
- SPF insulation should be installed in a continuous and fully adhered manner to form an air barrier.

Attic Access

- Apply a minimum of 3 inches of SPF insulation to the access door or permanently attach rigid foam with adhesive or mechanical fastener to assure that the overall assembly meets the required values specified in the Compliance Documentation.

Attics and Cathedral Ceilings

- Prior to installation, verify that the building official in your area permits SPF insulation directly applied to the underside of the roof.
- SPF insulation shall be kept away from combustion appliance flues in accordance with flue manufacturers' installation instructions or labels on the flue for clearance.
- In unvented-conditioned attics where entry is made for the service of utilities, SPF applied in direct contact with the underside of the roof deck shall be protected from ignition in accordance Building Energy Efficiency Standards Joint Appendices JA3.5.6[10]
- In cathedral ceilings where restricted spaces do not allow entry, SPF insulation does not require protection from ignition.

2.2.4 Best Practices

- Insulation shall cover all recessed lighting fixtures. If recessed light fixtures are not rated for insulation cover (IC) and air tight (AT), the fixtures should be replaced.
- To prevent deficiencies in the thermal boundary (insulation layer), it is considered best practice to refrain from batt-type insulation products in the attic, above the ceiling plane. It is recommended to use blown-in products such as blown-in fiberglass or cellulose.
- All care should be taken to minimize dust and insulation materials from entering the living space. There are different ways to resolve this; One is to create separate entrances into the attic space outside of the living space such as through a gable-end vent or skylight shaft or, if that is not possible, at least keep a controlled pathway through the home that minimizes dust transfer into living space. Another strategy is to positively pressurize the living space to prevent migration of dust particles into the living space.

[10] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

- Protect the installing crews by providing safety gear (dust masks and protective clothing), ample light, and fresh air to the space they are working in.

2.2.5 Verification

- Field QC verifications will include measuring random points within the attic and comparing installed levels to insulation charts showing R-values for the different types of insulation.
- The location of insulation and how well it serves the occupants will be assessed. Insulation installed in areas with no comfort or energy saving benefit does not qualify.
- Attic access hatches shall also be evaluated for their insulation effectiveness.

2.3 Duct Sealing

2.3.1 Minimum Requirements

- Home Upgrade pathway eligibility: Home has not participated in duct test and seal program or has not done duct sealing (10 percent or less leakage) in past six years.
- Home must be served by an existing central air conditioner, furnace, or heat pump; new systems installed when no prior equipment was present will not qualify since state building code already requires a duct test on these systems.
- Individual cooling systems must be between 1.5 and 7 tons capacity. Air conditioning systems with multiple compressors and economizers are not eligible. Multiple systems at the same address are eligible in Advanced Home Upgrade, but only the primary system is eligible in Home Upgrade.
- Ducts must be sealed, repaired or replaced in accordance with the requirements contained in the 2013 Building Energy Efficiency Standards, Subchapter 9, "Additions and Alterations in Low-Rise residential Buildings" and applicable BPI Standards.[11, 12]
- When duct sealing is recommended in Advanced Home Upgrade, the work scope must include pre- and post-installation duct leakage and system airflow testing (only post-installation 'test-out' is required in Home Upgrade). The results of these tests must be documented and used to verify the effectiveness of the installation. When quantifying duct leakage, an appropriate type of measurement system shall be used that includes a metered and calibrated duct pressurization device. Duct leakage shall be measured and

[11] California Energy Commission (2014), *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf

[12] Building Performance Institute (v1/4/12),*Building Performance Institute Technical Standards for the Building Analyst Professional, www.bpi.org/standards_approved.aspx*

documented any time that duct sealing is part of the work scope to verify the success of the installation.

- For Home Upgrade, duct systems are to be sealed with duct mastic (not tape) down to at least 10 percent of nominal or actual air flow of the heating/cooling system as calculated utilizing cooling capacity first when present or using a correction factor and BTU output of a furnace as defined in Building Energy Efficiency Standards Residential Appendices RA3.1.4.2.2.[13]. For Advanced Home Upgrade, any modeled improvement in duct leakage is acceptable, but duct sealing work should target the same leakage percentage goals for existing systems, follow the same leakage reduction practices (all systems) and must comply with code requirements for replacement systems.
- Sheet metal and flexible ductwork shall be sealed at all duct connections using duct mastic or similar product designed for sealing ducts. 'Duct tape' is not an allowable duct sealing material. Aluminum FSK tape may be used on duct board systems and at the connections to the air handler cabinet.
- CAS testing (and Blower door for Advanced Home Upgrade) shall be performed whenever insulation, air sealing of shell or the ducts, or ventilation is installed to confirm safe conditions for the occupants.
- When heating ducts are located outside the building envelope or cooling ducts are located in attic spaces, they should be sealed underneath the duct wrap, at all accessible connections with duct mastic and insulated to a minimum R-8 as part of the work scope.

2.3.2 Best Practices

Use the following checklist from BPI's Shell Standards as a guide for prioritizing duct sealing installations:

- Seal the largest leaks first. These include: disconnected ducts, missing end-caps, and other catastrophic holes
- Seal the areas of highest pressure. These include all the connections near the air-handler cabinet and supply and return plenums, flexible canvas plenum connectors, and filter slot covers.
- Seal return leaks that may contribute to negative pressures in the combustion appliance zone.
- Seal all accessible connections between duct sections, at branches, and where take-offs connect to main trunk lines.
- Seal take-off connections to register boots and boot connections to floors, walls, and ceilings.

[13] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

2.3.3 Verification

- FQC verifications will include measuring duct leakage as a percentage of nominal or actual (sum of returns) airflow depending on the method used by the contractor. FQC verifiers results should be within 0.5 percent of contractor's test-out test results.
- The following procedures for testing total duct leakage (TDL) will be utilized:
    - The duct zone should be relieved of any potential pressures by opening it up to the outdoors. This can be done by opening a window or door. The point is to create as close to zero pressure around the duct, so that leaks can be measured at a specific pressure of 25 Pascals.
    - All ducts are to be closed and sealed at the register with duct mask, tape or plastic wrap. It is important to make sure that ALL supply and return registers are sealed. Otherwise there is no accuracy to the test. Seal any register grills that may be in the plenums of the appliance. Make a final pass around the building prior to conducting the test, and look for any registers that may have been missed.
    - Configure the building and install diagnostic equipment for duct leakage testing.
    - For testing to be valid, you must set up a repeatable testing scenario.
    - Disable all vented combustion appliances and air conditioners.
    - Establish a manometer to measure the fan pressure of the duct blaster with respect to duct zone.
- For testing duct leakage to outside (DLTO), procedures will follow CEC protocols in Building Energy Efficiency Standards Residential Appendices RA3.1.4.3.4. [14]
- The location of duct sealing efforts will be evaluated to determine effectiveness and ensure that all efforts had been made to eliminate air leakage out of the distribution system.
- FQC verifiers will also be checking specifically for zero percent leakage on the return-side of the system if it is sharing space with other combustion appliances.

2.4 Hot Water Pipe Insulation Wrap (Optional Measure)

2.4.1 Minimum Requirements

- Home Upgrade Pathway Eligibility: Recommended, not required. If performed, pipe insulation must be installed on the first 5 feet of accessible pipe coming from the water heater. This measure is not available if the first 5 feet of piping itself is inaccessible.
- Install new foam-type insulation on first 5 feet of accessible hot and cold pipe extending from hot water heater.

[14] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

- All pipe insulating shall meet 2013 Title 24 requirements at a minimum as described in RA4.4.1.[15]
- Install all insulation materials in accordance with manufacturer's recommendations and recognized industry practices.
- Insulation materials furnished and installed shall meet the fire hazard requirements of applicable building codes when tested in composite form per UL 723 / ASTM E 84.[16]
- Insulation materials furnished should meet the minimum thickness requirements of ASHRAE Standard 90.1.[17] Pipe insulation wall thickness should be no less than interior pipe dimension (e.g., ½-inch nominal pipe should get ½-inch wall thickness insulation).
- Pipe insulation should be installed so as not become a fire hazard. Proper clearances should be maintained from the flue opening of any naturally-vented water heaters.
- Pipe insulation should be installed in a manner to avoid future material shrinkage. During insulation, pipe insulation should be compressed along its length and sealed from one length to the next. All turns and corners should be carefully mitered to insure full enclosure of the insulating product and sealed with adhesives and mechanical fasteners if necessary to prohibit delamination.
- Pipe insulation may be omitted where hot water distribution piping is buried within attic, crawlspace or wall insulation. In attics and crawlspaces, the insulation should completely surround the pipe with at least 1 inch of insulation and the pipe should be completely covered with at least 4 inches of insulation further away from the conditioned space. In walls, the insulation should completely surround the pipe with at least 1 inch of insulation. If burial within the insulation will not completely or continuously surround the pipe to these specifications, then this exception does not apply, and the pipe must be insulated as specified above.

2.4.2 Best Practices

- Increase wall thickness to 1-inch when hot water distribution piping resides in unconditioned areas.
- Insulate all accessible piping.
- Install insulation materials with continuous, full-length pieces if possible. Avoid butting together smaller pieces. Install transition pieces firmly to ensure complete, tight fit over all piping surfaces.

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[15] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

[16] American Society for Testing of Materials International (2011), *ASTM E84 - 11a Standard Test Method for Surface Burning Characteristics of Building Materials*, www.astm.org/Standards/E84.htm

[17] American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. (2010), *Energy Standard for Buildings Except Low-Rise Residential Buildings*, ANSI/ASHRAE Standard 90.1-2010, www.ashrae.org.

- All mitered sections of insulation should be equivalent in thickness and composition to that installed on straight pipe runs and sealed at seams.

2.4.3 Verification

- If installed, FQC verifiers will be assessing the effectiveness of the work performed and determine if all efforts had been made to mitigate unwanted heat loss.
- Pipe insulation will be assessed on quality of installation; no visible piping where insulation installed, sound connections and support, and continuous coverage as accessible within the first 5 feet of the water heater.

2.5 Combustion Appliance Safety Testing

Minimum Requirements

- Combustion appliance safety testing must be conducted or supervised by a BPI-certified professional with PG&E Advanced Technical Training anytime work is done that impacts the pressurization of the home (including infiltration measures). In particular, this procedure is to be performed both before and after the installation of any air sealing measures.
- All CAS (combustion appliance safety) and CAZ (combustion appliance zone) testing must be done in accordance with the testing protocols in the *Whole House Combustion Appliance Safety Test Procedure for Pacific Gas and Electric Company (PG&E) Home Upgrade Program*. Contractors must make repairs or take other corrective actions as specified in the *Whole House (CAS) Action Guidelines*.[18]
- For buildings with 2-4 units, each unit and each CAZ must be tested, with particular attention paid to the possibility of pressure 'communication' between units.

2.5.1 Best Practices

- There is no need to test direct-vent combustion appliances if they are properly installed (except for ambient CO in the vicinity of the appliance). Focus on older appliances that need to pull air out of the house to operate safely (natural draft combustion appliances).
- Each zone is a separate set of circumstances, and must be brought to its worst-case depressurization separately from the other zones.
- If the CAZ testing reveals that the difference between baseline pressure and worst-case exceeds recommended depressurization limits, there are five choices to help remedy the issue:
    1. Replace the natural draft combustion appliances with modern direct-vent units.
    2. Remove and reinstall the combustion appliance to outside of the home's pressure boundary (usually to the garage or attic) or entirely 'outdoors'.

[18] Available at www.builditgreenutility.org/document-library

3. Install "jump ducts" or transfer grills which allow air to flow more freely into and out of rooms when the HVAC system is operating. If opening the door to any given room reduces the depressurization of the CAZ, this strategy can be effective. With jump ducts or transfer grills, the same improvement can be achieved without the need to leave that room's door open.
4. Design and install two independent paths for combustion ventilation air (CVA) to reach the appliance zone directly from outdoors. Then air-seal and insulate these paths, and also insulate and air seal the appliance zone itself.
5. Enlarge the combustion appliance zone by removing obstructions like interior partitions and doors, so that air can flow freely into the zone from other parts of the house.

- Appliance replacement is usually the most practical and least expensive. It provides energy savings plus safe operation.
- If combustion appliance testing reveals that there is not enough negative draft pressure in the vent of the appliance, there are a few potential choices to help remedy the issue:
    1. Replace the appliance with a modern sealed-combustion unit.
    2. Remove and reinstall the combustion appliance outside of the home's pressure boundary (usually to the garage or attic) or entirely 'outdoors'.
    3. Add jump-ducts or transfer grills between "compartmented spaces" to reduce the pressure differences created when the HVAC system's blower is operating. (Compartmented spaces are rooms with doors, but without an air outlet to relieve pressures created by the HVAC system.)
    4. Add more CVA to the area where the appliance is located (the combustion appliance zone).
- Of these alternatives, appliance replacement with direct-vent units is by far the preferred alternative. It saves energy through much-increased heating efficiency and provides an opportunity for further energy-saving synergies with other heating and cooling components.

2.5.2 Verification

- FQC verifiers will be assessing the effectiveness of the work performed and determine if all efforts had been made to mitigate health and safety hazards.
- Combustion safety is of utmost concern. FQC verifiers will be testing all CAZ areas as well as the appliances for combustion safety per BPI and PG&E's *Whole House (CAS) Action Guidelines*.

2.6 Carbon Monoxide Monitors

2.6.1 Minimum Requirements

- Carbon monoxide (CO) alarms are appropriate wherever there is a CO hazard

- As required for compliance with CA SB-183 (also known as the "Carbon Monoxide Poisoning Prevention Act"), as of July 1, 2011, all Program Single-Family Dwelling projects, regardless of necessity for building permit, must include permanent installation of at least one CO alarm/detector meeting UL-2034 (for alarms) or UL-2075 (for detectors), installed according to manufacturer's instructions in all dwelling units intended for human occupancy. Existing alarms/detectors less than five years old and meeting Program requirements are allowed. 2-4 Unit Dwelling projects are also required to comply (as of January 1, 2013). CO Monitors must be installed in areas with atmospherically vented appliances, in kitchens, in hallways near bedrooms, and near doors to attached garage.
- Instructions and paperwork including service and maintenance of the unit shall be provided to customer.
- CO monitors should be replaced every five years; existing monitors less than five years and meeting Program requirements are allowed.

2.6.2 Best Practices

- It is recommended that additional CO detectors are installed, as needed, to provide a separate detector for each floor of the building. (see *Participant Handbook*, Section 6.1 for additional details and resources)

2.6.3 Verification

- FQC verifiers will conduct field compliance verification for installation of carbon monoxide alarms.

2.7 Thermostatic Control Shower Valves (Recommended, Not Required)

2.7.1 Minimum Requirements

- If a thermostatically controlled shower valve (TCSV) is installed, it shall be installed on the primary shower if not already so equipped. Thermostatic control can be achieved by installing a retrofit device or through installing a new shower head with an integral device. Both integral and retrofit devices are referred to here as TCSV.
- Qualifying hardware shall feature a stop mode that is triggered when water reaches 95 degrees F.
- The device shall have a self reset feature after a period of inactivity.
- Installations shall be leak-free and per manufacturer's instructions.
- Stub-out threads and the TCSV threads shall be cleaned and prepared for a good seal with Teflon plumbers tape or equivalent. Pipe dope or any other liquid/paste sealing compounds are prohibited.
- Device shall be made primarily from durable materials and shall carry a manufacturer's warranty of three or more years.

- Contractor shall instruct customer on how the device works and furnish a copy of the TCSV instructions and owner's manual. Contractor shall warn customer that the device provides no safety upgrade or scald protection.

2.7.2 Best Practices

- Caution: thermostatic mixing valves (TMVs) are often marketed as thermostatic control valves. TMVs blend hot water with cold water to ensure constant, safe outlet temperature and preventing scalding. However, they provide no energy efficiency benefit and do not satisfy the requirements of this measure.
- Install shower heads that are both low-flow and thermostatically controlled for maximum benefit. Whenever possible, install devices that bear the WaterSense® label, a water performance and economy standard written by the EPA and Department of Energy.[19]

2.7.3 Verification

- If installed, FQC verifiers shall confirm that an operational thermostatic control shower valve is in place on the primary shower and that the installation is leak-free.

2.8 Low Flow Showerheads (Recommended, Not Required)

2.8.1 Minimum Requirements

Contractor should recommend the installation of a low-flow showerhead with thermostatic shut-off valve in the most-used shower.

2.8.2 Best Practices

- Install showerheads at or below 1.6 gallons/minute (gpm). Install devices that bear the WaterSense® label, a water performance and economy standard written by the EPA and Department of Energy.
- Install low-flow showerheads on all showers.
- No fixture or accessory shall have the capabilities, including instructions to the user, to override the appropriate flow rates at the appropriate psi or gpm, as established by WaterSense® specifications or state and/or local code requirements. This includes any instructions or indications on packaging directing the user to an alternative water-use setting that would override the appropriate flow rate.
- Install shower heads that are both low-flow and thermostatically controlled for the most benefit.

[19] For more information visit www.epa.gov/watersense

2.8.3 Verification

- If installed, FQC verifiers shall confirm flow rate by documentation or visual inspection of the shower head.

2.9 Health & Safety

- All Participating Contractors must abide by BPI Health and Safety standards and have all the necessary personal safety equipment required by all applicable federal, state and local laws, including, but not limited to, the "Occupational Safety and Health Standards" promulgated by the U.S. Secretary of Labor and the California Division of Occupational Safety and Health (OSHA and CalOSHA, respectively).[20] Required safety equipment includes, but is not limited to:
    - Canister-type respirators
    - Gloves
    - Protective clothing or overalls
    - Elbow and knee pads
    - Safety glasses
    - Hard hats
    - First aid kit
    - Fall arrestors
- Technicians and installers must be trained on the proper use and applicability of these safety devices and adhere to all OSHA regulations when performing diagnostics or work at the site.
- All tools and machinery must be used in a safe manner and be properly maintained and or calibrated per manufacturer's recommendations.
- Diagnosticians and installers must have in their possession all applicable MSDS Sheets for all materials brought on site. This includes but is not limited to:
    - Diagnostic smoke
    - Caulking and adhesives
    - Insulation and air-sealing materials
- If there is known or suspected presence of lead, mold, asbestos, or any other perceived or potentially hazardous materials found at test-in or the initial assessment, all care must be taken to ensure occupant and worker safety. All applicable codes, ordinances, and guidelines must be followed.
- Training and certification in the identification, removal, disposal, abatement and remediation of hazardous materials is outside of the scope of the Program. If any

[20] Code of Federal Regulations, 29 CFR, Part 1910, *Occupational Safety and Health Standards*, and Part 1926, *Safety and Health Regulations for Construction*, U. S. Department of Labor, Occupational Safety and Health Administration, www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0

hazardous materials are encountered during the course of a project, only those Participating Contractors that have the necessary training and required certification(s) and/or license(s) may remove, dispose, abate and/or remediate hazardous materials discovered on a job site. Participating Contractors shall be solely responsible for their identification, removal, disposal, abatement and/or remediation of hazardous materials encountered on a job site. Neither Build It Green nor PG&E shall have any liability arising out of, resulting from or regarding a Participating Contractor's detection, identification, inspection, removal, disposal, abatement, and/or remediation of hazardous materials.

2.10 Wall Insulation

2.10.1 Minimum Requirements

- Installation shall conform to the General Requirements for Insulation specified in Section 2.2.1.
- Wall insulation should achieve R-13 or greater.
- Insulation is installed full-stud thickness regardless of material used.
- Insulation should cover all-accessible (at least 50 percent of total) wall area.
- Where accessible, wall stud cavities should be caulked or foamed to provide a substantially air-tight envelope to the outdoors, attic, garage and crawl space. Special attention should be paid to plumbing and wiring penetrations through the top plates, electrical boxes that penetrate the sheathing, and the sheathing seal to the bottom plate. All gaps in the air barrier greater than 1/8 inch should be caulked, or sealed with expansive or minimally expansive foam.
- Installation should uniformly fill the cavity side-to-side, top-to-bottom, and front-to-back.

2.10.1.1 *Standards for Batt Insulation*

- Insulation should be fitted and cut around pipes, wires, etc. that may be traversing the bay. The batt should be split so that equal amounts of insulation are in back of and in front of those items. Ideally, nothing is viewable after insulation is installed except for the insulation product itself.
- The batt should be friction fitted into the cavity unless another support method is used.
- Batt insulation should be installed to fill the cavity and be in contact with the sheathing on the back and the wallboard on the front - no gaps or voids.

- Non-standard-width cavities should be filled with insulation fitted into the space without excessive compression.
- Batt insulation shall be cut to butt-fit around wiring and plumbing, or be split (delaminated) so that one layer can fit behind the wiring or plumbing, and one layer fit in front.

2.10.1.2 *Standards for Loose-Fill Insulation*

- Loose-fill insulation, whether it is fiberglass or cellulose, can be installed behind netting, which is stapled to the fronts of studs. If moisture is added to cellulose or adhesives added to fiberglass, the product could be installed without netting.
- CAUTION: Moisture levels in insulation must be carefully monitored before installing sheet goods. If the walls are closed up too soon, moisture could affect interior of walls and cause durability issues.
- Loose-fill insulation should be installed to fill the cavity and be in contact with the sheathing on the back and the wallboard on the front - no gaps or voids.
- Loose-fill wall insulation shall be installed to fit around wiring, plumbing, and other obstructions.
- The installer shall certify on the Installation Certificate forms that the manufacturer's minimum weight per-square-foot requirement has been met.

2.10.1.3 *Standards for Spray Foam Insulation*

- Spray foam insulation may be used in walls to decrease air infiltration and add thermal performance to the wall assembly.
- Installation should be according to Building Energy Efficiency Standards Joint Appendices JA3.5.6[21]
- In wall cavities, SPF insulation should be applied to provide an air-tight envelope to the outdoors, attic, garage and crawl space. Special attention shall be paid to plumbing and wiring penetrations through the top plates, electrical boxes that penetrate the sheathing, and the sheathing seal to the bottom plate.
- SPF insulation installation should uniformly cover the cavity side-to-side and top-to-bottom. An air space may be left between the surface of the Medium-Density SPF insulation and the interior sheathing/drywall provided the appropriate thickness of SPF insulation has been applied to achieve the specified R-value and the SPF insulation is

[21] California Energy Commission (2014) *Reference Appendices for the 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-005/CEC-400-2012-005-CMF-REV3.pdf

installed to cover and form an air barrier on the framing at the top, bottom and sides of each cavity.

- Narrow spaces (2 inches or less) at windows and door jambs should be filled with minimally expansive foam.
- Narrow spaces (2 inches or less) between studs at the building corners and at the intersections of partition walls should be filled with batt insulation snuggly fitted into the space (without excessive compression), loose-fill insulation, or expansive or minimally expansive foam.
- SPF insulation should be spray-applied to fully adhere and seal around wiring and plumbing.
- SPF insulation should be spray-applied to fully seal between the sheathing and the rear of electrical boxes and phone boxes.
- In cold climates, where water pipes may freeze (including Climate Zones 14 and 16) pipes should have at least two thirds of the insulation between the water pipe and the outside. If the pipe is near the outside, as much insulation as possible shall be placed between the pipe and the outside and no insulation (minimal amounts of SPF overspray are acceptable) shall be allowed between the pipe and the interior wall.

2.10.2 Best Practices

- Batt insulation products should be installed with care. This type of insulation product is the most susceptible to 'human error' and may not perform well if not installed properly. Loose-fill insulation products are better at avoiding deficiencies in quality while installing the product.
- Have all insulation installation work third-party verified for quality and level (QII).
- Thermal imaging cameras can be utilized to provide insight into the quality and thoroughness of the installed wall insulation.

2.10.3 Verification

- FQC verification will include visual inspection and comparing installed levels to insulation charts showing R-values for the different types of insulation.
- The location of insulation and how well it serves the occupants will be assessed. Insulation installed in areas with no comfort or energy saving benefit does not qualify.

2.11 Floor Insulation

2.11.1 Minimum Requirements

- Installation shall conform to the General Requirements for Insulation specified in Section 2.2.1.

- Insulation should not be installed in floors separating unconditioned areas from unconditioned areas.
- Insulation should be installed full-joist thickness regardless of material used.
- Floor insulation should be brought up to R-19 at a minimum.
- Floor insulation should cover all-accessible (at least 50 percent of total) floor area.
- All floor insulation work must follow local, state, and federal guidelines specifically around ventilation and vapor barriers.

2.11.1.1 *Standards for Batt Insulation*

- Insulation should be fitted and cut around pipes, wires, etc. that may be traversing the bay. The batt should be split so that equal amounts of insulation are in back of and in front of those items. Ideally, nothing is viewable after insulation is installed except for the insulation product itself.
- If the batts have a vapor barrier attached to them then this facing should make contact with the sub-floor above it, touching the warm side of the assembly for best performance and to prevent moisture issues.
- Raised-floor insulation shall be installed between floor joists with a means of support that prevents the insulation from falling, sagging or deteriorating. Two approaches that accomplish this are:
    1. Nailing insulation hangers 18 inches apart prior to rolling out the insulation. Hangers are heavy wires up to 48 inches long with pointed ends, which provide positive wood penetration.
    2. Attaching wire or plastic mesh to form a basket between joists to support the insulation. Mesh is nailed or stapled to the underside of the joists.

2.11.1.2 *Standards for Loose-Fill Insulation*

When choosing to use loose-fill insulation under floors it is mandatory that approved netting be used to hold the product securely in place.

2.11.1.3 *Standards for Spray Foam Insulation*

All efforts must be made to adhere to local, state, and federal standards and codes as it relates to coverage and flame protection.

2.11.2 Best Practices

- Consider locating under-floor insulation to perimeter of crawl space walls in lieu of under floor in areas where HVAC distribution systems are located under the home. This is considered a “sealed crawl space” and many rules are triggered by this method that must be followed (for more information contact Build It Green at 510-590-3360).

- Loose-fill insulation can be installed in floors cautiously. Cellulose insulation may not be the best choice because of its absorptive properties. It may be best to use fiberglass products when insulating floors over a crawl space. Spray Foam insulation used under floors is a great way to accomplish air-sealing and thermal enhancement to an underperforming floor assembly. Consult with reputable spray foam insulation installers when selecting high or medium density foam products and where they will be used.
- Ensure that worker safety is top priority when applying any insulation products.

2.11.3 Verification

- FQC verification will include visual inspection and comparing installed levels to insulation charts showing R-values for the different types of insulation.
- The location of insulation and how well it serves the occupants will be assessed. Insulation installed in areas with no comfort or energy saving benefit does not qualify.
- Floor access hatches shall also be evaluated for their insulation effectiveness.

2.12 Windows

2.12.1 Minimum Requirements

- For the Home Upgrade pathway (only), installed windows must be 0.32 U-Factor (or less),0.25 SHGC (or less). All of the homes' windows should meet these minimum window technical specifications when the job is done, but at a minimum, the square footage of new windows must comprise 14% of conditioned floor area or 17% of conditioned wall area.
- All windows should be evaluated and inspected for signs of moisture either on the surface, on the frame, or in-between the panes. Because windows have a lower R-Value compared to surrounding materials, they often reveal moisture issues that can be mitigated using the proper remedies such as improving ventilation within the home; increasing insulation levels in attic, walls, and floors; and correcting poor air flow from forced-air conditioning systems.
- Specify windows that meet or exceed ENERGY STAR standards and offer air leakage less than 0.3 CFM/ft².
- Preferred frame materials include wood, composite materials, aluminum-clad wood, and fiberglass. If aluminum frame windows are specified, then frames must incorporate a thermal break.
- Window installations should be installed according to the manufacturer's instructions. Install the new window unit so it is plumb and level and all operations are in good working order. Special care should be exercised to ensure that flashing provides a water-tight fit around the perimeter.

- Repair or replace any damaged wood surrounding the window opening. Prime and paint all surfaces of wood that will be exposed to the weather. Care should be taken to ensure worker and customer safety as it relates to Lead Paint Safety. Consult EPA's guidelines on safe lead paint remediation practices.
- To determine if the window is air-tight, run a Blower door and pressurize the home. With the home slightly pressurized go around the interior frame of the window with a smoke stick and see if any tries to escape. If smoke is pulled outward locate gaps and seal with caulk and/or foam. Use low-emitting caulks and adhesives when air-sealing the window into place.
- If weather-stripping is needed, be sure to prime and paint those surfaces first. When selecting weather-stripping materials be sure to pick the appropriate type for the use. Mechanically fastened weather-stripping holds up better than just adhesive.

2.12.2 Best Practices

- Protect the area immediately around the window both inside and out. If possible, isolate the construction area from the rest of the house with plastic drapes and weather-stripping to prevent unwanted dust and debris from entering living space.
- Windows, like renewables, should be farther down on the priority list because often, in California, they are not cost-effective solutions for reducing energy usage.
- Never assume a dual-pane window has low emissivity coatings. To make sure, always verify with a coating detector.
- As an alternative to replacing windows, summer shading of the south side of the home could help control solar gains. Exterior landscape such as deciduous trees could help shade the southern facade and prevent unwanted heat gain during the summer. Physical shading devices such as awnings and overhangs might also help control solar gains through windows.
- In predominately cooling climates windows in the southern and western facing orientations should be replaced with low SHGC (Solar Heat Gain Coefficient) and Low-Emissivity (Low-E) coatings for best results.
- Solar gain and loss through windows could also be controlled with window coverings internally although exterior "heat barriers" are preferred.

2.12.3 Verification

- FQC verifiers will visually inspect and/or review of window schedule or invoice.
- For Home Upgrade, calculation of percentage installed windows as a proportion of conditioned floor area and/or wall area (if necessary).

2.13 Heating & Cooling (HVAC) Equipment Replacement

2.13.1 Minimum Requirements

- All heating and cooling equipment replacement must meet Title 24, Chapter 6, Building Energy Efficiency Standards, including requirements for ducts sealing, setback thermostat, refrigerant charge verification, minimum cooling coil airflow, and requirements to conduct a complete system third-party inspection by a certified HERS Rater.[22]
- All replacement equipment and ducts should be properly sized according to ACCA Manuals J, D, and S at a minimum, with specific room-by-room load calculations, no "rule-of-thumb" sizing. Air conditioning evaporator coils and condensing units must be properly matched according to ACCA Manual S so that they can deliver the rated efficiency.[23]
- Ideally, central natural gas furnaces should have an Annual Fuel Utilization Efficiency (AFUE) rating of 94 percent or greater. For Advanced Home Upgrade, furnace AFUE must at least be an improvement over existing and meet code requirements. For Home Upgrade, any claimed measure must have an AFUE rating of 92 percent or greater.
- At the conclusion of projects for buildings with 2-4 units (Advanced Home Upgrade only), all heating and domestic hot water appliances for all units must be either (1) power vented or closed combustion, (2) moved outside the building shell (including garages and attics), or (3) sealed off from the living space such that there is adequate combustion air and combustion gases are appropriately exhausted. This is true whether or not each unit participates in the EUC program.
- Ideally, Air Conditioning systems should have equipment efficiency ratings of 15 SEER and 12.5 EER or better. For Home Upgrade, Air conditioning systems must have equipment efficiency ratings of 15 SEER and 12.7 EER or better to qualify for the Central Air Conditioning measure. For Advanced Home Upgrade, Air Conditioning systems must meet or exceed the following minimum performance standards in Table 2 (below):

[22] California Energy Commission (2014), *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf

[23] Air Conditioning Contractors of America, *Manual J Residential Load Calculation*, *Manual D Residential Duct Systems,* and *Manual S Residential Equipment Selection,* www.acca.org/industry/ansi-standards

Table 2. Advanced Home Upgrade AC (minimum) Performance Standards

	SEER	EER	HSPF
Split central AC	14	12.2 [24]	
Packaged central AC	14	11	
Split Heat-Pump/AC	14	12.2 [24]	8.2

2.13.2 Best Practices

- When installing a new HVAC system, always try to locate it in an area not subject to extreme temperatures (attics) and look for locations that are central that will require shorter, straighter duct runs.
- If the home is too small for conventional gas-fired furnace output, consider a combined-hydronic heating systems which utilizes a hot-water heat exchange with the water heater.
- Air-Source Heat Pumps might be a wise choice when replacing electric systems and/or the home is adding PV.
- Insertion of high resistance filters could add extraneous static pressure to the system unless it has been designed to accommodate such filters. For best performance, filter pressure drop should not exceed 0.10 inches of water column. Systems designed to utilize filters rated MERV 6 or more should be designed to accommodate the additional static pressure these more restrictive filters present. It is also good practice to create filter slots near the air handler that will accommodate the increased filter thickness.

2.13.3 Verification

- FQC verification will include visual inspection of equipment and/or review of invoice.
- System airflow measurement will be performed if used for duct leakage calculation.
- CAS testing will be performed on gas appliances.

[24] EER 11.7 for rated cooling capacity ≥ 45,000 Btu/hour, Table C-2 (Page 108), California Energy Commission (2014), *2014 Appliance Efficiency Regulations*, www.energy.ca.gov/2014publications/CEC-400-2014-009/CEC-400-2014-009-CMF.pdf

2.14 Duct Insulation

2.14.1 Minimum Requirements

Duct insulation should be R-8 or greater.

2.14.2 Verification

- FQC verification will include visual inspection.

2.15 Duct Sealing

2.15.1 Minimum Requirements

Reduce duct leakage to 10% of nominal or actual system air flow. Verification must be done using procedures defined in Appendix RA3 of California Energy Commission publication CEC-400-2008-004-CMF, the Reference Appendices for the 2008 California Building Energy Efficiency Standards.

2.15.2 Best Practices

Strive for duct leakage near zero. The target is to make all duct systems as tight as possible to both save energy and maintain performance.

2.15.3 Verification

- FQC verification will include visual inspection and duct leakage testing at 25 Pascals (via the testing method contractor used for reporting – TDL or DLTO).

2.16 HVAC Distribution Systems (Duct Replacement)

2.16.1 Minimum Requirements

- Installation of new ducts shall comply with Title 24, Chapter 6, Building Energy Efficiency Standards, including requirements for duct insulation, and ducts sealing, and third-party inspection by a certified HERS Rater. Duct leakage shall not exceed six percent of nominal or actual air flow.[25]

[25] California Energy Commission (2014), *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf

- Ducts should be designed in conformance with ACCA Manual D.[26] Distribution systems should be sized according to the amount of air delivery required to each location and duct runs should be as short as possible. Main supply trunk velocities should be designed to deliver 700–900 feet per minute. Branch supply ducts should be designed for 500–700 FPM. Minimize friction by designing systems with round duct systems and transfer to rectangular ducts minimally and with a transition piece in-between square to round.
- To avoid polluted air migration through the distribution system, avoid installing return grills in bathrooms and kitchens. Make sure combustion zones are not affected by equipment operation.
- Avoid delivering conditioned air to very small rooms such as hall bathrooms or pantry. The room would most likely overheat/cool when the system is operating.
- Measure the temperature rise/drop of air moving across the HVAC system to ensure that it falls within manufacturer specifications.
- Pressure balance of the duct system. Any pressures created within any part of the building should not to exceed 3 Pascals of pressure (positive or negative) with reference to the outdoors when the HVAC system is running. Correct any zonal pressure differentials that create air leakage from the garage or other potentially contaminated zones into the house.
- Minimize conductive losses/gains through the distribution system:
    - Bury the ducts under the insulation layer.
    - Duct insulation should be R-8 or greater.
    - Duct surface area should be minimized by shortening ducts whenever possible.
    - Run supply ducts to the closest corner of each room and minimizing the number of supply registers.
    - Plenums should be wrapped with fiberglass duct insulation or rigid insulation board.

2.16.2 Best Practices

- Strive for duct leakage near zero. The target for all new duct systems is to make them as tight as possible to both save energy and maintain performance. Brand new systems should be able to keep leakage below 50 cfm in the complete system with careful quality and craftsmanship.

[26] Air Conditioning Contractors of America (2009), *Manual D Residential Duct Systems,* www.acca.org/industry/ansi-standards

- Pressure imbalances may be corrected by:
    - Adding/enlarging a return air duct. Consider adding a return air duct to areas where occupants complain of discomfort, or erratic temperatures, or enlarging an existing return.
    - Undercutting doors to relieve pressures. A one-inch undercut of a door is often the easiest and most cost-effective solution.
    - Installing balancing grills through the wall.
    - Installing a jumper duct from the room to the main living area.
- The new duct system should be placed strategically to avoid over-heating or cooling. This might require moving a system from an attic to a crawl space area if it makes sense to do so, based on budget, performance enhancement, and delivery potential.
- Consider installing high-performing commercial diffusers and grills for better delivery and performance. These grills must be carefully selected. They should have minimal interference within them (no dampers) and deliver air across the room to induce convective currents. Never blow delivered air on the occupants, above a headboard of the master bed for example.

Bigger area at the return grill is a benefit to the system but avoid increasing return air duct sizes too much due to more duct surface area being exposed to unconditioned air temperatures which increase cooling loads.

2.16.3 Verification

- FQC verification will include visual inspection and duct leakage testing at 25 Pascals (via the testing method contractor used for reporting – TDL or DLTO).

2.17 Storage Hot Water

2.17.1 Minimum Requirements

- Replacement domestic hot water systems shall comply with Title 24, Chapter 6, Building Energy Efficiency Standards and shall meet or exceed ENERGY STAR standards when applicable.[27]
- When specifying a combination water and space heating system, specify a combined appliance efficiency rating (CAE) of 0.85 or higher.

[27] California Energy Commission (2014), *2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings*, www.energy.ca.gov/2012publications/CEC-400-2012-004/CEC-400-2012-004-CMF-REV2.pdf

- Insulate all accessible pipes per standards specified in Section 2.4.
- At the conclusion of projects for buildings with 2-4 units, all heating and domestic hot water appliances for all units must be either (1) power vented or closed combustion, (2) moved outside the building shell (including garages and attics), or (3) sealed off from the living space such that there is adequate combustion air and combustion gases are appropriately exhausted. This is true whether or not each unit participates in the EUC program.

2.17.2 Best Practices

- When replacing the water heater, replace with maximum efficiency unit with sealed-combustion, direct vent design in order to eliminate the threat of flue gas spillage or flue backdrafting.
- Select units in anticipation of future solar pre-heat if climate and location allow. Prep for solar water pre-heating.
- Select units that take advantage of lowest fuel costs and the wishes of client. As an example, if there is both electricity and natural gas available at the site, and the customer has a wish to be carbon neutral, they may prefer to have an all-electric home that produces zero harmful carbon emissions. In this case, an electric water heater could be used. It could be augmented by adding solar pre-heat and only heating with electricity at night to take advantage of lower rates.
- Seek the highest feasible Energy Factor within budget.
- Install on-demand re-circulation pumps.
- Install structured plumbing systems to minimize pipe length and increase delivery performance.

2.17.3 Verification

- FQC verification will include visual inspection of equipment and/or review of invoice.
- CAS testing will be performed on gas appliances.

2.18 On-Demand (Tankless) Water Heater

2.18.1 Minimum Requirements

- Install per manufacturer's specifications.
- At the conclusion of projects for buildings with 2-4 units, all heating and domestic hot water appliances for all units must be either (1) power vented or closed combustion, (2) moved outside the building shell (including garages and attics), or (3) sealed off from the living space such that there is adequate combustion air and combustion gases are

appropriately exhausted. This is true whether or not each unit participates in the EUC program.

2.18.2 Verification

- FQC verification will include visual inspection of equipment and/or review of invoice.
- CAS testing will be performed on gas appliances.

3 Advanced Home Upgrade Pathway

In order for customers to take advantage of Advanced Home Upgrade pathway rebates, it is strongly recommended that all Home Upgrade pathway Base Measures (i.e., Whole Building Air Sealing, Duct Sealing and Attic Insulation) be previously completed or incorporated within the scope of work proposed for the Advanced Home Upgrade pathway. All Advanced Home Upgrade pathway projects, regardless of work scope, shall comply with standards specified in 2.5, Combustion Appliance Safety Testing, and 2.6, Carbon Monoxide Monitors.

The following list represents the primary measures available to increase a home's efficiency as modeled in Program-approved energy modeling software. This list is not necessarily exhaustive. All permanent improvements that can be modeled using Program-approved software, with the exception of solar thermal and solar PV systems, and secondary refrigerator and dishwasher replacement, are eligible for inclusion in an Advanced Home Upgrade pathway scope of work (as long as the upgraded equipment doesn't switch 'fuels' [gas to electric or electric to gas]).

Program standards represent the target value to achieve through the improvements. These standards are strong recommendations through December 31, 2014. In the future, they may become mandatory requirements for the measures to be included in an Advanced Home Upgrade pathway scope of work.

The following energy efficiency measures may be selected for modeling in approved Program software:

Table 3. Advanced Home Upgrade Measures

Measure Description	Program Standard
1. Wall insulation	R value ≥ 13, installed per CEC QII standards.
2. Floor insulation	R value ≥ 19, installed to full-joist thickness, per CEC QII standards.
3. Attic Insulation	R value ≥ 38, installed per CEC QII standards.
4. Infiltration reduction measures (air barriers)	Install per manufacturer's specifications. Must result in measurable air infiltration reduction.

5. Windows	ENERGY STAR® compliant, air leakage less than 0.3 CFM/ft, installed per manufacturer's instructions.
6. Window film	Install per manufacturer's specifications.
7. Heating and cooling equipment replacement	Central natural gas furnace: AFUE ≥ 94% Split central AC SEER: ≥ 15, EER ≥ 12.5 Packaged central AC: SEER ≥ 15, EER ≥ 12 Split heat pump: ≥ 15, EER ≥ 12.5, HSPF ≥ 8.2 All systems properly sized according to ACCA Manuals J, D, and S with room-by-room air flows and register types identified.
8. Radiant heating system	Install per manufacturer's specifications.
9. Hydronic heating system	Install per manufacturer's specifications.
10. Refrigerant charge verification	Restore to stamped charge. Requires HVAC change out and CF-3R submittal by certified HERS rater.
11. System air flow verification	Minimum 350 CFM per ton. Requires HVAC change out and CF-3R submittal by certified HERS rater.
12. System fan wattage verification	Maximum .58 watts/CFM. Requires HVAC change out and CF-3R submittal by certified HERS rater.
13. Duct insulation	R-8 or greater.
14. Duct Sealing	Reduce duct leakage to 10% of nominal or actual air flow of the hearing or cooling system.
15. HVAC duct replacement/retrofit	Designed and sized per ACCA Manual D; ducts located in unconditioned spaces shall be buried in insulation or insulated to minimum R-8; duct leakage shall not to exceed 6% of nominal or actual air flow; meet or exceed Title 24 requirements.
16. Hardwired lighting	Exceed Title 24 requirements or ENERGY STAR® standards when applicable.
17. Domestic hot water	Exceed Title 24 requirements or ENERGY STAR® standards when applicable.
18. On-Demand (Tankless) water heater	Install per manufacturer's specifications.
19. Cool roofs	Aged Thermal Emittance ≥ 0.75; Low slope: Aged Solar Reflectance ≥ 0.55; Steep slope: Aged Solar Reflectance ≥ 0.35.

20. Radiant Barrier	Emissivity ≤ 0.1; reflectivity ≥ 0.9; install per manufacturer's specifications.
21. Energy-efficient refrigerator	ENERGY STAR® labeled. Install per manufacturer's specifications.

3.1 All Home Upgrade Measures and Tasks (2.1-2.18)

- All of these measures can be modeled for savings in software approved for Advanced Home Upgrade, except for 2.5-2.9 (which are job-site tasks than can be part of Advanced Home Upgrade work, but are not measures that can be 'modeled' in approved Program software). Perform/install per manufacturer's specifications and see Table 3 (above) for Program Standards within the context of the Advanced Home Upgrade pathway. See sections 2.1-2.18 of this document for details.

3.2 Window Film

3.2.1 Minimum Requirements

- Install per manufacturer's specifications.

3.2.2 Verification

- FQC verification will include visual inspection and/or review of invoice.

3.3 Radiant Heating System

3.3.1 Minimum Requirements

- Install per manufacturer's specifications.

3.3.2 Verification

- FQC verification will include visual inspection of equipment and/or review of invoice.
- CAS testing will be performed on system-connected gas appliances.

3.4 Hydronic Heating System

3.4.1 Minimum Requirements

- Install per manufacturer's specifications.

3.4.2 Verification

- FQC verification will include visual inspection of equipment and/or review of invoice.
- CAS testing will be performed on system-connected gas appliances.

3.5 Refrigerant Charge Verification

3.5.1 Minimum Requirements

- Restore to stamped charge. This upgrade can only be used in conjunction with a HVAC change-out. The refrigerant charge must be verified using procedures defined in Appendix RA3 of California Energy Commission publication CEC-400-2012-005-CMF-REV3, the Reference Appendices for the 2013 California Building Energy Efficiency Standards. A valid CF-3R form must be submitted by a certified HERS Rater.

3.5.2 Verification

- A valid CF-3R form must be submitted by a certified HERS Rater and uploaded with application documents for review by QA verifier.

3.6 System Airflow Verification

3.6.1 Minimum Requirements

- Verify that the system air flow is a minimum of 350 CFM per ton of heating or cooling capacity. This upgrade can only be used in conjunction with a HVAC change-out. Verification must be done using procedures defined in Appendix RA3 of California Energy Commission publication CEC-400-2012-005-CMF-REV3, the Reference Appendices for the 2013 California Building Energy Efficiency Standards. A valid CF-3R form must be submitted by a certified HERS Rater.

3.6.2 Verification

- A valid CF-3R form must be submitted by a certified HERS Rater and uploaded with application documents for review by QA verifier.

3.7 System Fan Wattage Verification

3.7.1 Minimum Requirements

- Verify that the system fan watt draw does not exceed .58 watts per CFM of system air flow. This upgrade can only be used in conjunction with a HVAC change-out. Verification must be done using procedures defined in Appendix RA3 of California Energy Commission publication CEC-400-2012-005-CMF-REV3, the Reference Appendices for

the 2013 California Building Energy Efficiency Standards. A valid CF-3R form must be submitted by a certified HERS Rater.

3.7.2 Verification

- A valid CF-3R form must be submitted by a certified HERS Rater and uploaded with application documents for review by QA verifier.